Fjrs.futa.edu.ng

FUTA Journal of Research in Sciences

FUTA Journal of Research in Sciences, Special Edition, Vol. 13 (3), December, 2017: 502-516

DEVELOPMENT AND QUALITY EVALUATION OF COOKIES PRODUCED FROM FLOUR BLENDS OF WHEAT, ALMOND NUTS AND SOME NATURAL PLANT MATERIALS

***Oyedele[1], D. S., Oluwafemi[2], G. I., Adepeju[1], A. B., Otutu[1], O. L. and Oluwasola[1], P. O.**

[1]Department of Food Science and Technology,
Joseph Ayo Babalola University, Ikeji- Arakeji, Ilesa, Osun State, Nigeria
[2]Department of Food Technology, Federal polytechnic, Ado-Ekiti
* Corresponding Author (**mercyoye2001@yahoo.com)**

ABSTRACT

Development of cookies with adequate nutrients at affordable costs is quite a challenge for developing countries. The study investigated the energy value, proximate composition (moisture, protein, fat, ash, fiber and carbohydrate), physical (diameter, weight, thickness and spread ratio) and organoleptic (aroma, taste, colour and crispiness) characteristics of cookies produced from blends of wheat flour (WF), almond nut flour (ANF) and some natural plant materials The various ratios of WF and ANF used were 100:0, 90:10, 80:20, 70:30, 60:40, 50:50 and 0:100 while 1g of each of the natural plant materials was used for each composite cookie sample. The energy value, protein, fat, fiber, ash contents of the cookies ranged from 402.60 to 408.99 kcal/g, 7.33 to 11.03%, 9.8 to 12.03%, 1.40 to 2.11%, 1.40 to 1.89% respectively while the moisture and carbohydrate contents ranged from 8.80 to 9.20% and 64.02 to 71.27%. The weight, thickness, diameter and spread ratio of the cookies ranged from 9.90 to 16.24 g, 1.62 to-1.75 mm, 6.11 to 4.80 mm and 3.72 to 2.60 respectively. The mean scores for all the assessed sensory parameters were significantly ($p<0.05$) different among the cookie samples, with varied ranges for aroma (6.01-8.50), taste (6.10- 7.90), colour (6.20-7.90), crispiness (7.10- 8.70) and overall acceptability (6.20- 8.40) respectively. The enriched cookie sample with the incorporation of 10% almond nut flour could substantially reduce foreign exchange on wheat importation and great contribution of the natural plant materials could improve the nutritional status of the vulnerable groups especially children.

Keywords: Cookies, almond nut flour, wheat flour, physical properties, nutrition

INTRODUCTION

The current global economic melt-down has resulted in an upsurge in the number of malnutrition cases in Nigeria. Malnutrition is mainly due to inadequate energy intake as well as protein and micronutrients. The intense search for an alternative protein sources is a major challenge in Africa and Nigeria, owing to the fact that animals and animal products (such as eggs, milk, meat and fish) are unaffordable as source of nutrients (Mbaeyi-Nwaoha and Onweluzo, 2013). Consequently, the effort of enhancing the potential of some underutilized and lesser known plant materials as industrial raw material for food application in Nigeria continues to receive significant attention as human population continued to grow. Underutilized crops could be used to meet world food security demands when properly processed and prepared for consumption.

Nuts are dry fruits with one seed in which the ovary walls become hard at maturity. They are nutrient dense foods, rich source of bioactive macronutrients and antioxidant (Emilio, 2010). Several edible nuts such as walnut, cashew, mango, dikanut, peanut, almond and tigernut abound in Nigeria.

Almond plant (*Terminalia catappa*) is a hardy, fast-growing and deciduous multipurpose tree, reaching 25-40 m tall which produces edible fruits. The fruit consists of an outer flesh and a hard shell with a nut inside. In Nigeria, the processing of almond nuts into flour is limited as most fruits are popularly eaten by children and the kernel often discarded as waste (Olatidoye *et al*., 2011). Whole almond nuts are essential source of high quality protein, fibre, minerals and bioactive compounds (Olatidoye *et al*., 2011). The insoluble dietary fibers (cellulose, hemicellulose) fraction of almond nuts play an important role in the relief of constipation to improves colon health and may have protective effect against colon cancer (Liu, 2004). The soluble dietary fibers (pectin, mucilage gum) also aid the lowering of serum glucose and cholesterol level (Knekt *et al*., 2002). Other health-promoting compounds in almonds are phytochemicals (e.g polyphenols), which have been shown to be protective agents against cancer and cardiovascular diseases (Yang *et al*., 2009).

In addition, the role of vegetables and spices as sources of nutrients and maintenance of good health cannot be over-emphasized. In Nigeria and other African countries, a wide range of plant materials abound as an indispensable constituent of human diet and medicine. These materials constitute great reservoir of a wide variety of bioactive compounds which exhibit some medicinal and nutritive properties and hence they are used either as spices, food or for medicinal purposes (Edeoga, 2003). They are consumed for their unique aroma, texture and colour. Natural plant materials, such as carrot, ginger, onion bulb, pumpkin and basil leaves are readily available in Nigeria market and continuous supply is available throughout the year to serve the ever growing population (Edeoga, 2003).

Onions (*Allium cepa* L.) are spices, which are used locally for medicinal and therapeutic purposes. Onion juice is helpful in fighting nervousness, insomnia, rheumatism, nose and throat infection and is a good purifier (Etukudo, 2003).

Carrot (*Daucus carota sativus*) is one of the important root vegetables that is rich in carotene and carotenoids, with appreciable amounts of vitamins B_1, B_2, B_6, B_{12} and minerals (Krishan *et al*., 2012). It is a large, palatable and less woody-textured edible root vegetable, usually orange in color, with crispy texture when fresh. Carrots are widely used in many cuisines, especially in the preparation of salad, soups, stews, curries, sweet meats, juices, flakes, fermented pickles, purees, nectars and jellies (Krishan *et al.*, 2012).

