NIGERIAN AGRICULTURAL JOURNAL
ISSN: 0300-368X
Volume 53 Number 2, August 2022 Pg. 96-104
Available online at: http://www.ajol.info/index.php/naj
https://www.naj.asn.org.ng

Evaluation of Functional, Physical Properties, Proximate and Sensory Characteristics of Cookies Produced from Wheat and Oat Composite Flour Sweetened with Date Syrup

[1]Nwanagba, N.L., [1]Ukom, A., N., [1]Ifokwe, G., [2]Okudu, H., [2]Okoli, J. N. and [3]Okparauka, I.I.

[1]Department of Food Science and Technology;
[2]Department of Human Nutrition and Dietetics,
Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria
[3]Science Laboratory Technology Biochemistry Unit, Akanu Ibiam
Federal Polytechnic Uwana Afikpo Ebonyi State
Corresponding Author's email: nwanagban@yahoo.com

Abstract
Evaluation of the functional, physical properties, proximate and sensory characteristics of cookies produced from wheat and oat composite flour sweetened with date syrup was investigated. Healthy grains of oat and wheat were purchased from Central Market Katsina State, and date nut purchased from Wuse Modern Market, FCT (Federal Capital Territory), Abuja. The oat grains were sorted, cleaned, washed, steamed, kilned, dried, cooled, milled into flour and packaged in an airtight container. The wheat grains were sorted, cleaned, washed, dried, milled and packaged prior to analysis. The date fruits were washed, soaked in distilled water for easy removal of dates, after removal, the dates were then rinsed, blended and boiled for 15 minutes. The slurry obtained after boiling was sieved with cheesecloth under manual pressure, and then subjected to another boiling under medium low heat for 20 minutes. A thick like liquid dates obtained after cooling was packaged in a plastic container and stored in fridge prior to analysis. The cookies were prepared accordingly using the necessary ingredients. The composite flour samples were evaluated for functional properties, while the cookies produced from these composite flour samples were evaluated for physical properties, proximate composition and sensory characteristics. The result of the functional properties of the flour blends of oat and wheat showed that sample 202 and 404 (100% oat meal and 60% wheat with 40% oatmeal) had the highest value (2.37 g/ml) of water absorption capacity (WAC), while sample 505 (50% wheat flour and 30% oat flour) had the lowest value (1.87 g/ml). The functional properties values for the flour blends ranged from 1.87-2.37 g/ml for WAC, 1.37-1.67g/ml for oil absorption capacity, 0.68-0.79g/ml for bulk density, 58.27 to 72.57 ^{0}C for gelatinization temperature and 23.67-71.67s for wettability. The result for physical properties ranged from 10.10-10.46g, 3.90-4.37 cm, 0.22-1.17 cm, and 3.34-5.29 for weight, diameter, thickness and spread ratio respectively. The cookies had proximate composition ranging from 5.35-6.75% for moisture, 13.58-18.01% crude protein, 2.91-5.87% crude fiber, 13.23-18.80% fat, 1.48-2.58% ash, 93.25-94.65% dry matter and 50.21-62.06% for carbohydrate. The result of the sensory attributes of the cookies showed that sample 101 (100% wheat flour) was most preferred in terms of general acceptability.

Keywords: Functional and physical properties, proximate, sensory, composite flour (wheat and oat), date syrup

Introduction
Cookies can be defined as edible snacks made from unpleasant dough that turns into an appetizing product by application of heat in an oven (Olaoye *et al*., 2007). Cookies are ideal for nutritional availability, taste, compactness, and convenience (Vijykumar *et al*., 2013). Cookies are widely consumed as a snack around the world. They are a good example of ready-to-eat breakfast baked goods that have many properties, including broad consumption, greater convenience, long shelf life and are nutritionally rich. Oats (*Avena sativa L.*) are the most commonly cultivated species of the Gramineae family and are rich source of fiber, especially β-glucans. Oats are an important grain in developing countries, most widely grown (Singh, 2007), and have received considerable attention due to their high fiber content, phytochemicals and nutritional value. Oats are one of the most nutritious whole grains because they are high in protein. Oat protein is *Phoenix dactylifera L* usually greater than that of other grains;

contains large amounts of vitamins and minerals (Ahmad *et al*., 2014).

The date palm (*Phoenix dactylifera*) belongs to the Arecaceae family (Al-daihan and Bhat, 2012) is a sweet, edible fruit. Date palm contains more than 70% sugar, mainly glucose and fructose (Dada *et al*., 2012). It has many potential medicinal benefits, have high source of iron, calcium, copper, magnesium and potassium (Dada *et al*., 2012; Farheena *et al*., 2015). In addition, dates are rich in fiber (Hamza *et al*., 2014), very rich in antioxidants such as beta-carotene, lutein and zeaxanthin. Date palm is a source of antioxidants, good for blood sugar levels, have a low glycemic index, help maintain bone mass, and lower blood pressure. Increased intake of added sugar can increase the risk of obesity, cardiovascular disease, dental caries, glucose intolerance, diabetes, high blood pressure, and behavioral complications such as hyperactivity in children (Johnson and Yon, 2010). Replacing sugar completely with dates in cookies making will not only reduce the rate of sugar importation but also improve the nutritional profile of the cookies given the abundance of nutrients in date palm (Nwanekezi *et al*., 2015).

