Chapter 7
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Studies on D_{10} Values (γ- Irradiation) of Five Postharvest Fungal Pathogens and their Effect on the Biochemical Properties of Fresh *capsicum* Fruits

G. K. Frimpong[1*], A. A. Adekunle[2], T. O. Ogundipe[2] and A. A. Okyere[1]

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ABSTRACT

Fungi are increasingly implicated as the agents of spoilage of economically important fruits and vegetables. Five postharvest fungi of pepper fruits namely *Aspergillus niger, A. fumigatus Colletotrichum capsici, C. trumcatum* and *Fusarium solani* were tested for their population responses to gamma irradiation. These fungi were irradiated at dose 0.2, 0.4, 0.6 and 0.8KGy at a dose rate of 1.08KGy/hour. Stumbo equation was used in generating D_{10} values of the organisms. The fungi were inoculated on the pepper fruits for 8 days and their biochemical/physiochemical properties (pH, total ascorbic acid, total titratable acidity and soluble solids) and physiological weight loss were assessed. Complete randomized block design was employed. GenStat 12th edition was used with one- and two-way Anova for D_{10} values and biochemical parameters respectively. The D_{10} values ranged from 0.714 to 0.995 KGy with *Fusarium solani* being the most radio resistant whereas *Colletotrichum* species were also more susceptible to the lethal effect of gamma irradiation. Generally, fungi inoculated pepper fruits had higher biochemical values compared to the control samples. Gamma irradiation decontaminated fresh pepper fruits of their bioburden thereby extending their postharvest life since these fungi when present are either pathogenic or saprophytic to the pepper fruits. Deteriorating activities of fungi also have adverse effect on the physiochemical properties of pepper fruits.

Keywords: Fungi; D_{10} values; pepper; deterioration; postharvest.

1. INTRODUCTION

Pepper (*Capsicum sp*) is one of the most important crops, not only because of its economic importance, but also for the nutritional value of its fruits, mainly because they are an excellent source of natural colours and antioxidant compounds [1]. It is the only crop which produces capsaicinoid alkaloids responsible for its aroma and pungency [2]. However, pepper production is being humped by pests and diseases incidence in both pre- and postharvest stages of its production. According to FAO [3]. report, postharvest losses in fruits and vegetables could be as high as 90% if appropriate postharvest practices are not adhered to. Amongst the disease-causing organisms, fungi are increasingly implicated as the agents of spoilage of economically important fruits and vegetables [4]. Additionally, the diseases caused by fungal pathogens in harvested fresh fruits are considered as one of the most serious losses of production at the postharvest and consumption levels [5-7]. Fungal infection on the fruit may occur during the growing season, harvesting, handling, transport and post-harvest storage and marketing conditions, or after purchasing by the consumer [8]. Moreover, fungal contamination on agricultural produce does not only lead to quantitative postharvest losses but qualitative terms i.e. mycotoxins production which have adverse health effect on consumers. Frimpong et al., [9]. reported *Aspergillus fumigatus* strain GKF11*, Asperillus* niger strain GKF12, *Colletotrichum capsici* strain GK17A*, Colletotrichum truncatum* strain GK17B and *Fusarium solani*

[1]*Biotechnology and Nuclear Agriculture Research Institute – GAEC, Ghana.*
[2]*Department of Botany, University of Lagos, Nigeria.*
**Corresponding author: E-mail: gabiz1891@gmail.com;*

strain GK26A as pathogenic fungal isolates of seven pepper varieties from Accra, Ghana and Lagos, Nigeria.

Ionizing radiation has been widely recognized as a method of decontamination of foodstuffs. Exposing food to radiation treatment delays spoilage and improves safety by eliminating or reducing pathogenic microorganisms [10]. Medium doses of gamma radiation (1- 10) KGy has been used to decontaminate and inactivate microorganisms on pepper and spices in general over the years. Ionizing radiation up to 1.75 kGy has been used for sprout inhibition in tubers, bulb and root vegetables, insect disinfestation, delay ripening of some tropical fruits and control of postharvest diseases [11]. Jeong et al. [12] also reported on inhibitory effect of low dose of 0.1 kGy gamma irradiation on bacteria soft (*Erwinia carotovora* sub sp. *Carotovora (Ecc*.) on paprika/pepper. Additionally, gamma radiation dose of 5 kGy applied as a post-harvest treatment process of *Melissa officinalis* and *Aloysia citrodora*, assured the microbial safety of dried medicinal plants with low potentiality of deleterious effects on plants' quality attributes [13].

