Short note

Effect of gamma irradiation and cooking on the physico-chemical properties, nutrients, and anti-nutrients compositions of egusi melon (Citrullus vulgaris) seeds

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Received: November 1, 2023
Accepted: March 13, 2023

The effect of gamma irradiation and cooking on the physico-chemical and functional properties of "egusi" melon as well as its impact on quality attributes of the oil were investigated. The seeds of "egusi" melon were divided into five portions. One part was cooked, one irradiated at 5KGy, another was irradiated at 10KGy, and one part was cooked and irradiated at 10KGy as a double treatment method. The last part was left as is (raw) for reference. Irradiation was done using Cobalt-60 as gamma radiation source. Proximate compositions, mineral contents, amino acid contents, oil quality attributes, as well as anti-nutritional factors were determined for all samples using standard methods. Results revealed that gamma irradiation caused a decrease in values of moisture from the raw sample (5.80) with cooked, 10KGy and 5KGy irradiated samples of "egusi" melon showing reduced moisture contents of 4.27, 4.27 and 4.14% respectively. Protein decreased from 32.20% in raw "egusi" melon seeds to 29.77% and 29.47% in the 10KGy and 5KGy irradiated samples respectively. Mineral content of "egusi" melon seeds were affected by irradiation at 10 and 5kGy where the values of potassium increased from 14.93 in the raw to 20.88 in the 10KGy irradiated and 22.83 in the 5KGy irradiated samples. For the quality attributes of "egusi" melon oil, gamma irradiation caused significant decrease ($P \leq 0.05$) in iodine value and significant increase in acid and peroxide values. The treatments had profound effects on the Amino Acid Contents of "egusi" melon. Cooking increased the level of amino acids except for glutamic acid which decreased from 14.26 to 13.63 when cooked. Irradiation also had this effect, increasing in all but glutamic acid (14.26 to 13.83) but the combined treatment (cooking and Irradiation) showed an increase in glutamic acid content. Lysine, Histidine, Valine, and Leucine decreased when subjected to the combined treatment. The study showed that irradiation only caused little changes in the nutrient composition of "egusi" melon at low dosage highlighting its potential as a preservation and disinfection treatment for "egusi" melon.

Keywords: Gamma irradiation, domestic cooking, "egusi" melon seed, oil extract.

INTRODUCTION

Irradiation is a general term for the deliberate exposure of materials to radiation energy. Irradiation is often called 'cold pasteurisation' because of the significant reduction of several pathogenic microorganisms, negligible loss of nutrients and minimal changes in sensory attributes [1]. Food irradiation is done mostly by using Cobalt-60 Gamma rays because of its deep penetration which enables the administration of treatment to entire industrial pallets or totes, reducing the need for material handling making it the preferred method by most processors. Food irradiation is a beneficial technology providing food with good shelf life and safety but could, on the other hand, cause both physiological [2] and biological changes that may disrupt the nutritional value and organoleptic properties of the irradiated foods [3]. Processing of food by Ionizing radiation, depending on the dose, kills some or all the harmful bacteria and other pathogens present. This prolongs the shelf-life of the food

especially in cases where microbial spoilage is the greatest concern. Irradiation has also shown to delay the sprouting of vegetables or the ripening of fruits.

MATERIALS AND METHODS

Melon ("egusi") seeds (*Citrullus vulgaris*) used for the study were purchased from a local market called Oja-Oba in Akure, Ondo state, Nigeria. Seeds were screened to remove bad ones, dehulled mechanically and further screened. The seeds were then divided into five parts (the raw; cooked; cooked and irradiated at 10kGy; irradiated at 5 and irradiated at 10KGy respectively). The gamma irradiation was conducted at the Shedan Science and Technology Complex (SHESTCO), Abuja, using cobalt-60 irradiation facilities at 5kGy and 10kGy respectively. They were all dried to constant weight in an oven at 60°C, ground using mechanical blender, put in an air-tight container, and stored in a dry cool environment for further analysis. All chemicals and reagents used in the study were of an analytical grade.

