SCVJ
Volume 4, Issue 1, 2023
DOI: https://doi.org/10.55989/RIGK5223
Science View Journal
ISSN (Online): 2734-2638

International Science View Journal (Proximate Composition, Physical Properties and Sensory Characteristics of Wheat-Tropical Almond Seed Composite flour Biscuits)

P. O. Ohaegbulam, N. V. Amadi, G. O. Ojeh, C. P. Mgbemena

Department of Food Technology, Federal Polytechnic Nekede, Owerri, Imo State, Nigeria.

Email: oohaegbulam@fpno.edu.ng

Abstract:
This work investigated the nutrient potential, physical and sensory properties of biscuits made from flour blends of wheat and tropical almond seeds. The tropical almond fruits were cracked open, the seeds extracted, dried and finely milled. Composite flour samples were made by partially substituting wheat with 10%, 20% and 30% inclusion levels of tropical almond seed flour. The composite flours were mixed with other baking ingredients and used to produce biscuits. The biscuits were subjected to proximate, physical and sensory analyses to ascertain the nutrient potential, physical attributes and degree of acceptability. There were significant differences amongst the samples tested, across parameters. The range of values of the results based on proximate analysis is as follows: Protein (10.06 to 11.70%), fat (13.36 to 15.42%), moisture (4.10 to 8.48%), ash (1.74 to 3.41%), crude fiber (1.06 to 3.60%) and carbohydrate (59.45 to 67.62%). Selected physical properties are as follows for mean diameter, thickness, weight and volume: 51.25 - 61.21mm, 7.20 - 8.46mm, 13.96 – 17.69g and 17.55 – 23.45cm3 respectively. The outcome of sensory evaluation indicated that, amongst the composite flour samples, the 90% wheat: 10% tropical almond seed blend was the most preferred biscuit sample (besides the Control) using a 9-point hedonic scale on all parameters tested. This work suggests that there exists a positive potential for improving biscuit quality and variety by the incorporation of wheat and flour from the underutilised tropical almond seed.

Keywords: Biscuit, Physical properties, Proximate analysis, Seed flour, Tropical almond.

I. Introduction

Biscuits represent the largest category of snack foods among bakery products because they are made from simple, cheap and easily available raw materials. They are widely consumed because they have a very acceptable taste and their low water activity allows a long shelf life (Klunklin and Savage, 2018).

Among ready-to-eat snacks, biscuits possess several attractive features including wider consumption base, relatively long shelf-life, more convenience and good eating quality. Long shelf-life of biscuits makes large scale production and distribution possible. Good eating quality makes biscuits attractive for protein fortification and other nutritional improvements. Development of fortified biscuits or other composite flour bakery products is the latest trend in bakery industry (Baljeet et al., 2010).

Wheat flour has been the major ingredient used in the production of biscuit and other pastry products. In Nigeria, reliance on wheat flour in the pastry and bakery industries has over the years restricted the use of other cereals and tuber crops available to domestic use. In recent years, government has through intensive collaboration with research institutes encouraged the use of composite flours in the production of bread and related food products such as biscuit. This initiative has enhanced the use of flours from cassava, Sweet potato, bread fruit, plantains and other underutilized crops that are good sources of flour. The adoption of these locally produced flours in the bakery industry will increase the utilization of indigenous crops cultivated in Nigeria and also lower the cost of bakery products (Oyeyinka et al., 2014).

Terminalia catappa, commonly called tropical almond or Indian almond, is a medium to large deciduous tropical tree that grows to 75 - 90 feet tall. It belongs to the family Combretaceae with typically one to five fruits developing on the basal part of the flower spike. The fruit is a sessile, laterally compressed, and ovoid to ovate, smooth-skinned drupe. During maturation, it changes skin colour from green through yellow to bright red or dark purplish red at full maturity. The fruit is edible, tasting slightly acidic (ABB, 2020). Edible nuts are valued for their sensory, nutritional and health attributes. They are rich sources of lipids and proteins, containing certain vitamins and minerals in appreciable amounts (Olatidoye et al., 2011).

The seeds of tropical almond (Terminalia catappa), are discarded into the environment as they are normally considered to be of no commercial value due to the stress associated with cracking the seed pod. The fruit is high in tannic acid which stains cars, pavements and sidewalks. It also litters the ground, thus creating waste management problems. Tropical almond seed, though discarded due to its “waste” status, has been reported to have some nutrients which are vital to the body. Consumers seek newer biscuit product options to explore to meet their ever-changing preferences. This study would thus be of importance in the following ways: It will strongly encourage the reduction in the wastage of tropical almond and its seed which occurs due to poor consumption and under-utilisation/poor diversification of use. It is also hoped that the use of composite blends of wheat flour and almond seeds will result in the production of biscuits that are cheaper, acceptable and more nutritive than those made from wheat only. This

DOI: https://doi.org/10.55989/RIGK5223

research work would also serve economic benefits at the industrial level by adding value to an item (tropical almond) which, otherwise, would have been disposed of. This study is aimed at assessing the proximate composition, physical and sensory characteristics of wheat-Tropical almond seed composite flour biscuits. This will be achieved by:

i) processing the tropical almond seeds into flour.
ii) making biscuits from wheat-tropical almond seed flour mix in varying ratios.
iii) determining the proximate composition of the biscuit samples.
iv) assessing the physical properties of the biscuits so produced.
v) evaluating the sensory properties of the biscuit samples.

