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Production, nutrient and sensory qualities of biscuits produced from wheat-coconut-almond flour blend

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Abstract
This study asses the proximate and sensory analysis of biscuits made from dried almond seed and coconut blend. Biscuits was produced from blends of wheat, coconut and almond flour. Five blends were prepared by homogenously mixing wheat with coconut and Almond flour in the percentage proportion ratios of 80:10:10, 70:15:15, 60:20:20, 50:25:25 and 100:0 respectively. The 100% wheat serve as the control. The biscuits were evaluated for proximate composition and sensory qualities. The result shows that moisture content ranged from 5.15 ±0.03 to 8.48± 0.02%, ash content ranged from 1.89±0.01 to 5.24± 0.02%, fibre content ranged from 0.87±0.01 to 1.85±0.04%, fat content ranged from 6.20±0.02 to 18.90±0.01%, protein content ranged from 4.65±0.00 to 15.54±0.02 % and carbohydrate 63.54±0.03 to 79.39±0.15% respectively. The sensory quality is based on the aroma, texture, colour, taste and overall acceptability. It was observed that significant difference exist at 5% confidence level ($p<0.05$) in the aroma, taste, appearance, crispiness and overall acceptability. The variation in the sample is due to the addition of almond and coconut flour which was not commonly eaten by people before. The overall acceptability shows sample B was preferred among the biscuits.

Keywords: biscuits, coconut, almond seed, proximate, sensory

Introduction
Among ready to-eat snacks, cookies and biscuits are widely consumed throughout the world. They are sold at markets, street shops and hawked at motor parks and schools where they could be bought and consumed by people of all ages (Ayo and Gaffa, 2002) [6]. Biscuits are one of the most consumed cereals food apart from bread, because they are readily available in local shops as ready to eat, convenient and inexpensive food products containing digestive and dietary principles of vital importance Biscuits are produced as nutritive snacks from unpalatable dough that is transformed into appetizing products through the application of heat in the oven (Olaoye *et al.*, 2007) [22]. Efforts are made to partially replace wheat flour with non-wheat flours as a possibility for increasing the utilization of indigenous crops cultivated in Nigeria as well as contribute to lowering cost of bakery products. (Mepba *et al.*, (2007) [19].
Almond (*Terminalia catappa*) is one of the lesser known legumes found in the tropics and in Nigeria ecosystem. Almond is a large deciduous tree that thrives as an ornamental tree. Almonds are rich in healthy fat, protein, minerals and vitamins. It is also used by many rural dwellers in southern Nigeria to fortify the local complimentary foods, which are usually low in protein. (Mbah *et al*., 2013) [18].
Coconut (*Cocos nucifera*) is a member of the family Arecaceae (palm family) and the only species of the genus *Cocos* (Bawalan, 2000) [8]. Coconut plays an important role in the diet of people in Nigeria supplying about 22% of the total calories. Coconut flour is from coconut residue, a by-product of coconut milk extraction. The whitish residue that remains after the extraction of coconut oil from cold press can be milled to flour (Bawalan, 2000) [8]. It is extremely high in fiber with almost double the amount found in wheat bran (Barrett and Ramaswamy, 2004) [7]. Coconut flour provides not only value added income to the industry but also a nutritious and healthy source of dietary fibre, free of trans-fatty acids and low in digestible carbohydrates, it plays a role in controlling cholesterol and sugar levels in blood (Masa, 2001) [17]. Wheat (*Triticum aestivum*) is the third most important cereal crop after maize and rice, with world production of 695 million metric tons annually (FAO, 2013) [11]. Among the cereal flours, wheat is extensively used for bread making apart from its other uses.
The unique cookies properties of wheat flour are due to its gluten protein when hydrated, it forms strong, cohesive dough that retains gas and produces a light, aerated baked product (Hoseney, 2008) [13]. Wheat grain contains all essential nutrients; 12% water, carbohydrates (60-80%), proteins (8-15%) containing adequate amounts of all essential amino acids (except lysine, tryptophan and methionine), fats (1.5-2%), minerals (1.5-2%), vitamins and 2.2% crude fibers. Animal and animal products are very expensive as source of nutrients in developing countries. Discovery of alternative protein sources is a major need in Africa and Nigeria in particular. Food seeds and nuts rich in protein and vitamins will effectively reduce the level of malnutrition (Tropilab, 2015) [24] This objectives of the research is an effort aimed at production of biscuit from wheat, coconut and almond seed composite flour. And also to determine the sensory characteristics and proximate quality of the biscuit produced, so as to ascertain it nutrient and overall acceptability.

