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Effect of storage time and ionising irradiation on the physical properties, cooking time and sensory attributes of cowpea (*Vigna unguiculata L. Walp*)

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Abstract: Cowpeas are rich in protein but their utilization is limited because of hard to cook phenomenon developed by the grain during storage. The effect of storage and ionizing irradiation on the quality attributes of cowpeas was investigated. Control and irradiated samples were stored for six months at ambient temperature. At three months intervals they were evaluated for physical, cooking time and consumer acceptability. Irradiated and non-irradiated drum cowpea was significantly higher in length and width. The length ranged between (9.01-9.71 mm) and width (7.11-7.40 mm). At 0 month the cooking time in non-irradiated cowpea ranged between (26-38 min). Drum cowpea was found to be lower than other cowpeas with 26 mins. At six months with irradiation dose of 15Gy, cooking time was reduced from (19-25 mins). Cowpeas (15Gy), stored for six months on cooking had similar acceptability to freshly harvested cowpeas. Summarily, ionizing irradiation reduced cooking time and did not mar acceptability of cooked beans.

Keywords: Cowpeas, ionizing irradiation cooking time, dose, sensory properties

INTRODUCTION

Cowpea is prominent in many African countries because of its abundant distribution of wild and weedy species in the Savannah and Forest zones (Rawal, 1975). Cowpea is known by many names in Africa, it is called *Ewa, Wake* and *Akedi* (Nigeria) *Kondi* in Cameroon, *Wewe* (Benin), *Soso* (Gambia), *Tuya* (Ghana), *Duv* (Mali), *Niebe* (Senegal), *Seneni* ([Sierra Leone) and *Tombing* in Togo (Dovlo *et al.,* 1976). There are many varieties of cowpea in Nigeria, which are usually found in different colours varying from off-white, black eye, brown or combination of these colours. The white and brown seed types are the most prominent and are generally preferred (Oyenuga, 1968).

Cowpea is an inexpensive source of protein and minerals unlike animal sources, which are scarce and expensive. It provides more than half of the plant protein in human diets. It serves as a key staple food for the poorest sector of many developing countries in the tropics. (Singh and Rachie, 1985; Oyefeso, 1980). In Nigeria cowpea can be cooked plain, mixed with other foods or processed into formulated recipes. It is anticipated that the world population will reach 7.5 billion by the year 2025 according to United Nations' World Population Prospects. Food production needs to meet these growing demands with limited water resources and arable lands. Therefore, agriculture and the food industry will continue to play crucial roles in both food security and our economies. Cowpea, which is regarded as a prominent food crop in the 3rd world, has a great role to play in alleviating poverty and malnutrition in developing countries. FAO (2001) estimates that 3.3 million metric tonnes of cowpea dry grains were produced worldwide in 2000. Nigeria produced 2.1 million tonnes of this making her the world's largest producer, followed by Niger (650,000 metric tonnes) and Mali (110,000 metric tonnes)

In the raw grain their acceptability as staple foods is limited with the problem known as hard to cook phenomenon which normally occur during storage (Barron *et al.*, 1996). Gamma irradiation at moderate doses (Rao and Vakil, 1985) has been shown to reduce these defect with no adverse effect on the sensory characteristics and nutritional quality of the final product. In Europe, the use of irradiation to extend the shelf life of crops has been very prominent (Farkas, 2006). But in Nigeria, this practice is only limited to sprout inhibition in bulbs, roots and tubers, (Agbaji *et al.,* 1981) reduction of Aflatoxin B1 on some Nigerian food stuffs (Ogbadu, 1980), changes on the microflora and essential oil of Ashanti pepper (*Piper guineense*) berries (Onyenekwe *et al.,* 1997), radiation sterilization of Red chilli pepper (Onyenekwe and Ogbadu, 1995), changes in the protein, amino acids and carbohydrate contents of soy-gari diet (Ogbadu and

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Bassir, 1979), retardation of fruit ripening (Aina *et al.,* 1990) and insect disinfestations on legumes (Olaifa *et al.*, 1990).

This work is therefore aimed at evaluating the effect of storage and ionizing irradiation on the physical properties, cooking time and sensory attributes of cowpea (*Vigna unguiculata L.Walp*)

MATERIALS AND METHODS

Procurement and handling of cowpeas

Freshly harvested cowpea variety Ife brown was obtained from the experimental research farm at the Institute of Agricultural Research and Training (I.A.R and T) Ibadan while Kano white and Drum varieties were obtained from the research farm at Premier seeds Nigeria (LTD) Zaria. The grains were harvested from the experimental research farms when their pods are dry. The harvested grains were sorted to remove damaged grains and extraneous matter such as stones and chaff and packed in low-density polyethylene bags of 5 Kg capacity obtained from factory in Ibadan Nigeria.

