Nutrient Evaluation and Acceptability of Cookies Produced from Wheat Flour, Tiger Nut Milk and Fermented Jack Fruit Seeds (*Artocarpus Heterophyllus*)

Amadi, Joy A.C[1,*] and Ezenwa, Chinyere, P[2]

[1]Department of Nutrition and Dietetics, Imo State University P.M.B. 2000, Owerri, Nigeria
[2]Department of Home Economics, Federal College of Education, Umunze (T), Nigeria

ABSTRACT

Nutrient evaluation and acceptability of cookies produced from wheat flour, tiger nut milk and fermented jack fruit seeds (*Artocarpus heterophyllus*) were carried out. Jack fruit seeds were removed, sliced and boiled for about 60 minutes. The fermented seed was obtained by adding 3:1 ratio of water to 500g boiled jackfruit seed and were allowed to ferment naturally at room temperate for 48 hours, oven dried at 60°C for 1hour, milled and sieved. Date palm fruit was washed and de-seeded. The date palm (with the pericarp) was oven dried at 45°C for 8hours, milled and sieved. Tiger nut tubers was cleaned, sorted, washed and soaked overnight and milled. Tiger nut milk was centrifuged for 15mintues and pasteurized at 72°C for 15minutes. Four samples were formulated FJWC1 to FJWC4. Proximate composition of the cookies shows that cookies were higher in moisture, protein, ash (19.70%, 18.97% and 2.99%) for sample FJWC4, crude fibre (2.00%) and carbohydrate (58.82%) in FJWC1 while crude fat (13.44) in FJWC3. Micronutrient composition shows that sample FJWC4 was higher in calcium (48mg/100g), manganese (7250mg/100), iron (54250mg/100g), zinc (32720mg/100g), vitamin A (1180mg/100g) and vitamin C (1840mg/100g) while sample FJWC3 was higher in manganese (60mg/100g) and copper (2520mg/100g). Sample FJWC4 had the best score in all the sensory parameters for the formulated cookies except sample FJWC1 (100% wheat flour).

Introduction

Protein energy malnutrition (PEM) and hidden hunger are still the major health issues in developing countries, especially Nigeria. It is associated with about 50 to 60% of under-five mortality in developing and under-developing countries with its associated morbidities (Van de Poel *et al.,* 2013). Cookies consumption in Nigeria is high as a result of urbanization, high number working mother and prolonged stay in school period (Onyechi and Afieroho, 2017). Increased cookies consumption has predisposed individuals to overweight and obesity; inadequate meal and nutrient intake as a result of sedentary lifestyle and unhealthy food choices respectively (Amadi, 2017). Cookies intake is associated with meal skipping among different age groups like children, adolescence, and adult, and can also contribute to the provision of basic nutrients (Larson *et al.,* 2016). Wheat flour contains gluten proteins which gives it consideration in cookies production more than others cereal flours (Gernah *et al.*, 2010). Sanful and Darko (2010) in their work reported the significant need of supplementing wheat flour with other crops such as cereals, legumes, vegetables to improve its use and thereby reduce the cost of wheat importation.

Jackfruit is an underutilized crop but it has great potential due to its rich nutritive value in reducing malnutrition and hunger. Presently, there is no ready- to- eat jackfruit products (snacks) produced or marketed in Nigeria except the unconventional or traditional roasted/boiled seed kernel and fresh pulp (Fasoyiro *et al*., 2011). Jackfruit seeds have been reported to have an appreciable protein quality which makes it an acceptable crop for complementing cereal flour which is poor in protein and is used in fighting protein energy malnutrition (Muhammed *et al.,* 2017, Amadi *et al.,* 2018). Different works have been reported in wheat flour and jack fruit blends (Okpala, 2010; Priyadarshini *et al.,* 2013).