Ginger (*Zingiber Officinale*) is a very important spice commercially grown on large scale for export, owing to its pleasant aroma, pungency and high oleoresin (gingerol) content (Njoku, *et al*., 1995). The aromatic characteristic is central to its use in the production of food, drugs and in the manufacture of beverages and perfumes (Akinwande *et al*., 2008) a plant with leafy stems and yellowish green flowers. Ginger is commonly used to treat various types of diseases, such as "stomach problems", including morning sickness, stomach upset, diarrhea, irritable bowel syndrome (IBS), nausea, as well as loss of appetite (FAO, 2005).

Basil leaf (*Ocimum basilicum*) is a herb belonging to the mint family *Lamiaceae* often used as seasoning in cooking, which differ in taste and smell. Sweet basil has a strong clove scent because of the high concentration of eugenol content, whereas lime and lemon basil have a strong citrus scent due to their high concentration of limonene (USDA, 2010).

Pumpkin (*Cucurbita pepo*) has received considerable attention in recent years because of the nutritional and health protective values of the seeds, pulp and leaves. It is a rich source of carotene, pectin, minerals, salts, vitamins and other substances that are beneficial to human health and this account for its processing into various products and its incorporation into different food formulations (Djutin, 1991).

It is however worthy to note that based on detailed investigation and reports on the nutritional and medicinal values of these plant materials, one of the promising ways of increasing their consumption is inclusion as ingredients in the production of cookies.

Cookies are the most popular bakery products consumed world-wide by all age groups owing to its convenience, palatability, inexpensive and long shelf-life nature ((Anozie *et al.*, 2014). They are generally produced from refined wheat flour which is a rich source of carbohydrates, fat and calories but limiting in protein, minerals and dietary fibre (Anozie *et al.*, 2014). The major ingredients are flour, fat, sugar, salt and water, which are mixed together with other minor ingredients, such as baking powder, skimmed milk, emulsifier and sodium meta-bisulphite to form dough containing a gluten network (Akinwande *et al*., 2008).

This study provides some insight to the attributes and properties of cookies with regards to the inclusion of almond nut flour as sources of protein, fiber and minerals. Hence, this study is designed to evaluate the proximate composition, physical and sensory properties of cookies produced from wheat flour enriched with almond nut flour.

MATERIALS AND METHODS

Source of materials

Refined wheat flour, granulated sugar, powdered milk, baking fat, salt, baking powder, carrot, ginger, onion bulb, pumpkin and basil leaves were procured from Oja-oba market in Ondo state, Nigeria. Fresh almond fruits were collected from local farm in Ipetu-Ijesha in Osun state.

Preparation of Almond nut flour

Almond fruits were sorted to remove damaged ones. The cleaned fruits were then sun-dried for 96 h to prevent rancidity of the kernel and to facilitate dehulling. The dried seeds were dehulled by cracking along the margins with hammer to obtain the inner brown spindle-shaped nuts. The nuts were dried at 60°C for 6 h, pulverized with the aid of a Kenwood Chef blender (Model: PT N0.77551) and the whole almond nut flour were then kept in an air –tight zip-lock polyethylene bag until needed.

Preparation of carrot, onion, ginger, basil and pumpkin flours.

Carrots, onions, gingers, basil and pumpkin leaves were sorted, rinsed with water, cut into small pieces and then oven-dried at 55°C for 5h. The dried samples were milled separately using a Kenwood Chef blender (Model: PT N0.77551) to flour (1mm mesh) and then kept in high-density polyethylene bags until needed.

Formulation of composite flour

The composite flour was prepared by replacing wheat flour (WF) with almond nut flour (ANF) at 10, 20, 30, 40 and 50% respectively as shown in Table 1. Samples with 100% WF served as the control sample.

Production of cookies

The essential ingredients for the production of cookies and their various proportions are shown in Table 2. Powdered milk, fat, baking powder, salt, sugar, powders of carrots, onions, gingers, basil and pumpkin leaves were the same for all the proportions. After weighing, the fat was manually mixed vigorously with sugar for 10 min. to form cream, wheat flour and almond nut flour at different substitution levels were then added with other ingredients (milk and baking powder). The mixing was properly carried out and the method described by Akinwande *et al*. (2008) was followed to produce cookies. The flow-chart for the production of cookies is as shown in Figure 1.

Proximate composition

The proximate composition (moisture, protein, fat, crude fibre and ash) of the cookies were determined according to the methods as described by AOAC (2010). The total carbohydrate was calculated by difference method. Food energy value (kcal/100g) was determined according to the method of Marero *et al*., (1998) using the factor [(4 × % Protein) + (4 × % Carbohydrate) + (9× % Fat). **Physical characteristics**

Diameter

The diameter of the cookies was determined according to the method of AACC (2000). Four cookies were placed edge to edge and their total diameter was measured with the aid of a ruler. The cookies were rotated at angles of 90^0 for duplicate reading. The experiment was repeated twice and average diameter was recorded in millimeter.

Table 1: Formulation of wheat and almond nut flour blends

Wheat Flour (%)	Almond nut flour (%)
100	0
90	10
80	20
70	30
60	40
50	50
0	100

Table 2: Recipes for cookies production

Ingredients	Quantity (g)						
Almond nut flour	100	10	20	30	40	50	0
Wheat flour	0	90	80	70	60	50	10 0
Fat	55	55	55	55	55	55	55
Baking powder	1	1	1	1	1	1	1
Sugar	45	45	45	45	45	45	45
Salt	1	1	1	1	1	1	1
Water	20	20	20	20	20	20	20
Carrot	1	1	1	1	1	1	1
Ginger	1	1	1	1	1	1	1
Basil leaf	1	1	1	1	1	1	1
Onion	1	1	1	1	1	1	1
Pumpkin leaf	1	1	1	1	1	1	1

Composite flour

↓

Mixing (Dried carrot, onion, ginger, basil and pumpkin leaves powders)

↓

Kneading

↓

Rolling and cutting

↓

Baking (220^{0}C for 20 min.)

