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Physicochemical, functional, pasting and sensory properties of wheat flour biscuit incorporated with Okra powder

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Abstract
Evaluation of the physicochemical, functional, pasting properties and sensory characteristics on wheat flour biscuits incorporated with okra flour in ratio, (100%, 95:5%, 90:10%, 85:15%, 80:20% and 75:25%) were investigated using standard analytical methods. The biscuit samples were prepared using a standard production method to acquire the required thickness and baked in the oven at 200ºC for 20 minutes. Flour blends were evaluated for functional and pasting properties while the biscuit produced were analyzed for proximate composition and sensory qualities. Proximate analysis results showed significant ($p<0.05$) increase in protein (10.56-21.93%), Ash (0.91-4.17%), fiber (1.01-4.49%), while fat (17.90-20.791%), energy value (419.06-455.15kcal) and CHO (42.56-56.45%) decreased with inclusion of okra. The pH values (5.62-5.92) were not significantly different, but the titratable acidity shows a significant difference (0.13-0.32%). Functional properties analysis showed significant difference in water absorption, oil absorption, foaming capacity, emulsion capacity and emulsion stability. No significant differences ($p<0.05$) occur in bulk density values. Significant differences ($p<0.05$) occur in the sensory quality of the products due to the composite ratio, but they were however acceptable with high rating degree of likeness. Hence, acceptable biscuit from the composite of (wheat: okra flour blends) can be produced, which could enhance the nutritional wellness of the target consumers.

Keywords: biscuits, okra, wheat

1. Introduction

In recent times the consumption of food is not only for nutrition but also for health. Food development has advanced from ordinary combination of ingredients for improved nutritional status to development of healthy foods for healthy living (Functional foods). Snacks such as biscuits are ready to eat and are generally acceptable as a relief for short time hunger, or eaten between meals. Biscuits are widely accepted across the world and there are variety of biscuits from different sources and compositions [1, 2]. Biscuits could be a very good product for the addition of functional ingredients due to its long shelf life and wide acceptability between children where indigestion and constipation is prevalent and also owing to its sweet taste [3].

Okra *(Abelmoschus Esculentus)* is one of the most widely known and utilized species of the family *Malvaceae* [4] and an economically important vegetable crop grown in tropical and sub-tropical parts of the world [5, 6, 7]. Okra is a dietary fiber rich crop which helps in combating the onset on cancer, coronary diseases and brain dysfunction [8].

Okra has been called "a perfect villagers vegetable" because of its robust nature, dietary fiber and distinct seed protein balance of both lysine and tryptophan amino acids (unlike the proteins of cereals and pulses) [9, 10]. The amino acid composition of okra seed protein is comparable to that of soybean and the protein efficiency ratio is higher than that of soybean [11]. The amino acid pattern of the protein renders it an adequate supplement to legumes or cereal based diets [12]. Okra seed is known to be rich in high quality protein especially with regards to its content of essential amino acids relative to other plant protein sources [5]. Hence, it plays a vital role in the human diet [13].

Okra has been reportedly used to treat digestive issues. The polysaccharides present in immature okra pods possessed considerable anti-adhesive properties (i.e. they help remove the adhesive between bacteria and stomach tissue, preventing the cultures from spreading). Okra polysaccharides were particularly effective at inhibiting the adhesion of *Helicobacter Pylori*, a bacterium that dwells in the stomach and can cause gastritis and gastric ulcers if left unchecked. Therefore, eating more okra can keep the stomach clean and create an environment that prevents destructive cultures from flourishing [14].The fiber okra offers help to cleanse the intestinal system, letting the colon to operate at higher amounts of effectiveness. In addition, its Vitamin A plays a role in wholesome mucous membranes, assisting the digestive system to function adequately [15].

In previous studies, reports have been on the production of functional biscuits enriched with phenolics and anthocyanins extracted from grape marc [16]. Agu [17] reported on the inclusion of African breadfruit in wheat flour for biscuit production. Therefore in this study, the feasibility of supplementing wheat-flour based biscuits with protein and fibre rich flour from okra, in order to improve the nutritional value of this food type was examined.