Tiger nut (*Cyperus esculentus*) is a tuber crop and is widely consumed in Nigeria as fresh or dried nuts. Tiger nut is known as *aya* in Hausa, *ofio* in Yoruba and *akiausa* in Igbo. It has black, brown and yellow varieties but the yellow variety is most acceptable (Gambo and Da'u, 2013). Tiger nut has high protein content, low fat but packed with high density lipoprotein (HDL) (Belewu and Abodunmi, 2006). According to Gambo (2012), tiger nut milk can be used to produce youghurt with similar organoleptic properties like soymilk and cow milk. Tiger nut is recommended to patients with heart problem, diabetes, celiac disease, lactose-intolerance, digestive problems, and diarrhea (Chukwuma *et al.,* 2010 and Adejuyitan, 2011). Previous studies shows that tiger nut flour can be useful in baking such as cookies (Akajiaku *et al.,* 2018),bread (Ade-Omowaye *et al.,* 2008) and chinchin (Ade-Oyetoro *et al.,* 2017). However, there is paucity of works on fermented jackfruit seed flour in cookies production. This research work sought to evaluate the nutrient composition and acceptability of cookies produced from wheat, fermented jackfruit seed flour and tiger nut milk.

Tele: +2347030987007
E-mail address: Joyevans2020@gmail.com

Materials and Methods

Procurement of Sample and Materials

Fresh ripe jackfruits, date palm, tiger nut and other baking materials were purchased from Relief Market Owerri, Imo State.

Sample processing

Processing of fermented Jackfruit seed flour

Jack fruit seeds were removed and sliced into pieces with a sterile knife; it was boiled for about 60 minutes. The fermented seed was obtained water to 500g boiled jackfruit seed in the ratio of 3:1 and were allowed to ferment naturally at ambient conditions for 48 hours, oven dried at 60$°C$ for one hour milled and sieved using 300μm sieve to obtain jackfruit flour of uniform sizes.

Date palm flour processing

Two hundred grams (200g) of date palm fruit was washed and de-seeded. It was cut into pieces with clean knife. The date palm (with the pericarp) was oven dried at 45$°C$ for 8hours. It was milled and sieved to obtain the date palm flour.

Processing of tiger nut milk

Four hundred grams of tiger nut tubers was cleaned, sorted, washed and soaked overnight. It was wet milled with Saisho electric blender. The slurry obtained was sieved using a muslin cloth. Tiger nut milk was centrifuged for 15mintues and pasteurized at 72$°C$ for 15mintes. It was cooled and packaged in a clean plastic container and stored in the refrigerator at 5$°C$.

Sample Formulation

The jackfruit flour and wheat flour were mixed in different ratios. The blends were thoroughly measured, mixed and kept in separate containers until needed for further analysis.

Table 1. Sample Formulation.

Sample	Wheat flour (%)	Fermented jack fruit flour%
FJWC 1	100	-
FJWC 2	50	50
FJWC 3	70	30
FJWC 4	30	70

Key: FJWC1 (fermented jackfruit wheat cookies: 100% wheat flour (control), FJWC2 (fermented jackfruit wheat cookies: 50% wheat flour and 50% jack fruit flour), FJWC3 (fermented jackfruit wheat cookies: 70% wheat flour and 30% jack fruit flour), FJWC4 (fermented jackfruit wheat cookies: 30% wheat flour and 70% jackfruit flour)

Recipe for Cookies Preparation

The method according to Amadi (2017) was adopted with little modification. In the cookies preparation, date palm and sunflower oil were used to replace sugar and fat respectively.

Table 2. Recipe for cookies preparation.

Ingredients	Quantity
Wheat/fermentedjack lend	300g
Baking powder	2tsp
Date palm	100g
Vanilla flavoring	1tsp
Salt	½ tsp
Tiger nut Milk	125ml

Method of preparation

- Sieve the baking powder into a small bowl
- Add wheat /fermented jackfruit flour blend, salt, date palm together into the bowl.
- Cream the tiger nut milk and vanilla flavoring until the mixture is light and fluffy.
- Knead to make soft dough
- Roll out the dough and cut into desired shapes with cookies cutters with 32mm and thickness 5mm
- Transfer to a greased baking frays
- It was baked for 10- 12 minutes at 100°C until a golden brown colour was achieved

Plate 1. FJWC1: 100% wheat flour (control).