The lethal dose of gamma radiation can vary depending on the organism and the growth stage i.e. vegetative or reproductive. Despite the effectiveness and advantages in the use of gamma irradiation in controlling post-harvest decay by microorganism, excessively high doses of it may have negative effect on biochemical and physical qualities of the irradiated crop, it is therefore important to use accurate radiation dose to achieve decontamination of crops as a phytosanitary measure. Irradiated fruits are clean, safe, kept in fresh state and have extended shelf life which forms integral part of Sustainable Development Goals (Goal 12, target 3) by reducing food losses along production and supply chains. The aim of this study was to ascertain the D_{10} values of some virulent fungi causing postharvest diseases on fresh pepper fruits and to assess the effect of these five fungi on some biochemical properties of the pepper fruits.

2. MATERIALS AND METHODS

2.1 Sample and Site Selection

Seven pepper varieties were used in this experiment, four of these were sampled from Shopping and Market Centres located in Accra, Ghana and Lagos, Nigeria. *Touto* (TT), Yellow *Sisi* (YS), *Makopa* (MP) and *Kpakpo shito* (KS) were sampled from Accra, whereas *Rhodo* (RD), *Shombo* (SB) and *Nsukka Yellow* (NY) were sampled from Lagos.

2.2 Sample Preparation

Sample collection and identification of fungi were done as described by Frimpong et al., [9]. Freshly harvested and healthy pepper fruits purchased from selected sites were thoroughly washed three times under running tap water and mopped. The five pathogenic fungi were inoculated on the pepper fruits as described by Baiyewu et al*.* [14] and Chukwuka et al*.* [15]. The samples were put on aluminium trays and kept under room temperature for 8 days.

2.3 Biochemical Analysis of Pepper Fruits

Cleaned 10 g pepper fruits were weighed (when necessary) and blended for 5 min with 100 ml of deionised water. The fruit juice was then filtered through a sieve of 1 mm pore size to remove the remaining seeds and flesh as described by Antoniali et al. [16] with slight modification.

2.4 pH Determination

Juice of pepper was extracted from 10 g fruit sample to which 90 ml distilled water was added and homogenized in a blender as described by Antoniali et al. [16]. The homogenized sample was filtered using funnel with filter paper in a beaker and the pH value of the filtrate was measured by a pH meter (350 pH meter).

2.5 Total Soluble Solids (TSS)

The total soluble solids were determined using a refractometer (RHB-32ATC) as prescribed by the manufacturer. One millilitre each of the filtrate (juice) was applied on the refractometer and the readings from the scale was recorded directly as percentage.

2.6 Total Titratable Acidity (TTA)

Ten millilitre of extracted pepper fruit juice was measured and thoroughly mixed in 50 ml of deionised water. The mixture was potentiometrically titrated against 0.1 N NaOH with three drops of phenolphthalein until a pink colour was attained or the pH is 8.1 when the mixture colour is already pink [17].

Calculation of TTA

% Acid (wt/v) = titre x citric acid factors x 100 ÷ 10ml of juice

The sugar acid ratio = ^{0}Brix value ÷ % acid

2.7 Ascorbic Acid (Vitamin C)

A single vitamin C tablet was dissolved in 250 ml of distilled water in volumetric flask. Iodine solution of 0.005 mol/L was prepared using 1 g of potassium iodide and 0.65 g of iodine dissolved in 500 ml of distilled water in a volumetric flask. A starch indicator solution of 1% was prepared by dissolving water 0.5 g of potato starch in 50 ml of distilled water. A mixture of 10 ml vitamin C standard, 1 ml of distilled water titrated against 0.005 mol/L iodide solution. Three replicates were done and the averages calculated as follows:

Standard (Vol. (ml) iodine solution/g Vit. C) = Sample Vol. (ml) iodine solution / X (ml) Vit. C) g/l = (X/Vol. of sample juice) X 1000

2.8 Weight Loss

Batches of fruits in each replication were weighed at the beginning of the experiment using an electronic balance and then after every 8 days during storage. Percentage changes in weight (g) were calculated.

2.9 Determination of D_{10} Values

The five pathogenic fungi (*Aspergillus fumigatus* strain GKF11*, Aspergillus* niger strain GKF12, *Colletotrichum capsici* strain GK17A*, Colletotrichum truncatum* strain GK17B and *Fusarium solani* strain GK26A at NCBI) were put in 100 ml of buffer peptone water in 250 ml flat bottom beakers and incubated at 45 ^{0}C for 24 h. They were then serially diluted up to 10^{-6} and their inoculum concentrations of irradiated as well as the control samples were determined using plate counts on PDA.

2.10 Irradiation of Samples

The inoculum in McCarthy bottles were acutely irradiated at calculated doses (0.2, 0.4, 0.6 and 0.8) kGy. Irradiation of the samples was carried out in water at a dose rate of 1.08 kGy/h using a Cobalt-60 source. The absorbed dose was determined by using a Lithium fluoride photo- fluorescent film dosimeter (SUNNA Dosimeter System, UK). The irradiated as well as control samples were all kept at room temperature (28°C) after irradiation.

