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Contents

- Vegetative Structure of the Perennating Organ of *Telfairia Occidentalis*** 6-20
M. O. Akoroda, I.M. Ojeifo, N.I. Odiaka, O.E. Ugwo and B. Fuwa
- Evaluation of Split Seeds of *Telfairia Occidentalis* (Hook. F.) for Propagation** 21-27
Ojeifo I. M and Ajekenrenbiaghan T. W
- Uninterrupted Sustainable Hydroelectric Power in Nigeria: Problems and Prospects of Kainji Hydroelectric Power Station** 28-37
Charles Temitope Jegede and Abimbola Olugbenga Fayomi
- Socio-Demographic Characteristics of Multidimensional Health Locus of Control** 38-47
Adegoke, Adekunle Anthony
- Lipid and Fatty Acid Profiles of Wild Stocks of Juvenile and Adult *Tilapia Zillii* (Gervais)** 48-55
Samuel A and A. Zelibe
- Modelling of Instantaneous Current Value (ICV) for Fault Detection in Power Systems** 56-62
C.O. Ahiaikwo
- Consumer Protection in a Deregulated Economy: The Nigerian Experience** 63-71
Timothy Ifedayo Akomolede and Patrick Olajide Oladele
- Selected Least-Cost Feedstuff for Fish Culture: Assessment of Lipid Quality** 72-81
Samuel A and A. Zelibe
- Exploratory Study of Factor Productivity in Nigerian Agriculture: A Case Study of the Agricultural Development Projects (A. D. P.) 1981-1996** 82-90
Chukwuji, C. O, Ike, P. C and Idoge, D. E
- Assessment of Aerobic Fitness of Lagos State University Female Administrators** 91-96
Grace Olapeju Otinwa, Adeyemi O. Phillips and C. A. Mbakwem
- Genotype by Diet Interaction on Body Weight of the Local Chicken and its Crosses with Barred Plymouth Rock** 97-101
F. U. C Mmereole and I. Udeh
- Effect of Processing Variables on the Quality of Traditional Dry-Yam Slices** 102-113
Babajide, J.M, Henshaw, F.O and Oyewole, O.B
- Synthesis of Well Ordered Spherical Ethane-Bridged Hybrid Silica Nanoporous Polymer** 114-119
Alireza Badiei, Ghodsi Mohammadi Ziarani and Mina Saeedi

Evaluation of Hepatitis A Virus Contamination in Environmental Water and Shellfish Samples of Casablanca Region (Morocco)	120-125
<i>Yahaya Karamoko, Chimène Nze Nkogue, Khadija Ibenyassine, Raja Ait Mhand, Mohamed Idaomar and Moulay Mustapha Ennaji</i>	
Determination of the Optimal Preventive Maintenance of the Reserve Source in the Industrial Electric Network	126-132
<i>M. Bouguerra, H.Meglouli and I.Habi</i>	
In Vivo Animal Model Toxicological Studies of Nigerian Medicinal Plants II: Eniantha Chlorantha and Khaya Ivorensis	133-138
<i>S.O. Nwozo, E.O. Ajaiyeoba, F.O. Oladeinde and I. Olanrewaju</i>	
The Spiritual Healing Dimensions of Islam: Sheu Kokoroadua as a Case Study	139-145
<i>M.O.adeniyi</i>	
Land and Vegetation Degradation Caused by Military Activities: A Case Study of the Sabah Al-Ahmad Nature Reserve of Kuwait	146-158
<i>Samira Omar, N. R. Bhat, S. A. Shahid and A. Assem</i>	

Vegetative Structure of the Perennating Organ of *Telfairia Occidentalis*

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Abstract

Telfairia occidentalis is a herbeceous facultative perennial, whose aerial shoot dies annually but is replaced after an interval of time by new shoots from surviving vines attached to the underground rootstock. The rootstock as an organ of perennation, could also serve in vegetative propagation. The swollen roots of the rootstock become more prominent with increase in age. Rootstocks average about 200g with seven primary roots among which there are tuberous, and may have a residual vine. Most roots are found in the top 20cm of soil, but not the finer roots that absorb soil solution. These are found below the furrow slice depth of 30cm. This study indicates that the nexus between the residual vine and the underground roots is the chief site from which the new shoots regenerate. Better insights into the hidden world of *Telfairia* rootstocks has been gained, especially on the interrelationships between the components of the vegetative structure of the rootstock as the perennating organ. This and other studies will enable us to use them in propagation, and control of sex ratio among plants in the field.

Keywords: *Telfairia* rootstock, tuberous root, regeneration of rootstock, perennating organ, nexus, *Telfairia* vines

Introduction

The fluted pumpkin (*Telfairia occidentalis* Hook, F.) is an important leaf and seed cucurbit in the Guinea Coast of West Africa, but its use is most intense in southeast Nigeria. Though mainly propagated from seed every year, a fair to good percentage of old plants regenerate from rootstocks left in the ground after total or partial shoot senescence at the end of the previous season. Asiegbu (1985) reported 74% survival of old plants after the dry season. From Ossom's (1986) data we estimated 41-63% survival of periodically pruned plants at the peak of the dry season in February. Besides their important role in seed production, female plants produce more leaves of better quality than male plants and their rootstocks also survive and ratoon better than male plants (van Epenhuijsen, 1974; Asiegbu, 1982; Ossom, 1986; Esiaba, 1982a; Asoegwu 1988). The need for more female plants in farms is therefore evident.

To date, researchers and farmers do not yet know how to distinguish between sexes before floral bud initiation. Predictions of sex of plants based on seed or seedling features do not often fit the sex expressed. Ibe and Ezedinma (1979) observed 53% fit to prediction in a test of the traditional claim of native farmers in being able to distinguish sex of seedlings on the assumption that those with larger stems are potential females. The method is unreliable.

Supply of seeds as and when needed is greatly reduced at planting time due to the following: (i) early harvest of immature fruits from which edible seeds are extracted: and (ii) post-harvest losses of mature fruits and seeds are common. As seeds are recalcitrant (Akoroda, 1986; Akoroda, 1990; Nwufu, Obiefuna and Emebiri, 1990), their storage at ambient conditions lasts only for a few days. *Telfairia* propagation using seed sections, split corm, and also by rooted shoot tips (Esiaba 1982b; 1982c; Obiefuna, 1995; Ajekenrenbiaghan, 2002) have not entered into practice among farmers. First, the care and handling of such tissue materials so as to achieve a high enough establishment still needs to be extended to farmers. Second, the performance of such propagules under actual field production conditions have not been assessed.

How then can we control the sex ratio of plants in the field, if we desire more female plants to meet the demand for more and better leaves and or produce more seeds? Attempts to thin out males so as to adjust the sex ratio (Anyim, 1977) is not practical, because, almost half the plants in the field would be expected to be males (Akoroda, Ogbechie-Odiaka, Adebayo, Ugwo and Fuwa, 1990). Besides, such an operation can only take place after the sexes of plants are expressed much later in the growth of the plant.

In the field, the lianoid habit of *Telfairia* complicates the separation of vines of males from those of females in the same plot to enable effective removal of male plants. Loosening the tangled vines is slow and painstaking and greatly disturbs plant growth. Even then, some male plants would still have to serve as sources of pollen for successful fruiting and seed formation. It is preferred that rootstocks of plants whose sexes have been noted in a previous season and tagged at flowering can be carefully dup up and transferred to another field plot; thus enabling better manipulation of sex ratio among plants in farms.

Better knowledge of the rootstocks which serve as the perennating organs of the crop will enable us to shift field production towards more perenniality rather than just annual schedules as is presently the common practice among growers. Furthermore, controlled placement of rootstocks can result in any desired ratio of male to female plants. In this way, leaf and fruit and seed yield could be better managed. This paper reports on the vegetative structure of the perennating organ of *Telfairia* based on studies of rootstocks of plants grown in the green house, garden and in field plots.

Materials and Methods

On 4 November 1999, seeds of *Telfairia* were sown in sawdust in plastic trays and seedlings transplanted 10 days later into two 70l drums: 42cm diameter, 50cm high, with about 40cm depth of topsoil equivalent to 56l in drum A and 55l in drum B. The drums were placed in the greenhouse; mulched and supplied with a slight dressing of poultry manure and NPK (15.15.15) fertilizer, and

regularly watered. Plants were staked and trained unto a raised bamboo platform. Each drum had three plants, although one plant in drum A and two plants in drum B survived. These three plants were all male and were senescing by 30 December 2001 when their roots were inspected. Before root inspection, all soil in the drums were slowly washed off with a jet of water. The total mass of the root system of the plants were photographed and studied. A 0-15cm soil sample (Greenhouse drums) was taken and analysed (Table I).

Table 1: Selected variables of root growth medium of the *Telfairia* plants used in this study.

	Greenhouse Drums		Field FAN		Field NIO		Field IWO (Topsoil, 0-15cm)	
	A	B	0-15(cm)	15-30(cm)	0-15(cm)	15-30(cm)	normal	garden
pH (Water)	6.4	6.7	7.0	7.0	7.0	7.0	7.2	7.4
pH (CaC ₂)	5.8	5.9	-	-	-	-	-	-
Total Nitrogen (%)	-	-	0.06	0.04	0.04	0.03	0.07	0.20
Na (exch. meq/100g)	0.09	0.07	0.15	0.34	0.10	0.15	0.26	1.09
K “ “ “	0.05	0.02	0.18	0.17	0.17	0.09	0.25	1.92
Ca “ “ “	0.90	0.66	2.65	2.35	1.85	1.85	2.35	2.45
Mg “ “ “	0.84	0.56	0.83	0.87	0.58	0.61	1.32	3.01
Ex. acidity “ “	-	-	0.2	0.4	0.2	0.2	1.0	1.4
CEC “ “	-	-	4.01	4.13	2.90	2.90	2.63	3.19
Base saturation (%)	-	-	95.0	90.3	93.1	93.1	96.2	95.6
Organic carbon (%)	2.25	1.82	0.63	0.40	0.47	0.36	0.95	95.6
Available P (ppm)	-	-	69.1	7.1	77.2	40.5	25.7	2.00
Sand (%)	-	-	81.2	79.2	83.2	81.2	72.4	43.4
Silt (%)	-	-	12.0	12.0	10.0	12.0	14.0	60.4
Clay (%)	-	-	6.8	8.8	6.8	6.8	1.36	160
Soil class	loamy sand	sandy loam	loamy sand	loamy sand	loamy sand	loamy sand	sandy loam	sandy loam

On 3 April 2002, a sample of 14 plants established in March 2001 were dug up. Recovered portions of their roots systems were then examined. The 0-15 cm and 15 – 30cm soil layer sampled (Field FAN) were analysed (Table I).

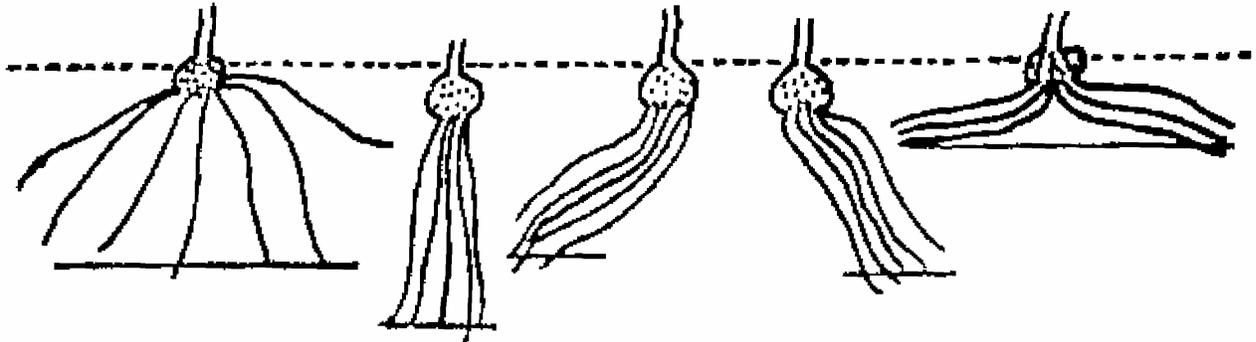
During 2005 (13, 14, 21 August and 10 October), a much larger sample of 373 rootstocks were dug up from two field plots. Representative soil cores (0-15 and 15 – 30cm) labelled Field N10 and Field IWO were taken and analysed for selected chemical and physical variables (Table I). In the larger of the two plots, a disc plough tilled the soil, exposing the rootstocks with varying portions of their primary roots and associated secondary roots. The soil depth cut by the disc blades was around 20cm but reached 30cm in furrows between the old beds. Exposed rootstocks with attached vines and root portions were then collected for study.

Observations were made on the presence of live residual vine, ratoons, and root galls due to attack by nematodes and pathogens, the number of all primary roots and of tuberous roots. The length of the longest root recovered on each rootstock was measured.

Fresh weight of rootstocks: These were determined after vines were cut to less than 30cm for rootstocks whose live residual vines appeared to have a storage role. However, selected cut portions of storage stems, nexus, medium roots and thin roots were weighed and oven-dried at 80°C and re-weighed. The length of detached pieces of primary and secondary roots were then individually measured.

Principal axis of root orientation: Rootstocks were held in space as they would most probably have been positioned in the soil. This was based on the inclination of the residual vine, nexus, and the soil mark together with visual experience of the spatial distribution of roots observed during manual digging up of roots. The general axis of orientation of the primary roots were classed as shown in figure 1.

Figure 1: Classes of the axes of orientation of the general root mass of rootstocks of *Telfairia occidentalis* plants grown in field plots.

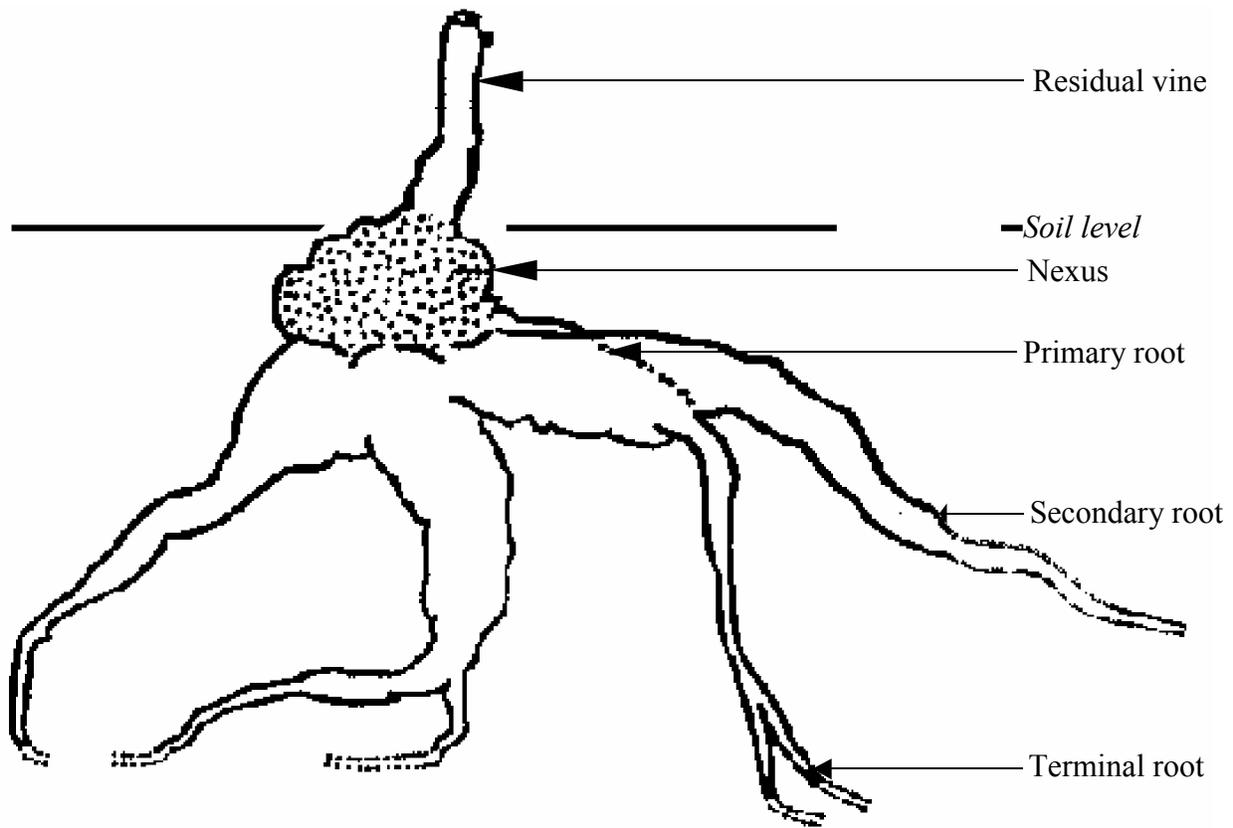


Root depth: was measured from aerially displayed rootstocks from the nexus (n) to the bottom of the root zone recovered as shown in Figure 1.

Dispersion of root mass in soil: During digging and recovery of roots, their lengths and spatial arrangements were distributed. Data on the root axis length of secondary roots, longest roots, and root depth have been combined in examining the probable distribution of the root system in the soil.

Deriving an index of rootstock tuberstock tuberosity (Ti): In fresh rootstocks, primary roots, nexus and storage residual vines adjoining the nexus were subjectively scored on a relative scale of 1, 2, or 3 with increasing thickness (girth). These scores were then unified into index Ti. Of the three parts of the rootstock (Figure 2), the residual vine may be long or short, senesced or senescing or even absent. The vine seems inessential for rootstock integrity as a perennating organ. The root being subterranean, appears to be better endowed for storage of sustenance reserves. The nexus may also store food but is the most essential site from which new shoots emerge. Although the residual vine stores food and could also produce new shoots, its exposure to the harsh environment above ground indicates that a dependence on it for plant regeneration may be risky. Of 373 live rootstocks examined in detail, 52.56% had no residual vines. Thus, the root plus the nexus are necessary and sufficient to assure perennation, although the residual vine plays a supplementary role.

Figure 2: The three principal parts of the rootstocks (residual vine, nexus and root) of *Telfairia* plant.



Based on this assessment of the survival value of the different parts of the rootstock; we estimated $T_i = (r + v/2) / 105$; where r , n , and v are the tuberosity score for root, nexus and vine. The maximum T_i value equals unity. T_i is a subjective measure of the potential survival value of the rootstock as regards plant regeneration. The more tuberosus the rootstock, the greater its reserve of food resources for regrowth at the onset of favourable micro-environment. Whilst T_i measures the relative distribution of thickness among the parts of the rootstock, the fresh weight of the rootstock; determines the size or effective mass of the perennating organ per se.

Results

The nexus produces new shoots (Figure 3a). Tuberosus root are prominent with a diameter that approach 9cm (Table 2; Figure 3), although one farmer claims that it could be 50% more if grown on moist deep fertile soils. The variation in root diameter (Table 2 and 3; Figure 3) shows that tuberosus roots exceed 1cm diameter. Individual tuberosus root length vary widely around 10-15cm and rarely extend more than 30cm per swollen root. Roots from plants in drums provides us with the details of how the roots ramify (Figure 3b, c, d) in terms of the relation between the different sizes of roots. The extensive root extremities and fine rootlets formed a dense mat at the bottom of the drum, being less than 1mm thick. In hard, less penetrable soils, fewer roots become tuberosus; just as is the case for short-lived crops that where regularly pruned for edible shoots during growth (Figure 3e). The variation of the tuberosity of the different parts of the rootstock is shown in Figures 3f, g, h.

Figure 3: Rootstocks of *Telfairia occidentalis*. A) new shoot formed after 12 month growth; B) from plants grown in drum in the greenhouse for 26 months with prominent tuberous roots and many secondary and terminal fine roots; C) similar to B, but has tuberous residual vine and nexus which has sprouted a new shoot; D) similar to C, but its secondary roots have rotted; E) from 12 months old plants grown in a garden, with single tuberous roots; F) from plants grown in the field for 14 months, with more primary roots though non-tuberous; G) similar to F, but has tuberous nexus and roots; H) similar to G, but has tuberous residual vines, nexus and primary roots.

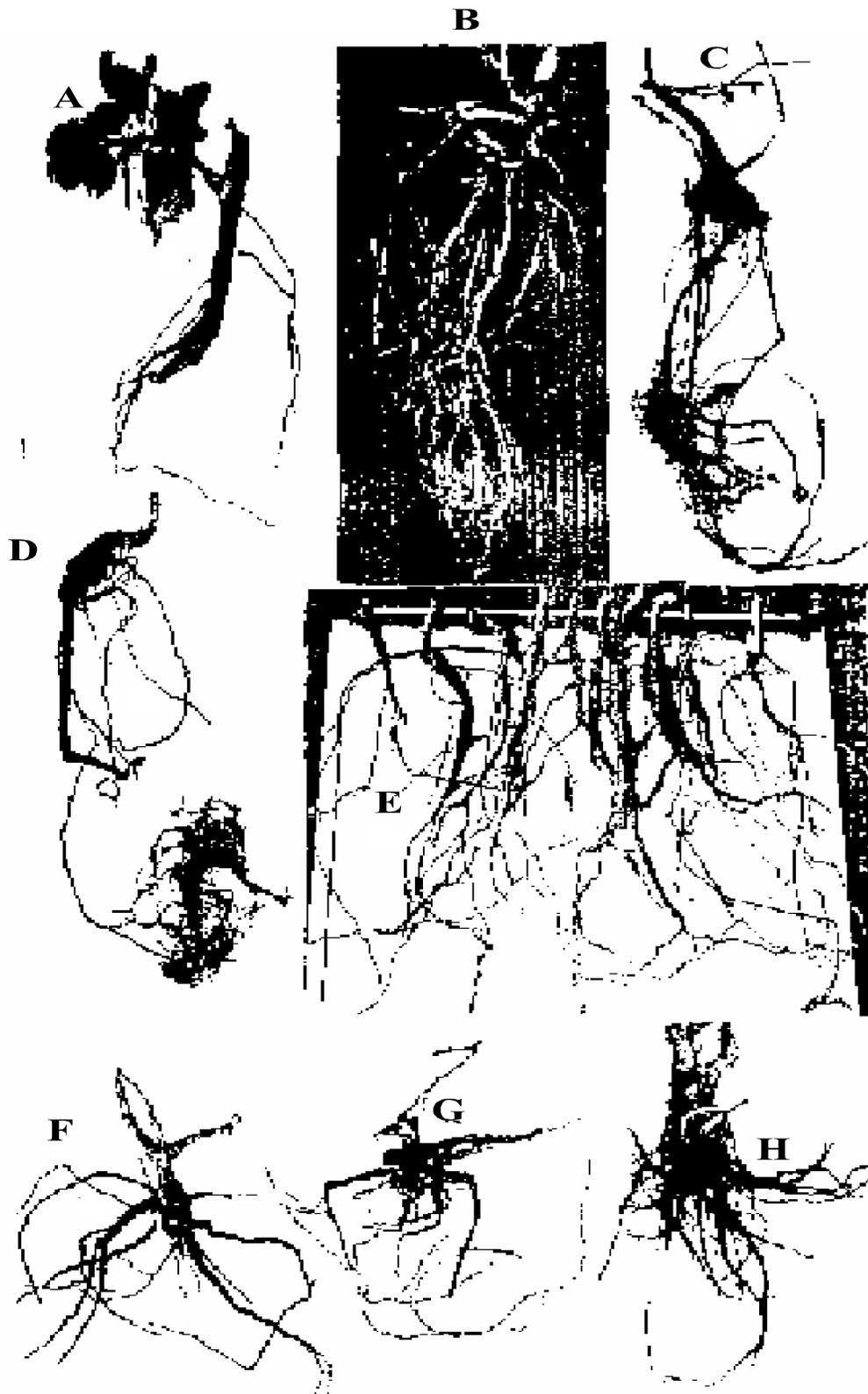


Table 2: Features of 14 rootstock of *Telfairia occidentalis* plants grown on in a garden and dug up after 12 months during 2001– 2002.

Isu Ugo Plant Code	Primary root length (cm)	Secondary Root		Tuberous roots	
		No	Length(cm)	Length (cm)	diameter(cm)
1	45	3	78	18	8.5
2	42	2	34	16	4.5
3	30	2	98	9	3.0
4	33	4	104	4	6.0
5	116	3	134	27	5.5
6	26	4	119	10	3.5
7	41	4	49	20	5.0
8	16	4	65	1	4.0
9	26	8	257	14	3.5
10	17	3	50	12	3.0
11	24	4	151	9	3.0
12	59	2	33	7	3.0
13	32	4	84	9	3.0
14	29	5	136	2	5.5
Average	38.3	37	99.4	11.3	4.32

Table 3: Characteristics of three rootstocks of *Telfairia* plants grown in drums in the green house for 26 months (1999 – 2001).

Rootstock Weight (g)	Non-Tuberous roots			Tuberous roots		
	No.	Length (cm)	Diameter (cm)	No.	Length (cm)	Diameter (cm)
400	7	27.4	1.1	7	11.0	1.9
400	4	57.6	0.8	4	6.1	2.1
525	4	63.3	1.1	4	9.3	2.1

Figure 4 shows that fresh weight rootstock generally declines with increase in the depth of the root zone. With a depth of tractor-disc cut of 30cm, the longest roots exceeding this length would either be slanted (oblique) or horizontal. At this depth, the spread for the mean longest root is 62.76cm in the horizontal axis or 55.13cm in the oblique axis after Table 4 and Figure 5. Adding the mean length of the cut pieces of roots (49.20cm) brings the radial spread of roots to 111.96cm (horizontal) and 107.87cm (oblique) corresponding to diameters of spread of 223.92cm and 215.73cm. It is noteworthy that this distance approximates the length of the longest intact root attached to the nexus (233cm).

Figure 4: Frequency distribution 373 rootstocks of *Telfairia occidentalis* plants by fresh weight and depth of main roots mass in soil

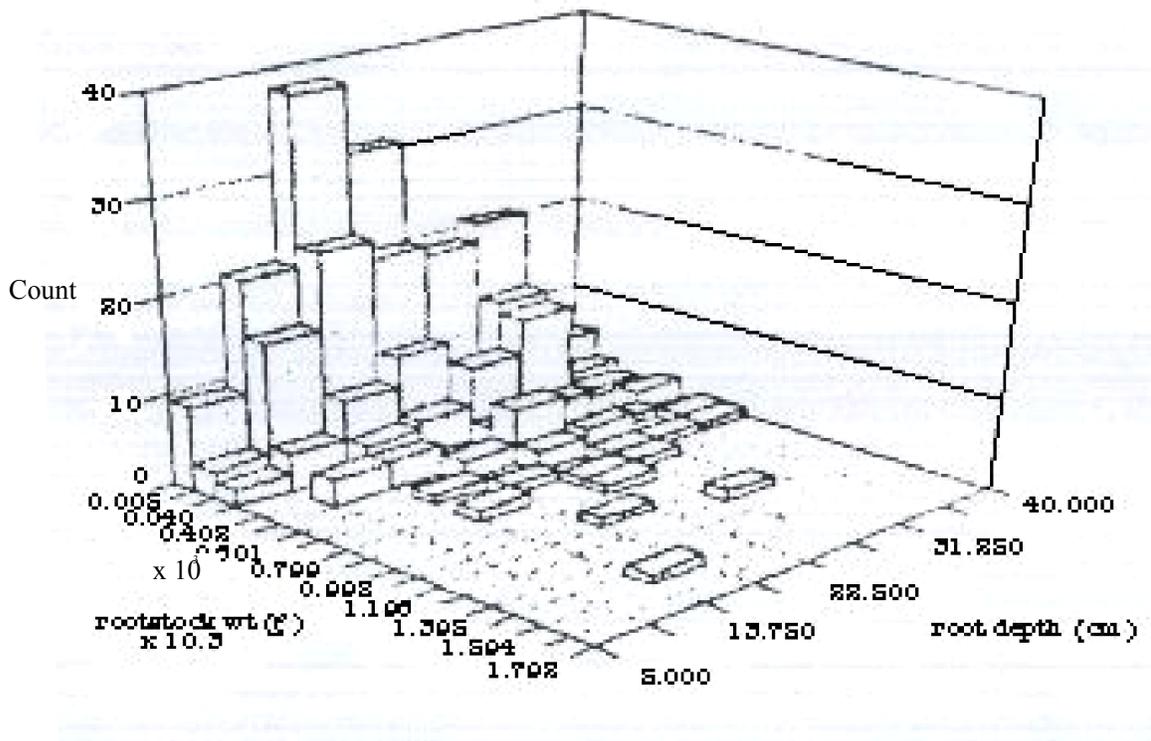


Figure 5: An approximate placement of the roots of *Telfairia occidentalis* in soil based on measurements from 373 rootstocks.

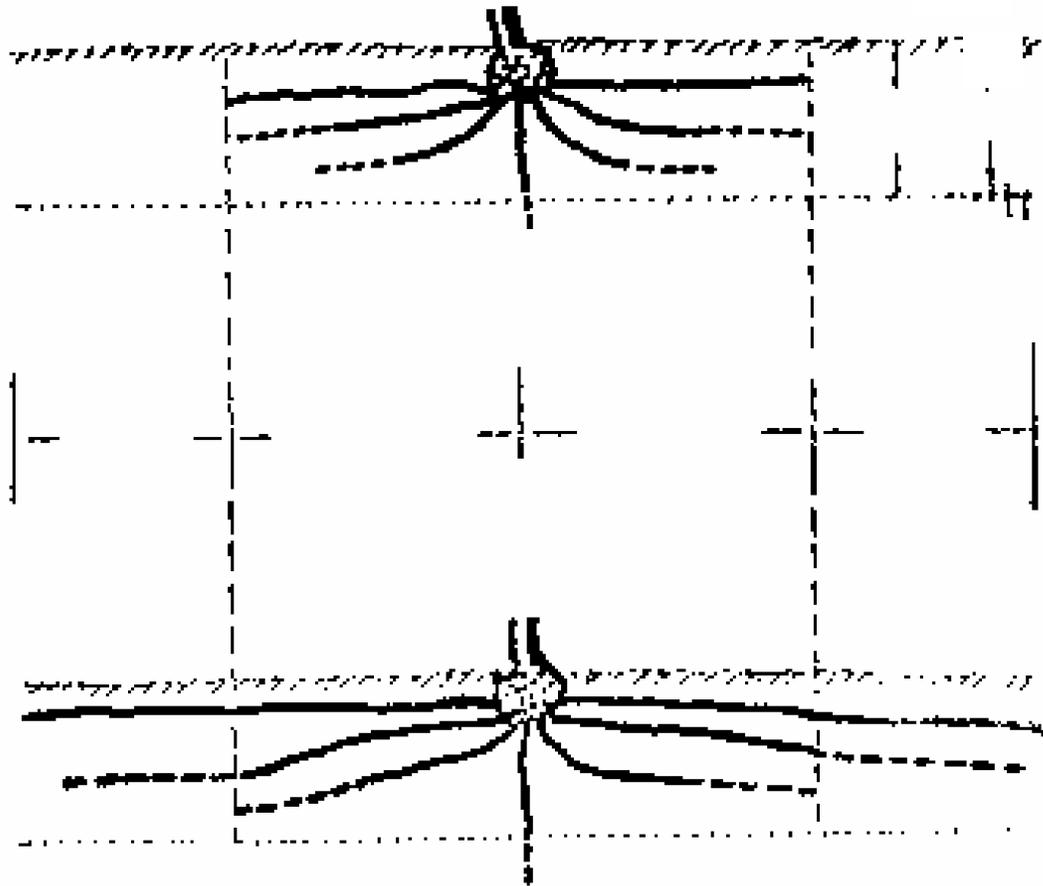


Table 4: Characteristics of rootstocks of *Telfairia occidentalis* plants grown on field plots during 2004 – 2005.

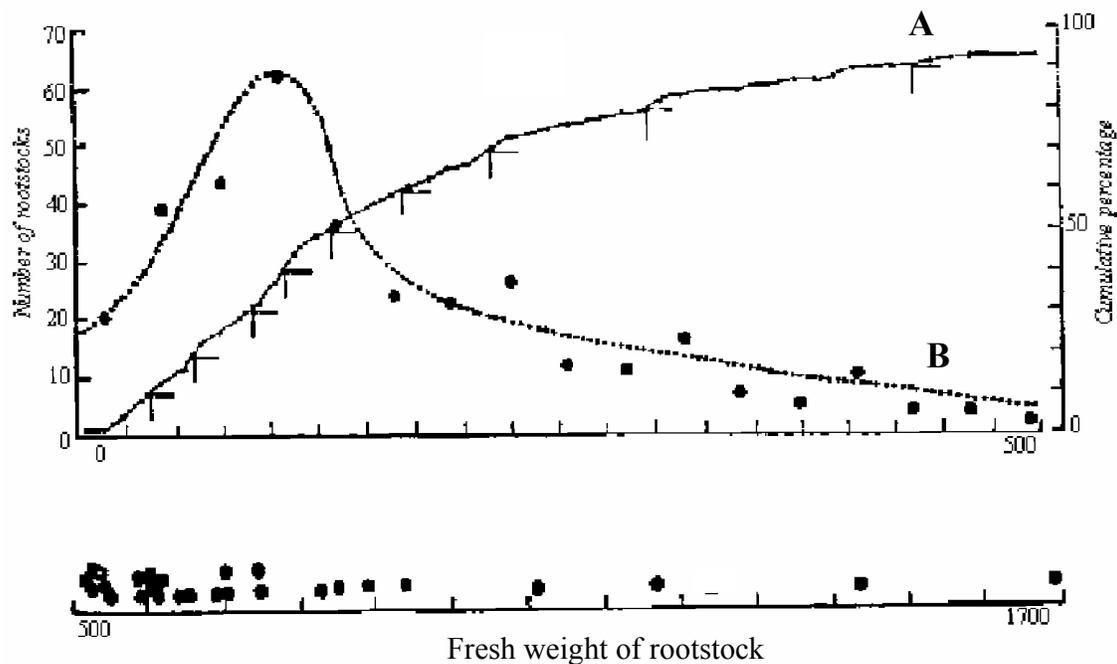
Quantitative Characters	No of Cases	Mini-mum	Maxi-mum	Medium	Mean	sd	CV(%)
Fresh rootstock weight (g)	373	5	1792	133	203	211	104
Primary roots (no)	373	1	21	7	7.34	3.23	44
Big tuberous roots (no)	373	0	8	3	3.20	1.60	50
Longest root length (cm)	373	12	233	55	62.76	33.35	53
Depth of main roots (cm)	373	5	40	21	21.23	7.17	34
Length of cut roots (cm)	401	9	160	42	49.20	29.80	61
Index of tuberosity	369	0	1.000	0.429	0.497	0.230	46

sd = standard deviation

cv = coefficient of variation

Figure 6a shows that in one season of growth, 75% of rootstocks weigh less than 250g. About 50% are normally distributed within 5 to 200g. Of the 27 rootstocks (7.5%) weighing over 500g (Figure 6b), only four exceeded 1kg. Based on field and crop history, these rootstocks belonged to plants with more than two growth cycles. Overall, plants with longer growth periods, in more fertile soils, with better moisture supply and less biotic competition had greater plant biomass and correspondingly heavier rootstocks.

Figure 6: Frequency distribution of fresh weight of rootstocks below 500g (A) and a linear distribution of those above 500g (B). In A, the dots are the midpoints of intervals; while in B, dots represent individual cases.



The presence of root galls was significantly more frequent on rootstocks without residual vines and ratooned shoots, but such associations were statistically weak (Table 5). Cross-tabulations of all paired combinations of the presence of ratoons, root galls, root axis, presence of a live residual vine, did not show large correlations or strong dependence. Thus these characters appear to be expressed independently.

Table 5: Association of selected pairs of categoric features of rootstocks of *Telfairia occidentalis* plants from field plots grown during 2004 – 2005

Character Pair	No. of Cases	Chi-Square	Degree of Freedom	Measure of Dependence
Presence of root galls vs Absence of live residual vine	313	10.28**	1	0.033
Presence of root galls vs Absence of ratooned shoot	315	4.09*	1	0.013
Presence of live residual vine vs Presence of ratooned	371	1.92ns	1	0.005
Axis of main roots vs Presence of ratooned shoots	372	0.52ns	3	0.001
Axis of main roots vs Presence of root gall	314	0.54ns	3	0.002
Presence of live residual vine vs Axis of main root	370	2.05ns	3	0.006

vs = versus

ns = not significant (P = 5%)

*, ** represent significance at 5% and 1% levels respectively.

Table 6 shows that all correlations among the quantitative characters were significant. The variation in the number of primary roots explained 30.25% of the variation in the number of tuberous roots. Thus, every primary root need not be tuberous, despite being correlated. The fresh weight of the

rootstock was partly determined by the number of the tuberous roots (20.25%) and its tuberosity (26.01%). The depth of main roots did not sufficiently explain the variations in the longest roots (14.44%).

Table 6: Simple linear correlation coefficients (lower values) and coefficient of determination, as % (upper values) among 373 rootstocks of *Telfairia occidentalis* plants grown in field plots during 2004 – 2005.

	Fresh rootstock weight	Primary roots	Tuberous roots	Longest root length	Depth of main roots	Index of Tuberosity
Fresh rootstock wt	1.00	7.84	20.25	10.89	4.00	26.01
Primary roots	0.28**	1.00	30.25	1.44	3.24	1.44
Tuberous roots	0.45**	0.55**	1.00	6.76	3.61	8.41
Longest root length	0.33**	0.12*	0.26**	1.00	14.44	2.25
Depth of main roots	0.20**	0.18**	0.19**	0.38**	1.00	1.21
Index of Tuberosity+	0.51**	0.12*	0.29**	0.15**	0.11*	1.00

+ n = 369 for correlations with this character

*, ** represent significance at 5% and 1% levels respectively.

Table 7 indicates that: (i) rootstocks oriented in the vertical and oblique axes were fewer, had less tuberous roots and lighter than those in the radial and horizontal axes; (ii) rootstocks were heavier if they had live residual vines (+15.4%), with ratoons (+22.0%) and lacked root gall (+29.5%), (iii) rootstocks were more tuberous if they had residual vines (+15.1%), and no root gall (+9.8%); (iv) the longest roots were shorter in the vertical axes; and longer both in the horizontal axis and in those rootstocks with live residual vines (+22.2%), without ratoons (+16.7%); or without root gall (+7.5%); (v) despite the high variation in the depth of main roots (Table 4), the mean depth by categories was rather invariant around 21 cm depth.

Table 7: Average of quantitative variables and their percentage partitioning under categoric characteristics of 373 rootstocks of *Telfairia occidentalis* plants grown in the field during 2004 – 2005.

Character and Category	Fresh rootstock weight (g)	Primary roots (cm)	Tuberous roots(cm)	Longest root length (cm)	Main root depth (cm)	Index of tuberosity (max = 1)
Root axis						
Horizontal	215.35	7.39	3.38	67.68	21.76	0.515
(%)	27.67	26.09	27.80	27.62	24.22	26.28
Radial	225.53	8.10	3.51	61.50	21.16	0.493
(%)	28.97	28.61	28.88	25.08	24.69	25.11
Oblique	169.76	6.60	2.72	63.81	21.92	0.505
(%)	21.82	23.31	22.37	26.04	25.58	25.71
Vertical	167.78	6.23	2.54	52.09	21.88	0.450
(%)	21.55	21.99	20.94	21.26	25.52	22.90
Residual Vine						
Alive	219.333	7.733	3.43	68.97	21.84	0.510
(%)	53.57	52.58	53.49	55.01	51.46	51.40
Dead	190.093	6.974	2.98	56.42	20.59	0.482
(%)	46.43	47.42	46.51	44.99	48.54	48.60
Ratooned Shoot						
Present	243.43	7.16	3.164	55.05	19.61	0.513
(%)	54.03	49.25	49.45	46.58	47.64	50.93
Absent	199.47	7.73	3.208	64.26	21.55	0.494
(%)	45.97	50.71	50.35	53.42	52.36	49.07
Root gall						
Present	165.053	7.40	3.096	59.689	20.28	0.507
(%)	43.58	49.28	47.67	48.19	49.26	50.58
Absent	213.697	7.19	3.398	64.174	20.88	0.495
(%)	56.42	50.72	52.33	51.81	50.74	49.42

Discussion

The difficulties of studying root systems are well known; but the essential role of the roots in the anchorage of plants; as sites of synthesis of growth compounds, and as absorber and transporter of aqueous mineral solutions emphasize the need to study them. Roots also store food reserves and aid plant survival and regeneration.

Telfairia is either a geophyte or a hemicryptophyte according to Raukiaer's (1937) classification of life forms. In many rootstocks that lack residual vines, their perennating buds are on the vine base point or nexus at the soil level or usually just below the soil surface only slightly protected by about 3 cm of soil. During unfavourable dry season, the resting buds are sustained by the bulk of the food materials located principally in the tuberous roots and also in the lower vine portions, and the nexus. Hemicryptophytes seem adapted to areas with weak evapotranspiration; otherwise their buds will be prone to desiccation.

That no rootlets were collected from soil in the top 30cm, suggests a deeper zone of soil moisture absorption in sandy soils by *Telfairia* roots. All complementary pieces of roots had secondary phloem and xylem. Thus they conduct rather than absorb soil solution. The pattern of rooting from the root system from the drum is typical, in that tuberous primary roots graduate into roots of smaller diameters which terminate with numerous fine roots bearing root hairs that absorb soil solution; especially so when a water-laden soil zone or pocket is encountered.

Weaver and Bruner (1927) reported on the root distribution of four cucurbit species. In a fine sandy loam surface soil at Norman, Oklahoma, USA with excellent tilth becoming compact sandy clay at 45-60cm. *Cucumis melo* var *reticulatus* Ser had a maximum rooting depth of 135cm, a working root depth of 60cm which was the average depth reached by many roots or root branches and to which depth a considerable absorption must take place; with a lateral spread of 450cm from the base of the plant. In a deep, dark brown fertile Carrington silt loam at Lincoln, Nebraska, USA the corresponding values were: *Cucumis sativa* L. – 120cm, 110cm, 210cm; *Cucurbita maxima* Duch. – 210cm, 60cm, 500cm and *Cucurbita pepo* L. – 180cm, 120cm, and 500cm. Decline of freshweight of rootstock with depth for many whole rootstocks rather than within individual rootstocks suggest that the chief contributors to the rootstock weight are to be found in the shallower parts of the root zone.

In this study, the beneficial influence of the dispersion of roots in the horizontal axis within the topsoil zone (20cm) is apparent but not fully understood. Superiority of rootstocks with live residual vines without root gall seems to be related to the state of health and growth in the above- and below-ground milieu of the crop. Less pest and disease incidences and a moderate pruning of edible shoots coupled with good soil nutrient and water supply as well as a non-critical population of soil microbes and nematodes would favour a higher overall crop growth resulting in more vigorous rootstocks. From the foregoing, it seems that the lateral spread of roots among cucurbits is much greater than the vertical depth.

Though the estimates of the diameter of root spread yet exclude that of root extremities, we note that roots are not straight lines. So the distance of coverage of soil would in reality be less than their total length. The estimate of around 200cm therefore corroborates the recommended spacing of 2 x 2m (Anyim, 1977, NIHORT, 1986). It seems right that a minimum interplant distance or spacing of 2m is needed to maximize root to root competition among plants of *Telfairia*. However, the compromise density in the field will depend on the genetic ability of the specific variety to compensate yield from less space by more plant number as well as on the status of soil nutrient elements and overall moisture supply. We observed as some farmers also claimed that *Telfairia* is greatly affected by the abrupt cessation of the rainy season; such that regular watering is immediately needed for it to survive and grow. This implies that its root system and its water exploitation zone is shallow.

The vegetative structure of the perennating organ of *Telfairia* seems to comprise three distinct but interrelated components. First, a good reservoir of food materials for sustenance during the rest period and which also provides the requirements for new shoot formation. This part is principally represented

by tuberous roots, swollen residual vines, and the nexus. Fawole *et al* (1979a, 1979b) found that the swollen roots of *Chromolaena odorata* (syn. *Eupatorium odoratum*) were important for its regeneration. Alone, the root could not produce shoots, except from stem portions attached to it. Thus, the storage of food seems to be the major role of the tuberous roots. The second part is the “pipeline system” that connects the rootstock to the sources of water below the ground surface. The non-tuberous parts of the primary and secondary roots are important in this regard. The third part of the system which is most elusive, comprises the finer part of the root extremities which commonly absorb water and nutrient elements. The extensiveness of this part assists the rootstock in transforming stored food into translocates needed for new shoot growth when the weather becomes favourable. Our experience is that this part is very small in terms of overall dry weight; although its ramification is intense within the soil mass especially where there is adequate water. As Daubenmire (1959) stated, absorption of a small percentage of growth water in a large mass of soil yields equal lives as much as a large percentage in a small mass of soil. Thus regeneration of rootstock will depend also on the relative efficiency of absorption of soil solution by these parts within the root zone.

The health of these roots is important in as much as 23.33% of rootstocks had galls. Dead or diseased pipeline or absorbers or food reservoirs would complicate and endanger overall survival. The patho-physiological status of roots greatly affect their functions which in turn determine the eventual performance of the whole plant (Cook, 1984). An economic life of two years has been suggested for *Telfairia* although plants in compound gardens continue for four or more years provided pests and diseases do not damage the root system (NIHORT, 1986). Whereas Atu and Ogbuji (1984) reported that the roots of *T. occidentalis* are resistant to nematode gall attack, but what we noticed for over 60 rootstock specimens in this study was more in line with the observations of *T. pedata* inducing the formation of a single swelling or gall (7cm long, 5cm diameter) on the main root just below the soil surface. At first, the surface of the gall is smooth but becomes spongy and is invaded by fungi and free-living soil nematodes.