Plate 2. FJWC2 70% wheat flour and 30% jack fruit flour.

Plate 3 .FJWC3: 50% wheat flour and 50% jack fruit flour.

Plate 4. FJWC4: 30% wheat flour and 70% jackfruit flour.

Nutrient Analysis

Cookies were analyzed for proximate composition using standard methods by AOAC (2012). Moisture content was determined using hot air oven method. Protein content was determined using micro-kjeldahl method. Ash was determined by weighing 1g of each sample into a tarred porcelain crucible. This was incinerated at $600\,^{\circ}C$ for 6 h in an ashing muffle furnace until constant weight was obtained. Lipid was estimated by exhaustively extracting a known weight of flour sample with petroleum ether (B.pt 40-60$^{\circ}C$) using tecator soxhlet apparatus. Carbohydrate was calculated by difference (100 - %Moisture + Ash+ Protein+ Fibre+ Fat). Mineral content was determined as described by Ranjiham and Gopal (1980). After wet digestion with concentrated nitric and perchloric acids, the minerals calcium (Ca), magnesium (Mg), iron (Fe) and zinc (Zn) were determined using atomic absorption spectrophotometer (Model 3030 perkin Elmer, Norwalk, USA). Phosphorous (P) was determined calormetrically with spectrophotometer using phosphor-vana domolybdate method. Vitamin A was determined using spectrophotometric method described by Pearson (1979) while vitamin C was determined using AOAC (2012). All analysis was done in triplicates.

Statistical Method

Means and standard deviation were calculated for all the samples. One way analysis of variance (ANOVA) and turkey tests were used to separate and compare the means (James, 1999).

Sensory Evaluation

Sensory evaluation of the cookies was assessed using 50 trained final students of Nutrition and Dietetics, Faculty of Health Sciences, Imo State University, Nigeria. Flavor, colour, taste, crispness and general acceptability were rated on a 9-point Hedonic scale, ranging from 1 = like extremely to 9 = dislike extremely (Onwuka, 2005). The judges were provided with glasses of water to rinse their mouth after each tasting.

Results and Discussions

Proximate composition of jackfruit seed cookies was presented in Table 3. Sample FJWC4 had the highest moisture content (19.70%) while sample FJWC3 had the lowest moisture content (10.66%). The moisture contents of the cookies obtained from the present study was similar to (Hossain *et al.,* 2014) but higher than (Islam, 2015). This could be as a result of the tiger nut milk that was used which was in liquid form while previous works used dried cow milk. Dried tiger nut milk should be used in subsequent studies. High moisture contents of food samples indicate an increased water activity, which decreases the keeping quality of foods. It was also observed that, the moisture content of the cookies increased with increasing jackfruit seed flour substitution.

The protein content of the cookies increased with increasing substitution of jackfruit seed flour to wheat flour. Sample FJWC4 had the highest protein content 18.97%. Though, there was no significant difference between sample FJWC2 and FJWC4. The protein content was consistent with Amadi (2017) on fortification of cookies with moringa leaves. Preschooler, school age children and adolescences eat more of snacks especially cookies. This study has shown that jackfruit fortification would help in fighting protein malnutrition. Protein is needed for growth and repair of tissues in the body and for the synthesis of enzymes and certain hormones. Crude fibre content was highest in sample FJWC1 (100% wheat cookies) while sample FJWC4 had the lowest crude fibre content (0.99%). It was also observed that the crude fibre content of the cookies decreased with increased jackfruit seeds flour substitution. Introduction of jackfruit seed flour decreased the crude fibre content of the cookies. Crude fibre was lower than Amadi (2017) but consistent with Ojinnaka (2016). The decreased fibre content may be attributed to the fermentation of jackfruit seeds because during fermentation there is breakdown of cellulose and hemicelluloses by fermenting enzymes (Ejigui *et al.,* 2005). Fiber enhances bowel movement and increases bulk of the diet.

