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Quality Evaluation of a Ready-To-Eat Breakfast Cereal (Muesli) Made from Selected Nigerian Indigenous Food Crops

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Abstract Production of high quality and well packaged multi-cereal product is lacking in Nigerian and muesli which is mostly imported is scantly circulated. Thus, this study aimed at producing and assessing the qualities of muesli made from Nigerian food crops. Muesli was produced from two different combinations of separately processed food crops (i.e cereal, tuber, nuts, fruit) and a commercially produced muesli served as the control. The muesli samples were assessed for their functional properties, nutritional composition, sensory qualities and cost of production. The samples were stored for eight weeks (28°C ±2) during which total bacterial and fungal counts were determined at two weeks interval. All analyses were done in triplicate and data was subjected to Analysis of variance ($P< 0.05$) and means were separated by Duncan Multiple Range Tests. Results showed that the muesli samples had the same bulk density (0.63 ±0.00 g/ml) which was not significantly different from the control (0.61 ±0.00 g/ml) while the swelling capacity (113.33±23.09 % and 106.67±32.32 %) of the two muesli samples was significantly different from the control. The control was significantly different in moisture content (7.21%) and carbohydrate (62.51%) content while the muesli samples were significantly different in crude protein (9.93 %), crude fat (14. 67 %), crude fibre (7.05 %), ash content (6.13 %), and energy (394.03 Kcal). At the end of the storage period the total bacteria count was 3.0×10^{-1} and total fungal count was 2×10^{-1} for the muesli samples while there was no growth in the control. The muesli samples were not significantly different from the commercial muesli in colour but were significantly different in other sensory attributes. The cost analysis showed the retail price of commercial muesli to be 192 % to 203 % of the production cost of the muesli samples.

Keywords: *grains, tuber, nuts, fruits, breakfast, muesli*

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1. Introduction

The ready to eat breakfast cereal belong to the category of foods that are inherently stable and have a long shelf life [1]. The advantage of ready-to-serve or ready-to-eat breakfast food is not only that it is time saving, but it also exclude all the demands of food preparation and these advantages, supplemented by the attractive flavour and crispiness of the products are responsible for its popularity. Breakfast cereals are very numerous in the market, some are sweetened to a level appropriate for use without further addition of sugar [2] and examples of ready-to-eat breakfast cereal include granola, rice krispies, corn flakes, cheerios, muesli etc.

The current Nigerian market for cereals is largely dominated by single grain products (mostly corn flakes). Modern business providing high quality well packaged African multi-cereal whole-grain product is lacking in Nigerian despite the important health benefits of such products. Thus, there is a need for food businesses with the objective to develop, produce and package novel food products from local raw materials that are native to Nigeria. Over the past years, Nigerians preference is changing towards more quality and well-packaged food. Consumption patterns are changing in line with the strong growth of the middle class. Cereals are standard staple items in daily Nigerians diet and it is convenient for many Nigerians. Hence factors like cultural attachments, health and nutritional advantages indicate a strong potential market for a well packaged fortified multi-cereal whole-grain meal. However, processing of these traditional African grains for food is getting too little innovation and investment at a commercial level, especially in the area of convenience-type foods aimed at the rapidly growing middle-class urban population [3].

Muesli was developed around 1900 by Swiss physician Maximilian Bircher-Benner for patients in his hospital, where a diet rich in fresh fruit and vegetables was an essential part of therapy. Muesli in its modern form became popular in western countries starting in the 1960s

as part of increased interest in healthy food and vegetarian diets. Muesli is a breakfast and brunch dish based on raw rolled oats and other grains, fresh or dried fruits, seeds and nuts and it contain all of the basic nutrients: carbohydrates, protein, fat, minerals, vitamins and fibre [4,5]. Muesli may be mixed with cow milk, soy milk, almond milk, other plant milk, and yoghurt or fruit juice. It is not doused in any sweeteners or oils to aid in the baking process because there *is* no baking process. So it tends to be a lighter, healthier option than granola in that it is cool, it is quick, and it is healthy [6].