Gamma irradiation of cowpeas

The packaged beans were irradiated at 0, 5, 10 and 15 Gy at ambient temperature (27±1^{0}C) in a Cobalt-60 Gamma cell 220 (AEC Model) having an influx of 0.10556 Gy/s, located at the centre for Energy Research and Development, Obafemi Awolowo University, Ile-Ife, Nigeria. The irradiated and non irradiated packaged beans were then stored at room temperature (27±2^{0}C) for a period of 6 months. Samples were taken every 3 months for analysis on physical properties such as length breadth and thickness of the grain and cooking time Consumer acceptability of cooked grains from irradiated and non- irradiated cowpeas were evaluated by untrained ten membered panel randomly selected from male and female adults.

METHODS

Length, width and thickness

The seed length, width and thickness were determined using the method described by Obatolu *et al.* (2001).

Cooking time

Cooking time was determined using the method of Akinyele *et al.* (1986). The beans were cooked on a Gallenkamp regular hot plate (10 Amps) model 68909R and the cooking time was estimated by arranging plungers (38± 1.2 g) with their needle tips resting on the seeds previously soaked in 100 ml water for 30 mins. The cooking time was taken as the time the needles of 20 of the 40 plungers penetrated the seeds.

Preparation of cooked beans

Taking into cognizance the cooking times of the cowpeas (Akinyele *et al.*, 1986). Four hundred milliliters of water was added to 200 gm of cowpea, and this was cooked in a pot placed on a hot plate.

Sensory evaluation of cooked beans

Sensory evaluation of cooked beans was on the basis of colour, taste, texture, flavour and general acceptability using a ten membered untrained male and female adults that are familiar with the product in question. They were independently evaluated using the difference technique described by Larmond (1977). The nine point hedonic scale was used to determine the preference of panelist. Ratings were from (1-9). One corresponding with extreme dislike and 9 with extreme likeness and data generated was subjected to statistical analysis.

RESULTS AND DISCUSSION

Tables 1, 2 and 3 depict the length, width and thickness of irradiated and non irradiated cowpeas. It was observed that there was a higher significance difference in the length and width of drum cowpea samples when it was compared with other cowpeas at $p<0.05$. The thickness of Ife brown cowpea was however significantly lower. There was also a reduction in the dimensional attributes of all the cowpeas with increase in storage time. This may be due to textural differences amongst the cowpeas (Odeyemi and Daramola, 2000; Singh and Rachie, 1985; Taylor and Aluko, 1974).

Figures 1 - 3 shows the effect of ionising irradiation on cookability of cowpeas. At 0 month, the cooking time in non-irradiated cowpea ranged between (26-38 min). Drum cowpea was found to be lower than other cowpeas with (26 min) this agrees with (Akinyele *et al.,* 1986). At 6 months with irradiation dose of 15Gy, ionizing irradiation reduced cooking time ranging from (19 - 25 min). Drum cowpea was lower in cooking time than other cowpeas having (19 min). Ionizing irradiation is known to increase activity of polymer-water interaction of denatured carbohydrate and proteins thereby reducing cooking time (Rao and Vakil, 1985).

Table 1: Effect of ionizing irradiation on the length of cowpea grains

	0 month (mm)	3 months (mm)	6 months (mm)
IB1	7.68^{e}	7.59^{e}	7.50^{e}
IB2	7.87^{e}	7.80^{de}	7.70^{de}
IB3	7.81^{e}	7.75^{de}	7.65^{de}
IB4	7.53^{f}	7.41^{ef}	7.33^{ef}
KW1	8.93^{c}	8.70^{c}	8.61^{bc}
KW2	8.39^{d}	8.30^{cd}	8.19^{cd}
KW3	8.30^{d}	7.99^{d}	7.90^{d}
KW4	8.61^{cd}	8.30^{cd}	8.21^{c}
D1	9.58^{ab}	9.51^{ab}	9.40^{a}
D2	9.37^{b}	9.29^{b}	9.20^{ab}
D3	9.17^{bc}	9.10^{bc}	9.01^{b}
D4	9.71^{a}	9.63^{a}	9.29^{ab}