However, the crude fiber content of the control cookies (100% wheat) obtained from the present study was consistent with previous reports by Chowdhury *et al.*, (2012), Okoye and Obi (2017) and Hossain *et al.,* (2014).

Sample FJWC4 (2.99%) had the highest ash content while FJWC1 (1.17%) had the lowest ash content. The ash content is a measure of the nutritionally important minerals present in a food material (Oluwamukomi *et al.,* 2009). The ash content observed in this study was lower than Aderinola and Allikura (2015) on supplementation of breadfruit in cookies production. Fat content was 13.44% in Sample FJWC3 while sample FJWC1 (7.74%) had the lowest fat content. Fat provides the major source of energy needed for the body.

It also forms the basic nerve fibers and for the synthesis of certain hormones. The fat content of the cookies in the present study was similar with Olaoye *et al.,* (2007), Ajani *et al.,* (2012) and Aderinola and Allikura (2015) who reported on cookies production with breadfruit. The increased fat content of the cookies in the present study could be as a result of tiger nut and sunflower oil that were used. Tiger nut contains high fat (Oladele and Aina, 2007; Belewu and Abodunrin, 2008 and Adejuyitan *et al.,* 2009).

Tiger nuts alone may be used without additional fat or oil. This also would reduce the cost of buying oil or fat for cookies production; create value addition which will in turn reduce the cost of cookies as well as the risk of chronic diseases from over consumption of fat (Nzeagwu and Onwudiwe, 2016). Literature reported that tiger nut can be compared to fatty acid found in avocado, olive and halzenut (Eze *et al.,* 2014). It contains high unsaturated fatty acids though more in monounsaturated fat than polyunsaturated fats (Adel *et al.,* 2015). The use of tiger nut as milk and oil substitute should be encouraged in cookies production because of the value addition. Carbohydrate content of the cookies shows that sample FJWC1 (58.82%) was the highest while sample FJWC4 (49.37%) was the lowest. All the samples differed significantly ($p<0.05$). Carbohydrate content of the cookies decreased with increased jack fruit seed substitution. Carbohydrate content of the cookies reduced with increased jackfruit seeds flour substitution.

This is consistent with Ojinnaka *et al.* (2016) in cookies production with African breadfruit, wheat and pigeon pea and Islam *et al.,* (2015) in biscuit making with wheat and jackfruit composite flour but lower than than that obtained by Ojinnaka *et al.,* (2013) cookies with African breadfruit starch and wheat, and Aderinola and Allikura (2015) in cookies made from wheat and African breadfruit. The decreased carbohydrate content of the cookies could be because jackfruit seed has low carbohydrate content of 7.89% (Amadi *et al.,* 2018) as a result of its fermentation.

The micronutrient composition of the cookies Table 4 showed that Sample FJWC4 was significantly (p<0.05) higher in calcium (48 mg/100g) while sample FJWC1 had the lowest calcium content. Calcium content increased significantly with increased jackfruit seed substitution. Good micronutrient status is essential among preschool, school-age children and adolescents who constitute the greater percentage of cookies consumption. The present study showed that cookies produced from jackfruit seed with tiger nut milk was rich in minerals needed in the development of strong immune system. Previous studies on jackfruit reported lower calcium content in jackfruit seed flour and jackfruit seed cookies respectively (Okafor *et al.,* 2015 and Okpala,

2010). However, calcium content of the cookies was similar to Nzeagwu and Onuwudiwe (2016) on production of biscuit with whole tiger nut and wheat flour. So it can be deduced that the increased calcium content observed in the present study was contributed by tiger nut milk. The study was similar to the trend reported by Dooshima *et al.* (2016) on cookies production with acha and mung beans. Calcium is beneficial for healthy bone mass, nerve function, muscle contraction, blood clotting and teeth. Manganese (725 mg/100g) was significantly higher in sample FJWC4. It was observed that manganese increased with jackfruit seed substitution among the samples.