The aim of this study is to formulate protein and fibre okra flour-incorporated wheat-flour-based biscuits which can be consumed as protein, dietary and micronutrient supplements required for normal and healthy living.

2. Materials

Wheat flour, Fresh mature green healthy okra (*Abelmoschus esculentus*) and other basic baking ingredients (baking fat (margarine), sugar, milk flavour, powdered milk, eggs, baking powder and salt) were procured at a local market in Ilaro, Ogun State. South West, Nigeria.

2.1 Preparation of Okra powder

The fresh matured green okra pods were washed under running portable water to remove dirts, cuts into thin slices of approximately 1.50 to 2.00 mm thickness, spread on a clean tray and dried in a vacuum oven at 45ºC for 72hr and was milled using a laboratory hammer mill into a fine powder, to pass through 100µm sieve which gave a very fine powder, stored in an air-tight plastic container prior to use.

2.2 Formulation of composite flour

Composite flours with different proportions of Wheat flour and Okra powder were prepared as shown in Table 1.

Table 1: Formulation of composite flours (%) for biscuits production

Samples	Wheat flour (%)	Okra Powder (%)
ASN	100	0
AAJ	95	5
AYA	90	10
AAS	85	15
AOT	80	20
AAM	75	25

Biscuits were prepared using the traditional creaming method described by [18].The fat and sugar were mixed in a Kenwood mixer (HM 450) until the mixture was fluffy. Eggs and milk were added, while mixing continued. Baking powder, ground nutmeg, composite flour, and salt were introduced into the mixture to form a soft dough. The dough was removed from the bowl and kneaded on a flat surface to obtain a uniform mix. The kneaded dough was rolled out into sheets using a rolling pin and cut into the desired shape using a cutter. The cut mass was transferred to a greased baking tray. Baking was carried out at 180°C for 17 min. Samples were removed from the oven, allowed to cool, packaged in clean plastic jars, labelled and stored for further analyses.

3. Methods

3.1 Determination of functional Properties of flour samples

The bulk density, water absorption capacity, oil absorption capacity, Emulsion capacity and stability, and foaming capacity were determined in triplicates using the method described by AOAC [19].

3.2 Pasting properties

This was determined using a Rapid Visco Analyser (RVA) (Tecmaster Perten N103802 Australia), as described by Li [20]. About 3.5 g of the samples was weighed into the test canister. Then 2.5 g of flour blends sample were weighed into a dried empty canister; 25 ml of distilled water was dispensed into the canister containing the sample. The solution was thoroughly mixed and the canister was well fitted into the RVA, as recommended. The slurry was heated from 50 to 95 ºC with a holding time of 2 min followed by cooling to 50ºC with 2 min holding time. The rate of heating and cooling were at constant rate of 11.25 ºC/min. Peak viscosity, trough, breakdown, final viscosity, setback, peak time and pasting temperature were read from the pasting profile with the aid of Thermocline for Windows Software connected to a computer.

3.3 Determination of chemical properties of biscuit samples

The proximate composition of the biscuit sample, pH and TTA of the composite flour was determined in three replicate using the standard procedures of Association of Official Analytical Chemists [19]. The carbohydrate content was calculated by difference. The energy value was estimated from Atwater factors (Protein×4+ Carbohydrate×4+ fat ×9).

3.4 Sensory evaluation

Coded biscuit samples were subjected to sensory evaluation and a total of thirty panelist drawn from the Federal Polytechnic Ilaro based on their familiarity with the product (biscuits) were used for the evaluation. The parameters evaluated include flavour, appearance, crunchiness, aroma, texture and overall acceptability. The coded samples were served in a clean white plastic plate at room temperature (25ºC) in individual booths with adequate fluorescent lights.

Sample presentation to the panelists was at random and one at a time. They were to evaluate the samples and check how much they liked or disliked each one and rate them as such using a 9-point hedonic scale system in which 9 represent like extremely and 1 represent dislike extremely [21].

3.5 Statistical analyses

Data were conducted in three replicates and analyzed using SPSS 21.0 software. Means with significant difference were separated by applying Duncan's multiple range test at 95% confidence level.