Biscuits and cookies are small, sweetened, cereal based, baked products. They are broadly characterized by dough properties and hind (Cauvain and Young, 2001). Although, biscuits vary in their shape, sizes and composition, the three main ingredients are always flour (primarily, wheat flour), sugar and fat (butter or vegetable shortenings). Commercial biscuits normally constitute 50% of calories from fat and carbohydrates, with over 400 calories per 100g in plain biscuits. Biscuits broadly fall into two groups, hard and soft biscuits, depending on their ingredient mix. The four main processes to make biscuits are mixing, cutting, baking and packing. Biscuit production needs precise preparation to make a successful product. The ingredients are mixed to form a dough using mixers that are either operated manually or using a pre-set mixing programme. As the dough is mixed, the protein molecules form long strands of gluten resulting in an elastic web which, essentially, controls the quality of wheat flour-based products. Once the dough is mixed, it is then made into different shapes and sizes. This process leads to an increase in the stress on the gluten structure (Klunklin and Savage, 2018).

Baking is a very important process to achieve good quality biscuits. This process transforms the physical and chemical characteristics of the dough when baked in an oven, where the temperature and time will be accurately controlled. The oven temperature affects the moisture loss during baking, which plays an important role in achieving a good texture and the structure of the biscuits. Biscuit production changes both the chemical and physical characteristics, which result in the structure, texture and colour alterations in the biscuits. Overall, the characteristics of high quality biscuits also depend on the type and proportions of the ingredients (Cauvain and Young, 2001). Biscuit and other baked food products are important items belonging to the classes of food that are sold in ready to serve form.

Wheat flour is the major flour used in the production of biscuits.Celiac disease (CD), Non-Celiac Gluten Sensitivity (NCGS) and wheat allergy are medical conditions and types of food hyper-sensitivities connected with the consumption of wheat-based foods. There are many possible gastrointestinal symptoms of celiac disease and gluten sensitivity (GS), including cramping, diarrhea and constipations. Symptoms may also occur in other parts of the body in the form of bone or joint pain, headaches, orfatigue, to name a few. Symptoms of an allergy to wheat can include itching, hives, or anaphylaxis, a life threatening reaction. Treatment for CD and GS is to remove gluten from the diet. Gluten is a protein naturally found in wheat, rye and barley, as well as in hybrids and products made from these grains. Treatment for a person with a wheat allergy is removal of all forms of wheat from the diet. People with CD allergy are fortunate because they do not need complicated medical treatments to get well, but they must avoid the food or foods that are problematic. Celiac disease (CD) is a genetic, auto-immune disorder that occurs in reaction to the ingestion of gluten in genetically-susceptible individuals (Bender, 2006). The reaction to gluten causes villous atrophy or flattening of the cells lining the small intestine, which can lead to malabsorption of nutrients with wide-reaching symptoms. Wheat allergy is an immune reaction to any of the hundreds of proteins in wheat. When a person has a wheat allergy, one type of white cells, called T-cells, send out immunoglobin E (IgE) antibiotics to "attack" the wheat. At the same time, local tissues in the body send out natural chemical messengers to alert the rest of the body that there is a problem. This reaction happens very fast (within minutes to a few hours) and can involve a range of symptoms from nausea, abdominal pain, itching, swelling of the lips and tongue, to trouble breathing, or anaphylaxis (a life-threatening reaction). A person with a wheat allergy must avoid eating any form of wheat, but does not have trouble tolerating gluten from non-wheat sources (The GIG Educational Bulletin, 2014).

Tropical almond (Terminalia catappa) is a large, spreading tree now distributed throughout the tropics in coastal environments, especially along sandy seashores, for shade, ornamental purposes, and edible nuts. The timber makes a useful and decorative general-purpose hardwood and is well suited for conversion into furniture and interior building timbers. Fruits are produced from about 3 years of age, and the nutritious, tasty seed kernels may be eaten immediately after extraction (Thomson and Evans, 2006).

Figure 1: Plate 1 - Unripe tropical almond fruits.