↓

Cooling

↓

Packaging

↓

Cookies

Figure 1: Flow-chart for cookies production
Source: Akinwande *et al*. (2008)

Weight

The weight of the cookies was determined according to the method of Ayo *et al*., (2007).

Thickness

The thickness of the cookies was determined according to the method of Ayo *et al*., (2007).The cookies thickness was measured with the aid of a digital vernier caliper with 0.01 mm precision.

Spread ratio

Spread ratio of the cookie samples was determined according to the method of Gomez *et al*., (1997). For spread ratio, two rows of four well formed cookies were made and the height measured. They were arranged horizontally edge to edge and the sum of their diameters measured. The spread ratio was calculated as diameter divided by height, using the formula below;

$$SF = \frac{D \times CF \times 10}{T}$$

Where, CF is a correction factor at constant atmospheric pressure. It has a value of 1.0 as indicated by AACC (2000).

Sensory evaluation of the cookies

Sensory evaluation of the cookies was carried out with twenty trained panelists comprising of students and members of staff in Food Science and Technology Department, Joseph Ayo Babalola University, Nigeria. Each panelist was served with 7 randomly arranged cookie samples on a white rectangular plastic tray. The cookies were individually sealed in a pouch and coded with a three-digit number prior to testing. Questionnaire describing the quality attributes (colour, crispiness, taste, flavor and overall acceptability) of the cookies was given to individual panelist to evaluate using a 9-point hedonic scale with 1= dislike extremely, 2=dislike very much, 3= dislike moderately, 4=dislike slightly, 5=neither like nor dislike, 6= like slightly, 7=like moderately, 8= like very much and 9= like extremely.

Statistical analysis

All results were analyzed statistically at 5% significance level. Data generated were subjected to statistical analysis (ANOVA) using a statistical package for the Social Sciences, (SPSS for Windows software version 21) and mean separation was done using Duncan multiple range test. The cookies were accepted at 95% significant level.

RESULTS AND DISCUSSION

Proximate composition

The results of the proximate compositions and energy values of the cookies are presented in Table 3. The moisture content of the cookies were significantly ($p \leq 0.05$) different, ranging from 8.80% to 9.20% with samples; (100%WF) and (90%WF: 10% ANF) having the lowest and highest values respectively. The protein content of the cookies increased significantly ($p \leq 0.05$) from 7.33% (100%WF) to 11.03% (50%WF: 50%ANF) as the supplementation level of almond nut flour increased.

The fat content of the cookies ranged from 9.80 to 12.03%; cookie samples produced from 100% wheat flour and 50% WF: 50% ANF had the lowest and highest values respectively. The high fat content of the cookies could be attributed to the presence of high amount of fat in the almond nuts.

Table 3: Proximate compositions of cookies

Samples WF: ANF	Moisture (%)	Protein (%)	Fat (%)	Fibre (%)	Ash (%)	CHO (%)	Energy value (KCal)
100:0	8.80[d]	7.33 [f]	9.80[d]	1.40 [g]	1.40 [g]	71.27[a]	402.60[g]
0:100	9.17[a]	10.10[d]	13.73[a]	1.82[e]	1.69[d]	63.49[g]	417.93[a]
90:10	9.20[a]	9.70[e]	11.87[c]	1.76[f]	1.63[f]	65.84[b]	408.99[b]
80:20	9.16[a]	9.80[e]	11.89[c]	1.85[d]	1.67[e]	65.63[c]	408.73[d]
70:30	9.03[b]	10.70[c]	11.93[bc]	1.95[c]	1.73[c]	64.66[d]	408.81[c]
60:40	9.00[b]	10.83[b]	11.97[b]	2.05[b]	1.81[b]	64.34[e]	408.41[f]
50:50	8.92[c]	11.03[a]	12.03[b]	2.11[a]	1.89[a]	64.02[f]	408.47[e]

Means in the same column with the same superscript are not significantly different ($P \geq 0.05$). Values are means of duplicate determinations.
WF- Wheat flour, ANF- Almond nut flour, CHO- Carbohydrate

The crude fiber content of the cookies were significantly ($p<0.05$) different, ranging from 1.40% to 2.11%; with control sample (100%WF) and (50%WF: 50%ANF) having the lowest and highest values respectively.

The ash content of the cookies ranged from 1.40-1.89% with samples A (100% WF: 0%ANF) and G (50%WF:50%ANF) having the lowest and highest values respectively. The ash content, an indication of mineral composition in a food product, showed significant ($p<0.05$) increase in the cookies compared to the control sample.

The carbohydrate content of the cookies ranged from 63.49 to 71.27% and significant ($p<0.05$) difference exists among the samples. Cookies made with 100%WF (control sample) had the highest value while those from 100% ANF had the least value. The low carbohydrate content of the cookies could be attributed to low amount of this component in almond nut compared to wheat flour.

The energy value of the cookies ranged between 402.60 and 417.93 kcal/100g; cookies made from 100%WF (control sample) had the least value while those from 100%ANF had the highest value.

The results of the physical properties of the cookies are shown in Table 4. The weights of the cookies were significantly different from each other, ranging from 9.90 to 19.40 g. The cookies weight increased with the substitution levels of almond nut flour.

The thickness of the cookies ranged between 1.62 and 1.85 mm; cookies made from 100%WF (control sample) had the least value while those from 100%ANF had the highest value. There was significant ($p<0.05$) difference in thickness among the cookies which increased with increasing level of substitution with almond nut flour. The diameter of the cookies ranged from 4.80 to 6.11% with 90%WF:10%ANF and 50%WF:50% ANF having the highest and lowest values respectively. There was significant ($p<0.05$) decrease in diameter among the cookies as the replacement levels with almond nut flour increased. The spread ratio of the cookies ranged from 2.60-3.77, with the control sample (100% WF) and cookies with 100% ANF having the highest and lowest values respectively. Significant ($p<0.05$) decrease exist in the spread ratio of the composite cookies as the substitution levels with almond nut flour increased.