Cookies are made mainly with wheat flour, which is one of the main ingredients for making cookies in general because of its gluten content. Also, flour used for the production of baked products are always blanched and are thus known as slow poison or intestinal glue as a result of high intake which has health implications (Erleen, 2011). Some call it intestinal glue (Erleen, 2011) and prevent people from consuming it or reduce their intake of foods made from this flour because of the health risks associated with it (Erleen, 2011). Cookies are mainly processed with refined wheat flour, which is higher in starch, low in fiber and minerals, and the resulting biscuits are characterized by low protein, fat and mineral content (Archana *et al*., 2004; Ali *et al*., 2012). Celiac disease; an autoimmune disease caused by gluten interactions in genetically predisposed individuals, is common in areas of northern India where wheat is a staple food (Mir *et al*., 2014). A strict gluten-free diet can completely restore the health of patients with celiac disease and improve the quality of life and is therefore, the mainstay of treatment (Stern, 2008). This research aimed at evaluating the functional, physical properties, proximate and sensory characteristics of cookies produced from wheat and oat composite flour sweetened with date syrup

Materials and Methods

Source of Raw Materials

Whole oat grains, wheat grains and date nuts were the raw materials used in this study. Healthy grains of oat and wheat were purchased from Central Market, Katsina State. The date palm was purchased from Wuse Modern Market, FCT, Abuja. Other baking ingredients such as egg, margarine, vanilla flavor, milk etc were also purchased from the same market. The equipment and reagents used were gotten from National Root Crops Research Institute (NRCRI) Umudike, Abia State.

Preparation of Flour Sample

***Production of Oat Flour**:* The method described by Giradet and Webster (2011) was adopted for the production of oat flour with slight modification. The oat grains were carefully sorted and cleaned to remove defective grains and foreign particles. They were then washed properly with clean water to remove dust or sand particles after which the water was drained. It was steamed for 9 minutes and heated at about 100°C for 45 minutes. This was done to develop flavour and prevent rancidity. The kilned oats were then dried in a hot air oven (model Schutzartdinen 6052G-1p20) to evaporate excess moisture and produce desirable nutty flavours, cooled, milled into fine flour and packaged in an airtight container prior to analysis.

Production of whole wheat flour: The method described by Ndife *et al*. (2014) was used in the production of whole wheat flour. Wheat grains were sorted, washed and drained. This was followed by drying (in oven at 60 ºC for 8 h) (Gallenkemp, 300 Plus, England), milling (using hammer mill) (HMC-HM6630, China) to obtain whole wheat flour that was packaged in a polyethylene pack until it was used.

Production of Date Syrup

The method described by Lee (2016) was adopted with modification in the production of date palm syrup. The date fruits were washed and soaked in distilled water for few minutes for easy removal of the pits. The pits were then removed with knife, rinsed and blended with 200 ml of water in a Blender. The mixture was poured in a clean pot followed by addition of water until it covered part of the can containing the mixture. The mixture was boiled under medium heat for about 15 minutes and cooled. The slurry was separated by a cheese cloth under manual pressure to expel great impurities and insoluble materials. The liquid was poured back into a clean pot boiled again at reduced medium-low heat to maintain a low boiling for 20 minutes until it became thicker, cooled at room temperature, packaged in a plastic container and stored at freezer temperature prior to analysis.

Formulation of Composite Flour

Super Interment electric blender in Food Science and Technology Laboratory was used to blend the flour to a homogenized form and then packaged in polyethylene bags and stored under room temperature for further use.

Production of Cookies

The cookies were baked using the method of Ceserani *et al*. (2008) with slight modification. A quantity of 50 g of Fat and 30 ml of date syrup were creamed to a smooth consistency; eggs and milk were also added and mixed. The dry ingredients; flour (100g), baking powder (1g) and salt (0.5g) were mixed together and added to the cream, followed by the flavor (vanilla flavor) and nutmeg to form a dough. The dough was kneaded into uniform thickness, rolled into shapes, placed in greased pans and baked at 150°C for 20 minutes. The cookies were cooled and packaged in cellophane bags prior to analysis.

Functional Properties Analysis

The water absorption capacity (WAC), oil absorption capacity (OAC), bulk density(BD), gelation temperature (GT) and wettability were determined by the method described by Onwuka (2018).

Physical Properties of the Cookie Samples

The weights, diameter, thickness were determined using the method described by Ayo *et al.* (2007), while the spread ratio was determined by Onwuka *et al*. (2018) and breaking strength of the cookie samples determined by Okaka and Iseih (1990).

Proximate Analysis

The proximate compositions of the cookie samples (moisture, crude fiber, fat and protein contents were determined using the method described by Onwuka (2018). The ash content was determined using the furnace incineration gravimetric method described by AOAC (2005), while the carbohydrate content was determined by difference.

Sensory Evaluation

Sensory evaluation was carried out in 24 hrs after the production of the cookies. A total of 25 panelists who were familiar with the quality attributes of cookies were selected among students of the Department of Food Science and Technology, Michael Okpara University of Agriculture, Umudike. A criterion for selection of panelists was that panelists were not allergic to any cookies. The panelists were instructed to evaluate the aroma, taste, texture, crispiness, appearance and overall acceptance of the cookies using the 9-point hedonic scale with 1 dislike extremely and 9 like extremely. The panelists were instructed to rinse their mouths with water after analyzing (tasting) each sample. They were also asked to comment freely about each sample tasted on the questionnaires given to them.