PROXIMATE COMPOSITION DETERMINATION

Proximate composition of samples was determined using AOAC [4] methods of analysis. Carbohydrate was determined by a different method.

MINERAL CONTENT DETERMINATION

Minerals of each sample (Ca, Mg, Zn, Fe) were determined by Flame Atomic Absorption Spectrophotometer as described by AOAC [4]. Potassium and Sodium contents were determined using flame photometer. A weighed 0.5 g of each sample was digested in 6.5 ml of acid solution (HNO_3, H_2SO_4, $HClO_4$ in ratio of 5:1:0.5). The resulting solution was heated until white fumes appeared. The clear solution was diluted up to 50 ml with distilled water and filtered with Watman filter paper no. 41. The standard calibration curves were obtained for the elements of interest using prepared standard working solutions. The concentration of a particular element in a sample was determined by absorption using the calibration curves. Cathode lamps were used as a radiation source. This experiment made use of Air acetylene gas. Other elements in the sample will generally not absorb the chosen wavelength and thus will not interfere with the measurement which makes this method highly selective and sensitive.

Physicochemical properties like Acid Value, Saponification Value, Iodine Value, Peroxide Value and Free Fatty Acids were determined using the A.O.C.S. [5] methods of analysis.

DETERMINATION OF WATER AND OIL ABSORPTION CAPACITIES

The method of Prinyawiwatkul *et al.* [6] with modifications was used in the determination of water and oil absorption capacities. Each flour sample (1.0 g) was thoroughly mixed with 10 ml of deionised water (Density = 1.00 g/cm^3) or oil (Density = 0.9095 g/cm^3) in 10-ml centrifuge tubes. Suspensions were stirred intermittently over a 30 min period at room temperature (25°C) and then centrifuged at 12,000 g for 30 min at 25°C. The supernatant was decanted into a 10 cm graduated measuring cylinder. The volume of supernatant of water and oil absorption capacities were then calculated. The bonded oil and water were determined by difference and converted to grams. The percentage of oil and water absorption capacity were expressed as g/g % of the flour sample. Each flour sample was analysed in triplicates.

ANTI-NUTRITIONAL FACTOR DETERMINATION

The antinutritional factors of the oils were determined by the method of Inuwa *et al.* [7].

Oxalate determination: the oxalate content of the samples was determined using titration method. 2 g of each sample was placed in a 250 ml volumetric flask suspended in 190 ml distilled water. 10 ml of 6 M HCl solution was added to each of the samples and the suspension was digested at 100ºC for 1h. The samples were then cooled and made up to the 250 ml mark of the flask. The samples were filtered and duplicate portions of 125 ml of the filtrate were measured into beakers and four drops of methyl red indicator were added, followed by the addition of concentrated NH_4OH solution (dropwise) until the solution changed from pink to yellow colour. Each portion was then heated to 90ºC, cooled and filtered to remove the precipitate containing ferrous ion. Each of the filtrates was again heated to 90ºC and 10 ml of 5% $CaCl_2$ solution was added to each of the samples while stirring consistently. After cooling, the samples were left overnight. The solutions were then centrifuged at 2500 rpm for 5 min. The supernatants were decanted, and the precipitates completely dissolved in 10 ml 20% H_2SO_4. The total filtrate resulting from the digestion of 2 g of each of the samples were made up to 200 ml. Aliquots of 125 ml of the filtrate were heated until near boiling and then titrated against 0.05 M standardised $KMnO_4$ solution to a pink colour which persisted for 30 sec. The oxalate contents of each sample were calculated.