Muesli is not among the list of products produced by leading breakfast cereal industries in Nigeria though there is possibility of small scale industries to be producing the product however, it is not widely circulated. In a survey conducted in an urban area prior to this research it was found that 80 % of the respondents were not aware of the product. Hence, this research aimed at producing muesli from multi grains and other crops that are indigenous to Nigeria which will perhaps help our cereal companies to give a thought to utilization of our crops in this manner. There will also be firsthand information on the nutritional and sensory qualities of muesli produced from combination of different Nigerian indigenous crops

2. Materials and Methods

2.1. Materials

The raw materials were obtained from Babcock University Superstore and Ilishan- Remo market, Ogun State. The materials used were divided into three (3) groups; Grains/ tuber, Nuts, and Fruit. Grains and tuber group include; maize (*Zea mays*), wheat (*Triticum aestivum*), sorghum (*Sorghum bicolour*), tiger nut (*Cyperus esculentus*). While the nuts were groundnut (*Arachis hypogaea*) and coconut (*Cocos nucifera*) and the fruits were banana (*Musa acuminata*), paw-paw (*Carica papaya*) and dates (*Phoenix dactylifera*).

2.2. Processing of the Grains/Tuber

The method used for the muesli production was developed from information obtained from MacEacheran [3], Australian Food History Timeline [4] and Troughton [6] about production of muesli. Before processing, the cereal grains and tigernut were properly cleaned and sorted to remove stones, dirt, chaff, bad seeds and other extraneous matter. Wheat and sorghum (350 g each) were boiled with 2.5 L of water separately while 350 g of maize was boiled with 4.5 L of water and 2 g of salt was added to each of them. The density of the water left after boiling was determined in order to know if there was any loss from the grains during boiling. The boiled grains were weighed and combined in ratio 2:1: 2:1 for wheat, maize, sorghum and tigernut before being blended with 1 L of water. This was later dried at 80 °C for 24 h. The process is as described in Figure 1.

2.3. Processing of the Nuts

The brown skin of the coconut was peeled after de- shelling, grated, immersed in sugar syrup, drained and dried at 80°C for 6 h (Figure 2) while the already processed cashew nut was merely crushed into smaller sizes.

2.4. Processing of the Fruits

The banana was peeled and then cut into small cubes after which it was immersed in sugar syrup (to prevent browning) and then drained. The banana was then dried in the oven at 80°C for 24 h. The date and pawpaw fruits were washed, after which the seeds were removed. Then they were cut into small pieces, immersed in sugar syrup, drained and dried at 80 °C for 24 h (Figure 3).

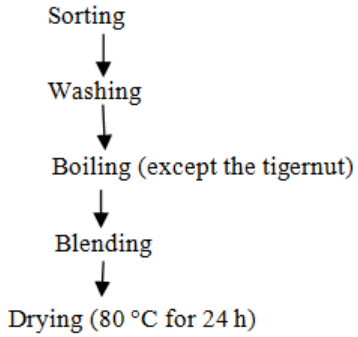

Figure 1. Processing of the cereals (Wheat, Sorghum, Maize, Tigernut)

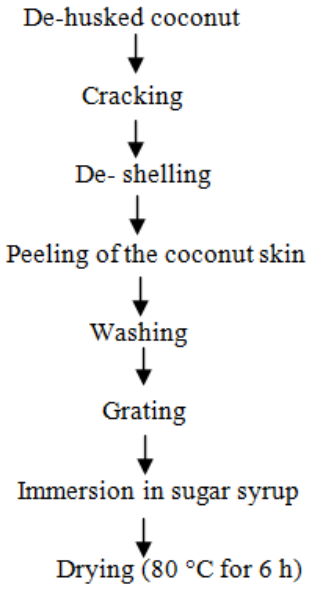

Figure 2. Processing of the coconut

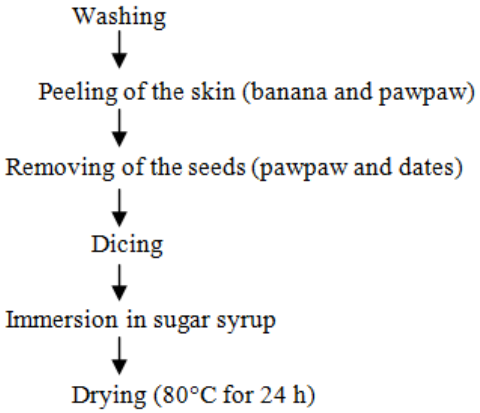

Figure 3. Processing of the fruits

2.5. Production of Muesli

The processed ingredients were stored in clean air-tight containers until required for mixing.