The tropical Almond (*Terminalia catappa*) is one of the lesser known legumes found in the tropics and in Nigeria's ecosystem. Almond is a large deciduous tree that thrives as an ornamental tree. Due to the phytochemical properties of *T. catappa*, the leaves, bark and fruits are useful in the treatment of dysentery, rheumatism, cough and asthma (ABB, 2020). The fruits are also to treat leprosy and headaches. The leaves are specifically used to treat intestinal parasites, eye problems,

SCVJ
Volume 4, Issue 1, 2023
DOI: https://doi.org/10.55989/RIGK5223
Science View Journal
ISSN (Online): 2734-2638

wounds and liver ailments. The seed is edible and highly cherished by children. It is also used by many rural dwellers in southern Nigeria to fortify the local complimentary foods, which are usually low in protein. The *T. catappa* tree produces fruits whose pulp is fibrous, sweet and edible when ripe. The fruit is widely eaten by children as forage snack with the nuts and seeds often discarded (Mbah *et al.*, 2013).

Composite flour has been defined as a mixture of several flours obtained from roots and tubers, cereals, legumes with or without the addition of wheat flour; that is created to satisfy specific functional characteristics and nutrient composition (Ohaegbulam *et al.*, 2021). Composite flour has better nutritional value, bearing elements of minerals, vitamins, fibres and proteins than flour milled from any specific cereal alone. The functional properties of composite flours play an essential role in the manufacturing of food products. The functional properties determine whether the blends would be useful in bakery products where hydration to improve handling is desired (Hasmadi *et al.*, 2020).

The use of composite flours have a few advantages for developing countries in terms of; the saving of hard currency, promotion of high-yielding, inactive plant species, a better supply of protein for human nutrition, better overall use of domestic agriculture production. Composite flour is considered advantageous in developing countries at it reduces the importation of wheat flour and encourages the use of locally-grown crops as flour. Local raw materials' substitution for wheat flour is increasing due to the growing market for confectionaries. Thus, several developing countries have encouraged the initiation of programmes to evaluate the feasibility of alternative locally available flours as a substitute for wheat flour (Noorfarahzilah *et al.*, 2014).

There are challenges that may arise if the use of composite and/or wheatless flours is enforced for making leavened and unleavened baked products in Nigeria. These include:

i. There may be inadequacy/unavailability of the non-wheat crops (e.g. cassava) for the production of composite flour.
ii. Unwillingness of multinational firms operating in Nigeria to incorporate non-wheat flours for composite flour productions, as this will reduce the quantity of wheat they import and the profit their parent companies make from the sale of wheat.
iii. Detoxification to low/safe levels of the cyanide content of cassava and other indigenous crops, if the crop flour is to be used as a part of the composite flour.
iv. Competition between the consumers and processors of the non-wheat crop, if the crop is eaten as a staple food. This would increase the cost of the staple food.
v. Possible sabotage from multinational flour-milling companies via importation of low quality wheat for their mills since the percentage of non-wheat flour incorporated with wheat flour to form composite flour suitable for bread making depends on the quantity and quality of gluten protein (Adeboye *et al.*, 2014).

Flour confectionery preparations are exorbitant baking operations in the food industry due to the costly nature and insufficiency of their constituents which are predominantly imported in Nigeria, particularly when restrictions are placed on the importation of some of these ingredients (Ohaegbulam *et al.*, 2021). In most cases, the wheat or wheat flour needed for making bread, rolls and pastry goods have to be imported since the climatic conditions and soil do not permit wheat to be grown locally, or make it very difficult in developing countries. The imports of wheat have had an increasingly adverse effect on the balance of trade. For these reasons, the FAO and developing countries have shown interest in the possibility of replacing the wheat needed for making baked goods and also pasta, wholly or partly, with flour obtained from home-grown products. Possible sources are tuberous plants rich in starch such as cassava, yam, sweet potatoes; protein-rich flours such as soy and peanuts; and other cereals including maize, rice, millet, and sorghum. Although it is well-known that no other crop can achieve the baking properties of wheat, composite flours are the subject of numerous recent studies (Seibel, 2009).

Composite flour is a welcomed development in developing countries to promote high yield of native plant species and better use of domestic agricultural product and thus prevent them from going into extinction (Adeboye *et al.*, 2014). The use of composite flour to produce baked goods, where feasible, helps to lessen total dependence on imported wheat (Hasmadi *et al.*, 2020). Composite flour is desirable in this regard because it improves the nutritional value of food products such as bakery products. Biscuit has been suggested as a better use for composite flour than bread due to its ready-to-eat form, wide consumption, relatively long shelf life and good eating quality (Popoola *et al.*, 2019).

II. METHODS

Whole, matured and ripe Tropical almond fruits were sourced from trees growing around Mile 2, Medical Center area, on the campus of Federal Polytechnic, Nekede, in Owerri-West Local Government Area of Imo State, Nigeria. Selected quantities of the fruits were subsequently taken to the Department of Agricultural Technology, Federal Polytechnic, Nekede, Owerri, Imo state for identification. The other ingredients used in the production of bakery products were sourced from Relief Market in Owerri, Imo State.