2.11 Calculation of D_{10} Values

Using Stumbo equation with Microsoft excel, D_{10} values of fungi survival populations were calculated:

$$\frac{1}{D} = \log\left(\frac{N}{No}\right) \times d$$

Where D is the D_{10}, N = survival population, No = initial population, d = dose applied.

2.12 Statistical Analysis

One-way and two-way ANOVA in randomized complete block design were used for D_{10} and biochemical analysis respectively. Split-plot design was used for physiological weight (%). Genstat 12th edition statistical package was used and Microsoft excel was used for means separation and plotting of graphs.

3. RESULTS AND DISCUSSION

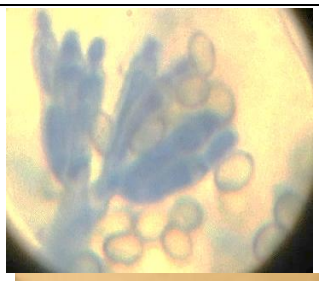
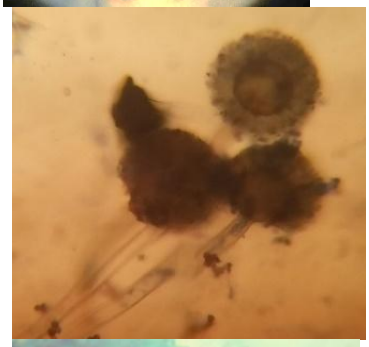
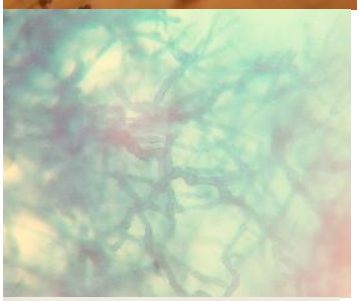
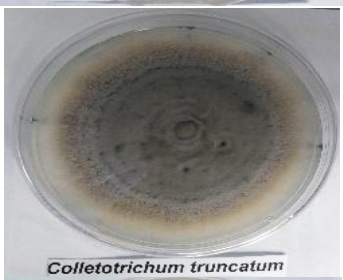
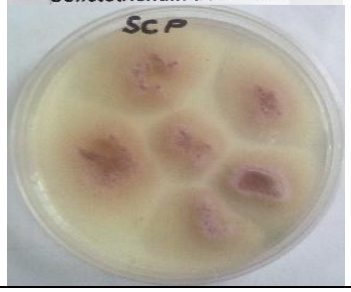
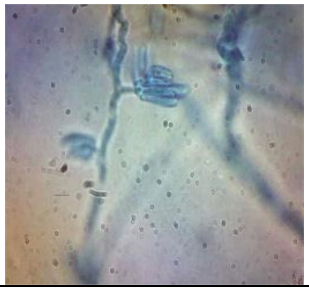
The five postharvest pathogenic fungi selected were assigned to division *Ascomycota* from the families of Glomerellaceae, Trichomaceae and Nectriaceae. The colour of *Aspergillus* species ranged from black to dark-brown conidia with uniseriate or biseriate, coarsely, hyaline conidiophores, spherical vesicles and hyaline or lightly pigmented hyphae near the apex. *Colletotrichum* species were large, dark-walled stromatic structures were present in the cultures forming perithecia often embedded in agar with their ascospores strongly curved and typically tapering towards the ends. *Fusarium* species were characteristically white or pink mycelia with presence of micro and macroconidia as illustrated (Table 1)

The D_{10} values of the five selected pathogenic fungi were in the following descending order *Fusarium* sp*., Aspergillus* sp*.* and *Colletotrichum* sp*.* These results indicate that *Fusarium solani* is the most radio tolerant among the five selective pathogens. The dose required to clear 90% of the initial *F. solani* population or bioburden ranged from 0.995 KGy which is approximately 1 KGy was significantly higher and different from the rest of pathogens. *Aspergillus niger* and *A. fumigatus* required 0.919 and 0.948 respectively and were significantly different ($p > 0.05$) from each other and other organisms. *Colletotrichum* sp. were the most radio susceptible group hence had the least D_{10} values 0.714 to 0.746 and were significant different statistically as illustrated (
Table **2**;
Fig. **1**-5). The two *Colletotrichum* specie, *capsici* and *truncatum* are very closely related genetically than any other species in *Colletotrichum* hence the two are often called by one name *C. truncatum.* The clade occupies a sister position to the combined *C. gloeosporioides* and *C. boninense* clade according to our multilocus analysis [17]. This might have accounted for the no significant differences in the D_{10} values of the *Colletotrichum* species. However, the difference in the D_{10} values of the five fungi were highly significantly different ($p > 0.05$). This implies that minimum of 1 KGy of gamma radiation dose is required to substantially extend shelf life of any fruit crop with combination of these fungi. Dighton et al., [18] reported *Fusarium* sp. among the most resistant fungi to ^{60}Co and ^{137}Cs rays which explained that pigmented fungi are more radioresistant to unpigmented micro-fungi. Melanin has been shown to account for between 45-60% of ^{60}Co and ^{137}Cs incorporation into fungal hyphae [19]. *Colletotrichum capsici and C. falcatum* have been reported to be radio sensitive as unpigmented mutant were measured by the germination of spores. The results obtained in this study was in line with reports of [20] and [10] that the effectiveness of the gamma radiation treatment is dependent on several factors including the composition of the food (Matrix), the number and type of microorganisms and the dose applied.