The composition of the muesli was as follows:

Sample 1	
Composition	Ratio
60 % grains (wheat: maize: sorghum : tigernut)	2:1: 2:1
30 % fruits (banana : paw-paw : dates)	1:1:1
10 % nuts (coconut :cashew nut)	1:1
Sample 2	
Composition	Ratio
60 % grains (wheat: maize: sorghum : tigernut)	2:1: 2:1
20 % fruits (banana : paw-paw : dates)	1:1:1
20 % nuts (coconut :cashew nut)	1:1

2.6. Determination of Specific Gravity of the Water Left after Boiling

Fifty millilitre specific gravity bottle was thoroughly cleaned with distilled water, dried in an oven at 50°C and allowed to cool. The weight of the cooled dried bottle (W1) was recorded. The dried bottle was filled with distil water and surface of the bottle was cleaned with a cotton wool and weighed as (W2). The bottle was emptied and rinsed twice before it was filled with 10 ml of the water that was left after boiling of the grains separately. The bottle was cleaned with cotton wool and weighed as (W3) and specific gravity (S.G) was calculated as follows;

$$S.G = \frac{W_3 - W_1}{W_2 - W_1}. [7]$$

2.7. Determination of Bulk Density

Bulk density was determined by a modified method of Nwanekezi et.al, [8]. Each experimental cereal (muesli) was slowly filled into 100 ml measuring cylinder. The bottom of the cylinder was gently tapped on a laboratory bench until there was no further diminution of the sample after filling to 100 ml mark. Bulk density was estimated as mass per unit volume of the sample (g/ml). The mean of triplicate measurements of each treatment was taken as the estimate of bulk density.

2.8. Water Swelling Capacity

The water swelling capacity was determined by the method described by Okaka and Potter [9]. 50 ml graduated cylinder was filled with the sample to the 5 ml mark and distilled water was added to give a total volume of 35 ml. The top of the graduated cylinder was tightly covered and mixed by inverting the cylinder. The suspension was inverted again after 2 minutes and left to stand for further 8 minutes and the volume occupied by the sample was taken after the eighth minute.

2.9. Determination of Nutritional Composition of the Muesli Cereal

The moisture content, ash content, crude protein, carbohydrate content, crude fibre, crude fat of the muesli cereal with commercial muesli cereal were determined. Samples were analyzed chemically according to the official method of analysis described by the Association of Official Analytical Chemist [10]. All analyses were carried out in triplicate.

2.10. Energy Content

Energy content was determined according to Atwater and Woods [11]. It uses a single factor for each of the energy-yielding substrates (protein, fats and carbohydrates), regardless of the food in which it is found. The energy values are 17kJ/g (4.0 kcal/g) for protein, 37kJ/g (9.0kcal/g) for fat and 17kJ/g (4.0 kcal/g) for carbohydrate.

2.11. Determination of Storage Stability

One hundred grams with four replicates of the respective muesli samples was sealed in polythene bags and stored under ambient condition of 28 ± 2°C for eight weeks. The total viable and fungal count was determined using pour plate method [12] at the beginning and at two weeks interval.

2.12. Sensory Evaluation

Muesli samples were compared with the commercially produced muesli by a ten-membered, untrained panel which consists of lecturers and students of Nutrition and Dietetics. The muesli samples produced were soaked in milk for 30 minutes before presenting to the panelists this was because the muesli products were very hard compared to the commercial muesli. The samples were analyzed for odour, colour, taste, texture and overall acceptability. The score was based on a hedonic scale ranging from 1 representing dislike extremely to 9 representing like extremely [13].

2.13. Statistical Analysis

Data obtained were subjected to analysis of variance (ANOVA) and means were separated using the Duncan multiple range tests (SPPS 20.0)

3. Results and Discussion

3.1. Specific Gravity of the Water Left after Boiling the Grains

Specific gravity of the water left after boiling of wheat, sorghum and maize was 0.99, 0.99 and 0.96 respectively. With specific gravity of less than 1, the implication is that food materials were not likely to have been lost in the water.

