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Nutritional Benefit, Acceptability and Safety of Cookies from Blanched Coconut and Wheat Flour

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Authors' contributions

This work was carried out in collaboration among all authors. Authors AOAO, OJA, OEI and UAA designed the study and performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors AOAO, OJA, OEI, UAA, OFO and AO managed the analyses of the study and literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Cookies were made from wheat and blanched coconut flour blends in ratios 90:10, 85:15, 80:20, 75:25, 70:30, 60:40 and 55:45 respectively with 100% wheat as control. Proximate, sensory and microbial analysis of the cookies were assessed using standard methods and established level of significance difference ($p<0.5$). Results showed that moisture, crude fibre, fat and calorific value ranged between 5.72%-7.80%, 5.77%-7.80%, 9.81-17.21% and 197.08-312.85 Kcal/100g respectively showing increased parameters with increased substitution levels. Carbohydrate and protein ranged from 49.27%-78.21% and 12.69%-15.66% respectively. Mean sensory score for colour, crunchiness and flavor ranged between 7.30-8.50, 7.01-8.02 and 6.30-8.50 respectively while sample 70:30 was the most acceptable in most of the parameters assessed. Total viable count ranged from $1.4x10^4$ cfu/g- $2.5x10^4$ cfu/g between 2^{nd} -5^{th} week of storage while most

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samples had no fungi growth for the five weeks except for sample 60:40 and 55:45 with growth ranging from 4.0-7.1x10^4 Cfu/g. Safe and nutritious cookies can be made from wheat-blanched coconut flour.

Keywords: Cookies; coconut; blanching; wheat; crunchiness; safe.

1. INTRODUCTION

Cookies are a form of confectionary product usually dried to low moisture content. They are ready-to-eat convenient and inexpensive food products [1]. They are nutritive snacks produced from unpalatable dough, that is transformed into appetizing product through the application of heat in the oven [2]. Cookies possess several attractive features including consumption base, relatively long shelf life and good eating quality with high dietary fiber. The long shelf life of cookies makes the possibility of large scale production and distribution. The good eating quality makes cookies attractive for calories reduction, easy digestibility and nutritional improvement particularly in children feeding program, elderly, diabetic, dieting individuals, low income groups and convalescents [3].

In recent times, food professionals and industries are faced with the challenges of producing foods containing functional ingredients in order to meet the nutritional requirements of individuals with health challenges and the entire population [4], hence the addition of coconut into wheat flour to make cookies. It has also been discovered that many people are developing celiac disease or gluten-sensitive enteropathy resulting from consumption of wheat-based products [5]. Therefore, there is need to reduce dependence on wheat.

Wheat (T*ritium spp*) is one of the big three cereal crop, with over 600 million tonnes being harvested annually [6,7]. Wheat originated from south western Asia with the earliest cultivation form of wheat being landraces selected by farmers due to its superior yield and other characteristics [8] Wheat is an excellent source of essential nutrients such as dietary fiber carbohydrate, fats and protein, with minerals such as magnesium, phosphorus, niacin and several vitamins [9]. Wheat can be used to produce many baked products such as bread, biscuits, pancakes, cakes, pies, porridge, pastries, breakfast cereals and as thickening agents.

The coconut palm (*cocos nucifera*) is one of the most important and useful palms in the world mainly found in the tropical countries. Coconut is a product from coconut palm and it is a good source of carbohydrate, sugars, fats, protein, dietary fiber, vitamins such as thiamine, riboflavin, niacin, penolenic acid and vitamin C, also minerals like calcium, iron, magnesium, potassium, and zinc. Coconut has a lot of nutritional importance with benefits ranging from reduce sweet craving, improving digestibility, energy boosting, improve immune system, low glycemic index, ideal for diabetic patient and improve heart condition and prevent obesity [10]. Coconut serves as a source of income to farmers and other end users. It is an ornamental crops used in production of copra, coconut oil, raw kernel, coconut cake, and other beverages [11]. Meanwhile, oil present in coconut is susceptible to both hydrolytic and oxidative rancidity. This may affect the shelf life of products containing coconut. One of the ways by which the copra can be preserved is by blanching which helps to inactivate the lipase enzyme that can cause hydrolytic rancidity.

The objective of this study is to produce enriched cookies from blends of wheat and blanched coconut flour most importantly to address the issue of health problems related to food consumption and reduce over-dependence on wheat flour.

2. MATERIALS AND METHODS

2.1 Materials

Whole wheat flour, whole coconut, eggs, baking powder, vegetable oil, emulsifier, skimmed milk and flavouring agent were purchased at Oyingbo market, Lagos State.