Phytate determination: the phytate contents of each of the samples was determined through phytic acid determination. This entails weighing of 2 g of each sample into 250 ml conical flasks. 100 ml of 2% conc. HCl was used to soak the samples in the conical flask for 3 h and then filtered through a double layer filter paper. 50 ml of each of the filtrates were placed in a 250 ml beaker and 107 ml of distilled water added to give proper acidity. 10 ml of 0.3% ammonium thiocyanate solution was added to each sample solution as an indicator and titrated with a standard iron chloride solution which contained 0.00195 g iron/ml and the end point was indicated by a brownish-yellow colouration that persisted for 5 min. The percentage

Table I - Effect of gamma irradiation on the proximate composition of melon (Egusi) (%)

Test	Raw	Cooked	C+I	10KGy	5KGy
M.C	3.80 ± 0.01[a]	4.27 ± 0.01[c]	4.46 ± 0.06[b]	4.27 ± 0.01[c]	4.14 ± 0.02[d]
ASH	4.59 ± 0.08[c]	3.76 ± 0.03[d]	3.41 ± 0.02[e]	6.15 ± 0.04[a]	5.47 ± 0.01[b]
FAT	48.92 ± 0.01[a]	47.00 ± 0.12[b]	45.44 ± 0.03[c]	44.71 ± 0.02[c]	49.31 ± 1.15[a]
C.F	2.31 ± 0.03[d]	4.34 ± 0.29d[a]	4.02 ± 0.01[b]	3.00 ± 0.01[c]	3.07 ± 0.01[c]
PROTEIN	32.20 ± 0.02[b]	31.88 ± 0.03[c]	35.32 ± 0.02[a]	29.77 ± 0.05[d]	29.47 ± 0.02[e]
CHO	9.99 ± 0.06[e]	13.29 ± 0.02[c]	11.78 ± 0.01[d]	16.36 ± 0.02[a]	13.99 ± 0.01[b]

Values are expressed as means ± Standard Deviation
Means in the same row with different superscripts are significantly different ($P \leq 0.05$)
Keys: M.C = moisture content, C+I = Cooked and irradiated at 10kGy, C.F = Crude fibre

phytic acid was calculated.
Tannins determination: one gram of each sample was dissolved in 10 ml distilled water, agitated, and left to stand for 30 min at room temperature. Each sample was centrifuged, and the supernatant recovered. 2.5 ml of the supernatants were transferred into 50 ml volumetric flasks. Similarly, 2.5 ml of standard tannic acid solution was measured into a separate 50 ml flask. A 1.0 ml Folin-Denis reagent was measured into each flask followed by 2.5 ml of saturated Na_2CO_3 solution. The mixture was diluted to 50 ml in the flask and incubated for 90 min at room temperature. The absorbance of each sample was measured at 250 nm with the reagent blank at zero. The % tannin was calculated by the difference in absorbance against calibration graph.

DETERMINATION OF AMINO ACID PROFILE

The amino acid profiles were determined using the methods described by Spackman *et al.* [8]. The samples were dried to constant weight, defatted, hydrolysed and evaporated in a rotary evaporator. They were then loaded into the Technicon Sequential Multi-Sample Amino Acid Analyser (TSM).

DEFATTING SAMPLE

A known weight of the sample was weighed into extraction thimble and the fat was extracted with chloroform/methanol (2:1 volume/volume mixture) using Soxhlet extraction apparatus as described by AOAC [4]. The extraction lasted for 15 hours.

NITROGEN DETERMINATION

A small amount (200 mg) of ground samples was weighed, wrapped in Whatman filter paper (No.1) and put in a Kjeldhal digestion flask. Concentrated sulphuric acid (10 ml) was added. Catalyst mixture (0.5 g) containing sodium sulphate (Na_2SO_4), copper sulphate ($CuSO_4$), and selenium oxide (SeO_2) in ratio of 10:5:1, was added into the flask to facilitate digestion. Anti-bumping granules (4 pieces) were added.
The flask was then put on Kjeldhal digestion apparatus for 3 hours until the liquid turned light green, the digested sample was cooled and diluted with distilled water to 100 ml in standard volumetric flask. A 10 ml aliquot of the diluted solution with 10 ml of 45% sodium hydroxide added was put into the Markham distillation apparatus and distilled into 10 ml of 2% boric acid containing 4 drops of bromocresol green or methyl red indicator until about 70 ml of distillate was collected.
The distillate was then titrated against standardised 0.01 M hydrochloric acid until a grey coloured end point. The percentage nitrogen in the original sample was calculated using the formula:

$$\text{Percentage Nitrogen} = \frac{(a-b)x0.01x14xVx100}{WC}$$

Where:
a = Titre value of the digested sample
b = Titre value of the blank sample
V = Volume after dilution (100ml)
W = The dried sample weight (mg)
C = 10 ml aliquot of the sample
14 mg = Nitrogen constant in mg
100 = Conversion factor to percentage