Statistical Analysis

The data collected were subjected to analysis of variance (ANOVA) following a completely randomized design (CRD), using the statistical package for the Social Science (SPSS) version 22. Means were separated using Duncan's multiple range test at 95% confidence level.

Results and Discussion

Functional Properties of the Flour Blends

The results of the functional properties of the flour blends produced from oat meal, wheat and date syrup is presented in Table 3. Results shows that WAC values ranged from 1.87 to 2.37 g/ml and differed significantly ($p<0.05$). There were differences between sample 101 and sample 505, but they were not significant. Sample 202 and 404 also did not show any significant difference, while Sample 103 was significantly different from all other samples. Ayo-Omogie and Odekunle (2012) also obtained higher values in the wheat sample which may be due to variation in the concentration of protein content, degree of association and conformational characteristics (Butt and Batool, 2010) and higher number of hydroxyl groups found in fibre structure; which tends to allow more water interactions through hydrogen bonding has been reported to be responsible for high water absorption capacity of fibre-rich flours (Noor Aziah *et al.,* 2012). Water absorption obtained in this study was lower compared to 101.93 to 224.94 g/ml reported by Abiyot (2017). Water absorption capacity is used to indicate starch degradation and thus it determines the amount of free polysaccharide released from the granule on the addition of excess water (Oshundahunsi *et al*., 2003). Oil absorption capacity is very important from an industrial viewpoint; since it reflects the emulsifying capacity (Kaur and Singh, 2017). The Oil absorption capacities of the samples were generally high. Sample 303 (50% wheat flour and 50% oat meal) had the highest value (1.67% g/ml), while sample 101 (100% wheat flour) had the least value (1.37 g/ml). Oil absorption capacity increased with increase in the proportion of oat flour bends. The major chemical component affecting OAC is protein, which is composed of both hydrophilic and hydrophobic parts. Non-polar amino acid side chains can form hydrophobic interaction with hydrocarbon chains of lipids (Jitngarmkusol *et al*., 2008). Therefore, the possible reason for increase in the OAC of composite flours might be due to the variations in the presence of non-polar side chain, which might bind the hydrocarbon side chain of the oil among the flours of oat. In terms of bulk density, sample 101 had the lowest value of 0.68 g/ml, while sample 202 (100% oat flour) had the highest value of 0.79 g/ml. Abiyot (2017) observed a lower bulk density for oat flour (0.54g/ml) from wheat based cookies supplemented with oat and fenugreek flour, which is similar to this study. Bulk density of flours was observed to be slightly same as that reported values by Okafor *et al.* (2017) (0.63 to 0.72 g/ml) for flours from whole wheat and date palm fruit pulp. Low bulk density of flour has been reported to be useful in food formulation. Flour with low bulk density when used for food formulation has less retrogradation. Low bulk density is an indication of the heaviness of the flour sample (Olade and Aina, 2009). The lowest bulk density implies the flour will occupy less space during storage and more economical during transportation because more quantities can be transported (Abiyot, 2017). The less the bulk density, the more packaging space required (Agunbiade and Ojezele, 2010). Gelatinization temperature is the temperature at which starch molecules in a food substance lose their structure and leach out from the granules as swollen amylase, and it affects the time required for the cooking of food substances (Eleazu *et al*., 2014). The gelatinization temperature as shown in Table 3 ranged from 58.27 to 72.57 ^{o}C with sample 303 (50% wheat and 50% oat flour) having the highest value and sample 505 having the least value. In terms of wettability, sample 101 (100% wheat flour) had the highest value of 71.67 sec, while sample 202 had the least value 23.67 sec (100% oat meal). There was significant difference ($p<0.05$) among the samples analysed. However, their values were observed to decrease with increase in proportion of the oat flour. The flour with the lowest value (202) dissolved faster in water, while flour with the highest (101) took longer time to dissolve. This implies that blends of wheat and oat flour with increased proportion of oat flour takes longer time to dissolve. Okafor *et al.* (2017) reported high wettability value of 13.00 to 116.70 sec in the study he conducted on whole wheat and date palm fruit pulp. Wettability values as observed in samples with high date palm pulp proportion reduced the time for the flour to become completely wet (Mishra and Chandra, 2012).