Fungi have been identified to contribute immensely to postharvest losses of fruits and vegetables both quantitative and qualitative measures including loss of weight, ascorbic acid content as well as sugar acid ratio. The pH values range of non-inoculated fruits were between 5 and 6 whereas inoculated fruits had pH values as higher as 8 (slightly alkaline). These differences may be attributed to interactive effect between varieties and fungal treatment (Table 3). Significant difference ($P \leq 0.05$) in pH content of pepper fruit was observed between varieties considered in this study. Pathogeneses of the inoculated fungi significantly increased pH values compared to the control. This may be a result of deteriorating activities caused by fungi on the pepper fruits which adversely affects acid metabolism and carbohydrate breakdown during postharvest period. According to Samira et al. [21], carbohydrate

and acid metabolism are closely connected during postharvest ripening period which would thus raise pH (alkalinity) of the produce. TTA and pH have negative correlation as titratable acidity increases and pH acidity decreases hence the differences in total titratable acidity. Deterioration activities of the fungi may lead to fermentation where much titratable acids are produced. These decreases were significantly different at (P≤0.05) as well as difference observed in varieties and their interactive effect.

Table 1. Morphology of pathogenic fungi of freshly harvested capsicum fruits (Magnification 1/5)

Front view	Reverse view	Fungus name
		*Aspergillus fumigatus*
		*Aspergillus niger*
		*Colletotrichum capsici*
		*Colletotrichum truncatum*
		*Fusarium solani*

