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Effects of irradiation on physical and sensory characteristics of cowpea seed cultivars (*Vigna unguiculata* L. Walp)

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ABSTRACT

Cowpeas (*Vigna unguiculata* L. Walp) are leguminous seeds widely produced and consumed in most developing countries of sub-Saharan Africa where they are a good source of affordable proteins, minerals and vitamins to the mainly carbohydrate-based diet of sub-Saharan Africa. At storage cowpea may be attacked by insects that cause severe damage to the seeds. The objective of this study was to investigate the effects of gamma irradiation on some physical and sensory characteristics of cowpea seed cultivars. Four cowpea cultivars were irradiated with gamma radiation at dose levels of 0.25, 0.50, 0.75, 1.0 and 1.5 kGy. Moisture content, thousand grain weight and bulk densities were determined as well as the amount of water absorbed during soaking and some sensory characteristics were equally determined. All the physical parameters studied were not significantly ($p > 0.05$) affected by the radiation. There was no significant ($p > 0.05$) effect of the radiation on the sensory attributes like flavour, taste, texture, softness and colour of the cowpea seeds. Similarly, the radiation did not affect significantly ($p > 0.05$) the acceptability of the treated cowpea cultivars.

1. Introduction

In Africa and the rest of the developing world, where malnutrition due to inadequate protein in the diet is a prevalent problem, there is an urgent need to explore the utilisation of plant proteins in the formulation of new food products or in conventional food (Khalid et al., 2003). Cowpea (*Vigna unguiculata* L. Walp) are leguminous seeds widely produced and consumed in most developing countries of sub-Saharan Africa where they are a good source of affordable proteins, minerals and vitamins to the mainly carbohydrate-based diet of sub-Saharan Africa (Phillips et al., 2003).

Most households in Ghana could use cowpea for "koose" (fried food made up of beans and maize flours), "tubani" (steamed bean cake), "gari" (roasted fermented cassava dough) and beans, rice and beans, cake, "apapransa sausage rolls", jam rolls, pie, chips and can also be used in the school feeding programme based on their nutritional content (Ghana News Agency (GNA), 2008). Cowpeas are stored as dry seeds and form an enormous reserve of food. However, vast quantities of stored legumes are lost annually as a result of insect attack. Throughout in tropical Africa, *Callosobruchus maculates* is estimated to consumed 50–90% of cowpea in storage annually (International Institute of Tropical Agriculture (IITA), 1989). According to Busasi (2010), 25% of cowpea is lost each year to pest (Bruchids) after harvesting.

The higher percentage of loss can be minimised by the application of gamma irradiation as a method of disinfecting (to sterilise or kill the insects) the stored products (Urbain, 1986). The loss of the external membrane integrity in irradiated wheat cereal (Dadayli et al., 1997) and increased seed coat permeability of green gram (Rao and Vakil, 1983) due to irradiation had been reported. Lapidot et al. (1991) observed that red bean irradiated with a dose of 1 kGy was not significantly discriminated as the odd one by sensory panel. Organoleptic evaluation of dry broad beans (*Vicia faba*, L.) conducted by El Kady and Hekal (1991) was in favour of irradiated beans because of the absence of live insects. In Ghana, the impact of gamma irradiation on the physical and sensory attributes of legumes and for matter cowpeas has not been reported.

This research is therefore aimed at investigating the effects of gamma irradiation on the physical and sensory characteristics of some cowpea seed cultivars found in Ghana.

2. Materials and methods

2.1. Sample collection and preparation

Four cultivars of dry cowpea ("Asontem", "Nhyira", "Togo" and "Nigeria") were bought from the Crop Research Institute of CSIR, Fumasua-Kumasi and a local market in Accra, Ghana.

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2.2. Radiation

Five hundred grams of each of the cowpea seed cultivar was packaged in polyethylene bag and sealed for irradiation. The irradiation was done using a gamma irradiation facility of cobalt 60 source (SLL-515, Hungary) at the Radiation Technology Centre (RTC) of the Ghana Atomic Energy Commission (GAEC). The radiation doses used were 0.0, 0.25, 0.50, 0.75, 1.0 and 1.5 kGy at dose rates of 46.813 Gy h^{-1} (0.5 and 0.75 kGy) and 45.374 Gy h^{-1} (0.25, 1.00 and 1.50 kGy) at 100/70 cm positions in air and the absorbed dose confirmed by Fricke's dosimetry.

2.3. Moisture content determination

The moisture content was determined according to the modified method of Ajibola et al. (2003). The samples were ground using laboratory mortar and pestle. Two grams (M_0) of samples (done in triplicates) were weighed into pre-dried moisture tins that had been cooled in a dessicator. The samples were then dried for 1 h in an air oven (Gallenkamp, United Kingdom) at 130 °C. The dried samples were then cooled in a dessicator and weighed (M_1). The average mass of the three masses was used to calculate the moisture content of the samples. The moisture content expressed as a percentage was calculated as follows:

$$\text{Moisture content}\ (\%) = M_0 - M_1/M_0 \times 100$$

2.4. Thousand grain weight

The thousand grain weight (TGW) was determined for each variety according to Sakin et al. (2004) as follows: 100 grains were counted and weighed in an electronic analytical balance (Mettler Toledo, Switzerland) four times for each variety and the values obtained were averaged and multiplied by 10.

