



Sensory Attributes and Proximate Composition of Enriched Cookies Made from Blends of Maize, Millet and Crayfish

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Abstract

Food enrichment involves the addition of micronutrients to food to create a balanced and nutritious product with the outlook of providing essential nutrients. The study assessed the sensory attribute and proximate composition of enriched cookies made from blends of maize, millet and crayfish. three objectives guided the study. Descriptive survey and experimental design methods were adopted. The enriched cookies sample was varied into six major samples while the control comprised 100% maize. The sample product which was made with maize, millet and crayfish was coded according to the formulation ratio as follows; ABU₁(100:0:0), ABU₂(90:0:10), ABU₃(0:90:10), ABU₄(70:20:10), ABU₅(20:70:10), ABU₆ (30:60:10), ABU₇(60:30:10). Proximate composition of the seven cookies samples were assessed using standard methods. Sensory attributes were assessed using a 9-point hedonic scale and general perception of enriched cookies was assessed using a five-point Likert scale where the mean score of 3.00 was used as a cut-off to determine acceptable responses. The result of the proximate analysis showed that moisture content was significantly high in ABU₃ as compared to other samples. Protein content ranged from 1.43±0.04 to 7.03±0.03, also ABU₁ had the highest fat and carbohydrate content. The crude fibre content ranged from 1.97±0.01 to 2.68±0.10 while ash content was higher in ABU₃. Sensory attributes in the cookies sample showed that in terms of aroma and texture, the samples were not significantly different from one another but in terms of taste, they were different. The enriched cookie sample ABU₅ had the highest acceptability. Conclusively, moisture, protein, ash, fat, crude fibre and carbohydrate content of enriched cookies samples were within the normal range for cookies product. It is recommended that other protein-rich ingredients should be used to produce cookies for varieties and sustainable management of its consumers.

Keywords: Sensory attributes, nutrition, proximate composition, enriched cookies, blends.

Introduction

Good nutrition is critical for growth development and children. Malnutrition is a major public health problem, especially in developing countries. It can lead to stunted growth, cognitive impairment, weakened immune system and increased risk of infectious diseases. Various studies have been done on composite blends as a source of better nutrition for children and this inspires the use of the blends in snack products such as cookies that can offer more nutritive value to children thereby resulting in better growth and development. Most of the tropical snacks are based on cereals such as wheat. However, with the high cost of wheat in Nigeria, the use of indigenous crops such as maize and millet in flour blends for snacks needs to be explored.

Maize or corn belongs to the grass family known as *Poaceae* with its botanical name as *Zea mays* L. Maize is one of the most popular cereals crops, which is used for food, fodder and also for medical purposes in the world. More than 3,500 uses of corn products are identified by Huma et al. (2019). Maize products are also a good source of vitamins A, B, and E, and many minerals. It has reduced hypertension and prevented neural-tube defects at birth. According to Hossain et al. (2016), mankind has always utilized crops for its development and survival; achieving nutrition, economic, industrial, and research values from crops. Maize is one of the three most explored food crops by mankind in addition to rice and wheat, owing to the high value derived from the crop. Agba (2016) opined that maize exploration has been high from its point of origin in the Central American tropics

and Mexico to all parts of the globe, with its uses/utilization doubling as the day counts.

Millet is another cereal food that is gaining popularity globally. A study conducted by Kumar et al. (2018) asserted that millet has been used for food and feed from ancient times and has been a staple food, particularly in the diets of African and Asian people. These are consumed as flatbread, porridge, roasted and alcoholic and non-alcoholic beverages. Nigeria uses millions of tons of pearl millet as a staple food, especially in Northern Nigeria. According to Izge et al. (2013), millet is used in making a popular fried cake known as "masa". Its flour is also used in preparing "tuwo", a thick binding paste, also referred to as "toh" in northern Africa. It contains 18% protein, rich in vitamin B, especially niacin, B6 and folic acid. Food enrichment involves the addition of micronutrients to food to create a balanced and nutritious product with the outlook of providing essential nutrients (Nwadi et al., 2020).