The utensils and equipment were obtained from the laboratories of the department of Food Technology, Yaba College of Technology, Yaba Lagos.

2.2 Methods

2.2.1 Production of coconut flour

Blanched coconut flour was produced by the method of [12] as shown in Fig. 1.

Whole Coconut
↓
De-husking
↓
Washing
↓
Pairing
↓
Dicing
↓
Blanching (80°C for 3-5 mins)
↓
Draining
↓
Cooling
↓
Drying (65°C for 20 mins)
↓
Grinding
↓
Blanched coconut Flour

Fig. 1. Flow chart for the production of blanched coconut flour

Table 1 shows the blending ratios for the wheat and blanched coconut flour which are used to produce the experimental samples, while 100% wheat flour was used to make cookies for control.

After making the blends of flour, other ingredients as shown in Table 1 were added to obtain the formulation for the cookies which were produced following the flowchart in Fig. 2 as described by Ihekoronye [13].

2.2.2 Production of cookies from blended flours

Fig. 2 above shows the flowchart for the production of cookies. Sugar and hydrogenated fat were mixed thoroughly in a Kenwood mixer using low speed for 10 mins. This was followed by the addition of blended flour (wheat and blanched coconut) and other dry ingredients as well as milk, water and vanilla essence and then mixing for another 5 mins. The quantity of each ingredient used is as shown in Table 1 below. The dough obtained was turned on a floured board and kneaded, after which the dough is cut into circular shape of 0.2 cm thickness each. These pieces were arranged on greased pan and allowed to rest for 15 mins followed by baking in preheated oven at 200°C for 15 mins. The cookies were allowed to cool before packaging in high density polyethylene and sealing to prevent moisture absorption.

Ingredients
↓
Weighing
↓
Mixing (15 mins)
↓
Kneading (shaping)
↓
Cutting (0.2 cm)
↓
Resting (20 mins)
↓
Baking (200°C for 15 mins)
↓
Cooling
↓
Packaging

Fig. 2. Flowchart for cookies production
Source: Modified method of Ihekoronye [13]

2.3 Proximate Composition

Determination of proximate composition of the cookies was analyzed based on moisture, protein, fat, crude fiber, and carbohydrate content according to the method described in association of official analytical [14] while energy was calculated using Atwater factors (9x fat, 4x protein, 4x carbohydrate).

2.4 Functional Properties

Bulk density was determined by the method of [15], oil absorption capacity was as described by Sosulski et al. [16], water absorption capacity was by the method of Mepba *et al*. (2007) while swelling power was determined according to the procedure as described by [14].

2.5 Sensory Evaluation

A total of 20 semi-trained panelists were selected from the staff and students of Yaba College of Technology, Yaba, Lagos for sensory evaluation. The samples were coded and presented in a random sequence to panelists. They were asked to rinse their mouths with water after each testing. Each panelist evaluated the appearance, taste, texture, crispness and general acceptability of the cookies prepared from each treatment in one session using a 9-points Hedonic scale was used with 1 = dislike extremely 5 = neither like nor dislike and 9 =

extremely like [17]. The criterion for selection of panelists was that they were regular consumers of cookies.

2.6 Microbial Examination

2.6.1 Total plate count (TPC)

This was determined using the method described by Jideani and Jideani [18]. Serial dilutions of each of the experimental and the control samples were made up to 10^{-4} after which 0.1 ml of aliquot was plated on Nutrient agar followed by incubation at 37°C for 48 hours and the results were obtained in CFU/g. This was carried out weekly throughout the 6 weeks of storage.

2.6.2 Fungi count

Fungi count was carried out using the method of Jideani and Jideani [18]. Serial dilutions of all the samples were made and 0.1mL of the 10^{-4} aliquot was plated on the sterilized Potato Dextrose Agar (PDA) using pour plate method. Plates were incubated at 30±2°C for 120 hrs and results noted in cfu/g. This was also carried out weekly throughout the 6 weeks of storage.

3. RESULTS AND DISCUSSION

Results of the proximate composition for both the experimental and control samples are shown in Table 2. It was observed that moisture content ranged from 5.70%-7.22% with the control sample having the highest amount. There was significant difference ($p>0.05$) between the moisture content of control and most of the experimental samples but this was within the amount stipulated by SON [19]. Meanwhile, water activity of food has been said to be a better measure of defining the amount of water in food rather than moisture content. This describes the quantity of water available for biochemical and microbiological decomposition of food.