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Evaluation of Split Seeds of *Telfairia Occidentalis* (Hook. F.) for Propagation

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Abstract

An experiment was conducted to determine the possible limits of sectioning the seeds of *Telfairia occidentalis* for the regeneration of propagules. Whole and sectioned seeds were nursed in sawdust-filled medium and the seedlings were later transplanted to prepared ridges at 4 weeks after sowing. There were significant differences in the seedling emergence, vine length, number of leaves and marketable yield between the seed sections, while plant stand, which ranged from 81 – 97%, compared favourably irrespective of the size of seed section. A potential marketable yield estimated from the marketable yield, using the value of whole seeds as an index showed that seedlings regenerated from halved, quartered and one-eighth seeds had the potential of out-yielding whole seeds by values of 86%, 172% and 432% respectively. This study has indicated significant reduction in seed requirement of *Telfairia occidentalis* for planting a unit area from 100% for whole seed, to 50% for halved seed, to 25% for quartered seeds and to 12½% for 1/8 seeds. Further investigation for improving propagule regeneration, growth and development of split seeds was discussed.

Keywords: *Telfaria occidentalis*, fluted pumpkin, split seeds, seed section, propagation.

Introduction

Telfairia occidentalis (Hook F.), popularly called fluted pumpkin or telfairia is a member of the family *Curcubitaceae*. It is a perennial vegetable commonly called “Ugu” by the Ibos of the South Eastern Nigeria. where the crop is most popularly grown. It originated from West Africa (Tindall, 1983). Although classified as one of the lesser-known or endangered crops (Oyolu, 1978; Denton and Ojeifo, 1992; FAO, 1992), telfairia is generally used in Southern Nigeria as a leaf and seed vegetable. The leaf is cherished for the young tender shoots and leaves. These are cut at intervals or when needed and eaten as potherbs. The seeds are boiled and eaten as nuts or ground for use in soups. The seed has a high nutritional and industrial value, being rich in protein and fat (Tindall, 1968). Sun-dried seeds were found to have about 45-52% oil in the kernel (Girgis and Turner, 1972). According to Johnson and

Johnson (1976), 100g of kernel contains 6.2g moisture, 20.5g protein, 45.0g fat, 21.3g carbohydrate, 2.2g fibre and 4.8g ash.

The crop is a vigorous vine, and creeps up to 10m in length. Attached to the vines are tendrils that branch with coiled tips which are used to grip any stake they come in contact with. The leaves are 3-5 palmately arranged leaflets, with petioles length of 2-3cm (Tindall, 1983). *Telfairia* is dioecious. However, Akoroda, Ogbechie-Odiaka, Adejoro, Ugwo and Fuwa (1990) reported that the *tefairia* plant grown in isolation was able to produce a fruit which contained only four seeds. They opined that the plant could be monoecious and that the crop could be provoked or induced by some environmental factors to exhibit such behavior. An alternative reasoning is that the plant was exhibiting parthenocarpy by producing fruits in isolation. This later argument holds sway when there is no evidence of male inflorescence on the plant.

The male inflorescence of *tefairia* project conspicuously from the stem on the peduncles which is about 5-25 cm in length, while the female flowers are produced in the axils of the leaves. The male plants produce relatively smaller leaves than the female plants (Akoroda, 1990). The fruits are usually very large, up to 105cm in length and 25cm in diameter. And weigh about 3-6kg (Tindall, 1983; Okoli and Mgbeogu, 1983). The epicarp is characterized by pale green or powdery deposits, outwardly marked by 10 longitudinal ridges and strongly ribbed flutes. The flesh is light yellow and fibrous. About 2-5 fruits are produced per plant, although this fluctuates as many female flowers do not reach full maturity (Tindall, 1983). Embedded in the fibrous mesocarp are a large number of seeds. About 30-196 seeds were reported per fruit (Pospisil, 1965, 1967; Longe, Farinu and Fetuga, 1983; Okoli and Mgbeogu, 1983; Akoroda, 1990). The seeds are flat, up to 5cm in length, about 3.5cm in diameter and attached by a slight projection to the placenta. The crop is partially drought and shade tolerant. It is grown in elevations of up to 1000m and is adapted to a wide range of soils, with planting space of 75-90 cm each way (Tindall, 1983).

The production of *tefairia* has been impeded by some constraints. These include the poor storability of the recalcitrant seed (Robert and King, 1980; Akoroda, 1990). Also, the dioecious character of the crop, which has the probability of male: female sex variation ratio on the average of 1:1 (Akoroda, 1990), reduces the chance of seed production per unit area to 50%. In other words, since the male does not produce fruits, the number of crops that can produce fruits from a given population is halved. Prices range from ₦250 – ₦ 500 (US\$2-4) per fruit during planting season due to demand pressure. As such, a farmer with about one hectare of farmland may require as much as ₦ 58,000 – ₦ 72,500 (US\$464-584) to buy seeds only. There is also the issue of demand pressure from the farmers, consumers and industrialists for the few available fruits, which arises as a result of the high nutritional value and industrial potential of the crop as reported by Tindall (1968). These constraints limit the amount of available seeds, during the growing season.

Telfairia is propagated principally by seed Okoli and Mgbeogu, (1983). In some cases, studies have been carried out to investigate the propagation of the crop by the use of stem cuttings or split root (Esiaba, 1982a; Obiefuna, 1995) with little success. (Esiaba 1982b) reported that seed sections could be used as propagules for the propagation of *tefairia*. However, since the advancement in the efficient utilization of *tefairia* seed by quartering, no efforts have been made to unravel the attendant benefits of this work or to explore the possibilities of advancing the level of seed sectioning. This study is expected to forestall this neglect. The objective of this study was therefore to determine the possible limits of sectioning the seeds of *tefairia* for the regeneration of propagules for propagation and to assess the growth and development of seedlings produced by such sectioning

Materials and Methods

This study was conducted between May and December, 2004, in the Teaching and Research Farm of Delta State University, Asaba, Nigeria (06°14'N and 06°49'E). This location is characterized by rainy season between April and October, with an annual rainfall range of 1500 to 2000mm.

Three fruits of *Telfairia occidentalis*, each containing about 70-100 seeds were used. The fruits were split open using a knife, and the seeds were extracted, and cured by spreading them out under shade for a day to reduce exogenous moisture and the effect of pathogens. Cured seeds were pre-germinated in sawdust medium for 5 days to encourage the split of cotyledon. This was intended to enable easy seed sectioning. Pre-germinated seeds were packed into four seed lots corresponding to four treatments as follows: - One set was left whole which was the experimental control, the second was split into two cotyledons, the third set was quartered by cutting each cotyledon into two, while the fourth set was sectioned into eight equal parts by cutting each cotyledon into four equal parts with surgical blade. While cutting, care was taken to ensure that each section had relatively equal portion of the embryonic region. Thereafter, each treatment containing 64 propagules or explants, were treated with 10g of Apron star (a commercial fungicide cum insecticide for seed treatment) diluted in 10 litres of water. The active ingredients of Apron star is 20% w/w thiamethoxan, 20% w/w metalaxyl-M and 2% w/w difenoconazole. Treated seeds were cured under shade for about two hours.

Subsequently, the whole seeds and miniset seeds were sown in sawdust-filled seed trays in the nursery. Watering was carried out at 2 days interval. The seedlings were later transplanted to prepared ridges at a spacing of 0.3m within ridge and 1m between ridges from 30 days after sowing in a randomized complete block design with four replications. Poultry droppings of 100g were worked into the soil for each plant stand at two weeks after transplanting, amounting to about 3t/ha. Creeping stands were staked using erect bamboo at 3WAS. Weeding was carried out manually at three-weekly intervals. Data collected included those of seedling emergence, plant stand, number of leaves, vine lengths, girth at maturity and marketable yield. These were determined from ten randomly selected plants. All the experimental data were subjected to analysis of variance (ANOVA) and the treatment means were separated using Duncan multiple range test (DMRT) or the least significant difference (LSD). Data in percentages were subjected to arsine transformation prior to analysis of variance.

Estimations for the potential marketable yield for sectioned seeds using the whole seed as an index was calculated as follows:-

Potential marketable yield = marketable yield x number of seed sections from one whole seed.

Results and Discussion

Seedling emergence and plant growth

Seedling emergence of *Telfairia occidentalis* monitored for 7 weeks increased with time for all the seed sections. At 3WAS, a dramatic increase in the rate of seedling emergence was observed across the seed sections (Table 1). This is in consonance with the results obtained by Okoli and Mgbeogu (1983) that emergence of the plumule of a viable *Telfairia* seed takes about 1-2 weeks from the date of sowing. From 4WAS, seedling emergence of whole and half seeds followed a similar trend and were significantly superior to those of quartered and one-eighth seeds. Similarly, the seedling emergence of quartered seeds were significantly superior to 1/8 seeds. By 5WAS both the whole and halved seed, had reached their peaks of seedling emergence while the quartered seeds and 1/8 seeds reached their peaks at 7WAS with values of about 86% and 47% seedling emergence respectively (Table 1). The superior trend observed with whole and halved seeds when compared to quartered and 1/8 seeds may be due to relatively higher food reserve in the former. This includes protein, carbohydrates, fats, minerals and vitamins, which are basic resources for rapid germination and seedling emergence. This corroborates the report by Akoroda and Adejoro (1990) that the cotyledon's food reserve of *telfairia* is a major factor in seed germination. Esiaba (1982b) suggested that all seed sections of *telfairia* should consist of food reserve for good and early growth. In this study, seed sections were made to include at least parts of the embryo and cotyledon. This probably accounted for relative success in the seedling emergence of all the seed sections made.

Table 1: Seedling emergence and plant stand of plants grown from sectioned seeds of *telfaria*.

Seed section	Weeks After Sowing						Plant stand(%)
	2	3	4	5	6	7	
	*Seedling emergence %						
Whole seed	18.8 (0.44a)	84.4 (1.22a)	96.9 (1.48a)	100.0 (1.57a)	100.0 (1.57a)	100.0 (1.57a)	96.9
Half seed	6.3 (0.25b)	65.6 (0.95b)	96.9 (1.48a)	100.0 (1.57a)	100.0 (1.57a)	100.0 (1.57a)	93.8
¼ seed	1.6 (0.06c)	19.6 (0.45c)	64.8 (0.94b)	75.0 (1.05b)	82.8 (1.15b)	85.9 (1.18b)	87.5
⅛ seed	0.5 (0.03d)	6.3 (0.24d)	23.4 (0.49c)	34.8 (0.62c)	41.1 (0.69c)	46.6 (0.69c)	81.3

*Means followed by the same letters in the same column are not significantly different at 5% probability level by DMRT. Values in parenthesis are transformed means

Plant stand of the seed sections was taken at 27WAS. The highest value (96.9%) of plant stand was obtained from the whole seeds while the least value of 81.3% was obtained from one-eighth seeds sections (Table 1). The difference observed in plant stands of the seed sections at 27WAS were however, not significant. This implied that it took smaller seed sections longer time to emerge. Future studies therefore should consider the incorporation of nutritional support for relatively smaller seed sections to enable rapid plant establishment.

The number of leaves generally increased with time for all the seed sections and the highest values were obtained at 12WAS. However, it generally decreased with decrease in the size of the propagules. The superior values for larger propagule could be attributed to the advantage in their food reserves. The whole seed consistently had higher number of leaves than the other seed sections and had values which generally more than doubled 1/8 seed section throughout the period of observation (Table 2),

Table 2: Number of leaves of whole plants grown from sectioned seeds of telfaria

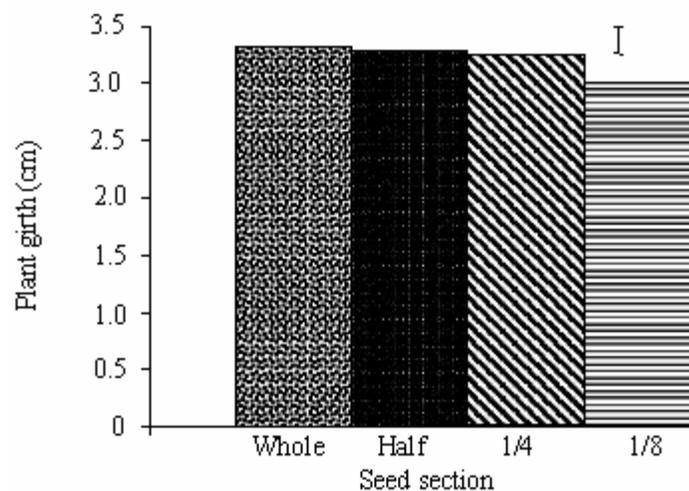
Seed section	Weeks after sowing										
	2	3	4	5	6	7	8	9	10	11	12
Whole seed	2.6	9.1	11.5	13.5	17.6	19.5	24.3	29.6	37.3	42.6	52.3
Half seed	1.2	5.3	8.3	11.1	13.2	14.1	20.1	28.6	30.9	36.4	39.1
¼ seed	0.6	3.6	6.4	7.3	8.7	10.8	13.8	17.5	23.9	27.2	28.4
⅛ seed	0.3	2.3	3.8	6.3	6.7	7.4	10.4	13.6	19.6	21.5	25.9
Mean	1.1	5.8	7.5	9.6	11.5	13.0	17.2	22.3	27.9	31.9	36.4
L.S.D (P=0.05)	0.7	1.2	1.4	1.5	1.5	1.6	3.3	3.3	2.4	2.6	4.7

Seed size had positive effects on the vine length of *Telfairia occidentalis* (Table 3). The vine length increased as propagule seed size increased throughout the period of observation. The highest vine length was obtained from the whole seeds and the least from the one-eighth seeds with highest values of 254cm and 194cm respectively at 12 WAS when all the seed sections reached their peak values (Table 3). Generally, vine length of whole seeds was significantly superior to those of the split seeds. A sharp increase in the vine length at the third week was observed in the entire seed sections. The sharp increase in the vine length at the third week after planting may be due to the photosynthetic role of the leaves, which had started developing at this period.

Table 3: Vine length (cm) of plants grown from sectioned seeds of telfairia

Seed section	Weeks after sowing										
	2	3	4	5	6	7	8	9	10	11	12
Whole seed	6.6	48.4	62.7	69.7	74.5	77.8	106.2	124.3	191.9	218.8	254.2
Half seed	3.1	24.4	40.8	50.1	61.2	71.9	87.3	100.7	159.3	179.3	206.2
¼ seed	1.6	14.4	26.2	30.1	41.3	47.3	55.8	68.1	120.3	153.9	177.2
⅛ seed	0.8	8.6	15.3	18.1	26.8	29.4	38.1	51.6	88.1	101.7	139.6
Mean	3.0	23.9	36.2	42.0	51.6	56.6	71.9	86.1	139.9	163.4	194.3
L.S.D (P=0.05)	2.0	7.6	7.3	9.5	9.9	8.0	11.4	17.7	16.4	15.3	24.7

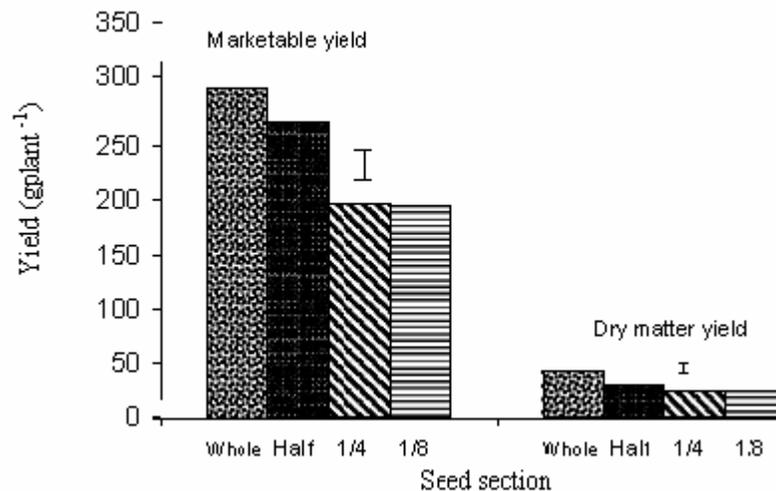
The girth at maturity was taken at 27WAS is presented in Fig. 1. The girth of whole seed plants produced was comparable to those of halved and quartered seeds but was superior to that of 1/8 seed.

Fig. 1: Plant girth of whole and split seeds at maturity (27WAS) of *Telfairia occidentalis*. Bar represents LSD at P=0.05

The high vigor exhibited by the whole and halved seeds may be due to the high food reserve in whole seeds. The availability of this in relatively higher quantities may have given the whole seed the initial vigor to have well developed roots, enhancing nutrient and water uptake. Esiaba (1982b) found that whole seeds produced roots in clumps, which efficiently foraged for nutrients and enhance their growth, while half and one-quarter seeds had free and long roots.

Marketable and dry matter yield.

Seed size had positive influence on the marketable and dry matter yields of telfairia (Fig.2). The marketable yields of plants grown from whole and half seeds were comparable and were significantly different from those of quartered and one-eighth seeds. The quartered and 1/8 seeds were however similar in marketable yields. With regards to the dry matter weight, the plants grown from whole seeds were superior to those of split seeds. The dry matter yield of half seed was however significantly higher than those of quartered and one-eighth seeds. The yields of quartered and 1/8 seeds section were also similar (Fig.2). Generally, plants grown from whole seed tended to accumulate dry matter better than split seed. The trend observed in which marketable yield decrease with size of propagule is similar to the findings of Esiaba (1982b). The superior value for whole seed may be due to its initial vigor for root development. This probably enhanced nutrient uptake and hence the superior values for most of the variables assessed here. According to Esiaba (1982b), higher food reserves in the whole seed enables it seedling to form chumps as against the free, long roots produced by split seeds (Esiaba, 1982b).

Fig. 2: Marketable and dry matter yield (gplant^{-1}) of whole and split seeds of *Telfairia occidentalis*. Bar represents LSD at $P=0.05$ 

When the potential marketable yield values for sectioned seeds were extrapolated from the marketable yields, the results showed that the seeds sectioned into eight could produce the highest value (Table 4). Using the value of whole seeds as index, the results obtained from half, quartered and one-eighth seeds were higher than whole seed value by 86.4%, 172.2% and 432.4% respectively (Table 4). This comparison is very relevant under homestead or compound farm where the population of telfairia planted is often sparse due to limited seeds and this enable the plants to forage sufficiently for water nutrient and light which are basic plant growth resources, often available in sufficient amounts.

Table 4: Estimated potential yields of plants grown from sectioned seed of telfaria using the marketable yield of whole seed as index.

Seed section	Marketable yield (gplant ⁻¹)	Potential marketable yield (gseed ⁻¹)	Potential marketable increase (g)	Percentage yield increase (%)
Whole seed	292.0	292.0	-	-
Half seed	272.1	544.2	252.2	86.4
¼ seed	198.7	794.8	502.8	172.2
1/8 seed	194.3	1554.4	1262.4	432.4
Mean	239.3	796.4	504.4	172.7

This study has shown that the size of seeds generally had positive influence on the rate of seedling emergence, growth and development of the plant. However, the results obtained from this experiment, have demonstrated the possibility of economic production of *Telfairia occidentalis* through the use of seed sectioned up to 8 equal portions. Since this work has indicated significant reduction in seed requirements from 100% for whole seeds to between 12½ to 50% for split seeds. This development could aid in reducing the problem of seed scarcity for propagation, since seedling emergence declined with decreasing size of seed section, it is therefore recommended that future studies should not only investigate the possibility of regenerating seedlings from smaller seed sections than the 1/8 section, but should also address the need to enhance the seedling emergence of split seeds through initial nutritional support to ensure early plant establishment.

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Uninterrupted Sustainable Hydroelectric Power in Nigeria: Problems and Prospects of Kainji Hydroelectric Power Station

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Abstract

Recently, the Federal Government of Nigeria announced the privatisation of the Kainji Hydroelectric Power station amidst public outcry against privatisation of essential utilities. This study is based on a research into the problems and prospects of Kainji Hydro Electric Power (HEP) station in Nigeria. HEP has been acclaimed to have a lot of potentials. Of the power resources, it is the cheapest partly because water is free and its running cost is relatively low. Geographical factors also favour its location in Nigeria. Despite its abundant potentials, the Kainji HEP station under the management of National Electric Power Authority (NEPA) continues to perform below expectations. The government associates the poor performance of Kainji HEP station to its spatial characteristics especially the water level variation. In order to investigate the reasons for the decreasing efficiency of Kainji HEP generation in Nigeria, questionnaires were designed and distributed to selected executives in the management team. Contrary to Government assertion, the study reveals that poor planning, funding, and political maneuvering from every successive political and military regime are the main challenges to efficient and effective HEP generation in Nigeria.

The study opines that the privatisation move of the government cannot solve the problems facing Kainji HEP generation. It therefore makes two recommendations. First, that Kainji HEP station under the management of NEPA should remain as a public organisation and second, that the government should give its top management team free hand to manage it strategically.

Introduction

Hydroelectric power supply over 6% of the world energy needs and furnished about 14 percent of the energy consumed by Nigerians in the 1980s (CBN, 2004:61). By 1990, most electricity was generated at Kainji HEP station, under the management of National Electric Power Authority (NEPA). This semiautonomous government agency had been established in 1972 through the merger of the Electric Corporation of Nigeria (ECN) created by the government in 1950 to generate and transmit power nationally and the Niger Dam Authority (NDA) set up in 1962 to develop the economic potential of the

Niger River (NEPA, 2005:2). As part of its mandate, the NDA had constructed the Kainji Dam and an associated hydroelectric plant, which began operations in 1968. Until the late 1970s, the plant was the principal source of Nigeria's electrical power. Other sources include coal, gas and petroleum. The Dam is built on River Niger in Kogi state of Nigeria.

The absence of regular electricity in urban towns and its non-availability in rural villages is swelling the tide of urban migration in Nigeria (Iloje, 1985: 32). Lack of adequate electricity negatively affects virtually all low-level workers. These include but not limited to welders, barbers, business centres, refrigerator/air-conditioner technicians, shoe makers/repairers, laundry workers, tailors, and other small and medium enterprises. The middle class workers are equally affected. Nearly all small-scale manufacturers suffered great loss from downtime due to frequent power failure. The few who can afford to buy generators are unable to operate them because of the high cost of fuel (CBN, 2004:68). One can also guess what price the upper class has to pay to provide generators at home, offices and factories. Unfortunately, at the end of the day, these prices are passed on to the low-level workers (the end consumers). It is obvious that without the full participation of the low and middle classes, especially through the formation of small and medium industries, the economy of any nation cannot thrive; no matter how hard the experts try.

The multi-dimensional role of adequate power supply was obvious to the Obasanjo administration when it came into power in May 1999 (NEPA, 2004: 3). One major problem this administration promised to solve immediately was that of electricity supply. In 1999, the total electricity available for use was less than 2,000 Megawatts (MW). Government as at 1999 realised that the minimum electricity requirement for the nation was about 4,000MW and there was the intention to reach that level within one year in office (i.e. year 2000). The Obasanjo administration quickly refurbished some of the generating sets that have suffered negligence in the hands of the past military governments. Afterwards, electricity output increased to about 3,500MW but later dropped again. Almost six years after (2005), the electricity capacity available for use is a little above 2,000MW even though as at 1999, Nigeria had a generating capacity of about 6,000MW, made up of 1,900MW from hydroelectric power and 4,040MW from thermal power (NEPA,2005: 1). This failure on the part of the Government has resulted into the privatisation of NEPA. It is pertinent to ask why the Government cannot generate at least 4,000MW from an installed capacity of over 6,000MW. For example, South Africa is generating 40,000 megawatts for her 15 million populations while Nigeria at best generated 3,500 megawatts for about 120, million people.

This paper attempts to investigate the problems and prospects of Kanji Dam in Nigeria and proffer solution to the identified problems. The paper specifically identifies the reasons for non-performance of Kainji HEP station amidst its prospects and proffers solution for uninterrupted sustainable power generation in Nigeria.

Literature Review

In literature, many studies have been conducted on hydro electric projects in the world especially in developed countries but few studies are available on developing countries and particularly studies on Nigerian hydro electric projects are very scanty. This study is an attempt in this direction to make more research reports available on Nigerian hydroelectric project at Kanji Dam.

Africa is well blessed with abundant natural energy resources. Oke (1995:112) observed that the rivers of Africa have a hydroelectric power potential greater than that of any other single continent in the world except Asia, if fully developed. African rivers have the potential to supply 23% of world Hydro Electric Power (HEP). Unfortunately, at present, Africa produces only about 2% of the world installed capacity.

In the same way, according to Shahi, (2003:5) exploitation of hydroelectric potential in various countries has been rather on a lower side (see table 1). While the countries like Canada and Norway

have exploited their hydro potentials to the extent of 48% and 58% respectively, Brazil has developed it to the extent of 31.5%, China and India both only to the extent of 18%.

Table 1: Exploitation Of Hydro Potentials In Some Selected Countries By Percentage

Country	Potential (MW)	Installed (MW)	Percentage (%)
Norway	47,000	27,360	58
Canada	160,000	65,378	48
Brazil	170,000	52,378	31
China	310,000	56,000	18
India	150,000	27,000	18

Source: Shashi, (2003:5)

Eight basic concepts have been universally identified as common problems militating against the hydro power generation (Adeleke and Goh Chen Leong, 1979:103; Michael and Okunrotifa, 1983:10; Bunnet, 1984: 48; Udoh, 1982: 77; Oyebande Lekan, 1990:5; V.O. Oke, 1995:112 and NEPA, 2005: 2) these concepts include:

- Seasonality of the river due to variation of the climate
- Poor management of water reservoir behind the dam
- Secret conversion of carbon dioxide to methane by some plants with its adverse result
- Problem of flash flood flow
- Evaporation and infiltration losses
- Low financing of hydro electric power station
- Under staffing of sensitive departments especially skilled technological manpower
- Electricity cannot be stored.

R.V. Shashi (2003:5) emphasised that during the last 30 years, problems of Hydroelectric power generation in developed countries has reduced its generation from 21% in 1973 to less than 17% in year 2000 while during the same period, coal based generation increased from 38% to 39%, gas increased greatly from 12%to 17.4%.

Propounding solutions to some of the problems militating against the full utilisation of HEP, Bunnet (1984:48) and Percy, (2004: 32) noted that it is important that rivers to be harnessed for HEP generation should not be subjected to great fluctuation in the volume of water, since this would make it difficult for plants to operate at optimum.

However, in recent years, hydroelectric projects contribute immensely to the national economic growth and development (Iloeje, 1985:185). The thrust on hydroelectric development, according to R.V Shashi (2003:4); Iloeje, 1985: 186 and Jerry, (2005:7) is based on the following consideration.

- Hydroelectric involves a clean process of power generation, devoid of pollution.
- It does not suffer from the limitation of inflation on account
- Power supply has a peculiar limitation of huge variation between peak and off-peak requirements.
- Locations of hydroelectric projects are also in areas which need substantial support for their economic development.
- In an integrated hydroelectric project, there are many such projects- involving not only supply of electricity but also provision of drinking water and irrigation.
- Integrated hydroelectric projects help to check and control flood.

Methodology

Primary data was generated through field observation, administration of structured questionnaire and in-depth interviews with top officers of NEPA at Kainji HEP station.

The questionnaire designed had 31 set of items on it and each item was provided with appropriate response. The questionnaire centred on questions about when the Kainji Dam construction started, completed and commissioned, its locational appropriateness, the source of fund and total cost for the construction of the dam, factors that favoured the construction of the dam, management problems and perceived solutions.

The study population consisted of top experienced managers of NEPA. This choice stemmed from the fact the theme of this study includes spatial limitations of the Kainji Dam project and NEPA's management performance in Nigeria. For the purpose of effective coverage, deeper study and lower cost, the population was stratified into two: namely Top and middle management NEPA staff. For deeper study, the sample size is fixed at 60% of the study population in each stratum. But the pilot study revealed a lot of repetitions in each stratum; thus in order to avoid this, only one stratum that had appropriate facts to answer the questions raised in the questionnaires was chosen. This happened to be the Top management staff category. For financial reasons, the whole population in this category could not be effectively covered. So 60% of the population was surveyed. This yields a total of seven respondents. This sample size was fixed after considering the number of respondents that could be effectively covered within the short time and financial resources available for this study; and the details and precision required. The sampling units are the individual research respondents in our study population.

Secondary data were extracted from journals, books, Government publications and desk study of various reports available in respect of NEPA. These include policy manuals, financial reports, and employee handbook among others. Collected data were analyzed using descriptive statistics such as percentages and means.

Problems of Kanji Hydro Electric Power Supply in Nigeria

In a nation, there must be a minimum standard of electricity generation and distribution below which electricity must never fall irrespective of whatever happens to the water level at the Kainji dam (see table 2). Research findings show that by now Nigeria should be in a position to generate and distribute at least 4,000MW of hydroelectricity. Government has linked their inability to generate adequate electricity to the fluctuations in water level. The highest water level at Kainji is 141.7 meters while the lowest is 126 meters. Business concerns need to envisage problems and plan ahead to ameliorate them. 'Fire brigade' solutions never endure. Adequate precautions need to be taken to safeguard electricity output during the fluctuations between minimum and maximum water levels.

Table 2: Designed Level of Water for Power Generation: Comparative analysis

Dam	Minimum Level (meters)	Maximum Level (meters)
Kainji	126	141.7
Shiroro	326	360
Jebba	99	103.15

Source: Field Survey (2005)

From table 3 below, we identify some main reasons for the present abysmal performance of NEPA. The Respondents were asked to mention problems militating against full utilisation of Kainji Dam HEP listing them in order of priority. All the Respondents gave high priority to poor planning, poor funding and biased political interest. Nigerian factor and poor management of reservoir were also given high recognition (See table 3). First, it is appropriate to focus our attention on the planning department of the authority.

The planning department was found deficient in its duties. Respondents argued that it ought to have analysed the two of the most vaunted reasons for NEPA's constant failure (low level of water at Kanji

dam and insufficient supply of gas by the Nigerian Gas Company) and provided better alternatives as a way out of the problem.

Table 3: Problems militating against full utilization of HEP in Nigeria

SN	Problems	Respondents (No)	%
1	Poor Planning	7	100
2	Poor funding/capitalization/old equipments	7	100
3	Selfish Political interest.	7	100
4	Seasonality of Rivers/ insufficient water	3	42.8
5	Unwanted Weeds on River Channels	2	28.6
6	Nigeria factor and Federal government character	6	85.7
7	Economic Factors/Austerity/SAP	4	57.1
8	Inadequate Manpower / lack of technical know how	5	50.0
9	Physical/Locational factor	3	42.8
10	Influence of others countries	2	28.6
11	Poor management of reservoir / flooding	6	85.7
12	Others e.g. poor gas supply	1	14.3

Source: Field Survey (2005)

1. Incidentally, the two factors were not given prominence by the respondents as only about 42.8% mentioned insufficient water and about 14.3% mentioned poor gas supply as being responsible for NEPA's poor performance.
2. The second is the issue of capitalisation. Though NEPA's management and engineers may be top class, yet if they do not have sufficient fund and freehand to turn things around, we will continue to live in delusion. All the respondents gave this factor high priority. Respondents were of the opinion that government was reluctant to adequately fund the project for fear of overcapitalisation, corruption, and embezzlement and over invoicing of heavy equipments to be purchased from overseas. The Respondents argued that this is being done in order to reduce rate of corruption in governmental parastatals. Maintenance costs of modern large-scale HEP projects are very high. The costs of maintaining power plants and cost of transmission round the year as well as incidental costs of compensation to workers affected during plants operations is huge. The delivery of the power supply from the point of generation to consumers, sometimes hundreds of miles away, involves the construction and servicing of pylons, high tension cables, even under sea cables in some cases and transmission lines often cross very difficult terrain.
A team of engineers, wiremen and administrative staff has to be maintained to run the entire operation. Most of the spare parts are outdated and lubricating oil is costly to purchase for the power plants due to lack of funds. The low financing is a major problem facing the hydroelectric station at Kainji. Due to inadequate capital, the obsolete equipment which ought to have been replaced over a decade is yet to be replaced. So the power being generated can not meet the demand of the citizenry in terms of energy consumption both for domestic and industrial purpose.
3. Unstable political structure: No sooner, the forerunner of the HEP project (Tafawa Balewa's regime) started the Kainji dam project than the administration crumbled under a military coup whose policy had to deviate from the former one. There were seven different military and two civilian administrations within a period of 38 years (1966-1999) when the current civilian administration of Obasanjo started. Each of the outlined administrations brought new policies that may improve upon or superimpose or obliterate the former. No wonder, all the respondents gave it high priority. One can say without iota of doubt that change of government policies are the major dilemma of the Kanji Dam project.
4. The Nigerian factor: During the military regimes in Nigeria, the Nigerian factor expressed itself in the multi-ethnic strata of the country coupled with religious segmentation, ethnic clashes, quota symptoms in government establishments and institutions. Nigerians are full of vices and antisocial practices like bribery and corruption, hatred, tribalism, nepotism, tribal clashes and oppression. It is

observed that Nigeria suffered a great deal of brain drain especially during the military administration. All the above setbacks are vehicles of hindrance to industrial and commercial growth of the country including electricity generation.

5. Socio-Economic factors: The military regimes (especially the regime of Babangida) in the early 1980s introduced series of structural adjustment programmes termed 'SFEM' and later the 'SAP' and 'VAI' which brought about an untold deadlock to the economic growth of the country that depend solely on importation of much needed machines. A host of the then growing industries started to collapse as it became very difficult to source for foreign exchange to pay for imported industrial machines.
6. Inadequate Skilled Man Power: There is a gross inadequate distribution of technologically qualified manpower resources to manage the Kanji Dam project. This emanates from the factor of government policy explained in items one and four above. Each administrator would like to post his favourites to high management positions in the name of quota system or ethnic origin. This cankerworm called Nigerian factor led to the colossal wastage of government money spent in the training of thousands of technicians and engineers in countries overseas. Another problem is understaffed departments especially the middle line management cadre. The skilled and experienced workers are very important to operating and maintaining the power plants but those that are employed are unskilled and semi-skilled workers, they do not know how to operate the power plants and their maintenances, which lead to frequent breakdown of the plants and makes the management of electricity supplies very difficult which often results in frequent power failures.
7. Locational Factors: Although a lot of geographical factors had been taken into consideration before locating the Dam, unforeseen weather conditions limit the full utilization of the Dam project. Inadequate supply of water due to drought has affected the flow of river Niger and this has led to slow rate of turning turbine to generate electricity.
8. Influence of other countries through which the river Niger flows and others making use of the Kanji Dam project: Other countries like the republics of Togo and Niger make use of the Kanji Dam Electricity supply on bilateral agreements. Occasional disagreement between these countries have caused some set backs in the full utilization of the project
9. Low level of technology in Nigeria has caused great drawback on the full utilization of Kainji dam. In advanced countries of the world, rivers are operated by scientific methods using computers to calculate river flow, reservoir levels and releases of water for electric power. This kind of technology is nowhere to be found in Nigeria.
10. Other Geographical factors:

Firstly, HEP production in Kainji is currently faced with the problem of poor reservoir management. Several species of aquatic weeds (e.g. Salvina floating grass) have been observed on the Kainji reservoir. The most recent being the water hyacinth are the most problematic of all the aquatic weeds, in view of its fast growth rate and propagation system. It increases evaporation and infiltration loses which reduces the flow of volume of the Niger Lake, causes navigational hazards preventing fishing and recreational facilities. Algae had caused serious blockage of the radiators of the hydro machines leading to over heating.

Secondly, one of the most newly discovered and most troubling environment consequences of Kainji HEP include the fact that some plants/weeds produce substantial amount of carbon dioxide (Co₂) and then serve to convert Co₂ to methane. This is due to plants material in the surrounding area of river Niger being inundated with water, decaying in an anaerobic environment, allowing for formation of methane, a very potent green house gas. There is no solution yet to the problem but clearing of the reservoir by the workers must be taken into consideration and must be done regularly.

Thirdly, there is problem of flash flood flow in the form of peak run off couple with lateral inflows occurring between 12 – 24 hours from the commencement of local rainfall as they were experienced in 1988/89 hydrological seasons. This phenomenon imposed stressful reservoir

operation, which had to be accompanied by spillage from the hydroelectric power station of Kanji, operated in an integrated fashion. The flash flood flows make it difficult for plant's engine to operate at a constant level of power production.

Fourthly, evaporation and infiltration losses are one of the major problems of HEP production in Kanji, upstream of Timbuktu, and the interior lake commonly referred to as the inland Delta of the Niger. This lake reduces the flow volume of the Niger by means of extensive evaporation and infiltration. The effect of the inland Delta and upstream activities has complicated reservoir operation at Kanji and Jebba during period of severe drought.

Fifthly, electricity cannot be stored unlike coal, oil or natural gas. Electricity supplies cannot be kept in reserve; they must be used as they are generated. This makes the management of electricity supplies very difficult, since if the power station ceases to function there are no reserves to fall back and electricity cuts are inevitable. Demand for electricity is also very variable, both on a seasonal and daily basis. Peak demand come at meal times and in the evening for domestic supplies while industrial plants require electricity only during working hours. During the night, the demand for electricity is low. The problem is usually over come by keeping some power stations at full production while others are only to supplement supplies at peak periods. It is essential to control output from power station to match fluctuations in demands.

Other problems militating against Kainji dam include vandalism of NEPA equipments, overloading of transformers and the non-installation of other units (about 4 at Kainji Power Station) and some equipments at the Kainji Power Station.

Some respondents mentioned that Kainji Dam Project created some problems like it has led to the death of some towns like Bussa and Agwara. The towns are now under water. As the dam was being built, the water above it was held back and its level started to rise. The result was that not only those large areas of cultivatable and pastoral land were lost, but also towns like Bussa, were submerged. A new town called New Bussa has now been built on higher ground to accommodate the people evacuated from the old drowned towns. Infact, records show that displaced people have been resettled in well over a hundred new villages.

Prospects of Hep Generation in Nigeria

When our respondents were asked about what they perceived to be the prospects of effective HEP in Nigeria, their responses were as follows (see table 4 below):

95% of the respondents agreed that effective HEP guarantees stable power. 80% considered irrigation from Kainji Dam very important to the economy. Another 90% feels that Kainji Dam makes farming possible through out the year.

From table 4, we can see that the advantages of effective HEP include:

- The provision of steady supply of electricity for domestic and industrial uses.
- The lake has potentialities for fishing, irrigation, Industrial and municipal water supply
- The Lake can be used for transportation.
- The lake has a modifying influence on the climate of the adjacent land.
- The project has led to the growth of Kainji town and the modern resettlement villages.
- By holding back some of the waters of the river Niger, the dam controls its flow and reduces flooding below Kainji.
- The project itself and its subsidiary industries have given employment to well over 5000 Nigerians.
- The various resources obtained from H.E.P. projects (e.g. fish, agricultural products etc.) are important for foreign exchange earnings.
- The lake, the dam, the power station, the modern villages and the new town of kainji are features of tourist interest.
- The H.E.P. projects are good centres for tourism and recreation.

- The H.E.P. projects form good bases for establishing research centres or activities.
- H.E.P. projects areas are centres for new development e.g. of cities and industries.

Table 4: Prospects of Effective HEP at Kanji Dam

Advantages	Respondents %
Generation of stable power.	95
Makes irrigation possible	80
Allow farming throughout the year through irrigation.	90
Provision of Pipe borne water for drinking	50
Good for fishing	80
Makes Navigation easy on river Niger	20
Create job opportunity	80
Allows exportation of Electricity to nearby poor countries thereby generating external earnings.	90
Support tourism and game reserves	10
Supports research centers e.g. on fishing	15
Supports growth of new towns(new Bussa)	40

Source: Field survey (2005)

Recommendations and Conclusion

The importance of HEP generation in Nigeria cannot be overemphasised. It allows exportation of electricity to nearby countries thereby generating external fund for the country, it contributes to the growth of the economy and it provides stable electric supply thereby making farming, fishing, and irrigation possible. Despite these prospects, HEP generation remains inefficient in Nigeria

It is obvious in Nigeria that the demand for hydroelectric power for domestic and industrial purpose is higher than the production rate; as such there is frequent power outage in the country.

The main reasons for this inefficiency as identified in this study include the fact that the planning department of Kainji power Station is not given the sufficient fund and freehand to manage the project. Political dictations with selfish interest supersede genuine management considerations. Other reasons are traceable to the fact that the machines being used to generate power are obsolete and need to be overhauled while weather changes continue to result in seasonality of river flows.

HEP productions problems require a multi-dimensional approach with joint and coordinated efforts on the parts of the stakeholders; the federal, states’ and local governments and the consumers at large.

Total commitment, determination and will power on the part of the three tier government will bring a positive change in the power sector in Nigeria rather than outright privatisation. Ability and willingness on the part of the consumers to pay for energy consumed timely will bring more income to NEPA.

Total overhauling of engines, machines and procurement of modern engines will promote full utilisation of Kanji Dam under a strategic management leadership.

The following recommendations are hereby made in line with the problems under consideration.

1. The service of experts in hydrology, meteorology and hydraulic engineering must be sought to improve water management practice.
2. The obsolete machines and engine at Kanji Dam must be overhauled.
3. Strategic planning to be vigorously pursued
4. The capacity of the reservoir must be expanded to reduce the problem of water level fluctuation, infiltration and evaporation losses which reduces the flow volume of the river.
5. The inflow and outflow from the reservoir must be well managed so as to obtain maximum benefits from the dam.
6. In addition, government should create conditions that will encourage innovation and investment in new technologies that will eventually aid the full utilisation of Kanji Dam.

7. Training and retraining of staff to be encouraged.
8. The federal Government should allow the planning department of the authority of Kainji Dam to have freehand to turn things around and should be provided with sufficient fund.
9. Efforts should be made to encourage NEPA retirees to set up small businesses to fabricate spare parts for NEPA use through sub contracting system.
10. National sub contracting system to be overhauled.
11. Lubricating oil should be made available by producing them at home or by timely importation.
12. The other 4 units at Kainji power station should be installed by the appropriate authority in order to increase the production of electricity.
15. Government attention needs to be focused on the following:
 - Additional budgetary and financial support for ongoing and new hydro projects under Central Public Sector Undertakings
 - Basin-wide development of hydro potential
 - Emphasis on quality of survey and investigations
 - Resolution of inter-state issues on sharing of water and power.
 - Renovation, Modernization & Updating of existing hydro stations
 - Promoting small and mini hydro projects (25 MW and below now fall into category of “non conventional” qualifying for benefits).
 - Simplified procedures for clearances by Central Electricity Authority; Electricity Act 2003 further liberalises this.
 - Rationalization of hydro tariff by allowing premium on sale rate during peak period
 - Realistic estimates of completion cost considering new development on geological front during execution.
 - Promoting hydro projects as joint venture
 - Government support for land acquisition, resettlement, development and rehabilitation etc.
 - Simplified procedures for transfer of techno-economic clearances, streamlining of clearance process and introduction of three-stage clearance approach for development of hydro projects in Public Sector/Joint Ventures, etc.

Finally, the Federal Government needs to rescind her decision to privatise NEPA. For now and until it can find its feet, NEPA should be regarded as part of utility services that should be provided for the people. Government should make sure they install and generate at least 4,000 MW from an installed capacity of over 6,000 MW before any form of privatization.

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Socio-Demographic Characteristics of Multidimensional Health Locus of Control

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Abstract

This study examines the socio-demographic characteristics of Multidimensional Health Locus of Control Scales among 33 sampled adults of ages 32-61 years. The Influence of respondents' sex, age, marital status and educational level were analysed on the three subscales. Results of the analyses revealed no significant age and sex difference among selected groups but found education and marital status to have significant influence on Health locus of control.

Respondents in the lowest educational cadre fell into the group of externals while those in the highest educational cadre were more in the internally controlled group. On marital status, it was revealed that single internally controlled individuals differ significantly from "significant other" and "chance" controlled groups.

Introduction

Since the concept "locus of control" was developed, and with the subsequent use of Rotter's (1966) Internal-External Scale, several attempts have been made to examine the construct with other variables. These have been with anxiety (Archer and Stein, 1978; Archer, 1979; Donovan et al, 1975; O'Leary et al (1974); Kutash, 1982; Molinary and Khanna, 1980); depression, loneliness and helplessness (Abramowitz, 1969; Peterson et al, 1978; Schill et al, 1980; Leggett and Archer, 1979); belief system (Russel & Jorgenson, 1978; Tipton et al, 1980; Silverstri, 1979; Clouser and Hjelle, 1970; Geist & Bangham, 1980; Wright and Phu, 1981; Oluwole, 1994); social behaviour (Ellis & Miller, 1981; Bachrach, Huesmann & Peterson, 1977; Replogle et al, 1980; Feinberg et al, 1978; Coovert & Goldstein, 1980); academic performance (Grandall et al, 1965; Borges et al, 1980; Schultz & Pome Santz, 1976; Owojori, 2000; Akinwumi, 2000), Vocational behaviour (Kimmons & Greenhaus, 1976; Zillmer, Archer & Clidden, 1986; Knoop, 1981; Dailey, 1980); extraversion – introversion (Morris & Carden, 1981; Irfani, 1978; Bull & Strongman, 1971); Age (Duke, Shaheen & Nowicki, 1974; Lao, 1976; Walls & Miller, 1970; Knoop, 1981).