4. Results and Discussion

4.1 Functional properties of composite wheat and okra flour

There were significant differences ($p \leq 0.05$) in the functional properties of wheat and okra flour blends as presented in Table 2. The bulk density, water absorption capacity, oil absorption capacity, foaming capacity, foaming stability, emulsion capacity and emulsion stability values of the composite flour blends increased with an increase in the level of inclusion of okra flour in the wheat flour. However there was a decrease in the values obtained for sample AAM (75:25). The result obtained for bulk density revealed an increase in bulk density with an increase in okra flour.

The bulk density of the composite flour were within the values of 0.54 – 0.65 g/ml and in agreement with the findings of Oladele [22] for tiger nut and wheat flour (0.78 g/ml) and was also close to the values of 0.77 g/ml which was reported for wheat flour by [21]. Bulk density is influenced by particle size and the density of the flour and it is important in determining the packaging requirement and material handling [23]. Plaami [24], reported that bulk density is influenced by the structure of the starch polymers (i.e. either loose or tightly packed structure) and loose structure of the starch polymers could result in low bulk density. This low bulk density indicates that all the flour samples can be used in food formulation without the suspicion of retro-gradation and also desirable in preparation of complementary foods and other culinary purposes. Bulk density is also a measure of heaviness of a flour sample, which indicate that the relative volume of the composite flour in a package will not reduce excessively during storage.

Both the water and oil absorption capacity increased with the increase inclusion of okra flour in wheat flour. The highest water and oil absorption values were recorded at 80:20 (251 g/g) and 75:25 (204 g/g) respectively, while the lowest values were in the 75:25 (186g/g) and 85:15 (143 g/g) respectively. Water absorption capacity is the ability of a flour sample to hold its own and added water during the application of centrifugation. The water absorption capacity was comparatively higher in the composite flour blends. This can be attributed to the high amount of fibre present in the okra flour. According to Lakshmi [25], Starch and fibre content of the composite flour blends can cause a subsequent increase in water absorption capacity and moisture retention. Mbofung [26] also reported that the ability of flour to absorb water has a significant correlation with its starch content. The oil absorption capacity is an important property in food formulations because fat improves the flavour and mouth feel of food and food products, and its values are close to the findings reported by Omodamiro *et al.* [27] who worked on *lafun* and starch processed from some improved cassava genotypes. Formability is related to the rate of decrease in the surface tension of the air-water interphase caused by absorption of protein molecules [28]. Foaming capacity and foaming stability increased as the level of okra flour increased, in exception of sample AAM (75:15). The values were in the range of 7.22±0.01 to 10.30±0.00% and 3.52±0.001 to 5.70±0.01%, respectively for foaming capacity and foaming stability. These result were significantly different within all the samples, with sample AAM (75:25) having the lowest and AOT (80:20) having the highest values within the fortified wheat flour blends. Mempha [29] reported that Foaming capacity and foaming stability have been related to the decreased surface tension of air-water interface caused by absorption of protein molecules.

The values of Emulsion Capacity (EC) and Emulsion Stability (ES) increased with increase in the proportion of okra flour. The values ranged from 11.15±0.03 to 15.35±0.03% and 5.22±0.02 to 8.00±0.00% respectively, which is a good indication that the flour blends have a good tendency to form a better emulsion, particularly with AOT (80:20) flour blends with the highest EC and ES of 15.32 % and 8.00% respectively, having better emulsion forming characteristics than other samples.