Materials and Methods
Source of Material
All ready processed wheat flour used in this study was purchased in Ilaro and the coconut with other baking materials such as granulated sugar, salt, leavening agent, shortening (butter/fat) were purchased at the local market in Sayedero market, Ilaro. Almond seeds were picked in a neat environment at the east campus, it was cracked with a mallet, packed in sterile polythene bag and it was later transported to the food processing laboratory for further processing.

Preparation of sample

Almond flour preparation

Almond seeds were conditioned for about 1 to 2 minute, and allow to cool. The almond was allow to completely dry in hot air oven 60°C for 12hours. Once dried, the almond seed was placed inside a food processor blender for 2 to 3 minutes. It was pulsed until finely textured flour was achieved. It was sieved, package and stored in air tight container until used as shown in Fig. 1(a).

Coconut
↓
Grating
↓
Partial milk extraction/spinning
↓
Partially defatted sepal
↓
Drying
↓
Pressing
↓
Flakes
↓
Grinding
↓
Coconut flour

Fig 1(a): Flow chart for the production of coconut flour

Coconut flour preparation

Coconut was cracked, washed and then subjected to grating. Through the grating process, coconut milk was extracted and then spinned. The coconut residue was later defatted.

The residue was then subjected to drying in the hot air oven 60°C for 6 hours. The coconut flakes was milled and sieved. Finely textured coconut flour was later obtained and packaged in airtight container until it was used as shown in Fig. 1(b).

Fresh almond seed
↓
Sorting
↓
Washing
↓
Breaking/Cracking of seed (endocarp)
↓
Washing
↓
Boiling
↓
Duhulling
↓
Drying (using cabinet dryer)
↓
Blending
↓
Packaging
↓
Storage

Fig 1(b): Flow chart for the production of almond flour

Biscuit Preparation

Coconut-almond flour was incorporated to replace refined wheat flour at different ratios (100:0:0, 80:10:10, 70:15:15, 60:20:20 and 50:25:25) in preparation for biscuits. 100% wheat flour serve as the control. Biscuits were produced from the five formulations using the method described by (Ihekoronye, 1999) and modified. All the ingredients were weighed accurately. The pre-weighed flour, sugar, salt and baking powder were mixed thoroughly. Then shortening and egg were added and mixed properly to make adequate dough and then the dough was rolled to a uniform sheet of thickness. The sheet was cut according to the desired shape and size of biscuits with a cutter and baked in the oven at a temperature of 220 °C for 15 mins. The biscuits were allowed to cool for 30 minutes and stored in polyethylene bags before further analysis as shown in Fig 2.

Ingredient weighing
↓
Mixing
↓
Molding
↓
Cutting
↓
Baking
↓
Cooling
↓
Packaging
↓
Biscuit

Fig 2: Flow chart for the production of biscuit

Proximate Analysis

Determination of moisture content

The moisture content of the biscuit samples were determined according to AOAC (2000) [4] method. Five grammes (5g) of the samples were accurately weighted into an evaporating dish and dried in an oven at 105^0c for 3hrs. The samples were cooled in a desiccator and weighted. The process of heating, cooling and weighting was repeated after every 30 minutes interval until a constant weight was obtained. The moisture content was then calculated as follows

$$\%\text{moisture} = \frac{W_1 - W_2}{W_1 - W_2} \text{ X } \frac{100}{1}$$

Where;

W_0 = weight of petri dish in grams

W_1 = Weight of petri dish in grams and sample before drying

W_2 = Weight of petrri dish in grams and sample after drying.

