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INFLUENCE OF THERMAL PROCESSING ON THE NUTRITIONAL COMPOSITION, AMINO ACID PROFILE AND SENSORIAL CHARACTERISTICS OF BISCUITS PRODUCED FROM WHEAT-DEFATTED MELON SEED FLOUR BLENDS

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ABSTRACT

The study was conducted to investigate the influence of thermal processing on the nutritional composition, amino acid profile and sensorial characteristic of biscuits produced from wheat flour-defatted melon flour blends from toasted and raw melon seeds. The melon seeds was toasted at 160^0 C for 20mins and the other portion left untreated. The treated and untreated melon seed was defatted using n-Hexane and grinded into flour. The flour from the defatted roasted and raw melon seed flour was incorporated with wheat flour at 4 percentage ratio (100:0, 95:5, 90:10, 80:20, 70:30) respectively. Nine (9) samples of biscuit was formulated with other ingredients to produce biscuits according to the standard method and subjected to statistical evaluation in complete randomized design using statistical Product for Social Services version 21. The means were separated using Duncan Multiple test range at ($p<0.05$). The inclusion of the defatted melon flour from the untreated (raw) and toasted melon significantly increased ($p<0.05$) the moisture (1.78-3.87 %), protein (13.47 to 21.05 %), ash (2.04 to 2.72 %), fat (9.34-12.73%) and reduced (74.92-56.86 %) carbohydrate content of the biscuits. The amino acid profile of the biscuits showed significant ($p<0.05$) difference. The amino acid values varied significantly ($p<0.05$) and showed increase with increase in the substitution of the defatted melon flour. The amino acid ranged from leucine (7.48 to 9.18 g/100 g), lysine (4.78-9.18 g/100g), Histidine (1.89-2.38 g/100g), Arginine (3.12-5.02 g/100g) and 10.48-12.80 g/100g in glutamic acid respectively. The physical analysis showed significant ($p < 0.05$) difference among the biscuit samples. The study showed that substitution of wheat flour with defatted raw and toasted defatted melon flour at a ratio of 95:5 and 90:10 yielded the most acceptable biscuits in all the sensory attributes assessed. This implies that biscuits produced from this composite blend contain sufficient amounts of protein, fat, fiber and carbohydrate. Hence, they can serve as relief for malnutrition.

1.Introduction

Biscuit is a term used for a diverse variety of baked products, commonly a flour based food product which is dry and flat and unleavened, usually savory and sweet, it could be combined with sugar, chocolate, honey etc. It is one of the ready-to-eat, cheap and convenience food product that is consumed among all age groups in many countries of the world (Iwegbue, 2012). This fact is reinforced by a research done by Nielsen which puts biscuits as the fourth most consumed snack in the world (Ferdman, 2019). Many of its, attractive features includes a wider consumption base, relatively long shelf life, greater convenience and good eating quality makes it good for enrichment (Hooda and Jooda, 2005). The growing interest in this type of bakery product is due to their better nutritional properties and the possibilities. Currently, the production of baked product has been centered on wheat as a major raw material and it is considered nutritionally poor, as cereal proteins are deficient in essential amino acids such as lysine and threonine (Dhingra and Jood 2001). Biscuits are predominantly based on refined wheat flour (RWF) and the blending of RWF with oilseed such as defatted egusi seed flour might elevate the protein nutritional quality.

Wheat flour (*Triticum aestivum*. L) is the major ingredient for production of baked products such as biscuit and it contributes more than 50% of the entire calorie intake across the world (Masood et al., 2020). The entire grain is rich in nutrients such as minerals, protein (8–16%), fat (1–3%) and fiber (12–15%) (Senya, Kwaatermaa and Sitsofe, 2021). The cereal is uniquely rich in methionine and cysteine but lacks lysine and threonine (Peluola-Adeyemi *et al*., 2021). It is known that legumes like soybean, cowpea, African yam bean, bambara nut and velvet bean impart significantly the mineral, protein and B-complex vitamin needs of people in developing countries (Adeyanju et al., 2021). Thus, wheat flour supplementation with low-cost staples, from different legumes, cereals, roots and tubers will contribute in enhancing the nutritive quality of wheat products (Urigacha, 2020). Notably, the consumption of biscuits in many countries is increasing due to urbanization but is faced with the problem of being deficient in protein and certain micronutrients, and high cost of wheat importation in many countries resulting in the high cost of biscuits (Mudau et al., 2021).

Citrullus colocynthis commonly known as the Egusi melon is a member of the Cucurbitaceae family and the biological ancestor of watermelon, now found all over the world. Its origin is from West Africa. It's an important food crop in Nigeria and other Africa countries. It is grown for the seed which is rich in protein and used in preparing assorted dishes, especially soups. It contains 50% oil and 35% protein (Jack, 1972), the seeds have both nutritional and cosmetic importance. The seeds contain vitamin C and B2, minerals, riboflavin, fat, carbohydrates and protein (Lazos, 1986). .