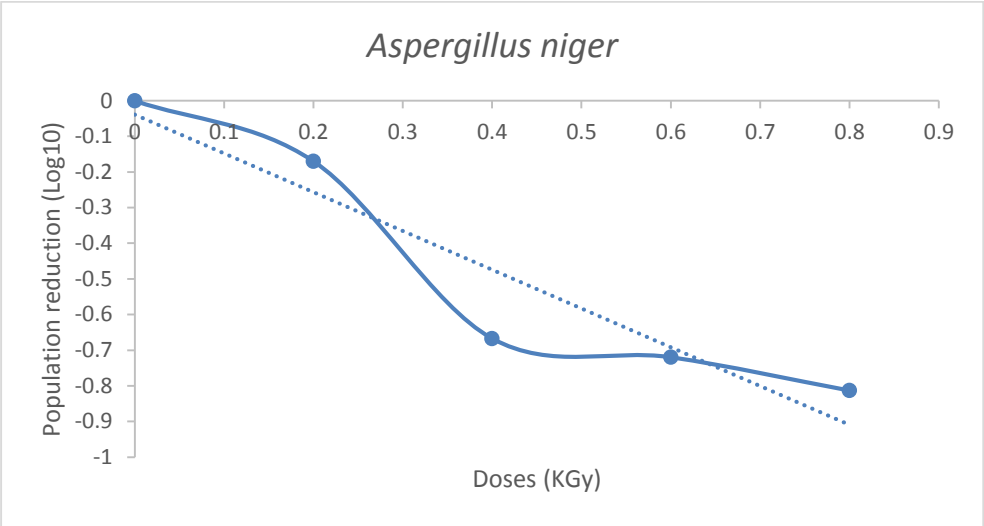


Fig. 1. Dose response curve of Aspergillus niger from pepper fruit

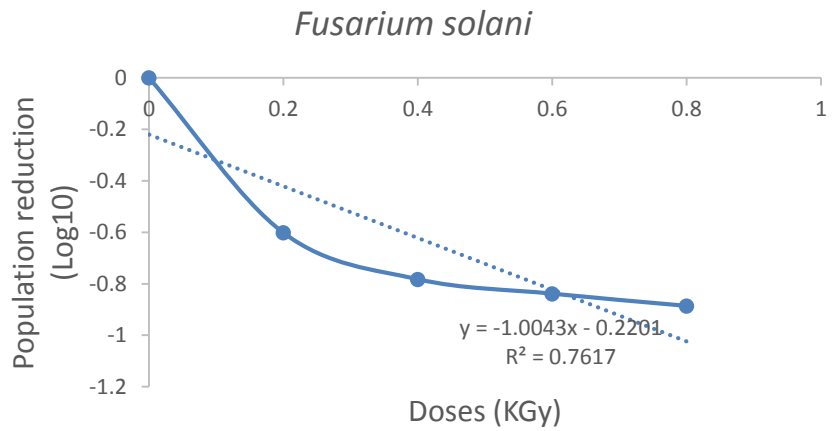


Fig. 2. Dose response curve of *Fusarium solani* from pepper fruit

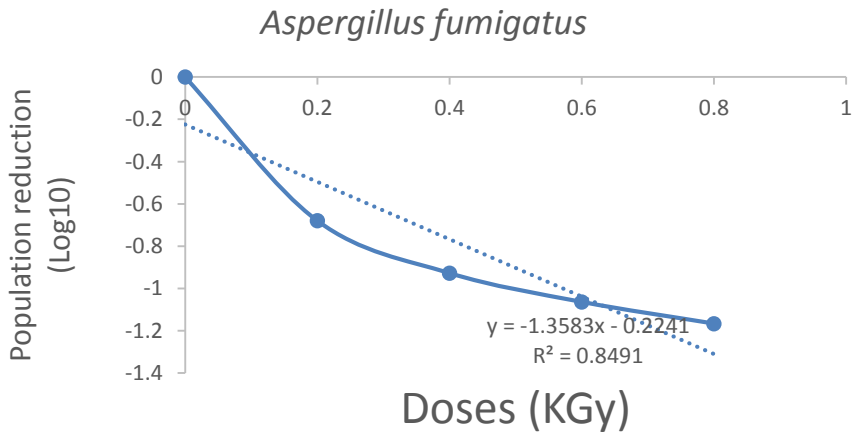


Fig. 3. Dose response curve of *Aspergillus fumigatus* from pepper fruit

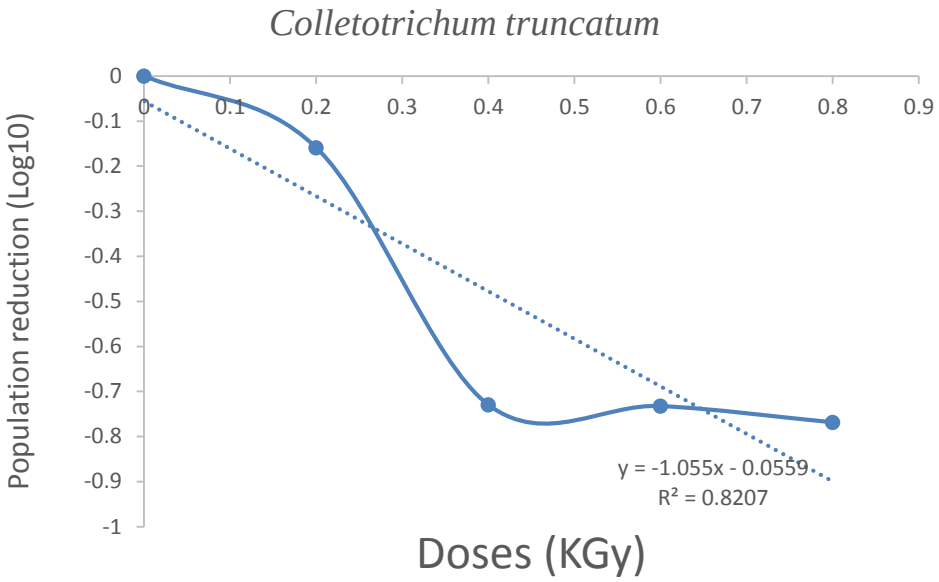


Fig. 4. Dose response curve of *Colletotrichum truncatum* from pepper fruit

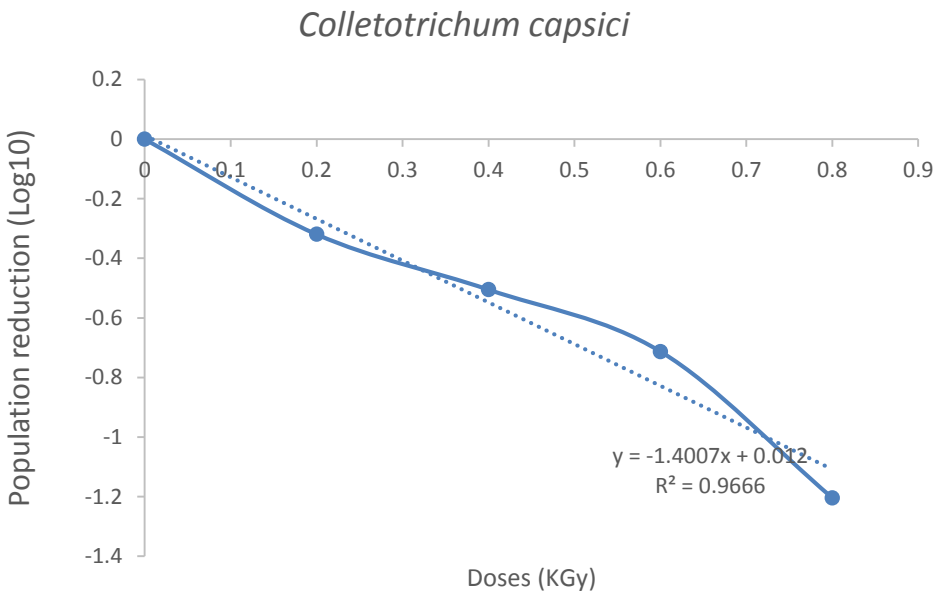


Fig. 5. Dose response curve of *Colletotrichum capsici* from pepper fruit

Table 2. D10 values for the five pathogenic fungi of fresh pepper fruits

Pathogen (NCBI accession number)	**D_{10} values (KGy)**
Fusarium solani (MK713428)	0.995[a]
Aspergillus fumigatus (MK713415)	0.948[b]
Aspergillus niger (MK713416)	0.919[c]
Colletotrichum truncatum (MK713420)	0.736[d]
Colletotrichum capsici (MK713419)	0.714[d]

Different lowercase superscripts in a column are significantly different (p >0.05)

Table 3. The interaction effect of fungi on the pH, total soluble solid (°Brix), total titratable acidity and total ascorbic acid values of pepper fruits for 8 days of storage

Variety	Fungi treatment	pH	TSS	TTA (%)	Vit. C (mg/100 g)
Kpakpo shito	Control	6.12st	1.4^{e}	0.02^{o}	2.40^{g}
	Aspergillus niger.	6.17^{rs}	2.0^{c}	0.12^{i}	1.87^{i}
	Aspergillus fumigatus	6.90^{m}	1.2^{e}	0.06^{l}	1.21^{jk}
	Colletotrichum capsici	5.98^{u}	1.6^{de}	0.12^{i}	1.75^{i}
	C. truncatum	5.61^{x}	1.6^{de}	0.13^{i}	0.91^{k}
	Fusarium solani	6.52^{p}	1.6^{de}	0.08^{k}	3.17^{e}
Makopa	Control	6.07^{t}	2.8^{b}	0.05^{m}	1.75^{i}
	Aspergillus niger.	6.71^{n}	2.0^{c}	0.20^{e}	1.57^{ij}
	Aspergillus fumigatus	6.6^{o}	3.2^{a}	0.31^{b}	1.40^{j}