Sensory evaluation of cookies

The results of the sensory evaluation of cookie samples is as presented in Table 5. There was significant ($p\leq0.05$) difference among the samples. The cookie samples produced from 90%WF:10%ANF blends and some natural plant materials had significantly ($p<0.05$) higher scores for all the attributes evaluated except for crispiness. However, significant difference ($p<0.05$) exist between the control cookie sample (100%WF) and the enriched cookies. Moreover, this indicates that wheat flour can be substituted up to 10% replacement level with almond nut flour without affecting the sensory characteristics as well as the consumer acceptability of the cookies.

The mean scores for the aroma of the cookies ranged from 6.01 to 8.50, with the control cookie sample and 90%WF:10%ANF having the least and highest scores respectively. There was significant ($p<0.05$) difference in terms of aroma between the control cookies and the enriched cookies.

The taste of the cookie samples with a mean scores ranging between 6.10 and 7.90 showed that there was significant ($p<0.05$) difference among the samples. Cookies samples produced from 90% WF: 10%ANF and 50%WF: 50%ANF had the highest and lowest scores respectively. The enriched cookies were found to be significantly ($p<0.05$) different in taste compared with the control cookie samples.

The cookie samples color had mean scores ranging from 6.00 to 7.90. Cookie made from 70%WF:30%ANF had the least score while the highest score was observed in 90% WF:10%ANF cookies. However, there was significant ($p<0.05$) difference in colour between the control cookie samples (100%WF) and enriched cookies.

The sensory scores for crispiness ranged between 5.90 and 8.70, with cookies produced from 0% WF: 100% ANF and 100%WF:0%ANF having the least and highest scores respectively. However, significant difference ($p<0.05$) exist between the control cookie samples (100%WF) and the enriched cookies with increase in the substitution level of ANF.

The mean scores for the overall acceptability of the cookies ranged from 6.20 to 8.40, with cookies produced from 50%WF: 50%ANF and 90%WF: 10%ANF having the least and highest scores respectively.

Table 4: Physical characteristics of cookies

Samples WF:ANF	Weight (g)	Thickness (mm)	Diameter (mm)	Spread Ratio (D/T)
100:0 (control)	9.90^{g}	1.62^{g}	6.10^{a}	3.77^{a}
90:10	13.52^{f}	1.65^{f}	6.11^{a}	3.70^{b}
80:20	14.15^{e}	1.68^{e}	5.97^{b}	3.55^{c}
70:30	15.29^{d}	1.71^{d}	5.90^{c}	3.45^{d}
60:40	15.36^{c}	1.73^{c}	5.85^{c}	3.38^{e}
50:50	16.24^{b}	1.75^{b}	5.50^{d}	3.14^{f}
0:100	19.40^{a}	1.85^{a}	4.80^{e}	2.60^{g}

Mean values with the same superscript within the same column are not significantly different. Values are means of duplicate determinations. WF- Wheat flour, ANF- Almond nut flour

Table 5: Mean sensory scores of cookies

Samples WF:ANF	Aroma	Taste	Colour	Crispiness	Overall acceptability
100:0(Control)	6.01^{e}	6.60^{c}	6.50^{cd}	8.70^{a}	6.90^{d}
90:10	8.50^{a}	7.90^{a}	7.90^{a}	8.50^{b}	8.40^{a}
80:20	7.80^{b}	7.50^{b}	7.00^{b}	8.00^{c}	7.60^{b}
70:30	7.40^{c}	6.60^{c}	6.60^{c}	7.70^{d}	6.80^{d}
60:40	7.30^{d}	6.30^{d}	6.40^{d}	7.20^{e}	6.40^{e}
50:50	7.10^{d}	6.10^{e}	6.20^{e}	7.10^{e}	6.20^{f}
0:100	7.20^{d}	7.40^{b}	7.10^{b}	5.90^{f}	7.30^{c}

Mean values with the same superscript within the same column are not significantly different ($P \geq 0.05$).Values are means of duplicate determinations. WF- Wheat flour, ANF- Almond nut flour

DISCUSSION

With regard to the moisture content of the cookies, significant difference exists between the control cookie sample and the enriched cookies. The control cookies had the least value compared to others. The moisture content of the cookie samples was low (<10%) to reduce the chances of spoilage by micro-organisms and consequently guarantee good storage stability (Ayo *et al*., 2007). However, low moisture content of the flour (<10%) is an indication of high dry matter content and possibly prolonged shelf-life. The results are in accordance with the moisture of cookies produced from flour blends of wheat- cassava cortex- millet-pigeon pea (7.00- 8.40%) (Omah and Okafor, 2015), maize-pigeon pea (9.37-10.03%) (Echendu *et al*., 2004) and unripe plantain-wheat-watermelon seed (12.10-12.57%) (Oludumila and Adetimehin, 2016) respectively. Moreover, the result obtained in the study converse with the moisture of cookies produced from flour blends of wheat-debittered *moringa oleifera* seed (3.42-3.50%) (Ogunsina *et al*., 2011) and wheat-alfalfa seed (3.26-3.57%) (Fahim *et al*., 2016) respectively. Cookies should have low moisture for safe storage and inhibition of microbial growth that could affect their quality.