The nutrient density of egusi seed which comprises nearly 50% w/w edible oil and 30% w/w pure protein makes it a functional food (Iwuoha and Eke, 1996). Traditionally, this oil seed has been processed by boiling in salted water, or roasting and then ground to be used as food thickener. Aside, its function as a thickener, the oil can be expelled and used for domestic purpose and also find application industrially. This oil are nutritious and expensive, and are used in homes for cooking and cosmetics purposes and of interest to pharmaceutical industries (Ayodele *et al*., 2013).

Locally, the residue from the oil after extraction is made into balls, fried to produce local snack, or is used as cattle feed (Schipper *et al*., 2000). In many parts of Africa, where farmers lack access to meat or dairy, the high oil and protein content can make an excellent dietary supplement (Jacob *et al*., 2015). The use of this locally available, nutritious feed stuff as a means of dietary diversification has been a continuous effort by researchers in combating the menace of micronutrient deficiencies and functional composition of the food crops. Nonetheless, information of the nutritive value of such local foodstuffs and ingredients is also necessary in order to encourage the consumption and its cultivations (Manpreet and Sharma, 2017).

Food product enrichment is a reasonable method for treating appropriate dietary deficiencies, which improves health and prevents chronic diseases. Numerous studies have been carried out around the world on how to maximize the nutritional value of food products while keeping costs down (Achu *et al*., 2005; El-Adawy *et al*., 2001; Rangel *et al*., 2003). Significant consideration has been given to enrich wheat flour products with high proteins food from different protein sources like pulses, legumes and oilseed flour (Hoover, 1979).

Nevertheless, having these effects, indigenous people from different groups who grow the egusi melon seed have limited the utilization of this highly nutritious and proteinous feedstuff only to pepare egusi soup. The Egusi oil, which contains a large amount of omega-6 fatty acids, likewise its defatted meal which is rich in protein has not found so much application in the food production (Bankole *et al*., 2005). There is therefore need, to assay the nutrient composition, amino acid profile and sensorial characteristics of wheat-defatted melon seed flour in baked goods like biscuits. This will improve its nutritive value, create variety and make it more affordable to consumers and to generate new information on wheat-defatted melon biscuits which is largely lacking.

2.0 Materials and methods

2.1. Material

Refined wheat flour (RWF-Honeywell ltd) and the Dehulled egusi seeds (*Citrullus Colocynthis sub spp mucosospermus*), shortening, baking powder, milk powder, salt, flavours and other general ingredients were procured from Ogige market in Nsukka Local Government Area of Enugu State. All chemical reagents used were procured from a pure analytical grade dealer.

2.1.1 Samples preparation

Dehulled egusi seeds (10 kg) were sorted to remove the foreign materials, chaff and damaged seeds as well as stones. The seeds were cleaned with water to further remove the dirts, dried in an oven at 50^{0}C for 24 hours to remove the moisture content. The clean and dried Egusi seeds were divided into 2 portion sizes of 5 kg each, and one portion was subjected to toasting and the other left as raw (control).

2.2. Methods

2.2.1 Processing of Toasted Egusi Flour (TEF)

The sorted cleaned dehulled Egusi seed (5 kg) were poured in a sauce pan and subjected to an open air heating at 100 - 140^{0}C for 30 minutes. The melon seed was stir until a golden colour was obtained using a wooden spoon to prevent burning. After toasting, the seeds were allowed to cool, milled using attrition milling machine into fine flour, packaged in a polyethylene bag and then kept in a cool dry place for further analysis.

2.2.2. Processing of Raw Egusi Flour (REF)

The finely cleaned melon egusi seed (5 kg) were grinded and packed in a polyethylene bag prior to use.

2.2.3. Processing of Defatted Egusi Flour

The method of Oniyeike *et al*. (1994), were adopted with slight modification. The toasted and raw egusi flour samples were defatted using solvent extraction apparatus for eight hours refluxing with n-hexane. After the extraction, the oil were collected in an air tight plastic container and the defatted flour were dried in an oven, milled into flour and stored in an airtight bag as defatted Toasted egusi flour and defatted Raw egusi flour. These were kept in a cool dry place for further analysis.

Table 1.Formulation of wheat-defatted melon flour.

Sample	Wheat	Defatted melon flour
A	95	5
B	90	10
C	80	20
D	70	30
E	95	5
F	90	10
G	80	20
H	70	30
I	100	0

2.3. Formulation of the Flour Blends

The Wheat and Defatted melon flour samples were formulated on the percentage ratio of (95:5; 90:10; 80:20; 70:30) for wheat with toasted and raw defatted melon flour respectively While the refined wheat flour (RWF) was used as control sample as shown in Table 1 below.