Additionally, several investigators (Abramowitz, 1973; Collins, 1974; Levenson, 1973a, 1973b, 1974; Levenson & Miller, 1976; Butler & Burr, 1980) have reported that I-E scale is not unidimensional but multidimensional in nature, hence the call for the use of multidimensional locus of control scale has gained ground in subsequent research on locus of control. Similarly, in recent past attention has been shifted from a more generalized locus of control scale to a more specific area. The development of Wallston & Wallston (1978) Multidimensional Health Locus of Control (MHLC) scales; Beck (1980) Dental health Locus of Control scale (DHLC); Labs and Wurtele (1986) Fetal Health Locus of Control scale, and Saltzer (1982) Weight Locus of Control (WLOC) scale are in this direction.

One of these, Multidimensional Health Locus of Control scales (Wallston, et al, 1978) was developed to measure health specific control expectancies with the objective of improving the prediction of health-related behaviour obtainable from more generalized measures in response to Rotter (1975) call for area specific locus of control measures. The Multidimensional Health Locus of Control Scale (MHLCS) measures locus of control as a multidimensional construct instead of internality and externality as polar opposites. The MHLCS consists of three scales, one for Internal Health Locus of Control (IHLC); one for Chance Health Locus of Control (CHLC) and the other for the Health Locus of Control by powerful others (PHLC).

Since its development, several studies have examined its relationships with overall health (Calnan, 1988; Raja, et al, 1994); adoption of preventive measures of health (McLean & Pietroni, 1990); health related information (Toner & Manuck, 1979); control for obesity and weight loss (Chavez & Micheals, 1980; Saltzer, 1981); smoking cessation (Kaplan & Cowles, 1978); disease control (Lowery), Age differences (Boyle & Sielski, 1981; Lachman, 1986; Calnan, 1985); Sex differences (Wallston, 1980; Price, 1981; Tolor, 1978; Taylor, 1981); Education (Price, 1981; Pill & Stott, 1982) and Marital Status (Raja, et al, 1994).

Effort in this direction has been with the assumption that internally controlled individuals will engage in health promoting behaviour to a great extent than externally controlled ones. This assumption has only been partially supported. (Macdonald, 1970; Lee & Mancini, 1981; Manno & Marston 1972; Dabbs & Kirscht, 1971; Lowery & Ducette, 1976). The aims of the present study were to examine Health Locus of Control among sample different from previous studies with the purpose of determining the predictive utility of the MHLCS in a more heterogeneous population. More specifically, the study examined the possible influence of sex, age, education and marital status on multidimensional health locus of control scale.

Method

Sample

Three hundred and thirty four individuals both within and outside Obafemi Awolowo University, Ile-Ife participated in this study. Of the 334 subjects sampled, 184 were male, 150 were female. The respondents age range between average of 33.6 years.

Instrument

The questionnaire used for the study contained Multidimensional Health Locus of Control Scale and some items on socio-demographic variables of the respondents. Multidimensional Health Locus of Control Scale was developed by Wallston, et al (1978) to measure the extent to which individuals will typically endorse statements attributing responsibility for health status to themselves (internal control) or to fate, chance or other extra personal influences (external control). The internal subscale measures the degree to which the individual perceives his health status as under his own control. The external scale has two subscales. The powerful others subscale evaluates the degree to which the individual attributes his health to be influenced by powerful others (family, friends, peers health care professionals, etc.). The chance subscale measures the degree to which the individual views chance of fate as responsible for his health status. Multidimensional Health Locus of Control Scale (MHLCS) is an 18 – item measure which comprises three subscales an internal locus of control; a powerful others and a chance locus of control.

Sample of items are “I am in control of my health”; “My family has a lot to do with my becoming sick or staying healthy”; and “My good health is largely a matter of good fortune”. Respondents were asked to indicate the extent to which they agree with each item using a 5-point Likert-type scale; 5 = strongly agree, 4 = agree, 3 = undecided, 2 = disagree, and 1 = strongly disagree. Subject’s score is obtained by summing the scores for the six items on each sub-scale.

Since its development, several studies have examined the psychometric properties of the MHLC scale (Marshall, Collins, and Crooks, 1990, McCallum, Keith and Wiebe, 1988, Laffrey and Isenberg, 1983). In a related study, Raja, Williams and Mcgee (1994), reported a coefficient alpha, a measure of internal consistency of a set of items for the MHLC dimensions, as 0.85 for the internal scale; 0.75 for the significant persons scale, and 0.71 for the chance scale. Using Kuder-Richardson method of establishing reliability, Germer and Price (1981) reported an alpha value of 0.75 for the total instrument, 0.71 for the internal subscale, 0.76 for powerful others and 0.64 for chance subscale.

As for possible correlation between subscales, this study reveals a significant positive correlation between “Internal” (I) and “Powerful others” (P) dimension ($r = 0.25$, $P < 0.05$). Similarly, a significant positive correlation was observed between the two external dimensions ($r = 0.20$, $P < 0.05$). However, there was no significant correlation between “internal” (I) and “chance” (C) dimensions of the scale ($r = 0.06$, $P > 0.05$). These findings are consistent with Raja et al (1994) analysis and Germer and Price (1981) study which reveals a non-significant correlation between internal and chance dimensions, significant correlation between internal and powerful others as well as between Powerful others and chance dimensions.

The sample’s mean scores of 18.6 for internals, 16.2, for chance and 19.2 for powerful others obtained in this study corroborates the work of Wallston and Wallston (1981) who reported mean scores of 25.6 for the internal dimension, 19.2 for the powerful others dimension and 16.2 for the chance dimension.

Procedure

Each respondent was given a copy of the questionnaire containing three subscales of Multidimensional Health locus of control and other items seeking information on the respondent’s sex, age, marital status, and educational qualification. Each of the independent variables (sex, age, marital status and educational level) were examined against internal, significant others and chance subscale of the multidimensional health locus of control using SPSS version 9.0 univariate analysis of variance. The results obtained were presented in table 1.

Results

Descriptive Analyses

Respondents’ personal opinions on Multidimensional Health Locus of Control Scale were examined descriptively. On internal subscale of the instruments, majority of the subjects agreed that (1) if they take care of themselves, they could avoid illness (80.6%) (2) If they take right actions, they can stay healthy (81.3%) and (3) if they got sick, it is their behaviour that determines how soon they will get well (58.5%).

With regards to taking responsibility for issues concerning their health, majority of the respondents disagreed that “when they are sick, they are to blame” (75.6%) while only forty three of them (13.1%) agreed that they are to be blamed. There are diverse opinion on items that has to do with one’s control over health. One hundred and forty-four respondents (43.8%) agreed that they are in control of their health while one hundred and forty six (44.4%) disagree that they are in control of their health.

There are also differences in the response categories of respondents to item “The main thing that affects my health is what I myself do”. One hundred and thirty one respondents (40.2%) agreed that they themselves control their health while one hundred and forty respondents (42.9%) felt that what they cannot control their health outcomes.

The second part of the instrument measures influences of significant others on the control over one’s health. Subjects’ responses on the items revealed that majority of them agreed that:

- (1) Having regular contact with their physicians is the best way for them to avoid illness (54.4%) as against those that disagreed (37.2%).

- (2) Whenever they don't feel well, they should consult medically trained professionals. (84.5%) as against those that disagreed (9.9%).
- (3) Whenever they recover from an illness, it is usually because other people (doctors, nurses, family friends) have been taking good care of them (59.7%) as against those that disagreed (27.9%).
- (4) Regarding their health, they can only do what their doctor tells them to do (60.9%) against those that disagreed (28.7%).

Majority of the respondents also disagreed that "Health professionals controls their health. This is revealed in their responses. Two hundred and thirty respondents (69.0%) disagreed while seventy-two respondents (21.6%) agreed that health professionals control their health. Different views were expressed on the role of the family in becoming sick or staying healthy. One hundred and forty-four respondents (43.1%) agreed that their family has a lot to do with their becoming sick or staying healthy. While one hundred and forty three respondents (42.9%) disagreed with it.

The last part of the questionnaires on health locus of control dealt with items that have to do purely with the influence of external factors on the control one's has over health. Subjects' responses on the items revealed that majority of them disagreed that:

- (i) Most of things that affects their health happened to them by accident (54.6%) against those that agreed (30.2%).
- (ii) Luck plays a big part in determining how soon they will recover from an illness (66.7%) against those that agreed (19%).
- (iii) No matter what they do, they are likely to get sick (64.5%) against those that agreed (21.9%)

There was no clear-cut position on two of the items. On one that says, "No matter what I do, if I am going to get sick, I will get sick", one hundred and thirty seven respondents (41.0%) agreed with it while one hundred and sixty three respondents (48.8%) disagreed. Again, one hundred and sixty six respondents (50.1%) agreed that their good health is largely a matter of good fortune while one hundred and thirty respondents (39.3%) disagreed with the statement.

Table 1: Univariate Analysis of Variance between sociodemographic variables and multidimensional locus of control

Source	Value Label	N	Dependent Variable	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model			Internal	375.571 (1)	9	41.730	1.946	.045*
			Sigother	306.397 (b)	9	34.044	1.271	.252
			Chance	411.944 (c)	9	45.722	1.820	.064
Intercept			Internal	4975.912	1	4975.912	232.082	.000
			Sigother	6010.501	1	6010.501	224.435	.000
			Chance	3604.677	1	3604.677	143.368	.000
Sex	Male	184	Internal	10.168	1	10.168	.474	.492
	Female	150	Sigother	68.633	1	68.633	2.563	.110
			Chance	45.021	1	45.021	1.791	.182
Age	21-40 years	240	Internal	1.871	1	1.871	0.87	.768
	41-60 years	94	Sigother	.668	1	.668	.025	.875
			Chance	60.513	1	60.513	2.407	.122
Marital	Single	95	Internal	162.807	2	81.404	3.797	.023*
	Married	235	Sigother	48.735	2	24.368	.910	.404
			Chance	56.545	2	28.272	1.124	.326
Education	Primary Education	5	Internal	203.907	5	40.781	1.902	.094
	Secondary/ Tech.	62						
	Post Secondary (OND, NCE, HSC)	85	Sigother	185.174	5	37.035	1.383	.230
	University Degree (B.A, B.Sc., B.ed)	96						
	Postgraduate (M.Sc., Ph.D)	85	Chance	280.087	5	56.017	2.228	.050*
Error			Internal	6946.668	324	21.440		
			Sigother	8676.909	324	26.781		
			Chance	8146.260	324	25.143		
Total			Internal	122858.000	334			
			Sigother	128420.000	334			
			Chance	95476.000	334			
Corrected Total			Internal	7322.240	333			
			Sigother	8983.305	333			
			Chance	8558.204	333			

* Statistically significant; $P \leq 0.05$

Discussion

The results of this study showed that age did not influence health locus of control. Likewise, there is no sex difference on the health locus of control of sampled respondents. These findings are consistent with those of Wallston (1980) study in which it was found that there is little indication that locus of control varies by age or sex. Toner and Manuck (1979) also found that subjects grouped as internals did not differ by sex nor age from those designated as externals. This was also partially supported by Germer and Price (1979) suggestion of no sex or age difference for the three subscales of Multidimensional Health Locus of Control. Evidence corroborating this finding was also reported by Boyle and Sielski (1981), which recorded a non-significant relationship between age, sex, alcoholism, psychiatric diagnosis, and health locus of control. These findings deviates from Wallston and Wallston's (1978) position that the relationship between locus of control and health may assume greater importance with increasing age.

However, the findings on marital status, and education are in the opposite direction. It was revealed that single internally controlled individuals differ significantly from significant others and chance controlled groups. This finding is in consonance with Lee and Mancini (1981) work that revealed that internally controlled single women were more likely to use effective contraceptives than were

externally controlled women. Education also plays a significant role in influencing the amount of control an individual has over his/her health. It was found that those in the lowest educational cadre fall into the group of externals more while those in the highest educational cadre were more in the internal group. The results revealed a significant difference among various educational categories on chance subscale of health locus of control. There is the possibility that as one gets higher on the ladder of educational status, there tends to be more of rationality and objectivity in individual thought patterns. As such, it becomes easier to discard superstitious and mystical beliefs. It seems that education broaden one's horizon and gives room for rational thinking.

While manifest results indicates that our subjects are internal and powerful others controlled, the latent exploration revealed that they failed to accept responsibility which is a crucial feature of locus of control. Majority of our subjects' felt that they are not in control of their health neither are they to be blamed for their ill health. Hence, their fate health wise lies outside their control. This point to various notions that Africans are not ready to accept blame. An average African individual will rather shift the blame to someone else. Another possible explanation is the predominant fatalistic beliefs inherent among African people. The possible effects of collectivism may account for a significant percentage of the people who believed their health outcomes are controlled by significant others. Unlike individualistic approach that dominates western thinking, African in general and Yoruba race in particular still place an individual within collective domains. As such, an average African person is collectively unconscious.

If the belief in significant others represent the actual practice of the people, and they follow the advice of professionals, then there is hope that lifestyle diseases that accompany health risk behaviours will be reduced drastically in years to come. But these may not necessarily be so as noted by Feyisetan, (1988; 1992), Feyisetan and Adeokun, 1989). It appears that "while people's perceptions of disease etiology and their choice of preventive or therapeutic measures will be correlated, there may be occasions when they are not. While an individual that attributes a disease to supernatural forces may seek modern medical treatment, another individual with a rational perception of disease agent may seek a magical (or traditional) cure if he believes that modern medical treatments have failed to achieve his desired ends.

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Lipid and Fatty Acid Profiles of Wild Stocks of Juvenile and Adult *Tilapia Zillii* (Gervais)

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Abstract

Lipid and fatty acid profiles of wild stocks of juvenile and adult *Tilapia zillii* (Gervais) were studied to provide baseline information specific to this species as well as strengthen fragmentary documents needed for future nutritional studies of tilapias that are receiving renewed interest on their culture. Juveniles of SL, 2.00 to 3.99 cm and adult fish of SL, 10.00 to 11.99 cm were used for this exercise. Mean total lipid contents were 7.59 % and 1.26 % for juveniles and adults respectively. Lipid classes present were cholesterol esters, triacyl glycerol, diacyl glycerol, free fatty acids, cholesterol and phospholipids. The major fatty acids in juveniles were, C_{18,9} or Octatetraenoic acid (32.2 %), C_{18,3} or Octadienoic acid (24.19 %) and C_{18,0} or Stearic or Octadecenoic acids (19.77 %). The major fatty acids in adults were, C_{16,0} or Palmitic or Hexadecenoic acid (9.64 %), C₂₂ or Behenic acid (9.45 %) and C_{18,0} or Stearic Octadecenoic (8.21 %).

The iodine number of juvenile fish lipid (189.997) differed significantly at $t \leq 0.05$ from that of adult *T.zillii* (190.256). Juvenile lipid mean peroxide value (7.313 $\mu\text{mole/g}$) did not differ significantly $t \geq 0.05$. and 18 degrees from that of adult lipid (7.305 $\mu\text{mole/g}$). They were therefore unoxidised lipids.

Introduction

Tilapia zillii (Gervais) is a member of the family: Cichlidae. Cichlids are found all over Africa, parts of America and Asia (Chimits, 1955, 1957; Fryer and Iles, 1972; Balarin, 1979). Tilapias are among the commercially exploited fish for human consumption especially in African lakes (Hicklings, 1961) and where these are not endemic, they have often been introduced and farmed in ponds (Hickling, 1971). *Sarotherodon* and *Oreochromis* species are the main tilapias cultured. As per Bardach *et al* (1972), *Sarotherodon mossambicus*, is probably the most extensively cultured tilapia in the world.

Since 1993, the growth of the *Tilapia* industry in the United States of America, has skyrocketed, both in terms of volume and corresponding value of imports. The renewed interest was triggered-off by sudden recognition of tilapias as excellent food by consumers in the US and around the world. *Tilapia* on a live weight basis, is now the third largest imported aquaculture product entering the United States

after farm-raised shrimp and Atlantic salmon (ANAC,2005). By 1994, Taiwan had gained controlling interest over the frozen fillets entering the US, Thailand, Indonesia and Taiwan continues to be major supplier of frozen fillets.

Tilapia zillii, in particular, has a wide occurrence in freshwater and estuarine water bodies, within the tropical and warm temperate regions. *T.zillii*, was found to live and reproduce in Lake Quarum, Egypt in salinities between 10-20 parts per thousand (El-Zarka *et al*, 1968) and in the Red Sea at salinity of 42.7 parts per thousand (Bayoumi, 1969). Most farmers however, consider *T.zillii*, a nuisance because of its small rarely commercial size (attaining maximum of 0.3 kg body weight) and the difficulty in controlling its relatively high spawning frequency. These reasons probably account for the scanty information available on the nutrition of *T.zillii*. However, from the viewpoint of its economic importance, *T.zillii*, as a detritus feeder (Payne, 1971), if raised in polyculture with other species, would enhance higher percentage utilization of pond production potentials.

Considerable attention has recently been paid to the essential fatty acid requirement of fish (Farkas *et al*, 1977; Watanabe,1982; Mukhopadhyay *et.al*,1991). Brockerhoff *et al* (1964b) found phytoplankton and zooplankton taken from the North Atlantic to have the Polyenoic C₂₀ and C₂₂ acids preferentially bound to the 2-carbon of the triacyl glycerol (triglyceride) in the same manner as found in fish.

Higashi *et al*, (1964) found rainbow trout fed on a practical diet of fish meal, soybean meal, wheat meal and liver, grew well with as much as 25% added marine oils. From their study on the carp, *Catla catla*, Mukhopadhyay and Rout,(1996), concluded that fatty acid profile of whole body is influenced by dietary fatty acid composition. Thus nutritional studies indicate fish growth is affected by the types and levels of lipids supplied in their diets.

Despite recently, renewed interest in mass culture of tilapias on a global scale, there is still a major constraint in developing complete diets for intensive tilapia culture and this is the limited nutritional knowledge specific to species of tilapias. This study is one in a series aimed at providing baseline information on nutrition of *T.zillii* as well as strengthening fragmentary documents needed for future studies of lipids and invariably, fatty acid requirements in nutrition of other tilapias and finfish in general.

Materials and Methods

Collection of fish specimens: Juvenile *T.zillii*, were caught with a scoopnet (65 cm long with 2 mm stretched mesh and a ring of external diameter, 36 cm and internal diameter of 34.5cm, along the shallow margins of Oba Dam, University of Ibadan, Ibadan. To catch adult fish specimens, cast nets were employed. Fish specimens were transported live in a Coleman Ice-Chest and within 3 hours of capture to Fish Technology Laboratory of Nigerian Institute of Oceanography and Marine Research (NIOMR), Lagos. In the Laboratory, they were maintained in well-aerated tanks for the next 21hours so that their digestive tracts would be cleared of residual food, which would otherwise tend to increase their mass prior to weighing.

Fish specimens were killed after 24 hours of capture by freezing and work commenced on them immediately. When work was not possible immediately, they were transferred to a cold store at a temperature of -20°C until they were required but usually within 2-3 days post-capture.

Laboratory Measurements

Total length (TL) and Standard length (SL) were measured on a graduated measuring board to the nearest 0.5 cm, while body weights (BW) were taken to the nearest tenth of a milligram using a top-loading Mettler balance (P1200N).

Lipid Analysis:

Fish from each class, juvenile and adult, were thawed (if frozen), beheaded, scales removed, eviscerated, bones separated from the flesh i.e. filleted, the flesh was minced and thoroughly mixed. The lipid extraction was performed by the method of Bligh and Dyer (1959). A few crystals of 2, 6, ditertiary-butyl-4-methyl phenol or butylated hydroxy -toluene (BHT) antioxidant were added to the extraction solvent in order to minimize oxidation. Another antioxidant, butylated hydroxy- anisole (BHA) was used for another set of extractions. The homogenate was then filtered under pressure on a sintered glass filter, the contents were collected in a separating funnel (PTFE-stop-cock) and the two layers allowed to separate. The lower layer was then run off, concentrated on a rotary film evaporator and the solute finally dried on a high vacuum line. All lipid extracts were weighed and the percentage lipid content of the tissues were calculated.

Iodine Number, measuring the relative unsaturation of fats, was determined by the Wij's Iodine Method while Peroxide Value, was determined by the modified Bank's method.

Total lipids in terms of all major lipids were determined by Thin Layer Chromatography (TLC) using the solvent systems of Freeman and West (1966). Solvent system A, comprised diethyl ether (40 ml), benzene (50 ml), ethanol (2 ml) and acetic acid (90.2 ml). Solvent system B comprised ethyl ether (6 ml) and hexane (94 ml) in a ratio of 6:94.

Fatty acid methyl esters (FAME) of extracted lipids were prepared by H₂SO₄ -catalyzed methylation as described by Christie (1982). A crystal of butylated hydroxytoluene (BHT) was added as an antioxidant. In another set of experiments, butylated hydroxyanisole (BHA) was used as antioxidant. Nitrogen gas was introduced into the sample bottle to further check oxidation. The efficiency of conversion to methyl esters was checked by TLC on silica gel G plates, hexane-diethyl ether-acetic acid (90:10:1ml) being used as the developing solvent. The spots were revealed with iodine vapour.

Gas liquid chromatography (GLC) was used to separate the free fatty acids. 0.5ml of hexane-extract of the esters were injected into the gas liquid chromatograph incorporating a 1.5m x 4mm (i.d.) glass packed with 25% DEGS (diethylene glucol succinate) on chromosob WHP mesh 100/120. The temperature was programmed linearly at a particular temperature for each lipid. The carrier gas was oxygen-free nitrogen at a flow-rate of 25ml/minute. Attenuation was 10×10^2 and chart speed was 240 sec/cm. The gas -liquid Chromatography instrument was equipped with a flame ionization detector.

To determine the composition of hexane-extract, information on the observed peaks were used for subsequent calculations of retention times (RT), relative retention time (RRT), and the equivalent chain length (ECL). The retention time in seconds is the product of the distance (S cm) from the point of injection of hexane extract into the gas liquid chromatography set-up and the chart speed V seconds/cm.

The RRT is the quotient of retention time of the standard fatty acid (Stearic or Octadecanoic acid, C_{18.0} in this case) used and the retention time of a peak. The ECL is the hypothetical carbon number of a saturated methyl ester with the same retention time as the particular ester.

In order to determine the ECL, a plot of log₁₀ RRT against carbon number was made and extrapolations of RRT on the carbon number axis, gave the ECL. The equivalent chain length (ECL) gave the corresponding fatty acids.

Results

Lipid Classes

Presented in Table 1, is the result of qualitative and quantitative analysis of total lipids and fat constants of two size classes of *T.zillii* namely, juvenile (SL. range, 2.00 to 3.99 cm) and adult (SL. range, 10.00 to 11.99 cm).

Table 1: Lipid Classes, Fat Constants and Percentage Lipid Extracted from Fillets of Juvenile and Adult *Tilapia zilli*

Lipid classes	Juvenile	Adult
Hydrocarbon	n.d.	n.d.
Cholesterol ester	p	p
Triacyl glycerol	p	p
Diacyl glycerol	p	p
Monoacyl glycerol	n.d.	n.d.
Ester	n.d.	n.d.
Free fatty acid	p	p
Cholesterol	p	p
Phospholipids	p	p
Total Lipids (%)	7.59	1.26
Mean Iodine Number	189.997	190.256
Mean Peroxide Value (umole/g)	7.313	7.305

n.d. = not determined

p = present

N for each determination = 10.

Table I, shows hydrocarbons, monoacyl glycerol and esters were absent from the lipids in fillets of both juvenile and adult of the experimental fish. The lipid classes present and identified, were cholesterol esters, triacyl glycerol, diacyl glycerol, free fatty acids, cholesterol and phospholipids.

Total lipids extracted from the fillets of both size classes had mean values of 7.59 % for juvenile and 1.26 % for adult (Table I). Table I also shows the mean values of iodine number which indicates the degree of saturation of fatty acids in lipids was lower (189.997) in juveniles that in adult lipid for which 190.256 was obtained. Test of significant difference between these values indicated that the difference, 0.289 was quite significant at $t \leq 0.05$ and $18(n+m-2)$ degrees of freedom. The calculated t-value was 2.260. The 95% confidence limit of the detected difference ± 0.269 . This implied that the actual difference between the values of iodine number fell within the range of 0.020 to 0.558 with a probability of 0.95.

The peroxide value (PV) which indicates the degree of saturation of fatty acids in lipids and their subsequent rancidity, was lower in juveniles, 7.313 mole/g while 7.305 mole/g was obtained for adults (Table 1). Results of t-test, did not indicate any significant difference between these values at 18 degrees of freedom and $t \geq 0.05$.

Fatty acid composition of juvenile *T.zillii* standard length of 2.00-3.99cm.

Results of GLC analysis of FAME of juvenile experimental fish are summarized in Table 2.

Table 2: Fatty Acids (as equivalent chain length) Present in Hexane Extract of Juvenile *Tilapia zilli*

Peak	Equivalent chain length	Fatty acid	Concentration of fatty acid (% Area)	Type of Fatty acid
1	142.5/5	14.5	0.6553	Tetratrienoic acid (Unsaturated)
2	16.0	16.0	0.1202	Hexadecanoic acid [Palmitic] (Saturated)
3	161/5	16.2	1.8712	Hexadienoic acid [Palmitoleic] (Unsaturated)
4	18.0	18.0	19.7648	Octadecenoic acid [Stearic] (Saturated)
5	181.5/5	18.3	24.1911	Octadienoic acid [Linolenic] (Unsaturated)
6	184.5/5	18.9	32.2145	Octatetraenoic acid (Unsaturated)
7	203/5	20.6	4.0505	Tetrienoic acid (Unsaturated)
8	22.0	22.0	2.5775	Behenic acid (Saturated)
9	-	-	14.5549	Unidentified fraction

Key: () = State of saturation

[] = Common name

Table 2 shows the equivalent chain lengths (ECL), corresponding fatty acid, their concentration in terms of percentage area and type of fatty acid for each of the peaks obtained on the chromatograph. C₁₄, C₁₆, C₁₈, C₂₀ and C₂₂ fatty acids were present in hexane extract of juvenile *T.zillii*. Apart from C₁₄ acid which was present in only the unsaturated form, the others, C₁₆, C₁₈, C₂₀ and C₂₂ appeared in both saturated and unsaturated forms (Table 2).

C₁₆ acid in the saturated form (hexadecanoic or palmitic acid), was least in concentration, accounting for 0.1202% of area under the curve. C₁₈ acid in both saturated and unsaturated forms appeared in relatively quite significant proportion. C_{18,9} acid had a concentration of 32.22% which was the highest while C_{18,3} acid or linolenic had a concentration of 24.19%.

All unsaturated acids contributed a total of 65.5601 %, all saturated acids contributed 19.8860% while 14.5549% were contributed by unidentified fraction.

Fatty acid composition of adult *T.zillii* standard length of 10.00-11.99cm.

Results obtained from GLC analysis of FAME of adult *T.zillii* are presented in Table 3.

Table 3: Fatty Acids (as equivalent chain length) Present in Hexane Extract of Adult *Tilapia zilli*

Peak	Equivalent chain length	Fatty Acid	Concentration (%) (Area)	Type of Acid
1	141/5	14.2	1.7371	Tetradecenoic acid (Unsaturated)
2	142/5	14.4	0.7900	Tetradienoic acid (Unsaturated)
3	143/5	14.6	1.2638	Tetratrienoic acid (Unsaturated)
4	16.0	16.0	9.6367	Hexadecenoic [Palmitic] (Saturated)
5	162/5	16.4	4.4234	Hexadienoic (Unsaturated)
6	163/5	16.6	3.0016	Hexatrienoic (Unsaturated)
7	18.0	18.0	3.6385	Octadecenoic (Saturated)
8	181/5	18.2	8.2149	Octadecenoic (Unsaturated)
9	184/5	18.4	4.7393	Octadienoic (Unsaturated)
10	201/5	20.2	6.3191	Eicosadecenoic (Unsaturated)
11	203/5	20.6	5.6872	Eicosatrienoic (Unsaturated)
12	221/5	22.2	9.4785	(Unsaturated)
13	-	-	41.0699	Unidentified fraction

Key: () = State of saturation

[] = Common name

Table 3 shows the equivalent chain lengths (ECL), corresponding fatty acids, their concentration and types for each of the 12 peaks obtained by GLC. Only C_{16.0} and C_{18.0} occurred in the saturated for while like for juvenile *T.zillii*, C₁₄, C₁₆, C₂₀ and C₂₂ were present in the unsaturated forms. C_{16.0} occurred in the highest proportion, C_{22.2} followed closely with a concentration of 9.48 % while C_{18.2} had a concentration of 8.22 %. C_{14.4} acid occurred in the least amount of 0.79 %.

All unsaturated acids contributed a total of 45.6549 %, all saturated acids contributed 13.2752 % while 41.0699 % were contributed by unidentified fraction.

Comparatively, C_{14.2}, C_{14.4}, C_{14.6}, C_{16.4}, C_{16.6}, C_{18.2}, C_{18.4}, C_{20.2} and C_{22.2} acids present in adult fish hexane extract were absent from hexane extract of juvenile *T.zillii* (Tables 2 and 3).

Discussion.

It was observed in the present work, that similar lipid classes-cholesterol esters, triacyl glycerol, diacyl glycerol, free fatty acids, cholesterol and phospholipids were found to be present in the chloroform-methanol extracts of juvenile and adult *T.zillii*. While hydrocarbons were not detected in the total lipid fractions of the experimental fish, Jaysinghe *et al* (2003) recorded 2.5- 11.6 hydrocarbon in the liver of shallow water sharks. Absence of hydrocarbons from the lipids analyzed, may suggest that Oba Reservoir, University of Ibadan, is not polluted by petroleum products.

The range of fatty acids found in hexane extract of both juvenile and adult *T.zillii*, $C_{14.2}$ to $C_{22.2}$, lie within that C_{14} to C_{24} which according to Bailey (1952), has been found to occur in marine fish oils. Anyila *et al* (1993), detected C_{12} or Lauric acid in pond-reared juvenile and adult of *Oreochromis niloticus*. This particular fatty acid, was absent from the chromatographs of both juvenile and adult *T.zillii*.

The observed significantly different ($t \leq 0.05$) iodine number of lipids of juvenile and adult *T.zillii* suggest significant differences in their degree of unsaturation. Both values were however, higher than iodine number of 160, reported for cormish mackerel, *Scomber scombrus*, by Hardy and Keay (1972).

The fatty acids identified in both juvenile and adult *T.zillii* contain substantial proportions of long chain, many of which are highly unsaturated. For example, all unsaturated acids in juveniles contributed a total of 65.5601 %, while adults contributed 45.6549 %. Among the saturated acids, juveniles accounted for 19.8860% while adults contributed 13.2752 %.

The observation that Palmitic acid ($C_{16.0}$) occurred in the highest concentration in adult agrees with the findings of Jayasinghe *et al* (2003), who reported that palmitic acid was the predominant fatty acid in all shark species studied. Equally, Jadranka *et al*,(2005), reported that palmitic acid was most dominant (20.8-43.4%) in the edible muscle tissue and liver of *Diplodus vulgaris* from the North Adriatic sea, Croatia In the present study however, palmitic acid ($C_{16.0}$) was the least in concentration in the lipid of juvenile experimental fish while stearic acid was higher ($C_{18.0}$).Mba (1980) reported that the fatty acid in the fish species he studied, were predominantly in the palmitic and stearic classes. Unlike the fatty acid profile reported by Anyila *et al* (1993) for all stages of fish they studied, level of arachidonic acid ($C_{20:4}$ w6) and absence of docosahexaenoic acid ($C_{22:6}$ w3), $C_{22.2}$ was observed to be the second highest fatty acid in adult while $C_{20.6}$ for both size classes were relatively low in concentration. In their studies, Lovern (1842) and Hilditch and Williams (1964) observed that fats of freshwater animals contain high proportions of palmitic and stearic acids while C_{20} and C_{22} acids are present in smaller proportions than fats of marine animals.

The reason why aquatic organisms unlike terrestrial one require, store and utilize such highly unsaturated fatty acids, is not at all clear. Undoubtedly, much of the materials is ingested in the diet (Lovern 1938, Kelly *et al*, 1958) but often in the process, the dietary lipids are broken down and re-synthesized (Brockerhoff and Hoyle, 1967). Synthesis of these lipids can also occur from non-fatty precursors. Studies of lipids of anaerobic organisms give no indication that life under oxygen deficient condition, induce unsaturated lipid production.

Other authors have indicated that lipids with their low specific gravity properties may have important hydrostatic function (Shul'man, 1960, Lewis, 1970). Again it is not clear why highly unsaturated lipids should be required for this function or induced for another role postulated for lipids, i.e. providing thermal insulation (Shull'man,1960).

In general, only pelagic fish have a high body lipid content and it would thus seem that such insulation by lipid is not a general requirement of fish even those found predominantly in cold water. Perhaps the overriding requirement is that of maintaining fluidity of the extra cellular lipids at low temperature.

Evidence for this has been provided by Farkas and Herodek (1964), who showed that selected freshwater crustacean, there is an inverse relationship between water temperature and iodine number and a direct relationship between water temperature and iodine number and lipids melting point. In particular, the melting points of lipids were always just below the mean temperature of environmental water. Finally, Lewis (1962), indicated that unsaturated lipids with their low melting point characteristics may be a means of keeping protoplasmic viscosity within the range of normal metabolic process.

It was observed in the present study, that juveniles had more total lipids (7.59 %) in their fillets than adults (1.26 %). While value obtained for juveniles are higher than what Anyila *et al* (1993) recorded for fingerling of *Heterobranchus bidorsalis* (6.10 %), lipid content obtained in this study for adults (1.26 %), is lower than 2.60 % and 3.63 % recorded for adult *H. bidorsalis* and *O. niloticus*

respectively by Anyila *et al* (1993). Jadranka *et al*,(2005), recorded total lipid of 1.1% and 4.5% in the edible muscle tissue and liver respectively of *Diplodus vulgaris* from the North Adriatic sea, Croatia.

While wild stocks of *T.zillii* were studied in the present work, Anyila *et al* (1993) used hatchery-raised fish stock for their studies. It was very likely, diets had effect on the lipid contents. Another possible reason why juveniles had higher values of total lipid, is that they were not diverting energy for gonad maturation as it is always the case with adults.

The peroxide values (PV) obtained in the present study, (7.31 umole/g) fell within the normal range for unoxidised lipids. Scanty information in literature on PV analysis of related species of fish following feeding in the wild, hamper comparison of any previous work with the present. Information obtained from this work therefore, is a great contribution to the knowledge of composition of a wild tropical fish.

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Modelling of Instantaneous Current Value (ICV) for Fault Detection in Power Systems

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Abstract

The complex nature of electrical power system and the instability at which the system now operates has increased the occurrence of failures in the network drastically. By improving fault detection and clearance time, system stability can be achieved. Fault detection speed of a relay is therefore very important for system reliability and stability. This paper presents fault detection and clearance algorithm which is able to detect and clear system faults very fast (within 1.32ms). The modelling utilised is instantaneous current values (ICV) model. The algorithm was validated by comparing its performance with popular fast fault detection models, and it was confirmed superior.

Keywords: Power system, ICV, Relays, ADC, DEM, LSQ, Faults.

Introduction

Fault detection and clearing were earlier administered by maintenance staff, who visually detected the fault and manually operated a switch to clear the fault. As fault currents became larger and more complex to be handled manually, the need for automatic fault clearance became a necessity.

Protection relays are designed to quickly detect possible disturbances and isolate the faulted system from the rest of network [1]. The faster the fault is cleared, the smaller the disturbance the fault will inflict on the system. Fault detection speed of a relay is an important feature. A relay should be sufficiently sensitive so that it operates reliably when required [2].

The introduction of relays as protection device on over-current principle brought about the era of fast fault detection [3, 5]. All the relays developed until 1940s were electromechanical relays, and must generate sufficient torque to trip circuit breakers. The advent of computers and digital technology since 1960s has been an important milestone in the history of power system protection [6]. Digital relays have mostly replaced the pre-existing electromechanical and static relays and introduced new relaying principles which were not feasible in the analogue type. The advancements in communication technology and new protocols that allow direct relay to relay communication have led the way to intelligent electronic devices [4].

The concept of sampling and holding voltage and current signals, and the development of digital computers led to digital (numerical) protection schemes [7]. Hence, numerical impedance calculation methods allowed digital techniques to be used in transmission line protection. Logic operations were assigned to detect a fault, locate it and initiate the tripping of the appropriate breaker [8].

The limitations of impedance relays motivated the use of filters attenuate high frequency signals generated by fault transients [9]. The presence of transients influences the accuracy of the impedance

estimate. The filtering process involved an inherent delay and could not be eliminated from many fast fault detection models. Attempts to increase the speed of the impedance relays to 6.91ms affected the accuracy of the impedance measurement [10]. The need to improve the fault detection and clearance times motivated consideration of high frequency transient signals for relaying purposes.

Researchers have investigated fault detection response time of traveling wave and impedance relays for different fault types and discovered that the former always detects faults quickly when steep wave-fronts are present, while impedance relays are slower but detects all faults within its reach [12]. Ultra High Speed relaying (UHS-relaying) was discovered and used for fault detection within a quarter of power frequency [13]. Common models used for UHS-relaying are so called traveling wave models. They measure the traveling waves generated by the initiation of fault.

Discrete Fourier Transform (DFT), Differential Equation Model (DEM) and Least Square Model (LSQ) were utilized for digital relay scheme but LSQ model did not take account of dc components, though it detected fault in 4ms while DEM detected fault within 1.75ms [14].

A superior model to the techniques discussed earlier to detect faults is presented in this paper. The model is instantaneous current value (ICV), with the ability to detect and clear faults within 1.32ms. It uses the instantaneous value of a sampled current to detect a fault when a certain level of current is exceeded. It is designed to quickly detect possible disturbances and isolate the faulted system from the rest of the network. It is reliable, secure, selective, fast and sensitive.

Modelling ICV Relay

Models for fault detection in numerical protection relays have been of academic and industrial interest. The ICV model is a DFT modified waveform model. The model fits sampled data values to a sinusoidal signal and the magnitude of the current at sampling value k for three consecutive current samples i_{-1} , i_0 and i_1 is denoted by $|I_k|$ given as [15, 16]:

$$|I_k| = \sqrt{(I_C^2 + I_s^2)} \quad (1)$$

Where,

$$I_C = \frac{i_1 \cos \theta + i_0 + i_{-1} \cos \theta}{1 + 2 \cos^2 \theta} \quad (2)$$

$$I_s = \frac{i_1 - i_{-1}}{2 \sin \theta} \quad (3)$$

The power frequency angle between two consecutive samples is given as:

$$\theta = 2\pi f_0 \Delta t \quad (4)$$

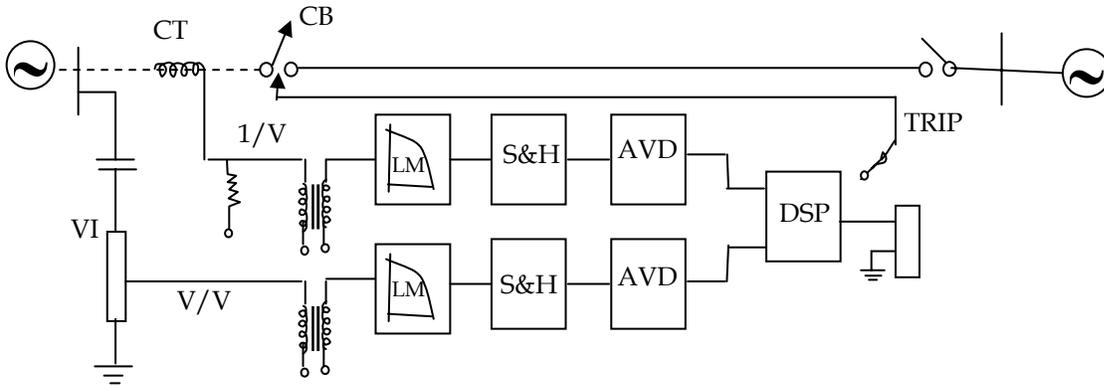
Where f_0 is the power frequency of the power system and Δt is the time difference between two consecutive samples. Whenever the estimated current I_k exceeds the predetermined trigger level, a fault will be detected and a trip-signal issued to control a circuit-breaker or a fault current limiting apparatus attached to a relay.

ICV Relay Configuration

In fig.1, the current and voltage at the relay point are measured with current transformers (CT) and voltage transformers (VT) respectively. The magnitude of the measured signals on the secondary side of the voltage and current transducers are further reduced using secondary transformers in order to bring the signal levels down to acceptable levels for microprocessor relays. The voltage and current transducer outputs are captured by the sample and hold circuits (S&H) at pre-specified time instances. These samples are then converted to discrete values by a linear gain input analog to digital converter (ADC). The sampled voltage and current signals are then sent to the microprocessor for processing. A

high-speed digital signal processor (DSP) capable of handling the extensive calculations described earlier was chosen for implementation.

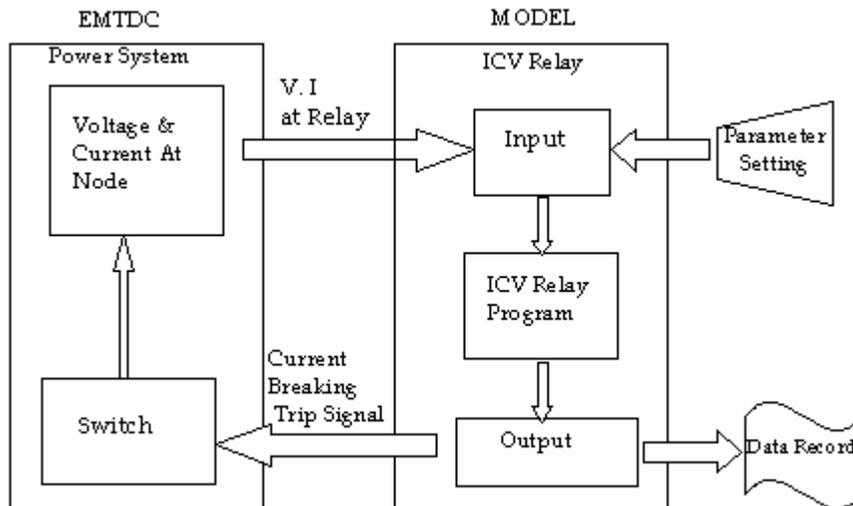
Fig. 1: ICV relay Configuration



Relay Operation of Icv

The operational description of ICV relay is depicted in fig 2. The signals of the node voltage values and the node **current values** are sent to the inputs of the model to be processed by the program. The parameter settings are also used in the program of the model to provide reference state of system. When a fault is detected, the model sends a trip signal to the circuit breaker and opening command of the Electric-Magnetic Transient Program (EMTP) switch to the EMTP main simulation. The output signals from the model changes the state of the power system. This process is repeated until simulation is completed.

Fig. 2: Operational Diagram of ICV Relay

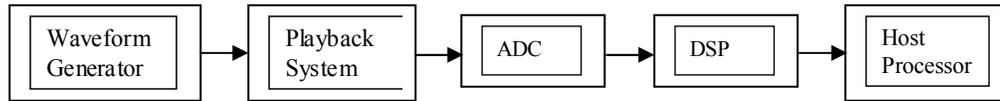


Laboratory Test for ICV

The configuration of the test setup comprises the waveform generator, playback system, data converter, DSP and host processor. The waveforms related to fault are generated by EMTP software. The voltage and current waveforms were regenerated as analog signals using a real time playback system [17].

The waveforms from the playback generator were sampled data were then processed in the DSP which performs the relay function. A host processor was used for configuring the DSP and monitoring the relay status. When a **fault is identified, a trip signal is sent back to the playback generator which accepts it as a digital input and records the trip time. A total of 20 simulations were performed. The block diagram of this arrangement is shown in figure 3.**

Fig 3: Block Diagram of the laboratory Test setup of ICV Model.



Characteristics of the Model

The model can detect, classify and clear faults correctly and rapidly and its performance is not affected by transients that are not faults. It can also determine the fault type, using its fault classification features, and quickly and correctly detect different kind of faults. It has good noise immunity, robustness and little fault tolerance. The decisions made by this model are not affected by variations in power system parameter.

ICV Model Validation

The simulations were performed using two power systems– IEC standard test data and power system data from Universal Steel limited, Lagos, Nigeria. For faults on a medium voltage transmission line (32/11kv), the transient signals can have a bandwidth as high as 16 kHz [18]. It was therefore decided that considering frequencies below 16 kHz is quite adequate for this experiment.

Three circuit-breakers, B_1 , B_2 and B_3 were used to apply three power system transients for both test systems (see fig 4 and 5). Breaker B_1 , was used to simulate faults imposed on the power system, B_2 was used to simulate capacitor (C) energization and B_3 for transformer (T).

The capacitor was rated at 4.08MVA/11kV and transformer rated at 10.2MVA/11kV. System voltages was selected as 11kV, nominal load current as 630A (measured at the load Z_L). Short-circuit phase current in case of a solid 3-phase fault was selected as 40kA.