Increased protein content of the cookies with increasing almond nuts flour substitution level could be associated with the presence of greater protein in the nuts than in wheat flour. In addition, almond nut flour is a valuable food resource on account of its protein content. Ojinnaka and Agubolum, (2013), Ayo *et al*., (2007) and Ogunsina *et al*., (2011) reported high protein contents (7.76-11.84%), (5.00-14.19%) and (7.5-18.06%) in cookies produced from flour blends of wheat- cashew paste, acha-wheat-soya bean and wheat-debittered *moringa oleifera* seed respectively. Protein is an essential building material in food necessary for the maintenance of all body parts, such as blood, hair, bones, brain, nails, skin muscles and body fluid (Ayo *et al*., 2007).

The increased fat content of the enriched cookies compared to the control cookie sample may be attributed to the incorporation of almond nuts which are essential source of oil. Fats are integral part of cookies being the third largest component after flour and sugar (Manley, 2000). However, Ihekoronye and Ngoddy, (1985) reported that fat content in food products should be ≤ 25%, since this could result to rancidity in foods leading to the development of unpleasant and odorous compounds. Moreover, the presence of high fat content in the cookies indicates high calorific value and also serves as a lubricating agent that improves the quality of the product, in terms of flavor and texture. In addition, fat is a rich source of energy and is essential as carriers of fat soluble vitamins; A, D, E and K. Several reports by researchers attest to the fact that almond nuts are rich sources of fat (Olatidoye *et al.*, 2011). The fat content of cookies obtained in the study were significantly lower than (14.80- 24.01%), (25.87-26.80%), (20.41-25.11%) and (16.31-21.33%) as reported by Ayo *et al*., (2007), Lee-Hoon *et al*., (2016), Oludumila and Adetimehin, (2016) and Okpala (2010) for fat contents in cookies produced from composite flours of acha-wheat-soya bean, wheat-pitaya peel, unripe plantain-wheat-watermelon seed and wheat-jackfruit pulp respectively but higher than those produced from flour blends of acha-cowpea (1.12- 1.48%) (Olapade *et al*., 2011) and wheat-debittered *moringa oleifera* seed (0.87-3.98%) (Ogunsina *et al*., 2011) respectively.

With regard to the crude fiber content of the cookies, the control cookie sample had the least value compared to other enriched cookies. Crude fiber is an indication of roughage/bulkiness of a sample and its presence in diet serves in reducing constipation by facilitating bowel movement (peristalsis) and preventing many gastrointestinal diseases in man (Abiodun *et al*., 2012). Increase in the fiber content of the cookies with increase in the levels of substitution could be attributed to the high fiber contents of almond nuts and some incorporated natural plant materials. Similar results were obtained for cookies prepared from flour blends of cassava cortex-millet-pigeon pea-wheat (1.25- 1.70%) (Omah and Okafor, 2015), wheat bran-date palm fruits (1.20- 2.46%) (Gamal *et al*., 2012) and acha-cowpea (1.67-2.34%) (Olapade *et al.*, 2011) respectively. However, higher fiber values were obtained for cookies made from composite flours of plantain –bambara groundnut protein concentrate (5.2-9.2%) (Kiin kabari and Giami, 2015), unripe plantain-wheat-watermelon seed (1.69-4.01%) (Oludumila and Adetimehin, 2016) and wheat-carrot pomace powder-germinated chickpea (0.5-3.2%) (Baljeet *et al.*,2014), but lower than those from wheat-jackfruit pulp (2.17- 2.43%) (Okpala, (2010) respectively.

Ash is an inorganic compound containing the mineral content of a food product and which nutritionally aids the metabolism of other organic compounds, such as protein, fat and carbohydrate (Okaka, 2005). Significant difference exists among the cookie samples, with the control cookie sample having the least value. The increased ash content recorded in the enriched cookies may be attributed to the partial replacement of wheat flour with almond nut flour, which has been reported as a rich source of minerals. In addition, the inclusion of some plant materials (onion, carrot, ginger, basil and pumpkin leaves) in the cookie recipe may have also contributed to the increased ash content and this implies the presence of higher mineral contents in the enriched cookies. Plant materials are known to be rich source of mineral elements. Ashing is usually carried out in order to evaluate the mineral matter of food. The results obtained in the study were lower to those observed in cookies made from composite flours of wheat-pitaya peel (2.17- 3.11%) (Lee-Hoon Ho and Nadratul, 2016), wheat-acha-soyabean (9.35-9.79%) (Ayo *et al.*, 2007), unripe plantain-wheat-watermelon seed (1.65 - 5.02%) (Oludumila and Adetimehin, 2016) and pigeon pea-cocoyam-sorghum (2.56-3.22%) (Okpala and Okoli, 2011), similar to wheat-alfalfa seed (1.37- 1.92%) (Fahim *et al*., 2016), but higher than wheat- carrot pomace powder- germinated chickpea (0.8-1.2%) (Baljeet *et al.*, 2014) respectively.

The carbohydrate content of the cookies in the study were higher compared with 49.7-52.0%, 44.4- 52.49%, 47.4-60.6% and 51.87-61.90% ranges from previous works of Baljeet *et al.* (2014), Ogunsina *et al*. (2011), Kiin kabari and Giami (2015) and Oludumila and Adetimehin (2016) respectively.

Regarding the energy value of the cookies, significant ($p<0.05$) difference exist among the cookies. The slight increase in the enriched cookies could be a function of the partial replacement of wheat flour with almond nut flour. Fat, protein and carbohydrate values contributed to the calorie content of the cookies. Cookies are energy-giving foods which are consumed by both young and old, especially in between meals. The results obtained in the study were lower to those observed in cookies made from composite flours of wheat-tumeric flower extract (472.86-482.37 kcal) (Nur, 2016) and wheat- cassava cortex-millet-pigeon pea (422.43-428.84 kcal) (Omah and Okafor, 2015) respectively.