Determination of Crude Fibre

Five grammes (5g) of samples was weighted into a 500ml Erlemeyer flask and 100ml of TCA digestion reagent was added. It was then brought to boiling and refluxed for exactly 40 minutes from the tie boiling commenced. The flask was removed from the heater, cooled a little and filtered through a 15.0cm No. 4 Whatman paper. The residue was removed with a spatula and transferred to a dessicator and weighted after cooling. It was ashed in a muffle furnace at 500^0c for 6hrs, allowed to cool and reweighted (AOAC, 2000) [4].

$$\%\text{crude fibre} = \frac{W_1 - W_2}{W_0} \text{ x } \frac{100}{1}$$

Where;

W_1 = Weight of dried sample + dish

W_2 = Weight of dish

W_0 = Weight of sample initially

Determination of Ash content

The ash content of the sample was determined by using AOAC (2000) [4] method. Five grammes (5g) of the samples were weighted into crucible in triplicate. The sample was placed in the muffle furnace at 50^0c until a high grey ash as observed and constant weight obtained. The sample was cooled in the desiccator to avoid absorption of moisture and weighted. The ash content was calculated as follows:

$$\% \text{ ash content} = \frac{W_2 - W_1}{W} \times \frac{100}{1}$$

Where;
W_2 = Weight of sample and crucible before ashing
W_1 = Weight of sample and crucible after ashing
W_0 = Weight of sample

Determination of Fat content

Fat content determined using the method described by AOAC (2000) [4]. Five grammes (5g) of the samples were weighted and wrapped up in a filter paper. It was then placed in the extraction thimble. Fat extraction unit was cleaned, dried in an oven and cooled in the desiccator before weighting. Petroleum either (25m) was measured into the flask and the content were then cooled in a desiccator and weighted. That fat content was calculated as follows;

$$\%\text{fat content} = \frac{X - Y}{Z} \times \frac{100}{1}$$

Where;
X = Weight of fat + flask
Y = Weight of flask
Z = Weight of sample

Determination of crude protein

The protein content determination of the sample were carried out using micro kjedhal method as described by AOAC (2000) [4] which consist of wet digestion, distillation and titration. The protein content was determined by weighting 3g of sample into boiling tube with 25ml concentrated sulphuric acid and one catalyst tablet (5g K_2SO_4, 0.15g $CuSO_4$, 0.15g T_1O_2). They were heated at low temperature for digestion to take place. The digestion was diluted with 100ml of distilled water, 10ml of 40% NaOH and 5ml of NaS_2O_3 anti-bumping agent were added, after which the component was diluted into 10ml of Boric acid.

$$\%\text{Protein} = \frac{\text{(Actual Titre values – Titre of Blank) x 0.1N of HCL x 0.014 x conversion factors}}{\text{weight of sample}} \times 100$$

Determination of total carbohydrate content

The total carbohydrate was determined between 100 and total sum of the percentage of fat, moisture, ash, crude fibre and protein contain (AOAC, 2000) [4].

Sensory Evaluation

The sensory evaluation of the biscuit samples was carried out for consumer acceptability and preference using 10 semi-trained panelist comprised of students and staff of Food Technology Department, The Federal Polytechnic, Ilaro. They were to evaluate the sensory properties based on Taste, Flavor, Crispiness, Appearance and Overall acceptability using a nine point Hedonic scale where 1 represents "extremely dislike" and 9 "extremely like" respectively.

Statistical Analysis

Analysis of variance (ANOVA) was performed on the data gathered to determine differences, while the least significant test was used to detect significant differences among the means.