Zinc content of the cookies was significantly higher in sample FJWC4 (32720 mg/100g) while sample FJWC1 (21550mg/100g) had the lowest zinc content. Zinc content of the cookies was higher than that reported by Ndife *et al.* (2014) who reported zinc content of 2.74-4.38 mg/100g on cookies produced from full fat soya and wheat flour but similar with Madukwe *et al.* (2013) on cookies based bambara groundnut and wheat flour. Zinc is implicated in wound healing, growth and enhancement of taste and appetite (Alayande *et al.,* 2012).

Table 3. Proximate composition of the cookies.

Parameters	FJWC1	FJWC2	FJWC3	FJWC4	LSD
Moisture (%)	4.15±0.60[b]	9.40±1.33[c]	5.66±0.40[a]	9.17±0.80[d]	0.85924
Protein (%)	15.15±0.18[a]	16.12±0.22[b]	15.35±0.13[a]	18.97±0.13[b]	0.17396
Crude fiber (%)	2.00±0.02[b]	1.02±0.04[a]	1.05±0.08[a]	0.99±0.01[a]	0.05322
Ash (%)	1.17±0.12[a]	2.31±0.23[b]	2.79±0.10[b]	2.99±0.02[c]	0.14228
Crude fat (%)	7.74±0.25[a]	10.60±0.40[b]	13.44±0.59[c]	8.66±0.34[a]	0.41904
Carbohydrate (%)	69.79±0.37[d]	61.55±1.45[b]	61.71±0.73[c]	59.22±0.25[a]	0.00180

Means are values of triplicate determinations. Mean values with different superscripts in the same column are significantly different (p<0.05). LSD = least significant difference. **Key: FJWC1** = (fermented jackfruit wheat cookies: 100% wheat flour (control), **FJWC2** = (fermented jackfruit wheat cookies: 50% wheat flour and 50% jack fruit flour), **FJWC3** = (fermented jackfruit wheat cookies: 70% wheat flour and 30% jack fruit flour), **FJWC4** = (fermented jackfruit wheat cookies: 30% wheat flour and 70% jackfruit flour).

Table 4. Micronutrient composition of the cookies.

Micronutrient (mg/100g)	FJWC1	FJWC2	FJWC3	FJWC4	LSD
Calcium	20.00±0.04[a]	38.00±0.11[c]	30.00±0.30[b]	48.00±0.23[d]	0.002
Magnesium	40.00±0.10[a]	50.00±0.05[a]	60.00±0.17[b]	40.00±0.06[a]	0.002
Potassium	2700.00±0.20[a]	2700.00±0.40[a]	4600.00±0.23[c]	3400.00±0.16[b]	0.001
Manganese	4250±0.35[a]	6250±0.31[b]	4750±0.35[a]	7250±0.35[c]	0.353
Iron	27250±0.35[a]	31000±0.70[b]	50000±0.70[c]	54250±1.06[d]	0.750
Copper	2320±0.17[b]	1850±0.14[a]	2520±0.10[b]	1750±0.10[a]	0.143
Zinc	21550±0.35[a]	29200±0.21[c]	23350±0.35[b]	32720±0.38[d]	0.316
Vitamin A	740±0.04[a]	950±0.04[a]	890±0.07[a]	1180±0.05[b]	0.08
Vitamin C	960±0.07[b]	1240±0.05[a]	1480±0.11[b]	1840±0.05[c]	0.11

Means are values of triplicate determinations. Mean values with different superscripts in the same column are significantly different (p<0.05). LSD = least significant difference. **Key = FJWC1** = (fermented jackfruit wheat cookies: 100% wheat flour (control)), **FJWC2** = (fermented jackfruit wheat cookies: 50% wheat flour and 50% jack fruit flour), **FJWC3** = (fermented jackfruit wheat cookies: 70% wheat flour and 30% jack fruit flour), **FJWC4** = (fermented jackfruit wheat cookies: 30% wheat flour and 70% jackfruit flour).