The method of Mbah et al. (2013) was adopted in the extraction and milling of the tropical almond fruit seeds. The tropical almond fruits were sun dried repeatedly for two weeks to prevent rancidity of the kernel and to facilitate dehulling. The dried seed pods were dehulled by cracking along the margins with a piece of pebble to obtain the brown spindle-shaped kernels. The kernels were dried in an oven held at 60°C for six hours to 5% moisture level, cooled and size-reduced with a single disc attrition mill. The powder obtained was finely-sieved, packaged in an air-tight glass jar (to exclude moisture and dust particles) and held for mixing and production of the bakery products (biscuits).

Volume 4, Issue 1, 2023
DOI: https://doi.org/10.55989/RIGK5223

Science View Journal
ISSN (Online): 2734-2638

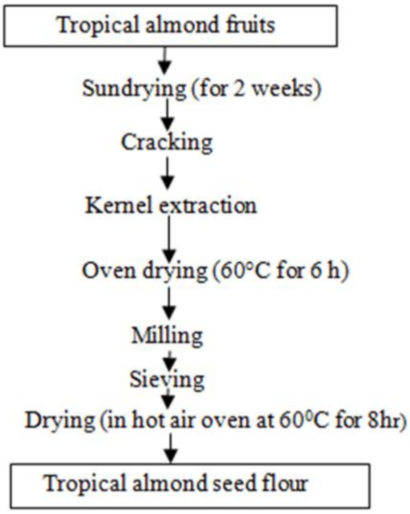

Figure 2: Process flow diagram for the production of Tropical almond seed flour.

Figure 3: Plates 2, 3 and 4 - Tropical almond fruits; Seeds removed from the fruits; Milled tropical almond seed flour.

An overall flour weight of 500g was adopted for the production of cookies (made of composite flour) using the following ingredients: Wheat flour, Tropical almond seed flour, margarine, sugar, salt and milk.

The cookies were prepared according to the methods adopted by Ohaegbulam et al. (2021). The flour, sugar and baking powder were manually mixed in a glass bowl. The margarine, milk and beaten whole egg were well creamed for 1 min, and the dry ingredients were added at once and mixed for a minute to form dough. The dough was rolled out on a table uniformly using a rolling pin and cut with a biscuit cutter. The cut pieces of dough were placed on baking trays and baked at 170oC for 20 min in the oven. After baking, the biscuits were cooled at ambient temperature, packaged in polythene bags, sealed and stored in plastic vessels prior to analyses.

Moisture, protein, fat, ash and crude fibre contents of the samples were determined according to the methods described by AOAC (2005). The carbohydrate was obtained by difference as follows: Carbohydrate 100 –(%Moisture + %Protein + %Fat + %Ash + % Crude fibre) (1)
Physical properties determination was conducted according to the method described by Bala et al. (2015) with slight modifications, to evaluate the biscuit samples for the following parameters: Thickness, Weight, Diameter, Spread ratio and Bulk volume.

The sensory evaluation of the biscuit samples was carried out using a twenty-member panel of judges drawn from the Polytechnic community. The procedure was explained to the panelists before commencement. The quality attributes of the biscuit samples to be assessed were appearance (colour), flavour (aroma and taste), texture and overall acceptability. The coded samples were presented to the panelists with water to rinse their mouths between determinations, thus masking the sensory attributes of the previous determination. The 9-point hedonic scale was used. The rating scale was as follows: 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, 9 - Like extremely.

The experimental data generated from the various assessments were statistically analyzed with the aid of SPSS 20.00 and MS Excel package at a confidence level of 95%. Analysis of variance (ANOVA) was deployed for the replicate measurements to show significant differences among the sample results. The mean and standard deviation for each parameter was calculated. Experimental outcomes were presented as mean± standard deviation.

III. RESULTS AND DISCUSSION

The results from the proximate composition of biscuits made with wheat-tropical almond seed composite flour is shown in Table 1. There were significant differences amongst the biscuit samples across the various parameters. The result of proximate analysis revealed that the ash content ranged from 1.74% to 3.41%. The 100% wheat flour (control) had the least ash content (1.74%), while the 70:30 wheat-tropical almond seed composite flour biscuit had the highest ash content (3.41%). The ash content of a food material could be used as an index of mineral constituents of the food (Ohaegbulam et al., 2021). The result of ash obtained is slightly comparable to ash content of 1.80 to 2.30% in complementary foods produced from sorghum, soybean and oil seed as reported by Ponka et al. (2015). The values were quite less compared to the values obtained by Onuegbu et al. (2016) (3.84 – 6.79%) for soy-maize fortified cookies. These findings indicate that the biscuits from the 70:30 wheat-tropical almond seed composite flours would release the most amounts of minerals for absorption and assimilation upon ingestion.