2.4.Recipe for the Biscuit Production

The recipe of Aliyu and Sani (2009) was adopted for the biscuit production. The raw materials used include refined wheat flour and defatted egusi flour (100 g), sugar (10 g), margarine (30 g), salt (2 g), sodium bicarbonate (1 g), water (50 g), milk (10 g), vanilla flavour (2 g). These were weighed appropriately and all the ingredients except flours were mixed thoroughly in a Kenwood mixer (a 3-speed hand mixer), it was then transferred to a bowl. The flours and baking powder were added with continuous mixing for 15 min until smooth dough was obtained. The dough were cut, placed on a clean platform then rolled out using rolling pin until the desired uniform texture and thickness is obtained. Cookies cutter were used to cut the sheet of the dough into required shapes and sizes. They were transferred on to a greased (with margarine) baking tray. The baking were done at a temperature of 180 - 200^{o} C, allowed to bake for 30 - 45 minutes. After baking, the hot cookies were removed from the pan and placed on a clean tray to cool down. The cookies were allowed to cool, the samples was then stored in polyethylene bag and kept in a shelf for further analysis and sensory evaluation.

2.5. Proximate Composition of the Biscuits

The moisture, crude protein, total ash, fat, crude fiber was determined described by AOAC (2012) and carbohydrate content was determined by difference as summarized : % Carbohydrate = 100 – (% moisture + % protein + % Ash + % Crude fibre). The energy value (kcal/100 g) was determined according to the method of Marero *et al.* (1998) was calculated by application of the thermal coefficients of Atwater and Rosa (1899). with 4 calories for 1g of proteins; 9 calories for 1 g of lipids and 4 calories for 1 g of carbohydrates.

The energy value (kcal /100 g) = (4 x Protein %) + (4 x Carbohydrate %) + (9 x fat %)

2.6. Determination of Amino Acid Composition

The amino acids composition of the samples was measured on hydrolysates using amino acids analyzer (Sykam-S7130, Tokyo, Japan) based on high performance liquid chromatography technique. Sample hydrolysates were prepared following the method of Moore and Stain (1963). About 200 mg of the sample was taken in a hydrolysis tube. Then 5 ml of 6 N HCl was added to the sample and the tube tightly closed and incubated at 110 ^{o}C for 24 h. After incubation, the solution was filtered and 200 ml of the filtrate was evaporated to dryness at 140oC for 1 h. The hydrolysates after dryness were diluted with 1.0 ml of 0.12 N citrate buffer (pH 2.2). Aliquot of 150 of the sample hydrolysate was injected in an action separation column at 130 ^{o}C. Ninhydrin solution and an eluent buffer (solvent A, pH 3.45 and solvent B, pH 10.85) were delivered simultaneously into a high temperature reactor coil (16 m length) at a flow rate of 0.7 ml/min. The buffer ninhydrin mixture was heated in the reactor at 130^{0} C for 2 min to accelerate chemical reaction of amino acids with ninhydrin. The products of the reaction mixture were detected at wavelengths of 570 and 440 nm on a dual channel photometer. The amino acids composition was calculated from the areas of standards obtained from the integrator and expressed as gm/100 gm protein.

2.7. Determination of the physical characteristic of the biscuits

Weight:

The weight of the cookies was determined according to the method of Ayo, Ayo, Nkama, and Adeworie (2007). The weights of cookie samples were determined with the aid of a weighing balance (model) immediately after cooling.

Diameter:

The diameter (D) of the cookies was determined according to the method of AACC (2000). Four cookies were placed edge to edge and their total diameter was measured with the aid of a ruler. The cookies were rotated at angles of 90° for duplicate reading. The experiment was repeated twice and average diameter was recorded in millimeter.

Thickness:

The thickness of the cookies was determined according to the method of Ayo et al. (2007). The cookies thickness was measured with the aid of a digital vernier caliper with 0.01 mm precision.

Spread ratio

Spread ratio of the cookie samples was determined according to the method of Gomez et al. (1997). For spread ratio, two rows of four well-formed cookies were made and the height measured. They were arranged horizontally edge to edge and the sum of their diameters measured. The spread ratio was calculated as diameter divided by height.

Breaking strength

The breaking strength was determined according to the method described by Okaka and Isiehs (1997). Cookies of known thickness (0.4 cm) were placed centrally between two parallel metal bars (3 cm apart) and weights were applied until the cookies snapped. The least weight that caused the breaking of the cookies was regarded as the break strength of the cookies.

2.8. Sensory evaluation of the cookies

Sensory evaluation of the cookies was carried out according to the method described by Retapol and Hooker (2006). A panel of twenty members consisting of students and members of staff in Food Science and Technology Department, University of Nigeria, Nsukka was chosen based on their familiarity and experience with wheat-based cookies for sensory evaluation. Cookies produced from each flour blend, along with the reference sample were presented in coded form on white plastic plates and were randomly presented to the panelists. The panelists were provided with portable water to rinse their mouth between evaluations. However, a questionnaire describing the quality attributes (colour, taste, flavour, crispiness and overall acceptability) of the cookies was given to each panelist. The panelist assigned scores for each parameter as against the maximum score of 9. Each sensory attribute was rated on a 9-point hedonic scale (1 = dislike extremely and 9 = like extremely).

