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Proximate, vitamins and sensory analyses of biscuit produced from blends of wheat and potato flour enriched with chia seed (*Salvia Hispanica*)

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Abstract

Proximate, vitamin and sensory analyses of biscuit produced from blends of wheat and potato flour enriched with Chia seed *(Salvia Hispanica)* were carried out in this study. Flour blends of wheat and potato were composite at replacement ratios of 50:50 %, 70:30 %, 60:40 % and 100 % wheat which served as the control and the three formulated samples were enriched with 5% Chia seed per sample. The biscuits produced were evaluated for their sensory, proximate and vitamins attributes. The result of sensory evaluation revealed that the biscuit was accepted with a mean score of 6.40% similar to the 100% wheat flour with mean score of 6.80 %. There were significant difference among the samples at (P≤0.05) based on appearance, aroma, taste, crispiness and texture. The results of proximate analysis shows that the protein content of the enriched blends increased with mean score of 7.95 % higher than that of the control (100 %) wheat flour of 7.04%. The 100 % wheat flour (sample D) had high moisture content with sample A, B, and C, having 6.38 %, 7.17 % and 6.77 % respectively. The carbohydrate and energy value of the samples were significantly different at (P<0.05). Sample A had the highest carbohydrate and energy value of 75.68 % and 391 % respectively. The result of the vitamins content shows that the chia seed enriched samples of A, B, and C recorded 1.83 to 1.47 % respectively for Vitamin A and 0.64 to 0.62 % for Vitamin E. Sample D (100 % wheat flour) recorded the highest Vitamin C content of 4.64% higher than the enriched samples. The samples were significantly different at (P<0.05). In conclusion, biscuit of acceptable quality were produced from the formulation of wheat and potato flour enriched with chia seed (*Salvia Hispanica*).

Keywords: Biscuits; Chia Seed; Enrich; Proximate and Sensory

1. Introduction

Biscuit is a popular snack consumed by a wide range of population due to its taste, long shelf – life and relatively low cost. Biscuit maybe regarded as a form of confectionery and are eaten mostly with tea or coffee. Biscuit have become very popular in Nigeria especially among children. Biscuits are produced as nutritive snacks from unpalatable dough that is transformed into appetizing product through the application of heat in the oven (Olaoye *et al*., 2017). Wheat flour, water, sugar fat and eggs are the main ingredients of simple biscuit, which are mixed into dough with another compound if needed (Chioma and Chizoba, 2015). View on the traditional biscuit processing, biscuits has changed significantly because of the competition between the producers at the retail market and the increased demand for healthy natural and functional foods. In Nigeria, ready to eat baked product. E.g. biscuit consumption is continually growing and there has been increasing reliance on imported wheat. The economy of any country importing wheat for production of baked foods like biscuit would improve if other staple food like sweet potato, cassava, yam and other cereals which are grown locally are used in producing such products (Ayo and Gaffa, 2002). Attempts are being made to improve the nutritive value of biscuit and functionality by modifying the ingredients and their composition (Steffoani *et al*., 2017). The

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nutritional value of biscuit can be enhanced by fortification and supplementation with a variety of dietary fibre rich plant products such as chia seeds.

Chia seed (*Saliva hispanica*) is an annual herbaceous plant that belongs to the lamiaceae family. It comes from southern Mexico and northern Guatemala. Despite the high nutritional value, the seeds are rarely used in food production. The seeds contain fat that is a good source of omega 3 and omega 6 fatty acids. In addition, chia seeds have a relatively high content of protein of high biological value. They are rich in essential amino acids, particularly leucine, lysine, isoleucine, and valine (Sierra, 2015). Therefore, the seeds can be a complement of cereal proteins that are different in essential amino acids. Additionally, chia seed have high water absorption and the ability to form aqueous solution with increase viscosity. In recent years, European parliament approved chia seeds as a novel food. This resulted in an increase in use of chia seeds in food production (Uchenna, 2017). Recent studies have shown that chia seed can be used to produce food products such as biscuits (Barrietos *et al*., 2014), pasta (Oliveira *et al*., 2015), bread (Uchenna, 2017)