	Colletotrichum capsici	7.59^{j}	2.0^{c}	0.09^{k}	2.45^{g}
	C. truncatum	6.54^{p}	2.4^{b}	0.31^{b}	2.17^{h}
	Fusarium solani	7.46^{l}	2.0^{c}	0.10l	2.17^{h}
Nsukka	Control	5.68^{w}	1.8c	0.03^{no}	4.21^{b}
Yellow	*Aspergillus niger*.	6.54^{p}	1.2e	0.06^{l}	3.57^{cd}
	Aspergillus fumigatus	7.83^{f}	2.0c	0.02^{o}	3.66^{c}
	Colletotrichum capsic	7.03^{m}	1.6^{de}	0.05^{m}	4.13^{b}
	C. truncatum	7.32^{l}	1.6^{de}	0.05^{m}	4.20^{b}
	Fusarium solani	8.85^{a}	0.8^{g}	0.06^{l}	2.73^{ef}
Rodo	Control	6.11st	1.4^{e}	0.02^{o}	3.94^{bc}
	Aspergillus niger.	6.16^{s}	0.8^{g}	0.13^{i}	3.64^{c}
	Aspergillus fumigatus	8.24^{d}	0.8^{g}	0.13^{i}	3.82^{c}
	Colletotrichum capsic	7.33^{l}	1.6d^{e}	0.17^{g}	3.61^{c}
	C. truncatum	7.27^{l}	0.8^{g}	0.06^{l}	3.96^{bc}
	Fusarium solani	7.78^{fg}	1.2^{e}	0.05^{m}	4.27^{ab}
Shombo	Control	5.57^{x}	1.4^{e}	0.05^{m}	4.80^{a}
	Aspergillus niger.	8.02^{e}	1.6^{de}	0.04^{mn}	4.45^{a}
	Aspergillus fumigatus	8.61^{b}	0.8g	0.09^{k}	4.31^{ab}
	Colletotrichum capsici	7.75^{gh}	1.6d^{e}	0.06l	4.69^{a}
	C. truncatum	8.06^{e}	1.6d^{e}	0.03^{no}	4.34^{ab}
	Fusarium solani	8.46^{f}	1.2^{e}	0.08^{k}	4.62^{a}
Touto	Control	6.23^{r}	1.8^{c}	0.03^{no}	1.68^{i}
	Aspergillus niger.	5.63^{wx}	1.7^{d}	0.34^{a}	1.40^{j}
	Aspergillus fumigatus	6.30^{q}	1.7^{d}	0.15^{h}	1.47^{j}
	Colletotrichum capsici	5.82^{v}	1.6d^{e}	0.26^{c}	1.47^{j}
	C. truncatum	5.68^{w}	1.2^{e}	0.31^{b}	1.34^{j}
	Fusarium solani	6.53^{p}	1.1^{f}	0.15^{h}	1.62^{i}
Yellow Sisi	Control	6.31^{q}	1.6d^{e}	0.04^{n}	1.07^{k}
	Aspergillus niger.	5.95^{u}	0.8^{g}	0.18^{f}	1.36^{j}
	Aspergillus fumigatus	5.69^{w}	1.6^{de}	0.23^{d}	1.35^{j}
	Colletotrichum capsici	7.57^{j}	0.8^{g}	0.05^{m}	1.33^{j}
	C. truncatum	7.74^{h}	1.2^{e}	0.24^{d}	1.08^{k}
	Fusarium solani	7.66i	1.6d^{e}	0.05^{m}	1.05^{k}