Results and Discussion

Results

Table 1: Proximate composition of biscuit made from coconut-wheat-almond flour (%)

Sample	Moisture	Ash	Fat	Fibre	Protein	Carbohydrates
A	5.15+0.03	5.24+0.02	6.20+0.02	1.85+0.04	4.65+0.10	79.39+0.15
B	6.42+0.02	4.12+0.01	8.35+0.02	1.24+0.03	6.03+0.01	76.51+0.09
C	7.92+0.04	3.38+0.05	11.5+0.02	1.07+0.01	9.48+0.02	73.13+0.01
D	8.48+0.02	2.34+0.01	15.9+0.01	0.94+0.03	11.55+0.41	68.29+0.05
E	8.26±0.04	1.89+0.01	18.9+0.01	0.87+0.01	15.54+0.02	63.54+0.09

Data are mean value of duplicate determination + Standard deviation
Key: A = Biscuit From 100%Wheat flour.
B = Biscuit From 80%Wheat, 10% (coconut and almond flour each).
C = Biscuit From 70%Wheat, 15% (coconut and almond flour each).
D = Biscuit From 60%Wheat, 20% (coconut and almond flour each).
E = Biscuit From 50%Wheat, 25% (coconut and almond flour each).

Table 2: Sensory Evaluation of Biscuit Made From Coconut - Wheat-Almond Flour

Parameter	Sample A	Sample B	Sample C	Sample D	Sample E
Aroma	7.5^{ab}	7.3^{ab}	6.9^{b}	7.2^{ab}	7.5^{ab}
Taste	8.1^{a}	7.8^{a}	8.0^{a}	7.1^{ab}	8.1^{a}
Appearance	7.2^{ab}	7.1^{ab}	6.9^{b}	7.1^{ab}	7.3^{ab}
Crispiness	7.8^{a}	7.7^{a}	7.3^{ab}	6.8^{b}	6.5^{b}
Overall acceptability	8.3^{a}	8.1^{a}	7.7^{ab}	7.6^{ab}	7.2^{ab}

Value of sensory evaluation with superscript of not significant differences at ($p<0.05$) of the biscuit

Discussion of Results

Proximate Analysis

This study determines proximate and sensory analysis of biscuit made from wheat-dry almond seed and coconut flour. Table 1 shows the result of proximate composition of biscuit from wheat-wheat almond seed and coconut flour. There was significant increase in the moisture, fat and protein content of the biscuits. The moisture content of the biscuits ranged from 5.15 ±0.03 to 8.48± 0.02 with wheat-almond and coconut flour having the highest moisture content. The lowest moisture content of the sample is ratio 100% whole wheat flour. The high moisture content is an indication that the product cannot be kept for a long period of time before microbiological degradation set in (Echendu *et al.,* 2004) [10]. The ash content ranged from 1.89±0.01 to 5.24± 0.02 with sample 50:10:10% has the lowest ash content and 100% whole wheat flour has the highest ash content. This is as a result of noticeable ash content in the wheat flour, which shows the presence of some minerals in the flour samples. The fat content ranged from 6.20±0.02 to 18.90±0.01 there is significant increase in the fat content as the level of almond and coconut flour increases and this could have contribute to the high energy values. This finding is also in line with the findings of Hagenmaier (2003) [12] who work on coconut flour and wheat flour cookies respectively. The crude fibre content ranged from 0.87±0.01 to 1.85±0.04 with the sample with 50% wheat flour has the lowest. The crude fibre of this biscuits were within the recommended range for diets of not more than 5g dietary fiber per 100g dry matter (FAO/WHO, 1994) and would enhance gastrointestinal tract and cardiovascular health (Bibiana *et al*., 2014) [9]. Fibre aid lowering the blood cholesterol level and slows down the process of absorption of glucose, thereby helping in keeping blood glucose level in control (Anderson *et al*., 2009) [3]. It also ensure smooth bowel movement and this helps in easy flushing out waste product from the body, increase safety and hence impacts some degree of weight management. The protein content ranged from 2.17±0.03 to 6.54±0.02 with the increase in protein content as the increase in almond and coconut flour was noticeable. The variation in this result can be attributed to their original raw material. Coconut flour on fresh dry basis are noted to contain 17.5% of protein according to (Arancon, 1999) [5]. Coconut flour do not form gluten, incorporation of wheat help to make the dough tougher. The fermentation processing could have resulted in increase in protein content. The carbohydrate content ranged from 63.54±0.03 to 79.39±0.09 as the carbohydrate content decreases as the level of substitution of coconut and almond flour increase. The same trend was observed by (Iwe, 2000) and wheat flour supplemented with cowpea flour (Okaka and Isieh, 1990) [21]. The higher level of protein in the blends is nutritionally significant since biscuit consumption is very high among Nigerians.