Means in the same column followed by the same letter are not significantly different from each other at $p<0.05$

Table 2: Effect of ionizing irradiation on the width of cowpea grain

	0 month (mm)	3 months (mm)	6 months (mm)
IB1	5.29^{d}	5.23^{cd}	5.10^{cd}
IB2	5.43^{c}	5.37^{c}	5.25^{c}
IB3	5.47^{c}	538^{c}	5.29^{c}
IB4	5.30^{cd}	5.22^{cd}	5.10^{cd}
KW1	6.29^{bc}	6.20^{bc}	6.06^{bc}
KW2	6.33^{b}	6.24^{bc}	6.09^{bc}
KW3	6.42^{b}	6.35^{b}	6.21^{b}
KW4	6.32^{b}	6.24^{bc}	6.13^{b}
D1	7.40^{a}	7.33^{a}	7.24^{a}
D2	7.35^{a}	7.26^{a}	7.18^{a}
D3	7.26^{a}	7.18^{ab}	7.11^{ab}
D4	7.35^{a}	7.27^{a}	7.17^{a}

Means in the same column followed by the same letter are not significantly different from each other at $p<0.05$

Table 3: Effect of ionizing irradiation on the thickness of cowpea grains

	0 month (mm)	3 months (mm)	6 months (mm)
IB1	3.13^{d}	3.68^{c}	3.67^{cd}
IB2	3.99^{c}	3.99^{bc}	3.96^{c}
IB3	3.70^{cd}	3.68^{c}	3.67^{cd}
IB4	3.67^{cd}	3.64^{c}	3.62^{cd}
KW1	4.74^{bc}	4.71^{b}	4.75^{b}
KW2	4.85^{b}	4.82^{b}	4.79^{b}
KW3	4.87^{b}	4.84^{b}	4.83^{ab}
KW4	5.08^{ab}	5.00^{ab}	4.98^{ab}
D1	5.68^{a}	5.63^{a}	5.57^{a}
D2	4.73^{b}	4.71^{b}	4.67^{bc}
D3	4.77^{b}	4.74^{b}	4.69^{bc}
D4	4.78^{b}	4.75^{b}	4.73^{b}

Means in the same column followed by the same letter are not significantly different from each other at $p<0.05$

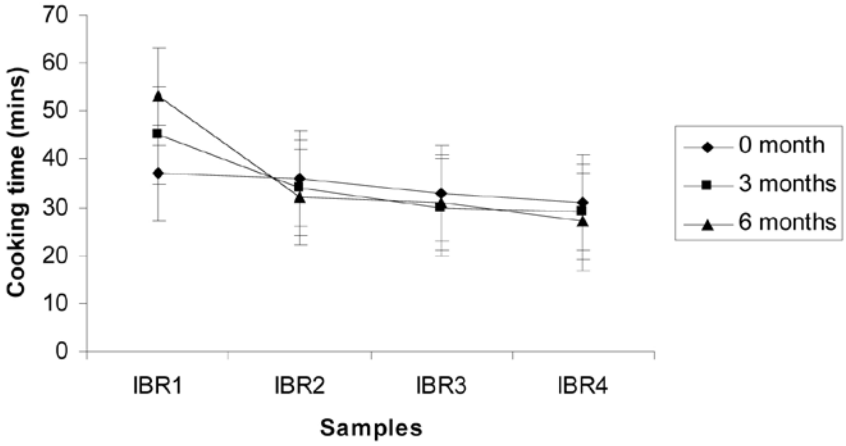

Figure 1: Effect of ionizing irradiation on cooking time of irradiated and non- irradiated Ife brown cowpea stored under ambient temperature
IBR_{1-4} : Irradiated and non-irradiated Ife brown cowpea under ambient temperature at 0,5,10 and15Gy