2.5. Bulk density of grain

The bulk density of grain was determined according to the modified method described by Okaka and Potter (1979) by weighing an empty graduated cylinder (M_0) using Mettler Toledo, Switzerland. The graduated cylinder was then filled with the grain/flour to a certain volume. The mass of the two (grain/flour+cylinder) was also taken (M_1). The ratio of the mass of the grain/flour ($M_1 - M_0$) to the volume of the graduated cylinder was taken as the bulk density.

2.6. Water absorbed by cowpea seed during soaking

The water absorbed during soaking was determined according to a modified method of Agbo et al. (1987). Approximately 10 g of sample was placed in 100 ml Erlenmeyer flasks containing 50 ml deionized water. The flasks were placed at a room temperature of 30 ± 2 °C for 1, 2, 3, 4, 5 and 6 h. After soaking, the excess water was drained using a metal sieve (2.5 mm) and the samples were blot dried with absorbent paper to remove excess water and weighed. The gain in weight was expressed in g of water kg^{-1} sample.

2.7. Sensory evaluation

Two hundred and fifty grams of each sample was soaked for 1 h in water after which they were cooked in 1495 ml of water for 1.45 h on a gas burner. The cooked samples were served by placing them in white dishes, with blind codes with three digits and presented to 30 untrained panels. Each panellist in his/her booth received his/her samples in a random presentation order and answered the questions. Using the multiple comparisons test and 9-point Hedonic scale, the panellist were asked to rate each sensory attribute by assigning scores for surface colour, taste, flavour, texture (bite and touch) and preference (Larmond, 1977). Between the samples, the mouth was cleaned with water.

The 9-point hedonic scale:

9—Like extremely	8—Like very much	7—Like moderately
6—Like slightly	5—Neither like or dislike	4—Dislike slightly
3—Dislike moderately	2—Dislike very much	1—Dislike extremely

2.8. Statistical analysis

All analyses were done in triplicates. Analysis of variance (ANOVA) was done using GenStat Discovery Edition 3 (2007) and StatGraphics Plus (3.0) Statistical Software Programs. The least significant difference test (LSD-test) was applied in selected cases. The level of significance used was 95% ($p < 0.05$). Correlation between selected physical properties and moisture content was obtained.

3. Results and discussion

3.1. Moisture content of irradiated cowpea seed cultivars

There was no significant difference ($p > 0.05$) observed in the moisture content of grains of both the irradiated and non-irradiated samples for "Nhyira" and "Togo" (Table 1). Findings of A'Azim et al. (2009) and Rady et al. (2002) revealed that irradiation has no effect on the moisture contents of oil seeds. Decreased moisture content of seed was observed at radiation doses of 0.75 and 1.5 kGy in "Nigeria" and "Asontem", respectively, which may not be attributed to the irradiation (Table 1). Ihsanullah et al. (2005) also observed a decrease in moisture content of dates at even lower irradiation dose (0.2 kGy) although no proper pattern of change was observed. During radiation processing, the moisture content of the sample is of utmost importance as it controls the net radiochemical changes (Wilkinson and Gould, 1998).

3.2. Thousand grain weight

The thousand grain weight (TGW) of "Asontem", "Nhyira" and "Togo" showed no significant differences ($p > 0.05$) between the controls and the irradiated samples. The "Nigeria" sample showed some significant differences ($p < 0.05$) between samples irradiated with 0.5 and 0.75 kGy and the rest including the control (Table 2). The differences observed in "Nigeria" may be attributed to the physical structure of the cowpea cultivars. This was so

Table 1
Moisture content of irradiated "Asontem", "Nhyira", "Nigeria" and "Togo" Seeds.

Cultivar	Dose (kGy)						SEM
	0.00	0.25	0.50	0.75	1.00	1.50	
"Asontem"	15.00^{a}	13.83^{b}	15.00^{a}	15.00^{a}	15.00^{a}	13.17^{c}	0.22
"Nhyira"	14.17^{a}	14.17^{a}	14.25^{a}	14.25^{a}	14.00^{a}	14.17^{a}	0.31
"Nigeria"	12.33^{c}	14.17^{a}	13.17^{b}	11.25^{d}	12.17^{c}	12.00^{c}	0.36
"Togo"	13.17^{a}	13.00^{a}	12.80^{a}	12.75^{a}	13.00^{a}	13.00^{a}	0.37

Means followed by different superscripts within a row are significantly different ($p < 0.05$) for each cultivar. SEM=Standard Error of Mean.