Although cereal foods are rich in nutrients and provide bulk meals, they do not adequately contain some of the essential nutrients such as protein and minerals, therefore, there is a need for their products to be enriched with high protein sources such as crayfish. Enrichment of snack products can come in the form of blends designed to provide a range of essential nutrients such as protein, vitamins, minerals, fibre and antioxidants in a convenient and accessible form (Oyeyinka et al., 2018). One benefit of enrichment in nutrition is that it offers versatility and flexibility in meeting individual nutritional requirements.

Crayfish are crustaceans that are also known as crawdads, crawfish, freshwater lobsters, mountain lobsters, mudbugs, or yabbies (Iwar & Amu, 2021). They are closely related to lobsters, crabs, and shrimp. Crayfish are eaten worldwide like other edible crustaceans. It is usually prepared for consumption by smoking, and occasionally preserved by sun-drying, and is a common delicacy in the diet, among the people of Southern and Western - Nigeria. Moreover, it may also be available in all seasons, affordable and suitable to supply essential nutrients to meet infants' estimated daily nutrient requirements to eradicate malnutrition in developing countries (Adegbusi et al., 2023). Crayfish is classified as an animal polypeptide source, accounts for 36-45 per cent of crude protein, and is a freshwater crustacean. It was reported to have high nutritive value with a superior biological value, true digestibility, net protein utilization, and high content of essential amino acids (Ahmad, et al., 2013).

In rural areas, homemade foods tend to be from a single class of nutrients, which is of low nutritional quality resulting in inadequate feeding which is one of the major causes of malnutrition (UNICEF, 2019). Due to the high cost of processed foods, the low-income families within the Ilorin metropolis, end up feeding their children with unfortified cereal-based foods such as maize gruel (ogi) since it is cheap and affordable. However, it lacks the essential nutrients needed for healthy growth. Unfortified cereal-only formulations based on maize, millet or guinea corn are relatively poor in energy and protein density, which usually leads to protein-energy malnutrition (PEM) in infants. Adding a

fortified snack to children's meals might be an effective strategy to enhance their nutrient intake. This is because children tend to have more appetite for ready-to-eat snacks (for example cookies and biscuits), and this can be formulated using a blend of cereals and legumes to ensure the provision of essential nutrients needed for healthy growth.

A cookie is a baked or cooked snack or dessert that is typically small, flat and sweet. It usually contains flour, sugar, egg, and some type of oil, fat, or butter. Ajibola et al. (2015) stated that cookies are popular examples of bakery products of ready-to-eat snacks that possess several attractive features including soft texture, convenience, long shelf-life and the ability to serve as vehicles for important nutrients. According to Farheena, et al. (2015), cookies and other bakery products have become loved fast-food products for every age group, because they are easy to carry about, tasty to eat, cholesterol-free, and contain dietary fibre that allows digestibility. Awolu et al. (2016) stated that the enriching cookie helps to improve its nutritional and functional quality. In this regard, the study focused on the production of cookies from the combination of maize flour, and millet flour enriched with crayfish for the sole aim of improving children's nutrition.

The Objectives of the study: The objectives of the study were to;

- i. Produce enriched cookies using different ratios of maize, millet and crayfish flour blends;
- ii. determine the proximate composition of enriched cookies;
- iii. determine sensory attributes and acceptability of produced cookies and

iv. evaluate the general perception of enriched cookies.

Materials and Methods

Design of the study: The study adopted a quasi-experimental design. A quasi-experimental design was considered appropriate for the study because there was no randomization carried out.

Procurement of raw materials: The raw materials used for the production of cookies were flour made from yellow maize (*Zea mays*), millet (*Pennisetum glaucum*) and crayfish (*Palaemon hastatus*). These items were procured from a local (Ipata) market in Ilorin South Local Government Area, Kwara State, Nigeria.