2.9. Statistical analysis

Data obtained were subjected to appropriate statistical analysis (ANOVA) using a statistical package for the Social Sciences, SPSS (version 16). Mean separation was done using Duncan multiple range test and significance difference was accepted at 5% confidence level.

3.Result and Discussion

The result of the proximate composition of the wheat-defatted melon seed biscuits is shown in Table 2. Moisture, protein, fat, ash and carbohydrate contents of the flour samples ranged from 1.78-3.87 %, 11.13 – 13.19 %, 1.74 -2.72 %, 11.14 -21.05 % and 56.86 – 74.92 % respectively. The moisture content of the biscuits samples incorporated defatted raw and toasted melon flour with wheat showed a significant ($p<0.05$) difference among the samples. The significant increase was observed in the moisture level with increase in the incorporation of the defatted flour sample from raw and toasted melon. Sample D had the highest value (3.87 %) while sample E has the least moisture value (1.78 %). The moisture value as observed in the study was lower when compared with the moisture value (6.25 – 10.0 %) reported by Peter-Ikechukwu *et al*. (2016) for biscuit from wheat blend with toasted watermelon flour. The moisture content of the samples were all within the acceptable range of (<14 %) for shelf stability. Sample D (70:30 % wheat: defatted raw melon flour) had the highest value of protein 21.05 % while sample E (95:5 % wheat:defatted toasted melon flour) has the least (11.74 %) protein content. There was a significant ($p<0.05$) increase in the protein content with incorporation of the defatted melon seed flour. This is expected as defatted melon flour has been reported to contain 60 % dry weight basis of protein (El-Adawy and Taha, 2001; Ojieh et al., 2007).

The highest ash content of the biscuits (2.72±0.03 %) were record in sample D (wheat 70 % + defatted raw melon flour 30%) and the lowest ash content (1.74±0.01 %) was recorded for sample F (wheat 90% + 10 % defatted toasted melon flour). The lower percentage of ash content as observed with the biscuits from the blends of defatted toasted biscuits could be attributed to toasting treatment effect.

Table 2. Proximate composition of wheat- defatted raw and toasted melon seed flour blend biscuits

SAMPLE	MC (%)	ASH (%)	FAT (%)	PROTEIN (%)	CRUDE-FIBRE (%)	CHO (%)	ENERGY (Kcal)
A	1.91± 0.05[e]	2.52± 0.05[b]	11.13± 0.08[e]	14.29± 0.13[e]	0.99± 0.13[e]	69.18± 0.08[c]	434.03± 0.11[d]
B	2.21± 0.01[d]	2.16± 0.06[d]	11.36± 0.06[e]	16.55± 0.19[c]	1.22± 0.02[d]	66.52± 0.04[e]	434.44±. 05[d]
C	3.29± 0.03[b]	2.07± 0.04[d]	11.64± 0.05[d]	17.08± 0.08[b]	1.33± 0.04[c]	64.60± 0.06[f]	431.44± 0.33[e]
D	3.87± 0.11[a]	2.72± 0.10[a]	12.66± 0.16[b]	21.05± 0.23[a]	2.85± 0.07[a]	56.86± 0.06[h]	425.54± 0.21[g]
E	1.78± 0.04[f]	1.74± 0.01[e]	9.34±0. 10[f]	11.14± 0.08[g]	1.09± 0.01[e]	74.92± 0.13[a]	428.28± 0.69[f]
F	2.36± 0.02[c]	1.83± 0.04[e]	11.82± 0.16[d]	11.29± 0.04[g]	1.11± 0.01[e]	71.61± 0.25[b]	437.94± 0.55[b]
G	2.39± 0.08[c]	2.36± 0.06[c]	12.73± 0.10[b]	14.32± 0.16[e]	1.30± 0.01[c]	66.92± 0.23[d]	439.51± 0.58[a]
H	3.19± 0.03[b]	2.50± 0.03[b]	13.19± 0.18[a]	15.98± 0.12[d]	1.64± 0.05[b]	63.51± 0.35[g]	436.65± 0.72[c]
I	3.22± 0.04[b]	2.04± 0.04[d]	12.32± 0.12[c]	13.47± 0.12[f]	0.11± 0.06[f]	68.86± 0.06[c]	440.12± 0.86[a]

Values are means ± SD of duplicate analysis. Means in the same column having same superscript are not significantly different (p>0.05). Key. Sample A 95:10 % Wheat:Raw defatted melon seed; Sample B 90:10 Wheat: Raw defatted melon seed,; Sample C 80:20 % Wheat :Raw defatted melon seed, Sample D 70:30 % Wheat :Raw defatted melon seed, Sample E 95:10 % Wheat:toasted defatted melon seed; Sample F 90:10 Wheat: Toasted defatted melon seed,; Sample G 80:20 % Wheat :Toasted Defatted melon seed, Sample H 70:30 % Wheat :Raw defatted melon seed, sample I 100% wheat flour watermelon.