Table 2: Functional properties of composite wheat and okra flour

Samples	Bulk Density (g/ml^3)	Water Absorption (g/g)	Oil Absorption (g/g)	Foaming Capacity (%)	Foaming Stability (%)	Emulsion Capacity (%)	Emulsion Stability (%)
ASN	0.61±0.00^a	199±0.01^a	200±0.00^b	8.35±0.07^b	4.25±0.03^b	11.58±0.01^a	6.32±0.02^b
AAJ	0.61±0.00^a	203±0.02^a	192±0.03^b	8.93±0.07^b	4.53±0.04^b	12.05±0.07^b	7.02±0.04^c
AYA	0.62±0.01^a	239±0.01^b	188±0.00^b	9.55±0.04^c	4.95±0.02^c	12.22±0.01^b	7.22±0.02^c
AAS	0.63±0.00^a	244±0.01^b	143±0.02^a	9.81±0.01^c	5.50±0.01^c	13.45±0.01^c	7.31±0.01^c
AOT	0.65±0.00^a	251±0.01^b	158±0.01^a	10.30±00^d	5.70±0.01^d	15.32±0.03^d	8.00±0.00^d
AAM	0.54±0.01^a	186±0.02^a	204±0.01^c	7.22±0.01^a	3.52±0.01^a	11.15±0.03^a	5.22±0.02^a

Values represent means of three replicate determination and standard deviation Mean values with different superscripts within the same column are significantly different ($p \leq 0.05$) ASN=100% wheat flour, AAJ=95wheat flour: 5% okra flour, AYA=90 wheat flour: 10% okra flour, AAS=85 wheat flour: 15% okra flour, AOT=80 wheat flour: 20% okra flour, AAM=75 wheat flour: 25% okra flour.

4.2 Pasting properties of composite wheat and okra flour

The pasting properties of wheat flour incorporated with okra flour are presented in Table 3. The peak viscosity ranged between 791.50 to 920.00 cP, where the 100%wheat had the highest value, while sample AAM (75:25%) had the least value. This is in agreement with the findings of [30]. Peak viscosity is the maximum attainable viscosity during heating, it also indicates the water binding capacity of the starch, and however a significant difference was observed in the peak viscosity of the composite flour. The peak viscosity of the composite flour was observed to decrease as the okra inclusion increased. This might be due to the higher content of protein and fibre which has been reported to lower paste viscosity [28]. Trough viscosity is the maximum viscosity at the constant temperature phase of the rapid visco analyser profile and the ability of the phase to withstand breakdown during cooling. The trough strength showed that there was a significant difference ($p \leq 0.05$) in all the samples. Similarly 100% wheat had the highest value of 790.50 cP. The addition of okra flour generally lowers the trough viscosity of wheat flour. And this implies that the blends may not find good application in the food system where high paste stability during cooling is required [31]. The breakdown in viscosity sometimes called shear thinning showed that there was a significant difference ($p \leq 0.05$) across the samples. The breakdown which is the difference between the peak and through viscosity is an indication of the rate of gelling stability, which is dependent on the nature of the product [31]. The results revealed that increase in okra flour could cause a decrease in gelling stability. Sample ASN (100%) had the highest value and sample AAM (75:25%) had the lowest value. The Setback region is the phase on the pasting curve after cooling the sample to 50^{o}C. It is the phase where retrogradation of starch molecules occurs. High setback value is known to be associated with a cohesive paste, while a low value is an indication that the paste is not cohesive with less tendency to retrograde upon cooling. The setback values decreased with an increase in okra flour inclusion. Sample ASN had the highest value (1298 cP) while sample AAM had the lowest value (378.00 cP). Peak time is indicative of ease of cooking a particular sample. The decrease in the peak time can be attributed to the inclusion of the okra flour. High peak time has been reported for wheat flour which can be attributed to the high degree of swelling of wheat starch granules [32]. The peak time ranged between 6.50 to 5.17 min. The pasting temperature gives an indication of the minimum temperature needed to cook a sample, which also have indication on the energy cost of preparing a product. The results indicated an increase in the pasting temperature with increase in okra flour inclusion. Sample AAM had the highest pasting temperature of 86.98°C while sample ASN had the least pasting temperature of 80.65°C.