Blend formulation: To determine acceptable levels of cookies made from the blend of maize, millet and crayfish flour, seven products were formulated, each sample weighing 125g. and 100% maize sample was used as the control. yellow maize/millet

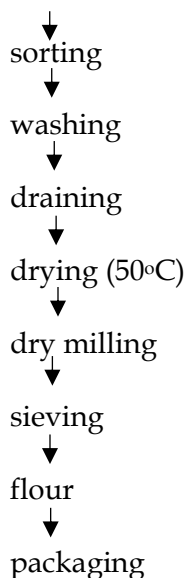


Figure 1. Flow chart of the blend formulation

Cookies production: Cookies were produced using Peter et al. (2017) method with a slight modification.

Ingredients	Quantities
Flour	125g
Butter	50g
Sugar	50g cup
Vanilla Essence	1 teaspoon
Baking powder	1 teaspoon
Salt	½ teaspoon
Milk	⅓ cup (31 ml)
Egg	One medium-sized
Nutmeg	½ teaspoon

Procedure:

- Flour was measured into a bowl with the use of the rubbing-in method, butter, nutmeg, salt and baking powder were added and rubbed for 30 minutes.
- In a separate bowl, egg, milk, vanilla and sugar were mixed into the flour-based mixture and kneaded to make a dough.
- The dough was then picked in bits at a weight of 10g, rolled out and then placed on the greased pan with a fork to give its flat circular shape.
- The dough was then baked at 150°C for 30 minutes in the oven.
- After baking the cookies, it was allowed to cool down to room temperature then packed in low-density polyethylene (LPDE) bags and sealed in a plastic transparent container.

Method and Instrument of Data

Collection

Sensory evaluation: The organoleptic test of the cookies was done using a 9-point hedonic scale. The panellists comprised thirty (30) healthcare professionals from the University Teaching Hospital of

Nigeria, Ilorin. This group of people were selected as panellists because we believe they could provide objective opinions on enriched snacks. Each attribute was rated according to its intensity scaled on a 9-point hedonic scale quality with 9 = Like extremely, 8= Like very much, 7= Like moderately, 6 = Like slightly, 5 = Neither like nor dislike, 4= Dislike slightly, 3 = Dislike moderately, 2= Dislike very much and 1= dislike extremely to test for appearance/colour, aroma, taste and mouthfeel. The product was served in a white bowl, and the tasting for each product was done after rinsing out mouth. The overall acceptability of the product was determined. They also rated their general perception of enriched cookies using a 5-point Likert scale. The response options were strongly agreed (5), agreed (4), undecided (3), disagree (2) and strongly disagree (1).

Proximate analysis: The proximate composition of samples of cookies was determined using the method described by the Association of Official Analytical Chemists of AOAC. The protein content was done by the Kjeldahl method recommended by AOAC, (2000). The moisture, crude fibre, ash, fat and carbohydrate content was done by the method described by AOAC (2005).

Statistical analysis: Data were analyzed using descriptive statistics such as percentages, frequencies, mean and standard deviation, and inferential statistics. The mean cut-off for the general

perception of enriched cookies was 3.00. An item with a mean ≥ 3.00 was accepted. Analysis of Variance (ANOVA) was used to test for significant differences in the acceptability of cookies in varying proportions. The significant level was accepted at $p < 0.05$.

Results

The socio-demographic characteristics of healthcare professionals in selected hospital shows that the majority of the respondents were females (90%) while (10%) were male, their occupation were doctors (46.70%), Nurses (13.30%), Dieticians (16.70%) and Surgeons (23.30%) which is reflected in their level of education as (83.30%) had tertiary education while (16.70%) had secondary school education. Also, their monthly income ranged between ₦30,000-₦40,000 (46.70%), while 53.30% had an income above ₦40,000.