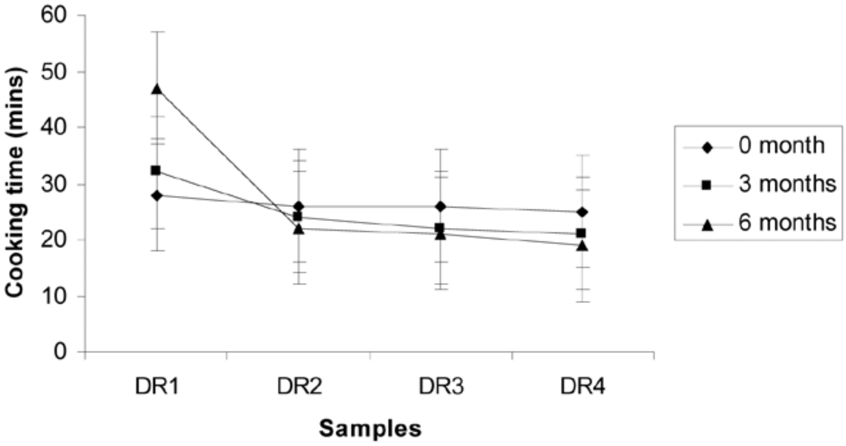

Figure 2: Effect of ionizing irradiation on cooking time of irradiated and non- irradiated Drum cowpea stored under ambient temperature
DR_{1-4} : Irradiated and non-irradiated Drum cowpea under ambient temperature at 0,5,10 and15Gy

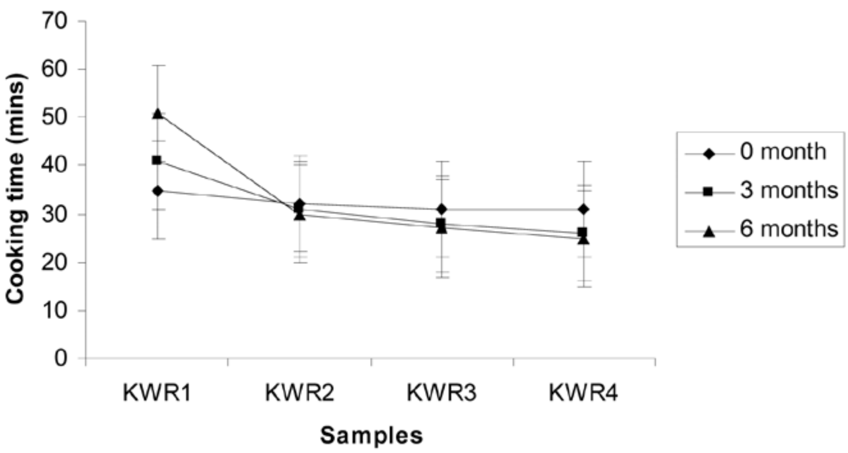

Figure 3: Effect of ionizing irradiation on cooking time of irradiated and non- irradiated Kano white cowpea stored under ambient temperature
KWR_{1-4} : Irradiated and non-irradiated Kano white cowpea under ambient temperature at 0,5,10 and15Gy

It is apparent from Table 4 that the sensory scores given to non irradiated cooked cowpeas were generally high although there were significant differences in taste, this could be due to varietal difference. In Table 6, it is notable that cowpea irradiated at irradiation dose (15Gy) and stored for 6 months on cooking had similar acceptability to the freshly harvested cowpeas (Table 4), although fresh one had higher score in quality attributes. These observations agreed with the report of Al-Bachi. and Mehi (2001), and Jae *et al.* (2004) who reported no alteration in sensory properties of irradiated anchovy sauce and luncheon meat. It can, therefore, be deduced that ionizing irradiation did not mar acceptability of cooked beans

CONCLUSION

Ionizing irradiation did not alter the physical properties of stored cowpeas; however it reduced their cooking time and did not mar their acceptability.

Table 4: Effect of ionizing irradiation on the sensory quality of cooked cowpeas at 0 month

	Colour	Taste	Texture	Flavour	General Acceptability
IBRI	7.7[ab]	7.8[a]	7.9[b]	7.2[b]	7.5[b]
IBR2	7.9[a]	7.8[a]	8.2[a]	7.4[ab]	7.2[bc]
IBR3	7.9[a]	7.7[ab]	7.7[bc]	7.4[ab]	7.6[ab]
IBR4	7.7[ab]	7.3[b]	8.2[a]	7.7[a]	6.8[c]
KWR1	7.9[a]	7.4[b]	7.8[b]	7.3[ab]	7.7[ab]
KWR2	7.9[a]	7.9[a]	8.1[ab]	6.9[c]	7.7[ab]
KWR3	7.8[a]	7.8[a]	7.9[b]	7.7[a]	8.0[a]
KWR4	8.0[b]	7.9[a]	7.8[b]	7.2[ab]	7.5[b]
DR1	7.9[a]	7.6[ab]	7.9[b]	7.2[ab]	7.7[ab]
DR2	7.6[ab]	7.9[a]	8.0[ab]	7.1[b]	7.5[b]
DR3	7.6[ab]	7.3[b]	8.2[a]	7.6[a]	7.7[ab]
DR4	7.9[a]	7.7[ab]	8.3[a]	7.4[ab]	7.9[a]

Means in the same column followed by the same letter are not significantly different from each other at $p<0.05$ according to Duncan multiple range test.