Potato (*Solanum tuberosum*) is popularly known as the king of vegetable. It is a starchy, tuberous crop of the solancea family. Potato is a semi – perishable food in nature, it contains 80 % water and 20 % dry matter. A major portion of dry, matter is starch and sugar that constitute about 16 % on fresh wet basis potato has potential for a beneficial role in world food production owing to its status as a cheap plentiful crop, which can be raised in a wide variety of climates and local (Zhang, 2020). In Nigeria, potato is abundantly produced of past harvest storage facilities.

Biscuit can hardly be regarded as a healthy snack because they usually contain high levels of rapidly digested carbohydrates high fat, generally low levels of fiber and only modest amounts of protein (Chinma *et al*, 2017). Several studies have used blended flours or composite flours to produce biscuits (Caponio *et al*., 2006). There have also been a number of attempts to improve their nutritional characteristics by partially replacing the wheat flour with non-wheat ingredients in the production of biscuits. Recently, Products with high protein and fiber contents are more commonly chosen by consumers to reduce the risk of diabetes and obesity. The protein enrichment of biscuits can be achieved by adding different kinds of ingredients such as chia seeds. Consumers are always concerned about the fat content of biscuits. In recent years, an enormous amount of research work has been carried out to study the possibility of adding healthy fats to biscuits without changing the flavor and texture of the final products.

2. Material and methods

2.1. Sample Collection

The materials used which includes wheat flour, margarine, sugar, salt, egg, milk, flavor, strawberry flavours, baking powder, were purchased from Eke market, Afikpo, Ebonyi State. While sweet potato flour, chia seed were purchased from International Market Abakaliki.

2.2. Sample Preparation

The chia seeds were milled while the wheat and sweet potato flour were sieved and measured including other ingredients.

2.3. Methods

The flours were sieved, measured and mixed with sugar, salt, margarine, baking powder and the chia seed. Then the liquid ingredients, eggs, milk flavor, strawberry flavor were added to the dry ingredients and mixed properly to form a dough. The mixed dough was kneaded and cut into desire shapes. The trays were greased and oven preheated and baked at 200 ^{0}C for about 45 minutes.

2.3.1. Determination of Crude Protein Content

Crude protein was determined using the kjeldahl method (AOAC, 2010). Two gram of sample was placed in the kjeldahl flask, Anhydrous sodium sulphate (5 g of kjeldahl catalyst) was added to the flask. Concentrated H_2SO4 (25 ml) was added with few boiling clips. The flask was heated in the fume chamber until the sample solution became dear. The sample solution was allowed to cool at room temperature, then transferred into a 250 ml volumetric flask and made up to volume with distilled water. The distillation unit was cleaned, and the apparatus set up. Five milliliters of 2 % boric acid solution with few drops of methyl red indicator was introduced into a distillate collector (100 ml conical flask). The conical flask was placed under the condenser, then 5ml of the sample digest was pipetted into the apparatus and washed down with distilled water. Five (5) milliliters of 60 % sodium hydroxide solution was added to the digest. The same was heated until 100 ml of distillate was collected in the receiving flask. The content of the receiving flask was titrated with 0.049 m H_2S04 to a pink coloured end point. A black with filter paper was subjected to the same procedure.