Means within a column followed by the same letter (s) are not significantly different at P≤0.05; (n = 3)

There were increases in the total soluble solids (TSS) contents of all varieties treated with the fungi compared to the control and these were significantly different at (P≤0.05). The TSS of *Makopa* (MP) variety was the highest among all other varieties. Aside *Kpakpo shito* and *Nsukka yellow*, the other varieties did not show much increase in TSS. According to Antoniali et al. [16] the polysaccharides of the cell wall are broken up with a consequent increase in sugar levels during ripening. The increase in TSS content could potentially be attributed to moisture loss over the eight-day period by the fruits according to Samira et al. [21].

Table 4. The interaction effect of fungi activities and storage period on the physiological weight loss (%) of seven varieties of pepper fruits

Variety	Fungi treatment	Day 2	Day 5	Day 8
Kpakpo shito	Control	26.10^{e}	34.75^{f}	67.37^{l}
	Aspergillus niger.	14.25^{bc}	45.84^{h}	51.43^{i}
	Aspergillus fumigatus	18.02^{d}	55.60^{ij}	61.97^{k}
	Colletotrichum capsici	11.59^{b}	37.91^{fg}	42.38^{gh}
	C. truncatum	17.96^{d}	63.18^{kl}	70.43^{m}
	Fusarium solani	15.04^{bc}	48.37^{hi}	59.96^{jk}
Makopa	Control	18.02^{d}	42.61^{gh}	64.23^{kl}
	Aspergillus niger.	15.14^{bc}	56.33^{j}	64.40^{kl}
	Aspergillus fumigatus	17.38^{c}	64.50^{kl}	73.23^{mn}
	Colletotrichum capsici	12.98^{b}	51.40^{i}	60.04^{jk}
	C. truncatum	17.72^{c}	54.43^{ij}	62.88^{k}
	Fusarium solani	12.51^{b}	52.88^{ij}	62.39^{k}
Nsukka Yellow	Control	9.56^{b}	41.04^{g}	77.46^{n}
	Aspergillus niger.	3.18^{a}	38.96^{fg}	53.85^{ij}
	Aspergillus fumigatus	4.81^{a}	50.57^{hi}	71.03^{m}
	Colletotrichum capsici	4.62^{a}	52.90^{ij}	76.02^{n}
	C. truncatum	8.78^{ab}	49.92^{hi}	76.06^{n}
	Fusarium solani	8.79^{ab}	52.40^{ij}	67.34^{l}
Rodo	Control	18.23^{d}	50.94^{hi}	73.96^{mn}
	Aspergillus niger.	18.52^{d}	37.66^{fg}	58.64^{jk}
	Aspergillus fumigatus	31.35^{ef}	48.22^{hi}	63.60^{kl}
	Colletotrichum capsici	25.84^{e}	56.79^{j}	75.18^{mn}
	C. truncatum	27.37^{e}	44.62^{gh}	68.52^{lm}
	Fusarium solani	10.72^{b}	52.33^{ij}	68.99^{lm}
Shombo	Control	24.99^{e}	48.35^{hi}	75.3^{1n}
	Aspergillus niger.	13.34^{bc}	58.73^{jk}	67.29^{l}
	Aspergillus fumigatus	8.66^{ab}	46.49^{h}	55.79^{ij}
	Colletotrichum capsici	11.97^{b}	53.40^{ij}	68.76^{lm}
	C. truncatum	16.90^{bc}	58.30^{jk}	76.23^{n}
	Fusarium solani	9.73^{b}	55.13^{ij}	69.18^{lm}
Touto	Control	8.76^{ab}	31.28^{ef}	53.45^{ij}
	Aspergillus niger.	12.17^{b}	38.74^{fg}	45.35^{h}
	Aspergillus fumigatus	12.44^{b}	46.48^{h}	57.16^{j}
	Colletotrichum capsici	12.88^{b}	47.45^{hi}	55.70^{ij}
	C. truncatum	11.20^{b}	42.09^{g}	51.37^{i}
	Fusarium solani	10.76^{b}	37.42^{fg}	48.74
Yellow Sisi	Control	13.59^{bc}	45.01^{h}	68.59^{lm}
	Aspergillus niger.	11.70^{b}	62.05^{k}	70.80^{m}
	Aspergillus fumigatus	14.72^{bc}	46.21^{h}	56.77^{j}
	Colletotrichum capsici	9.63^{b}	37.51^{fg}	45.54^{h}
	C. truncatum	13.24^{bc}	46.28^{h}	55.42^{ij}
	Fusarium solani	11.50^{b}	40.80^{g}	51.57^{i}
		Treatment	Day	Treatment*Days
	LSD	2.683	1.897	4.647
	Standard error	0.682	0.965	1.671