RESULTS AND DISCUSSION

The effects of gamma radiation on the proximate composition of "egusi" melon seeds are presented in Table I. A decrease in moisture content is observed for all treatments. This reduction is however negligible. This agrees with the observations made by Rady *et al*. [9] who reported that gamma radiation has little effect on moisture content of oil seeds. Minimal changes were also observed in the fat contents of the samples. This is also in line with the findings of Siddhuraju *et al.* [10] and Seda *et al*. [11] on different plant materials. There were great increases in crude fibre contents of the treated seed in contrast to the report of Bhat *et al.* [12] who reported a decrease in crude fibre and ash contents of velvet bean seeds when irradiated.
Table II shows the effects of gamma radiation on the functional properties of "egusi" melon seeds. Oil absorption capacity was slightly reduced when irradiated at 5KGy but increased as the dosage was increased to 10KGy. Abu *et al.* [13] reported that the oil absorption capacity of Cowpea seeds was not affected at low doses (2KGy). Water absorption capacity improved slightly at the 5KGy irradiation level

Table II - Effect of gamma irradiation on functional properties of melon (Egusi) seeds

Tests	Raw	Cooked	C+I	10KGy	5KGy
E.C(%)	34.00 ± 0.12^{d}	38.00 ± 0.13^{b}	36.00 ± 0.12^{c}	40.34 ± 0.68^{a}	36.00 ± 0.12^{c}
L.G.C(%)	6.34 ± 0.48^{a}	6.34 ± 0.48^{a}	6.34 ± 0.48^{a}	6.34 ± 0.48^{a}	6.34 ± 0.48^{a}
F.C(%)	10.03 ± 0.23^{b}	2.20 ± 0.36^{d}	8.54 ± 0.63^{c}	12.82 ± 0.34^{a}	8.54 ± 0.25^{c}
W.A.C(ml/100g)	120.00 ± 0.12^{d}	140.00 ± 0.12^{c}	200.00 ± 0.12^{b}	300.00 ± 0.12^{a}	140.00 ± 0.12^{c}
O.A.C(ml/100g)	320.01 ± 0.12^{a}	205.00 ± 0.12^{c}	115.00 ± 0.12^{d}	310.00 ± 0.12^{b}	104.96 ± 0.06^{e}

Values are expressed as means ± Standard Deviation
Means in the same row with different superscripts are significantly different (*P≤ 0.05*)
Keys: E.C = Emulsion capacity; L.G.C = Least gelation capacity; F.C = Foaming capacity; C+I = Cooked and irradiated 10kGy; W.A.C = Water absorption capacity; O.A.C = Oil absorption capacity

Table III - Effect of gamma irradiation on minerals of Egusi melon (mg/100g)

Tests	Raw	Cooked	C+I	10KGY	5KGY
K	14.93 ± 0.01^{e}	25.38 ± 0.01^{a}	22.65 ± 0.01^{c}	20.88 ± 0.01^{d}	22.83 ± 0.02^{b}
Na	1.71 ± 0.02^{e}	2.50 ± 0.02^{b}	2.27 ± 0.06^{c}	2.01 ± 0.04^{d}	2.61 ± 0.01^{a}
Ca	5.58 ± 0.02^{e}	12.84 ± 0.04^{a}	11.57 ± 0.04^{b}	6.81 ± 0.01^{d}	8.50 ± 0.01^{c}
Mg	3.30 ± 0.03^{e}	5.04 ± 0.01^{a}	4.47 ± 0.01^{c}	4.08 ± 0.02^{d}	4.98 ± 0.03^{b}
Zn	4.70 ± 0.01^{a}	3.36 ± 0.05^{c}	3.07 ± 0.03^{d}	3.48 ± 0.02^{b}	3.03 ± 0.02^{e}
Fe	1.58 ± 0.04^{d}	1.32 ± 0.13^{e}	1.70 ± 0.15^{c}	2.67 ± 0.03^{a}	2.26 ± 0.01^{b}
P	2.71 ± 0.01^{e}	3.57 ± 0.15^{b}	3.23 ± 0.02^{d}	3.32 ± 0.01^{c}	4.18 ± 0.02^{a}