Crude Protein

$$\% \text{ Total Nitrogen} = \frac{(Titre - blank)\ X\ Normalty\ of\ acid\ X\ H2}{Weight\ of\ sample}$$

Nitrogen factor = 6.25

Crude Protein = % total N x 6.25

2.3.2. Determination of Moisture Content

Moisture content was determined as described by the standard methods of Association of official Analytical chemists (AOAC, 2010). Stainless steel oven dishes were cleaned and dried in the oven at 100 ^{o}C for 1 hour to achieve a constant weight. They were cooled in a desiccator and then weighed. Two grams of the sample was placed in each dish and dried in the oven at 100 ^{o}C until constant weight was achieved. The dishes together with the samples were cooled in a desiccator and weighed

$$\% \text{ moisture content} = \frac{(W_2 - W_3)}{(W_2 - W_1)} \text{ x } 100$$

Where
W_1 = weight of dish
W_2 = Weight of dish + sample before drying
W_3 = Weight of dish + sample after drying

2.3.3. Determination of Fat

The fat content was determined according to AOAC (2010). Soxhlet extraction method. A 500 ml capacity round bottom flask was filled with 300 ml petroleum either and placed to the soxhlet extractor. Two grams of sample was placed in a labeled thimble. The extractor thimble was sneaked with cotton wool. Heat was applied to reflux the apparatus for six hours. The thimble was removed with care. The petroleum either was recovered for reuse. When the flask was free of either, it was removed and dried at 105 ^{o}C for 1 hour on an oven. The flask was cooked in a desiccator and weighed.

Calculation

$$\% \text{ fat} = \frac{weight\ of\ fat}{weight\ of\ sample} \text{ x } 100$$

2.3.4. Determination of Crude Fiber

Crude fiber was determined using the method in AOAC (2010). Three (3) gram of the sample was weighed into a 50 ml beaker and fat was extracted with petroleum either by stirring, willing and decanting three times. The extracted sample was air dried and transferred to a 600 ml beaker. Then 200 ml of 1.25 % sulphuric acid and few drops of anti-foaming agent were added to the beaker. The beaker was placed on digestion apparatus with pre adjusted hot plate and boiled for 30 minutes, rotating beaker periodically to keep solid from adhering on the sides of the beaker. At the end of 30 minutes period, the mixture was allowed to stand for one minute and then filtered through a funnel, without breaking suction, the insoluble matter was washed with bottle containing 200 ml of 1.25 % sodium hydroxide solution. It was again boiled briskly for 30 minutes with similar precaution as before. After boiling for 30 minutes, it was allowed to stand for one minute and then filtered immediately under suction. The residue was washed with boiling water, followed by 1 % hydrochloric acid and finally with boiling water until it was free of acid. It was washed twice with alcohol and then with either for three times. The residue was transferred into ash dish and dried at 100 ^{o}C to a constant weight. Incineration to ash was done at 800 ^{o}C for 30 minutes, cooled in a desiccator and weighed. The difference in weight between oven dry weight and the weight after incineration was taken as the fiber content of the sample. This was expressed as a percentage weight of the original sample taken for analysis.

$$\text{Crude Fiber (\%)} = \frac{oven\ dried\ sample - weight\ of\ sample\ incineration}{weight\ of\ sample\ taken} \text{ x } 100$$

2.3.5. Determination of Carbohydrate

The carbohydrate was determined by difference according to Oyenuga (1968), as follows

$$\% \text{ carbohydrate} = 100 – (\% = \text{moisture} + \% \text{ fat} + \% \text{ Ash} + \% \text{ protein} + \% \text{ crude fiber})$$

2.3.6. Determination of Ash Content

Ash content was carried out according to AOAC (2010) procedure. Two grams of sample was placed in silica dish which had been ignited, cooled and weighed. The dish and sample were ignited first gently and then at 350 ^oC in a muffle furnace for 3 hours, until a grey ash was obtained. The dish and content were cooked in a desiccator and weighed

$$\% \text{ Ash} = \frac{(W_{2-} W_{3)}}{(W_2 - W_1)} \text{ x } 100$$

Where
W_1 = weight of dish
W_2 = Weight of dish + sample before ashing
W_3 = Weight of dish + sample after ashing