TABLE 1: PROXIMATE COMPOSITION OF WHEAT-TROPICAL ALMOND BISCUITS

	Samples/Concentration (%)				
Parameters	**WOW**	**XOX**	**YOY**	**ZOZ**	**LSD**
Ash	1.74^c±0.1	1.99^{bc}±0.01	2.59^b± 0.12	3.41^a± 0.02	0.67
Moisture	4.10^b±0.09	7.91^a± 0.03	7.69^a± 0.14	8.48^a±0.13	1.47
Fibre	1.06^b±0.09	1.46^b±0.09	2.24^b± 0.03	3.60^a±0.09	1.32
Fat	15.42^a± 0.12	14.74^a±0.18	13.46^b±0.07	13.36^b±0.31	1.02
Protein	10.06^c±0.06	10.44^{bc}±0.07	10.89^b±0.03	11.70^a±0.19	0.54
Carbohydrates	67.62^a±0.08	63.46^b±0.18	63.13^b±0.09	59.45^c±0.18	1.45

Values are means ± SD of two replications. Means with different superscripts along a row are significantly different ($p < 0.05$). a> b > c > d.
Keys: WOW = Wheat flour (100%; Control); **XOX =** Wheat flour – Tropical Almond seed flour (90:10).**YOY =** Wheat flour – Tropical Almond seed flour (80:20). **ZOZ =** Wheat flour – Tropical Almond seed flour (70:30).**LSD**= Least significant difference.

The moisture content of the biscuits ranged from 4.10 to 8.48%. The Control sample (100% wheat flour biscuit) had the least moisture content (4.10%), whilst the 70:30 wheat-tropical almond seed composite flour biscuit had the highest moisture content (8.48%). The difference in moisture content may be due to the baking temperature applied or the method of analysis used. However, the moisture content of the composite flour biscuits blended with tropical almond seed flour in this study is within the recommended moisture content of dried powder (14% or less). This shows that biscuits supplemented with tropical almond seed flour can be stored at room temperature for long periods without been attacked by micro-organisms if well packaged. Hence, the biscuit samples would have long shelf life if they are protected from absorbing moisture from damp surroundings or the atmosphere (Duru et al., 2019).

The crude fiber content ranged from 1.06 to 3.60%. The 100% wheat flour biscuit (control) had the least crude fiber content (1.06%), while the 70:30 wheat-tropical almond seed composite flour biscuits had the highest crude fiber content (3.60%). The fiber content range obtained in this study is based upon the incremental replacement of wheat flour with tropical almond seed flour – which has been reported to possess high fibre content. Crude fiber composition is a measure of quality of indigestible cellulose, pentose, lignin and other components of this type of food. Crude fiber has little food value but provides bulk necessary for peristaltic action in the intestinal tract. Fiber content of food contributes to bulk and encourages bowel movement, discourages constipation and piles, reduces blood cholesterol levels and helps prevent cancer of the colon (Duru *et al*., 2019).

The fat content of the biscuit samples ranged from 13.36 to 15.42% with the 100% wheat flour (Control) having the highest fat content, while the 70:30 wheat-tropical almond seed composite flour biscuit had the least fat content. The values were quite less than the range of values obtained by Atobatele and Afolabi (2016) (16.10 - 18.13%) for soy-maize fortified cookies. The observed variations in fat contents may be due to the effect of fiber addition as the tropical almond seed flour proportion in the blends steadily increased. Fat is important in the diet of infants and young children as it provides essential fatty acids, facilitates the absorption of fat-soluble vitamins, enhances dietary energy density and sensory qualities (Obinna-Echem *et al.*, 2018). The low values of fat content suggest that the samples may be less prone to spoilage via rancidity (Ohaegbulam *et al.*, 2021).

The protein content of the biscuit samples ranged from 10.06 to 11.70%, with the 100% wheat flour (Control) having the least protein content (10.06%) while the 70:30 wheat-tropical almond seed composite flour biscuit had the highest protein content (11.70%). This is most probably because the sample of 70:30 wheat-tropical almond seed composite flour biscuit consisted of higher proportions of tropical almond seed flour, unlike the 100% wheat flour biscuit that had only wheat. It is expected that the amino acid composition of tropical almond seed flour will complement that of wheat flour. According to the American Society for Nutrition (2011), by combining plant protein sources, it is possible to ensure that one gets all the nine (9) essential amino acids. This trend would account for the steady rise in the value of protein as the levels of inclusion of jute leaf flour in the biscuit samples were steadily increased.

The carbohydrate (CHO) content ranged from 59.45 to 67.62%. The 70:30 wheat-tropical almond seed composite flour biscuit sample had the least carbohydrate content (61.67%), while the 100% wheat flour (control) had the highest carbohydrate content (70.23%). The incremental levels of the substituent flour (tropical almond seed) in the other samples may have accounted for the gradual reduction in the value of carbohydrates when compared with the control sample – due to the diluting effect of other non-wheat flours on the overall Carbohydrate content.