Physical Properties of the Cookies Samples

The physical properties of the cookies samples shown in Table 4 indicates that the weight of the cookies ranged from 10.10 to 10.46 g. Sample 101 (100%) was heaviest among the samples, while sample 202 (100% oat) had the least weight value. It was noticed that the weight of the composite cookies displayed a decreasing trend along with the increasing substitution level of oat. The high weight in sample could be because the 100% wheat flour had more gluten, which is responsible for increased dough development and elasticity (Badifu *et al*., 2005). The findings obtained in the study are in agreement with those reported for cookies made from fenugreek and oat flour (8.11 to 10.12g) (Abiyot, 2017). The weight in this study is higher than that reported by Okafor *et al*. (2017); 1.88g to 3.35g for cookies made from wheat flour and date fruit pulp. The diameter of the cookies sample ranged between 3.90 cm to 4.37 cm. Cookies sample had no significant difference ($p<0.05$), except for sample 101 (100% wheat flour). The diameter of the cookies increased with inclusion of oat flour. 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), but contradicts Abiyot (2017), who stated decreasing trend in diameter of cookies sample made from oat and fenugreek flour. The cookies thickness ranged from 0.22 cm to 1.17cm. Sample 101 has the highest thickness and the least thickness was recorded in sample 505. The less thin the cookies, the less its ability to withstand stress. Sample 101 was significantly different ($p<0.05$) from the other samples. The thickness of the cookies decreased as oat flour substitution increased. Okafor *et al*. (2017) observed similar results of 0.55 to 0.79 cm for cookies made from wheat flour and date fruit pulp. The spread ratio is an indication of binding properties and texture. Spread ratio of the cookies samples ranged from 3.34 to 5.29 with decrease in sample 101 (100% wheat) and increase in sample 404 (60WF: 40 oat flour). The dilution of gluten in the blended flours resulted in increased cookies spread ratio. The weak connections of starch polymer molecules in oat flours might have also contributed to increased expansion of blended flour cookies, yielding larger spread ratio. The findings of this study contradicted the report of Florence *et al.* (2020) and Suriya *et al.* (2017) who reported that composite biscuits and cookies had lower spread ratio compared to those produced from 100% wheat flour and Okpala *et al*. (2011) also reported that reduction in spread ratios has been attributed to the hydrophilic nature of flours used in cookie production, Moreover, Abiyot (2017) reported increased spread ratio for cookies made from oat and fenugreek flour (6.10 to 10.41). The spread ratio is an important characteristic for determining the quality of cookies. Abou-Zaid (2012) reported that cookies with higher spread ratios are considered the most desirable.

Proximate Composition of Cookies Samples

Table 5 shows that the moisture content of the cookies ranged from 5.35 to 6.75%, with sample 101 (100% wheat) having the highest value of moisture content, while sample 202 (100% oat flour) had the least moisture content. There were significant differences ($p<0.05$) observed among the cookies. The low moisture content observed among the cookies samples will result to high resistance to microbial attack and consequently guarantee good storage stability (Ayo *et al*., 2007). The results are in accordance with the moisture content of cookies produced from flour blends of wheat-cassava cortex-millet-pigeon pea (7.00-8.40%) (Omah and Okafor, 2015) and unripe plantain-wheat-watermelon seed (2.10-12.57%) (Oludumila and Adetimehin, 2016). The crude protein ranged from 13.58 to 18.01%. Sample 303 (50% wheat flour and 50% oat flour) had the highest value, while sample 101 (100% wheat flour) had the least value. There were significant differences ($p<0.05$) observed among the samples. These findings are in agreement with the work of Chappalwar *et al*. (2013) who observed the same increase in protein content due to increase in the proportion of oat and finger millet flour in their cookies prepared from oats and finger millet composite flour. These findings are higher than the work of Abiyot (2017) on evaluation of wheat based cookies of oat and fenugreek flour which ranged from 8.95 to 12.26% and 6.20% to 11.15% obtained by Okafor *et al*. (2017) from wheat based with palm date fruit pulp as sugar substitute. The crude fiber result as shown in Table 5 indicates that the values ranged from 2.91 to 5.87% with sample 202 (100% oat flour) having the highest value, while sample 101 (100% wheat flour) had the lowest value. Significant difference ($p<0.05$) were observed among the cookies samples except for sample 303 (50% wheat flour and 50% oat flour) and 404 (60% wheat flour and 40% oat flour). The values observed in this finding are higher than that of Abiyot (2017) which ranged from 1.95% to 3.68%, crude fiber content was also low in the findings of Okafor *et al.* (2017) ranging from 1.50% to 2.39%. These results are in agreement with the work of Vijayakumar *et al*. (2013) in which the crude fiber content ranged from 1.45% to 3.05% in their cookies prepared from oats and finger millet based composite flours. Sample 101 (100% wheat flour) had the least value of fat (13.23%), while 303 (50% wheat flour and 50% oat flour) had the highest value of fat (18.80%). There were significant differences ($p<0.05$) observed among the cookies samples. The fat content increased with increase in the flour proportion. This increase in crude fat content of the cookies may be due to addition of oat flour and date syrup. Fats are integral part of cookies being the third largest component after flour and sugar (Manley, 2000). However, Ihekoronye and Ndoddy (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. However, the presence of high fat content in the cookies indicates high calorific value and can serve as a lubricating agent that improves the quality of the product in terms of flavor and texture (Oyedele *et al*., 2017). In terms of ash content, sample 101 (100% wheat flour) had the least value (1.48%), and sample 202 (100% oat flour) (2.58%). There was significant difference (p<0.05) among the samples, except sample 202 (100%oat flour) and 505 (70% wheat flour and 30% oat flour); there was no significant difference (p>0.05). These finding was in agreement with the result of Omah and Okafor (2015) in cookies from Blends of Millet-Pigeon Pea Composite Flour and Cassava Cortex. An increase in ash content was observed with the ratio of oat flour, supplementation. This might be because of the high amount of ash content found in oat (2.60%) flour reported by Abiyot (2017) and higher mineral content in date fruit (Okafor *et al*., 2017). High mineral content has been reported to increase ash content (Dada *et al*., 2012). The carbohydrate values ranged from 50.21 to 62.06% with sample 101 (100% wheat flour) having the highest value (62.06%) and sample 303 (50% wheat flour and 50% oat flour) having the least value. The cookies samples were significantly different (p<0.05). The carbohydrate content of the cookies in the study are higher compared with 49.7-52.0%, 44.4- 52.49%, 47.4-60.6% and 51.87-61.90% reported from previous works of Baljeet *et al.* (2014), Ogunsina *et al.* (2011), Kiin kabari and Giami (2015) and Oludumila and Adetimehin (2016).