Sensory Properties

Table 2, shows the result of sensory evaluation of biscuit made from coconut-wheat almond flour. The quality assessment is based on the aroma, appearance, taste, crispiness and overall acceptability. It was observed that significant difference exist at 5% confidence level ($p<0.05$) in the aroma, taste, appearance and overall acceptability. The variation in the sample is due to the addition of almond and coconut flour which was not commonly eaten by the people before. Significant different do not occur in the crispiness at 5% confidence level ($p<0.05$). The result of sensory evaluation of biscuit made from wheat coconut almond flour shows that there was significant difference ($p<0.05$) in Aroma. Samples A and E have the highest mean score of 7.5 % while sample C recorded the least mean of 6.9% this shows that samples A and E are the most preferred in terms of aroma. Flavour is the main criteria that makes the product to be liked and disliked. (Ojinnaka and Agubolum, 2013) [20].

There is significant difference in Taste, samples A and E have the highest mean score of 8.1% while sample D has the least mean count of 7.1%. The sensation of taste and smell are function of flavour which is a complex of sensations (Iwe, 2007) [15]. Significant difference exist in Appearance. Sample E has the highest 7.3% while samples B and D have the lowest 7.1%. In cripsiness, Sample A has the highest score of 7.8% and sample E with the least score 6.5%. Overall acceptability of sample A has the highest score of 8.3% and sample E has the least score of 7.2%. The analysis of variance shows that the coconut-almond biscuits were not significantly different ($p<0.05$) from the wheat biscuit up to 10% in terms of all sensory attributes but it was observed that significant difference exist at 5% confidence level ($p<0.05$) in the aroma, taste, appearance crispiness and overall acceptability. The variation in the sample is due to the addition of almond and coconut flour which was not commonly eaten before by most people. The sensory result is similar to the findings of Ojinnaka and Agubolum (2013) [20] who reported in the sensory that increase in level of cashewnut in cookies resulted in significant decrease in the sensory attribute of the biscuits. Similar findings were also made by Abu-salam and Aboluarb (2011).

Conclusion

This research work has shown that acceptable ready to eat biscuits could be produced from wheat-almond seed and coconut flour blends. These composite flour and their products were good sources of ash which shows the presence of macro mineral, fat and dietary protein. Supplementation of wheat flour with dried almond seed and coconut flour increased protein content of the biscuit produced as compared to the counterpart control wheat flour products. The increase in fat content is explained by the addition of almond and coconut flour at increasing levels. However, as the increase in coconut and almond seed flour also notably decreased the carbohydrate of the products.

The sensory qualities of the biscuit clearly depicts the acceptability of biscuit made from the 100% wheat flour were generally acceptable followed closely by sample B 80% wheat 10% coconut and 10% Almond flour than the other biscuits samples. This research has clearly depicted the possibility of utilizing coconut and almond flour with wheat baked product. This would support industrial utilization and the consumption of under-utilized crops such as coconut and almond.

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