Values are expressed as means ± Standard Deviation
Means in the same row with different superscripts are significantly different (*P≤ 0.05*)
Key: C+I = Cooked and irradiated at 10kGy

and was greatly increased at 10KGy irradiation levels. This may be due to an exposure to non-polar protein sites as reported by Zayas [14]. Gamma irradiation increased the emulsion capacity of "egusi" melon. The variations in emulsion properties may be attributed to protein aggregation as well as surface hydrophobicity which affect emulsifying properties in different ways [15]. No significant changes were observed in the least gelation capacities of both cooked and irradiated sample of "egusi" melon.

In Table III, there was an increase in the mineral contents of the treated "egusi" melon samples after treatment with the cooked sample having the highest values except in the case of Iron where the cooked sample had the least content. Generally, "egusi" melon seeds treated with the lower irradiation dose of 5KGy had higher mineral contents compared to those treated with the higher dose (10KGy). This is in accordance with the findings of Hassan *et al.* [16] who reported an increase in the mineral contents of maize and sorghum after irradiation.

Table IV shows the amino acids contents of raw and processed melon seeds while Table V shows the percentage compositions of different types of amino ac-

Table IV: Effect of gamma irradiation on the Amino acids of melon (Egusi). (mg/g protein)

Tests	Raw	Cooked	C+I	10KGY
LYSINE	3.71 ± 0.13^{b}	4.20 ± 0.21^{a}	2.91 ± 0.18^{c}	3.98 ± 0.18^{ab}
HISTIDINE	2.08 ± 0.22^{b}	2.80 ± 0.23^{a}	1.75 ± 0.05^{b}	2.52 ± 0.13^{a}
ARGININE	7.16 ± 0.23^{c}	8.35 ± 0.16^{b}	8.86 ± 0.06^{a}	8.01 ± 0.08^{b}
ASPARTIC ACID	6.43 ± 0.21^{b}	9.73 ± 0.10^{a}	9.44 ± 0.21^{a}	9.67 ± 0.16^{a}
THREONINE	2.76 ± 0.15^{b}	3.12 ± 0.20^{b}	3.67 ± 0.12^{a}	2.90 ± 0.21^{b}
SERINE	2.88 ± 0.24^{c}	3.57 ± 0.18^{b}	4.76 ± 0.17^{a}	3.19 ± 0.31^{c}
GLUTAMIC ACID	14.26 ± 0.23^{b}	13.63 ± 0.14^{c}	16.88 ± 0.21^{a}	13.83 ± 0.18^{c}
PROLINE	2.98 ± 0.17^{c}	3.65 ± 0.18^{b}	4.46 ± 0.17^{a}	3.20 ± 0.20^{c}
GLYCINE	3.71 ± 0.20^{b}	4.99 ± 0.22^{a}	4.09 ± 0.26^{b}	4.60 ± 0.13^{a}
ALANINE	3.64 ± 0.22^{c}	4.10 ± 0.21^{b}	4.68 ± 0.18^{a}	3.91 ± 0.17^{bc}
CYSTINE	1.07 ± 0.16^{a}	1.40 ± 0.19^{a}	1.53 ± 0.22^{a}	1.33 ± 0.24^{a}
VALINE	4.48 ± 0.19^{b}	5.01 ± 0.16^{a}	3.21 ± 0.23^{c}	5.01 ± 0.23^{a}
METHIONINE	0..95 ± 0.25^{a}	1.26 ± 0.23^{a}	1.31 ± 0.24^{a}	1.10 ± 0.18^{a}
ISOLEUCINE	3.65 ± 0.18^{b}	3.99 ± 0.09^{ab}	4.34 ± 0.18^{a}	3.96 ± 0.14^{ab}
LEUCINE	5.73 ± 0.13^{b}	6.22 ± 0.11^{a}	5.01 ± 0.09^{c}	6.02 ± 0.22^{ab}
TYROSINE	2.43 ± 0.21^{b}	2.74 ± 0.06^{b}	4.36 ± 0.14^{a}	2.75 ± 0.23^{b}
PHENYLALANINE	3.90 ± 0.22^{b}	4.11 ± 0.10^{b}	5.25 ± 0.32^{a}	3.98 ± 0.19^{b}