Formulated flour blends

Table 1 shows the flour blends that were formulated according to various ratios as follows; ABU₁:(maize-100%, millet-0%, crayfish-0%) which served as the control, ABU₂:(maize-90%, millet-0%, crayfish-10%), ABU₃:(maize-0%, millet-90%, crayfish-10%), ABU₄:(maize-70%, millet-20%, crayfish-10%), ABU₅:(maize-20%, millet-70%, crayfish-10%), ABU₆:(maize-30%, millet-60%, crayfish-10%) and ABU₇:(maize-60%, millet-30%, crayfish-10%).

Table 1: Blending ratio of flour used in the production of cookies

Sample Code	Proportion of blend ratio (%)		
	Maize flour	Millet flour	Crayfish
ABU ₁ *	100	0	0
ABU ₂	90	0	10
ABU ₃	0	90	10
ABU ₄	70	20	10
ABU ₅	20	70	10
ABU ₆	30	60	10
ABU ₇	60	30	10

Key: *; control flour blend; ABU stands for maize, millet & crayfish sample

Proximate composition of enriched cookies

The proximate composition of cookie samples was presented as means and the standard deviation was shown in Table 2. The moisture content of enriched cookies ranged from 4.40%-5.44% but was not significantly different from one another, with ABU₃ (5.44±.00^a) having the highest mean. The protein content of cookies increased significantly as compared to the control, having ABU₆ with the highest

content of 1.88±.01^a. Ash and crude fibre content of all other enriched cookies samples had a higher content as compared to the control except for ABU₆ (ash-1.95±.05^c; crude fibre-1.97±.01^a) that had low content. The fat and carbohydrate content of the enriched cookies significantly decreased with the addition of millet and crayfish as compared with the control and were significantly different.

Table 2: Proximate composition of enriched cookies made from blends of maize, millet and crayfish (125g weight)

Samples	Moisture%	Protein%	Ash%	Fat%	Crude fibre%	Carbohydrate%
ABU ₁ *	4.54±.00 ^a	1.01±.04 ^b	1.47±.00 ^a	8.12±.00 ^b	2.04±.04 ^{ab}	7.57±.04 ^g
ABU ₂	5.02±.00 ^a	1.43±.01 ^c	2.26±.02 ^d	1.62±.00 ^g	2.17±.00 ^{ab}	6.00±.00 ^e
ABU ₃	5.44±.00 ^a	1.73±.04 ^e	2.27±.00 ^d	1.52±.07 ^d	2.14±.01 ^{ab}	5.76±.16 ^b
ABU ₄	5.25±.00 ^a	1.83±.05 ^f	2.18±.03 ^c	1.62±.06 ^d	2.24±.04 ^{ab}	5.59±.19 ^a
ABU ₅	4.40±.00 ^a	1.69±.00 ^d	2.26±.01 ^d	1.62±.01 ^f	2.68±.10 ^c	5.83±.09 ^d
ABU ₆	5.09±.00 ^a	1.88±.01 ^a	1.95±.05 ^b	1.55±.01 ^e	1.97±.01 ^a	5.61±.03 ^a
ABU ₇	5.21±.00 ^a	1.51±.04 ^f	2.22±.01 ^{cd}	1.44±.06 ^c	2.36±.42 ^{bc}	5.79±.09 ^c

Key: *; control flour blend; ABU stands for maize, millet & crayfish sample

Values are mean ± SD, values with different superscripts along a column are significantly different (p<0.05)

Sensory attributes and acceptability of enriched cookies

The sensory attribute scores (colour, aroma, mouthfeel, taste and general acceptability) of cookies are presented in Table 3. The cookies sample, in terms of colour, was statistically different; the control ABU₁ (8.79±0.00^a) had better colour compared to the enriched samples. In terms of aroma and mouthfeel, the samples were not statistically different, the control sample had better aroma followed by ABU₄ (8.68±0.24^a) also, for

mouthfeel, the control was better followed by ABU₇ (7.55±0.00^a). In terms of taste, the cookies samples were statistically different ABU₅ (9.00±0.24^b) had better taste as compared to the control. For general acceptability, the cookies samples were significantly different from one another where ABU₅ (8.95±0.05^a) had higher acceptability followed by ABU₁(8.26±1.02^a) while ABU₃ (6.18±0.03^c) had the lowest acceptability.