2.3.7. Determination of Vitamin A

The method of the association of vitamin chemists was employed. A measured weigh (5 g) of each processed sample was dispensed in 30 ml absolute alcohol. 5 ml of 50 % potassium hydroxide solution was added to it and boiled reflux for 30 minutes. After cooling rapidly in running water, 30ml of distilled water was added to it and the mixture was transferred to a separation funnel. The portions of 50 ml of either were used to wash the mixture thus extracting the vitamin A extract was washed with 4 x 50 ml distilled water. The extract was then transferred to avoid formation of emulsion. The extract was then evaporated to dryness and dissolved 10 ml of Isopropyl alcohol. Meanwhile, standard vitamin A was dissolved in Isopropyl alcohol and its absorbance was measured at 325 mm, similarly the absorbance of the vitamin A extract was also measure at 325 mm. The vitamin A content was calculated using the relationship below.

$$\text{Vit A} = 1/100\text{g} = \text{Au} / \text{As x c x } 100/\text{w}$$

Where,
Au = absorbance of sample
As = Absorbance of standard
W = Weight of sample
Cr = Concentration of standard Vitamin A

2.3.8. Determination of Vitamin C

Vitamin C content of the sample was determined by (Kirk, 1998). 20 g of each processed sample was homogenized in 100 ml of EDTA/CA extraction solution by blenching for 5 minutes in a National slender. The homogenate was filtered, and test samples were passed through a packed cotton wool containing activated charcoal to remove the colour. The volume of the filtrate was adjusted to 100ml by washing with more of the extraction solution. 20 ml of each of filtrate was measured into a conical flask. 10 ml of 20 % potassium iodide solution was added to each of the flasks, followed by 5 ml of starch solution (indicator) the mixture was titrated against 0.01 ml CuS_{04} solution. Titration was done till an end point marked by black sparks of the brick of the mixture. The vitamin C content was given by the relationship the 1ml of 0.01ml CuS_{o4} 0.38mg Vitamin C. Therefore Vitamin C content mg/100 g sample. Vitamin C (mg/100 g) = 0.88 x Txvf/va x 100/w.

2.3.9. Determination of Vitamin E

The spectrophotometric method described by (Kyric and Sawyer 2011) was used. One gram (1 g) of each best sample was mixed with 10 ml of absolute alcohol and 20 ml of molar alcoholic sulphuric acid solution. The mixture was boiled under reflux, under reduced light (Aluminum wrapped containers) for 45minutes. Fifty milliliters (50 ml) of distilled water were added and the mixture was transferred to a separation funnel using and additional 50 ml of distilled water to wash out. The unsaponifiable matter was extracted with 5 portions of 30 ml diethylethor. The combined extract was washed free of acid by using several portions of distilled water and then dried over sodium sulphate in desiccator. Thereafter the extract was evaporated until the solvent was gone. The extract was then dissolved in 10 ml of absolute ethanol, standard vitamin E in solution was prepared and diluted. 2 ml of the extract solution and 2 ml of the standard solution as well as 2 ml of distilled H_2O were dispensed into 3 different test tubes to serve as sample standard and blanks respectively. 5 ml of absolute alcohol was added to each test tubes followed by 1ml of cons HNO_3 which was added with great caution. The test tubes were placed in a water bath at 90 ^{o}C until the alcohol boiled. Boiling was allowed for 3 minutes only. The volume of the content of each tube was made up to 20 ml with absolute alcohol. The absorbance of each was measured at 470 mm with the blank at zero. The vitamin E content was calculated as shown below;

$$\text{Vitamin E} = \text{mg}/100\text{g} = Au/As = C \times vf/va \times 100/w$$

Where,
Au = Absorbance of sample
As = Absorbance of standard vit E solution
C = Concentration of standard vit E solution (mg/ml)
Vf = Total extract volume
Va = Volume of aliquot of extract analyzed
W = Weight of sample used.