TABLE 2: PHYSICAL PROPERTIES OF WHEAT-TROPICAL ALMOND SEED COMPOSITE FLOUR BISCUITS

	SAMPLE				
Parameters	**WOW**	**XOX**	**YOY**	**ZOZ**	**LSD**
Diameter (mm)	$51.25^{c}\pm1.01$	$52.65^{bc}\pm2.29$	$61.21^{a}\pm2.54$	$53.84^{b}\pm2.28$	2.14
Thickness (mm)	$8.36^{a}\pm0.30$	$7.20^{b}\pm0.22$	$8.46^{a}\pm0.17$	$8.42^{a}\pm0.64$	0.74
Weight (g)	$17.69^{a}\pm0.87$	$16.68^{a}\pm0.77$	$15.42^{b}\pm0.58$	$13.96^{c}\pm2.55$	1.16
Volume (cm^3)	23.45±0.99	17.55±3.88	18.35±2.89	19.40±2.90	1.38
Bulk volume (g/cm^3)	0.752	0.95	0.8391	0.719	-
Bulk density (g/cm^3)	31.18	18.47	21.87	26.98	-
Spread ratio (m)	6.13	7.3125	7.235	6.394	-
Percentage spread factor (%)	100	119.29	118.02	104.30	-

Values are means ± SD of three replications. Means with different superscripts along a row are significantly different ($p < 0.05$). a>b>c>d.
Key: WOW = Wheat flour (100%; Control); **XOX =** Wheat flour – Tropical Almond seed flour (90:10).
YOY = Wheat flour-Tropical Almond seed flour (80:20); **ZOZ =** Wheat-Tropical Almond seed flour (70:30).
LSD = Least significant difference

Table 2 shows the outcomes of the physical properties of wheat-tropical almond composite flour biscuits and the Control sample. The range of values for mean diameter, thickness, weight and volume were 51.25 – 61.21mm, 7.20 – 8.46mm, 13.96 – 17.69g and 17.55 – 23.45cm3 respectively. The blending of the seed flours appeared to have a key impact in reducing the values of mean thickness, weight and volume as the inclusion level increased (i.e the more the wheatless flour added, the less the observed values compared to the Control sample). These imply that the composite flour samples contain less matter on equivalent basis (Ohaegbulam et al., 2018).

The Bulk volume and Bulk density values were in the range of 0.719 – 0.95 g/cm3 and 18.47 – 31.18 g/cm3 respectively. The Bulk density is generally affected by the particle size and the density of flours, which is very important in determining the packaging requirement, raw material handling and application in wet processing in the food industry (Ohaegbulam et al., 2019). Bulk density is a property of powders, granules, and other “divided” solids, especially used in reference to mineral components, chemical substances, ingredients, foodstuff or any other masses of corpuscular or particulate matter. It is defined as the mass of many particles of the material divided by the total volume they occupy and is not an intrinsic property of a material (Fellows, 2000).

Spread ratio ranged from 6.13 in the Control sample to 7.3125 in the 90:10 sample. Spread ratio or diameter is used to determine the quality of flour used in preparing biscuits and the ability of the biscuit to rise (Bala et al., 2015). The higher the spread ratio of biscuit the more desirable it is (Chauhan et al., 2016). Hence, biscuit prepared from the flour blend containing 90% wheat and 10% tropical almond seed flour may be the most preferred based on spread ratio.

TABLE 3: SENSORY PROFILE OF WHEAT-TROPICAL ALMOND SEED COMPOSITE FLOUR BISCUITS

Sample	Taste	Aroma	Colour	Crunchiness	General Acceptability
WOW	$6.90^{b}\pm2.33$	$6.70^{a}\pm2.71$	$7.80^{a}\pm1.20$	$6.80^{ab}\pm2.30$	$7.55^{ab}\pm1.63$
XOX	$8.40^{a}\pm0.94$	$7.60^{a}\pm1.31$	$7.45^{ab}\pm1.32$	$7.70^{a}\pm1.45$	$8.20^{a}\pm1.77$
YOY	$6.50^{bc}\pm2.01$	$6.50^{ab}\pm2.52$	$6.30^{bc}\pm1.69$	$7.20^{ab}\pm1.76$	$7.60^{a}\pm1.57$
ZOZ	$5.50^{c}\pm2.12$	$5.40^{b}\pm2.58$	$5.20^{c}\pm2.41$	$5.80^{b}\pm2.38$	$6.25^{b}\pm2.47$
LSD	1.2266	1.3032	1.2525	1.4944	1.3200

Values are means ± SD of twenty replications. Means with different superscripts along a column are significantly different ($p < 0.05$). a>b>c>d. Proportions are between white flour and African almond seed flour. LSD = Least significant difference
Key: WOW = Wheat flour (100%; Control), **XOX =** Wheat-Tropical Almond seed flour (90:10).
YOY = Wheat-Tropical Almond seed flour (80:20), **ZOZ =** Wheat-Tropical Almond seed flour (70:30).