Table 3: Pasting properties of composite wheat and okra flour

Samples	Peak Viscosity (cP)	Trough Viscosity (cP)	Break Down Viscosity (cP)	Final Viscosity (cP)	Set Back Viscosity (cP)	Peak Time (Sec)	Pasting Temperature (°C)
ASN	920.00±2.82^{e}	790.50±8.13^{d}	129.50±8.13^{d}	1842.00±5.65^{c}	1298.00±8.48^{d}	6.50±0.04^{b}	80.65±6.01^{a}
AAJ	881.50±7.07^{d}	760.50±10.61^{c}	121.00±7.25^{c}	1765.00±14.14^{b}	1100.50±19.09^{c}	5.90±0.04^{a}	81.98±0.03^{a}
AYA	851.50±6.35^{c}	735.00±24.04^{b}	116.50±8.02^{bc}	1703.50±12.74^{b}	739.50±30.40^{b}	5.80±0.28^{a}	82.18±0.60^{a}
AAS	835.50±10.25^{b}	725.50±12.02^{b}	110.00±7.51^{b}	1671.00±20.51^{a}	497.00±50.91^{a}	5.54±0.42^{a}	83.78±0.03^{b}
AOT	800.00±2.99^{a}	695.00±12.72^{a}	105.00±8.25^{ab}	1600.00±5.89^{a}	392.00±14.44^{a}	5.34±0.19^{a}	84.15±0.49^{b}
AAM	791.50±2.83^{a}	691.00±2.12^{a}	100.50±3.12^{a}	1583.00±5.65^{a}	378.00±1.41^{a}	5.17±0.04^{a}	86.98±0.03^{c}

Values represent means of three replicate determination and standard deviation.
Mean values with different superscripts within the same column are significantly different ($p \leq 0.05$).
ASN=100% wheat flour, AAJ=95wheat flour: 5% okra flour, AYA=90 wheat flour: 10% okra flour, AAS=85 wheat flour: 15% okra flour, AOT=80 wheat flour: 20% okra flour, AAM=75 wheat flour: 25% okra flour.

The final viscosity, a parameter commonly used to determine a sample's ability to form a gel after cooking and cooling had significant difference across the sample. The final viscosity decreased with increase in the okra flour inclusion. Sample ASN had the highest value (1842 cP) and sample AAM had the lowest value (1583.00 cP). The pasting properties in general reduced as the inclusion of okra flour increases. This is due to the protein and fibre content of the okra flour.

4.3 Chemical composition of biscuit produced from wheat flour incorporated with okra flour

Table 4. Presents the chemical composition of biscuit produced from wheat flour incorporated with okra flour. There is a significant ($p<0.05$) difference between the biscuit samples. The moisture content of the biscuit samples decreased as okra flour inclusion increased with the values between 8.95 to 10.28%. Akanbi [33] reported that moisture content is an indicator of shelf stability, thus increase in moisture content can enhance microbial growth which leads to deterioration in foods. The moisture content of the samples were lower than the range recommended by FAO [34] of 12 to 14%. The low moisture content of the samples reduced the possibility of microbial attack and would increase its shelf stability. High moisture content is not desirable in a product such as biscuits, because it has an inverse relationship with the texture of the product, which is an important attribute that consumer desire in biscuits.

The fat content of the biscuit sample ranged from 18.20 to 20.79 with sample AAM (75:25) having the lowest value and sample ASN (100:0) having the highest value. The results revealed that the fat content decreased as the okra flour inclusion increased. The fat and protein content of the biscuits were within the range of values reported by Adebowale [35] who worked on biscuit produced from composite of sorghum and wheat. The increase in the protein content of the biscuit samples could be due to high protein content of wheat, and okra which has been reported as a new high protein crop for the temperate and the tropics [36]. Similar studies also reported high protein content for soy-maize "agidi" and wheat-soy plantain bread [37]. Jideani [38] reported that maize supplementation with dry okra seed flour (70:30) increased the protein of the weaning food to 211 g kg-1. High crude protein of the okra and wheat composite biscuit signifies that the composite flour can serve as cheap source of protein to consumers. Products from the flour have the potential of solving the problem of protein-energy malnutrition in Africa [39]. The ash and fibre content of the biscuits increased as okra flour inclusion increased with values between 0.91 to 4.71% and 1.01 to 4.49% respectively. Significant differences exist on both the ash and fibre content of the samples. Ash content of a food material is a non-organic compound containing mineral content of food. Nutritionally, it aids in the metabolism of other organic compounds such as fat and carbohydrates [17]. The biscuit made with 75:25% wheat /okra flour had the highest ash content. While the fiber content aids good bowel movement and is necessary in foods generally as it reduces food retention time in the digestive tract.