The weight of the cookies was significantly different from one another. The findings obtained in the study are in agreement with those reported for biscuits made from composite flours of wheat-defatted pumpkin seed (13.30-13.53 g) (Atuonwu and Akobundu, 2010), wheat –precooked taro-njansang meal (3.86-4.61 g) (Edith *et al.*, 2016) and wheat-quality protein maize (16.49-21.99 g) (Giwa and Ikujenlola, 2010) respectively. On the contrary, Ayo *et al.*, (2007), Okaka and Isieh, (1990), Alobo, (2001), Okpala and Chinyelu, (2011) and Yusuf *et al.*,(2015) reported a reduction in cookies weight produced from flour blends of wheat-soyabean, cowpea-wheat, millet-sesame flour, pigeon pea-cocoyam and green bean-wheat respectively. The difference in observation could probably be due to the fact that other cookies were produced from wheat flour with partial substitution with legume/oilseeds

Regarding the thickness of the cookies, the difference could be attributed to the inconsistent rolling thickness of the dough which was exhibited as a result of the high fat content. These results are in accordance with those reported for cookies made from flour blends of acha- soyabean hulls (3.80- 6.40 mm) (Ayo and Kajo (2016), wheat-alfalfa (7.53-8.10 mm) (Fahim *et al*., 2016), sweet-potato-mango mesocarp(6.1-7.6 mm) (Sengev *et al.*, 2015) and wheat - precooked taro-njansang meal (0.76- 0.89 cm) (Edith *et al.*, 2016) respectively. On the contrary, lower cookie samples values of 2.30- 2.70 mm and 47- 60cm were reported by Yusuf *et al.* (2015) and Atuonwu and Akobundu (2010) respectively.

With regard to the diameter of the cookies, similar finding was observed by Saha *et al.* (2011) and this could be attributed to increased protein content in the flour blend. These results are also in accordance with the findings of Shalini and Sudesh (2005). Tiwari and Brennan (2011) reported that the diameter of biscuits decreased with increase in the dehulled pigeon pea flour inclusion at different levels in wheat flour.

Cookies spread ratio represents a ratio of diameter to thickness. High spread ratio and large diameter are considered as desirable quality attributes of cookies. From this study, cookies produced from 90:10% WF-ANF had the highest values in terms of diameter and very close to the control cookie sample's spread ratio. Conversely, Arti *et al*., (2016) reported that composite cookies produced from wheat-amaranth flour blends displayed an increasing trend for the cookies spread ratio.

The increase in the aroma of the cookies at high level of substitution with almond nut flour could probably be due to the nutty flavor associated with almond nuts. Besides, addition of powders of onion, ginger and basil leaves as part of the ingredients could have also contributed to the flavor and acceptance of the cookies, even though the panelists are not familiar with them.

The taste of the enriched cookies decreased with increase in ANF substitution level. This could be attributed to the bitter after-taste observed in the cookies at higher concentration. Furthermore, the unpreparedness of the panelists to explore for new taste as well the non-familiarities of the product made only cookies produced from 90% WF:10% ANF to be most preferred in terms of taste.

Visual color is an importance criterion of cookie, as perceived in the consumer's eye. Moreover, color is a very important parameter in judging properly baked goods that not only reflect the suitable raw material used for preparation but also provides information about the formulation and quality of the product (Ferial and Abusalem, 2011). The sensory scores for color indicates that the panelists are well acquainted with wide arrays of different colored cookies. The enriched cookies had dark brown coloration with green patches of plant-based materials. This coloration could be due to the reaction between reducing the sugar and amino acids (Maillard reaction) and caramelization as reported by Fahim *et al.* (2016). Similar findings was observed by Fahim *et al.* (2016) who reported dark brown coloration in biscuits made from wheat-alfalfa nut flour blends. The results in this study are also in accordance with the findings of Ndife *et al.* (2011) as well as Ferial and Abusalem (2011) who reported a dark brown color in whole wheat flour-based biscuits supplemented with soybean flour and bambara groundnut flour respectively.

Crispiness is another important criterion perceived when snack is chewed between the molars and is usually expressed in terms of hardness and factorability. The panelists gave higher preference to the crispiest cookies. The disparity could be attributed to the higher percentage of gluten in 100% WF that leads to the formation of elastic dough which was hard during handling, thus resulting to cookie with higher crispiness after baking than other composite cookies.

It is worth nothing that both the control cookie samples and other supplemented cookies were generally well accepted, since all the scores were higher than 4.5 which is the minimum acceptable values on the nine point hedonic.

CONCLUSION

Based on the results of the study, it can be deduced that cookies produced from flour blends of wheat, almond nuts and some plant materials have improved protein, fiber and ash contents compared to the control cookie sample made from 100% wheat flour. The enriched cookies were most preferred and acceptable at 10% inclusion level with almond nut flour which correspond to sample with protein- 9.70%, fiber- 1.76%, ash- 1.63%, Carbohydrate- 65.84% and energy value- 408.99 Kcal.

REFERENCES

AACC. (2000). *Approved methods of the American association of cereal chemists* (17th ed.). St.Paul, MN: Author.

Abdul, W. K., Javid, A., Tariq, M., Muhammad, A., Mohammad, P. and Said, H. (2015). Effect of oat bran on the quality of enriched high fiber biscuits. World Journal of Dairy and Food Sciences, 10:68–73.

Abiodun, O.A., Adegbite, J.A. and Omolola, A.O. (2012). Chemical and physicochemical lproperties of Moringa flours and oil. Global Journal of Science Frontier Resource Biological Sciences, 12(5): 2249- 4626.

Agu, H.O., Ukonze, J.A. and Paul, K.A. (2010). Quality characteristics of bread made from wheat and fluted pumpkin seed flour. Nigerian Food Journal, 28(1): 188- 198.

Ajanaku, K.O., Dawodu, F. A., Ajamaku, C.O and Nwinyi, O.C (2011). Functional and nutritional properties of spent grain enhanced cookies. American Journal of Food Technology, 6: 763-771.

Akinwande, B. A., Ade-Omowaye, B. I. O., Olaniyan, S. A., and Akintaro, O. O. (2008). Quality evaluation or ginger flavoured soy-cassava biscuit. Journal of Nutritional and Food Science, 38:473–481.