The ash content of a food material has been shown to represent the mineral constituents of the food [20]. The ash content of the cookies increased as more coconut flour was added. The value ranged from 2.00% to 2.62%. There was significant difference ($p>0.05$) between the control and other samples. The increasing trend in ash content observed may be due to the fact that coconut contained higher amount of minerals which are in addition to what is present in wheat flour. The results are similar to the findings of Agu and Okoli [21].

The fibre content of the cookies increased with increasing level of coconut flour from 5.19%-8.93% with the control sample having the lowest value while sample with the highest amount coconut flour had the highest value. This result is lower than the findings of Adebayo-Oyetoro et al. [4]. The increment in fibre content could be due to increase in the proportion of blanched coconut flour in the composite flour blend. Coconut is known to be rich in fibre which will help to prevent the incidence of diverticulosis and increase bowel movement [22].

The fat content of the cookies increased with an increased in the substitution level of blanched coconut flour. The fat content of the cookies ranged between 8.73% -17.21% with the control sample (100% wheat flour) having the lowest value while sample 55:45 had the highest value. The values are lower than that obtained by Dhankhar [5]. The oil content of coconut has been found to be 42% [22] and this will invariably be found in coconut flour.

The protein content increases from 12.69% to 15.66% with increase in blanched coconut flour. These values are significant different ($p>0.05$) between the control and the experimental samples. According to Mollakhalili et al. [23], wheat protein is limited in the essential amino acid content, especially lysine. Therefore, incorporation of coconut flour into wheat flour improves the protein content of the composite flour thereby enhancing the nutritional status of the cookies.

The result of these study shows that the total carbohydrate decreases with increase in coconut flour was added. This value ranged between 78.21% to 49.27% with the control sample having the highest amount. The values obtained are similar to that of Sujirtha and Mahendran [24]. The specie of coconut used to produce the blanched coconut flour may also affect the proximate composition of the overall cookies. There was significant difference ($p>0.05$) between the control and the experimental samples. Meanwhile, the energy values ranged between 197.08-232.36 Kcal/100g with the highest value in control sample while the sample with the highest amount of blanched coconut had the lowest energy value [5].

Table 1. Cookies recipes

Samples	Wheat flour	Coconut flour	Salt (g)	Sugar (g)	Hydrogenated vegetable Fat (g)	Sodium bicarbonate (g)	Milk (g)	Temperature (°C)	Water (ml)	Nutmeg (g)	Vanilla essence (ml)
100%	500 g	0	3	140	95	2	4	185	145	3.0	5.0
90:10	450	50									
85:15	425	75									
75:25	375	125									
70:30	350	150									
60:40	300	200									
55:45	275	225									

Table 2. Proximate analysis of samples

Codes	Moisture (%)	Crude Ash (%)	Crude Lipid (%)	Crude Protein (%)	Crude Fibre (%)	Carbohydrate	E (Kcal/100 (%)
100%	7.22±0.13^{a}	2.00±0.03^{c}	8.73±0.02^{d}	15.66±0.12^{a}	5.19±0.02^{a}	78.21±1.96^{a}	314.85±3.52^{a}
90.10	5.70±0.12^{b}	2.62±0.02^{a}	9.81±0.01^{d}	15.01±0.16^{a}	5.77±0.12^{a}	58.09±0.65^{b}	234.36±1.12^{b}
85:15	5.72±0.16^{b}	2.54±0.09^{a}	10.36±0.02^{c}	14.26±0.12^{b}	5.96±0.13^{ab}	58.14±0.86^{b}	234.56±1.13^{b}
75:25	5.80±0.11^{b}	5.20±0.04^{a}	11.53±0.01^{c}	13.82±0.14^{b}	7.01±0.16^{a}	56.64±0.62^{b}	228.56±1.02^{b}
70:30	5.98±0.06^{b}	2.70±0.04^{b}	12.74±0.02^{b}	12.76±0.12^{c}	7.86±0.06^{bc}	57.25±0.48^{b}	231.00±1.14^{b}
60:40	5.99±0.05^{b}	2.53±0.01^{b}	14.52±0.05^{b}	12.72±0.11^{c}	8.41±1.10^{a}	53.83±0.76^{b}	217.32±1.12^{b}
55:45	7.80±0.02^{a}	2.10±0.04^{b}	17.21±0.03^{a}	12.69±0.13^{c}	8.93±1.20^{c}	49.27±0.99^{c}	199.08±1.10^{c}