Table 4: Proximate composition of biscuit produced from wheat flour incorporated with okra flour

Samples	Moisture (%)	Fat (%)	Ash (%)	Protein (%)	Fiber (%)	Cho (%)	Energy kcal
ASN	10.28±0.3^{c}	20.79±1.35^{d}	0.91±0.30^{a}	10.56±0.06^{a}	1.01±0.01^{a}	56.45±0.74^{e}	455.15±2.73^{f}
AAJ	9.73±0.43^{b}	20.44±0.05^{d}	0.99±0.51^{a}	12.65±0.06^{b}	1.41±0.15^{a}	54.78±1.54^{de}	453.68±5.87^{e}
AYA	9.31±0.12^{b}	19.83±0.29^{c}	2.38±0.00^{b}	13.62±0.12^{c}	2.22±0.16^{b}	52.64±0.89^{d}	443.51±0.39^{d}
AAS	9.29±0.05^{b}	18.41±0.06^{b}	2.53±0.04^{b}	16.62±0.00^{d}	3.47±0.60^{c}	49.68±0.89^{c}	430.27±4.09^{c}
AOT	9.08±0.05^{b}	18.20±0.00^{ab}	3.45±0.07^{c}	19.07±0.02^{e}	3.60±0.56^{c}	46.60±0.56^{b}	426.48±13.29^{b}
AAM	8.95±0.31^{a}	17.90±2.32^{a}	4.17±0.16^{d}	21.93±0.06^{f}	4.49±0.37^{d}	42.56±0.47^{a}	419.06±1.56^{a}

Values represent means of three replicate determination and standard deviation
Mean values with different superscripts within the same column are significantly different ($p \leq 0.05$)
ASN=100% wheat flour, AAJ=95wheat flour: 5% okra flour, AYA=90 wheat flour: 10% okra flour, AAS=85 wheat flour: 15% okra flour, AOT=80 wheat flour: 20% okra flour, AAM=75 wheat flour: 25% okra flour.

The carbohydrate content of the biscuit samples ranged from 42.56 to 56.45 %, with sample AAM (75:25) having the lowest and sample ASN (100:0) having the highest value. The carbohydrate values are higher than the values reported by Adebowale *et al.* [35]. These results showed that wheat and okra are good sources of carbohydrate. The results obtained in this study is similar to the findings of Okoye *et al.* [40] who reported a decrease in carbohydrate content (73.4- 34.9%) of wheat-soy bean flour with increasing soy flour substitution. Messiaen [41], reported that the higher the protein, fat, and ash content the less the carbohydrate content.

The energy values which is the total available energy in any food samples ranged from (455.15 to 419.06 kcal). The energy value decreased as okra flour inclusion decreased. This could be due to the high fiber content present in the okra flour. The energy values of the biscuits are higher than 332.88-342.01 kcal for wheat cowpea based snack as reported by Ogunmodimu *et al.* [42]. The low energy values of these snacks has some nutritional and health benefits, for instance, the regular intakes of these snacks could facilitate weight reduction in overweight/obese individuals or in managing diabetes mellitus.

The result of the TTA and pH of wheat flour incorporated with okra flour are presented in Table 5, the pH and TTA values ranged from 5.62 to 5.92 and 0.13 to 0.32% respectively. The pH is an important parameter in the formulation of biscuits. An acidic pH is associated with the development of a pleasant taste [43]. The low TTA in these samples may be due to the departure of volatile acidity and organic compounds during cooking. However the values of the pH and TTA observed for this study are within the values reported by Grah *et al.* [44].