Alobo, A.P. (2001). Effect of Sesame seed flour on millet biscuit characteristics. *Plant food for Human Nutrition*, 56:195-202.

Anozie, G. O., China, M. A., and Beleya, E.A. (2014). Sensory evaluation and proximate composition of snacks produced from composite flour of *Discorea alata* and *Telfaira occidentalis* seed flours. *Journal of Home Economic Research*, 20:100–108.

AOAC (2010). Official methods of analysis. 14th edition. Association of Official Analytical Chemists, Washington, D. C.

Arti Chauhan, Saxena, D.C. and Sukhcharn S. (2016). Physical, textural, and sensory characteristics of wheat and amaranth flour blend cookies. *Cogent Food and Agriculture*, 2: 1125773.

Ayo, J. A. and Andrew, E. (2016). Effect of added Bambara groundnut on the quality of acha-date palm based biscuit. *International Journal of Biotechnology and Food Science*, 4(3): 34-38.

Ayo, J. A., Ayo, V. A., Nkama, I. and Adeworie, R. (2007). Physiochemical, *invitro* digestibility and organoleptic evaluation of acha-wheat biscuit supplemented with soybean flour. *Nigerian Food Journal*, 25:15-17.

Ayo, J.A. and Kajo, N. (2016). Effect of soy hulls supplementation on the quality ofached based biscuits. *American Journal of Food and Nutrition*, 6(2):49- 56.

Baljeet, S. Y., Ritika, B.Y. and Reena, K. (2014). Effect of incorporation of carrot pomace powder and germinated chickpea flour on the quality characteristics of biscuits. *International Food Research Journal*, 21(1): 217-222.

Bokanga, M. (1995). Cassava: Opportunity forfood, feed, and other industries in Africa.

In: Agbor T, Egbe A, Brauman Griffon D, Treche S (eds.) Orstom, 557-569.

Chinma, C.E., Igbanul, D.B. and Omotayo, O.O. (2012). Quality characteristics ofcookies prepared from unripe plantain and defatted sesame flour blend. *Armenian Journal of Food Technology*, 7(7): 395- 408.

Djutin, K. E.(1991). Pumpkin: Nutritionalproperties. Potatoes and Vegetables,3:25-26.

Echendu, C.A., Onimawo, I. A. and Somtochi, A. (2004). Production and evaluation of doughnut and biscuit from maize-pigeon pea flour blends. *Food Journal*, (22):147-153.

Edeoga, H. O., Okwu, D. E. and Mbaebie, B.O. (2003). Mineral and nutritive value of some Nigerian medicinal plants. *Journal of Aromatic plant science*, 25: 689-694.

Emilio, R. (2010). Health benefits of nut consumption. *Nutrients Journal*, 2: 652-682. doi.10.3390/nu2070652.

Etukudo, I. (2003). Ethnobotany: Conventional and traditional uses of plants. The verdict Press, Uyo, Nigeria. 81

Fahim, U., Sajjad, A., Said, W., Alam, Z., Mansoor, Khan K., Saleem, K. and Min, K.(2016). Quality Evaluation of Biscuits Supplemented with Alfalfa Seed Flour. *Food Journal*, 5: 68.doi10.3390/foods040068.

Ferial, M. Abu-Salem and Azza, A. Abou-Arab (2011). Effect of supplementation of ambaragroundnut (*Vigna subterranean* L.) flour on the quality of biscuits. *African Journal of Food Science*, 5(7): 376-383.

Gamal, A. E., Salah, M. A. and Mutlaq, M. Al-Otaibi (2012). Nutritional Quality of Biscuit Supplemented with Wheat Bran and Date Palm Fruits (*Phoenix dactylifera* L.). *Journal of Food and Nutrition Sciences*, 3:322-328.

Giwa, E. O. and Ikujenlola, A. V. (2010). Quality characteristics of biscuits produced from composite flours of wheat and quality protein maize. *African Journal of Food Science and Technology*, 1:118–119.

Ihekoronye, A. I.,and Ngoddy, P. O. (1985). Integrated Food Science and Technology for the Tropics. London: Macmillan.

Kiin-Kabari, D. B. and Giami, S. Y. (2015). Production and quality assessment of enriched cookies from plantain flour and bambara groundnut protein concentrate. *European Journal of Food Science and Technology*, 3(4): 32-40.

Knekt, P., Kumpulainen, J., Jarvinen, R., Rissanen, H., Heliovaara, M., Reunanen, A., Hakulinen, T., Aromaa, A. (2002). Flavonoid intake and risk of chronic diseases. *American Journal of Clinical Nutrition*, 76:560–568.

Krishan, D. S., Swati, K., Narayan, S. T. and Surekha, A. (2012). Chemical composition, functional properties and processing of carrot: a review. Journal of Food Science Technology, 49 (1): 22-32

Lee-Hoon, H., Nadratul, Wahidah B. and Abdul, Latif (2016). Nutritional composition, physical properties, and sensory evaluation of cookies prepared from wheat flour and pitaya (*Hylocereus undatus*) peel flour blends. *Cogent Food and Agriculture*, 2:1136369

Liu, R. H. (2004). Potential synergy of phytochemicals in cancer prevention: mechanism of action. *Journal of Nutrition*, 134:3479–3485.

Manley, D. (2000). Technology of Biscuits, Crackers and Cookies, Third Edition, Woodhead Publishing limited, Cambridge England, 21-223.

Marero, L. M., Payumo, E. M., Librando, E.C., Laine, W. N., Gopez, M. D. and Homma, S. (1998). Technology of using food formulations prepared from germinated cereals andlegumes. *Journal of Food Science*, 53:1391–1395.