DOI: https://doi.org/10.55989/RIGK5223

Table 3 shows the sensory evaluation of composite flour biscuits made with African almond seed flour and the Control sample. There were significant differences amongst the samples across the various parameters. The sensory score for taste varied from 5.50 to 8.40. The 90:10 Wheat-tropical almond seed biscuit sample had the highest score (8.40), indicating favourable preference by the panelists, while sample 70:30 Wheat-tropical almond seed biscuit had the lowest score (5.50). This may be due to the overbearing effect of the unfamiliar taste associated with the increased addition of tropical almond seed flour in the blend.

The score for aroma ranged from 5.40 to 7.60. The 70:30 Wheat-tropical almond seed biscuit sample had the least score (5.40), while the 90:10 Wheat-tropical almond seed biscuit sample had the highest value (7.60), implying positive preference by the sensory panel constituted. The domineering impact of the phytochemicals' overtones with increased inclusion of tropical almond seed flour in the mix may have led to this trend.

The highest colour rating was recorded for the sample baked with 100% wheat flour (7.80), while the lowest colour rating or value (5.20) was observed in the 70:30 Wheat-tropical almond seed biscuit. It was observed that each sample decreased in colour rating (with increased intensity) with the addition of the non-wheat flour. Nonetheless, amongst the composite flour biscuit samples, the 90:10 blend still had relatively high colour rating (7.40).

The value for crunchiness ranged from 5.80 to 7.70. The 90:10 blend had the highest value (7.70), while the 70:30 Wheat-tropical almond seed biscuit had the least score (5.80) for crunchiness. This variation in textural properties as detected by the consumers may be due to the level of addition of the tropical almond seed flours.

The score for general acceptability ranged from 6.25 to 8.20. The values decreased with an elevation in the addition of the non-wheat flour. The sensory panel seemed to prefer the biscuit with a lower concentration of tropical almond seed flour, as these seemed to increase their interest in the biscuit sample (i.e the 90:10 mix).

IV CONCLUSION AND RECOMMENDATIONS

The production of cookies from wheat flour and Tropical almond seed flour blends was successfully accomplished in this study. The proximate composition, physical properties and sensory characteristics of the Tropical almond seed and wheat composite flour cookies were successfully investigated. The quality assessment of the composite flour cookies indicated that the use of wheat flour and Tropical almond seed flour blends in the production of cookies significantly improved nutritional values (ash, crude fibre and crude protein contents) and sensory qualities of the samples without adversely affecting most baking characteristics. The 70:30 blend of wheat and Tropical almond seed flour cookies was least accepted due to its deep-brown colour and unfamiliar taste compared to the other blends (100:0, 90:10, and 80:20) of wheat and Tropical almond seed flour cookies which were generally accepted.

Based on the results of this study, it is recommended that cookie-producing industries should promote the use of Tropical almond seed flour in cookies or biscuit production (at 10% inclusion level) due to its higher nutritive values.

Good consumer education and public enlightenment on the nutritional benefit of wheat flour and Tropical almond seed flour complementation should be encouraged. The use of Tropical almond seed flour in baked cookies and biscuits products will go a long way in enhancing their utilization and thus, prevent wastage of this valuable material.

Also, storage trial and tests on packaging considerations should be conducted to determine the optimal shelf life and best packaging material for the composite flour biscuit.

Further attempts should be advanced towards the conduct of research on the phytochemicals and amino acid compositions of wheat and Tropical almond seed flour biscuit

V REFERENCES

ABB (2020). Terminalia catappa (Tropical almond). An Environmental Awareness Initiative by ABB India Limited (ELDS, Nashik).

Adeboye, O., Akanbi, C. T. and Igene, J. O. (2014). Quality of cookies produced from blends of false yam (Icacina tricachantha) and wheat. Nigerian Food Journal, 36 (1): 74 – 85.

AOAC (2005). Official Method of Analysis.Association of Official Analytical Chemists.17th edition. Horowitz, W. (ed.). Vols. 1 and 2. Maryland. AOAC International.

Atobatele, O. B. and Afolabi, M. O. (2016). Chemical composition and sensory evaluation of cookies baked from the blends of soya bean and maize flours. Applied Tropical Agriculture, 21 (2): 8 - 13.

Bala, A., Gul, K. and Riar, C. S. (2015). Functional and sensory properties of cookies prepared from wheat flour supplemented with cassava andwater chestnut flours. Cogent Food and Agriculture, 1 (1): 1 – 7.