Sensory Properties

The sensory scores for the cookies samples are presented in Table 6. The sensory scores showed no significant difference (p>0.05) for all the parameters accessed, except for samples 101 and 505 (p<0.05). The result for appearance ranged from 7.30 to 8.00. Sample 101 and 303 (100% wheat flour) (50% wheat flour and 50% oat flour) had the highest score for appearance. Visual color (appearance) is an important criterion of cookies, as perceived in consumer's eyes (Oyedele, 2017). Moreover, appearance is a very important parameter in judging properly baked goods that not only reflect the suitable raw material used for the preparation, but also provides information about the formulation and quality of the product (Ferial and Abusalem, 2011). The result of the mean score of taste ranged from 7.00 to 7.85. Sample 101 (100% wheat flour) had the highest score, while sample 505 (70% wheat flour and 30% oat flour) had the least score. There were no significant difference (p>0.05) among the cookies samples. The taste of the enriched cookies decreased with increase in oat flour substitution level. This could be attributed to unpreparedness of the panelists to explore for new taste and the non-familiarity of the product, although the samples were liked very much in terms of taste. The mean score for aroma ranged from 7.05 to 7.55. Sample 101 (100% wheat flour) had the highest score, and sample 505 (20% wheat flour and 30% oat flour). Aroma of the cookies was found to be influenced by blend proportion. This might be because of the aroma of oat was not attractive to the panelists. The Aroma influences acceptability of food products. Aroma is carried by the air to the nose, and is transmitted by special nerves (Olfactory nerves) to the brain (Oyedele, 2017). The aroma score for the cookies samples showed that the panelist neither liked nor disliked the cookies product with date syrup. This is likely because the cookies is a new product that the panelist were not used to (Iwe, 2002). The texture of the cookies ranged from 7.35 to 7.95 with sample 101 (100% wheat) having the highest score, while sample 505 (70% wheat flour and 30% oat flour) had the least score. The texture of the product is determined by mouth feel. The crispiness score ranged from 7.60 to 8.05. The blend proportion did not significantly affect the crispiness of the cookies, the acceptability score for the crispiness of cookies from composite flour exhibited decreasing trend as the supplementation level increased. The decrease in crispness of the cookies might be because of the increase in moisture content of the cookies as the blending proportion increased, it might also be due to the effect of the increase in the total fat of content of oat flour and date syrup as observed by Oyedele (2017). Crispiness is another important criterion perceived when snack is chewed between the molar and is usually expressed in terms of hardness and factorability (Oyedele, 2017). The level of general acceptability of the cookies samples ranged from the maximum score of 8. 25 in sample 101 (100% wheat flour) and minimum level of 7.42 in sample 505 (70% wheat flour and 30% oat flour). This may be due to familiarity of panelists with cookies made from wheat flour. The control (101) was most preferred.

Conclusion

The present study showed that cookies can be made from wheat and oat composite flour. It has also revealed that date syrup can be substituted for sugar for the production of cookies. Cookies made from 100% wheat flour were preferred most in terms of sensory evaluation.

References

Abiyot, N (2017). Development and Quality Evaluation of Wheat Based Cookies Supplemented with oat and fenugreek flour. Presented in Partial Fulfillment of the Requirements for Degree of Master of Science in Chemical and Bio Engineering (Food Engineering stream).

Abioye, V.F., Olatunde S.J. and Elias, G. (2018). Quality attributes of cookies produced from composite flours of wheat, germinated finger millet flour and african yam bean. *International Journal of Research* - Granthaalayah, 6(11): 172-183.

Abou-Zaid, A.A.M., El-Bandy, M.A.S. and Ismaeil, H. (2012). Rheological Properties and Quality Evaluation of Pan Bread and Biscuits Supplemented with Mushroom Micelles Flours, *Australian Journal of Basic and Applied Sciences*, 6(6): 237-245.

Al-daihan, S. and Bhat R.S. (2012). Antibacterial activities of extracts of leaf, seed and bark of Phoenix dactylifera. *African Journal of Biotechnology*, 11(42):10021-10025.

Agunbiade, S. O. and Ojezele, M. O. (2010). Quality evaluation of instant breakfast cereals fabricated from Maize, sorghum, soybean and African yam bean (*Sphenostylis stenocarpa*). *World Journal Dairy and Food Science*, 5:7-72.

Ahmad, A., Anjum, F. M, Zahoor,T., Nawaz, H. and Ahmed, Z. (2010). Extraction and characterization of β-glucan from oat for industrial utilization. *International Journal of Biological Macromol.,* 46:304–309.