Mbaeyi-Nwaoha, I. E. and Onweluzo, J.C. (2013). Functional Properties of Sorghum (*S.bicolor* L.) - Pigeonpea (*Cajanus cajan)* flour Blends and Storage Stability of a Flaked Breakfast Formulated from Blends. *Pakistan Journal of Nutrition*, 12(4): 382-397.

Micheal, O. Ameh, Dick, I. Gernah and Bibiana, D. Igbabul (2013). Physico-chemical and sensory evaluation of wheat bread supplemented with stabilized undefatted rice bran. *Food and Nutrition Sciences*, 4: 43-48.

Ndife, J., Abdulraheem, L.O. and Zakari, U. M. (2011). Evaluation of the nutritional and sensory quality of functional breads produced from whole wheat and soya bean flour blends *African Journal Food Science*, 5:466–472.

Ndife, J., Kida, F. and Fagbemi, S. (2014). Production and quality assessment of enriched cookies from whole wheat and full fat Soya. *European Journal of Food Science and Technology*, 2(1): 19-28.

Njoku, B.O., Mbanaso, E. N. and Asumugh, G.N. (1995). Ginger production by conventional and tissue culture techniques, NRCRI and FAOUN, Dolf Madi Publishers, Owerri.

Noor Aziah, A.A. and Komathi, C.A. (2009). Acceptability attributes of crackers made from different types of composite flour. *International Food Research Journal*, 16: 479-482

Nur, Syakila A., Rajeev, B. and Yeoh, T. K. (2016). Quality evaluation of novel cookies prepared by supplementing with fresh turmeric flower (*Curcuma longa* L.) extracts as a value added functional ingredient. *International Food Research Journal*, 23(4): 1514-1522.

Ogunsina, B.S., Radha, C. and Indrani, D. (2011). Quality characteristics of bread and cookies enriched with debittered Moringa oleifera seed flour. *International Journal of Food Sciences and Nutrition*, 62(2): 185–194.

Ojinnaka, M.C., Anyanwu, F.A. and Ihemeje,A. (2013). Nutritional evaluation of cookies produced from African breadfruit (*Treculia africana)* starch and wheat flour. *International Journal of Agricultural and Food Science*, 3(3): 95-99.

Okaka, J.C and Isieh, M.K. (1990). Development and quality evaluation of cowpea-wheat biscuits– *Nigerian Food Journa*l, 8:56-62.

Okoye, J.J and Okaka, J.C. (2009). Production and evaluation of protein quality of bread from wheat-cowpea flour blends, *Continental Journal of Food Science and Technology*, 3: 1-7

Okpala, L.C. and Chinyelu, V. A. (2011). Physicochemical, nutritional and organoleptic evaluation of cookies from pigeon pea (*Cajanus cajan*) and cocoyam (*Xanthosoma sp.*) flour blends. *African journal of Food Agriculture Nutrition and Development*, 11 (6): 5431-5443.

Okpala, L.C. and Okoli, E.C. (2001). Nutritional evaluation of cookies produced from pigeonpea, cocoyam and sorghum flour blends. *African Journal of Biotechnology*, 10: 433-438.

Okpala, M. O. (2010). Development and evaluation of baked products from jackfruit (*Artocarpus heterophyllus*) seed kernel and pulp flour. M.Sc. Thesis, Department of Food Science and Technology, University of Nigeria, Nsukka.

Olapade, A. A., Aworh, O. C. and Oluwole, O. B. (2011). Quality attributes of biscuit from acha (Digitaria exilis) flour supplemented with cowpea (Vigna unguiculata) flour. *African Journal of Food Science and Technology*, 2 (9): 198-203.

Olatidoye, O. P., Sobowale, S. S., Akinlotan, J.V. and Olorode, O.O. (2011). Chemical composition and physicochemical characteristics of tropical almond nuts (*Terminalia catappia*) cultivated in South

West *Nigeria. Journal of Medical and Applied Biosciences*, 2: 629- 633.

Oludumila, Omolara R. and Adetimehin, Abosede M. (2016). Quality Characteristics of cookies produced from composite flours of unripe plantain, wheat and watermelon seed. *Indian Journal of Nutrition*, 2(2):117.

Omah, E.C. and Okafor, G.I. (2015). Production and quality evaluation of cookies from blends of millet-pigeon pea composite flour and cassava cortex. *Journal of Food Resource Science*, 4 (2): 23-32.

Saha, S., Gupta, A., Singh, S.R.K., Bharti, N., Singh, K. P., Mahajan, V. and Gupta,H. S. (2011).Compositional and varietal influence of finger millet flour on rheological properties of dough and quality of biscuit. *Journal of Food Science and Technology*, 44: 616–621.

Shalini, H. and Sudesh, J. (2005). Organoleptic and nutritional evaluation of wheat biscuits supplemented with untreated and treated fenugreek flour. *Journal of Food Chemistry*, 90:427–435.

Tiwari, B. K., Brennan, C. S., Jaganmohan, R., Surabi, A. and Alagusundaramb, K. (2011). Utilisation of pigeon pea (Cajanus cajan L.) by-products in biscuit manufacture. *Journal of Food Science and Technology*, 44:1533-1537.

Towseef, A. Wani and Monika, Sood (2014). Effect of incorporation of cauliflower leaf powder on sensory and nutritional composition of malted wheat biscuits. *African Journal of Biotechnology*, 13(9):1019- 1026.

Tropilab Incorporated (2005). *Terminalia catappa*- Tropical Almond. Retrieved on June 5th, 2005 from http://www.tropilab.com/terminalia- cat.html.

Yang, J., Liu, R.H., Halim, L. (2009). Antioxidant and antiproliferative activities of common edible nut seeds. *LTW—Food Science and Technology*, 42:1–8.

Yusuf, M.I, Obiegbuna, J.E and Yusuf, P.A (2015). Studies on the utilization of green bean as raw material in cookies produced from wheat flour. *Journal of Agricultural Science Research*, 5 (6): 92-97.