Values are expressed as means ± Standard Deviation
Means in the same row with different superscripts are significantly different (*P ≤ 0.05*)
Key: C+I = Cooked and irradiated at 10kGy

Table V - Summary of amino acids composition of the total Egusi melon fractions

Amino acid	Raw	Cooked	C+I	10KGy
Total Amino Acid (TAA)	71.82	82.87	86.51	79.96
Total Essential Amino Acid (TEAA)	37.92	43.2	42.2	41.56
TEAA/TAA (%)	52.79	52.12	48.78	51.97
Total Non-Essential Amino Acid (TNEAA)	33.9	39.67	44.31	38.4
Total Sulphur Amino Acid (TSAA)	4.78	2.66	2.84	2.43
% Cystine (TSAA)	22.38	47.36	46.12	45.26
Total Aromatic Essential Amino Acid phe.+tyr. (ArEAA)	6.3	6.85	9.61	6.73
Total Acidic Amino Acid (TAAA) % Glu.+ Asp.	28.8	28.18	30.42	29.38
Total Basic Amino Acid (TBAA) % Lys. +Arg. + Hist.	18.03	18.52	15.62	18.14
Total Neutral Amino Acid (TNAA) %	58.27	61.26	60.61	60.93
Ratio of TEAA **:** TNEAA	1.1	1.1	0.8	1

Table VI - Effect of gamma irradiation on the Anti-nutritional factor of Egusi melon (g/100g)

Tests	Raw	Cooked	C+I	10KGy	5KGy
OXALATE	0.04 ± 0.01^{a}	0.01 ± 0.00^{c}	0.01 ± 0.01^{c}	0.02 ± 0.05^{b}	0.04 ± 0.00^{a}
TANNIN	0.09 ± 0.03^{a}	0.03 ± 0.02^{bc}	0.01 ± 0.02^{c}	0.04 ± 0.01^{b}	0.09 ± 0.01^{a}
PHYTATE	5.34 ± 0.12^{a}	4.58 ± 0.16^{c}	4.41 ± 0.12^{c}	4.87 ± 0.12^{b}	1.62 ± 0.12^{d}
PHATIC ACID	18.95 ± 0.02^{a}	16.48 ± 0.08^{b}	15.66 ± 0.06^{c}	17.30 ± 0.01^{b}	5.77 ± 0.02^{d}

Values are expressed as means ± Standard Deviation
Means in the same row with different superscripts are significantly different ($P \leq 0.05$)
Key: C+I = Cooked and irradiated

Table VII - Effect of gamma irradiation on physico-chemical properties of Egusi melon.

	Raw	Cooked	C+I	10kGy	5kGy
A.V (mgNaOH/g)	1.01 ± 0.07^{d}	1.08 ± 0.08^{d}	1.69 ± 0.02^{c}	1.92 ± 0.13^{b}	2.14 ± 0.07^{a}
S.V (mgNaOH/g)	304.02 ± 0.11^{c}	306.13 ± 0.06^{b}	307.03 ± 0.06^{a}	306.27 ± 0.06^{b}	306.08 ± 0.05^{b}
I.V (g/100g)	192.20 ± 0.12^{a}	164.31 ± 0.13^{b}	126.42 ± 0.11^{c}	101.01 ± 0.08^{e}	119.13 ± 0.08^{d}
FFA (% oleic acid)	0.52 ± 0.04^{c}	0.58 ± 0.17^{c}	0.79 ± 0.08^{b}	0.85 ± 0.09^{ab}	1.02 ± 0.10^{a}
P.V (mEq/kg)	21.30 ± 0.13^{c}	20.31 ± 0.09^{e}	20.72 ± 0.12^{d}	23.06 ± 0.14^{b}	25.11 ± 0.13^{a}