Table 5: pH and Titratable acidity of composite flour

Samples	pH	TTA (%)
ASN	5.62±0.11^a	0.32±0.00^b
AAJ	5.66±0.10^a	0.29±0.01^b
AYA	5.73±0.02^a	0.26±0.70^b
AAS	5.75±0.01^a	0.17±0.0^a
AOT	5.86±0.14^a	0.14±0.00^a
AAM	5.92±0.02^a	0.13±0.01^a

Values represent means of three replicate determination and standard deviation
Mean values with different superscripts within the same column are significantly different (p≤ 0.05)
ASN=100% wheat flour, AAJ=95wheat flour: 5% okra flour, AYA=90 wheat flour: 10% okra flour, AAS=85 wheat flour: 15% okra flour, AOT=80 wheat flour: 20% okra flour, AAM=75 wheat flour: 25% okra flour.

4.4 Sensory

Table 6, Shows the sensory properties of the biscuit samples produced from wheat flour incorporated with okra powder. There were significant differences (p≤ 0.05)across the samples in terms of appearance, flavour, aroma, texture, crunchiness and overall acceptability with values that ranged from 6.4 to 8.6, 5.9 to 8.44, 6.5 to 8.6, 6.9 to 8.7, 6.4 to 8.8 and 7.0 to 8.9 respectively, sample ASN (100% wheat flour) had the highest rating across all the attributes evaluated. Samples AYA (90%wheat and 10% okra powder) had the lowest rating in terms of appearance, flavour, aroma and overall acceptability, while sample AAS (85% wheat flour and 15% okra) had the lowest rating in terms of texture and crunchiness. From these results it was observed that panelist liked all the samples. AAJ (95% wheat flour and 5% okra flour) had the highest rating in terms of overall acceptability, while other samples where in the range of “moderately liked”. This could be attributed to the change in the composition of the biscuit samples by incorporating okra powder into the products, which affects its basic attributes and also the judgment of the panelist and consumer. Similar results were reported by Mir *et al.* [45] for cakes by increasing non-wheat flour in the formulation. However, [38] reported that maize supplementation with dry okra seed flour (70:30) for weaning food acceptability in terms of colour, appearance, and overall acceptability was low. This was due to the presence of black specks from the okra hulls. This is one of the reasons the control sample is liked above all other samples in terms of sensory properties.

Table 6: Sensory properties of biscuit produced from wheat flour incorporated with okra flour.

Samples	Appearance	Flavour	Aroma	Texture	Crunchiness	Overall acceptability
ASN	8.6±0.51^c	8.44±0.72^d	8.6±0.51^c	8.7±0.48^c	8.8±0.42^c	8.9±0.31^d
AAJ	6.8±0.91^a	7.70±0.82^c	7.6±1.26^b	7.5±1.5^b	7.7±1.05^b	8.0±0.66^c
AYA	6.4±0.96^a	5.90±1.37^a	6.5±1.08^a	7.0±1.33^b	7.6±0.69^b	7.0±0.81^a
AAS	7.3±1.70^b	7.00±1.49^b	6.9±1.44^a	6.9±1.66^a	6.4±2.17^a	7.2±1.75^a
AOT	7.3±0.67^b	7.00±1.41^b	7.4±1.07^b	7.2±1.47^b	7.9±1.19^{bc}	7.8±1.22^b
AAM	7.5±1.26^b	7.10±1.10^b	7.0±0.66^b	7.4±1.07^b	7.5±1.26^b	7.7±1.05^b

Values represent means of three replicate determination and standard deviation
Mean values with different superscripts within the same column are significantly different (p≤ 0.05)
ASN=100% wheat flour, AAJ=95wheat flour: 5% okra flour, AYA=90 wheat flour: 10% okra flour, AAS=85 wheat flour: 15% okra flour, AOT=80 wheat flour: 20% okra flour, AAM=75 wheat flour: 25% okra flour.

5. Conclusion

Incorporation of okra flour to wheat flour for biscuit making had significant effect on the proximate composition and sensory properties of the resulting biscuits. Substitution of okra flour to wheat flour had a significant effect on all the functional properties except the bulk density of the composite flour. The sensory results revealed an average of 7.0 rating for all the samples (i.e. "like moderately") in term of the overall acceptability. Therefore acceptable biscuit can be produced from wheat and okra flour with inclusion level of up to 25%.

3. References

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