Fig. 4: IEC Simulation Single Line Diagram

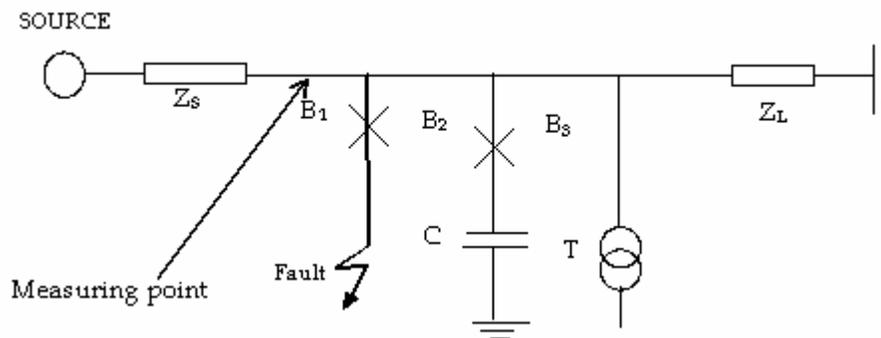
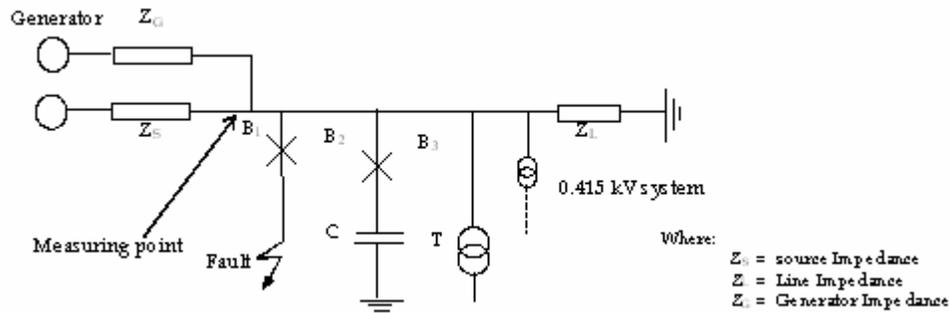


Fig. 5: Universal Steal Simulation Single Line

Results

A number of simulations were performed to estimate the current magnitude when a fault occurs. Three different types of fault detection models at different frequencies were compared namely: LSQ, DEM and ICV (See results in Appendix: Table A₁ and Table A₂).

Conclusion

Fault detection for power systems that requires fault removal or limitation before the first current peak after the initiation of short-circuit was studied. Simulations were performed with different power systems, taking note of the effect of fault currents frequencies and magnitudes on two existing fast-fault detection models. The performance of the models were compared with the designed instantaneous current values ICV model, and it is found that the ICV model was able to detect and clear a fault within 1.32ms. It was concluded that the developed algorithm for ICV model is superior to the earlier algorithms.

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Appendix

Table A1: Output Printout of Model showing Maximum Detection Time Results using different Frequencies for IEC power system.

Sampling Frequency	LSQ	DEM	ICV
1 kHz	3.00ms	4.00ms	1.00ms
2 kHz	1.50ms	3.00ms	0.75ms
4 kHz	0.75ms	2.00ms	0.50ms
8 kHz	0.38ms	1.00ms	0.25ms
16khz	No response	No response	0.34ms

Table A2: Output Printout of Model showing Maximum Detection Time Results using different Frequencies for Universal Steel Nigeria Limited Power System.

Sampling Frequency	LSQ	DEM	ICV
1 kHz	3.30ms	3.50ms	3.00ms
2 kHz	2.40ms	2.80ms	1.50ms
4 kHz	1.56ms	2.30ms	0.75ms
8 kHz	1.05ms	1.50ms	0.25ms

Consumer Protection in a Deregulated Economy: The Nigerian Experience

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Abstract

It is an unassailable fact that the protection of the consumers through law and policies is a soothing feature of contemporary commercial transactions. The advanced economies of the world have long responded to the social and economic feelings generated by consumerism by enacting laws, fashioning out policies and putting in place suitable regulatory measures to guide against the oppression, nay intimidation of the consumers in their daily interaction with the producers of goods and services.

Most of these advanced economies are heavily policed and regulated thus making it susceptible to control measures that ensure succour for the consumers. The same can hardly be said of the economies of the developing and third world countries that are left to the vagaries of the market system with its imperfections and consequent suffocating effects on the consumers of goods and services.

It is against the foregoing background that this paper examines consumer protection in a deregulated economy using Nigeria as a case study. The paper considers the various laws and institutions through which the consumers are protected and concludes that even though considerable progress has been made in recent years to protect the vast consuming public, consumer protection largely remains a farce in Nigeria of today.

The paper therefore recommends a more regulated consumer protection regime by way of a comprehensive consumer code where the rights and remedies of the consumers are well articulated. This will guide against the somewhat *laissez faire* system that holds sway presently and one that has made the consumers to remain as pawns in the hands of the sellers in the today's markets largely controlled and dominated by the sellers or producers of goods and services.

Introduction

Adam Smith in his work regarded as a monumental contribution to classical Economics had this to say:

Consumption is the sole end and purpose of all production and the interest of the producers ought to be attended to only so far as it may be necessary for promoting that of the consumer.¹

¹ Adam Smith, *Wealth of Nations* (1910) Vol 1.

The foregoing brilliant postulation is evident of the skewness of the relationship between the manufacturers or providers of goods or services on one hand and the consumers on the other in favour of the former such that the latter is often regarded as pawns in the hands of the former in the chain of production.

The centrality of the position of the consumers in the chain is often shown by the aphorism that there cannot be production without the consumers². Despite the importance of the consumer in the production process, he has often been treated as the sacrificial lamb whose interests are the least to be considered in the process³. Even classical Economists in identifying the factors of production of land, labour, capital and the entrepreneur neglected much to the chagrin of the consumer to mention and consider the interest of the person that would consume the end product of the combination of the factors of production⁴.

Today, that the consumer needs to be protected is no longer a subject of controversy and the reasons why he must be protected are also settled in favour of the need to address the imbalance in the bargaining power between the consumer and the producer or supplier of goods and services⁵. Since the consumer is often seen as a weaker party and therefore unable to protect himself, the modicum of protection offered to the consumer is often through the instrumentality of the state. This itself is done by means of legislation targeted at redressing the imbalance in the power relation between the producers and consumers⁶. The assumption of responsibility by the state to protect the consumers consciously or otherwise has gained momentum since the collapse of *laissez-faire*, a curious feature of the 18th century mercantilism in Europe⁷. The protection by the state is in addition to the pockets of protection offered to the consumers directly or indirectly at common law⁸.

In Nigeria, Consumer Protection has largely remained a farce until recently when conscious efforts were made by the government to set up a regulatory framework for the protection of the consumers through the Consumer Protection Council Act⁹. Though before the Act, there were a number of legislations through which the consumers were indirectly or unconsciously protected¹⁰.

Since the introduction of the Structural Adjustment Programme in 1986, Nigeria has pursued relentlessly the objectives of the programme including a policy of deregulation. With the major sectors of the economy being caught in the web of deregulation, this paper seeks to examine the protection of the consumer vis-à-vis the government policy of deregulation and the challenges facing the consumer protection regulatory institutions in Nigeria with the view to ensuring that the consumers are not made the sacrificial lambs by losing the modest gain made in the realm of consumer protection in the last few years.¹¹

² Consumption is often said to be the end product of production. The process is also complete only when the goods are available to the ultimate users, the consumers.

³ The consumer being at the tail end of production is considered as not being important and always willing to accept whatever goods or products that are made available to him.

⁴ The factors of production in traditional economics are land, labour, capital and the entrepreneur. The consumer is clearly excluded.

⁵ See Kanyip, B (1999) "Consumers, Producer Hegemony and the Nigerian Economy" a public lecture delivered at Arewa House, Kaduna on 18th March, 1999 at p.2; Also Harvey W and Parry, D, *The Law of Consumer Protection and Fair trading* (1987) pg. 13.

⁶ See Cranston R "Regulation and Deregulation General Issues" (1982) 5 *Univ. of N. South Law Journal*, at p.1.

⁷ Kanyip B. *op cit* at p.2.

⁸ For instance the rules relating to sale of goods as contained in the Sale of Goods Act have some pockets of protection for the consumers and the tort of negligence.

⁹ Decree 66 of 1992 now Cap C25, *Laws of the Federation of Nigeria*, 2004.

¹⁰ See for example Sale of Goods Act and Law in Western Nigeria; Hire Purchase Act, 1965, Standard Organization of Nigeria Act, 1971; Weight and Measures Act, 1974, Food and Drugs Act, 1974 and the Price Control Act, 1977.

¹¹ The structural Adjustment Programme (SAP) was introduced in 1986 and a cardinal objective of the programme was to deregulate the major sectors of the Nigerian economy.

Conceptual Framework

The Concept of a Consumer

There is no universally acceptable definition of a consumer in commercial transactions as text writers and legal draftsmen are not unanimous about the meaning of a consumer that should be protected in his relationship with the producer or supplier of goods and services¹². The Black Law Dictionary defines consumer as one who consumes, individuals who purchase, use, maintain and dispose of products and services, users of final products, a member of the broad class of people who is affected by pricing policies, financing policies, quality of goods and services, credit reporting, debt collection and other trade practices for which the state and general protection laws are enacted¹³.

O'Grady defines consumer as the final or end user of all goods and services produced in an economy¹⁴. Tarr (1984) defines consumer as any person, natural or legal, to whom goods, services or credit are supplied or sought to be supplied by another in the course of a business carried on by him¹⁵.

In attempting a definition of the consumer, a distinction has also been made between the personal consumer and the organizational consumer¹⁶. The personal consumer is the individual who buys goods and services for his own use or for the use of his household and in this respect, the goods or services bought must be consumed as end or ultimate users. An organizational consumer on the other hand, refers to private organizations, government agencies and institutions who must buy products or services to be able to pursue the objectives of such organizations.

The Fair Trading Act 1973 (UK) defines a consumer as any person who is either,

- (a) *A person to whom goods are supplied or are sought to be supplied (whether by way of sale or otherwise) in the course of business carried on by the person supplying or seeking to supply them, or*
- (b) *A person to whom services are sought to be supplied in the course of a business carried on by the person supplying or seeking to supply them and who does not receive or seek to receive the services in the course of a business carried on by him¹⁷*

The Consumer Protection Council Act¹⁸ defines a consumer as an individual who purchases, uses, maintains or disposes of products or services. The foregoing definition removes the restrictions imposed by the English Legislation by defining the consumer and producer/supplier relationship as contractual. The definition has however been criticized as superfluous to the extent that it includes such words as "maintains and disposes" which clearly mean that even after the purchase and usage of a product or a service, a person can still be described as a consumer¹⁹.

The English authorities have gone ahead to ascribe to consumer transactions three elements. First, that the consumer must be an individual who does not act in a business capacity. Second, the supplier of goods and services must act in a business capacity. Third, the goods or services must be intended for private and not business use²⁰.

A learned writer has criticized the above approach to the definition of consumer transactions on two grounds²¹. First, it is limited in application in suggesting and providing for a consumer, purchaser and a supplier who contracts in the course of business with the effect that the consumer in the contemplation

¹² See Monye, F. op cit at p. 17, Harvey, op. cit at p.7.

¹³ Blacklaw Dictionary, 6th Edition p. 316

¹⁴ O'Grady (1982), "Consumer Remedies", 60 Canadian Law Review (No 4) p. 549

¹⁵ Tarr (1981-84), "Consumer Protection and the Market Place," 5 Otago Law Review, p. 397

¹⁶ Schiffman, LG&Anor (1978), Consumer Behaviour, p.4

¹⁷ S.137 (2) Fair Trading Act 1973 (UK)

¹⁸ Section 32, Consumer Protection Council Act, 1992

¹⁹ For example, Ajai, op cit criticized the word "dispose" as an aberration. Also, Adekunle, O. A. in "Consumer Representation and Participation in Economic and Political Processes in Political Reform and Economic Recovery of Nigeria, NIALS, 2001 at p. 5 where he reasoned that the notion that even in the course of selling products an individual can still be described as a consumer is undoubtedly novel.

²⁰ Oughton, D.W. Consumer Law: Text Cases and Materials (Blackstone Press Ltd: London), 1991 at p.11.

²¹ Kanyip,B, (1997), "Historical Analysis of Consumer Protection Laws in Nigeria, NIALS, Lagos at p.2

of the principle laid down in the case of *Donoghue v. Stevenson*²² is excluded. Secondly, the insistence on a contractual relationship means that the concept of freedom, sanctity and privity of contract which limit protection for the consumers will become applicable.

It is suggested as also reasoned by the foregoing learned author²³ that the approach in Section 32 of the Consumer Protection Council Act²⁴ is preferable. The attempt to confine the term consumer to purchasers of goods or services is rather restrictive and objectionable. The implication is that only a contractual consumer can qualify as a consumer for purposes of a protection. A learned author has argued that the approach would adversely affect possible claims of many end users that may not be in the direct contractual relationship with the producers or suppliers of goods and services²⁵.

The reference to individuals in the definition of a consumer is also noteworthy. It suggests that only natural persons can be consumers under the Consumer Protection Council Act. It is suggested that individuals should be interpreted to include partnerships and other unincorporated associations that may also engage in commercial transactions in the appropriate circumstances²⁶.

In modern times, the term “consumer” has been interpreted to include any person who purchases or is supplied goods, or uses or consumes goods or services at the end of a chain of production²⁷. This thus includes the otherwise excluded plaintiff in the case of *Donoghue v. Stevenson*²⁸. The cases that followed *Donoghue v. Stevenson* have established clearly that the modern conceptualization of the consumer includes purchaser of any kind of goods or services including a bus, train or air ticket, consultancy service, banking, telecommunication service, purchase of goods through the internet (e-commerce) and any person who is supplied electricity, telephone, water, gas or petroleum products²⁹.

The Legal and Regulatory Framework of Consumer Protection

There are a plethora of laws that directly or indirectly protect the consumer in Nigeria. Most of these laws do not have the consumers directly in mind, but in the process of fashioning out macro and micro economic policies for good governance and regulation of the economy, the consumers are incidentally protected. Again, there are pockets of protection offered by common law. For the purposes of this paper however, four of the legislation and the institutions created under them shall be examined with the view to determining their adequacy or otherwise for the continued protection of the consumers in the era of deregulation.

The Standard Organisation of Nigeria Act

The Act³⁰ was enacted in 1971 with the aim of standardizing products in industries throughout Nigeria and to ensure compliance with the government policy on standardisation. It has been amended a number of times to ensure that the objectives of the Act are in conformity with the objectives of successive governments in Nigeria³¹. The Act established the Nigerian Standards Organization (SON)

22 (1932) A.C.32

23 Kanyip, B op. cit at p.2

24 Decree No 66 of 1992.

25 Monye, F, op cit at p.17.

26 See S.189(1) of the Consumer Credit Act 1974 (UK) where individual was defined as including partnership and other unincorporated body of persons not consisting entirely of bodies corporate.

27 See for example the case of *Amadi v. Essien* (1994) 1 NWLR 91; *Nigerian Bottling Co. v. Ngomadi* (1985) 1 WLR (Pt 4) 739 at 747.

28 (1932) A.C. 652

29 See Aremu, J.A. (2001) “Consumer Protection as a strategy for Social-Economic Growth and Development in Political Reform and Economic Recovery of Nigeria, NIALS, 2001 at p. 348; *Grant v. Australian Knitting Mills Ltd* (1940) A.C. 85; *Osemobor v. Niger Biscuit (Nig) Ltd* (1973) NCLR 382; *Croydon Corporation* (1938) 4 ALL ER 631

³⁰ Originally promulgated as Decree No 56 of 1971, but now Cap S9, Laws of the Federation of Nigeria, 2004.

³¹ See Decree No 20, 1976, Decree No 32, 1984, Decree No 18, 1990.

which is vested with wide functions and powers in respect of standardization³². Also, the Act established the Standards Council to award certification marks to manufacturers whose products do not only fall within those standards but are also of importance to the national economy³³.

The Act is thus of particular relevance to the consumers in that it regulates industrial standards and ensures that substandard products are not sold to the consumers. There is no doubt that the law will continue to be relevant in the armoury of the protection of the consumers in the era of deregulation.

Food and Drug Act

This Act was enacted in 1974³⁴ not directly as a consumer protection legislation³⁵, but to all intents and purposes, its intent is to protect the consuming public. The Act makes elaborate provisions for the regulation of manufacture, sale and advertisement of food, drugs, cosmetics and devices³⁶. These terms are elegantly defined in the Act³⁷. Under the Act, sale of any article of food which is unfit for a human consumption is prohibited³⁸. What is unfit for human consumption is not defined in the Act, but generally an article of food should be unfit for human consumption if it is shown that it is injurious or dangerous to health³⁹. The Act also prohibits the sale, importation and manufacture or storage of poisonous or harmful food, drugs and cosmetics⁴⁰. Thus, any substance which is capable of producing any adverse effect on the health of the consumer is regarded as harmful or poisonous. It is an offence which attracts penalties under the Act.

The Act further prohibits the sale of adulterated food or drugs⁴¹. The Act does not define adulteration but is defined somewhere else⁴² as the act of debasing a commercial commodity with the object of imitating or counterfeiting a pure or genuine commodity or substituting an inferior article for a superior one in order to gain an illegitimate profit.

The greatest challenge that is facing the Nigerian consumer today is in the area of fake and adulterated foods and drugs and the debilitating effect on the health and psyche of the consumer⁴³. While it is agreed that the National Agency for Food Drug Control and Administration (NAFDAC), an agency set up to enforce the provisions of the Food and Drugs Act has been up and doing in the area of creating consumer awareness of the existence of adulterated products and taking steps to destroy same, it is not certain if the culprits are prosecuted and penalized in accordance with the provisions of the Act to act as a deterrence to others.

It is suggested that such persons be promptly arrested and prosecuted and such prosecution publicised to the knowledge of the consumers. The Act also prohibits the importation and exportation of drugs specified in the second schedule except as authorized by regulations⁴⁴. It is also an offence to import into Nigeria any regulated product unless it is accompanied by a certificate from the manufacturer to the effect that it was manufactured in accordance with an existing standard or code of practice and where such code does not exist, in accordance with any international standard⁴⁵.

³² See section 1 (1) of the Standard Organisation Act Now caps S9, Laws of the Federation of Nigeria, 2004.

³³ See Section 2 of Cap S9

³⁴ Decree No of 1974 now Cap. F 32, Laws of the Federation of Nigeria, 2004

³⁵ No mention was made of the word "consumer" any where in the Act. See further the preamble to the Act.

³⁶ See S. 4 of the Act

³⁷ See section 20

³⁸ S. I (1) (b)

³⁹ See the cases of *David Greig Ltd v. Gold find* (1961) 105 Sol. J 367 *J. Miller Ltd v. Baltersea Borough Council* (1956) QB 43; *Turner & Sons Lts. V. Owen* (1956) 1 Q.B. 48. Contrast with *Lindley v. George W. Hornes co Ltd* (1950) 1 All ER 234.

⁴⁰ S.I (1) (a)

⁴¹ S.I (2)

⁴² *Strands Judicial Dictionary of Words and Phrases* 4th ed. London & Maxwell ltd (1973)

⁴³ From time to time NAFDAC publishes the list of fake products found in the Nigerian markets and warns the public against buying and consuming such products.

⁴⁴ See 5.3. of the Act

⁴⁵ See the laudable provisions of S. 8(2) of the Act.

The foregoing provisions are no doubt meant to safeguard the country from being used as a dumping ground for fake, adulterated and sub-standard products that may not have been accepted in the international markets. It is however disheartening that despite the foregoing provisions, our markets are inundated with fake and adulterated products. This has resulted in NAFDAC having a running battle with these dealers for quite sometime. Goods worth millions of Naira are being destroyed on regular basis where they are found to be adulterated or substandard⁴⁶.

It is a defence under the Act that a retailer was not aware of any fraud or sharp practice by the manufacturer when he sells or offers for sale goods manufactured by the manufacturer⁴⁷. In that situation, the manufacturer would be held liable. The provision is laudable to the extent that where the retailer cannot be held responsible for contravening the provisions of the Act, the manufacturer would be held responsible. It is suggested that the penalty of #50,000.00 or imprisonment for a term not exceeding two years⁴⁸ should be reviewed upward considering the gravity of the harm usually done to consumers and even the cost of doing such illicit business.

The National Agency for Food and Drug Administration and Control Act 1993

The National Agency for Food and Drug Administration and Control Act⁴⁹ was promulgated in 1993 by the Federal Government to regulate and control the importation, exportation, manufacturing, advertisement, sale and distribution of foods, drugs and cosmetics and medical devices⁵⁰. The Act also deals with the regulation and control of bottled water, chemicals and detergent powder⁵¹.

The Act created a regulatory body known as the National Agency For Food and Drug Administration and Control which was created as a body corporate with perpetual succession and may also sue and be sued in its corporate name⁵². The Agency ensures that manufactured products are safe for consumption by conducting appropriate tests from time to time on these products and by also ensuring that the manufacturers comply with the various specifications and standards set up by the Agency. The various consumer products to which the Act relates cannot be produced except the manufacturer has registered the product with NAFDAC. The agency has functions that are similar to those performed by the defunct Food and Drugs Department of the Federal Ministry of Health and Social services under the Food and Drugs Act⁵³.

The Agency is vested with very wide powers under the Act to ensure that regulated products are safe for human consumption⁵⁴. Thus, it has powers amongst others to carry out appropriate investigation into the premises where consumer products are produced and can also inspect the raw materials for making such regulated products and establish relevant quality assurance system including certification of production sites.

The truth is that the agency as it is constituted today has been in the forefront of the crusade for consumer protection in Nigeria. The agency has evidently overcome the slumber that largely characterized her existence in the formative years. It has been transformed into a veritable instrument through which protection and comfort have been brought to Nigerian consumers.

⁴⁶ For example, NAFDAC destroys from time to time fake and adulterated drugs and issues warning to the public to steer clear of such drugs.

⁴⁷ Sees. 18 (2)

⁴⁸ The upward review was done by the 1999 Amendment to s. 17 (I) of the Act, under the repealed section the maximum penalty was #1,000.00

⁴⁹ This Act was amended by the NAFDAC (Amendment) Act No 19, 1999 and The Tribunals (Certain Consequential Amendment etc) Act No 60, 1999.

⁵⁰ See s.5 of the Act.

⁵¹ Section 5 and 24 (5) (9).

⁵² Section 1.

⁵³ The functions are spelt out, in extenso under Ss. 5 and 25 of the Act. Also, S.3 of Decree No 19 of the 1999, the Act that amended the principal Act

⁵⁴ Regulated products are defined under section 30 to mean food, drugs, cosmetics, medical devices, bottled water and chemicals

The agency does not only regulate and control the manufacture and sale of consumer products, harmful, adulterated or obnoxious products that might have found their ways into the Nigerian markets are also prohibited and the consumers are also warned through paid adverts in the print and electronic media to be wary of such products⁵⁵. That the war against fake and adulterated products in Nigeria has not been won is perhaps attributable to the diverse nature of the Nigerian market and the extent to which these unpatriotic businessmen are involved in these nefarious activities.

The Act also creates a number of offences⁵⁶. For instance a person who obstructs an officer of the Agency in the performance of his duties is guilty of an offence and liable on conviction to a fine of #5,000 or imprisonment for a term not exceeding two years or both⁵⁷ and by Section 25(2), any person who contravenes the provisions of any regulation made under the Act is guilty of an offence and shall be liable on conviction to the penalties specified in the regulations and where no penalty is specified, shall be liable to a fine of #50,000.00 or imprisonment for a term of one year or both⁵⁸. Where the offence is committed by a body corporate with the negligence or contrivance of her Director, Manager or Secretary or any of her officers, the body corporate shall be guilty of an offence and be liable on conviction to a fine of #400,000.00⁵⁹.

The foregoing offences were introduced in 1999 by the NAFDAC (Amendment) Act. Prior to the time, the only offence under the principal Act was that of obstruction of officers from performing their duties. The Act does not contain specific offences. Offences can only be committed in relation to specific regulations made by the Agency under the Act.

Again, the agency has the power to prosecute offenders in respect of the offences under the Act⁶⁰. Thus any officer of the Agency may conduct criminal proceedings in respect of the offence under the Act and regulations, but such criminal proceedings must be with the consent of the Attorney General. The idea of subjecting such proceedings to the consent of the Attorney General is good to the extent that frivolous proceedings can be prevented, but it is also hoped that the bureaucratic process of obtaining such consent will not hamper possible prosecution of offenders under the Act. It is the federal High Court that has exclusive jurisdiction to try offences under the Act⁶¹.

The Consumer Protection Council Act^{62a}.

This legislation makes provisions directly for the protection of the consumers against hazardous products unlike other legislation that indirectly protect the consumers. The Act established the Consumer Protection Council as a body corporate which can sue and be sued in its corporate name⁶². The council is invested with wide powers ranging from provision of speedy redress to consumers complaints to seeking ways and means of removing or eliminating from the markets, hazardous products and causing offenders to replace such products with safer and more appropriate alternatives⁶³.

The Act also creates the Consumer Protection Committees in the states⁶⁴. The State Committees are to function under the control of the Council for the purposes of achieving the objectives of the Act. The idea of the committees at the state level is to enable numerous consumers all over the country have access to the Council whose office may be far away from such towns.

⁵⁵ The lists of drugs found to have been faked or adulterated through laboratory analysis are published on a regular basis by NAFDAC

⁵⁶ See section 25 also s.3 of NAFDAC (Amendment) Act No 19 of 1999 that amended the principal Act.

⁵⁷ S. 25 (1)

⁵⁸ See S. 25 (3)

⁵⁹ See S. 25 (4)

⁶⁰ S. 25A of the Act introduced by the 1999 Amendment.

⁶¹ See part 1 of the Tribunal (Certain Consequential Amendments e.t.c) Act No 62 of 1999

^{62a} Cap. C 25, Laws of the Federation of Nigeria 2004.

⁶² See Section 1 of the Act.

⁶³ See S. 2 of the Act on the functions of the Council.

⁶⁴ See Section 5 of the Act.

As laudable as the foregoing idea is, it is however regrettable that the Committees in most of the states are not firmly established and as such their activities and even presence are not known to the consumers. The effect is that the Nigerian consumer continues to suffer in silence in the hands of the greedy manufacturers or producers of goods and services.

Again, the activities of the Council fall short of the expectation of the consumers in relation to the articulation and enforcement of consumer rights. The Council in deserving cases can only promote negotiations, mediation or reconciliation. Where these fail as is the case sometimes, the aggrieved consumer is left to pursue his right as provided in the Laws of obligations and this is only possible where such a consumer is economically empowered to pursue such rights⁶⁵.

Through a number of offences are created under the Act to check the manufacturers or distributors of a product from interfering with the rights of the consumer⁶⁶, the law has only succeeded in providing a regulatory framework for consumer protection without articulating by way of codification of the rights of the consumers. This is perhaps the reason why the impact of the council is not being felt by the average Nigerian consumers⁶⁷.

The provisions entitling the consumer to compensation for personal injury in addition to whatever penalty that may be imposed on an offender are noteworthy as this may obviate the necessity of the consumer instituting another civil action against the offender for damages especially with the excruciating economy in which the consumers have found themselves⁶⁸.

By and large, that this legislation has the consumers directly in focus is heart-warming. The scope of the law should be expanded to provide more and practical consumer remedies. The identified grey areas of the law should also be removed to sharpen its protective gadgets for the consumers. The Council under the present leadership has also become more alive to her responsibilities. For instance, regulations were made recently by the Council to regulate sales promotions and monitor products and services that are circulated within the economy^{68a}. The Council is also threatening to sue the providers of GSM services for their poor services to the consumers^{68b}.

Concluding Remarks

It is a truism that there is no single law in Nigeria that can be referred to as a consumer code, but the amalgam of the various legislation that constitute the legal framework for the protection of the consumers in Nigeria coupled with the pockets of protection offered at common law do not leave the consumers completely unprotected. That the consumer in Nigeria is still unprotected wholly is partly as a result of the inefficiency and ineffectiveness of most of the institutions that should offer concrete protection to the consumers and also as a result of the lack of the awareness of the laws and institutions through which the consumers are protected.

Concrete efforts at ensuring protection for the consumer in Nigeria must not only stop at the reformation of the laws and institutions but must also include the sensitization of the generality of the consumers as to the existence of such laws and institutions including the remedies provided under them.

This era of deregulation is perhaps the period that the consumers should be protected mostly because of the aggrandisement of private entrepreneurs who are often driven by their motive of profit maximization to “sniff” life out of the consumers through the provision of fake and substandard goods and services and also at costs that are prohibitively high.

⁶⁵ Section 8 however preserves the civil rights of the consumer.

⁶⁶ See Sections 9 (2) , 11,12,18,19, and 21 of the Act for examples.

⁶⁷ See also Monye, F op cit at page 62, Kanyip, B “Reflections on Consumer Protection Law in Nigeria” in Law Justice and the Nigerian Society, NIALS, 1995 at page 282.

⁶⁸ See S. 13 (1) on the rights of the consumers to compensation.

^{68a} See “The Guardian” Newspaper of Tuesday 3rd May, 2005 at page 50.

^{68b} See also “The Guardian” Newspaper of Tuesday 10th May, 2005 at page 7.

The modest gains in the area of consumer protection must not be allowed to go down the drain during this era of economic exploitation. The crusade for the protection of the consumer through law must be vigorously pursued and sustained to ensure the ascendancy of the consumers as “kings” in the today’s sellers market.

Selected Least-Cost Feedstuff for Fish Culture: Assessment of Lipid Quality

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Abstract

Lipid classes and fatty acid profiles of selected agricultural wastes and industrial by-products in use as feedstuffs for fish culture were investigated to bridge a gap in fragmentary nutritional literature. They were subjected to cold-storage, sun-drying, oven-drying, steam-drying, and milling etc. before chemical evaluation. For poultry droppings, total lipid (TL), iodine number (IN) and peroxide value (PV) ranged from 5.42 – 7.36 %, 126.2 – 132.0, 16.4 – 16.5 $\mu\text{mole/g}$ respectively. For brewer's yeast, TL, IN and PV ranged from 1.96 - 8.91 %, 76.0 - 86.9, 9.8 – 11.1 $\mu\text{mole/g}$ respectively. For brewer's spent grain, TL, IN and PV ranged from 8.00 – 13.87 %, 189.3 – 190.4, 9.4 – 9.6 $\mu\text{mole/g}$ respectively.

The three feedstuffs contained triacyl glycerol, free fatty acids, cholesterol and phospholipids while all lack ester. Only steam-dried yeast had diacyl glycerol, both brewer's wastes had cholesterol ester while only the dehydrated and milled poultry dropping (DMPD) had hydrocarbons.

C₁₂, C₁₄, C₁₆ and C₁₈ fatty acids were found in DMPD. Saturated fatty acids contributed 60.30 %, monoenoic acid , 0.71 %; the polyunsaturated fatty acids or PUFAs, 10.03 % while the highly unsaturated fatty acids or HUFAs, accounted for 23.19 %.

C₁₄, C₁₆, C₁₈ and C₂₀ fatty acids were found in SDBY. Saturated acids accounted for 27.82 %; monoenoic acid, 0.00 %; PUFAs , 27.53 % ; HUFAs accounted for 26.95 % of which those from the palmitic acid family was most prominent at 23.53 %.

Oleic, linoleic and linolenic acids were not found in both oils. This work has thrown more light on the quality of feedstuff for aquaculture.

Key words: Fish feed, brewer's waste, poultry droppings, lipid quality, fatty acid, culture.

Introduction

Nutrition supplies the raw materials for the maintenance of life, metabolism. Research groups in many countries are working to bridge the fragmentary information on definition of specific and general

nutrition requirements for several of the warm-water fish species. Culture of these species, has gone beyond focusing efforts on methods to increase natural food of high proteins and vitamin content in ponds (FAO,1979). This is because, under commercial culture conditions, involving high density stocking of fish, natural food may become limiting. It is under such a condition that artificial or supplementary diet became secondarily important.

Tilapia zillii (Gervais) is a member of the family: Cichlidae that are found all over Africa, parts of America and Asia (Chimits, 1955, 1957; Fryer and Iles, 1972; Balarin, 1979). Tilapias are among the commercially exploited and cultured fish for human consumption.

Mesket (1967), gave a list of food materials used in African tilapia culture, which include all types of soft agricultural and household wastes. However, details of nutritional status of some of them are still fragmentary.

With increased intensification of culture of tilapias in recent years, it became necessary to provide complete ration which will satisfy their nutrient requirement and encourage high production of the fish. The major constraint in development of complete diet for intensive tilapia culture, is the limited species- specific nutritional knowledge. Most fish farmers in Nigeria especially believe that fish can eat anything. However, eating just anything will not produce the expected quantitative and qualitative growth. There is need to properly evaluate what fish are fed on.

The current trend in feed production, is utilization of cheap and unconventional protein sources. The present work was aimed at evaluation of the lipid classes and fatty acid profiles of selected feedstuff of agricultural (poultry droppings) and industrial by-products (brewer's waste) subjected to different treatments for formulation of complete rations for fish.

Materials and Methods

Collection of materials: Poultry droppings and brewer's wastes were used in this study. They were sourced as follows:-

1. Fresh samples of poultry droppings were collected from caged layers from Temperance Farms Limited, Sango Otta, Ogun State. The standard diet used for layer was Pfizer feed. A bag of 50kg of poultry droppings was collected.
2. Dehydrated and milled poultry droppings from caged layers on a similar Pfizer feeds were collected from SamRose Agro-Industrial Company Limited, Alimosho, Ipaja, Lagos. A bag of 50kg of dehydrated and milled poultry droppings was collected.
3. Fresh brewer's yeast and brewer's spent grain were collected from Sona Breweries Nigeria Limited, Sango Otta, Ogun State, Nigeria. 50kg of each of these materials were collected.
4. Steam-dried brewer's yeast and steam-dried brewer's spent grain, were collected from Guinness Nigeria Limited, Ikeja, Lagos State. Again, 50kg of each of these materials were collected.

Treatment of Fresh Samples

For all fresh samples of poultry droppings and brewer's spent grain and brewer's yeast, three (3) treatments viz:- freezing in coldstore, sun-drying and the conventional oven drying at 70°C for 48hours were executed using 10kg of each of the materials.

The brewer's yeast and brewer's spent grain from Guinness Nigeria Limited were steam-dried while the poultry dropping from SamRose was dehydrated at 250-300°C and needed no further treatment.

Chemical Analysis

The lipid extraction was performed by the method of Bligh and Dyer (1959). A few crystals of 2, 6, ditertiary-butyl-4-methyl phenol or butylated hydroxy -toluene (BHT) antioxidant were added to the extraction solvent in order to minimize oxidation. Another antioxidant, butylated hydroxy- anisole

(BHA) was used for another set of extractions. The homogenate was then filtered under pressure on a sintered glass filter, the contents were collected in a separating funnel (PTFE-stop-cock) and the two layers allowed to separate. The lower layer was then run off, concentrated on a rotary film evaporator and the solute finally dried on a high vacuum line. All lipid extracts were weighed and the percentage lipid content were calculated.

Iodine Number, measuring the relative unsaturation of fats, was determined by the Wij's Iodine Method while Peroxide Value, was determined by the modified Bank's method.

Total lipids in terms of all major lipids were determined by Thin Layer Chromatography (TLC) using the solvent systems of Freeman and West (1966). Solvent system A, comprised diethyl ether (40 ml), benzene (50 ml), ethanol (2 ml) and acetic acid (90.2 ml). Solvent system B comprised ethyl ether (6 ml) and hexane (94 ml) in a ratio of 6:94.

Fatty acid methyl esters (FAME) of extracted lipids were prepared by H_2SO_4 -catalyzed methylation as described by Christie (1982). A crystal of butylated hydroxytoluene (BHT) was added as an antioxidant. In another set of experiments, butylated hydroxyanisole (BHA) was used as antioxidant. Nitrogen gas was introduced into the sample bottle to further check oxidation. The efficiency of conversion to methyl esters was checked by TLC on silica gel G plates, hexane-diethyl ether-acetic acid (90:10:1ml) being used as the developing solvent. The spots were revealed with iodine vapour.

Gas liquid chromatography (GLC) was used to separate the free fatty acids. 0.5ml of hexane-extract of the esters were injected into the gas liquid chromatograph incorporating a 1.5m x 4mm (i.d.) glass packed with 25% DEGS (diethylene glucol succinate) on chromosob WHP mesh 100/120. The temperature was programmed linearly at a particular temperature for each lipid. The carrier gas was oxygen-free nitrogen at a flow-rate of 25 ml/minute. Attenuation was 10×10^2 and chart speed was 240 sec/cm. The gas-liquid Chromatography instrument was equipped with a flame ionization detector.

To determine the composition of hexane-extract, information on the observed peaks were used for subsequent calculations of retention times (RT), relative retention time (RRT), and the equivalent chain length (ECL). The retention time in seconds is the product of the distance (S cm) from the point of injection of hexane extract into the gas liquid chromatography set-up and the chart speed V seconds/cm.

The RRT is the quotient of retention time of the standard fatty acid (Stearic or Octadecanoic acid, C18.0 in this case) used and the retention time of a peak. The ECL is the hypothetical carbon number of a saturated methyl ester with the same retention time as the particular ester.

In order to determine the ECL, a plot of \log_{10} RRT against carbon number was made and extrapolations of RRT on the carbon number axis, gave the ECL. The equivalent chain length (ECL) gave the corresponding fatty acids.

Results

Total lipids extracted from feedstuff subjected to different treatments and their fat constants:

The mean total lipids and fat constants obtained from chemical analysis of selected feedstuff subjected to varied treatments are summarized in Table 1.

Table 1: Total Lipid and Fat Constants of Treated Feedstuff

Samples of Feedstuff and treatment applied	Parameters estimated		
	Lipid (%)	Iodine Number	Peroxide Value ($\mu\text{mole/g}$)
Fresh Poultry Dropping	7.34	126.2	16.5
Cold stored Poultry Dropping	7.36	126.3	16.4
Oven dried Poultry Dropping	6.21	129.4	16.4
Sun dried Poultry Dropping	5.82	129.9	16.6
Dehydrated & Milled Poultry Dropping	5.42	132.0	16.5
Fresh Brewer's Yeast	1.96	86.3	10.3
Cold stored Brewer's Yeast	2.50	86.9	11.1
Sun dried Brewer's Yeast	4.92	79.2	10.1
Oven dried Brewer's Yeast	5.28	76.1	9.9
Steam dried Brewer's Yeast	8.91	76.0	9.8
Fresh Brewer's Spent Grain	8.00	190.4	9.4
Cold stored Brewer's Spent Grain	6.20	190.3	9.4
Sun dried Brewer's Spent Grain	9.34	190.1	9.5
Oven dried Brewer's Spent Grain	7.19	189.9	9.6
Steam dried Brewer's Spent Grain	13.87	189.3	9.6

Poultry Dropping:-

The cold-stored sample, had the highest lipid content of 7.36 % while the dehydrated and milled stuff had the least lipid content of 5.42 %.(Table 1).The fresh poultry dropping had the least iodine number of 126.2 while the dehydrated and milled stuff had the highest iodine number of 132.0 (Table 1). In respect of peroxide values, the cold-stored and oven-dried stuffs had the least values of 16.4 $\mu\text{m/g}$ while the sun dried material had the highest value of 16.6 $\mu\text{m/g}$ (Table 1).

Brewer's Yeast:-

The steam dried brewer' yeast had the highest lipid content of 8.91 while the fresh brewer's yeast had the least value of 1.96 (Table 1).The cold stored brewer's yeast had the highest iodine number of 86.9 while the steam dried stuff had the least value of 76.0.Incidentally, steam dried brewer's yeast had the least peroxide value of 9.8 $\mu\text{m/g}$ while the cold stored stuff had the highest peroxide value of 11.1 $\mu\text{m/g}$ (Table 1).

Brewer's Spent Grain:-

The steam dried brewer's spent grain had the highest lipid content of 13.87 % while the value was least (6.20 %) in the fresh sample (Table 1). The fresh brewer's spent grain had the highest iodine number of 190.4, but had the least peroxide value of 9.4 $\mu\text{m/g}$. The steam dried stuff had the least iodine number of 189.3 and the highest peroxide value of 9.6 $\mu\text{m/g}$ (Table 1).

Lipid Classes of Pre-treated Feedstuffs.

Results of the qualitative analyses of lipids of dehydrated and milled poultry dropping, steam dried brewer's yeast and steam dried brewer's spent grain determined on Thin Layer Chromatography Plates are presented Table 2

Table 2: Lipid Classes of Dehydrated and Milled Poultry Droppings, Steam Dried Brewer's Yeast and Steam Dried Brewer's Spent Grain

Lipid Classes	Feedstuffs		
	Dehydrated and Milled Poultry Dropping	Steam Dried Brewer's Yeast	Steam Dried Brewer's Spent Grain
Hydrocarbon	P	A	A
Cholesterol Ester	A	P	P
Triacyl glycerol	P	P	p
Diacyl glycerol	A	P	A
Ester	A	A	A
Free fatty acid	P	P	P
Cholesterol	P	P	P
Phospholipid.	P	P	P

Key: P = Present A= Absent.

Table 2 shows the lipid classes present in or absent from the lipids of the feedstuffs. Phospholids, cholesterol, free fatty acids, and triacyl glycerol were present in the lipids from the three feedstuffs analysed. Hydrocarbons were present in only the Dehydrated and Milled Poultry Dropping. Diacyl glycerol was present in only Steam Dried Brewer's Yeast; esters were absent from brewer's wastes (both Steam Dried Brewer's Yeast and Steam Dried Brewer's Spent Grain).

The Fatty Acid Profiles of Dehydrated and Milled Poultry Dropping.

Presented in Table 3, are Fatty acids (as Equivalent Chain Length) found in the hexane- extract of dehydrated and milled poultry dropping.

Table 3:Fatty acids (as Equivalent Chain Length) found in hexane- extract Dehydrated and Milled Poultry Dropping

Peak	Equivalent Chain Length	Fatty Acids	Type of Fatty Acids	Concentration of Fatty Acids (% Area)
1	12 4/5	12.8	Decapolyenoic acid (Unsaturated)	0.08
2	14 0.7/5	14.1	Tetradecamonoenoic acid (Unsaturated)	0.71
3	14 1.5/5	14.3	Tetradecatrienoic acid (Unsaturated)	4.50
4	14 2.5/5	14.5	Tetradecapolyenoic acid (Unsaturated)	10.50
5	14 4/5	14.8	Tetradecapolyenoic acid (Unsaturated)	2.59
6	16.0	16.0	Hexadecanoic acid (Saturated)	35.95
7	16 1.5/5	16.3	Hexadecatrienoic acid (Unsaturated)	5.53
8	16 4/5	16.8	Hexadecapolyenoic acid (Unsaturated)	10.02
9	18.0	18.0	Octadecanoic acid (Saturated)	24.35
10	18 2/4	18.4	Octatetrapolyenoic acid (unsaturated)	4.35
			Unidentified	6.48

C₁₂, C₁₄, C₁₆ and C₁₈ fatty acids were present in hexane- extract of dehydrated and milled poultry dropping lipid. Except for C_{16.0} (hexadecanoic or palmitic acid) and C_{18.0} (octadecanoic or stearic acid) both of which are saturated, all other fatty acids were present in the unsaturated form. C_{16.0} was the most abundant oil fraction (35.95%) (Table 3). This was followed by C_{18.0} which had a concentration of 24.35%. The C_{14.5} acid (Tetradecapolyenoic acid), had a concentration of 10.50% while the C_{16.8} acid (Hexadecapolyenoic), had a concentration of 10.02%. (Table 3).

As can be seen from Table 3, saturated fatty acids (C_{16.0} and C_{18.0}) contributed 60.30 %, monoenoic acid (C_{14.1}) contributed 0.71 %; the polyunsaturated fatty acids or PUFAs (C_{14.3} and C_{16.3}) contributed 10.03 % while the highly unsaturated fatty acids or HUFAs (C_{12.8}, C_{14.5}, C_{14.8} and C_{16.8}) accounted for 23.19 %. Oleic, linoleic and linolenic acids were not found.

The Fatty Acid Profiles of Brewer's Yeast.

Presented in Table 4, are Fatty acids (as Equivalent Chain Length) found in the hexane- extract of steam dried brewer's yeast.

Table 4: Fatty acids (as Equivalent Chain Length) found in hexane extract of steam dried brewer's yeast.

Peak	Equivalent Chain Length	Fatty Acids	Type of Fatty Acids	Concentration of Fatty Acids (% Area)
1	14 3/5	14.6	Tetradecapolyenoic acid (Unsaturated)	0.60
2	14 4/5	14.8	Tetradecapolyenoic acid (Unsaturated)	0.12
3	16.0	16.0	Hexadecanoic acid (Saturated)	4.17
4	16 1.5/5	16.3	Hexadecatrienoic acid (Unsaturated)	15.47
5	16 3.5/5	16.7	Hexadecapolyenoic acid (Unsaturated)	23.53
6	18.0	18.0	Octadecanoic acid (Saturated)	14.78
7	18 1.6/5	18.3	Octadecatrienoic acid (Unsaturated)	11.59
8	18 2.5/5	18.5	Octadecapolyenoic acid (Unsaturated)	1.16
9	18 4/5	18.8	Octadecapolyenoic acid (Unsaturated)	2.01
10	20 0.4/5	20.0	Eicosanoic acid (Saturated)	8.87
11	20 1.7/5	20.3	Eicosadecatrienoic acid (Unsaturated)	0.47
			Unidentified	17.7

The C₁₄, C₁₆, C₁₈ and C₂₀ fatty acids, were present in the hexane- extract of the steam dried brewer's yeast lipid (Table 4). There were only three saturated fatty acids viz hexadecanoic or palmitic acid (C_{16.0}), octadecanoic or stearic acid (C_{18.0}) and eicosanoic or arachidic acid (C_{20.0}). The rest fatty acids were present in the unsaturated forms. C_{16.7} acid (Hexadecapolyenoic acid) was the most abundant as it contributed 23.53%. The C_{16.3} acid (Hexadecatrienoic acid) and C_{18.0} acid (Octadecanoic acid) were present in appreciable quantities of 15.47% and 14.78% respectively. C_{14.8} acid (on the other hand, occurred in the least quantity of 0.21% (Table 4).