Baljeet, S. Y., Ritika, B. Y. and Roshan, L. Y. (2010). Studies on functional properties and incorporation of buckwheat flour for biscuit making. International Food Research Journal, 17: 1067 – 1076.

Bender, D. A. (2006). Benders' Dictionary of Nutrition and Food Technology. 8th edition. CRC Press. Boca Raton.

Cauvain, S. and Young, L. (2001). Baking problems solved. Boca Raton. CRC Press.

Chauhan, A., Saxena, D. C. and Singh, S. (2016). Physical, textural and sensory characteristics of wheat and amaranth flour blend cookies. Cogent Food and Agriculture, 2 (1): 1 – 8.

Duru, F. C., Ochulor, D. O., Nwachukwu, C. A. and Ohaegbulam, P. O. (2019). Proximate and organoleptic assessment of biscuit from composite flour of wheat and tigernut. Proceedings of the 1st School of Industrial and Applied Sciences SIAS Conference. Nekede 2019. pp. 82 – 87.

ISSN (Online): 2734-2638
DOI: https://doi.org/10.55989/RIGK5223

Fellows, P. J. (2000). Food Processing Technology – Principles and Practice.Woodhead Publishing Ltd. Cambridge.

Hasmadi, M., Noorfarahzilah, M., Noraidah, H., Zainol, M. K. and Jahurul, M.H.A. (2020). Functional properties of composite flour: A review. Food Research,4 (6): 1820 - 1831.

Klunklin, W. and Savage, G. P. (2018). Biscuits: A substitution of wheat flour with purple rice flour. Advances in Food Science and Engineering, 2 (3): 1 – 8.

Mbah, B. O., Eme, P. E. and Eze, C. N. (2013). Nutrient potential of Almond seed (Terminalia catappa) sourced from three states of Eastern Nigeria. African Journal of Agricultural Research, 8 (7): 629 – 633.

Noorfarahzilah, M., Lee, J. S., Sharifudin, M. S, Mohdfadzely, A. B. and Hasmadi, M. (2014). Applications of composite flour in development of food products. Int'l Food Research Journal, 21(6): 2061 - 2074.

Obinna-Echem, P. C., Barber, L. I. and Enyi, C. I. (2018). Proximate composition and sensory properties of complementary food formulated from malted pre-gelatinized maize, soybean and carrot flours. Journal of Food Research, 7 (2): 17 – 24.

Ohaegbulam, P. O., Amadi, N. V. and Opabisi, A. K. (2021). Proximate composition, amino acid profiles and sensory properties of confectionery products supplemented with African pear (Dacryodes edulis var. edulis) seed flour. IOSR Journal of Environmental Science, Toxicology and Food Technology, 15 (5): 41 – 48.

Ohaegbulam, P. O., Okorie, S. U. and Ojinnaka, M. C. (2018). Evaluation of the engineering properties of African yam beans (Sphenostylis stenocarpa) seeds. J. Hum Nutr. and Food Sci, 2018; 6 (1): 11158.

Olatidoye, O. P., Sobowale, S. S., Akinlotan, J. V. and Olorode, O. O. (2011). Chemical composition and physicochemical characteristics of Tropical almond nuts (Terminalia catappa L.) cultivated in South-West Nigeria. Journal of Medical and Applied Biosciences, 2: 1 – 10.

Onuegbu, N. C., Nwuka, M. U., Ojukwu, M, and Kabuo, N. O. (2016). Nutritional Properties of African Pear Seed and Performance of Defatted Cake in poultry feed formulations. International Journal of Life Sciences, 5 (3): 149 – 151.

Ponka, R., Bouba, A. A., Fokou, E., Beaucher, E., Piot, M., Leonil, J. and Gauchewn, F. (2015). Nutritional component of five varieties of pap commonly consumed in Maraua (far-North, Cameroon). Polish Journal of Food and Nutritional Science, 65 (3): 183 – 190.

Popoola, O. O., Balogun, D. A., Bello, A., Adeyemi, H. J., Jibrin, J., Isijiola, B., Hassan, N. M., Kumapayi, T. A., Odeh, E., Raji, M. O., Ajibola, O. T. and Ajulo, K. (2019). Quality characterization of biscuit baked from Acha-Ripe plantain. Research Journal of Food Science and Quality Control, 5 (1): 12 – 20.

Seibel (2009). Definition of composite flours. The International Journal for Cereal Science and Technology. (6): 29-38.

The American Society for Nutrition (2011).Protein Complementation. Retrieved on 16/07/2021 fromhttps://asn.com/pages/ protein_complementation

The GIG Educational Bulletin (2014). Celiac disease, non-celiac gluten sensitivity wheat allergy. Gluten Intolerance Group (GIG). pp. 1-3.

Thomson, L. A. J. and Evans, B. (2006). Terminalia catappa (Tropical almond). Species Profiles for Pacific Island Agroforestry - A publication of the Traditional Tree Initiative. April, 2006.