Values are expressed as means ± Standard Deviation
Means in the same row with different superscripts are significantly different ($P \leq 0.05$)
Keys: A.V = acid value, S.V = saponification value, I.V = iodine value, F.F.A = free fatty acid, P.V. = peroxide value

ids. The essential amino acids composition appears adequate making up about half of the total amino acids content of each "egusi" melon treatment. Lysine, being a limiting essential amino acid in plant proteins [17], is 3.71 mg/g in the raw sample, 4.20 mg/g in the cooked sample, 2.91 mg/g in the cooked and irradiated sample and 3.98 mg/g in the10kGy irradiated sample. Glutamic acid accounted for approximately 14%, 13%, 16%, and 13% of the total amino acid contents of raw, cooked, cooked and irradiated, as well as irradiated at 10kGy samples respectively. The concentrations of methionine were found to be the lowest of all the amino acids (0.95-1.31%). This confirms previous observations that sulphur-containing amino acid concentrations are not very high in most cereals and oilseeds [18]. In a 1997 study, Taha [19] found that glutamic acid, leucine and arginine were predominant among amino acids of soya protein, accounting for over 35% of the total amino acid content, whereas methionine and cystine accounted for only 2.5%. The study also showed that Lysine, Isoleucine, Phenylalanine, Valine, Tyrosine, Arginine and Histidine were significantly destroyed only by radiation doses of 20-40kGy. The small amino losses in this study might be a result of a radiation-induced splitting of peptide bonds with a formation of free radicals. It may also stem from deamination-decarboxylation of some of the amino acid linkages, followed by a chain of chemical reactions [20].

The effects of Gamma radiation on the antinutritional constituents of "egusi" melon are presented in Table VI. Irradiation significantly lessened phytic acid content. This agrees with the findings of Doudu *et al*. [21] who reported that cooking and irradiation caused significant reduction in phytic acid levels of sorghum. Using both treatments further reduced the phytate content. This reduction may be due to chemical degradation of phytate to the lower inositol phosphates and inositol by the action of free radicals produced by radiation [22]. Tannin and Oxalate contents were also decreased by cooking and irradiation. The combined treatment showed the greatest antinutrient reduction. Table VII shows the effect of Gamma radiation on the physico-chemical properties of "egusi" melon. The results indicate that cooking and/or irradiation caused a decrease in iodine value. For acid and peroxide values, the irradiated samples had higher contents to the non-irradiated ones. Similar findings were obtained by Zeb and Ahmed [23] who reported that the iodine value of sunflower and soybean

oil decreased significantly with high gamma radiation (15 and 20 KGy). The decrease in iodine value may be attributed to the engagement of the unsaturated fatty acid double bonds [24]. For saponification value, no significant differences were observed between the contents of the cooked and irradiated samples although all treatments showed a slight increase in value. This result is also in agreement with the report of Zeb and Ahmed [21]. In the tropics, where vegetable oils are the most commonplace dietary lipid, it has been observed that a free fatty acid (FFA) content of cooking oil within the limits of 0.0-3.0% is desirable [25]. The low levels of FFA in all the "egusi" melon seeds investigated indicate that the oils from these seeds are good and may store for long periods without going rancid.

CONCLUSIONS

Irradiation at doses 5KGy and 10KGy had no major adverse effect on the chemical composition of "egusi" melon seeds. The mineral and amino acid contents were also improved. Irradiation was effective in decreasing phytic acid and tannin contents of the seeds. However, susceptibility to oxidative rancidity of irradiated samples increased as irradiation dose increased. Low doses are recommended for better preservation and longer shelf life. This study has clearly demonstrated that gamma irradiation is a safe and successful method to preserve and improve the nutritional value of "egusi" melon seeds and enhance the properties of its oil.

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