2.4. Sensory Evaluation

The four samples of biscuit produced were presented and evaluated in terms of appearance, aroma, taste, crispiness, texture and general acceptability. The sensory evaluation consists of 20 man sensory panelist from AIFPU environment using a 7- point hedonic scale.

2.5. Statistical Analysis

The data collected were illustrated using tables and figures, result were presented as means ±Standard deviation of four determinations. Data were analyzed by analysis of variance (ANOVA). Duncan test were used for means separation for statistical significance at 95 % ($P \leq 0.05$) confidence level, using statistical software SSPS 23.0 for windows (SPSS inc, Chicago III, USA).

3. Results

Table 1 Proximate composition of biscuit enriched with chia seed

Parameters	**A**	**B**	**C**	**D**
Moisture	6.38 ± 0.02^{d}	7.17 ± 0.02^{b}	6.77 ± 0.01^{c}	8.17 ± 0.03^{a}
Protein	7.83 ± 0.01^{b}	7.95 ± 0.02^{a}	7.91 ± 0.02^{a}	7.04 ± 0.03^{c}
Fat	6.35 ± 0.01^{c}	6.71 ± 0.01^{a}	6.51 ± 0.01^{b}	6.17 ± 0.03^{d}
Fiber	2.73 ± 0.02^{c}	2.94 ± 0.01^{a}	2.83 ± 0.02^{b}	2.15 ± 0.03^{d}
Ash	1.05 ± 0.02^{c}	1.28 ± 0.02^{b}	1.37 ± 0.02^{a}	0.83 ± 0.02^{d}
Carbohydrate	75.68 ± 0.02^{a}	73.97 ± 0.02^{c}	74.63 ± 0.02^{b}	75.64 ± 0.02^{a}
Energy kcal)	391.17 ± 0.16^{a}	388.03 ± 0.04^{c}	388.71 ± 0.13^{b}	386.23 ± 0.23^{d}

Mean scores with the same super scripts in the same row are not significantly different ($P > 0.05$); Key: Sample: A: 50 % wheat flour, 50 % potato flour, 5 % chia seed; B: 70 % wheat flour, 30 % potato flour, and 5 % chia seed; C : 60 % wheat flour, 40 % potato flour with 5 % chia seed; D: 100 % wheat flour.

4. Discussion

The proximate composition of biscuits made from wheat and potato flour blends enriched with chia seed is shown in Table 4.2. The moisture content mean score ranges from 6.38 to 8.17 %. The samples were significantly difference at ($P < 0.05$). Sample D (100 % wheat flour) had the highest moisture content. Sample A (50 % wheat flour and 50 % potato flour) had the least moisture content. The moisture content of the biscuit were lower compared to the values reported by (Onabanjo *et al*, 2014) on biscuit produced from wheat-sweet potato composite. This implies that wheat flour retains moisture more than when combined with sweet potato flour.

The crude proteins mean score ranges from 7.04 to 7.95 %. There were significant difference at (P<0.05) sample A,B, and C which is (50 % wheat, 50 % potato flour. 70 % wheat and 30% potato flour and 60% wheat and 40 % potato flour) respectively had the highest protein content while sample D (100 % wheat flour) recorded the least protein content. The protein content increased as the ratio of the potato flour increased. The samples enriched with chia seed which is the sample A, B and C contains more protein than sample D which is the control. This implies that chia seed increased the protein content of the biscuit and should be recommended for biscuits and other baked foods production. The concentration of fat in the samples ranges from 6.31 to 6.71 with highest concentration of fat sample B which is (70 % wheat and 30 % potato flour), followed by sample C and A (60 % wheat 40 % potato flour and 50 % wheat, 50 % potato flour respectively). Sample D (100 % wheat) had the least fat content. The increase in fat content of the enriched samples maybe as a result of the addition of chia seed. Chia seed is reach in Omega 3 fatty acids which are super important to brain health.