Al-Farsi, M.A. and Lee, C.Y.(2008). Nutritional and functional properties of dates: A review. *Critical Review Food Science Nutrition*, 48: 877–87.

Ali A.Y., Anwaar, A., Asif, A., Tabassum, H. and Muhammad, A.R. (2012) Nutritional and functional evaluation of wheat flour cookies, supplemented with gram flour. *International Journal of Food Science and Nutrition*, 64:63-68.

Archana, R., Asna, K., Salil, S. and Byron, H. (2004). Influence of depigmentation of pearl millet (Pennisetum gluacum L) on sensory attributes, nutrient composition and in vitro digestion of biscuits. *LWT*, 37: 184-192.

Ayo, J.A., U.A., Nkama, I. and Ademori, R. (2007). Physicochemical In-Vitro Digestibility and Organoleptic Evaluation of Acha Wheat Biscuit Supplement with Soy Bean Flour. *Nigerian Food Journal,* 25(1):77-87.

Ayo-Omogie, H. N. and Odekunle, O. Y. (2012). Substituting Wheat Flour with Banana Flour: Effects on the Quality Attributes of Doughnut and Cookies. *Applied Tropical Agriculture*, 1:134-142.

Badifu, G.I.O., Chima C.E., Ajayi Y.I. and Ogori A. F. (2005). Influence of mango mesocarp flour supplement to micronutrient, physical and organoleptic qualities of wheat-based bread. *Nigeria Food Journal*, 23: 59 - 68.

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): 217-22.

Butt, M. S. and Batool, R. (2010). Nutritional and functional properties of some promising legumes proteins isolates. *Pakistan Journal Nutrition*, 9(4):373–379.

Ceserani, V. and Kinton, R. (2008). Practical Cookery (10th ed.), John Wiley and Sons, New York. Ceserani, V., Kinton, R 2008. Practical Cookery (10th ed.), John Wiley and Sons, New York.

Dada, M., Nwawe, C.N., Okere, R.A. and Uwubanmwen, I.O. (2012). Potentials of Date Palm Tree to the Nigerian Economy. *World Journal of Agricultural Sciences,* 8(3): 309-315.

Eleazu, O. C., Eleazu K. C. and Kolawole, S. (2014). Use of indigenous technology for the production of high quality cassava flour with similar food qualities as wheat flour. *Acta Science Pol Technology Aliment.,* 13(2): 249-256.

Erleen, Tilton (2011).www.livingahealthylifestyle.com accessed 5th April,2016.

Farheena, I., Avanish, K. and Uzma, A. (2015), Development and Quality Evaluation of Cookies Fortified with Date Paste (Phoenix dactylifera L). *International Journal of Science and Technology,* 3(4).

Ferial, M. A. and Azza, A. A. (2011). Effect of supplementation of Bambara groundnut (*Vingina subterranean L*) flour on the quality of biscuits. *Afr. J. Food Sci*., 5(7):376-383.

FAO (2014). Food and Agriculture Organization of the United Nations. FAOSTAT (Online). Available at: http://www.fao.org/faostat.

Florence, A. B., Etoro-Obong, E. A. and Victor, E. N. (2020). Development and Quality Characteristics of Cookies from Sprouted Sorghum, Pigeon Pea and Orange Fleshed Sweet Potato Flour Blends. *European Journal of Nutrition & Food Safety*, 12(2): 11-21.

Giradet, N. and Webster, F.H. (2011). Oat milling, specification, storage and processing. In:*Oats Chemistry and Technology* 2[nd] Ed. Association of Cereal Chemists. Pp. 301-302.

Hamza, M. A. Agbo, C. A, S.G, Ikuenobe, C.E., Ataga, C.D. and Odewal, J.O. (2014). *International Journal of Plant and Soil Science,* 3(3):248-259.

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

Iwe, M. O. (2002). Handbook of sensory methods and analysis. PROJOINT Communication Service Ltd. Enugu, Pp 70-72.

Jitngarmkusol, S., Hongsuwankul, J. and Tananuwong, K. (2008). Chemical composition, functional properties and microstructure of defatted macadamia flours. *Food Chem*., 110(1):23-30.

Johnson, R. K. and Yon, B. A. (2010). Weighing in on added sugars and health. *Journal of America Dieticians Association*, 110:1296-1299.

Kaur, M. and Singh, S. (2017). Physical characteristics of different cultivar: influence on pasting, functional and antioxidant properties. *Quality Assurance and Safety of Crops and Foods*, 9(3): 285-293.

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.

Lee-Hoon, H., Nadratul, W. B. and Abdul, L. (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

Manley, D. (2000). *Technology of Biscuits, Crackers and cookies*, Third Edition, Woodhead Publishing limited, Cambridge England, 4(1): 21-223.

Mir, N. A., Gul, K. and Riar, C. S. (2014). Physicochemical, pasting and thermal properties of water chestnut flours; A comparative analysis of two geographic sources. *Journal of Food Processing and Preservation*. doi:10.1111/jfpp.12359

Mishra, N. and Chandra, R. (2012). Development of functional biscuit from soy flour and rice bran. *International Journal of Agricultural and Food Science,* 2: 14-20.