Table 3: Sensory attributes of enriched cookies made from blends of maize, millet and crayfish

Samples	Colour	Aroma	Mouthfeel	Taste	Overall acceptability
ABU ₁ *	8.79±0.00 ^a	9.00±0.68 ^a	8.59±0.05 ^a	6.03±0.99 ^a	8.26±1.02 ^a
ABU ₂	7.61±0.03 ^c	7.17±0.00 ^a	6.18±0.03 ^a	8.35±0.99 ^a	7.27±1.00 ^b
ABU ₃	6.59±0.19 ^a	6.24±1.06 ^a	6.27±0.02 ^a	5.69±0.00 ^a	6.18±0.03 ^c
ABU ₄	6.85±1.23 ^a	8.68±0.24 ^a	6.30±1.90 ^a	6.40±2.28 ^a	6.90±1.83 ^b
ABU ₅	8.00±0.00 ^b	8.36±0.10 ^a	7.26±0.25 ^a	9.00±0.24 ^b	8.95±0.05 ^a
ABU ₆	7.57±0.04 ^a	7.55±0.01 ^a	7.47±0.00 ^a	7.51±0.05 ^b	7.22±0.02 ^b
ABU ₇	7.50±0.50 ^a	6.52±0.06 ^a	7.55±0.00 ^a	6.51±0.00 ^a	7.00±0.00 ^b

Key: *; control flour blend; ABU stands for maize, millet & crayfish sample
 Mean ± SD. with different superscripts along a column are significantly different (P≤0.05).

The general perception of enriched cookies produced the blends of maize, millet and crayfish

The general perception of enriched cookies is presented in Table 4. The panellists agreed that enriched cookies can be sold in the local market (\bar{x} =4.33), the price of enriched cookies can be relatively affordable (\bar{x} =4.23), they will

recommend enriched cookies to other families (\bar{x} =4.17), enriched cookies can easily be preserved (\bar{x} =4.13), and enriched cookies can be purchased by everyone (\bar{x} =3.93). The panellists did not agree with the item; "I feel people are willing to learn how to prepare enriched cookies (\bar{x} =2.45)".

Table 4: Perception of healthcare professionals on enriched cookies made from blends of maize, millet and crayfish

Statements	(\bar{x})	SD	Remark
I think enriched cookies can be sold in the local market	4.33	3.80	Agreed
I feel enriched cookies can be purchased by everyone	3.93	3.50	Agreed
I think the price of enriched cookies can be relatively affordable	4.23	4.10	Agreed
I think the prices of these cookies are relatively moderate based on their contents	3.90	3.86	Agreed
Enriched cookies will be easier to produce	3.56	3.00	Agreed
I will recommend enriched cookies to other families if made available	4.17	3.23	Agreed
I feel enriched cookies will not have a long shelf-life due to their contents.	3.97	3.70	Agreed
I think enriched cookies if exposed to air will lose their taste	3.10	4.00	Agreed
I think enriched cookies can always be packaged to avoid external contamination	3.23		Agreed
Enriched cookies can easily be preserved	4.13	3.20	Agreed
I think the enriched cookies can always be sealed with durable material to avoid spoilage	3.53	3.00	Agreed
I feel children should be the major consumers of enriched cookies	3.12	3.12	Agreed
Enriched cookies ingredients are readily available in the local market	3.12	3.00	Agreed
Enriched cookies ingredients are easily accessible in the local market	3.45	3.24	Agreed
I feel people are willing to learn how to prepare enriched cookies	2.45	2.20	Disagreed
Enriched cookies are produced to improve children's appetite	3.01	3.36	Agreed
Grand mean	3.58		