It can be seen from Table 4, that saturated acids (C_{16.0}, C_{18.0} and C_{20.0} accounted for 27.82 %; monoenoic acid 0.00 %; PUFAs (C_{16.3}, C_{18.3} and C_{20.3}) contributed 27.53 % ; HUFAs (C_{12.8} , C_{14.5} , C_{14.8} and C_{16.8}) accounted for 26.95 % of which those from the palmitic acid family was most prominent at 23.53 %.

Oleic and linoleic acids were not found but linolenic occurred at 11.59 %.

Discussion

It was observed in the present work that the iodine number of lipids of dehydrated and milled poultry dropping and stem-dried brewers yeast were quite high indicating that they contain high proportions of saturated fatty acids and good quality oil too. The relatively lower iodine number of brewer's yeast indicates that its proportion of saturated fatty acid content is lower (27.82 % as against 60.3 % saturation in DMPD).

Despite high level of unsaturation in the fatty acids, oleic and linoleic acids were not detected in both oils. Absence of linoleic acid from both oils implies it cannot function as the precursor of arachidonic acid and both are essential for fish growth. What could be an advantage is the absence of oleic acid which is considered to have inhibitory effect on the conversion of linoleic to arachidonic acid (Lowry and Tinsly, 1966)

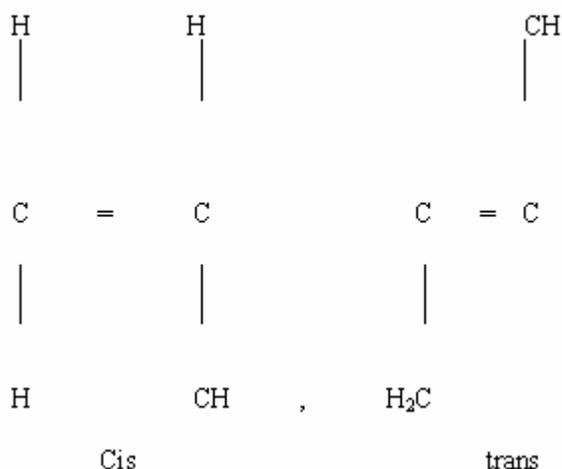
Freshwater fish and marine fish larvae, require both linoleic and linolenic acids (Watanabe *et al*, 1983) and the content of both should be high. Linolenic acid formed 11.59 % in SDBY while PUFAs accounted for 27.53 %. C₂₂ or Behenic fatty acid series that have important metabolic function in freshwater fish, were equally missing in the feedstuff. They can however be synthesized mainly from linolenic acid (Takeuchi and Watanabe, 1977).

C₂₂ fatty acid series are known to occur in fish (cod liver) oil (NRC,1993).

The peroxide values of the poultry droppings and brewer's yeast range from 9.4 to 16.6 $\mu\text{m/g}$. Their relatively low values imply that they have low concentration of hydroxylated acids. Peroxide values of some natural oils as given by West *et al* (1973) are butter fat oil which has peroxide value of 1.9 to 8.6 $\mu\text{m/g}$; olive oil, 10 to 11 $\mu\text{m/g}$ and cottonseed oil, 21 to 25 $\mu\text{m/g}$. Puangsri *et al* (2005), obtained peroxide value of 66 for *Carica papaya* seed oil.

Since low proportion of saturated fatty acids indicate that oils are prone to oxidation (rancidity) (West *et al*, 1973), this was a pointer in need to stabilize lipids with antioxidant in the finally formulated diets. Unsaturated and oxidized fats have been found to have harmful effects when fed in quantity to rainbow trout, brook trout is less affected while brown trouts are rarely affected (Cowey *et al*, 1976). Liver lipid disease (LLD) or ceroidosis is the resulting disease especially in the trout and symptoms include accumulation of pigmented insoluble fat (ceroid) in liver macrophage, kupfer cells or parenchyma cells, spleen, kidney and adrenal cortical tissue (Wood and Yasutake, 1956b; 1970).

This suggests that a nutritional imbalance may be a factor in rancid fats resulting from prolonged and inadequate storage of feedstuff prior to feeding. Heat and alkali treatment isomerise fatty acids. Unnatural cis, trans or trans, trans, linoleic acids have essential fatty acid activity and may even possess ant-metabolic action (Holman, 1956). Only the cis, cis linoleic is physiologically active.



With two or more double bonds, a fatty acid might be cis at one end and trans at the other end (inactive) or cis at both ends (active) or trans at both ends (inactive).

The presence of double bonds at the 6,7, and the 9,10 positions (counting from the terminal CH_2 -group, is associated with biological activity. More double bonds on the CH_3 -side result in decreased activity while additional bonds on the $-\text{COOH}$ side may augment activity.

Unsaturated fatty acids are generally prone to oxidation (rancidity) in the presence of molecular oxygen or certain animal products which act enzymatically to catalyse the autoxidation (Cowey *et al*, 1976). The higher the lipid level or the lower the antioxidant used in the formulation of diets, the greater is the likelihood that rancidity will develop. Rancid lipids per se are toxic, they also react with protein to lower its biological value and therefore have a deleterious effect. The vitamin, α -tocopherol is an antioxidant (Cowey *et al*, 1976).

In Phillipines, composition of non-conventional feedstuffs of potential value in Aquaculture, indicate that brewer's dried grain contain 6.5 % ether extract (lipid) for which 13.87 % was obtained in the present work. No information was given with respect to fatty acid of this stuff nor any chemical information given on the chicken manure listed. (FAO, Gerpacio and Castillo (1979), Sison (1983), Devendra (1985), PCARRD (1986).

This work provides information on the lipid characters of industrial and agricultural wastes and contributes to knowledge required for good least cost fish feed formulation.

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Exploratory Study of Factor Productivity in Nigerian Agriculture: A Case Study of the Agricultural Development Projects (A. D. P.) 1981-1996

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Abstract

Measurement of physical factor productivity in Nigeria, a case study of the Agricultural Development Project (A. D. P.) for the periods 1981-1996 was made using simple output and input indices with implicit weighting system. This weighting system did not use relative prices of the inputs and outputs quantities but rather, the base year quantities as the weights. This is because our interest is in physical and not value productivity of factors. The results indicate that both inputs and outputs grew steadily over the period of study, with output growing more than inputs. The average growth rate in total physical factor productivity for the period was 8.2%. However, marginal physical factor productivity was sufficiently higher than average physical factor productivity, indicative of the fact that the farmers under the A.D.P. are operating at stage one of the classical production function where more inputs are required to boost food production in the country. To actualise this goal, it is recommended that the policy of liberal access to production credits be intensified to enable the farmers increase their farm outputs and generate higher farm income.

Introduction

One of the cardinal objectives of governments of Nigeria is the attainment of self-sufficiency in food production as part of the overall economic growth and development strategies of which factor productivity is an important indicator (Iyaniwura and Osoba, 1983 Rayner, Whittaker and Igenesent, 1986). Except in few cases where productive resources are adequate in relation to population, the level of productivity is a central determinant of the living standard of the people (Onitiri, 1983). Commenting on the situation in Nigeria, Onitiri reported that there is a general acknowledgement of

low productivity in Agricultural sector of the economy, resulting in high prices of industrial products and lack of incentives in the farm sub-sector leading to rural-urban migration among the youths.

Research Institutions in Nigeria and indeed the world over have made sustained attempts and advances towards improving the productivity of the farm sub-sector by producing improved varieties of crops that have significant yields over the local varieties (Ashamu, 1983, Gotsh and Burger, 2001). Despite these commendable advances by the research institutions, food production in Nigeria remains far below requirements. The reasons for this are the general lack of funds by the rural dwellers to purchase yield increasing inputs and overall ignorance of better farming practices.

To address this problem, a national programme, the Agricultural Development Project (A.D. P.) was established as an enclave project in 1976 and progressively became statewide in 1983 with the mandate of disseminating farm innovations, distribution of improved farm inputs and provision of technical know-how to farmers. By use of contact farmers who serve as models for non-contact ones, the A.D. P. employs different techniques to educate the farmers on how best to reap the benefits of the research findings among which are increased farm output and income and higher standards of living.

The issue is, how far has this programme been able to address the low productivity problem in the farm sector? To answer this question, it is necessary to measure factor productivity in this enclave sub-sector of the economy as a pointer to the overall national factor productivity of the agricultural sector.

While acknowledging the fact that some works have been done on measurement of productivity at the micro level, it is worthy of note that no such studies at the macro levels have been undertaken due to conceptual, model specification and data problems (Iyaniwora and Osoba, 1983). The current practice in Nigerian is the estimation of agricultural production index as a fixed based volume relative index of production. This has little or no bearing on agricultural factor productivity.

Besides, there are no national reports on aggregate input use, or accurate data on number of farmers and aggregate farm sizes distribution. The issue is more complicated in multiple cropping farming systems, which are the usual practices among the smallholder farmers in Nigeria (Iyaniwura and Osoba, 1983). This is so because of the problem of factor disaggregation for specific crops (Just *et. al*, 1990; Xhang and Fan, 2001).

The choice of A. D. P. for this study is based on the fact that data on input and output on the crop sub-sector among the contact farmers are available. Furthermore, the contact farms are under strict monitoring and evaluation systems with data reporting by Extension Agents attached to the A. D. P.

The general objective of this study is to determine the level of physical efficiency of farm inputs in agricultural production. Specifically, we intend to estimate and analyse:

- (i) short-term total factor productivity
- (ii) short-term average and marginal factor productivities
- (iii) growth rates in the short-run total factor productivity and
- (iv) their implications for agricultural development.

Methodology

Factor productivity is a measure of the amount of increase in total output not accounted for by increase in total inputs (Jorgenson and Gollop, 1992; Rosegrant and Evenson; 1992).

The rate of growth in total factor productivity over time is the difference between the growth in total outputs minus the growth in total inputs (Fan, 1991; Rosegrant and Evenson, 1992). This difference is referred to as productivity gains. It reflects the impact of technological improvements upon the ratio of physical output to physical input or a measure of technical efficiency.

Measurement of factor productivity has been attempted using several approaches among which are production function analysis (Osuntogun, 1980), value added and gross output methods (Christensen, 1975) and index number constructions (Christensen, 1975; Langham and Ahmad, 1983; Jorgenson and Gollop, 1992; Rosegrant and Evenson, 1992).

By far, the index number approach is the most conventionally adopted method. It involves the computation of an index of total output and an index of all factor inputs (Christensen, 1975). In constructing the index numbers, several weighting methods are usually employed to reflect the relative importance of the various output and input in the output and input mix. The different weighting methods have resulted in different versions of the index numbers, some of which are; the Divisia index number, the Tornquist-Theil index number, the Laspyres quantity index. Each of these versions has its merits and demerits depending on the nature of data available, purpose of the analysis and the nature of the products involved (Iyanuwora and Osoba, 1983).

However, one thing central to these versions is the use of explicit weighting system using base period values as the choice weights (Christensen, 1975; Langham and Ahmad, 1983; Rosegrant and Evenson, 1992). The essence of the weighting is to reflect the importance of each output in total revenue and each input in total cost.

The Tornquist-Theil index number, which provides consistent aggregation of outputs and inputs under the assumption of competitive and constant returns to scale, has greater appeal and flexibility of use over other versions (Rosegrant and Evenson, 1992).

This version of index number, with little modification is used for this study. The modification is that simple output and input indices with implicit weighting systems are used. This approach is adopted for two reasons. Firstly, our interest is in physical factor productivity, and not value productivity, which the price weighting system implies. Secondly, most inputs in Nigeria, were subsidized and as such, their purchase prices do not reflect their true commercial values or opportunity costs.

The output index or total physical productivity (TPFP), average physical factor productivity (APFP), marginal physical factor productivity (MPFP) and input index are given respectively as:

$$\ln Q_{it} (TPFP) = \frac{\sum [\ln(Q_{it}/Q_{io})]}{m} \quad (1.1)$$

$$APFP = \left[\frac{\sum \ln(Q_{it}/Q_{io})}{\sum \ln(X_{jt}/X_{jo})} \right] \quad (1.2)$$

$$MPFP = \left[\frac{\sum \partial \ln(Q_{it}/Q_{io})}{\sum \partial \ln(X_{jt}/X_{jo})} \right] \quad (1.3)$$

$$\ln X_{jt} = \frac{\sum \ln(X_{jt}/X_{jo})}{n} \quad (1.4)$$

Where Q is output, X is input, $i = 1, 2, \dots, m$ outputs, $j = 1, 2, \dots, n$ inputs, t is time in years and δ is change in the respective quantities.

Data for this study were obtained from the Central Bank of Nigeria's (C. B. N.) Annual Reports and statement of Accounts, for the periods, 1981-1996. Inputs and output, which were measured in physical units, were aggregated by normalization with common base year quantities. Considering the economic history of Nigeria, 1986, being the year of introduction of the Structural Adjustment Programme (S.A.P.) was used as the base year. The SAP brought in a number of structural changes into the economy such as, reduction of subsidies on most inputs, privatisation of most public enterprises and adoption of tight monetary and fiscal policies (CBN, 1997) and progressively realistic foreign exchange valuation. Thus, 1986 marked a turning point from years of macro-economic imbalances to years in which stabilisation measures were put in place. Normalisation removes the problem of aggregating different units and qualities because relative of base year values are the subject of aggregation. But it assumes constant and proportionate changes and composition of inputs and also of outputs. This means that inputs are perfect substitutes (Christensen, 1975).

Nine crops (maize, rice, millet, sorghum, cowpea, cassava, yam, cotton and groundnut) were reported and therefore, included in the output index. Included in the input index, were, fertilizers, seeds, roots, tubers, liquid agrochemicals, sprayers, tractors and water pumps. Thus, the input list includes only intermediate inputs, while labour was excluded. Because of this major defect in the input list, our result is merely exploratory.

Results and Discussion

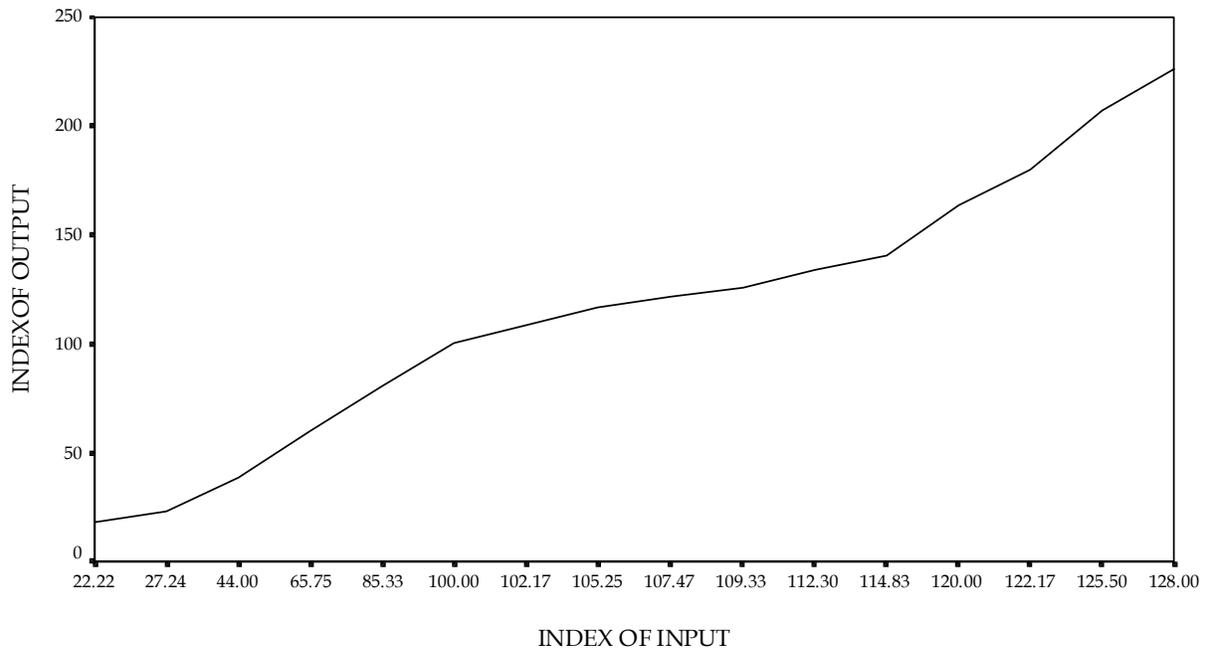
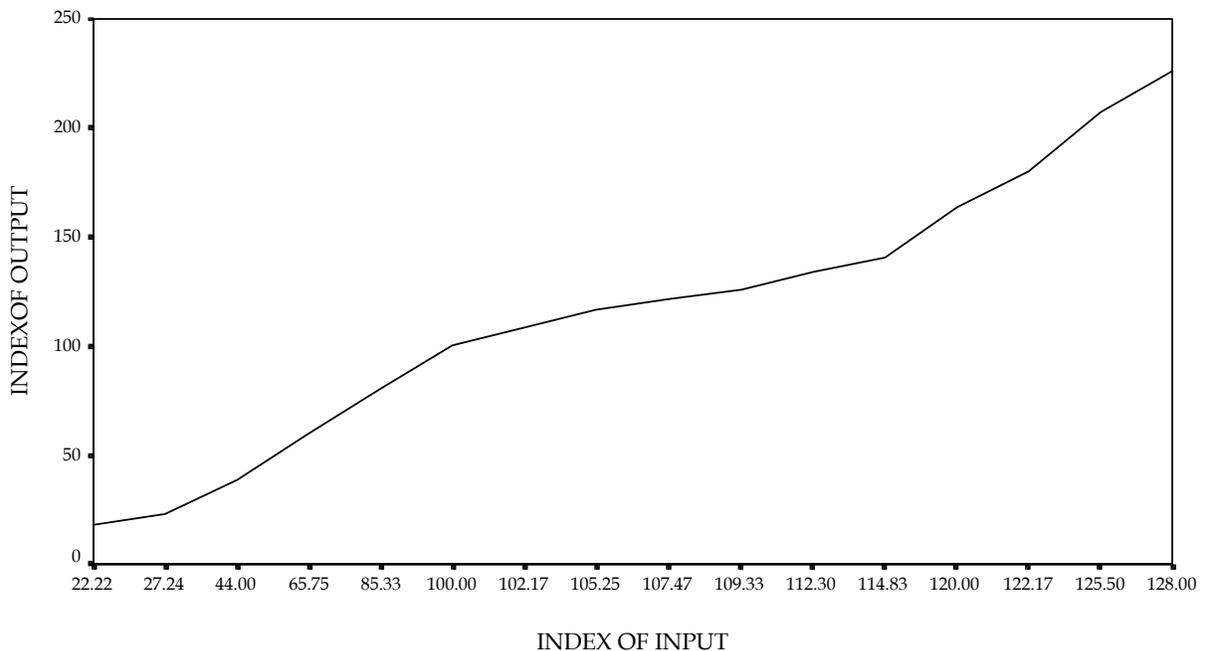
The trend in growth of input and output are as shown in Table 1 and in Figure 1. As could be seen, both inputs and outputs grew steadily over the period of study, but with large fluctuations in input growth occurring between 1984 and 1986 and in output between 1987 and 1990. Except for the periods 1981 to 1986, index of output was higher than index of input. The period of higher growth in input compared to growth in output coincides with the pre-SAP era, while the reversed trend occurred in the post SAP era due to the economic stabilisation measures introduced. The periods 1992 to 1996 witnessed steady growth in both input and output while input index was fairly stable.

Increasing levels of input resulted in successively higher levels of output. This can be seen in

Figure 2, which shows total physical productivity of inputs. The steady growth in aggregate output with increasing levels of input suggests that increasing the aggregate levels of input

Table 1: Index of Output and Input for the periods, 1981-1996.

Year	Output	Input
1981	18.22	22.22
1982	23.11	27.24
1983	38.33	44.00
1984	80.56	85.33
1985	60.10	65.75
1986	100.00	100.00
1987	105.50	102.17
1988	163.30	120.00
1989	207.00	125.50
1990	132.00	109.30
1991	135.80	112.30
1992	123.87	105.25
1993	128.44	107.47
1994	140.78	114.83
1995	180.00	122.17
1996	226.20	128.00

Figure 1: Trend in input and output growth for the periods, 1981-1996.**Figure 2:** Total physical factor productivity (TPFP)

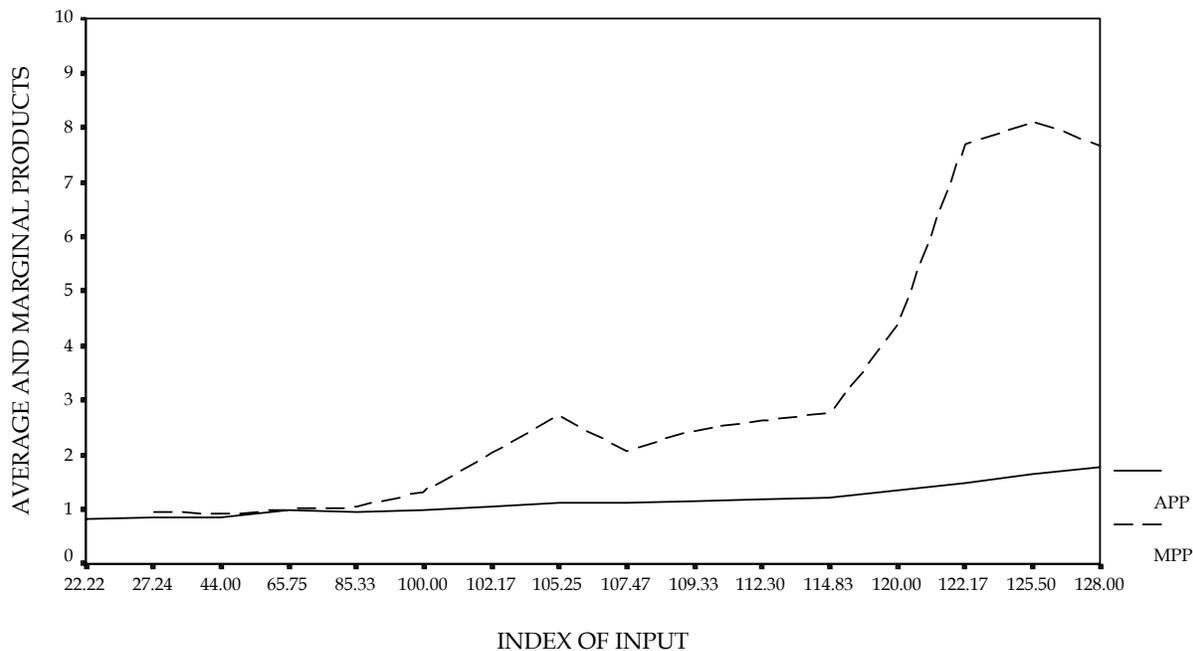
application could further increase output. In other words, opportunity exists for increasing aggregate total physical product by increasing the aggregate levels of input application in the enclave sub-sector of the agricultural sector. This can be achieved by increasing the quantity of aggregate inputs supplied to the contact farmers in addition to increasing the no of contact farmers.

The relationships that existed between average physical product on one hand and marginal physical product on the other hand are as shown in Figure 3. Both average physical product and marginal product increased with levels of input application. However, marginal product was sufficiently higher

than average product with the former attaining a peak at input index level of 125.5%, while the later continued to rise for all levels of input application over the periods of study. These results can be explained from three basic viewpoints. Firstly, it appears that the farmers were not supplied with adequate inputs to boost their outputs. This point is supported by the classical theory of production, which holds that at low levels of input application, total, average and marginal physical productivities of inputs would be rising, meaning that opportunity exists for using more of the inputs. This situation occurs in stage one of the production function. By implication therefore, the contact farmers are operating in stage one of the production function where the elasticity of production is greater than unity. This could be the major factor accounting for the prevailing poverty in the agricultural sector in Nigeria.

Secondly, the impact of continuous improvement in technology over the years may have induced the increasing addition to output per unit increase in input. This achievement was possible through the adaptive research and research findings dissemination, which are the primary pre-occupations of the A. D. P. Thirdly, improvement in the farm management practices of the

Figure 3: Average and Marginal physical productivities



contact farmers due to better education and awareness of more efficient input combination techniques resulting from contact with Extension Agents has contributed to the increasing input productivity.

The estimated rates of growth in factor productivity in this enclave sub-sector of the agricultural sector are as shown in Table 2 and Figure 4. As could be seen, except for the year, 1983-1984, 1989-1990 and 1991-1992, growth in factor productivity over the period of study was positive and strong in most other periods. The average rate of growth in factor productivity for the pre-SAP (1981-1986), the SAP (1986-92) and the post SAP (1993-96) periods were about 3.81%, 7.03% and 16.68% respectively. The differential growth rates in factor productivity (productivity gains) during these periods suggest that the economic stabilization measures that came with SAP encouraged more growth in factor productivity than was the case in the pre-SAP era. The effects of these stabilisation measures were even stronger years after the end of SAP. This is probably due to the benefits of the unspent investments made during the SAP era. By implications therefore, the economic discipline instilled into

the sector continued years after the programme had ended. The overall growth rate in factor productivity over the entire periods was about 8.19%.

Table 2: Differential Growth Rates In Total Factor Productivity Between The Periods, 1981-1986 (Pre-SAP) And 1987-1996 (Post SAP).

Pre-SAP		SAP		Post SAP		Overall
Year	Growth Rate	Year	Growth Rate	Year	Growth Rate	
1981-82	0.0425	1986-87	0.0333	1992-93	0.0158	
1982-83	0.0433	1987-88	0.3734	1993-94	0.0276	
1983-84	-0.3072	1988-89	0.2218	1994-95	0.2147	
1984-85	0.2688	1989-90	-0.2332	1995-96	0.4090	
1985-86	0.1430	1990-91	0.0014			
		1991-92	0.0250			
Average	0.0381		0.0703		0.1668	0.0819

From the above findings therefore, it is obvious that employing more production inputs can increase output in the agricultural sector. This would enable the farmers to move into stage two of the production function where net income and welfare can be maximized. Employment of more inputs by farmers, a vast majority of who are low-income earners means that they should have access to more inputs through credit liberalisation. This policy will definitely contribute to poverty alleviation in the agricultural sector. While it is acknowledged that liberal credit system would amount to resource misallocation, they may be justified from the viewpoints of welfare measures and income redistribution towards the rural poor.

If efforts are made at educating the farmers they will be able to improve their farm management practices with the attendant increase in factor productivity, farm income, rural welfare and overall economic growth and development. Besides, a well-educated farmer keeps reliable production records, on the basis of which a broader study of factor productivity in the agricultural sector can be undertaken in Nigeria. It is recommended that the Federal Office of Statistics (F. O. S.) and the Central Bank should devise input and output reporting systems for small-scale traditional farmers as a way of broadening studies of this nature in the future.

Figure 4: Growth in total factor productivity for the periods, 1981-1996



Conclusion

The paper has assessed the trend and growth rates in physical factor productivity in Agricultural Development Project (A. D. P.), an enclave sub-sector of the agricultural sector of Nigeria, for the periods, 1981 to 1996. It was observed that the contact farmers under the programme were operating at the stage one of the production function, indicative of the fact that opportunity exists for employing more inputs to increase output to meet the goal of self-sufficiency in food production in Nigeria and to alleviate poverty in the farm sector. To actualise this, it is recommended that the policy of liberal access to production credits be intensified to enable the farmers increase their farm outputs and generate higher farm income.

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Assessment of Aerobic Fitness of Lagos State University Female Administrators

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Abstract

Purpose: This study was undertaken to assess the cardiorespiratory fitness of Lagos state university female administrators, and to compare whether there is a similar distribution in fitness between study populations and reported norms.

Method: Cardiorespiratory fitness was determined using UKK2km walk test. A total of 45 women who volunteered and gave consent to participate in the study were screened by a cardiologist and then measured for height, weight, body height index and body fat percent. Resting values including heart rate, systolic and diastolic blood pressures were measured. Subjects walked 2km distance as fast as they could on 400m track wearing a polar heart rate monitor.

Statistics: The descriptive statistics of mean, standard deviation and prediction equation for calculating fitness index of women were used in the analysis.

Result: The result obtained showed that resting systolic and diastolic blood pressures were within normal range while fitness classification and index showed that subjects rated very low.

Conclusion: The low cardiorespiratory fitness obtained showed that subjects are in high-risk level for cardiovascular diseases. This status can be improved through the adoption of an active lifestyle.

Keywords:- Aerobic fitness, resting values, UKK 2km Walk Test, cardiovascular diseases, fitness category and fitness index.

1. Introduction

One of the health challenges of some developed and developing countries of the world seems to be in the area of physical fitness. While the developed countries have made significant progress in improving the fitness status of its citizens, it has been observed that authorities in the developing

countries otherwise called Third World have not dedicated enough attention to physical fitness (Matsudo, 1993).

A high degree of physical fitness is essential for well being, because this level of fitness increases the individual's physical vitality and zest for life and ability to work effectively, enabling him/ her to perform his daily or routine chores or task with sufficient energy and enthusiasm. It also enables the individual to meet with any emergencies without undue fatigue, muscle aches, palpitations of the heart or depression, (Nwankwo, 1990; Otinwa, 2004). There is a wide spread agreement that aerobic fitness otherwise called cardio-respiratory fitness is considered to be the most important component of health related fitness, while the most accepted physiological criterion of aerobic fitness is maximal oxygen uptake (Hoeger & Hoeger, 2002; Bunc, 1993). Cardio-respiratory fitness is the ability of the circulatory and respiratory systems to supply nutrients and oxygen to tissues during physical activities (Powers and Howley, 2001).

The sudden downward trend of life expectancy of Nigerian women from 56 years to 42 years as revealed by Population Reference Bureau (2001) raises concern on the causes of mortality among female population. Low level of oxygen supply has been linked to possibility of being predisposed to heart related diseases. The latter might be one of the reasons responsible for the drop in life span of women as it has been observed that some workers slum and die, while few are known to be hypertensive.

II. Objectives

This study evaluates the aerobic fitness indices and physical- physiological resting values of Lagos State University female administrators.

The evaluation of health related fitness variables of women will help ascertain their health status, and if need be suggest ways of improving fitness level.

III. Methods

The University of Lagos Central Research Committee approved all protocols before any testing was done. Participants were recruited by creating awareness through the circulation of research flyers and personal contacts made by researchers and assistants in various faculties of the Lagos State University, Ojoo, Lagos, Nigeria.

Written informed consent was obtained from 46 participants who volunteered to participate in the study before testing. To assess subjects' suitability to participate in the study, the Physical Activity Readiness (PAR-Q) questionnaire (Heyward, 2003) was administered for those found suitable, they were further subjected to electrocardiogram (ECG) test that revealed condition of the heart and other parameters. Only 33 volunteers were found suitable for the study.

Procedure

Participants arrived at the testing room in the faculty and rested for 10 minutes before the commencement of measurements. While at rest, participants were briefed on the test protocols. Resting heart rate, systolic and diastolic blood pressures were taken using an automated B/P instrument (A & D Medical blood pressure monitor UA-779 series). Body height and weight, were measured using staid-o-meter and calibrated Physician's scale in light clothing, without shoes. Body fat percent was determined by measuring waist - hip ratio using Superior Tailoring Rule (Butterfly Brand, China).

Walking Test Procedure

Participants were taken to the 400 meters Athletic track and were instructed to warm up for 10 minutes. The warm up was done by performing stretches and slow walk round the track. Heart rate transmitter and belt (Polar, E Series) was then attached round the chest below the pectoral muscle and across the

all the participants in the age brackets were slightly lower and therefore were found shorter in height when compared with University of Lagos female administrators who had a mean height 1.67m (Otinwa, Mbakwem & Phillips, 2005)

The body mass index of participants showed that ages 20-40 years are overweight while ages 41-60 were rated as been obese when compared with normal BMI norm of 18.5-24.9 kg/m² (Heyward, 2002). The waist –hip ratio reflects body fat percent of participants. All the age groups except 31-40 age bracket had high fat percent which was more than 0.84 for normal body fat category.

Table 2: Resting Values of Subjects (M ± SD)

Age (yrs)	20-30	31-40	41-50	51-60
N	4	15	10	4
RHR (bpm)	84	79.14	71.86	84
RSB/P (mmHg)	119	118.73	126.86	133.
RDB/P (mmHg)	73	73.50	76.14	78.50

Note: RHR = resting heart rate; RSB/P = resting systolic blood pressure; RDB/P = resting diastolic blood pressure.

Table 2 shows the resting values of the participants. The resting heart rates (RHR) of all subjects indicate a slight increase when compared to the normal resting heart rate of 72 bmp. The resting systolic blood pressures (RSB/P) of 20-30 and 31-40 years are rated normal. While the B/P of those in 41-50, & 51 to 60 years age brackets rated slightly above normal resting systolic blood pressure of 120 mmHg. The entire age groups were found to be within the normal resting diastolic blood pressure. Resting systolic and diastolic values of Nigerians were however found to be higher than the American female population.

Table 3: Performance Time, Heart Rate and Fitness Index

Age (yrs)	20-30	31-40	41-50	51-60
N	4	15	10	4
Time (min.)	21.5	21.77	22.71	22.5
Time (secs)	30.5	34.68	26.14	34.5
Ex. hr (bmp)	129	132.27	126.71	122.5
Fit. Ind	55.55	51.83	50.14	49.76

Table 3 indicates the performance exercise time, heart rate and fitness index. The 20-30 age group and 31-40 years spent less time to cover the 2Km distance when compared with the older age bracket. There was no significant difference in the exercise heart rate of participants in their various age brackets. All the participants were rated as markedly below average on the fitness category.

V. Discussion

The higher values obtained by Nigerian women in body fat percent and body mass index shows that the disease risk of participants is high for the development of heart related diseases such as, arteriosclerosis and may suffer musculo-skeletal health problems. For the older age bracket it doesn't seem that much can be done to improve this fitness variable, since there is an assumption that as age increases there is reduction in physical activities because of socio- cultural emphasis on the need to respect and help the older or senior citizens in performing activities that demand moderate to high level expenditure of energy. This position contradicts the principle of obtaining and maintaining aerobic fitness. If body fat and weight is not reduced then there is probability for degenerative diseases to thrive (Otinwa, 2002) The resting systolic and diastolic blood pressure values shows that the heart is strong and is able to pump sufficient blood at the appropriate intervals, and without undue pressures on the valves of the heart. It is an indication that the heart is at low risk level for the onset of cardiovascular disease, heart attack and stroke (Hoeger and Hoeger, 2002).

All the participants were found to have spent longer time in walking 2Km distance with lower exercise heart rate when compared with the findings obtained in a similar study conducted on American women (Otinwa, Mbakwem & Phillips, 2005.)

The low cardio-respiratory fitness level recorded among the older age brackets is an indication that the ability of the circulatory and respiratory systems to supply fuel during sustained physical activity is low (American Heart Association, 2003). The observed low aerobic fitness levels in the various age groups indicate low-level physical activity by the participants. This could be as result of the nature of occupation engaged in by these women, which made them lead a sedentary life style in a community where labour is cheap. Inactivity has been identified as a factor for the onset of many diseases, such as cancer, diabetes, arthritis, cardiovascular diseases and psychological health problems (Otinwa, 2005; Rockhill et al., 2001; Ainsworth & Macera, 1998; USDHHS, 1996; Pate et al, 1995).

VI. Conclusion and Recommendation

The findings of this study strongly support the involvement of women in a broad range of occupational, athletic, leisure-time, and routine daily-activity such as farming, brisk walking, jogging, running, team games, swimming and aerobic step dance these activities require either light, moderate, or vigorous effort which leads to improved health if practiced regularly (Nieman, 2003). The American College of Sports and Medicine (2000) recommended that exercises or physical activities should be performed three times in a week for a minimum duration of 30 minutes.

Authorities in Third World countries where majority of human population is living must work as a team and develop strategies on how to increase physical activity level of its citizens. It has been known that involvement in physical activity reduces the risk of dying prematurely, dying from coronary heart disease, or developing cancer, diabetes, reduces blood pressure, promotes psychological well-beng (Brown, Thomas & Kotecki, 2002).

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Genotype by Diet Interaction on Body Weight of the Local Chicken and its Crosses with Barred Plymouth Rock

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Abstract

This study was undertaken to investigate the effect of genotype by diet interaction on bodyweight and weight gain of the local chicken, barred Plymouth rock and their F1 reciprocal crossbred populations. Birds of each genotype were separated into two dietary groups. One group was placed on broiler diet while the other group was placed on layer type diet. The bodyweight and weight gain of the groups were monitored to 12 weeks of age. The effect of genotype by diet interaction on bodyweight and weight gain was not significant ($P>0.05$) throughout the period. Birds on broiler regime produced the highest weight gain ($80.97 + 5.01g$) compared with those on layer type diet ($60.96 + 5.01g$). The effect of genotype on weight gain was significant at the 1st, 8th and 12th weeks of age respectively. During these periods the F₁ reciprocal crossbred groups (G₂ and G₃) compared favourably with the exotic (G₄) in weight gain indicating that the local chicken may be relevant in meat bird production.

Key words: Genotype, diet, interaction, crosses, weight gain.

Introduction

The Nigerian local chicken has some useful genetic attributes such as adaptability to our local environment, resistance to some diseases, possesses good nicking ability when subjected to multiple crossing with the exotic strains, transmit genes for early age at first egg, lower clutch number and lower pause number (1). These attributes can be harnessed in a cross breeding programme with the exotic for the development of meat and egg type chicken (2, 3). Crossbreeding experiments involving the local and exotic chickens showed that the local chicken exhibited reasonable hybrid vigour in growth and egg production traits (4, 5, 1). In an effort to improve the local chicken through crossbreeding and selection, it is important to subject the crossbred local chicken to different environmental treatments to determine the effect of genotype by environment interaction on production traits. According to (6), one factor that could cause genotype by environment interaction in poultry is feeding and management systems. A number of works have evaluated the influence of genotype by environment interaction in poultry. For example, (7) reported significant genotype by diet (protein level) interaction on bodyweight, carcass yield and feed conversion ratio. Similarly, (8) reported a significant season by genotype interaction on heatstress in broilers which was attributed to the presence

of substantial genetic variation in the magnitude of heat tolerance. In egg production, strains a sire family by climate interaction was found for egg production (9, 10). Breeding for improved adaptation to a particular stressful environment should be the strategy when genotype by environment interactions significantly affect economic important traits (11 and 12).

This study was undertaken to test the effect of diet by genotype interaction on body weight and weight gain of the F1 crosses between the local chicken and Barred plymouth rock.

Materials and Methods

Local chickens made up of 20 males and 82 layers and parent stock of Barred plymouth rocks numbering 20 cocks and 60 hens were reciprocally crossed by artificial insemination. This resulted in four mating groups and the corresponding genotypes as follows.

- (i) Local chicken males x local chicken females (LC x LC) or G₁
- (ii) Barred plymouth rock males x local chicken females (BR x LC) or G₂.
- (iii) Local chicken males x Barred plymouth females (LC x BR) or G₃.
- (iv) Barred plymouth rock males x Barred plymouth rock females (BR x BR) or G₄.

From the various mating groups, eggs were collected for 14 days, incubated and hatched. The progeny of each mating group was divided into two groups at day old. One diet group was placed on broiler diet (D₁) while the other group was placed on layer type diet (D₂). The chicks were raised from day old to 12 weeks of age. The experiment was replicated once. The experimental layout and the number of birds are presented in Table1. The chicks were brooded on deep litter for 6 weeks after which they were transferred to the rearing house (deep litter) according to the test group. Those on broiler regime were fed commercial broiler starter for 6 weeks after which they were placed on commercial broiler finisher up to the 12th week. Those on layers regime were fed commercial chicks mash for 6 weeks and then fed commercial growers mash for the remaining 6 weeks of the experiment. The birds were weighed at day old and subsequently weighed weekly and the weight gain computed. All the data collected were subjected to analysis of variance procedure by (13). Significant means were further tested using Duncans multiple range test (14).

Table 1: The experimental layout of chicks and diets.

Pen	Group	No. of Chicks	Pen	Group	No. of Chicks
1	G ₁ D ₁	27	9	G ₁ D ₁	10
2	G ₁ D ₂	27	10	G ₁ D ₂	10
3	G ₂ D ₁	27	11	G ₂ D ₁	10
4	G ₂ D ₂	27	12	G ₂ D ₂	10
5	G ₃ D ₁	27	13	G ₃ D ₁	33
6	G ₃ D ₂	27	14	G ₃ D ₂	33
7	G ₄ D ₁	29	15	G ₄ D ₁	15
8	G ₄ D ₂	29	16	G ₄ D ₂	15

Results and Discussion

The mean square values from analysis of variance for effect of diet, genotype and diet by genotype interaction on body weight and weight gain of the F₁ crosses between the local Chicken and Barred plymouth rocks are presented in Tables 2 and 3 respectively. It will be seen that the effect of diet, diet by genotype interaction on body weight of the F₁ crosses between the local chicken and Barred Plymouth rocks were not significant (P>0.05) throughout the 12 weeks age period (Table 2). However, the effect of genotype on body weight of the experimental birds was highly significant (P<0.01) at the first week of age. The effect of diet on weight gain of the experimental birds was highly significant (P<0.01) at 12 weeks of age (Table 3). A separation of means (not shown in a Table) shows that the

birds on broiler regime produced the highest weight gain (80.97 ± 6.90 g) compared with those placed on layer type diet (60.96 ± 5.61 g). This result underscores the important of feeding the local by exotic crossbred chickens with broiler type diet during the finishing period (12th weeks of age) especially when the birds are reared as table birds. The effect of genotype on weight gain was significant throughout the period except the 4th week of age. Diet by genotype interaction effect on weight gain of the experimental birds was not significant through out the period (Table 3). The implication of this results is that any of the diet used in this study could support the growth of the local chicken, Barred plymouth rock and their crosses.

Table 2: Variance analysis for body weight at different age periods in the local chicken and its crosses with Barred plymouth rock

Age (Week)	Mean squares			
	Diet	Genotype	Diet x Genotype	Error
	(1)	(3)	(3)	(8)
1	0.01 ^{NS}	0.017**	0.00 ^{NS}	0.006
4	0.00	0.002 ^{NS}	0.002 ^{NS}	0.003
8	0.004 ^{NS}	0.003 ^{NS}	0.001 ^{NS}	0.004
12	0.00 ^{NS}	0.0063 ^{NS}	0.003 ^{NS}	0.0037

** P<0.01

NS: Not significant

DF (Degree of freedom) for sources of variance are written in parentheses.

Table 3: Variance analysis for weight gain at different age periods in the local chicken and its crosses with Barred plymouth rock

Age (Week)	Mean Squares			
	Diet	Genotype	Diet x Genotype	Error
	(1)	(3)	(3)	(8)
1	15.29 ^{NS}	21.90*	1.80 ^{NS}	3.31
4	430.97 ^{NS}	332.22 ^{NS}	66.97 ^{NS}	116.55
8	0.12 ^{NS}	1479.12*	201.71 ^{NS}	301.14
12	1601.60**	952.72**	211.22 ^{NS}	117.42

N.S: Not significant

* P< 0.05, ** P<0.01

DF (Degree of freedom) for sources of variance are written in parentheses.

Table 4 shows clearly the effect of genotype on the weight gain of the experimental birds. The local chicken (G₁) exhibited superiority in weight gain over the Barred plymouth rocks (G₄) and their F₁ crosses (G₂ and G₃) during the first week of age. However, this was reversed during the 8th and 12th weeks of age. During this period (8th and 12th weeks of age) the F₁ crossbred groups (G₂ and G₃) compared favourably with the exotic (G₄) in weight gain. This result indicates that the local chicken can be used in crosses with the exotic (meat type) chicken for the production of table birds in the tropics. A similar observation was reported by (15).

Table 4: Effect of genotype on weight gain of the experimental birds.

Age (Week)	G ₁	G ₂	G ₃	G ₄	Level of Significance
1	10.32 ^b (0.70)	8.78 ^{ab} (0.36)	8.07 ^{ab} (1.13)	4.77 ^a (1.43)	P<0.05
4	25.12 ^a (4.56)	45.52 ^a (8.37)	36.37 ^a (5.19)	28.33 ^a (3.35)	P>0.05
8	43.10 ^a (9.16)	62.71 ^{ab} (11.02)	89.77 ^b (1.86)	61.35 ^{ab} (6.51)	P<0.05
12	57.78 ^a (7.51)	69.65 ^{ab} (11.00)	63.50 ^{ab} (6.25)	92.95 ^b (6.93)	P<0.01

Mean values across row with different superscript letters are significantly different. Standard errors are in parentheses.

Conclusion

It is concluded that diet by genotype interaction has no significant effect on the body weight and weight gain of the F₁ crosses between the local chicken and Barred plymouth rocks.