Fat contents of the biscuits were observed to be increasing with increase percentage of the defatted melon flour and were significantly different (p<0.05) from the control sample I (100% wheat flour). The fat contents range 11.13 - 13.19 % obtained from this study was lower than the fat contents ranges of 25.08 to 30.79 % reported by Bolarinwa et al (2016) for malted sorghum-soy biscuits and (19.32 – 21.50 %) presented by Orafa et al. (2023) for acha-based biscuits incorporated with defatted melon seed, but were higher than the fat content (5.20 – 6.36 %) of cookies produced from cocoyam, sorghum and pigeon pea as reported by Okpala and Okoli (2011). The increase in fat with increase defatted melon flour shows that it is a good source of energy to human body. Fat and oil provides twice as carbohydrate on weight-weight basis (Iwe 2000). Increase in the level of flour inclusion increased the crude fibre content and were significantly (p<0.05) different.

The crude fibre content increased from 0.99 to 1.64 %. This increase could be attributed to the relative fibre content in defatted melon seed flour as Ojieh et al. (2007) reported a fibre content of (12.0 %) in melon seed. A decrease in the carbohydrate content (CHO) from 74.92 to 56.86 % in biscuits from wheat:defatted raw and toasted melon flour blend respectively. This observation was similar to the report of Orafa et al. (2023).

The biscuit with 30 % defatted raw melon flour substitute has the lowest carbohydrate content (56.86 %) while the biscuit with 5 % defatted toasted melon flour sample had the highest (74.92 %) carbohydrate content. This shows that defatted melon seed flour is low in carbohydrate content. Carbohydrate are macronutrients such as starch, sugar and fibre found in food, provides the body with energy (Ojieh et al., 2007)

3.1. Physical properties of wheat- defatted raw and toasted melon seed flour biscuits

The results of the physical characteristic of the biscuits were reported in Table 3 below. The diameter, spread ratio, weight, diameter and break strength were significant (p<0.05). The diameter ranges from 7.02 – 9.02 mm respectively in sample blends from wheat: defatted raw and toasted melon flour. The sample E (95:5 % wheat flour + defatted toasted melon flour) had the highest diameter value of (9.02 mm) and the least diameter value (7.02 mm) was recorded in the sample A (95:5 wheat+ defatted raw melon flour) and where significantly different from the sample I (control :100 % wheat flour) of 7.18 mm. The biscuits showed a progressive decrease with increasing percentage of the defatted flour in the diameter of the biscuit. The diameter of the biscuits were increasing with increased substitution of the defatted melon flour. The resultant effect could be attributed to the reaction of the gluten network during dough handling causing a stretch in the dough and the spring back after baking, thereby resulting to a thicker biscuits with smaller diameter. The report of the diameter observed in this study were relatively lower with the ranges of (50.2 – 57.3 mm) reported by Ikuomola et al. (2017) for cookies from malted barley bran blends. Gernah et al. (2010) also reported a similar increasing trend for the diameter (38.90–40.20 mm) of cookies made from wheat-brewers spent grain flour blends. The increase in the diameter of biscuit could also be attributed to the soluble fibre content of the flour in its correlation to the water absorption capacity of the flour, because the higher WAC observed in this flour blends could suggest percentage of soluble fibre in the blends causing the intake of water and reduced release of water for sugar breakdown during baking.

Table 3. Physical parameter of wheat: defatted raw and toasted melon seed flour biscuits

Sample	Height (cm)	Diameter (cm)	Spread Ratio	Break strength (kg)	Weight (g)
A	7.02±0.01^{e}	16.55±0.71^{e}	2.26±0.03^{d}	2.05±0.07^{b}	6.89±0.07^{d}
B	7.85±0.04^{d}	20.06±0.04^{d}	2.70±0.21^{c}	2.20±0.00^{ab}	12.62±0.18^{c}
C	8.23±0.07^{c}	21.01±0.01^{c}	2.56±0.02^{c}	2.28±0.11^{a}	14.68±0.29^{b}
D	7.60±0.08^{d}	19.05±0.01^{d}	2.51±0.04^{c}	2.32±0.18^{a}	11.99±0.59^{c}
E	9.02±0.06^{a}	17.04±0.01^{e}	1.88±0.01^{d}	1.68±0.04^{c}	16.65±0.00^{a}
F	8.65±0.33^{b}	21.55±0.70^{b}	2.49±0.01^{c}	1.64±0.01^{c}	16.47±0.52^{a}
G	8.24±0.05^{c}	24.53±0.69^{a}	2.98±0.10^{a}	1.60±0.00^{c}	16.88±0.01^{a}
H	7.93±0.22^{d}	21.56±0.71^{b}	2.73±0.16^{bc}	1.61±0.01^{c}	16.63±0.10^{a}
I	7.18±0.04^{e}	21.01±0.01^{b}	2.93±0.01^{ab}	2.17±0.08^{ab}	14.31±0.21^{b}

Values are means ± SD of duplicate analysis. Means in the same column having same superscript are not significantly different (p<0.05).