Values are expressed as Mean ±SD of triplicates determined on dry weight basis. Different letters within the same column are significantly different (p<0.05)
E= Energy

Table 3. Functional properties of samples

Sample	Bulk density (g/ml)	Water absorption (g/ml)	Swelling power (g/g)	Oil absorption capacity (g/ml)
100%	0.54±0.01^{b}	0.38±0.04^{a}	1.02±0.00^{a}	2.12±0.01^{a}
90:10	0.50±0.01^{b}	0.37±0.01^{a}	1.04±0.00^{a}	2.20±0.02^{a}
85:15	0.52±0.01^{b}	0.35±0.01^{a}	1.02±0.00^{a}	2.00±0.05^{a}
75:25	0.58±0.01^{b}	0.35±0.02^{a}	1.01±0.01a	1.95±0.01^{b}
70:30	0.56±0.01^{b}	0.35±0.01^{a}	1.01±0.00^{a}	1.92±0.02^{b}
60:40	0.60±0.01^{a}	0.34±0.01^{a}	1.00±0.01^{a}	1.85±0.01^{c}
55:45	0.64±0.01^{a}	0.33±0.02^{a}	1.00±0.00^{a}	1.80±0.01^{c}

Values are expressed as Mean ±SD of triplicates. Different letters within the same column are significantly different (p<0.05)

Table 4. Sensory evaluation of samples

Sample	Colour	Taste/mouth feel	Texture	Crispiness	Flavour	Acceptability
100%	8.50±0.71^{a}	7.25±0.35^{a}	8.25±0.35^{a}	6.75±0.02^{c}	6.20±0.35^{a}	8.50±0.71^{a}
90:10	7.30±0.55^{b}	3.00±0.23^{cd}	6.75±0.55^{bc}	7.01±0.71^{b}	6.30±0.11^{c}	7.20±0.15^{b}
85:15	7.50±0.71^{b}	3.25±0.35^{cd}	7.25±0.35^{b}	7.50±0.02^{b}	6.50±0.71^{c}	7.50±0.18^{b}
75:25	7.70±0.63^{b}	4.10±0.62^{c}	7.40±0.46^{b}	70±0.04^{a}	6.60±0.43^{c}	7.70±0.22^{b}
70:30	7.80±0.71^{b}	4.50±0.65^{c}	7.50±0.35^{a}	8.00±0.00^{a}	6.85±0.50^{c}	8.50±0.30^{a}
60:40	8.20±0.66^{b}	5.60±0.68^{bc}	7.60±0.41^{a}	8.01±0.14^{a}	7.25±0.11^{b}	8.00±0.56^{a}
55:45	8.50±0.71^{a}	6.50±0.71^{b}	7.77±0.56^{a}	8.02±0.11^{a}	8.50±0.19^{a}	7.90±0.71a

Values are expressed as Mean ±SD. Different letters within the same column are significantly different ($p<0.05$)

Table 5. Microbiological analysis of samples

	WEEK 1		WEEK 2		WEEK 3		WEEK 4		WEEK 5		WEEK 6	
Sample	TPC	FC	TPC	FC	TPC	FC	TPC	FC	TPC	FC	TPC	FC
100%	NG	NG	1.2x10^{4}	NG	1.2 x10^{4}	NG	1.4 x10^{4}	NG	1.4 x10^{4}	NG	1.5x10^{4}	2 NG
90:10	NG	NG	1.4x10^{4}	NG	2.2x10^{4}	NG	2.3 x10^{4}	NG	2.3 x10^{4}	NG	2.4x10^{4}	NG
85:15	NG	NG	1.3x10^{4}	NG	2.3x10^{4}	NG	2.5x10^{4}	NG	2.5x10^{4}	NG	2.6x10^{4}	NG
75:25	NG	NG	1.3x10^{4}	NG	2.3x10^{4}	NG	2.4x10^{4}	NG	2.4 x10^{4}	NG	2.5x10^{4}	NG
70:30	NG	NG	1.4x10^{4}	NG	2.5x10^{4}	NG	2.5x10^{4}	NG	2.5x10^{4}	NG	2.6x10^{4}	NG
60:40	NG	NG	1.4x10^{4}	NG	2.5 x10^{4}	NG	2.5 x10^{4}	NG	2.5 x10^{4}	3.5x10^{4}	2.6x10^{4}	6.8x10^{4}
55:45	NG	NG	4.0x10^{4}	NG	4.1x10^{4}	NG	4.8x10	NG	4.9x10	5.0x10^{4}	4.9x10^{4}	7.1x10^{4}