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Effect of Processing Variables on the Quality of Traditional Dry-Yam Slices

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Abstract

The effect of varied processing variables (yam thickness, parboiling temperature and time) on the moisture content, pasting property, sensory quality and microbiological quality of dry-yam was investigated. Sun dried yam of 2->3cm and 3->5cm thickness have mean moisture contents varying from 7.39% to 9.33%, which are not significantly different from each other but are significantly different ($p < 0.05$) from oven-dried yam 3.38 to 6.11%). The variations in processing variables of dry-yam showed distinct differences ($p < 0.05$) in the pasting properties of dry-yam. Canonical Discriminant analysis of result showed that the first function, which account for 78%; 89.5% of the variance for the sun and oven-dried samples respectively, mainly consist of peak viscosity (canonical correlation, $cc = 0.62$; 0.86) and final viscosity ($cc = 0.54$; 0.56). Regression analysis models for peak and final viscosities of both sun-dried and oven-dried yams revealed that yam thickness and parboiling time contribute more the variability in quality of dry-yam. Higher peak viscosities were obtained for oven-dried samples, except for the samples parboiled at 60°C. There were significant differences ($p < 0.05$) in appearance and hardness, for all the samples having different yam thickness, parboiling temperature, parboiling time and drying method. There were significant difference ($p < 0.05$) in the brown index ($100-L^*$) of both sun and oven-dried yam samples, with the oven-dried yam samples having lower brown index values of 12.7 to 29.99. The total viable count (cfu/g) of sun-dried gbodo vary from 5.09×10^4 to 1.51×10^6 while that of oven-dried yam varied from 5.69×10^2 to 7.71×10^3 .

Samples of 2->3cm thickness, parboiled at 50°C for 2h appeared to be the best in terms of the pasting properties and the sensory attributes, while the oven-dried yam have lower microbial load compared with the sun-dried yam.

Key words: processing variables, quality, dry-yam

Introduction

Yam, *Dioscorea (spp.)* is an important source of carbohydrate for many people of the sub-Sahara region, especially in the yam zone of West Africa (Akissoe et al., 2003). Yam is cultivated throughout the tropics, and in many parts of the sub-tropics and temperate zones (Kordylas, 1990). In West Africa and New Guinea, yam is one of the primary agricultural commodities (Coursey, 1983). There are over 150 species of yam grown throughout the world (Purseglove, 1991). Babaleye, (2003) reported that yam contributes more than 200 dietary calories per capita daily for more than 150 million people in West Africa and serves as an important source of income to the people.

In some West African countries such as Nigeria, Benin and Ghana, yams are processed into dry-yam tubers/slices and flour (Bricas et al., 1997). Dry-yam tubers/slices are processed by peeling, some times slicing, parboiling in hot water (at 40-60°C for 1-3hr), steeping for about a day and sun-dried, this is called “Gbodo” in the Yoruba land of Nigeria (Onayemi and Potter, 1974). The traditionally processed dry-yam is called “gbodo” and is an intermediate product to be milled into flour, called “Elubo”. The flour is consumed by stirring into boiling water to make a thick paste known as “Amala”, usually eaten with soups by the consumers (Akingbala et al., 1995; Akissoe et al., 2001). The main quality attributes of gbodo/elubo/amala are colour, texture and taste (Akissoe et al., 2001). Most consumers prefer a light brownish, elastic, non sticky amala with a slightly sweet taste, while a slightly bitter taste is also tolerated (Akissoe et al., 2001; Hounhouigan et al., 2003; Mestres et al., 2003).

The age-old traditional method is still being used for the processing of yam to dry-yam (Gbodo). The quality of dry-yam “gbodo” and yam flour “elubo” varies from one processor/location to another (Akissoe et al., 2001; Hounhouigan et al., 2003; Mestres et al., 2003). Indeed, local consumers of yam flour (elubo) have preference for the product made from a particular area of south-west Nigeria (Bricas et al., 1997). There is little or no information on the influence of processing variables on the quality of dry-yam. Therefore this study was conducted to determine the effect of yam thickness, parboiling temperature and time and method of drying on quality of dry-yam .

Materials and Methods

Raw Materials

A local variety of (*Dioscorea esculenta*) “Ijedo”, was purchased from a local market, Odo-oba in Oyo State, Nigeria. The yam tubers were 6-8 months old.

Processing of yam to dry-yam

Yam was processed to dry-yam in the laboratory following the method described by Ige and Akintunde (1981) with some modifications. The white yam tubers were thoroughly washed with clean water to remove adhering soil and other undesirable materials from the yam and to reduce microbial growth on the final product. Peeling was done using a sharp knife.

Effect of thickness of yam on quality of dry-yam:

The yam variety (“Ijedo”) was peeled, washed and cut into different sizes: 1->2cm, 2->3cm and 3->5cm in thickness.

Effect of parboiling temperature and time of yam on quality of dry-yam:

The different sizes of yam were parboiled at 40° C, 50°C and 60°C at for 1, 2 and 3 h.

The parboiled yams were dried in the sun and cabinet dryer respectively

Effect of drying on quality of dry-yam:

- (a) Sun – drying: The well drained samples were spread on a pre-cleaned black surface (which increases the rate heat penetration) in the sun.
- (b) Cabinet drying: Well drained samples were spread in the cabinet oven (Model 11, LEEC ltd., Noltingham) at temperature of 60°C.

The dried samples were weighed at intervals to obtain a constant weight. The dried yam were then packaged and stored before further analyses. Quality of the above samples was measured by carrying out the (functional- such as colour, pasting), sensory and microbiological analyses.

Moisture content: The method of AOAC, (1990) was used to determine moisture.

Pasting properties: The pasting properties of the samples were determined using a Rapid Visco Analyser (RVA, Newport Scientific, Narrabeen, Australia) on an 8% dry matter suspension.

Sensory Analyses of dry-yam: Multiple comparison test was used for examining the effect of varied yam thickness, parboiling temperature and time on gbodo samples, thus knowing the magnitude of differences (Iwe, 2002).

Instrumental colour measurement: The Instrumental colour measurement of dry-yam was determined using a portable PCMTM Colour Tec colourimeter (SN30002421, Accuracy Microsensors, Inc., Pittsford, New York, USA. US Patent 5, 137, 364).

Microbiological analyses: These included Total Aerobic plate count and Fungal count. The Total plate count was determined by diluting the samples serially and plating 1ml of the aliquots separately on triplicate plates of Nutrient agar (Oxoid) and incubating at $28 \pm 2^\circ\text{C}$ for 48h (Frasier and Westhoff, 1978).

The Fungal count was determined by plating 1 ml aliquots of the samples on acidified Potato Dextrose Agar (Oxoid) in order to suppress bacterial growth. This was done by acidifying to a pH 3.5 with 1ml 10% lactic acid solution and incubating at room temperature ($28 \pm 2^\circ\text{C}$) for 48h.

Statistical analysis: Analysis of variance (ANOVA) was used to determine differences in moisture content, pasting properties and sensory properties as influenced by processing variables (yam thickness, parboiling temperature and time as well as the drying method. Turkey's Studentized range test was performed for post-hoc multiple comparisons. Canonical discriminant analysis (SPSS version 10.0, 2000) was subsequently performed to identify pasting viscosities and sensory attribute that underlie group differences among dry-yam samples. Regression analysis was used to determine relationship between processing variables and pasting viscosities and brown colour index.

Results and Discussion

Moisture content of sun and oven-dried yam processed at varied yam thickness, parboiling temperature and time

In table 1, the mean moisture content of sun and oven-dried yam of 1->2cm thickness are not significantly different ($p>0.05$) from each other. Sun-dried yam of 2->3cm and 3->5cm thickness have mean moisture contents not significantly different from each other but are significantly different ($p<0.05$) from oven-dried yam. In other words, oven-dried yam have lower moisture contents compared to that of sun-dried yam. The 1->2cm thick samples had lower moisture content than the 2->3cm and 3->5cm thick samples which could be due to increase in surface area of samples (Ihekoronye and Nggody, 1985). The final moisture content of oven-dried yam were lower than that of the sun-dried yam, although both were still lower than minimum moisture content (13%) for dry food samples (flour) (Christensen and Kaumann, 1973). This does not prevent the growth of microorganisms because many foods in Nigeria with lower moisture content undergo rapid microbial deterioration due to the favourable atmospheric conditions (Adebajo et al., 1994). It is important to note that the sun drying was carried out during dry season (December-January, 2004) when there was higher intensity of heat from the sun. Also the samples were spread on a dark surface to increase the rate of heat absorption by the samples (Ihekoronye and Nggody, 1985). It may not be possible to attain such degree of dryness during the wet season, thus the importance of the use of oven/cabinet dryer which ensures drying any time of the year.

Table 1:*Moisture content of sun-dried and oven-dried yam processed at varied yam thickness, parboiling temperature and time

Drying method:	Sample parboiled at:		Yam thickness:		
	Temp.	Time (h)	1->2cm	2->3cm	3->5cm
Sun-dried yam	40°C	1	5.58 ^a ±0.02	7.51 ^a ± 0.14	8.72 ^a ±0.02
		2	5.26 ^a ±0.13	7.73 ^a ± 0.21	9.33 ^a ±0.50
		3	5.61 ^a ±0.07	7.44 ^a ± 0.08	7.81 ^a ±0.04
	50°C	1	5.82 ^a ±0.03	7.53 ^a ± 0.19	7.59 ^a ±0.05
		2	4.33 ^a ±0.11	7.40 ^a ±0.34	7.94 ^a ±0.03
		3	5.39 ^a ±0.21	7.85 ^a ±0.05	8.56 ^a ±0.06
	60°C	1	5.57 ^a ±0.08	7.67 ^a ±0.44	7.47 ^a ±0.17
		2	4.82 ^a ±0.03	7.75 ^a ±0.07	8.83 ^a ±0.21
		3	4.86 ^a ±0.14	7.39 ^a ±0.14	7.92 ^a ±0.07
Oven-dried yam	40°C	1	4.39 ^a ±0.03	4.39 ^b ±0.03	5.55 ^b ±0.05
		2	5.32 ^a ±0.24	5.32 ^b ±0.24	5.75 ^b ±0.02
		3	4.74 ^a ±0.07	4.74 ^b ±0.07	4.37 ^b ±0.51
	50°C	1	4.51 ^a ±0.31	4.51 ^b ±0.31	5.22 ^b ±0.06
		2	4.53 ^a ±0.61	4.53 ^b ±0.61	4.82 ^b ±0.26
		3	4.28 ^a ±0.04	4.28 ^b ±0.04	5.43 ^b ±0.22
	60°C	1	4.66 ^a ±0.08	4.66 ^b ±0.08	6.11 ^b ±0.06
		2	4.47 ^a ±0.17	4.47 ^b ±0.17	5.47 ^b ±0.04
		3	4.12 ^a ±0.04	4.12 ^b ±0.04	5.68 ^b ±0.33

* Mean ±SD, Mean values in a column not followed by the same letter are significantly different at p<0.05

Pasting properties of dry-yam with varied size and parboiling temperature and time

The variations in processing variables of dry-yam showed distinct differences (at p<0.05) in the pasting properties of dry-yam (Table 2 and 3), except for pasting temperature which were not significantly different (p>0.05) from each other for both sun and oven dried samples. It was generally observed that the pasting viscosity values of dry-yam parboiled at 40°C for all the yam thickness were higher than others, followed by the parboiled at 50°C while that of 60°C were the lowest (Table 2 and 3). The samples parboiled at 60°C would have undergone pregelatinisation, thus this could have reduced the pasting viscosities, especially, that of 1->2cm yam thickness. The samples parboiled at 40°C have higher values of peak and final viscosities probably because of the fact that, at this temperature, the yams undergo little or no parboiling. Thus, the starch have the capability to swell more, as a result of the heat applied during the measurement of pasting characteristics (Soni et al., 1985). This applied to both sun-dried and oven-dried yam samples but most of the pasting viscosity values for the oven-dried yam samples were higher than that of the sun-dried yam. The transition from a suspension of starch granules to a paste, when heat is applied, is accompanied by a large increase in viscosity. The increase in viscosity that occurs when starch or starch materials are sufficiently heated in sufficient water is the result of swelling of starch granules during gelatinization. Gelatinization is an order-disorder phase transition that involves diffusion of water into the starch granules, hydration and swelling, uptake of heat, loss of birefringence, crystalline melting, starch solubilization and amylose leaching (Olkku and Rha, 1978; Biliaderis et al., 1980). The changes that occur after starch gelatinization occurs is characteristic of the particular type of starch. The observed differences in paste viscosity among dry-yam of varied processing variables in this study are therefore indicative of variation in the hydration and swelling capacities of their starches. According to Miller et al., (1973), viscosity increase is due mainly to the formation of an extrudate network around starch granules.

Table 2: *Pasting properties of sun -dried yam of varied yam thickness, parboiling temperature and time

Sample size (cm)	Sample parboiled at: Temp. Time.		Peak viscosity (RVU)	Trough viscosity (RVU)	Breakdown viscosity (RVU)	Final viscosity (RVU)	Setback (RVU)	Peak time (min)	Pasting Temp. (°C)
	(°C)	(h)							
1->2	40°C	1	317.58 ^{ab}	274.75 ^a	42.83 ^c	422.00 ^a	147.25 ^c	5.35 ^b	61.90 ^a
		2	317.46 ^{ab}	278.17 ^a	39.29 ^{ef}	380.25 ^b	102.09 ^{de}	5.41 ^b	62.73 ^a
		3	311.92 ^{ab}	242.04 ^{ab}	69.88 ^d	365.83 ^b	123.79 ^{cd}	4.97 ^b	63.43 ^a
	50°C	1	242.75 ^c	214.75 ^c	28.00 ^{efg}	293.29 ^d	78.54 ^{efg}	5.80 ^b	61.93 ^a
		2	283.67 ^b	272.38 ^a	11.29 ^{fgh}	338.92 ^c	66.54 ^g	5.51 ^b	64.52 ^a
		3	280.42 ^b	211.29 ^c	69.13 ^d	326.71 ^{cd}	115.42 ^{cd}	5.13 ^b	63.35 ^a
	60°C	1	190.17 ^d	177.59 ^d	11.50 ^{fgh}	228.67 ^f	51.09 ^{gh}	8.99 ^a	62.40 ^a
		2	121.67 ^c	101.25 ^{fg}	8.63 ^h	138.08 ^g	36.34 ^h	8.96 ^a	64.13 ^a
		3	95.78 ^f	72.04 ^g	18.08 ^{fgh}	109.88 ^h	37.84 ^h	8.99 ^a	62.08 ^a
2->3	40°C	1	374.75 ^a	258.42 ^{ab}	116.34 ^c	388.67 ^b	130.25 ^c	4.56 ^b	62.90 ^a
		2	383.54 ^a	146.34 ^c	237.21 ^a	428.83 ^a	282.50 ^a	4.67 ^b	63.05 ^a
		3	352.46 ^a	183.33 ^{cd}	169.13 ^b	402.46 ^{ab}	219.13 ^b	4.63 ^b	62.58 ^a
	50°C	1	338.04 ^a	232.5 ^{9b}	105.46 ^c	296.75 ^d	64.17 ^g	4.91 ^b	63.55 ^a
		2	327.21 ^{ab}	291.38 ^a	26.92 ^{efg}	409.79 ^{ab}	118.42 ^{cd}	7.11 ^{ab}	62.63 ^a
		3	315.59 ^{ab}	278.08 ^a	34.50 ^{ef}	375.50 ^b	97.42 ^{de}	5.88 ^b	63.45 ^a
	60°C	1	270.04 ^b	250.79 ^{ab}	19.25 ^{fgh}	338.88 ^c	88.08 ^{ef}	5.23 ^b	63.10 ^a
		2	235.96 ^c	211.84 ^c	24.13 ^{efg}	297.17 ^d	85.33 ^{ef}	5.38 ^b	62.45 ^a
		3	269.55 ^b	192.92 ^{cd}	76.63 ^{cd}	349.21 ^c	156.30 ^c	4.43 ^b	63.03 ^a
3->5	40°C	1	321.84 ^{ab}	241.67 ^{ab}	80.17 ^{cd}	347.96 ^c	106.29 ^{dc}	4.74 ^b	62.80 ^a
		2	317.00 ^{ab}	268.92 ^{ab}	46.08 ^c	433.33 ^a	164.42 ^c	5.18 ^b	63.70 ^a
		3	241.58 ^c	200.38 ^c	82.41 ^{cd}	302.29 ^d	101.92 ^{dc}	5.12 ^b	63.26 ^a
	50°C	1	284.38 ^b	258.00 ^{ab}	22.17 ^{efg}	320.34 ^{cd}	62.34 ^g	9.00 ^a	64.48 ^a
		2	290.84 ^b	235.46 ^b	55.38 ^{de}	340.55 ^c	105.08 ^{dc}	5.33 ^b	62.38 ^a
		3	283.71 ^b	288.71 ^a	55.00 ^{de}	384.08 ^b	155.38 ^c	5.02 ^b	63.40 ^a
	60°C	1	220.29 ^{cd}	177.17 ^d	34.63 ^{ef}	300.21 ^d	123.04 ^{cd}	9.00 ^a	62.93 ^a
		2	204.67 ^d	174.05 ^d	14.00 ^{fgh}	225.75 ^f	51.71 ^{gh}	8.99 ^a	62.93 ^a
		3	209.92 ^d	189.17 ^{cd}	20.75 ^{fgh}	249.71 ^c	60.54 ^g	7.62 ^{ab}	63.18 ^a

*Mean values in a column not followed by the same letter are significantly different at $p < 0.05$

Table 3: *Pasting properties of oven-dried yam of varied yam thickness, parboiling temperature and time

Sample size (cm)	Sample parboil led at: Temp. Time		Peak viscosity (RVU)	Trough viscosity (RVU)	Breakdown viscosity (RVU)	Final viscosity (RVU)	Setback (RVU)	Peak time (min)	Pasting Temp. (°C)
	(°C)	(h)							
1->2	0°C	1	327.17 ^{ab}	274.21 ^a	52.96 ^{de}	402.30 ^b	128.09 ^c	5.43 ^b	63.15 ^a
		2	354.55 ^a	298.80 ^a	55.75 ^{de}	444.29 ^a	145.50 ^c	5.20 ^b	62.93 ^a
		3	322.05 ^{ab}	271.84 ^a	43.38 ^e	437.00 ^a	165.17 ^c	8.97 ^a	62.58 ^a
	50°C	1	308.21 ^{ab}	270.13 ^a	38.08 ^{ef}	366.75 ^{bc}	96.63 ^{de}	4.73 ^b	62.90 ^a
		2	307.17 ^{ab}	219.54 ^{bc}	87.63 ^{cd}	372.17 ^b	152.63 ^c	4.51 ^b	64.15 ^a
		3	325.17 ^{ab}	266.42 ^{ab}	58.75 ^{de}	396.09 ^b	129.67 ^c	4.87 ^b	63.50 ^a
	60°C	1	218.25 ^{cd}	198.00 ^c	17.04 ^{fgh}	255.46 ^c	57.46 ^{gh}	9.00 ^a	61.93 ^a
		2	198.13 ^d	172.71 ^d	10.88 ^{fgh}	233.50 ^{ef}	60.79 ^g	9.00 ^a	61.75 ^a
		3	144.42 ^e	131.00 ^c	32.30 ^{ef}	200.17 ^{fg}	70.17 ^g	9.00 ^a	62.18 ^a
2->3	40°C	1	383.46 ^a	289.46 ^a	94.00 ^c	455.42 ^a	165.96 ^c	4.73 ^b	63.05 ^a
		2	386.54 ^a	304.75 ^a	81.79 ^{cd}	466.92 ^a	162.17 ^c	4.99 ^b	63.03 ^a
		3	355.92 ^a	250.29 ^{ab}	66.13 ^d	387.21 ^b	136.92 ^c	5.02 ^b	62.73 ^a
	50°C	1	300.33 ^{ab}	221.13 ^{bc}	79.21 ^{cd}	316.08 ^{cd}	94.96 ^{de}	4.65 ^b	63.23 ^a
		2	355.68 ^a	267.33 ^{ab}	88.29 ^{cd}	388.42 ^b	121.09 ^{cd}	4.89 ^b	63.60 ^a
		3	284.13 ^b	225.46 ^{bc}	58.67 ^{de}	373.08 ^b	147.63 ^c	4.81 ^b	63.38 ^a
	60°C	1	263.96 ^b	206.17 ^c	57.79 ^{de}	307.42 ^d	101.25 ^{de}	4.86 ^b	62.65 ^a
		2	264.58 ^b	222.67 ^{bc}	42.92 ^e	334.96 ^c	112.29 ^{cd}	5.44 ^b	62.33 ^a
		3	248.13 ^{bc}	197.13 ^c	51.00 ^{de}	309.00 ^d	112.50 ^{cd}	5.01 ^b	63.15 ^a
3->5	40°C	1	344.83 ^a	247.17 ^{ab}	101.00 ^c	371.42 ^b	123.58 ^{cd}	4.28 ^b	62.30 ^a
		2	342.17 ^a	241.17 ^{ab}	97.00 ^c	356.67 ^{bc}	115.50 ^{cd}	4.69 ^b	63.10 ^a
		3	317.50 ^{ab}	248.00 ^{ab}	69.50 ^d	375.83 ^b	127.83 ^c	4.99 ^b	63.00 ^a
	50°C	1	254.88 ^{bc}	190.17 ^{cd}	64.71 ^d	299.92 ^d	109.75 ^{de}	4.68 ^b	63.00 ^a
		2	247.34 ^{bc}	209.54 ^c	37.80 ^{ef}	307.08 ^d	97.54 ^{de}	5.12 ^b	62.35 ^a
		3	274.50 ^b	220.29 ^{bc}	44.21 ^e	312.71 ^d	92.42 ^{de}	5.25 ^b	63.15 ^a
	60°C	1	209.21 ^d	176.42 ^d	32.79 ^{ef}	245.54 ^c	69.13 ^g	5.20 ^b	64.35 ^a
		2	205.13 ^d	178.30 ^d	19.21 ^{fgh}	243.63 ^c	65.59 ^g	8.99 ^a	62.35 ^a
		3	202.63 ^d	172.00 ^d	12.33 ^{fgh}	226.96 ^f	54.96 ^{gh}	8.99 ^a	63.08 ^a

*Mean values in a column not followed by the same letter are significantly different at $p < 0.05$

Results from canonical discriminant analysis identified peak viscosity as the variable that best explains the difference among the dry-yam flour for both sun-dried and oven-dried yam samples (Tables 4 and 5). Analysis of dimensions can explain about 84% of variance for both drying methods. For the sun-dried samples, the first dimension/function, which account for 77.9% of the variance, mainly consist of peak viscosity (canonical correlation, $cc = 0.62$) and final viscosity ($cc = 0.54$). For oven-dried samples, the first function, which accounts for 89.5% of variance, mainly consist of peak viscosity ($cc = 0.86$) and final viscosity ($cc = 0.556$). Higher peak viscosities were obtained for oven-dried samples, except for the samples parboiled at 60°C. Multiple regression analysis on both sun-dried and oven-dried yam showed that yam thickness/size, parboiling temperature and time of sun-dried yam could explain 68.3%; 77.4% and 61%; 79% of the variability in peak viscosity and final viscosity respectively ($p < 0.01$) (Table 6). The peak viscosity is dependent on yam size and parboiling time of yam while the final viscosity of dry-yam is dependent on parboiling time of yam.

Table 4: Summary of canonical discriminant functions for sun and oven-dried yam

	Function	Eigenvalue	% of variance	Cummulative %	Canonical correlation
Sun-dried Gbodo	1	0.411 _a	77.9	77.9	0.628
	2	0.117 _a	22.1	100	0.540
Oven-dried Gbodo	1	2.867 _a	89.5	89.5	0.861
	2	0.336 _a	10.5	100	0.556

a = First 2 canonical function were used in analysis

Table 5: Standardized Canonical Discriminant Function Coefficient of Sun and Oven-dried yam

		Function	
		1	2
Sun-dried yam	Peak viscosity	0.961	1.144
	Trough	-0.020	-0.582
	Breakdown	0.017	0.248
	Final viscosity	0.453	0.609
	Setback	0.164	0.306
	Pasting time	-0.070	-0.588
	Pasting temperature	-0.069	0.468
Oven-dried yam	Peak viscosity	0.620	0.509
	Trough	-0.180	-0.210
	Breakdown	0.230	0.097
	Final viscosity	0.588	0.982
	Setback	-0.003	-0.052
	Pasting time	0.159	0.015
	Pasting temperature	-0.159	-0.372

Table 6: Multiple regression analysis table of Peak and Final viscosities of Sun and Oven-dried yam

	Sun-dried yam		Oven-dried yam	
	Peak viscosity	Final viscosity	Peak viscosity	Final viscosity
Constant	424.88	795.46	449.83	719.05
Size	92.50	-89.06	74.83	-21.12
Temp.	-3.24	-9.18	-2.40	-6.82
Time	190.91	79.65	111.43	103.31
Size*temp.	-1.52	1.75	-1.77	0.05
Size*time	101.55	-27.03	51.94	42.72
Temp.* time	-3.98	-2.04	-2.54	-2.04
Size*temp*time	1.98	0.72	1.12	0.84
R2	0.68	0.61	0.77	0.79
P	<0.01	<0.01	<0.01	<0.01

In all, the peak viscosity of sample with 2->3cm thickness, parboiled at 50°C for 2h (355RVU for oven-dried yam), is not significantly different ($p>0.05$) from 'Baruba' dry-yam samples (359 RVU) (Babajide, 2005). 'Baruba' is the area/location where majority of the traditional dry-yam (gbodo) is being produced for consumption in southwest Nigeria.

Sensory quality of dry-yam slices with varied thickness, parboiling temperature, time and method of drying

There were significant differences ($p<0.05$) in appearance and hardness/ease of breaking, for all the samples having different yam thickness, parboiling temperature, parboiling time and drying method. (Table 7). For all the dry-yam with varied yam thickness and method of drying, there was no significant difference ($p>0.05$) in appearance and hardness respectively, for yams parboiled at 50°C for 2h.

Table 7: *Mean scores for Appearance and Hardness of dry-yam with varying yam thickness, parboiling temperature and time for sun and oven drying methods

Drying method	Sample parboiled at:		Appearance of Sun-dried yam			Hardness of Oven-dried yam		
			Yam Thickness			Yam Thickness		
	Temp.	Time (h)	1->2cm	2->3cm	3->5cm	1->2cm	2->3cm	3->5cm
Sun-dried yam	40°C	1	2.45 ^{bc}	2.75 ^c	2.4 ^{bc}	2.65 ^{ab}	2.05 ^c	2.7 ^{ab}
		2	2.7 ^b	3.15 ^b	3.65 ^a	2.7 ^{ab}	2.1 ^c	2.8 ^a
		3	2.8 ^b	3.05 ^b	3 ^{ab}	2.65 ^{ab}	2.4 ^{bc}	2.7 ^{ab}
	50°C	1	2.1 ^c	3.15 ^b	3.6 ^a	2.7 ^{ab}	2.45 ^{bc}	2.91 ^a
		2	3.55 ^a	4.2 ^a	3.6 ^a	2.8 ^{ab}	3.15 ^b	2.95 ^a
		3	3.2 ^a	3.25 ^b	3.9 ^a	3.1 ^a	3.15 ^b	3.05 ^a
	60°C	1	3.55 ^b	2.45 ^c	2.95 ^{ab}	3.1 ^a	2.35 ^{bc}	2.9 ^a
		2	2.75 ^c	2.95 ^{bc}	2.45 ^{bc}	2.65 ^{ab}	2.9 ^b	3 ^a
		3	2.1 ^c	2.6 ^c	2.4 ^{bc}	2.65 ^{ab}	2.7 ^b	2.75 ^{ab}
Oven-dried yam	40°C	1	2.4 ^{bc}	2.8 ^c	2.75 ^b	2.5 ^b	2 ^c	2.6 ^{ab}
		2	2.4 ^{bc}	3.55 ^b	2.6 ^b	2.4 ^b	2.95 ^b	2.8 ^a
		3	2.9 ^b	2.7 ^c	2.95 ^{ab}	2.8 ^{ab}	2.65 ^b	3.1 ^a
	50°C	1	2.8 ^b	2.2 ^d	3.05 ^{ab}	2.85 ^{ab}	3.15 ^b	3 ^a
		2	3.35 ^a	4.65 ^a	3.6 ^a	3.45 ^a	4.1 ^a	2.85 ^a
		3	3.45 ^a	4.4 ^a	3.85 ^a	3.25 ^a	3.75 ^a	3.2 ^a
	60°C	1	2.65 ^b	3.35 ^b	3.35 ^a	2.9 ^{ab}	2.65 ^b	2.95 ^a
		2	2.55 ^b	3.75 ^b	3.35 ^a	2.95 ^{ab}	3.55 ^a	2.85 ^a
		3	2.35 ^{bc}	3.35 ^b	2.3 ^{bc}	2.55 ^b	2.9 ^b	2.2 ^b

*Mean values in a column not followed by the same letter are significantly different at $p < 0.05$

Canonical discriminant analysis identified appearance as the variable that explains the difference among the dry-yam samples, which account for 72% of variance (with canonical correlation = 0.51). Dry-yam samples of 2-<3cm thickness, parboiled at 50°C for 2h seems to be the best in terms of appearance for both sun and cabinet-dried samples with the highest mean value of 4.65, followed by 3-<5cm sample parboiled at 40°C for 3h and 2-<3cm sample parboiled at 60°C for 1h (cabinet oven dried samples) (Table7). Although, there was no significant difference at $p > 0.05$ in hardness (easy of breaking) of all dry-yam samples dried in the sun and oven/cabinet dryer. Some level of difference was observed for 2-<3cm samples dried in the sun and oven, with the sample parboiled at 50°C for 2h, dried in the dryer/oven having the highest mean value of 4.1, indicating no amount of difference in colour from the reference sample. Thus, the dry-yam samples having 2-<3cm thickness, parboiled at 50°C for 2h appear to be the best in terms of appearance (brown colour) and hardness (ease of breaking/hardness).

Brown colour index of sun and oven-dried yam with varied size, parboiling temperature and time

There were significant difference ($p < 0.05$) in the brown index (100-L*) of both sun and oven-dried yam samples, with the oven-dried yam samples having lower brown index values of 12.2 to 29.99 and sun-dried samples having 100-L* values varying from 17.45-36.44. Oven-dried yam samples parboiled at 40°C for 1h and 2h of 1-2cm yam thickness and 2->3cm yam thickness and sample parboiled at 40°C for 3h were not significantly different ($p > 0.05$) from each other but were significantly different from other dry-yam samples. Sun-dried yam sample parboiled at 50°C for 2h (1->2cm yam thickness) and samples parboiled at 40°C for 2h and 50°C for 2h (2->3cm yam thickness) were not significantly different ($p > 0.05$) from the above mentioned oven-dried samples but are significantly different from the other dry-yam samples. Multiple regression analysis showed that yam thickness/size, parboiling temperature and time of sun and oven-dried yam could explain 77% and 83% ($p < 0.01$) of the variability in brown colour index respectively. From regression models, the brown colour index of sun

and oven-dried yam is dependent on yam size and parboiling time of yam. The brown colour index of sun-dried yams were higher than that of oven-dried yam for all the other variable variations, that is, size, parboiling temperature and time. Generally, the dry-yam samples parboiled at 60°C have the highest brown colour index, followed by that of 50°C and 40°C in a decreasing order, thus indicating that parboiling temperature as high as 60°C could cause darkening of dry-yam slices and yam flour (Table 8). The brown colour index of oven-dried sample parboiled at 50°C for 2h (that is 19.61) appear to be the same with the 'Baruba' dry-yam samples (19.57) (Babajide, 2005).

Table 8:*Brown colour index of sun and oven-dried yam with varied size, parboiling temperature and time

Sample size (cm)	Sample parboiled at:		Brown index of Sun-dried yam	Brown index of Oven-dried yam
	Temp. (°C)	Time (h)		
1->2	40°C	1	17.45 ^d	12.2 ^c
		2	17.62 ^d	12.61 ^c
		3	29.37 ^{ab}	15.98 ^b
	50°C	1	29.22 ^{ab}	16.1 ^b
		2	24.19 ^c	15.95 ^b
		3	29.11 ^{ab}	15.85 ^b
	60°C	1	35.93 ^a	22.53 ^{ab}
		2	34.03 ^a	25.93 ^a
		3	33.37 ^a	29.67 ^a
2->3	40°C	1	25.92 ^{bc}	16.9 ^b
		2	27.04 ^b	15.77 ^b
		3	25.35 ^c	13.42 ^c
	50°C	1	27.16 ^b	19.03 ^b
		2	24.4 ^c	19.61 ^b
		3	25.94 ^b	21.75 ^{ab}
	60°C	1	31.97 ^a	29.99 ^a
		2	32.41 ^a	27.39 ^a
		3	33.01 ^a	28.55 ^a
3->5	40°C	1	27 ^b	17 ^b
		2	27.09 ^b	15.24 ^{bc}
		3	26.7 ^{bc}	14.19 ^{bc}
	50°C	1	29.93 ^b	19.19 ^b
		2	25.56 ^c	29.72 ^a
		3	28.36 ^b	26.2 ^a
	60°C	1	32.76 ^a	28.8 ^a
		2	36.44 ^a	28.12 ^a
		3	35.3 ^a	29.36 ^a

Microbial load of sun and oven-dried gbodo

The sample of 2->3cm thickness was chosen for microbial analyses because they were neither big nor small and had almost the same moisture content for the different drying methods used. The results shown in table 9, revealed that the total viable count (cfu/g) of sun-dried yam vary from 5.1×10^4 (yam parboiled at 60°C for 3h) to 1.5×10^6 (yam parboiled at 40°C for 1h) while that of oven-dried yam varied from 3.1×10^2 (yam parboiled at 50°C for 2h) to 6×10^3 (yam parboiled at 40°C for 3h).

Table 9: Microbial load of sun and oven- dried yam cut to 2cm size

Drying method	Sample parboiled At:		Moisture content (%)	Aerobic plate count (cfu/g)	Fungal count (cfu/g)
	Temp.	Time (h)			
Sun-dried yam	40°C	1	7.51 ^a	1.5x10 ⁶	3.2x10 ⁵
		2	7.73 ^a	7.0x10 ⁵	4.2x10 ⁵
		3	7.44 ^a	5.1x10 ⁵	4.1x10 ⁴
	50°C	1	7.53 ^a	6.8x10 ⁵	3.9x10 ⁴
		2	7.90 ^a	5.4x10 ⁴	3.2x10 ⁴
		3	7.85 ^a	6.0x10 ⁴	4.0x10 ⁴
	60°C	1	7.67 ^a	6.1x10 ⁵	3.7x10 ⁴
		2	7.75 ^a	5.4x10 ⁴	3.5x10 ⁴
		3	7.39 ^a	5.1x10 ⁴	4.7x10 ⁴
Oven-dried yam	40°C	1	4.39 ^b	7.7x10 ²	8.2x10 ²
		2	5.32 ^b	5.1x10 ²	4.1x10 ²
		3	4.74 ^b	6.0x10 ³	6.2x10 ²
	50°C	1	4.51 ^b	2.3x10 ³	4.8x10 ³
		2	4.53 ^b	3.1x10 ²	2.3x10 ²
		3	4.28 ^b	4.9x10 ²	2.7x10 ²
	60°C	1	4.66 ^b	5.2x10 ³	3.8x10 ³
		2	4.47 ^b	5.7x10 ²	5.1x10 ³
		3	4.12 ^b	4.1x10 ³	6.3x10 ³

The fungal count (cfu/g) of sun dried vary from 2.3×10^2 (yam parboiled at 50°C for 2h) to 4.19×10^5 (yam parboiled at 40°C for 2h) while that of oven-dried yam vary from 2.3×10^2 (yam parboiled at 50°C for 2h) to 6.3×10^3 (yam parboiled at 60°C for 3h). The oven-dried yam were microbiologically cleaner than the sun-dried yam, as the approximately lethal dose of $10 - 10^4$ cfu/g for Total viable count and fungal count were not exceeded (International Commission on Microbiological Specification for Foods ICMSF, 1996). The microbial load of processors' dry-yam samples (10^4 - 10^7 cfu/g) were also above the lethal dose, as sun drying method is being practiced by the processors (Babajide *et al.*, 2006).

In conclusion, the quality of dry-yam slices is greatly influenced processing variables, such as yam thickness and parboiling temperature. Samples of 2->3cm thickness, parboiled at 50°C for 2h appear to be the best in terms of the pasting properties and the sensory attributes. Oven-dried yam have lower microbial load than sun-dried yam.

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Synthesis of Well Ordered Spherical Ethane-Bridged Hybrid Silica Nanoporous Polymer

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Abstract

The well ordered spherical ethane bridged hybrid silica nanoporous polymer with smooth surface was synthesized using BTEE and cationic surfactant tetradecyltrimethylammonium ($C_{14}TMA^+$) with Br⁻ counterion. The hexagonal mesophase array and spherical morphology demonstrated by XRD and SEM results, respectively. The TGA and FTIR indicated that ethyl bridge of precursor remain intact in template-free PMO.

Keyword: Mesoporous, PMO, Spherical silica, Tetradecyltrimethylammonium bromide, nanoporous polymer.

Introduction

After the discovery of micelle templated silica (MTS),¹ by using lyotropic liquid phase as supramolecular templated for polymerizing of inorganic species, a new pathway in nanotechnology was bloomed. The frameworks of MTS provide a very robust, open, and tunable periodic scaffold on the nanometer scale.² These properties have been utilized or could be potentially used for embedding of metal complexes³ and metallic nanoparticle encapsulation,⁴ selective adsorption,⁵ catalysis and as functional materials.

Recently, the new nanoporous organic-inorganic polymer with narrow pore size distribution and high surface area, so called periodic mesoporous organosilicas (PMO), have exposed a novel pathway in the field of MTS compounds.⁶⁻⁸ It was demonstrated that the PMOs have better hydrothermal and mechanical stability than MTS.⁹ These materials are, similarly to MTS, prepared with polymerization of bridged silsesquioxane molecules, $(RO)_3Si-R-Si(OR)_3$ ($R = C_2H_4, C_2H_2, C_6H_6, (C_6H_4)_2, S(C_6H_4)_2, O(C_6H_4)_2$), in the present of amphiphilic supramolecular templates. The synthesis of ethane-bridged hybrid silica nanoporous polymer was for the first time by Inagaki group using octadecyltrimethylammonium chloride ($C_{18}TMACl$) and the rodlike and spherical particles were

obtained.⁶ The same group also announced a crystal-like external morphology of decaoctahedron and uniform particle with cetyltrimethylammonium chloride (C_{16} TMACl) with the same precursor.¹⁰ Sayari and coworkers studied the synthesis, morphology, and growth PMO with ethane bridge used C_{18} TMACl, C_{16} TMACl as a template and 1,2-bis(trimethoxysilyl)ethane (BTME), 1,2-bis(triethoxysilyl)ethane (BTEE) as a precursors.¹¹ They found that cubic material obtains in the presence of C_{16} TMACl and BTME, first formed into truncated rhombic dodecahedral particles that grew into spheres. Although, for C_{16} TMACl as a template, the size and surface of the obtained spheres were not uniform and smooth, respectively. Kapoor and Inagaki have reported synthesis of a cubic hybrid organic-inorganic mesostructure with dodecahedral morphology from a binary surfactant mixture.¹² The system included of ethane-bridged organosilica (BTME), polyoxyethylene alkylether [C_{12} (EO)₄; Brij 30], and the octadecyltrimethylammonium chloride (C_{18} TMACl) surfactants in basic medium.

Previously, it was reported that any anions and cations present in the synthesis are not innocent spectators and they affect the silanolate concentration as well as the long range order in the Mesoporous templated silica (MTS).¹³ The latter route is known to generate more stable materials in which the surfactant counterion plays an important role on the long-range order, the nature of the phase and on the hydrophobicity of the organic-inorganic interface the counter ions.^{14,15} However, Lin and Mou reported that counterions of cationic surfactant have an important task in morphology of MCM-41.¹⁶ Therefore is rational to test Br⁻ as counterion of surfactant in synthesis of PMO. Here, the synthesis of well ordered spherical ethane-bridged hybrid silica nanoporous with smooth surface was presented using cationic surfactant tetradecyltrimethylammonium (C_{14} TMA⁺) with Br⁻ counterion and BTEE.

Experimental section

Materials

Surfactant tetradecyltrimethylammonium bromide (C_{14} TMABr), NaOH were obtained from Merck and 1,2-bis(triethoxy silyl)ethane (BTEE) was purchased from Aldrich.

Synthesis procedure

The synthesis procedure used mixtures with following compositions: BTEE, 1; C_{14} TMABr, 0.48; NaOH, 2.36; H₂O, 353. In a typical synthesis, 14.37 g of BTEE was added to a mixture of 7.30 g of tetradecyltrimethylammonium bromide (C_{14} TMABr), 3.82 g of sodium hydroxide (NaOH) and 258 g of water under vigorous stirring at 18°C. The obtained gel was conserved for 21 h at 95°C in a Teflon lined static autoclave without stirring. The white precipitate was filtered and washed with distilled water and then dried at 70°C. The surfactant was remove by stirring 1.0 g of as-synthesized mesoporous material in 20 mL of 0.1 N HCl and 80 mL of ethanol for 30 min. The precipitate was filtered and dried at 70°C. The yield was 32%.

Characterization

FT-IR spectra were recorded using a Bruker spectrophotometer. XRD was obtained from a Philips diffractometer employing nickel filtrated Cu K α . Scanning electron scope (SEM) image were obtained on a DSM 960A field emission scanning microscope with voltage of 20 kV. Weight change curve in nitrogen were measured on a TA instrument TGA Q50 V6.3 with maximum heating rate of 20°C/min.

Results and discussion

Fig. 1 shows the low angel XRD pattern of template-free material. The intense low angel Bragg reflection at 44.5 θ shows typical of hexagonal mesophase with the p6m symmetry. No lattice

contraction was observed under template removal condition. The BET (Brunauer-Emmett-Teller) surface area was $940 \text{ m}^2/\text{g}$.

Figure. 1: XRD pattern of template-free PMO.

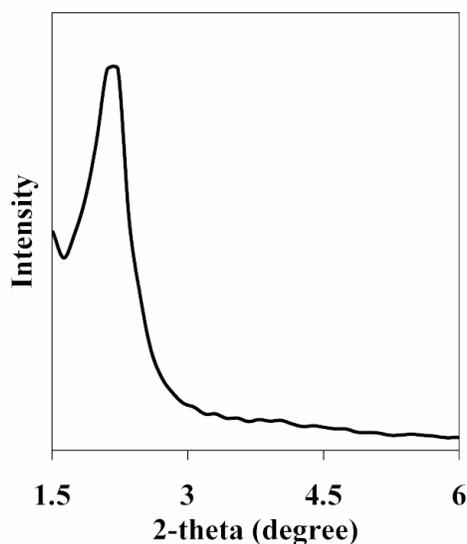


Fig. 2 shows the FTIR spectra of as-made and template-free PMO. The IR bands at 1463 and 2852 cm^{-1} (fig. 2a) attributed to CH_3 symmetry stretching and antisymmetry bending mode of cationic surfactant (CTMA^+).^{3,17} These bands for template-free PMO are disappeared after neutralization of silanolate with acid in as-made PMO, which indicates the removal of surfactant.¹⁸ The FTIR spectrum of as-made PMO (fig. 2a) shows a broad band at 1633 cm^{-1} , which attributed to deformation vibration mode (O-H of H_2O). After removal of surfactant, two bands at 1618 and 1700 cm^{-1} appear, which can attributed to water on surface and Si-O-Si vibration, respectively.¹⁹ The FTIR spectrum of template-free PMO (fig. 2b) shows that the organic groups of precursor ($\equiv\text{Si-CH}_2\text{-CH}_2\text{-Si}\equiv$) remain intact, indicated by presence of bands at 686 , 1134 , 1265 , and 1404 cm^{-1} that are attributed to Si-C vibration.²⁰

Figure. 2: FTIR spectra of a) as-made, and b) template-free PMO.

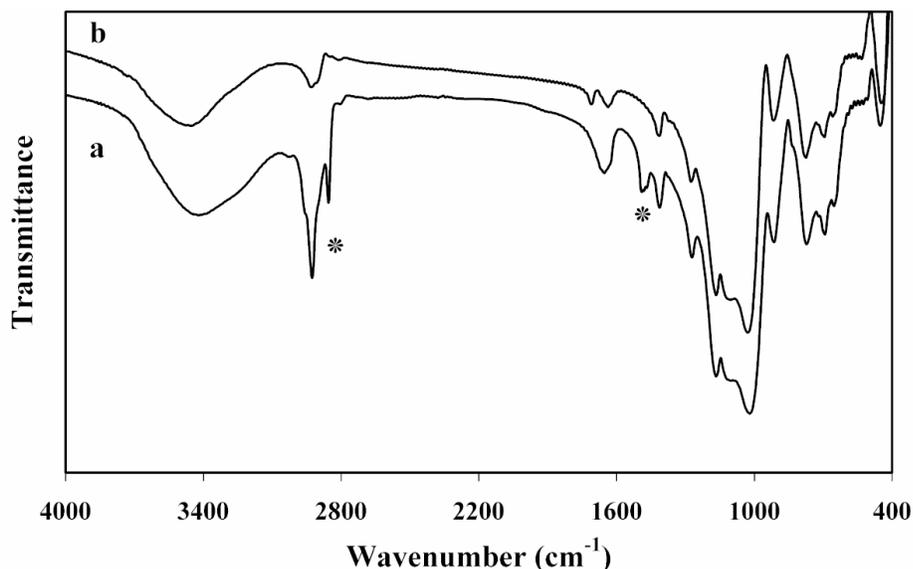


Fig. 3 shows the TGA of template-free PMO in N₂. The decrease in weight at temperature below 100°C was due to adsorption of water that indicated the minor amount of water (~0.5%). The major weight loss was remarked at 550 to 700°C, which may be related to decomposition and release of ethane fragments from the framework of template-free PMO. It indicated that ethane groups of precursors remain intact during the synthesis of PMO and removal of surfactant by acid. A weight gain is observed in the temperature range 700 to 950°C, and it continues until 1000°C. This phenomenon is most likely because of the reaction of partially decomposed bridging organic groups with nitrogen, as has already been observed for mesoporous materials.²¹

Figure. 3: Weight change curves for template-free PMO in N₂ flow.