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

Noor Aziah, A. A,. Ho, L. H., Noor Shazliana, A. A. and Rajeev, B. (2012). Quality evaluation of steamed wheat bread substituted with green banana flour. *International Food Resource Journal*, 19 (3): 869-876.

Nwanekezi, E. C., Ekwe, C. C. and Agbugba, R. U. (2015). Effect of Substitution of Sucrose with Date Palm (Phoenix dactylifera) Fruit on Quality of Bread. *Journal of Food Processing Technology*. 6:484. 10.4172/2157-7110.1000484.

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.

Okaka, J.C. and Isieh, M.I (1990). Development and quality evaluation of cowpea-wheat cookies. *Nigerian Food Journal*, 8: 56-62.

Okpala, L. C. and Okoli, E. C., (2011). Nutritional evaluation of cookies produced from pigeon pea, cocoyam and sorghum flour blends. *African Journal of Biotechnology*, 10(3): 433-438.

Olade, A. K. and Aina J. O. (2009). Chemical and properties of flour produced from two varities of tigernut (*Cyperns esculentus), African Journal of Biotechnology,* 2(2) 435-456.

Oludumila, O. R. and Adetimehin, A. 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.

Onwuka, I.A. (2018). *Food Analysis and Instrumentation (Theory and Practical)*. 2nd edition. Naphtali Prints Lagos Nigeria. Pp. 179-228.

Oshundahunsi, O. F., Fagbemi T. N., Kesselman, E. and Shimoni, E. (2003). Comparison of the physicchemical properties and pasting cahracteristics of flour and starch from red and white sweet potato cultivars. *Journal Agriculture Food Chemistry*, 51:2232-2236.

Oyedele, D. C., Oluwafemi, G .I., Adepeju, A. B., Otutu, O. I. and Oluwasola, .P. O. (2017). Development and quality evaluation of coookies produced from flour blends of wheat, almond nuts and some natural plant materials. *Journal of Research in Science*, 13(3): 502-516.

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.

Stern, M. (2008). Current therapy. In A. Fasano, R. Troncone, & D. Branski (Eds.), Frontiers in celiac disease (pp. 114–122). Basel: Karger. http://dx.doi.org/10.1159/000128671

Suma, P., Urooj, A., Asha M.R. and Rajiv, J. (2014). Sensory, Physical and Nutritional Qualities of Cookies Prepared from Pearl Millet (Pennisetum Typhoideum). *Journal of Food Processing Technology,* 5: 377.

Suriya, M., Rajput, R., Reddy, K., Haripriya, S. and Bashir, M. (2017). Functional and physicochemical characteristics of cookies prepared from *Amorphophallus paeoniifolius* flour. *Journal of Food Science and Technology*, 54(7):2156-2165.

Vijayakumar, M., Chappalwar, D., Peter, B. H., and Steffi. M. J. (2013). Quality characteristics of cookies prepared from oats and finger millet based composite flour. Engineering Science and Technology. *An International Journal*, 3(4): 677-638.

Table 1: Formulation of Composite Flour (%)

Sample code	Wheat	Oat
101 (100:0)	100	0
202 (0:100)	0	100
303 (50:50)	50	50
404 (60:40)	60	40
505 (70:30)	70	30

Table 2: Cookies Recipe

Composite flour	500g
Margarine.	250g
Date Syrup	150 ml
Eggs.	2 eggs
Vanilla flavor	10g
Salt.	0.5g
Baking powder	5g

Source: https://www.bbcgoodfood.com

Table 3: Functional properties of the cookies samples

Cookies WHT: OAT	Water absorption capacity (g/ml)	Oil absorption capacity (g/ml)	Bulk density (g/ml)	Gelatinization temperature (°c)	Wettability (s)
101 (100:0)	$2.13^{ab} \pm 0.23$	$1.37^{a} \pm 0.15$	$0.68^{e} \pm 0.00$	61.10 ± 4.65	$71.67^{a} \pm 4.16$
202 (0:100)	$2.37^{a} \pm 0.12$	$1.43^{a} \pm 0.21$	$0.79^{a} \pm 0.02$	70.20 ± 2.21	$23.67^{e} \pm 9.24$
303 (50:50)	$1.87^{b} \pm 0.12$	$1.67^{a} \pm 0.12$	$0.75^{b} \pm 0.01$	72.57 ± 2.76	$37.67^{d} \pm 6.66$
404 (60:40)	$2.37^{a} \pm 0.15$	$1.53^{a} \pm 0.15$	$0.72^{c} \pm 0.01$	61.00 ± 1.85	$50.67^{b} \pm 10.41$
505 (70:30)	$2.07^{ab} \pm 0.40$	$1.47^{a} \pm 0.12$	$0.70^{d} \pm 0.00$	58.27 ± 1.37	$39.33^{c} \pm 3.21$

$^{a-e}$ values are means ± SD of replicate determinations. Values with common superscript in the same column are not significantly difference (p>0.05). Sample 101:100% wheat, Sample 202: 100% oat, Sample 303: 50% wheat, 50% oat, Sample 404: 60% wheat, 40% oat, Sample 505 :70% wheat, 30% oat