Table 5. Sensory evaluation of cookies.

Sensory Properties	FJWC1	FJWC2	FJWC3	FJWC4	LSD
Flavor	7.18±1.36[c]	6.52±1.48[b]	6.10±1.46[a]	6.86±1.29[b]	0.2808
Colour	6.66±1.39[a]	6.42±1.45[a]	6.08±1.62[a]	6.70±1.47[a]	0.2981
Taste	7.28±1.48[b]	6.76±1.70[b]	5.98±1.80[a]	6.88±1.88[b]	0.3450
Crispness	6.52±1.71[a]	6.24±1.84[a]	6.06±1.54[a]	6.48±1.65[a]	0.3389
General acceptability	7.36±1.39[b]	6.96±1.66[a]	6.36±1.78[a]	7.06±1.44[b]	0.3161

Means are values of triplicate determinations. Mean values with different superscripts in the same column are significantly different (p<0.05). LSD = least significant difference. **Key = FJWC1** = (fermented jackfruit wheat cookies: 100% wheat flour (control)), **FJWC2** = (fermented jackfruit wheat cookies: 50% wheat flour and 50% jack fruit flour), **FJWC3** = (fermented jackfruit wheat cookies: 70% wheat flour and 30% jack fruit flour), **FJWC4** = (fermented jackfruit wheat cookies: 30% wheat flour and 70% jackfruit flour).

Zinc is essential in metabolic activity involving haemoglobin synthesis, enhances the immune system and help to prevent diarrhoeal episodes in children which is one of the leading cause of death among the children.

Sample FJWC4 had the highest iron content (54250mg/100g) while sample FJWC1 (27250mg/100g). Samples differ significantly p<0.05. Iron is important in cognitive development and other metabolic activities in human system. Iron content of the cookies in this study was higher than 3.31 to 4.91 mg/100g reported by Nzeagwu and Onuwudiwe (2016) on tiger nut biscuit and 2.31 to 2.79mg/100g as reported by Okpala (2010) on fermented jackfruit cookies. This study showed similar calcium, magnesium and potassium values with Nzeagwu and Onwudiwe (2016).

The highest vitamin A content (1180mg/100g) was observed in sample FJWC4, while sample FJWC1 had the lowest (740mg/100g). It was observed that other samples differed significantly (p>0.05) among each other. The highest vitamin C content (1840mg/100g) was observed in sample FJWC4, while the lowest (960 mg/100g) was seen in sample FJWC1. Cookies with 70% jackfruit seeds substitution had the highest vitamin A and C content; indicating that jackfruit seeds contents vitamin A and C. Vitamin A and C content in this study was higher than other literatures on cookies production with legume, breadfruit or other crop substitution (Okoye and Obi, 2017 and Dooshima *et al.,* 2016).

Table 5 shows the sensory evaluation of the cookies. Sample FJWC4 had the best flavor (6.86), colour (6.70), taste (6.88), crispness (6.48) and general acceptability (7.06). The control which is 100% wheat had the highest mean scores for all the sensory parameters studied. This agrees with Adamu *et al.* (2010) that people choose the product that is close to the ones they are familiar with. Cookies FJWC4 with 70% jackfruit seeds substitution rated highest among the cookies produced with jackfruit seeds substitution. This shows that cookies produced from jackfruit is acceptable.

Conclusion

This study has established that good quality and acceptable cookies can be produced from jackfruit seeds using the recipe. Cookies FJWC4 with 70% jackfruit seeds substitution had the highest values in proximate, vitamin and most of the minerals as well as sensory attributes. Tiger nut milk and date palm as used in the recipe can be effectively used instead of baking fat and table sugar. Production of cookies with indigenous crop like jackfruit would enhance its utilization and enhance value addition in production chain.

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