Discussion

The study assessed the sensory attributes and proximate composition of enriched cookies made from blends of maize, millet and crayfish. The proximate composition of enriched cookie samples varied significantly from one another. The moisture content of the cookies sample made from 90% millet and 10% crayfish was higher than the others. The high moisture content in the sample might be due to the physical properties of finger millet which is one of the ingredients used in the production of enriched cookies. However, the moisture content of the samples is within the normal range, this agrees with the study of Ramashia et al. (2017), who opined that the moisture content of finger millet grain ranges from 7.88 to 9.38% while their flour moisture content can range from 9.17 to 11.6% respectively. The higher the moisture content of the flour, the shorter the storage life, which can cause the rapid growth of mould (Abdullah et al., 2012).

The protein content of enriched cookies ranges from 1.01% to 1.83% which is relatively low. This may be attributable to the type of grains used in the production of the enriched cookies sample. This disagrees with the study that reported that the minimum level of protein in cookie products should be 5% (Nugraheni et al, 2019). The cookie sample with 100% maize which served as the control had a high fat and carbohydrate content which was reduced as the percentage inclusion of millet and crayfish increased. According to Amadi (2019), the addition of other flour products

with low-level carbohydrates and fat may be attributable to the reduction in carbohydrate content in the enriched cookies samples. Also, crude fibre and ash content in the enriched cookies increased on the percentage inclusion of millet and crayfish, this indicates that the mineral and dietary fibre content in the enriched cookies is high. Igbabul et al (2019) reported that cookie products are high in dietary fibre and enhance gastrointestinal health.

The sensory properties of enriched cookies produced from blends of maize, millet and crayfish; this attribute has a high sensory rating in all samples evaluated at a significant level ($p < 0.05$). The colour, aroma and mouthfeel of the control cookies sample (100% maize) had higher means, this might be resulting from been use of cookies made from maize composite flour, Awotadeju and Olapade, (2020) reported in their study on wheat-maize cookies that the control sample ranked the highest among the other presented samples. For taste, the enriched cookies sample with 20% maize, 70% millet and 10% crayfish (ABU₅) had the higher mean, this can be a result of preferences as taste is an important parameter in product formulation. Also, the sample ABU₅ was generally accepted better than the control and other enriched cookies samples. This contradicted the study of Ani and Okoye (2021) who reported that the colour, taste, aroma and general acceptability of cookies product increased at different levels of substitution with other ingredients made with cookies.

Healthcare professionals' perception of enriched cookies was positive. This reveals that the product can be introduced in the local market especially the enriched cookies sample with 20% maize, 70% millet and 10% crayfish which had a high general acceptability. Also, the products can be made available and affordable to encourage consumers to purchase them. In addition, attention can be paid to the packaging to preserve its taste and allow a longer shelf life. This is justified in the study by Tarrega et al. (2017), which reported that the perception of consumers on food products with cookies as a case study, positive values placed on products such as healthiness, familiarity and affordability can motivate acceptance of products.

Conclusion

Enriched cookies from blends of maize, millet and crayfish are generally accepted. The study concluded that the enriched cookies sample of 20% maize, 70% millet and 10% crayfish (ABU₅) was preferred over other samples. The enriched cookies showed that the moisture, protein, ash, fat, crude fibre and carbohydrate content are within the normal range which indicates that enriched cookies are good for consumption. The increased ash and crude fibre content serve as a great value for cookie enrichment as it enhances gastrointestinal health and improves the nutrition of its consumers. Enriched cookie samples had a positive outlook concerning acceptability; thus, this

product can be made available in local markets at affordable prices to consumers.

Recommendations

Based on the findings of the study the following recommendations were made,

1. Millet-maize cookies should be enriched with other protein-rich ingredients to increase the protein value of the cookie products.
2. Enriched cookies sample can be recommended by healthcare professionals for use as a healthful snack for consumers and the general public.

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