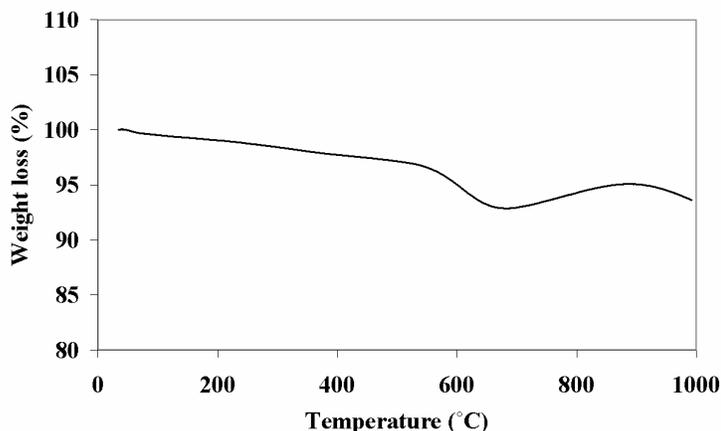
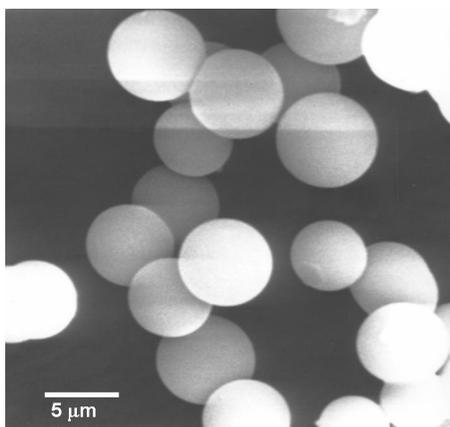


Fig. 4 shows the SEM image of as-made PMO. The spherical morphology is observed for overall particles. Also, the well ordered spherical PMO with the smooth surface is remarked. The well-defined external morphology of spherical particles is originated in growing up of spherical particle from rhombic dodecahedra.¹¹ The SEM image also shows a number of spherical particles join together. It is remarkable that the particles were not aggregated. This kind of morphology was not reported with C₁₄TMACl as a templating agent. It shows that morphology of PMO compounds depends on the counterion of cationic surfactant and it can not be innocent spectator in the synthesis of these type of compounds.

Figure. 4: SEM image of as-made PMO.



Conclusion

The well ordered spherical ethane bridged hybrid silica nanoporous polymer with smooth surface was synthesized using BTEE and cationic surfactant tetradecyltrimethylammonium ($C_{14}TMA$) with Br-counterion. The hexagonal mesophase array and spherical morphology demonstrated by XRD and SEM results, respectively. The TGA and FTIR indicated that ethyl bridge of precursor remain intact in template-free PMO.

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Evaluation of Hepatitis A Virus Contamination in Environmental Water and Shellfish Samples of Casablanca Region (Morocco)

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Abstract

Hepatitis A Virus (HAV) is a food and water borne Human pathogenic agent that is transmitted by faecal oral route. Since wild HAV can not be currently detected by cell

culture, molecular methods are the favourite way for the detection of viral particles in environment. In order to assess the contamination of environmental water as well as shellfish by HAV, we dealt with groundwater, wastewater and mussel samples from Mohammedia city (Casablanca region, Morocco). In this purpose water samples were concentrated by adsorption elution on cellulose acetate membrane filter. Virus concentration was done from mussel samples by an adsorption elution method followed by PEG 8000 flocculation. RNA was then extracted using acid phenol guanidinium thiocyanate. Subsequently RT-semi-nested-PCR was performed. HAV was detected in samples of sewage (43%); groundwater (16.67%) and mussels harvested in Mohammedia littoral (37.5 %). We also analysed mussel from a Category A growing area (Moroccan standards) none of these ones was positive. The use of such groundwater and mussels from the harvested In Mohammedia may lead to virus transmission to persons not immunised against HAV, mainly visitors from industrialised countries. To reduce HAV endemicity in Morocco, general hygiene of food and water should be improved.

Key Words: environmental samples, *Hepatitis A Virus*, shellfish, water, *RT-semi-nested-PCR*

1. Introduction

Hepatitis A virus (HAV) is a member of Picornavirus family (*Picornaviridae*), genus *Hepatovirus*. The virion is non enveloped. This virus has only one serotype. The occurrence is worldwide but the endemicity varies regionally (Bidawid et al., 2000; Divizia et al., 2005).

Like other enteric viruses, HAV is excreted in the faeces of infected persons and transmitted via faecal-oral route and is very resistant in environment (Divizia et al., 2005). This virus is among the most significant food and water borne Human pathogenic agents. Transmission via contaminated water is usually reported (Bosch et al., 2001).

Bivalves molluscs such as mussels are subject to contamination by HAV because they're filter feeder that accumulate enteric viruses in their digestive tissue. The analysis of food and water for HAV occurrence was formerly difficult in routine practice because this pathogen does not permit cell culture detection methods. Indeed we don't actually have any cell line on which wild strain of HAV can produce cytopathic effect. Nowadays molecular methods are broadly used for HAV detection in water and shellfish (Myrmet et al., 2004).

In order to assess HAV contamination mussel and water samples of Mohammedia city (Casablanca region, Morocco), we used RT-semi nested PCR as HAV detection method. Mussels, wastewater and groundwater were considered in this study. Virus concentration was necessary done before detection of HAV. In this purpose, we used adsorption-elution on cellulose acetate membrane cellulose acetate for water sample and direct glycine elution and PEG concentration. HAV RNA was extracted by acid phenol guanidine thiocyanate methods and RT-semi-nested-PCR was performed for HAV detection.

2. Materials and methods

2.1 Samples

We collected Thirty-two mussels' samples from the littoral of Mohammedia city (Casablanca region, Morocco) that is a wild mussel growing area. Thirty other mussel samples were purchased in two local markets. These last ones were from an aquaculture system classified in category A (consumption authorised without depuration).

Groundwater samples (thirty) were collected from five wells in the town. These wells were located in public bathrooms. We also took thirty wastewater samples from two sewage outlets.

2.2 Virus concentration

water samples were concentrated using cellulose acetate membrane filter Millipore® HA type (Kittigul et al 2001). Samples were adjusted to 0.05 M MgCl₂ and acidified to pH 5.0 with 2 N HCl. Adsorption was done by filtration of the conditioned sample through the filter (47 mm diameter). Subsequently the filter was washed with 0.15 M NaCl pH 3.5. Viruses were lastly eluted by 7.5 ml of 0.05M glycine pH 11.5. The obtained concentrate was rapidly neutralised to pH 7.2 by 1 N HCl and conserved at – 20°C until RNA extraction. Viruses were concentrated from mussels samples by direct glycine/NaCl (pH 9.5) elution followed PEG 8000 flocculation (Karamoko et al., 2005)

2.3. RT-seminested.-PCR

2.3.1. Nucleic acid extraction:

Total RNA was extracted by a guanidine thiocyanate method. 100µl of concentrate was treated with 500 µl of lysis solution (4M guanidine thiocyanate, 25 mM sodium citrate [pH 7], 0.5 % N-lauryl sarcosine 0.1 M 2-mercaptoethanol). 60 ml of 2M sodium acetate (pH 5.2) was added followed by 600 ml of phenol-chloroform-isoamyl alcohol (25:24:1). The tube was incubated 15 min on ice, the RNA in the aqueous phase after centrifugation (10 000 g for 20 min at 4°C) was precipitated with one volume of isopropanol for 2 h at –20 °C. The obtained pellet was washed with 1 ml of 70 % ethanol and dried. The resulting RNA precipitate was dissolved in 15 ml of RNase-free water (Promega, Madison, WI, USA) and conserved at -80° C before cDNA synthesis.

2.3.2 Oligonucleotide primers

we used previously designed primers (sequence 5'-3'): corresponding to the highly conserved 5' non-coding region (Table 1) as reported by Schvoerer et al., 2000.

Table 1: oligonucleotide primers used

Primers		Sequences 5'-3'	positions
H1	Antisense	GGAAATGTCTCAGGTACTTTCTTTG	2389 –2413
H2	Sense	GTTTTGCTCCTCTTTATCATGCTATG	2167 –2192
H3	Antisense	TCCTCAATTGTTGTGATAGC	2358 -2377

2.3.3. cDNA synthesis

cDNA was synthesised using extracted RNA with the specific antisens primer H1. A 25 µl reaction volume was used, containing 5 µl of 5X reverse transcriptase buffer [250µM Tris-HCl (pH 8.3 at 25°C) 375µM KCl 15µM MgCl₂ 50µM DTT], 20 U of Rnasin RNase inhibitors (Promega, Madison, WI, USA), 0.5 µM each dNTP , 200 U of M-MLV Reverse Transcriptase (Promega, Madison, WI, USA), 0.5 mM of primer H1 and 4.8 µl of RNA extract. DEPC treated sterile distilled water was used to adjust reaction volume. Reverse Transcription was carried out at 40°C for 1 h, and then DNA-RNA hybrid denaturation was performed by heating at 70°C for 15 min. the Obtained cDNA were immediately used for PCR.

2.3.4. Polymerase Chain Reaction (PCR) and seminested-PCR

10 µl of cDNA was mixed with 40µl PCR mix. PCR was performed in a 50 µl reaction volume containing 5 µl of 10X *Taq* DNA polymerase buffer, 0.5 µM of each dNTP, 2µM MgCl₂, 0.5 mM each primer(H1 & H2) and 2.5 U of *Taq* DNA polymerase (Promega, Madison, WI, USA). For Semi-nested PCR, 2 µl of PCR amplicon was added to 48 µl of semi-nested PCR mix. We undertook the reaction in the same conditions with PCR steps but H2 and H3 were used as primers. The amplification programme in both PCR and nested PCR steps the following: eight min preliminary denaturation

followed by 35 cycles: 45s at 94°C for denaturation, 45 s at 55 °C for hybridization and 60 s at 72 °C for extension. A final extension was done at 72 °C for 7 min. A Perkin Elmer® 2400 thermal cycler was used for amplification. PCR product was analysed on 1.8 % agarose gel electrophoresis runned at 80V during 45 min, stained with ethidium bromide and visualized under UV transilluminator. A 247 bp (PCR product) and 210 bp (seminested-PCR product) amplicon sizes were expected. 100 bp DNA molecular ladder(Promega® Madison, WI, USA) was used for amplicon sizes estimation.

3. Results and discussion

HAV has a worldwide distribution (Bidawid et al, 2000). However endemicity is important in developing countries such as Morocco where seroprevalence is very high (Bidawid et al, 2000). In literature HAV detection in domestic sewage of often reported. this study is the first report in morocco using molecular tools for HAV detection. These wastewaters serve as vehicle to contaminate groundwater as well as estuarine waters. It's known that HAV has a very high capacity of persistence in environment (Crocì et al., 2002). Some sewer lines are defective in Mohammedia city. Septic tanks are also used in a significant part of the town explain that HAV contamination reach ground water (Borchardt et a., 2003).

Numerous HAV outbreaks are regularly link to shellfish consumption. Usually shellfish is eaten crude or lightly cooked. This allows the transmission of the viral particles accumulated on the meat (Bosch et al, 2001). The shellfish virological quality depends on the contamination level of their surrounding water. The aquacultures samples are from an area classified in category A of shellfish growing area (Moroccan standards). The local standards as well as the European ones are based on bacterial indicators without taking virological analysis into account (Myrmel et al., 2004).

Table2: HAV prevalence in analysed samples

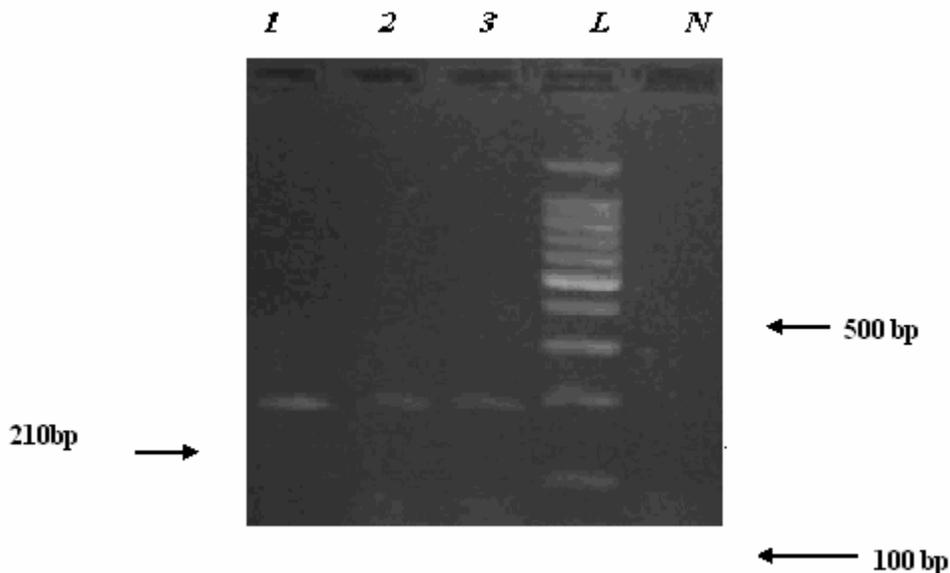
wastewater	Groundwater	Mussels from aquaculture ^b	Mussel harvested on Mohammedia littoral
13/30 ^a (43 %)	5/30 ^a (16.67 %)	0/30 ^a (0%)	12/32 ^a (37.5 %)

^a Ratio number positive sample/total number of samples

^b purchased in local markets

Figure 1: 1.8% agarose gel electrophoresis stained with ethidium bromide.

1: positive sewage sample; **2:** positive groundwater sample; **3:** positive mussel sample; **L:** 100 base pairs DNA molecular weight ladder (PROMEGA); **N:** negative control



The contamination ratio is important in environmental wastewater samples (43 %) considered in this study. This contamination is mainly due to the fact that endemicity is very high in Mediterranean south rive including Morocco. water and shellfish sanitary quality is currently assess only by bacterial indicators in Morocco. Many researchers have reported that this indicators are not reliable for virological quality evaluation (Skraber et al., 2004; Muniain-Mujika et al., 2003; Formiga-Cruz et al., 2003). In this study the aquaculture mussel samples did not show any HAV genome amplification when RT-seminested-PCR was applied. We can conclude according to the obtained results that the mussels from Oualidia aquaculture were not exposed to HAV contamination (0%). The mussels harvested on Mohammedia littoral were found contaminated in important proportion (37%). This contamination is an effect of the urban sewage impact on the coastal water (Griffin et al., 2003). This work shows the importance of analysing environmental sample for enteric virus HAV particularly. Because we are in an endemic region, the contamination of food as well as shellfish can occur easily. This contamination can be an health risk for people not immunised against HAV (Kingsley et al 2002). Such persons are mainly travelers coming from industrialised countries (Romalde et al., 2001; Bosch et al., 2001). Since local population has an important HAV seroprevalence. So the public health risk is not as important for local population as for visitors from industrialised countries whom should take additional precaution for immunisation prior travel. To reduce HAV endemicity in Morocco, general hygiene of food and water should improved. The use of molecular methods described in this paper can be an interesting tool to screen routinely enteric viruses environmental samples. Such method is costly and rapid.

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Determination of the Optimal Preventive Maintenance of the Reserve Source in the Industrial Electric Network

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Abstract

The great majority of the electric installations belong to the first and second category. In order to ensure a high level of reliability of their electric system feeder, two power supply sources are envisaged, one principal, the other of reserve, generally a cold reserve (electric diesel group).

The principal source being under operation, its control can be ideal and sure, however for the reserve source being in stop, a preventive maintenance's which proceed on time intervals (periodicity) and for well defined lengths of time are envisaged, so that this source will always be available in case of the principal source failure.

The choice of the periodicity of preventive maintenance of the source of reserve influences directly the reliability of the electric feeder system. On the basis of the semi-markovian processes, the influence of the periodicity of the preventive maintenance of the source of reserve is studied and is given the optimal periodicity.

Key words: Semi Markovian processes, reliability, optimization, electric network

Introduction

It is known that the electric installations are classified on the basis of several criteria, the principal ones are as follows :

- operation mode;

- nature of the current;
- voltage and power level;
- reliability required of their electric feeder system

According to the last criterion, the electric installations are divided into three categories[1]

- first category: these installations don't admit any stop (accidental or planned) of their electric feeder system (E.F.S), the stop of the latter can have the human death consequence, this is why their EFS must be carried out with two independent sources.
- Second category: these installations don't admit any stop (accidental or planned) of their electric feeder system (E.F.S), the stop of the latter can have a significant economic consequence, this is why their EFS must be carried out with two independent sources.
- Third category: these installations don't have a capital insert in the technological process, they can admit a stop (accidental or planned) of their EFS going up to 24 hours, their EFS is carried out with only one source.

The great majority of the electric installations belong to the first and second category. In order to ensure a high level of reliability of their electric system feeder, two power supply sources are envisaged, one principal, the other of reserve, generally a cold reserve (electric diesel group) [1]

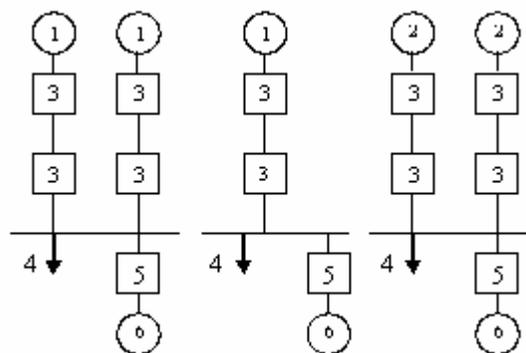
The principal source being under operation, its control can be ideal and sure, however for the reserve source being in stop, a preventive maintenance's which proceed on time intervals (periodicity) P_m and for well defined lengths of time d_m are envisaged, so that this source will always be available in case of the principal source failure.

The choice of the periodicity of preventive maintenance of the source of reserve influences directly the reliability of the electric feeder system. On the basis of the semi-markovian processes, the influence of the periodicity of the preventive maintenance of the source of reserve is studied and is given the optimal periodicity.

Principal Structures of the EFS of the Electric Installations

According to the criterion of the reliability level required by their EFS, the electric installations belong to the first and second category must have two independent sources, a main source and a reserve one (figure.1).

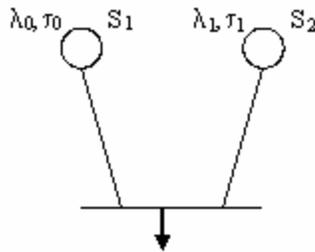
Figure 1: Standard diagram of the EFS structures



1. external source of the national network
2. local source
3. line circuit breaker
4. electric load
5. coupling circuit breaker
6. reserve source (electric diesel group).

On the basis of these structures, the EFS can be schematised with their reliability parameters as follows (Figure 2)

Figure 2: Representative sources diagram

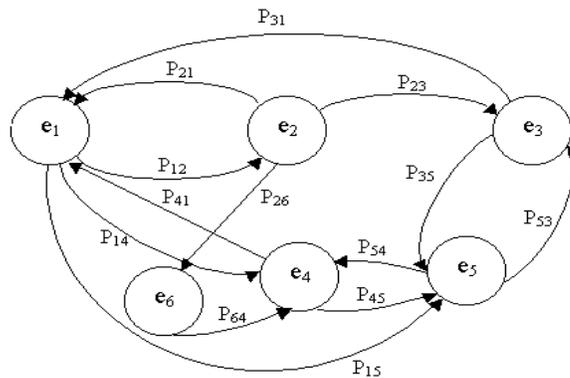


- S_1 : principal source;
- S_2 : reserve source;
- λ_0, τ_0 : principal source failure rate and time of repair respectively;
- λ_1, τ_1 : reserve source failure rate and time of repair respectively.

System (EFS) states and probability of transitions between states.

Under operation , the EFS can has several states, on the basis of the semi-Markovian processes [2,3], the evolution of the EFS operation can be described by the states and the probability of transitions P_{ij} according to figure 3.

Figure 3: semi-Markovian process states and transitions graph.



- e_1 : PS under operation, RS in reserve;
- e_2 : PS under operation, RS in preventive maintenance;
- e_3 : PS under operation, RS in repair;
- e_4 : RS under operation, PS in repair;
- e_5 : PS and RS in repair;
- e_6 : RS is started.
- PS : principal source, RS: reserve source.

The random values of the MTBF, ξ_0, ξ_1 as well as the repair time η_0, η_1 of the principal source and reserve source respectively follow an exponential law [4] $P(t)$ and $G(t)$ with the parameters λ_i, μ_i ($i = 0, 1$). The reserve source failure rate is taken equal to $\alpha\lambda_1$ with $0 < \alpha < 1$.

We suppose that the reserve source interlocking in the event of the principal source failure is absolutely reliable, the reserve source starting is immediate.

Calculation of the transitions probability P_{ij} between states

The transitions probability P_{ij} could be calculated as follows:

$$P_{12} = P\{\xi_0 > P_m\} = e^{-\lambda_0 P_m} \quad (1)$$

$$P_{14} = P\{\xi_0 < P_m\} \cdot P\{\xi_1 > P_m\} = (1 - e^{-\lambda_0 P_m}) \cdot e^{-\alpha \lambda_1 P_m} \quad (2)$$

$$P_{15} = P\{\xi_0 < P_m\} \cdot P\{\xi_1 < P_m\} = (1 - e^{-\lambda_0 P_m}) \cdot (1 - e^{-\lambda_1 P_m}) \quad (3)$$

$$P_{21} = P\{\xi_1 > P_m\} \cdot P\{\xi_0 > d_m\} = e^{-(\lambda_0 d_m + \alpha \lambda_1 P_m)} \quad (4)$$

$$P_{23} = P\{\xi_1 < P_m\} = (1 - e^{-\alpha \lambda_1 P_m}) \quad (5)$$

$$P_{26} = P\{\xi_1 > P_m\} \cdot P\{\xi_0 < d_m\} = e^{-\alpha \lambda_1 P_m} (1 - e^{-\lambda_0 d_m}) \quad (6)$$

$$P_{31} = P\{\xi_0 > \eta_1\} = \int_0^{\infty} [1 - P_0(t)] dG_1(t) = \frac{\mu_1}{\lambda_0 + \mu_1} \quad (7)$$

$$P_{35} = P\{\xi_0 < \eta_1\} = \int_0^{\infty} P_0(t) dG_1(t) = \frac{\lambda_0}{\lambda_0 + \mu_1} \quad (8)$$

$$P_{41} = P\{\eta_0 < \xi_1\} = \int_0^{\infty} G_0(t) dP_1(t) = \frac{\mu_0}{\mu_0 + \alpha \lambda_1} \quad (9)$$

$$P_{53} = P\{\eta_0 < \eta_1\} = \int_0^{\infty} G_0(t) dG_1(t) = \frac{\mu_0}{\mu_0 + \mu_1} \quad (10)$$

$$P_{54} = P\{\eta_1 < \eta_0\} = \int_0^{\infty} G_1(t) dG_0(t) = \frac{\mu_1}{\mu_0 + \mu_1} \quad (11)$$

$$P_{64} = 1 \quad (12)$$

where:

P_m : periodicity of preventive maintenance of the source of reserve;

d_m : time duration of the preventive maintenance;

P : probability;

λ_0, λ_1 : failure rate of the principal and reserve source respectively;

μ_0, μ_1 , repair rate of the principal and reserve source respectively,

ξ_0, ξ_1 : random time of good functioning of the principal and reserve source respectively,

η_0, η_1 : repair random time of the principal and reserve source respectively,

$P_0(t), P_1(t)$: failure law distribution of the principal and reserve source respectively,

$G_0(t), G_1(t)$: repair law distribution of the principal and reserve source respectively.

Calculation of the average time T_{ei} of occupation at state e_i

The the average time T_{ei} of occupation at state could be calculated as follows :

$$T_{e_1} = E \min\{\xi_0, P_m\} = \int_0^{P_m} [1 - P_0(t)] dt = \frac{1 - e^{-\lambda_0 P_m}}{\lambda_0} \quad (13)$$

$$T_{e_2} = E \min\{\xi_0, d_m\} = \int_0^{d_m} [1 - P_0(t)] dt = \frac{1 - e^{-\lambda_0 d_m}}{\lambda_0} \quad (14)$$

$$T_{e_6} = 0 \text{ (the reserve source starting is immediate).} \quad (15)$$

where:

E: expected valued.

For the other states, knowing the existence distribution law $T_{ij}(t)$ in the state e_i at the time of the transition to the state e_j , we determine the law of distribution $F_i(t)$ and the existence mean time at the state e_i , T_{ei} as follows:

$$F_i(t) = \sum_{j=0}^n P_{ij} T_{ij}(t) \tag{16}$$

$$T_{ei} = \int_0^{\infty} t dF_i(t) \tag{17}$$

where:

$$T_{31}(t) = P\{\eta_1 < t / \eta_1 < \xi_0\} = 1 - e^{-(\mu_1 + \lambda_0)t} \tag{18}$$

$$T_{35}(t) = P\{\xi_0 < t / \eta_1 > \xi_0\} = 1 - e^{-(\mu_1 + \lambda_0)t} \tag{19}$$

$$T_{41}(t) = P\{\eta_0 < t / \eta_0 < \xi_1\} = 1 - e^{-(\mu_0 + \alpha\lambda_1)t} \tag{20}$$

$$T_{45}(t) = P\{\xi_1 < t / \eta_0 > \xi_1\} = 1 - e^{-(\mu_0 + \alpha\lambda_1)t} \tag{21}$$

$$T_{53}(t) = P\{\eta_0 < t / \eta_0 < \eta_1\} = 1 - e^{-(\mu_0 + \mu_1)t} \tag{22}$$

$$T_{54}(t) = P\{\eta_1 < t / \eta_1 < \eta_0\} = 1 - e^{-(\mu_0 + \mu_1)t} \tag{23}$$

we determine that:

$$T_{e3} = \frac{1}{\mu_1 + \lambda_0}, T_{e4} = \frac{1}{\mu_1 + \alpha\lambda_1}, T_{e5} = \frac{1}{\mu_1 + \mu_0}$$

Calculation of the stationnary probabilities P_i of occupation at state e_i :

The stationnary probabilities P_i of occupation at the state e_i can be given by solving the equations system according to [3]:

$$\left| \begin{array}{l} P_i = \sum_{j \in e} P_{ij} \cdot P_j \end{array} \right. \tag{24}$$

$$\left| \begin{array}{l} \sum_1^6 P_i = 1 \end{array} \right. \tag{25}$$

$$P_1 = P_{21} \cdot P_2 + P_{31} \cdot P_3 + P_{41} \cdot P_4 \tag{25}$$

$$P_2 = P_{12} \cdot P_1 \tag{26}$$

$$P_3 = P_{23} \cdot P_2 + P_{53} \cdot P_5 \tag{27}$$

$$P_4 = P_{14} \cdot P_1 + P_{54} \cdot P_5 + P_{64} \cdot P_6 \tag{28}$$

$$P_5 = P_{15} \cdot P_1 + P_{35} \cdot P_3 + P_{45} \cdot P_4 \tag{29}$$

$$P_6 = P_{26} \cdot P_2 \tag{30}$$

Calculation of the mean time between failures.

The mean time between failures system (EFS) can be obtained as follows: [3]

$$T_f = \frac{\sum_{e_n \in e^+} P_{e_n} \cdot T_{e_n}}{\sum_{i \in e^+, j \in e^-} P_i \cdot P_{ij}} \tag{31}$$

where :

P_{e_n} : stationnary probability at state e_n

T_{e_n} : average time of occupation at state e_n

e^+ : states of good functioning of system

e^- : failure's states of system.

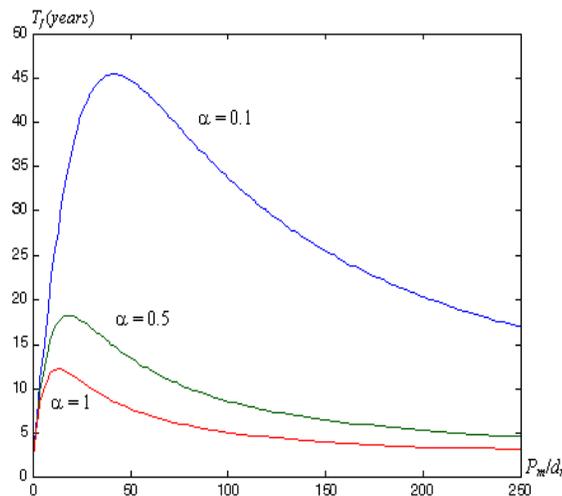
Application of the method.

The method is applied to an electric feeder system with two independent sources, a principal source, the second of reserve and having the following reliability parameters $\lambda_0 = 0.4 [1/year]$; $\lambda_1 = 5 [1/year]$;

$$\tau_0 = 50 \text{ h} , \tau_1 = 100 \text{ h} , d_m = 8 \text{ h}.$$

The mean time between failures variation curve obtained according to the ratio P_m/d_m is as follows (figure 4):

Figure 4. mean time between failures variation according to ratio P_m/d_m



Conclusion

An optimal periodicity of preventive maintenance of the reserve source has been found which corresponds to the maximum time between failure of the system.

An optimal periodicity of preventive maintenance of the source of reserve can be explained as follows: a great periodicity of preventive maintenance of the source of reserve has a consequence a great probability of having a failure of this source so we have a reduction in the mean time between failures, for a weak periodicity the probability to have a failure of the principal source during a preventive maintenance of the source of reserve is significant so we have a reduction of the mean time between failures of the system.

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In Vivo* Animal Model Toxicological Studies of Nigerian Medicinal Plants II: *Eniantha Chlorantha* and *Khaya Ivorensis

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Abstract

The stem bark of *Eniantha chlorantha* and *Khaya ivorensis* two antimalaria herbal remedies used as decoctions in Ilorin metropolis, in Nigeria were screened phytochemically for secondary metabolites. The acute toxicity of the methanol extracts of each herbal remedy was evaluated in albino mice.

Various degree of chemo suppression were obtained when extracts of remedies were injected intraperitoneally into the mice. *Eniantha chlorantha* and *Khaya ivorensis* were found to be relatively toxic with LD₅₀ of 375mg/kg and 549mg/kg respectively per body weight of the mice. In the same study, chloroquine, the reference drug had an LD₅₀ of 146mg/kg body weight of mouse.

Keywords: Herbal remedies, toxicological studies, mice.

Introduction

Herbal remedies are well known to be efficacious in treatment of diseases in Africa. Many medicinal plants have been mentioned in the African phytomedicine for the treatment of various ailments. Various species of *Khaya* have found use internally and externally for febrile illness, lotion for tumors, as analgesics and for headaches. Specifically from *Khaya ivorensis* coumarines have been found to have antianalgesic, antipyretic and anticonvulsant effects. *Khaya ivorensis* is a dominant tree about 60m high with high winged buttresses while *Eniantha chlorantha* on the other hand is an understory

tree of the tropical rainforest which attains a height of about 30m. *Eniantha chlorantha* is indigenous to Southern Nigeria and Western Cameroon. The wood is used for house building and various other furniture purposes. The bark is used in the treatment of sores in Nigeria and ulcers in Gabon. Bark extracts are widely used as antipyretic in the treatment of fevers. Two oxyaporphines have been isolated from the bark as well as alkaloids of the aporphine type.

In the present study *Khaya ivorensis* and *Eniantha chlorantha* were reported as effective in the clinical clearance of *Plasmodium falciparum* malaria in the Ilorin metropolis and that necessitated our interest in the toxicity studies of extracts of both plants.

Methodology

Plant Authentication and Extraction

The stem bark of *Khaya ivorensis* and *Eniantha chlorantha* were purchased from herb sellers in Sango Market, Ibadan on 29th of March, 2001 and these were authenticated by Dr. A.E. Ayodele of the herbarium section of Botany Department, University of Ibadan, Ibadan, Oyo State, Nigeria.

They were respectively air dried and ground into powdery form with the hammer mill. From 193g of *Eniantha chlorantha*, 9.17g (percentage yield was 6.20) of methanolic extract was obtained by soxhlet extraction and from 428.4g of *Khaya ivorensis*, 32.31g (percentage yield was 9.55) of methanol extract was obtained by soxhlet extraction.

Preliminary Phytochemical Screening.

Borntrager's Test for Anthraquinones

1g each of powdered stem barks of *Eniantha chlorantha* and *Khaya ivorensis* was boiled in 2ml of 10% HCl for five minutes respectively. The extract was filtered while still hot and the filtrate was allowed to cool. Equal volumes of chloroform was partitioned against the filtrate and shaken gently. The lower portion containing the chloroform was pipetted into a clean test tube and an equal volume of 10% ammonia solution was added to the chloroform portion, it was shaken, allowed to separate and then observed.

Alkaloidal Test

1g each of powdered stem barks of *E. chlorantha* and *K. ivorensis* was extracted with 10mls of 10% hydrochloric acid on a water bath, this was filtered and the pH of the filtrate was adjusted with ammonia solution. Each test filtrate was divided into five test tubes containing 0.5ml of the test filtrate. To each of these test tubes containing test filtrate were added drops of the following reagents and observed. Mayer's reagent, Dragendorff's reagent, Wagner's reagent, Picric acid and Tannin acid.

Tannin Test

1g each of powdered stem barks of *E. chlorantha* and *K. ivorensis* was boiled with 20mls of water for 5 minutes, cooled and filtered and the volume adjusted to 20mls. The following reagents were then added:

- (a). To 1ml of each test filtrate, 5mls of distilled water was added and three drops of 0.1% ferric chloride.
- (b). To 1ml of each test filtrate, 2 drops of bromine water was added.

Keller-Killiani Test for Cardiac Glycosides

1g each of powdered stem barks of *E. chlorantha* and *K. ivorensis* was extracted with 10mls of 80% alcohol for five minutes on a steam bath. The extracts were filtered and diluted with an equal volume of distilled water. A few drops of lead acetate was added, shaken and filtered after a few minutes of being left standing.

Aliquots of chloroform was used to extract the test filtrate. The chloroform extract was divided into two and both portions evaporated on a steam bath. The dried residue was dissolved in 3mls of Ferric chloride reagent in 50mls of glacial acetic acid. Conc. H₂SO₄ was then carefully poured down the stem of the test tube and it was observed.

Saponin Glycosides Test

1g of powdered stem barks of *E. chlorantha* and *K. ivorensis* was boiled in 10mls of distilled water for ten minutes. 10mls of distilled water was then added to 2mls of the filtrate and it was shaken vigorously for two minutes and then observed.

To a portion of test filtrate, 2 drops of liquid paraffin was added and boiled for about 10 minutes on a water bath. To another portion of the filtrate 20% NaOH solution was boiled with an equal volume of Benedict's solution on a water bath.

Results of phytochemical screening of these stem bark are shown on Table 1.

Determination of LD₅₀ of *E. chlorantha*, *K. ivorensis* and Chloroquine

ANIMALS: One hundred and fifty albino mice were obtained from Animals House of Physiology Department, University of Ibadan and a further twenty male albino mice were obtained from the Animal House of the National Institute of Horticultural Research (NIHORT) at Yaba, Lagos State. The mice were all housed under good conditions and at room temperature in the Animal House of Biochemistry Department, University of Ibadan. They were allowed access to feed purchased from Ladokun stores located at Mokola Market, Ibadan and water ad libitum in accordance with the principles on the care and use of laboratory animals.

Preparation of Stock Solutions

(i) PREPARATION OF NORMAL SALINE

2.275g of NaCl was dissolved in 250cm³ standard flask using distilled water, it was made up to mark.

(ii) PREPARATION OF CHLOROQUINE PHOSPHATE

0.5g of chloroquine phosphate was dissolved in 50mls of normal saline.

(iii) PREPARATION OF PLANT EXTRACTS

0.5g of *Khaya ivorensis* and *Eniantha chlorantha* were initially dissolved in 2mls of dimethylsulphoxide (DMSO) in a 50cm³ standard flask and it was made up to mark by adding normal saline.

(iv) PREPARATION OF STOCK CONTROL SOLUTION

2mls of DMSO was added to a 50cm³ standard flask and it was made up to mark using the stock normal saline solution.

Groups of Animals

***E. chlorantha*:** Ten groups of 4 animals each both for the test and control. Each group received 100, 150, 200, 250, 300, 350, 375, 400, 450 and 500mg/kg dose intraperitoneally respectively. Results obtained are shown on Table 2.

***K. ivorensis*:** Nine groups of 4 animals each of both control and test. Each group received 100, 150, 200, 300, 400, 450, 500, 550 and 600mg/kg doses (I.P.) respectively. Data obtained are presented on Table 3.

Chloroquine phosphate: Seven groups of 4 animals each for both test and control. Each group received 100, 120, 140, 150, 160, 180 and 200mg/kg dose (I.P) respectively. Table 4 shows results obtained.

After administering the chloroquine, extracts of bark of *K. ivorensis* and *E. chlorantha*, the animals were carefully observed for 24hrs and mortality within that period was recorded. A confirmatory administration was carried out, after which percentage death was calculated and this was plotted against dose on a graph to obtain the LD₅₀ of the respective additives.

Results

Table 1: (Result of Phytochemical Screening)

TEST	INFERENCES	
	<i>K. ivorensis</i>	<i>E. chlorantha</i>
Anthraquinones (Borntrager's test)	+	+
Alkaloids	++	+
Tannins	+	+
Deoxysugar (Keller-Killiani's test)	+	+
Saponin glycosides	+	+

Table 2: (Toxicity test LD₅₀ of Chloroquine)

Dose (mg/kg)	Mortality in Normal Saline	Mortality in Chloroquine	Percentage mortality in Chloroquine
100	-	-	0.0
120	-	2	25.0
140	-	3	37.5
150	-	5	62.5
160	-	6	75.0
180	-	8	100.0
200	-	8	100.0

Table 3: (Results of toxicity test LD₅₀) of *E. chlorantha*)

Dose (mg/kg)	Mortality observed in Control group	Mortality observed in Plant extract group	Percentage mortality in Plant extract
100	-	-	0.0
150	-	-	0.0
200	-	-	0.0
250	-	-	0.0
300	-	-	0.0
350	-	-	0.0
375	-	4	50.0
400	-	6	75.0
450	-	7	87.5
500	-	8	100

Table 4: (Results of toxicity test LD₅₀ of *K. ivorensis*)

Dose (mg/kg)	Mortality in Control group	Mortality observed in Plant extract group	Percentage mortality in Plant extract
100	-	-	0.0
150	-	-	0.0
200	-	-	0.0
300	-	-	0.0
400	-	1	12.5
450	-	2	25.0
500	-	2	37.5
550	-	6	75.0
600	-	8	100.0

Discussion

Earlier investigators have studied the phytochemical components of *E. chlorantha* (1-5) and *K. ivorensis* (1,6-9). Our results of phytochemical screening seem to agree with some of these earlier works. Alkaloids were found in *E. chlorantha* which agrees with previous reports while presence of tannins, anthraquinones, deoxysugars and saponin glycosides were not indicated as been either present or absent. On the other hand phytochemical screening of *K. ivorensis* showed the presence of alkaloids which is at variance with those of Adegoke et al in 1968 while the presence of tannins is in agreement with works by Watt and Breyer – Brandwijk in 1962. Deoxysugars, saponin glycosides and anthraquinones were also observed.

The main objective of this work however was to determine the acute toxicity level of these two medicinal plants which have been found effective for the treatment of malaria fever and compare it with chloroquine the most commonly used antimalaria. Results of toxicity test of chloroquine is in agreement with earlier works LD₅₀ of 146mg/kg body weight (10) oral administrations of both aqueous extract (10 and 11) and ethanolic extracts (11).

On careful observation of the intact animals after administering chloroquine intraperitoneally there was no loss of motor coordination or sleep prior to death but the animals were seen to asphyxiate prior to death. This pattern was similarly observed in *E. chlorantha* while *K. ivorensis* mortality was much milder. *K. ivorensis* has a sedative effect on the animals; they drifted between a state of sleep and wakefulness before death coupled with loss of motor coordination. Animals administered *E. chlorantha* were also seen to scratch their bodies just like those on chloroquine as contained in earlier reports.

We have shown from this study that chloroquine is the most toxicity followed by the methanolic barks of *E. chlorantha* (LD₅₀ 375mg/kg body weight) and lastly by *K. ivorensis* (LD₅₀ 549mg/kg body weight). *E. chlorantha* was very highly toxic as 100% death was observed at 500mg/kg within 40mins after administering while for *K. ivorensis* 100% death at 600mg/kg body weight) within 7-18 hours after administration. With chloroquine, 100% death was observed at 180mg/kg and 200mg/kg body weight in less than 10mins after drug administration. The side effects of these herbal remedies are itching as inferred from *E. chlorantha* while for *K. ivorensis* they are sedative and paralysis effects.

Histological examination of major tissues and organs was not done in this study since *E. chlorantha* and *K. ivorensis* have already been found to be efficacious in the treatment of malaria, bearing in mind that malaria remains the most endemic disease of tropical Africa, the results obtained would warrant further investigation to ensure the therapeutic use of these plant medicines are medically safe and possibly to develop them to compliment synthetic antimalarial drugs in the market.

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The Spiritual Healing Dimensions of Islam: Sheu Kokoroadua as a Case Study

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1.0. Introduction

The awareness created by spiritual healing in the Nigerian society has given the impetus for this paper. People are ready to claim their healing from any source irrespective of their religious leaning. It is however important to explain why healing has taken such a form particularly in Yoruba land of Nigeria. The age long belief of the Yoruba in the supernatural still persists today. Many people still believe that ailments occur in one of three ways, viz natural, mystical or supernatural. Dopamu¹ for example has argued that the natural ailments are the common everyday ailments that will cure after applying simple medicaments. Such ailments include headache, fever and boil. But when any of these does not respond to natural treatment, explanation is sought by consulting a diviner, a medicine – man, a Muslim priest or a Christian prophet. The belief of the Yoruba is that natural ailments can be induced to become mystical or supernatural.

Although the scientific age may not give room for such beliefs, the plain truth is that the Yoruba still cling to such beliefs and as a sociological phenomenon; we cannot wish away the beliefs that are affecting the lives of the people. In this paper we shall examine some of the prevailing beliefs and the spiritual healing processes among the Yoruba, using Shehu Kokoro Adua as a case study.

2.0. Sources of Problems and solutions

2.0.1. The Yoruba Point of view

To the Yoruba, diseases, which cause problems, are often a concatenation of several factors or sources. In the broad sense, we shall speak of three recognized by the Yoruba.

First, natural or physical source of diseases. The Yoruba recognize the fleeting nature of minor illnesses, which they regard as natural, and as falling within the range of physical plane of reality and understanding. Such diseases include headache, cough, fever, thrush, pyorrhoea, running stool, guinea worm, pile, giddiness, sore, ulcer, dysentery, cholera and the host of others.

Secondly, Yoruba also recognize diseases that their source can be explained in terms of supernatural phenomenon, almost always, any serious and protracted illness, any unusual malady, and sudden and violent sickness, anything extraordinary and mysterious and any accident not apparently the result of the victim's carelessness or ignorance is attributed by the Yoruba, to either the action of the sorcerer or the witch.

Thirdly, the source of diseases that cause problem can also be explained interms of mystical phenomenon. This entirely depends on the verdict of the oracle. The oracle may say that the source of

¹ P.A. Dopamu, "Yoruba magic and medicine and their Relevance for today" in sam Babs Mala et - al (ed) Religions: A journal of the Nigerian Association for the study of Religions vol. 4, Dec. 1979. pp12-13.

disease is through spiritual agents namely ancestors and divinities. In all, such diseases emanated from angered spirits or ancestors when taboos are broken or when they are rejected or when false oaths are taken or when there is a breach of divine ordained laws as found in the covenant relationship. That is why, among the Yoruba, worshippers try to avoid ritual errors which are regarded as offences against divinities, people believe that each divinity brings problem to people committing moral offences as punishment.

2.0.2. Names of diseases and medium/solution

Generally speaking, diseases get their names in the following ways: certain diseases are named after the parts of the body affected e.g. headache. There are others that are named after the cause. This includes born-to. Die. We have diseases named after their description such as stomach – ache – resulting in passing of stool². Whatever the names of diseases, their solution vary or there treatment vary from one another.

However, it is impossible to examine the treatment of the various diseases, we shall therefore give one example as illustration, when a Yoruba man falls sick, and the sickness is recognized to be a minor one, or one that belongs to the natural causation, treatment may be carried out by the patient himself or by the elders in the family. No one will ever consult any spiritualists. For example, in the case of a man in the family having constipation, uses famlax drug (caxative) but it did not work throughout the day. The second day, the man was feeling very uncomfortable. He therefore consulted the senior brother who collected some fresh herbs from the bush and squeezed them in water only to be drunk by the patient. The patient entered the toilet more than eight times to evacuate his bowels³. But when mystical or supernatural sources are the cause of the problem or disease, this is beyond the scope of the elders in the family and so the help of diviner or spiritualist like Shehu Kokoro Adua must be sought.