Means within column and row followed by the same letter (s) are not significantly different at P≤0.05; (n = 3).

Water and gas exchange take place through these lenticels. In addition to the size and density of stomata or lenticels, other surface features such as stem scars, cut ends of stems, cuts and scratches on the skin affect water loss. The highest moisture loss of pepper fruit was 77.46 % by untreated fruits of *Nsukka Yellow* while *Touto* recorded the lowest of 45.35% by the end of 8-day studies. There was overall weight lost to all the pepper fruits and observation may be ascribed to the temperature, at ambient conditions which increased the rates of water loss from pepper fruits possibly by increasing

vapour pressure deficit between the tissue and the surrounding air leading to enhancement of transpiration [22]. High temperatures also increased the rates of respiration and other metabolic processes that caused depletion of substrates like sugars and proteins resulting into further weight loss. It was observed that the control samples generally had the highest physiological weight loss compared to the fungi inoculated samples and these differences were significant at (P≤0.05). These differences in moisture loss may be due to the colonization of the inoculated fungus against other opportunistic microorganisms to act in deteriorating the fruits.

Again, there were significant differences (P≤0.05) in weight loss based on varietal difference and these differences may be attributed to thickness of flesh/skin of the fruit because flesh thickness and moisture content have positive correlation. This result is contrary to well-known assertion that fungi activities lead to breakdown of cell integrity and evaporation of moisture from the sample. Srivastava and Misra [23] also reported of loss of weight fruits of *Carica papaya* and *Vitis vinifer* infected with 26 species of pathogenic fungi for 8 days storage. Postharvest water loss in pepper fruit was found to be associated with membrane ion leakage, enzyme lipoxygenase (LOX) activity and membrane lipid content. Membrane lipid peroxidation is associated with high LOX activity, which catalyses the oxidation of linoleic and linolenic fatty acids in membranes. This leads to membrane damage resulting in ion leakage and water loss. LOX activity, among others that cause membrane deterioration, could be described as a pivotal process leading to water loss in pepper fruit during the postharvest period [24].

Total ascorbic acid was highest in *Shombo* variety and least in *Yellow sisi*. This varietal difference in total ascorbic acid content of pepper showed in both the treated pepper as well as their control. However, the treated still increased in their total ascorbic acid compared to the control in all varieties. The interactive effect of treatment and varietal difference were significantly different at (P≤0.05). A significant difference (P≤0.05) in the ascorbic acid content of pepper fruits was observed from the interaction effect of variety and fungi treatments.

4. CONCLUSION

A minimum of 1KGy of gamma irradiation is required to decontaminate fresh pepper fruits thereby extending their postharvest life with no or less adverse effect on biochemical properties of the fruits.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Biography of author(s)

Dr. G. K. Frimpong
Biotechnology and Nuclear Agriculture Research Institute – GAEC, Ghana.

Research and Academic Experience: Ten years of research experience

Research Area: Radiation Processing and Postharvest mycology

Number of Published papers: Ten publications in peer review journals

Special Award: ECOWAS Scholar Award

Any other remarkable point(s): Postharvest Mycologist