Crude fiber mean ranges from 2.15 to 2.97 %. crude fiber increased in the enriched samples which include sample B, C and A (70 % wheat and 30 % potato flour, 60 % wheat, 40 % potato flour, 50 % wheat, 50 % potato flour) respectively at 2.94, 2.84 and 2.71 respectively. Sample D had least crude fiber. There were significant difference between the samples at (P<0.05). The increase in fiber content maybe due to the addition of sweet potato which is found to contain more fiber than wheat flour and also chia seed which contains some proportion crude fiber. Eating enough fiber can prevent or relieve constipation, helping waste to move smoothly through the body.

The Ash content ranges from 0.83 to 1.37. Sample C (60 % wheat and 40 % potato flour) has the highest Ash content with the mean score of 1.37 followed by sample B and A (70 % wheat and 30 % potato flour). Sample D (100 % wheat) had the least Ash content of 0.83 %. There were significant difference between the samples at (P<0.05). The Ash content of biscuits increased in the enriched samples A, B, and C more than sample D due to higher ash content of sweet potato than wheat and also high Ash content of chia seed. The Ash content of the biscuit was similar to those reported by (Okoye *et al.*, 2008). Ash represents the total mineral contents in foods. The carbohydrate content ranges from 73.97-75.68 % sample A and D had the highest carbohydrates content of 75.68 and 75.64 respectively followed by sample C and B. There were significant difference between the samples at (p<0.05). The carbohydrate content is higher than that reported by (Okoye *et al.*, 2008) in biscuits prepared from wheat and potato blends.

The Energy value of the biscuits ranges from 386.23 to 391. Sample A has the highest energy value and sample D has the least energy value of 386.23. The energy value increased in the enriched samples which could be as a result of the added potato flour and chia seed. The samples were significantly difference at (P<0.05). The energy contents of the biscuit samples were similar with those reported by (Okoye *et al.*, 2008).

4.1. Evaluation of Vitamin Content

Table 2 Vitamin content of biscuit produced from wheat and potato flour

SAMPLE	Vit A	Vit C	Vit E
A	$1.83{\pm}0.02^a$	$2.82{\pm}0.02^d$	$0.64{\pm}0.02^a$
B	$1.43{\pm}0.02^b$	$4.04{\pm}0.01^b$	$0.58{\pm}0.01^a$
C	$1.47{\pm}0.03^b$	$3.71{\pm}0.02^c$	$0.62{\pm}0.02^a$
D	$0.09{\pm}0.02^c$	$4.64{\pm}0.02^a$	$0.50{\pm}0.02^b$

Determination were done in triplets ± S.D. Means within the same column with the same superscript are not significantly different (P>0.05).

4.2. Discussion on the Vitamin content

The data outlined in Table 2 represents the mean values of vitamins content in the biscuit sample produced from blends of wheat and potato flour enriched with chia seed. The data revealed that there was an increase in Vitamin A content between samples with mean score ranging from 0.09 to 1.83. Samples A, B, and C (50 % wheat, 50 % potato flour) (70 % wheat and 30 % potato flour and 60 % wheat, 40 % potato flour) respectively, had the highest vitamin A content than sample D (100 % wheat). The samples were significantly different. The increase in samples blended with potato flour may be due to the addition of potato flour which has more vitamin A content. There was significant difference among the sample at (P<0.05). The vitamin C content score ranges from 2.82 – 4.64 %. Sample D (100 % wheat) had the highest score of 4.64 % than other samples. The samples were significantly different at (P<0.05).

The data revealed that there was an increase in vitamin E content in the samples enriched which are A, B with mean scores of 0.64, 0.58 and 0.62 %. Sample D had the least score of 0.50. There were no significant difference between sample A, B and C at (P>0.05). Though there was significant difference between the samples at (P<0.05). The vitamin contents of the biscuits samples were lower than those reported by (Hanan, 2015).