Table 4: Physical properties of composite biscuits

Cookies WHT:OAT	Weight	Diameter	Thickness	Spread ratio
101(100:0)	$10.46^{a} \pm 0.04$	$3.90^{c} \pm 0.18$	$1.17^{a} \pm 0.04$	$3.34^{c} \pm 0.11$
202(0:100)	$10.10^{c} \pm 0.14$	$4.37^{a} \pm 0.09$	$0.85^{bc} \pm 0.11$	$5.21^{a} \pm 0.68$
303(50:50)	$10.18^{bc} \pm 0.24$	$4.14^{b} \pm 0.05$	$0.98^{b} \pm 0.08$	$4.26^{b} \pm 0.29$
404(60:40)	$10.44^{ab} \pm 0.14$	$4.21^{ab} \pm 0.03$	$0.80^{c} \pm 0.07$	$5.29^{a} \pm 0.47$
505(70:30)	$10.22^{ab} \pm 0.09$	$4.13^{b} \pm 0.04$	$0.20^{b} \pm 0.09$	$4.17^{b} \pm 0.33$

a-e (superscript) values are means ± SD replicate determinations. Values with common superscript letters in each column are not significantly (p>0.05).
WHT: Wheat flour, OAT= Oat flour
Sample 101:100% wheat, Sample 202: 100% oat, Sample 303: 50% wheat, 50% oat, Sample 404: 60% wheat, 40% oat ,Sample 505 :70% wheat, 30% oat

Table 5: Proximate composition of cookies samples

Cookies WHT:OAT	Moisture (%)	Crude protein (%)	Crude fiber (%)	Fat (%)	Ash (%)	Dry matter (%)	Carbohydrate (%)	Energy value (kcal)
101(100:0)	$6.75^{a}\pm0.03$	$13.58^{e}\pm0.22$	$2.91^{c}\pm0.61$	$13.23^{e}\pm0.09$	$1.48^{d}\pm0.03$	$93.25^{e}\pm0.00$	$62.06^{a}\pm0.72$	$421.49^{d}\pm2.61$
202(0:100)	$5.35^{e}\pm0.00$	$14.88^{d}\pm0.18$	$5.87^{a}\pm0.03$	$15.14^{d}\pm0.07$	$2.58^{a}\pm0.02$	$94.65^{a}\pm0.00$	$56.19^{b}\pm0.26$	$420.51^{d}\pm0.22$
303(50:50)	$5.80^{b}\pm0.01$	$18.01^{a}\pm0.20$	$5.11^{b}\pm0.03$	$18.80^{a}\pm0.15$	$2.07^{c}\pm0.06$	$94.20^{d}\pm0.01$	$50.21^{e}\pm0.43$	$442.05^{a}\pm0.45$
404(60:40)	$5.46^{c}\pm0.01$	$17.33^{b}\pm0.18$	$5.25^{b}\pm0.02$	$17.35^{b}\pm0.09$	$2.22^{b}\pm0.10$	$94.54^{c}\pm0.01$	$52.40^{d}\pm0.38$	$435.09^{b}\pm0.04$
505(70:30)	$5.40^{d}\pm0.00$	$16.38^{c}\pm0.26$	$5.44^{ab}\pm0.03$	$16.91^{c}\pm0.05$	$2.50^{a}\pm0.02$	$94.60^{b}\pm0.00$	$53.38^{c}\pm0.18$	$431.23^{c}\pm0.12$

$^{a-e}$ values are means ± SD of duplicate determinations. Values with common superscript in the same column are not significantly (p>0.05).
WHT: Wheat flour, OAT= Oat flour
Sample 101:100% wheat, Sample 202: 100% oat, Sample 303: 50% wheat, 50% oat, Sample 404: 60% wheat, 40% oat, Sample 505 :70% wheat, 30% oat.

Table 6 Sensory evaluation of the cookies samples

Cookies WHT:OAT	Appearance	Taste	Aroma	Texture	Crispiness	General acceptability
101(100:0)	$8.00^{a} \pm 0.86$	$7.85^{a} \pm 0.93$	$7.55^{a} \pm 1.23$	$7.95^{a} \pm 0.89$	$8.05^{a} \pm 0.20$	$8.25^{a} \pm 0.72$
202(0:100)	$7.30^{a} \pm 1.38$	$7.25^{a} \pm 1.25$	$7.10^{a} \pm 1.21$	$7.70^{a} \pm 0.98$	$7.80^{a} \pm 1.01$	$7.85^{ab} \pm 0.99$
303(50:50)	$8.00^{a} \pm 0.97$	$7.35^{a} \pm 1.39$	$7.25^{a} \pm 1.16$	$7.30^{a} \pm 1.49$	$7.90^{a} \pm 0.97$	$7.70^{ab} \pm 1.13$
404(60:40)	$7.55^{a} \pm 1.20$	$7.45^{a} \pm 1.43$	$7.35^{a} \pm 1.04$	$7.80^{a} \pm 1.01$	$7.75^{a} \pm 1.12$	$7.75^{ab} \pm 1.16$
505(70:30)	$7.60^{a} \pm 1.47$	$7.00^{a} \pm 1.08$	$7.05^{a} \pm 1.36$	$7.35^{a} \pm 1.14$	$7.60^{a} \pm 1.05$	$7.45^{b} \pm 1.43$

a-e (superscript) values are means ± SD of duplicate determinations. Values with common superscript letters in each column are not significantly difference (p>0.05).
WHT: Wheat flour, OAT= Oat flour