IBR_{1-4} : Ife brown at ambient temperature at 0,5,10 and15Gy
KWR_{1-4} : Kano white at ambient temperature at 0,5,10 and 15Gy
DR_{1-4} : Drum at ambient temperature at 0,5,10 and15Gy

Table 5: Effect of ionizing irradiation on the sensory quality of cooked cowpeas at 3 month

	Colour	Taste	Texture	Flavour	General Acceptability
IBRI	7.0[d]	5.7[d]	5.5[cd]	6.7[c]	6.8[cd]
IBR2	7.9[ab]	7.6[a]	7.7[a]	7.7[ab]	7.7[ab]
IBR3	7.7[b]	7.4[b]	7.6[a]	7.5[b]	7.5[b]
IBR4	7.3[c]	7.6[a]	7.5[ab]	7.9[a]	7.6[ab]
KWR1	6.3[e]	5.8[d]	5.8[c]	6.5[cd]	6.6[d]
KWR2	7.5[bc]	7.3[b]	7.4[ab]	7.9[a]	7.6[ab]
KWR3	7.7[b]	7.2[bc]	7.6[a]	7.5[b]	7.2[c]
KWR4	8.1[a]	7.2[bc]	7.1[b]	7.5[b]	7.9[a]
DR1	7.2[c]	5.8[d]	5.2[d]	6.3[d]	7.3[bc]
DR2	7.4[bc]	7.3[b]	7.2[b]	7.2[bc]	7.6[ab]
DR3	7.7[b]	7.3[b]	7.1[b]	6.8[c]	7.3[bc]
DR4	7.6[b]	6.7[c]	7.6[a]	8.0[a]	7.5[b]

Means in the same column followed by the same letter are not significantly different from each other at $p<0.05$ according to Duncan multiple range test.

IBR_{1-4} : Ife brown at ambient temperature at 0,5,10 and15Gy
KWR_{1-4} : Kano white at ambient temperature at 0,5,10 and 15Gy
DR_{1-4} : Drum at ambient temperature at 0,5,10 and15Gy

Table 6: Effect of ionizing irradiation on the sensory quality of cooked cowpeas at 6 month

	Colour	Taste	Texture	Flavour	General Acceptability
IBRI	2.6^{d}	1.8^{de}	2.2^{c}	2.4^{b}	1.9^{d}
IBR2	6.6^{c}	7.8^{b}	7.9^{ab}	7.7^{a}	8.0^{ab}
IBR3	6.9^{bc}	8.2^{a}	7.8^{b}	7.9^{a}	7.9^{b}
IBR4	6.7^{c}	8.2^{a}	7.8^{b}	7.7^{ab}	7.6^{c}
KWR1	2.5^{d}	1.8^{de}	1.8^{cd}	2.1^{bc}	1.7^{de}
KWR2	7.6^{a}	7.9^{ab}	8.1^{a}	7.9^{a}	8.0^{ab}
KWR3	7.4^{ab}	8.1^{a}	7.9^{ab}	7.8^{a}	7.9^{b}
KWR4	7.3^{ab}	8.1^{a}	8.1^{a}	7.7^{a}	8.3^{a}
DR1	2.6^{d}	2.0^{d}	2.2^{c}	2.3^{b}	2.0^{d}
DR2	7.3^{ab}	7.3^{c}	7.8^{b}	7.8^{a}	8.1^{ab}
DR3	7.3^{ab}	7.5^{bc}	7.9^{ab}	7.8^{a}	8.1^{ab}
DR4	7.1^{b}	7.5^{bc}	8.1^{a}	7.9^{a}	7.8^{bc}

Means in the same column followed by the same letter are not significantly different from each other at p<0.05 according to Duncan multiple range test.

IBR_{1-4} : Ife brown at ambient temperature at 0,5,10 and15Gy
KWR_{1-4} : Kano white at ambient temperature at 0,5,10 and 15Gy
DR_{1-4} : Drum at ambient temperature at 0,5,10 and15Gy

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