3.2. Functional Properties of the Muesli Sample

The results (Table 1) of the functional properties of the muesli samples showed that the muesli samples produced from Nigerian food crops were not significantly different in bulk density (0.63g/ml) from the commercial product (0.61g/ml) but differ significantly from the commercial sample in swelling capacity. The swelling capacity of the commercial sample being 73.33 % while the muesli samples had 106.67 and 113.335 % swelling capacity. High swelling capacity of the muesli samples was not desirable in that it may result in the reduction of the nutritional content [14] of the muesli products. The bulk density of the samples were higher than what was reported by Eke- ejiofor et al. [15] for granola, a similar product that is multi-grain.

Table 1. Functional properties of the muesli samples

Samples	Bulk density(g/ml)	Water swelling capacity (%)
A	0.61^{a} ±0.00	73.33^{b}±41.63
B	0.63^{a}±0.00	113.33^{a}±23.09
C	0.63^{a}±0.00	106.67^{a}±32.32

Means with the same superscript along the column are not significantly different (p<0.05)
A: Commercial Muesli
B: Muesli sample with 60% grains/tuber, 10% nuts and 30% fruits
C: Muesli sample with 60% grains/tuber, 20% nuts and 20% fruits.

3.3. Nutrient Content of the Muesli Samples

Nutrient composition of the muesli samples containing different quantities of fruits and nuts made from indigenous food crops was the same. However when compared with the commercially produced muesli, it was found that the test samples were significantly different in protein content (6.78 – 9.93%), Crude fat (11.87 – 14.67%), Crude fibre (6.39 – 7.05%), Ash content (5.25 – 6.13%), and Energy (383.99 – 394.03Kcal). However, the nutrient composition of the muesli samples from indigenous crops could be compared with what was reported by Germline [16] for nutrient composition of commercial muesli. When the nutrient composition was compared with nutritional composition of granola reported by Eke- ejiofor et al. [15], it was found that the carbohydrate and protein content of the muesli test samples was comparable to that of granola while the muesli samples had higher ash and fibre content, granola was higher in fat and energy content. Also, when compared with the report of Agbaje et al. [17] for granola bar it was found that the samples were higher in protein, fat, fibre, ash and energy.

3.4. Storage Stability of the Muesli Samples

The result of the microbial quality of the muesli samples on storage and the commercial muesli showed that there was no microbial growth in the commercial product [18] which was produced seventeen months before the analysis. However, growth ranging from 1.0×10^{1} - 3.0×10^{1} (cfu/ml) was recorded in the muesli from indigenous crops. The total bacterial and fungal count recorded for the samples were still within the limit ($<10^{3}$) for ready to eat foods [19]. The results are as presented in Table 3.

3.5. Sensory Quality of the Muesli Sample

The results of sensory evaluation of the muesli samples are as represented in Table 4. The muesli products from Nigerian indigenous crops were significantly different (P< 0.05) from the commercial muesli in taste, odour, texture and overall acceptability while there was no significant difference in the colour. However, the panelists generally commented on the rancid odour of the commercial product. The overall acceptability of the muesli produced using Nigerian indigenous crops had values of 7.80 ±1.03 and 7.30 ±1.50 while the commercially produced muesli was 4.20±2.25. It is necessary to mention that commercial muesli was scarce and only the one that has been produced few months back was available for this research.

3.6. Cost Analysis of the Muesli Sample

Cost analysis of the muesli samples is as presented in Table 5. The cost of production for sample B (760 g) was 748 Naira while 760g of sample C cost 791 Naira. However the retail price of a pack of commercial sample which is 375 g is 750 Naira thus, 375g of sample B cost 370 Naira while 375g of sample C cost 390 Naira.

Table 2. Nutrient content of the muesli samples

Variables	Samples		
	A	B	C
Moisture content (%)	7.21^{a}±0.03	6.65^{b}±0.07	6.65^{b}±0.07
Crude protein (%)	6.78^{b}±0.11	9.93^{a}±0.06	9.93^{a}±0.06
Crude fat (%)	11.87^{b}±0.02	14.67^{a}±0.02	14.67^{a}±0.02
Crude fiber (%)	6.39^{b}±0.03	7.05^{a}±0.02	7.05^{a}±0.02
Ash content (%)	5.25^{b}±0.02	6.13^{a}±0.02	6.13^{a}±0.02
Carbohydrate (%)	62.51^{a}±0.12	55.57^{b}±0.09	55.57^{b}±0.09
Energy (kcal/g)	383.99^{b}±0.00	394.03^{a}±0.00	394.03^{a}±0.00

Means with the same superscript across the row are not significantly different (p<0.05)
A: Commercial Muesli
B: Muesli sample with 60% grains/tuber, 10% nuts and 30% fruits
C: Muesli sample with 60% grains/tuber, 20% nuts and 20% fruits.