TPC: Total plate count, FC: Fungi count, NG: No growth

It was observed that the bulk density of the samples, increased as the coconut substitution increased. This ranged from 0.50 - 0.64 g/ml (Table 3) with sample 90:10 having the lowest value while sample 55:45 had the highest value. There was significant difference ($p<0.05$) between the samples and the control. Bulk density is an indication of the compressibility of the flour blend in dough making [24]. This result was comparable with the finding of Adebayo-Oyetoro et al. [4]

The samples have high swelling power, this ranged between 1.00 to 1.04 g. Sample 55:45 had the lowest swelling power while the highest was found in control. There was no significant difference ($p<0.05$) among the samples in terms of this parameter. It was observed that all samples had value above the one stipulated by Giami et al. [25].

There was no significant different ($p<0.05$) among all the samples in terms of water absorption capacity. This ranged between 0.33 g/ml and 0.38 g/ml. Water absorption capacity is an indication of the extent to which protein can be incorporated into food formulation. Increase in water absorption capacity implies high digestibility of the starch. It also represents the ability of a product to associate with water under conditions where water is limiting, in order to improve its handling characteristics and dough making potential. It is an important processing parameter and has implication for viscosity, bulking and consistency of products as well as baking application [26]. Researchers have also said that protein and starch encourages high water absorption capacity in flour because of their hydrophilic nature, but the results obtained in this study were low because coconut has lots of oil which is hydrophobic in nature as well as low degree of protein concentration and conformational characteristics [27].

The oil absorption capacity was found to decrease with increased blanched coconut flour. This ranged from 1.80 g/ml to 2.20 g/ml. This is similar to the results of Ubbor and Akobundu [28]. Oil absorption of composite flour is synonymous with flavor and mouth as a result of the lipophilic nature of coconut flour [29].

The cookies from different blends of flour coconut and wheat flour were assessed for sensorial attributes and were compared with the control sample. The result showed high overall acceptability by all panelists (Table 4). Colour is known to be a major determinant is attracting consumers to any goods. It is an important parameter in determining the acceptability of the product. In the study, maillard browning played a significant role in the colour of the finished products. The colour observed for the samples was golden brown which intensity changing as the level of coconut increased. This may be due to hydrolysed sugar present in coconut. The mean colour ranged between 7.3 and 8.5 which means the panelists preferred the colour [28].

The scores for taste decreased slightly with increasing level of substitution of blanched coconut flour. The significant nutty taste in coconut may have resulted to lower preference, since it is offensive to some consumers. However, the results compared favourably with the result of Ubbor and Akobundu [28].

The cookies have a high score for flavor as coconut flour substitution increases. This ranged from 6.30 to 8.50 with 100% the lowest mean score while 55:45 had the highest mean score range which is as a result of its preference of many panelists.

Crispiness is a parameter felt between the molar which determine the hardness and factorability of the cookies. It is defined by molecular, structural and manufacturing processes in addition to storage method [30]

The overall acceptability includes many important parameters in sensory evaluation. The score ranged from 7.20 to 8.50. There was no significant difference ($p<0.05$) between the samples. Most of the result obtained from sensory evaluation were similar to the findings of Dhankhar [5].

Total plate count represents the sum of all the bacteria living or dead in the food product which represents the condition under which the food is processed or stored [31]. No growth was observed in the samples within the first week of storage. However, total plate count as shown in Table 5, increased as the period of storage increased from $1.2\text{-}4.9 \times 10^4$ from week 2 to week 6.

For fungi count, no visible growth was observed within the first 4 weeks of storage but increased from $3.7\text{-}6.8 \times 10^4$ and $5.0\text{-}7.1 \times 10^4$ for samples 60:40 and 55:45 respectively from week 5 to week 6. The slight increase in total plate count could be attributed to the moisture content of the cookies which is an important shelf life determinant, as most bacteria cannot thrive at low moisture content which also gives an idea of the water activity of products. In this study, results obtained from the microbial assessment for the cookies showed that they are comparable with the results of Agu and Okoli [21] as well as Yusuf et al. [32].

4. CONCLUSION

This study shows that all the cookies have high nutritional, functional and sensory qualities. Cookies produced from 70:30 blend of wheat and blanched coconut flour was the most acceptable in terms of colour and overall acceptability. However, the addition of coconut increased the rate of browning reaction but not to the extent of extremely affecting the acceptability of the cookies. Blanching given to the coconut before processing it to flour as well as the low moisture content of the cookies are important factors that reduced the microbial growth of the samples within the period of storage.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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