4.3. Sensory analysis of biscuit samples

Table 3 Sensory evaluation of biscuit

	A	**B**	**C**	**D**
Appearance	$6.20±0.77^{bc}$	$6.00±0.91^{c}$	$6.60±0.50^{ab}$	$6.80±0.41^{a}$
Aroma	$6.40±0.82^{a}$	$6.20±0.41^{a}$	$6.40±0.82^{a}$	$6.20±0.41^{a}$
Taste	$6.40±0.50^{b}$	$5.00±0.64^{c}$	$6.20±0.41^{b}$	$6.80±0.41^{a}$
Crispiness	$5.40±0.12^{c}$	$5.60±0.05^{b}$	$5.40±0.04^{c}$	$6.80±0.41^{a}$
Texture	$5.60±0.39^{c}$	$5.20±0.76^{c}$	$6.20±0.76^{b}$	$6.80±0.41^{a}$
Gen Accept	$6.40±0.50^{b}$	$5.20±0.41^{c}$	$6.40±0.50^{b}$	$6.80±0.41^{a}$

Determinations were done in triplets ± S.D. Mean scores within the same column with the same superscript are not significantly different (P≤ 0.05); Key: Sample: A: 50 % wheat flour, 50 % potato flour, 5% chia seed; B: 70 % wheat flour, 30 % potato flour, and 5 % chia seed; C: 60 % wheat flour, 40 % potato flour with 5 % chia seed; D: 100 % wheat flour.

4.4. Discussion on sensory properties

In terms of appearance, the data ranges from 6.00 to 6.80. Sample D was mostly preferred followed by sample C with 6.80 and 6.60 respectively sample A and B were least preferred. There was significant difference between the samples at (P≤ 0.05).

In terms of texture, the mean score ranges from 5.20 to 6.80.Sample D was mostly preferred followed by sample C with 6.80 and 6.20 respectively. Sample A and B were least preferred. The scores obtained from the samples were significantly different at (P≤ 0.05).

In terms of Aroma, the mean score ranges from 6.20 to 6.40. Sample A and C having the highest scores were mostly preferred. There were no significant difference between the samples at (P>0.05).

The taste score ranges from 5.00 to 6.80. Sample D was mostly preferred with score 6.80 followed by sample A and C which has 6.40 each. Sample B was least preferred. There were significant difference between the samples at (P≤ 0.05) while sample A and C were not significantly different at (P>0.05).

In terms of crispiness, the mean score ranges from 5.40 to 6.80. Sample D was mostly preferred followed by sample B with the score of 6.80 and 5.60 respectively. Sample A and C were least preferred. There were no significant difference between sample A and C at (P>0.05). Though the sample were significantly different from each other at (P≤ 0.05).

The samples were generally accepted with mean score ranging from 5.20 to 6.80. Sample D was mostly preferred followed by sample A and C with mean score of 6.40 and 6.40 respectively. Sample B was least accepted. There were no significant difference between sample A and C at (P>0.05). This implies that the samples enriched with chia seed were generally accepted. The sensory mean score evaluated where similar with those reported by (Chioma and Chizoba, (2015).

5. Conclusion

Biscuits of acceptable quality similar to those made from wheat flour were produced from blends of wheat and potato flour enriched with chia seed. Enrichment of the biscuits with chia seed significantly increased the protein, crude fiber, fat, ash and carbohydrate contents of the biscuits than the one produced from 100 % wheat flour. The addition of chia seeds also increased the vitamin E and vitamin A contents of the biscuits. The results obtained could be very valuable in the baking industries that want to take nutritional advantage of chia seed in the formulation and enrichment of their products and also sweet potato flour can serve as an alternative to wheat flours. Chia seed should be explored in the production of nutritionally enriched products.

Compliance with ethical standards

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Disclosure of conflict of interest

There are no conflicts of interest in connection with this paper, and the material described is not under publication or consideration for publication elsewhere.

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