The spread ratio (S.R) of the biscuits ranged from 1.88 to 2.98 and were significantly different (p<0.05) among the varied samples from blends. Sample E (95:5 % wheat-defatted toasted melon flour) had the lowest S.R value of (1.88), while sample G (80:20 % wheat-defatted toasted melon flour) had the highest S.R value (2.98), when compared with the value of (2.93) for the control sample I (100 wheat Flour). The incorporation of the defatted melon flour caused a significant (p<0.05) increase in the S.R values of the biscuits. The S.R values was inconsistent in the trend with increase of the defatted melon flour. This was also in line with the observations of Gbadamosi et al. (2011) who also reported an inconsistent trend in the spread ratio values of cookies produced from blends of wheat flour and African oil bean seed flour.

The Break Strength of the biscuits ranges from 1.60 – 2.32 kg in blends of wheat-defatted melon respectively. Sample D (70:30 % wheat-defatted raw melon flour blend) have the highest break strength while sample H (70:30 wheat-defatted toasted melon flour blend) had the least breaking strength (1.60 kg), when compared with the B.S value of (2.17 kg) recorded with the control sample. This study reveals that the processing affect the break strength of the biscuits as observed with biscuits with defatted toasted melon seed flour when compared to the biscuits from the wheat:defatted raw melon seed flour. These significant reduction as observed with samples from toasted blends could be attributed to the carbohydrate/starch content of melon flour been affected by the thermal processing, thereby resulting to the biscuit not to be as hard/strong like that of wheat.

3.2. Sensory score of the biscuits from wheat defatted raw and toasted melon seed flour blends

The result of the sensory score from the biscuits produced from blends of wheat and defatted raw melon seed is shown in **Table 4** below. There were significance differences ($p<0.05$) among the biscuit samples in their sensory attributes of colour, flavor, taste, crispness and overall acceptance.

The colour score ranged from 4.90 - 7.50 with sample H (containing 70% wheat flour: 30% defatted toasted melon flour) having the lowest colour of (4.90) and sample I (100% wheat flour control) having the highest colour score (7.50) among the samples. The values obtained in the colours for the biscuit were above the poor rating when compared with the control sample. Colour is an important attribute in consumption of food and a significant parameter in judging well baked biscuits. It reflects the suitable raw material used for the preparation and also provides information about the formulation and quality of the product (Oyet and Chibor, 2020). There was a significant low score in colour observed for biscuits from blends with 30 % defatted raw and toasted melon seed flour substitution. This shows that at 30 % inclusion the biscuit was not acceptable by the panelist.

The flavour score of biscuits from defatted melon of raw and toasted melon flour and 100% wheat flour shows significant ($p<0.05$) difference. The flavor score ranged from 4.25 in sample containing sample D and 7.05 for sample I (100 % wheat flour). Increase in the percentage level of the flour reduced the flavor attribute. The 30 % inclusion of the defatted melon seed flour did not have a high acceptance in the flavor.

Table 4. Sensory score of wheat- defatted raw and toasted melon seed flour biscuits

Sample	colour	Flavour	Taste	Crispiness	General Acceptance
A	6.80 ± 1.01^{ab}	6.70 ± 1.56^{ab}	6.65 ± 2.13^{bc}	6.35 ± 1.69^{ab}	7.00 ± 1.38^{ab}
B	6.70 ± 1.63^{ab}	7.05 ± 1.23^{a}	7.25 ± 1.71^{a}	7.10 ± 1.48^{ab}	7.75 ± 1.41^{as}
C	6.50 ± 1.43^{abc}	5.65 ± 1.53^{bc}	6.20 ± 1.74^{abc}	6.60 ± 0.94^{ab}	6.60 ± 1.60^{ab}
D	5.45 ± 1.96^{cd}	4.25 ± 1.86^{d}	4.50 ± 2.04^{d}	5.10 ± 1.97^{c}	5.05 ± 2.09^{c}
E	6.95 ± 1.61^{ab}	6.10 ± 2.05^{abc}	6.85 ± 1.93^{ab}	7.25 ± 1.37^{a}	7.15 ± 1.63^{ab}
F	7.05 ± 1.47^{ab}	6.05 ± 2.04^{abc}	6.50 ± 1.99^{ab}	6.40 ± 1.73^{ab}	6.85 ± 1.50^{ab}
G	5.95 ± 1.64^{bcd}	5.55 ± 1.70^{bc}	5.55 ± 1.88^{bcd}	6.75 ± 1.71^{ab}	6.00 ± 1.56^{bc}
H	4.95 ± 2.24^{d}	4.90 ± 2.45^{cd}	4.95 ± 2.42^{cd}	6.05 ± 1.82^{bc}	5.30 ± 2.32^{c}
I	7.60 ± 1.47^{a}	6.80 ± 1.91^{bc}	7.00 ± 2.25^{a}	6.95 ± 1.64^{ab}	7.40 ± 1.47^{a}

Values are means ± SD of duplicate analysis. Means in the same column having same superscript are not significantly different ($p<0.05$).