There are many different other types of Yoruba medicine serving different ends and purposes, for example. Magic or medicine that protects one against all types of sorcery, specific magic or medicine against witches, that which aids memory, that which enables one to win a case in the court of law, that which makes people to love one and that which makes one immune from bullets⁴:

3.0. The Islamic Point of view

In Islam, healing is one of the fundamental issues, which the Qur'an describes as a mercy. The Qur'an says:

“We reveal from the Qur'an that which is
Healing and a mercy for the believers⁵”.

The above statement is a fact declared in the Qur'an and confirmed by the saying and practice of prophet Muhammad. The healing effort of the Qur'an is not limited to the ills of the society and the world. It extends to human beings, and contributes to his physical and mental health and well – being.

It is on the basis of this that most of Muslim clerics embark on healing and take it as a profession. Many of them are very prominent of this work and many people patronize them. These Islamic clerics have one endowment than the other depending on their knowledge of Qur'an. Shehu Kokoro Adua, who is the subject of this paper, is one out of the numerous Islamic clerics that have established themselves as spiritual healers in Yorubaland. Some use rosary and some use palm reading. Whatever the method, the purpose is one, that is, to unravel the problem of a client.

² P.A Dopamu, “Yoruba Magic and Medicine ”

³ P.A Dopamu, “Yoruba Magic and Medicine”

⁴ P. Ade Dopamu et al (ed), African culture, Modern science and Religious Thought. African centre for Religions and the science. University of Ilorin, Ilorin 2003.

⁵ Y.A.Ali, Holy Qur'an, Text, Translation and Commentary, Pakistan Agrof Publishing company Ltd. Q17:82

Again, the treatment varies from one cleric to another. There are those who combine Yoruba practice with Islamic practice, using black – soap for washing the body, cooking medicine for clients to eat, reciting incantations on objects and using thread to tie some objects which the clients are expected to put in the pocket or wear everywhere. But Kokoro Adua’s healing strategy, is purely spiritual, with prayer to Allah as a dominant force, we shall unfold this in the subsequent paragraphs.

It should be noted that apart from preaching and running of Qur’anic schools by some of these Yoruba Muslim clerics one important matter in which the Yoruba Muslims particularly the clerics seriously engage in is the practice of Tira magical medicine. The Glorious Qur’an as a Book of Wisdom and a Book of Healing for diseases calls attention to the secret knowledge in nature, saying:

In the creation of the heavens and the
Earth and the alternation of the night
And the day, there are surely signs for
Men of understanding. Those who
Remember Allah... and reflect on the
Creation of the heavens and the earth,
Saying: our lord, Thou have not created
This in vain: Glory be to Thee...⁶

The Muslim clerics who have secret knowledge of those signs as contained in that verse of the Qur’an is a scientist in that he seeks to discover and use the laws of the universe, not only of inanimate nature but also, of spiritual forces to the advantage of man. How he has been able to exploit the natural forces that are placed at the disposal of man by God is what we shall consider below using Shehu Kokoro Adua as a case study. However we want to place on record that these clerics are still patronized today. Some of those clerics in Yorubaland include Bintinlaye, from Ofa Kwara State of Nigeria, Olaiya from Ede in Osun State, Ajimolowo from Abeokuta in Ogun State. Interestingly, they treat both therapeutic and non-therapeutic needs of the people but in this paper, we are concern with healing process.

4.0. The Christian Point of view

The Pentecostal churches in Nigeria are increasing by day. They have increased the people’s belief in witches, sorcerers and the supernatural. They preach these forces as being responsible for human problems. Such diseases, like backwardness, barrenness, accident, poverty and all negative aspects of humanity. They also promise deliverance from these forces. People throng to crusades in the hope of getting over their problems. Although there is no empirical way of validating claims, people usually give testimonies of recovery after attending such crusades.

What we have seen above is the continued patronage of different sources of healing. What matters to people is their full recovery. It is in this vain that Shehu Kokoro Adua has many clients. What we find from Kokoro Adua can also be seen in the practice of other Muslim clerics. Let us now give attention to general Islamic healing practice.

5.0. Healing Strategies in Islam

In Islam, there is a belief that diseases can be healed and that all diseases are curable. Hence Prophet Muhammad was reported to have said “No disease Allah created by that He created its treatment”⁷. In essence, it becomes the responsibility of an afflicted individual to seek for the right and appropriate healing methods against all sorts of problems and misfortune. Healing falls under the mystic realm of religion. Hence the knowledge of it must necessarily be in degrees depending on the exposure and the knowledge of the clerics. The healing strategies in Islam are discussed below.

⁶ Y.A.Ali, Holy Qur’an, Text, Translation and Commentary, Q3: 189 – 190

⁷ M.M. Khan, Sahih Al-Bukhari Vol. II Daru – 1 – Kutub, Lebanon, 1985 p. 395

5.0.1. Prayer:

In Islam, prayer is the most appropriate phenomenon for tackling all problems of diseases and afflictions. It involves a passionate appeal to Allah. The Qur'an supports this when it says: Your Lord says call on Me I will answer your prayers"⁸. The efficacy of prayer as a form of healing in Islam rests on the fact that the words of Allah in the Qur'an have power over all problems and afflictions.

5.0.2. Sadaqah:

In Islam, Sadaqah or offering and alms are meant to serve as reinforcement in an attempt to solve one problem or the other whether physical or spiritual.

5.0.3. Sacrifice:

It connotes effecting ransom or redemption through the blood of an animal.⁹ Mention of sacrifice as an aspect of the healing system is contained in the Qur'an where Allah commands that: "Therefore to thy Lord turn in prayer and sacrifice..."¹⁰ Sacrifice in Islam should not be seen as tantamount to idolatry. The focal point is Allah and He is central to the concept of sacrifice in Islam.

5.0.4. Herbs and shrubs:

Plants constitute a major aspect of Allah's provisions for man on earth. Essentially, plants are for eating purposes (Q. 3:37) Besides this, many a leaf, shrub and herb of different plants and trees are also good for healing purposes, History is replete of the fact that herbs and shrubs were used for curing diseases during the time of the prophet. They were legitimately used because they are there as part of the favours of Allah on man (Q.2: 60).

6.0. Shehu Kokoro Adua healing methods

Shehu Kokoro Adua claims that he received a spiritual key from an angel while praying besides the sea at Lagos. He uses this key as a means of healing his clients. This claim is subjective since such matters are not subject to scientific enquiry. Many religious leaders claim such encounter with angels or the divine. In Yoruba land, Christians like Ayo Babalola (founder of the celestial church of Christ), Moses Orimolade and Abiodun Tunolase (co-founder of the cherubim and seraphim) claimed to have encountered with angels or spiritual beings before they began their ministries, which today are worldwide.

These were people that could not be described as suffering from psychoses people whose rationality could not be doubted and who had left indelible marks on the society at large. Their ministries were characterized by evangelism, healing and deliverance. Today, in Nigeria, the number of churches has proliferated and each church is claiming ability to heal and deliver from the shackles of the forces of evil. People throng to crusades to get spiritual healing. One needs to attend the crusades of the Redeemed church of God, Deeper life church, Mountain of Fire, Winners' Chapel, Obadare's Wosem and German Evangelist Bonkie among others to know the beliefs of people in spiritual healing.

Having said this, we shall examine cases of some clients healed by Kokoro Adua, In this regard; we look at the nature of disease and the method used by Kokoro Adua to cure the patient.

⁸ Y.A.Ali, Holy Qur'an, Text, Translation and Commentary, Q 108:1

⁹ G. Parrinder, Religion in Africa, Praeger Publishers, London, 1969 p. 46.

¹⁰ Y.A.Ali, Holy Qur'an, Text, Translation and Commentary, Q108:2

7.0. Case Study of Kokoro Adua's Client

The subsequent paragraphs will be devoted for a full discussion to give case studies of those that are, healed by Kokoro Adua, their names, type of ailments, what he did to cure the client and other relevant information based on our interview and interaction with some of the clients.

[a] First case study

Date: 9th July 2005.

Name of client: Okesile Adedoja.

Sex: female.

Nature of the disease: Barrenness for 10 years.

Classification of disease: Mystical.

Treatment:

When the client met Kokoro Adua, she was assured of getting over her problem. He asked for her name and the name of her mother. The father's name in making enquiry and healing is of no consequence. It is believed among the Yoruba that it is only the mother that can tell with assurances the father of a child. This is because a woman may have extra marital affair before pregnancy. Kokoro Adua commenced the process of healing by using a system of divination called **stargazing**. The purpose was to know the source of her barrenness. Kokoro Adua declared that her womb had been blocked by "witches" who had a grudge against her, as a result of a quarrel she had with one of them. Having discovered the source of her barrenness, Kokoro Adua charged a fee of two thousand and five hundred Naira only [N2, 500.00] for treatment. The woman paid the fee instantly. Kokoro Adua then wrote some Qura'nic verses on the black slate called **walla** in Yoruba language, dexterously washed the verses into a cup, added honey, and gave her to drink. The client was asked to return once a week for the same treatment for three weeks.

Result:

Three months after, the woman became pregnant. When she came to inform Kokoro Adua, he advised her to go and register at Ede maternity hospital. There, the woman gave birth to a baby boy. This is a kind of healing ability of Kokoro Adua.

The next client I interacted with was a case different from the issue of barrenness but protracted illness leading to loss of blood, water and appetite in man.

(b) Second Case study

Date: 26th July, 2005

Name of client: Ojo Asaolu

Sex: Male

Nature of disease: Protracted illness of unknown cause.

Classification: Mystical

Treatment:

When the client was brought to Kokoro Adua, by his family, they complained to Kokoro Adua that they have been to the hospital but with all the laboratory tests carried out on the patient, the tests could not trace any atom of a particular disease or cause. There and then, they were advised to take the patient home and try another means. According to my informant, the physical appearance of the patient by the time he was brought to Kokoro Adua was half-dead. The patient could not even walk properly or speak loudly.

Treatment:

As usual, Kokoro Adua asked of his mother's name. This time around asked the client to stretch his hand and palms wide open. Kokoro Adua then placed his spiritual key on the palm to know the true picture of the disease.

Having discovered the source of this protracted illness for over eight years asked the man to pay five thousand Naira (N5, 000.00) and when he is finally recovered, he should bring whatever he could afford as a sign of gratefulness to God. The money was paid by the family. Kokoro Adua wrote some verses of the Qur'an on two different white papers, tied each paper with white and black tread. He asked the patient to put one under his pillow in the night and the second one to hang it at the entrance of the room where he stays. The client was asked to come seven days after to collect similar thing but this time around to use it to wash the whole body.

Result:

Four months after the treatment the man had recovered from the protracted disease. Kokoro Adua then advised his client to visit hospital regularly for medical check up.

Conclusion:

From what we have discussed about shehu Kokoro Adua's spiritual healing practice and his new dimension to healing in Islam, we noticed that his healing strategy has led to unusual numerical growth in his clients. This was as result of what the people have seen through the healing method of his spiritual key. We need to understand that people are experiencing a lot of problems or hardship, particularly in the area of sickness, and they are in dire need of solutions to their problems. That explains why they always look for supernatural aids or spiritual succour in the treatment of their multifarious diseases. Kokoro Adua was one of the numerous spiritual healers in Yoruba land.

It should be noted that, among the Yoruba, many people still believe in sorcerer and witches. The main concern of Kokoro Adua was to liberate his clients from these malevolent powers and thus maintain good health among them through his healing strategies. Out of these strategies, the main method of healing was through intensive prayer with the use of the spiritual key. Kokoro Adua claimed that his clients in one month are over one thousand and they were of different religious backgrounds. He admitted that there is healing in other religions like Christianity especially in Aladura churches and in traditional religion but they differ in scope and in content. Kokoro Adua also approved of Western medicine but maintains that it is the spiritual aspect that makes the medication successful.

In summary, the high patronage, which Kokoro Adua enjoyed from people of different religious, and background in the community, had many implications. First, it shows that spiritual healing is now a welcome development and a popular alternative to Western medical care. It also shows that the people are increasingly becoming dependent on God for everything including the provision of good health. As observed by Roland:

As in many cultures, the art of healing and
Medicine among the Yoruba is anchored in
The World of the gods¹¹.

From this, we realize that man cures but God heals. Now that Western medicine is very expensive, this new dimension to healing the masses in Kokoro Adua's ministry serves as an alternative to Western medicine. Also, this new dimension of healing through the use of Qur'anic verses makes Islam to be more meaningful to the people at the grassroots especially in the area of healing.

¹¹ H. Ronald, "Religion and health among the Yoruba" in *Orita* xxiv/1-2, June and December, 1992, p. 67.

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Land and Vegetation Degradation Caused by Military Activities: A Case Study of the Sabah Al-Ahmad Nature Reserve of Kuwait

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Abstract

The invasion and occupation of Kuwait by Iraq and the liberation war during 1990-91 caused severe damage to the land and native vegetation in the Sabah Al-Ahmad Nature Reserve. During 1999-2001, studies were conducted to assess the damage and ascertain natural recovery of land and vegetation resources to design strategies to restore them to their pre-disturbance status. Based on a reconnaissance survey, a site measuring 135,000 m² in the desert flat sub-habitat of the reserve (At. Talhah) was selected for the study. On-site assessment of this site was severely impacted by military activities, such as refilled bunkers (65.6%), refilled foxholes (0.3%), compacted area between foxholes (9.4%), sandy low lying area (21.3%) and compacted road tracks (3.4%). The physical and chemical characterization of soil samples from different damage types indicated serious disruption of pedogenic processes in the soil profile and alterations in a number of soil properties. The composition, abundance and coverage of vegetation were also negatively impacted by military activities. Impact of different damage types on soil and vegetation properties was scored on an impact rating scale of 0 (no impact) to 4 (severely impacted). Areas covered by refilled foxholes, refilled ridges and compacted areas between foxholes and under road tracks were severely damaged, whereas the low-lying sandy areas created by erosion of loosened top soil was moderately damaged. The assessment of the present status of soil and vegetation also confirmed that natural recovery did not restore these resources to their predisturbance status.

Key words: Protected areas; soil assessment; damage assessment; vegetation cover.

Introduction

The Sabah Al-Ahmad Nature Reserve (formerly called Kuwait National Park/ Nature Reserve) was the first protected area established to preserve the natural heritage of Kuwait and to provide opportunities for education, research and outdoor recreation. The reserve comprises diverse landscape features and plant and animal life forms from both coastal and terrestrial ecosystems. *Rhanterium epapposum* Oliv. (60%), *Haloxylon salicornicum* (Moq.) Bunge ex Bioss. (30%), *Nitraria retusa* (Forssk.) Asch. and *Zygophyllum qatarense* Hadidi. (10%) (Omar et al., 1986) were the dominant plant communities in the reserve during the predisturbance period (i.e., prior to the Iraqi invasion). Similarly, the main wildlife habitats were the coastal plain, debris slope, escarpment and the desert plain. A number of studies were conducted between 1980 and 1986 to generate baseline information on the reserve's resources and an action plan was prepared to conserve and enrich the native biodiversity (Omar, 1982; Omar and Taha, 1984; Omar and Shuaibi, 1986; Taha and Omar, 1982; Omar, et al., 1998). The invasion and subsequent occupation by Iraqi military during 1990-91 disrupted all planned activities in the reserve and severely damaged its infrastructure, land, native vegetation and wildlife habitats. Specifically, numerous bunkers and foxholes were constructed all over the area and mines were laid from the coastal front of the park to the wadis and gullies in the Jal Az Zor escarpment. Heavy equipment and personnel carriers were used during occupation and liberation war. In the post war period, foxholes and bunkers were refilled with excavated and transported soils. Preliminary results showed severe negative impact of these war activities on vegetation structure and species composition, wildlife population and soil throughout the country (Al-Houty et al., 1993; Omar et al., 1998; Zaman and Al-Sdirawi 1993 and Omar et al., 1999).

With extreme temperatures, low and erratic rainfall and high evaporation rates, soil and plant recovery under arid environments is inherently slow (Kockelman, 1983; Prose and Wilshire, 2000). While majority of research done in areas affected by military activities have indicated that natural recovery of severely disturbed and compacted desert soil to be extremely slow, some have even suggested that the subsurface compaction may not recover at all. The establishment and growth of desert plants may be significantly retarded in compacted soils (Adams et al., 1982). Using a logarithmic model, Webb (2002) estimated that the time required for 85% compaction recovery ranges from 105 to 124 years. Prose and Metzger (1985) estimated that it requires eight to 112 years for vegetation to recover to predisturbance conditions on moderately compacted desert sites, and 100 to 3,000 years on heavily compacted sites. In view of these observations, the study reported in this paper was undertaken during 1999-2001 to examine the type and magnitude of damage to soil and native plants and the natural recovery of soil and vegetation ten years after the severe damage caused by military activities in the At. Talhah area of the Sabah Al-Ahmad Nature Reserve of Kuwait. The reserve was protected from human activities during the post-invasion period and immediately after the clearance of mines and ammunitions in 1994.

Materials and Methods

Climate and Geomorphology of Experimental Area

Geographically, Kuwait occupies approximately 17,800 km² of the northwestern part of the Arabian Gulf, between latitudes 28°30' and 30°05'N and longitudes 30°05' and 46° 33'E. Kuwait's climate is characterized by harsh summers and mild winters. Temperature extremes are high, with means during the warmest and coolest months ranging between 46.2°C and 6.9°C (Annual Statistical Abstract, 1998). Winter brings occasional frost. Rainfall is minimal; not exceeding 115 mm.y⁻¹, but evaporation is very high, ranging from 3.0 to 14.1 mm.d⁻¹. The relative humidity is low, and strong, dry and hot northwesterly winds prevail during summer, particularly in June and July.

The study site (At. Talhah) is in the desert flat habitat of the reserve and consists of a long stretch of relatively flat areas. The area slopes gently in the north-westerly direction with a slope angle $< 5^{\circ}$. The soil depth in this habitat varies from very shallow to deep sandy soil in the depression. The undisturbed soil in the study site contained 94 – 96 % sand, 11.3 – 13.6 % gravels and 3.6 – 5 % silt. The soil is slightly to moderately saline with E_{Ce} ranging between 2.4 and 6.9 mS/ cm with moderately high levels of chlorides (10.6 – 15.4 meq/ l) and sulfates (10.2 to 17.5 meq/ l). The soil is low in organic matter and most plant nutrients (Omar et al., 1986).

Pre-invasion Vegetation in the At. Talhah Area

During the preinvasion period, the desert flat sub-habitat, which includes the study site hosted a wide range of plant species. *Haloxylon salicornicum* (in the northeast) and *Rhanterium epapposum* (in the west) were the major perennial shrub communities, with a high density, but low coverage (5 – 45 %). The annual species, *Stipa capensis* Thunb. covered a large area, especially in the *Haloxylon* community (Omar et al., 1986). Other common species in this area were *Arnebia decumbens* Vent. Coss & Kral., *Asphodelus tenuifolius* Cav. Baker, *A. viscidulus* Boiss., *Astragalus shimpera* Boiss., *Brassica tournifortii* Gouan, *Cakile Arabica* Velen. & Bornm., *Cardus pycnocephalus* L., *Cutandia memphitica* (Spreng.) Benth., *Cynodon dactylon* (L.) Pers., *Emex spinosus* (L.) Campd., *Filago spathulata* L., *Hippocrepis bicontorta*, *Iflago spicata* (Forssk.) Sch.Bip., *Launaea capitata* (Spreng.) Dandy, *Lotus pusillus*, *Plantago boissieri* Hausskn. & Bornm., *Reseda Arabica* Boiss., *Silene arabica* Boiss., *Schismus barbatus* (L.) Thell. and *Schimpera arabica* Hochst et. Steud. Some of these plants were identified as rare. A lonely native tree, *Acacia pachyceras* O. Schwartz and a number of naturalized trees of *Prosopis juliflora* and *Zizyphus spina-christi* (L.) Willd. also existed near the study area.

Selection of Study Site

Based on the biophysical features the reserve was previously divided into five sections (coastal area, coastal sand dune area, escarpment, back slope and depressions). The site selected for this study is located in the desert plain habitat (desert flat sub-habitat) of the reserve. For selecting the study site, several potential sites in this habitat were individually assessed by a multidisciplinary team consisting of experts in range management, horticulture, environmental science and soil science. Indicators, such as nature and extent of damage, resemblance of damage to other areas in the reserve, importance of the area to the aim's of reserve and need for undertaking immediate rehabilitation measures were used in the selection of the study site (Omar et al., 2002). A 135,000 m² site that contained major damage types was selected for this study.

Damage Assessment

The study area contained five main types of disturbances (refilled bunkers, refilled foxholes, compacted area between foxholes, low-lying sandy area and off-road vehicle tracts). Semiquantitative field survey supported by laboratory analyses of soil samples was employed for assessing the nature and extent of damage caused by various war-related activities (Omar et al., 2002). The study area was thoroughly assessed by a multidisciplinary team, who systematically traversed the site and recorded the relevant observations on the ground (presence of munitions materials and *gatch* (a hard to very hard lime or lime silica hardpan) pieces, erosion of top soil, exposure of *gatch* layer and uneven topography) These information was later used in developing impact rating for various damage types.

The nature of the soil in the study area was examined by augering and collecting soil samples from identifiable horizons of the profile. A number of soil profiles were dug and total of representative soil samples were collected. In addition, a soil core of a known volume was collected from each area and oven dried to determine the bulk density according to the procedure described by Page et al., (1982). Porosity was calculated using bulk density values and standard particle size density of 2.65 g/ cm³.

Soil samples were air-dried at around 30°C until they were fully dry and were sieved through a 2-mm sieve to separate fine (< 2 mm) and coarse fractions (> 2 mm) according to the United States Department of Agriculture (USDA) specifications (Soil Survey Division Staff, 1993). The coarse fraction was discarded after recording its weight. The fine soil fraction was analyzed for various physical (color and saturation percentage) and chemical (electrical conductivity, pH of saturated paste and CaCO₃ levels) parameters. Soil color was determined by the Munsell® Color Chart (Munsell, 1998). pH and EC of saturated soil paste were estimated using USDA 1996 method (method 8a). Saturation percentage was calculated based on the amount of water required to prepare the saturated soil paste. CaCO₃ content was measured using calcimeter (USDA, 1996).

Infiltration Rate and Penetration Resistance

Infiltration rates were measured in refilled bunkers, refilled foxholes, compacted area between foxholes, low-lying sandy area and off-road vehicle tracts. Fall of water head (level) in the double-ring infiltrometer at fixed time intervals was used to calculate the rate of movement of water through the soil profile.

The penetration resistance was measured using the Bush soil penetrometer (model SP 1000). Specifications used for the test included sample type (2:25 readings per insertion at 2-cm depth intervals), cone diameter (12.83 mm) and pressure ($\text{Pressure (kg cm}^{-2}\text{)} = \text{Cone resistance} / (\pi i)^2$). The data from three insertions were averaged for each depth and entered into a computer. Penetration curves were prepared by plotting cone resistance against depth of insertion (i). The interpretation of these curves allowed the identification of location of soil compaction in the profile. Eight penetration tests were carried out in each disturbance type and an average values were computed.

Vegetation Assessment

The technique developed by Stohlgren et al. (1998) based on modified-Whittaker multiscale vegetation plot was used for assessing the vegetation cover. The percentage of ground cover was measured in ten (0.5 x 2 m) subplots, replicated four times. Plant species in each plot and subplot were identified and the percent ground cover determined visually for gravel, litter, bare ground and total vegetation. The vegetation assessment covered 5000 m². The data was statistically analyzed using the one-way ANOVA to compare means (Bonham, 1989). These results were compared with the previously reported data for this area of the reserve.

Impact Rating

Various features observed on the ground (such as loss of top soil, accelerated water erosion, exposure of *gatch*, uneven topography, compacted road tracts, mixing of broken pieces in soil profile, loss of vegetation, altered infiltration rates and altered penetration resistance) and the laboratory characterization of the soil (changes in physical and chemical properties) were rated on a scale of zero (no disturbance) to four (severely disturbed). A cumulative score was computed for each disturbance type to determine the severity of damage. This information have been used in the planning of a pilot rehabilitation study to restore the degraded land and vegetation to their pre-disturbance levels.

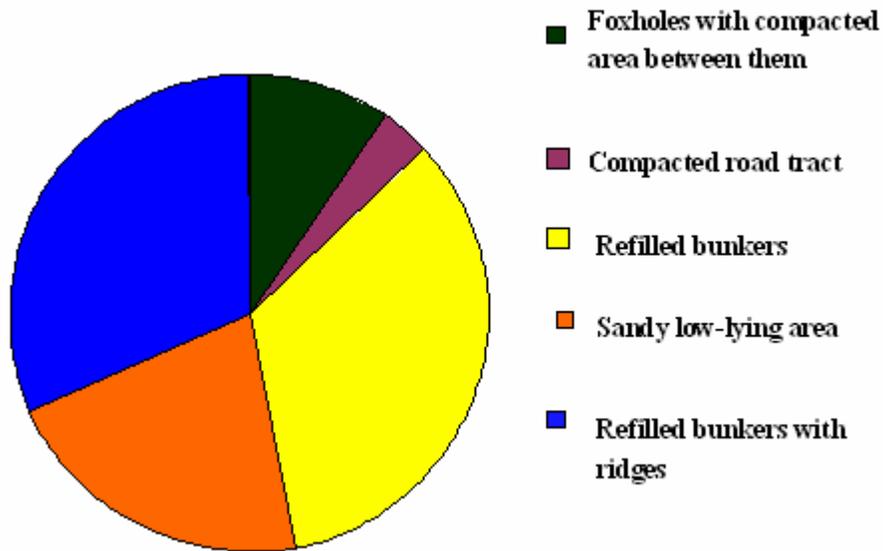
Results

Field Assessment of Damage

Over 65% of the total area of the study site was impacted by refilled bunkers and their surrounding ridges (Fig. 1). Excavation of refilled bunkers by shovel supplemented with hand augering revealed an average soil depth ranging from 40 to 50 cm (calcrete layer appeared at this depth), below which hand augering was difficult. The refilled bunkers had uneven topography and were highly impacted by

military activities. The refilled bunkers with slightly raised ridges were covered with shattered *gatch* pieces.

Fig. 1: Damage types in the study site.



The sandy low-lying area accounted for 21.3% of the total study area. This low-lying area was created due to compaction of refilled soils and subsequent accumulation of eroded soils on the surface. Excavation and hand augering revealed a soil depth ranging from 75 cm to 90 cm, below which calccrete layer (*gatch*) occurred. The soil profile had a 5 cm thick layer of loose, eroded sand at the surface followed by a 5 cm thick layer of silt and clay indicating that the surface materials was deposited recently indicating that the surface materials was deposited recently. The soil in the 10 – 90 cm layer was relatively stable.

The foxholes and the compacted area between them accounted for approximately 10% of the study area. These foxholes, which measured 1.5 X 1.5 m, were refilled with excavated soil containing calcareous (calcrete) *gatch* pieces of different sizes (2 x 5 to 4 x 6 cm). Excavated *gatch* pieces were also scattered nearly uniformly on the surface through out the area between foxholes.

The area under road tracks, which accounted for 3.4% of the total study area, was highly compacted and contained mostly micropores.

Physical and Chemical Properties of Soil in the Impacted Areas

The occurrence of distinct layers in soil profiles and soil properties were influenced by the nature of damage and the type of soil material used for refilling. For example, the profile in the refilled foxholes, refilled bunkers and stabilized ridges contained only two layers of varying depths compared to three layers in areas between foxholes and sandy low-lying areas (Table 1). Soils from all layers in refilled foxholes and areas between foxholes, and deeper layers in the sandy low-lying area (10 – 30 cm and 30 cm plus layers) and stabilized ridges (40 – 100 cm layer) had greater amounts of coarse fractions (10.2 to 56.0%) compared to those from all layers in refilled bunkers (0 – 0.8%) and the top layer (0 – 10 cm) in the sandy low lying area (5%). These observations indicate an interruption in the ongoing soil-forming processes caused by excavation and refilling operations.

Table 1: Selected Physical and Chemical Soil Properties in Area Impacted by Various Kinds damage

Damage Type	Depth (cm)	pHs	ECe(dS/m)	SP	CaCO ₃ (%eq)	Munsell Color	% Coarse Fraction
Foxholes	0-20	7.45	8.1	32.0	18.0	Pale brown	56.00
	20-50	7.66	21.6	34	16.6	Pale brown	22.00
Area between foxholes	0-20	7.35	2.8	23	13.9	Pale brown	15.4
	10-40	7.60	10.2	26	14.10	Pale brown	16.10
	40+	7.90	9.5	45	21.0	Pale brown	<i>Gatch</i>
Sandy low-lying area	0-10	7.64	0.8	24	12.7	Pale brown	5.00
	10-30	7.53	1.6	32	14.6	Pale brown	10.20
	30+	7.57	5.3	33	14.1	Pale brown	14.10
Refilled bunkers	0-10	7.68	1.2	26	13.8	Pale brown	0.80
	10- 40	7.66	1.5	27	8.0	Pale brown	Nil
Stabilized ridge	0-40	7.13	19.6	25.5	15.54	Very pale brown	1.08
	40-100	7.70	12.50	29.0	16.24	Very pale brown	13.18

SP = Saturation percentage; Munsell color according to Munsell chart (1998), pale brown and very pale brown corresponds to 10YR 6/3 and 10 YR 7/3, respectively.

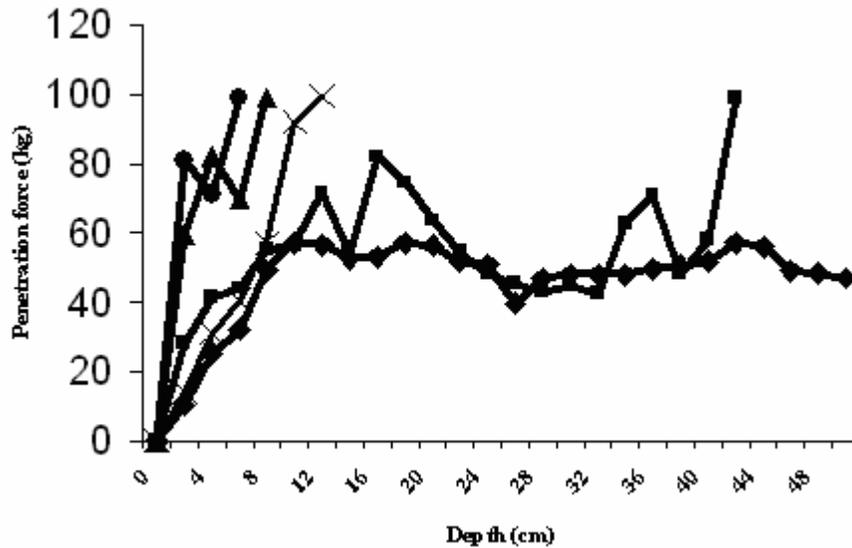
The pH of the saturated soil (pHs) ranged between 7.13 and 7.90. Deeper layers of profiles in foxholes, areas between foxholes and stabilized ridges were more alkaline than the shallow layers. The soils in the 0-10 cm layer in the sandy low-lying area had the lowest (0.8 dS/ m) ECe, whereas the 20-50 cm layer in the refilled foxholes had the highest (21.6 dS/ m) ECe. Excavation and refilling of foxholes also increased the saturation percentage.

The undisturbed soil the in the study site contained 94 – 96 % sand, 11.3 – 13.6 % gravels and 3.6 – 5 % silt. The soil is slightly to moderately saline with ECe ranging between 2.4 and 6.9 mS/ cm with moderately high levels of chlorides (10.6 – 15.4 meq/ l) and sulfates (10.2 to 17.5 meq/ l).

Penetration Resistance

The penetrometer was able to enter up to a depth of 42 cm in refilled foxholes, 50-70 cm in refilled bunkers and 12 cm in the sandy low-lying area (Fig. 2). Areas covered by road tracks, stabilized ridges and between foxholes offered maximum resistance, where penetrometer could only enter to depth ranging from 0 – 8 cm. The higher resistance observed in the low lying area was due to the deposition of silt and clay in the upper layers. Considerable variations in penetration resistance were observed in areas between the foxholes. The differences in force required at various depths reflected the degree of compaction.

Fig. 2: Penetration Resistance (Kg) in areas under various damage types: 1). foxholes refilled with gatch (!), 2). area between foxholes () 3). sandy low-lying area (3), 4). refilled bunkers (◆), 5). road tracts (⊛).



Infiltration Rate

The rate of infiltration of water through the soil profiles expressed in terms of fall-of-water-head in the double-ring infiltrometer (DRI) as a function of time lapsed from the start of the test was influenced by both the nature and the extent of damage. The water level in the DRI decreased at the rate of 4.8 cm/h in compacted road tracts compared to 65.2 cm/ h in refilled foxholes, 41.6 cm/ h in foxholes refilled with gatch pieces, 32.0 cm/h in areas between foxholes, 64.0 cm/h in sandy low-lying area, 58.0 cm/ h in refilled bunkers and 42.0 cm/ h in stabilized ridges (Fig. 3). The wetting zone ranged from 80 mm in the road tract to 270-350 mm in the sandy low-lying areas. The soils that offered resistance to water movement also had higher bulk density and less total pore space (Table 2).

Fig. 3: Infiltration rate (cm/ hr) and wetting zone in areas under various damage types: 1). foxholes refilled with gatch, 2). foxholes refilled with eroded sand, 3). area between foxholes, 4). sandy low-lying area, 5). refilled bunkers, 6). Refilled bunkers with ridges, 7). road tracts.

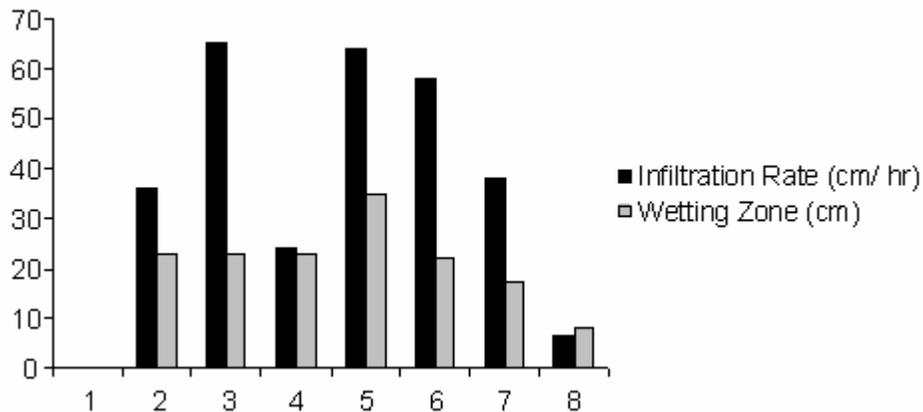


Table 2: Bulk Density of Soils in Areas affected by Various Military Activities

Military Impact	Bulk Density (Dry) (g.cm ⁻³)	Bulk Density (wet) (g.cm ⁻³)
Foxhole refilled with gatch pieces	1.71	2.04
Foxhole refilled with eroded sand	1.59	2.07
Area between foxholes	1.59	1.97
Sandy low lying area	1.59	1.88
Refilled bunkers	1.40	1.79
Refilled bunkers with stabilized ridge	1.58	1.89
Road track	1.77	2.04
Undisturbed control in the reserve	1.66	1.96

Vegetation Assessment

The comparison of vegetation before and after the occurrence of disturbance shows that military activities significantly altered the vegetation composition and increased variability within a small area (Table 3). The number of species recorded in plots 1, 2, 3, and 4 were 20, 21, 12 and 6, respectively. The number of species also varied among quadrates of different sizes. The dominant species were annual forbs, *Plantago boissieri* and *Ifloga spicata* and the annual grass, *Stipa capensis*. These three species showed highest percentage of cover. *Plantago boissieri* scored 21.8%, followed by *Stipa capensis* (11.1%) and *Ifloga spicata* (7.1%). Other species such as *Filago pyramidata*, and *Schismus barbatus* were moderately abundant (16-30% frequency). The mean total vegetation, litter, gravel and bare ground were 49, 12.5, 17.9 and 19.9 %, respectively; however, there were significant difference among the plots (Table 3). While the vegetation cover ranged between 35 and 64 %, the extent of bare ground varied between 0 and 41 %. This suggests that alterations in soil properties due to the damage caused by military activities are reflected in species distribution, abundance and percentage of native vegetation cover.

Table 3: Vegetation Assessment in the At. Talhah Study Area

Parameters	Mean	SD*	Plot 1	Plot 2	Plot 3	Plot 4	Predisturbance Frequency (%)**
Gravel	17.9	23.3	0.0b	0.0b	30.8a	40.7a	
Litter	12.5	10.2	9.0b	23.5a	8.2b	9.3b	
Bare	19.9	23.2	27.0ab	41.0a	11.5bc	0.0c	
Total Vegetation	49.8	20.6	64.0a	35.5b	49.5ab	50.0ab	
Anthemis deserti	0.0	0.2	0.1a	0.0a	0.0a	0.0a	3
Carduus pycnocephalus	0.0	0.0	0.0a	0.0a	0.0a	0.0a	57
Crucianella membranacea	0.0	0.0	0.0a	0.0a	0.0a	0.0a	3
Erodium sp.	0.4	1.3	1.6a	0.0b	0.0b	0.0b	11
Filago pyramidata	5.1	5.0	7.1a	7.2a	3.0a	3.1a	34
Gymnarrhena micrantha	0.0	0.2	0.1a	0.0a	0.0a	0.0a	7
Ifloga spicata	7.1	10.4	13.9a	6.8ab	5.8ab	1.7b	57
Lotus halophilus	0.1	0.8	0.0a	0.5a	0.0a	0.0a	6
Oligomeris sp.	0.0	0.0	0.0a	0.0a	0.0a	0.0a	3
Picris sp.	0.1	0.8	0.0a	0.5a	0.0a	0.0a	3
Plantago boissieri	21.8	22.7	35.50a	16.0ab	29.2ab	6.40a	17
Schismus barbatus	4.1	3.9	3.6a	5.0a	2.8a	4.8a	26
Stipa capensis	11.1	17.0	2.1b	0.0b	8.2b	34.0a	3

*SD = Standard deviation, The data were analyzed using one-way ANOVA and Tukey's mean separation procedures.

Figures followed by the same letter within the row are not statistically different at P = 0.05

** The predisturbance plant frequency was taken from a previous study in the nature reserve.

The studies conducted by El-Sheikh and Abbadi (2004) during the spring of 2001 showed that the undisturbed (control) areas in this habitat contained the highest number of species (98) and had a plant coverage of 51.6%. Major contribution to the plant cover was made by annual herbs and grasses

like *Plantago boissieri* Hausskn. & Bornum., *Picris babylonica* Hand. Mazz., *Schimpera arabica* Hochst., *Erodium laciniatum* (Cav.) wild, *Cutandia dichotoma* (Boiss.), *Neurada procumbens* L., *Schismus barbatus* (L.), *Stipagrostis ciliate* (Desf.) de Winter and *Stipa capensis* Thunb. *Haloxylon salicornicum* (Moq.) Bunge ex Boiss. was scattered throughout the undisturbed areas. Prior to the invasion, this habitat was dominated by *Haloxylon salicornicum* (Moq.) Bunge ex Boiss., *Calligonum polygonoides* L., *Arnebia decumbens* Vent. Coss & Kralik, *Cardus pycnocephalus* L., *Cutandia memphitica* (Forssk.) Trabut in Batt. & Trab., *Ifloga spicata* (Forssk.) Sch.Bip., *Ochradenus baccatus* Delile, *Pennisetum divisum* (Gmel) Henrard., *Launaea mucronata* (Forssk.) Muschl., *Lycium shawii* Roem & Schult. and *Gynandrisis sisyrrinchium* Parl. (Omar et al., 1986). These observations clearly indicate that the disturbance resulted in the loss of species diversity and increase in the number of species that are either rare or endangered.

Impact Rating

Overall, the land and native vegetation in the study site was severely degraded by military activities. The cumulative impact score ranged between 16 (low impact) in the sandy low lying area and 36 (severe impact) in areas that contained refilled bunkers and their surrounding ridges (Table 4). The areas that were covered by refilled bunkers (cumulative impact score of 33), refilled foxholes (cumulative score of 34) and off-road vehicle tracts (according to visual observations) were also severely damaged.

Table 4: Impact Rating of Damaged Areas in the Study Site

Damage Indicators	Damage Type*			
	Areas covered by refilled foxholes	Areas covered by refilled bunkers	Areas covered by bunkers with surrounding ridges	Low lying sandy area
Loss of top soil	4*	4	4	2
Accelerated water erosion	1	3	3	1
Exposure of gatch	4	3	3	1
Uneven topography	3	4	4	1
Soil compaction	4	1	4	1
Mixing of broken gatch pieces in soil profile	4	4	4	1
Loss of vegetation	4	4	4	4
Altered infiltration rate	2	2	2	1
Altered physical properties	4	4	4	2
Altered chemical soil properties	4	4	4	2
Cumulative scores	34	33	36	16
Damage magnitude**	Very Severe	Very severe	Very severe	Low

* Impact rating: 0 – no damage; 1- low and recoverable impact; 2 – moderate impact, recoverable with less intensive rehabilitation measures; 3 – severely impacted, needs active rehabilitation; 4- very severe impact, rehabilitation is essential, but may be expensive.

** Damage magnitude is based on cumulative score; Very Severe = 31- 40; Moderate = 21 - 30; low = 11 - 20; insignificant or no damage = 0 - 10.

Discussion

In Kuwait, harsh climatic conditions, increased human pressure, overgrazing and Gulf war activities have led to significant loss of biological diversity and desertification (Omar, 1990). The inherent fragility of soils and loss of native vegetation cover have accelerated land degradation further (Al-Awadhi *et al.*, 2003). A number of plant communities in the nature reserve have become either rare or endangered by the Gulf war crisis (Omar, 2000; El-Sheikh and Abbadi, 2004). Under these circumstances, enforcement of protection measures and restoration of plant diversity to their original status assume greater importance now than ever before.

The present study showed more than two-thirds of the study area has been severely degraded to the extent that the identity and the original soil class have been changed. Excavation and refilling operations during occupation destroyed established natural soil horizons and natural pedogenic sequence of soil horizons, and altered a number of their properties. The variations noticed in some properties (pHs, E_{Ce}, infiltration rate and compactness) may be related to altered soil texture and the integrity of *gatch* (calcrete containing CaCO₃). The creation of macropores by coarse soil fractions was probably the main cause of acceleration of percolation of water through soil matrix. This was substantiated by the fact that the refilled soil materials had lower bulk density and higher porosity. In contrast, the fine-textured soil materials eroded from surrounding areas increased the bulk density and reduced the porosity. These conditions, in turn, influenced percolation of water and chemical properties. Although macropores in soil will get blocked with time by fine-textured transported soil material, the slow pedological changes under arid climatic conditions make the natural rehabilitation rather difficult.

Several researchers all over the world have shown that severely disturbed soils are very slow to recover and in turn, have significant effects on ecosystem recovery (Johnson and Sallberg, 1960; Web and Wilshire, 1980; Web, 2002). Soil compaction increases soil's bulk density and changes other soil properties; most notably, the size distribution, strength characteristics, continuity of pores and decreases infiltration rate (Web, 2002). These changes will have considerable long-term influence on root growth, which may affect seedling establishment and restoration of vegetation cover. Subsequent seedling growth rates may also be poor because compaction may limit access to both water and nutrients. In playas or seasonally inundated soils compaction can limit oxygen availability to roots. It may also affect natural succession process by selectively affecting the establishment and/ or growth of certain species.

The assessment of vegetation composition and frequency (Table 3) suggested that currently, the area is inhabited mainly by two forbs (*Plantago boissieri* and *Ifloga spicata*) and one annual grass (*Stipa capensis*), and the frequency of most species have greatly been reduced. The perennial shrubs, particularly *Rhanterium epapposum* have completely disappeared from the area. Because of low productivity, the recovery of native plants from abiotic (drought, high salinity) and biotic (human interference, overgrazing, cutting, off-road vehicles, disruption of soil forming process by excavation and/ or refilling operations) stresses is very slow under Kuwait's environment. The harsh arid climatic conditions combined with the disruption of soil structure made it difficult for natural recovery of vegetation cover and wildlife habitats to predisturbance status.

The changes in soil properties, which have long-term influence on root growth, may have affected seedling establishment and restoration of vegetation cover. Subsequent seedling growth rates may also have been affected because increased compaction limited access of plant roots to water and nutrients. In low-lying areas (playas) or seasonally inundated soils can limit oxygen availability to roots. These changes also affect natural succession process by selectively affecting the establishment and/ or growth of certain species, which might be the case in the present study. Whilst a quick solution for a complete reversal of land degradation and deterioration in ecosystem health under harsh climatic conditions may not be possible, steps can and should be taken to tackle this problem. These measures should include continued enforcement of protection measures, creation of a favorable microclimate through temporary shelter belts and water conservation practices and reintroduction of native plant species.

Conclusions

It is concluded from this study that the major portion of At. Talhah site has been severely damaged due to military activities. The damaged areas, where the soil profiles indicated physical disturbance that can not be reversed by natural soil forming process would require adoption of intensive rehabilitation measures for improving soil properties and restoration of vegetation cover to their preinvasion levels.

Different rehabilitation options should be evaluated for their effectiveness in restoring native vegetation cover and wildlife habitats prior to their large-scale application.

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