Table 3. Microbiological quality of the muesli samples

	Weeks	Samples		
		A	B	C
Total bacteria	0	-	-	-
(cfu/ml)	2	-	1.0×10^{-1}	1.0×10^{-1}
	4	-	1.0×10^{-1}	2.0×10^{-1}
	6	-	1.0×10^{-1}	2.0×10^{-1}
	8	-	3.0×10^{-1}	2.0×10^{-1}
Total fungal				
(cfu/ml)	0	-	2.0×10^{-1}	-
	2	-	1.0×10^{-1}	2-0 $\times 10^{-1}$
	4	-	1.0×10^{-1}	2.0×10^{-1}
	6	-	2.0×10^{-1}	2.0×10^{-1}
	8	-	2.0×10^{-1}	2.0×10^{-1}

A: Commercial Muesli
B: Muesli sample with 60% grains/tuber, 10% nuts and 30% fruits
C: Muesli sample with 60% grains/tuber, 20% nuts and 20% fruits.

Table 4. Sensory quality of the muesli samples

Samples	Taste	Odour	Colour	Texture	Overall acceptability
A	3.70^{b}±2.67	5.60^{b}±2.01	6.40^{a}±2.50	5.60^{b}±2.12	4.20^{b}±2.25
B	7.80^{a}±1.03	7.90^{a}±0.99	7.40^{a}±0.70	7.40^{a}±1.43	7.80^{a}±1.03
C	7.70^{a}±1.16	7.80^{a}±0.92	7.60^{a}±0.84	7.20^{a}±1.75	7.30^{a}±1.50

Means with the same superscript along the column are not significantly different ($p<0.05$)
A: Commercial Muesli
B: Muesli sample with 60% grains/tuber, 10% nuts and 30% fruits
C: Muesli sample with 60% grains/tuber, 20% nuts and 20% fruits.

Table 5. Cost analysis of muesli from indigenous crops

Food Materials	Sample B Quantity (g)	Price (Naira)	Sample C Quantity	Price (Naira)
Wheat	200	45	200	45
Sorghum	200	40	200	40
Maize	100	40	100	40
Tigernut	100	130	100	130
Banana	40	66	26.7	40
Paw-paw	40	50	26.7	40
Dates	40	38	26.7	40
Coconut	20	34	40	210
Cashew nut	20	105	40	68
Power		100		100
Labour		100		100
Total	760g	748	760g	791

B: Muesli sample with 60% grains/tuber, 10% nuts and 30% fruits
C: Muesli sample with 60% grains/tuber, 20% nuts and 20% fruits.

The cost analysis showed a difference of 360 to 380 naira in the production cost of the muesli samples and the retail price of commercial muesli. The retail cost of the commercial sample was 192 % and 203 % of the production cost of the muesli from Nigerian indigenous crops. The wide margin between the production cost of the muesli samples and the retail price of commercial sample may be more than enough to take care of other expenses in the distribution chain. However, the present cost of muesli in the country is high for many to afford and only those in high class and very few in middle class are likely to be able to afford it. Production of muesli at very low cost by making use of indigenous food crops will be advantageous to its popularity and wide distribution in the country which is in accordance with the production concept [20].

4. Conclusion

The study showed that muesli produced from Nigerian indigenous crops had high swelling capacity, high content of crude protein, crude fat, crude fibre, ash content and energy content with low moisture and carbohydrate content. In addition, it was found that muesli from indigenous crops was more acceptable in taste, odour, texture and in overall acceptability. The cost of production was reasonable when compared to the retail price of the commercial muesli. Production of muesli in the country using indigenous food crops will go a long way in making muesli available at reduced price.

Statement of Competing Interests

The authors have no competing interests.

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