Table 5. Amino acid composition of biscuits from wheat: defatted melon flour

	Samples							
Amino acids (g/100g)	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
Leucine	8.18±0.01^{c}	8.57±0.04^{d}	8.61±0.00^{d}	9.18±0.02^{e}	7.48±0.04^{a}	7.78±0.31^{b}	7.95±0.07^{b}	8.85±0.07^{d}
Lysine	3.45±0.01^{a}	3.94±0.01^{c}	3.95±0.03^{c}	4.33±0.04^{d}	3.67±0.04^{c}	3.67±0.04^{b}	3.96±0.06^{c}	4.78±0.04^{e}
Iso- leucine	3.09±0.01^{a}	3.19±0.01^{a}	3.09±0.01^{a}	3.47±0.01^{b}	3.93±0.04^{d}	3.56±0.06^{c}	4.16±0.34^{d}	4.08±0.03^{d}
Phenylanin	3.20±0.01^{a}	3.39±0.02^{b}	3.39±0.02^{b}	3.46±0.00^{b}	3.86±0.06^{d}	3.15±0.06^{a}	3.67±0.05^{c}	4.00±0.01^{e}
Tryptophane	0.80±0.01^{a}	0.90±0.01^{b}	0.88±0.01^{b}	0.98±0.04^{c}	0.99±0.02^{c}	0.87±0.04^{b}	1.03±0.01^{c}	1.21±0.01^{d}
Valine	3.21±0.02^{a}	3.70±0.14^{d}	3.53±0.03^{b}	3.81±0.01^{d}	3.68±0.04^{c}	3.08±0.01^{a}	3.60±0.01^{c}	3.97±0.03^{a}
Methonine	1.29±0.01^{a}	1.46±0.02^{b}	1.36±0.02^{a}	3.50±0.07^{g}	2.17±0.04^{e}	1.68±0.03^{c}	2.04±0.01^{d}	2.29±0.02^{e}
Arginine	4.23±0.03^{c}	4.44±0.05^{d}	4.42±0.04^{d}	3.12±0.03^{a}	4.85±0.07^{e}	4.08±0.03^{b}	4.77±0.05^{e}	5.02±0.04^{f}
Trytosine	2.91±0.01^{a}	2.92±0.02^{a}	3.35±0.35^{b}	3.20±0.14^{ab}	4.17±0.05^{c}	3.46±0.02^{b}	3.79±0.01^{c}	4.40±0.14^{d}
Histidine	1.89±0.01^{a}	2.07±0.03^{c}	2.00±0.00^{b}	2.17±0.04^{d}	2.16±0.02^{d}	1.91±0.01^{a}	2.27±0.05^{e}	2.38±0.03^{f}
Cysteine *NEAA	1.18±0.04^{a}	1.29±0.02^{bc}	1.23±0.03^{ab}	1.37±0.05^{d}	1.29±0.02^{bc}	1.21±0.01^{ab}	1.40±0.01^{d}	1.56±0.06^{e}
Alanine	3.23±0.04^{a}	3.50±0.01^{b}	3.30±0.00^{a}	3.97±0.04^{c}	3.65±0.07^{b}	3.21±0.02^{a}	3.86±0.04^{c}	4.27±0.18^{d}
Proline *NEAA	3.17±0.02^{b}	3.37±0.02^{c}	3.37±0.02^{c}	4.86±0.06^{e}	2.97±0.04^{a}	3.18±0.04^{b}	3.38±0.04^{c}	3.53±0.04^{d}
Methonine	1.29±0.01^{a}	1.46±0.02^{b}	1.36±0.02^{a}	3.50±0.07^{g}	2.17±0.04^{e}	1.68±0.03^{c}	2.04±0.01^{d}	2.29±0.02^{e}
Glutamic acid	12.80±0.01^{d}	12.25±0.08^{c}	12.07±0.04^{c}	13.31±0.19 e	10.48±0.04 a	10.50±0.14 a	11.39±0.26 b	11.43±0.10^{b}
Glycine	3.10±0.01^{a}	3.26±0.06^{b}	3.07±0.04^{a}	3.43±0.04^{c}	4.05±0.01^{f}	3.59±0.02^{d}	3.90±0.01^{e}	4.29±0.06^{g}
Threonine	2.58±0.04^{a}	2.96±0.06^{b}	2.94±0.05^{b}	3.03±0.01^{b}	3.72±0.40^{c}	3.19±0.02^{b}	3.68±0.11^{c}	3.78±0.04^{c}
Serine	3.58±0.04^{b}	3.65±0.35^{b}	3.26±0.06^{a}	3.79±0.01^{bc}	3.77±0.05^{bc}	3.56±0.06^{ab}	3.85±0.06^{bc}	4.02±0.03^{c}

Values are means ± SD of duplicate analysis. Means in the same column having same superscript are not significantly different ($p<0.05$).

Key. Sample A 95:10 % Wheat:Raw defatted melon seed; Sample B 90:10 Wheat: Raw defatted melon seed,; Sample C 80:20 % Wheat :Raw defatted melon seed, Sample D 70:30 % Wheat :Raw defatted melon seed, Sample E 95:10 % Wheat:toasted defatted melon seed; Sample F 90:10 Wheat: Toasted defatted melon seed,; Sample G 80:20 % Wheat :Toasted Defatted melon seed, Sample H 70:30 % Wheat :Raw defatted melon seed, Flavor attributes is a pleasant desirable sensation by the panelist from every food produced. The flavor score of all the samples both the raw boiled and toasted samples showed a high score expect those with 30% inclusion of the flour.

The taste score shows significant ($p<0.05$) differences among the biscuits samples. Sample M (containing 100 % wheat flour) had the highest and most acceptable taste score of (7.25) and sample D (containing 30% raw defatted melon flour) had the least score of 4.50.

All the samples had a good taste rating score except for sample D (containing 30 % defatted raw melon flour) and sample L (containing 30 % defatted toasted melon flour) having 5.0 score rating. This shows that 30% inclusion of this flour affected the taste score of the products on preferential scaling but was not totally poor in acceptance. Taste is the primary factor that determines the acceptability of any product which has the highest impact as far as market success of product is concerned (Feyera, 2019).

3.3.Amino acid composition of biscuits

Table 5 shows the amino acid composition of biscuits from wheat:defatted raw and melon seed flour

There were significant ($p<0.05$) difference in the amino acid profile with biscuits sample. The leucine content ranged from (7.48 g/100g) in sample E to (9.18 g/100g) in sample D and was significantly ($p<0.05$) higher than other samples. Sample H (70:30 wheat-defatted toasted melon seed flour) had the highest lysine content (4.78 g/100g) while sample A (95:5 wheat-defatted raw melon flour) had the least Lysine value (3.45 g/100g). The high percentage of lysine recorded with sample from wheat blend with defatted toasted melon flour reveals that toasting treatment improved the lysine content when compared to the sample from defatted raw melon flour, and where significantly ($p<0.05$) increasing with increase in the defatted melon flour. Lysine is essential for children as its critical for bone formation, production of hormone, also helps to lower the serum triglyceride levels (Gersten, 2013). The value of lysine reported was relatively closer to the values of 3.35-5.07 g/100g reported by Oyet and Chibor (2020). The phenyl-lanine content of the composite biscuit showed an increase with substitution and ranges from 3.15 -4.00 g/100g. There was a significant ($P<0.05$) increase in the Arginine content and ranges from 3.12-5.02 g/100g, tyrosine (2.92 – 4.40 g/100g), Histidine content of the biscuits samples, 1.89- 2.38 g/100g). In this study, glutamic acid was observed to be the most abundant amino acid ranges from 10.48 to 12.80 g/100g. There was a significant ($p<0.05$) decrease in the glutamic acid of biscuits toasted, while there was observed increase with percentage increase of the raw defatted flour. The high value of glutamic acid observed shows that citrullus coloythnis seed is abundant, when compared with other amino acid value and this is in agreement with Ogunmodimu *et al*. (2015) that plant-base foods are most predominant in this amino acid. The effect of processing like toasting and defatting did not actually affect the amino acid profile of the biscuit but rather enhanced it.

4.Conclusion

The results vividly showed that it could be possible to produce nutritious and acceptable cookies through the substitution of wheat flour with defatted melon flour. The high protein, ash and fibre contents of cookies made from wheat: defatted raw and toasted melon seed flour as well as the acceptability of the composite cookies attested to this fact. The amino acid profile of the biscuits were improved and were significantly high in the essential amino acids. The processing of toasting did not actual affect the quality of the biscuits nutritionally. The results also showed that substitution from defatted raw and toasted melon seed flour did not alter the physical characteristics and consumer acceptability of the cookie samples especially at 5 – 20 % substitution level were preferred both in colour, Taste, flavor and general acceptabilty. Conclusively, the study actually reveals that producing a biscuits from the wheat defatted melon seed could actually be adopted and incorporating at 5 – 20 % could help to substantially reduce foreign exchange on wheat importation and reduce wastage of the by-product, while improving the nutritional status of consumers.

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