International Academic Research Consortium Journals (IARCJ)
International Journal of Food Science, Tourism & Home Economics
ISSN: 2360-9317. Volume 8, Issue 6
PP 30-45, January, 2025
OTL: 427251-39265-0863-1
arcnjournals@gmail.com
https://arcnjournals.org

Production and Acceptability of *Dubla* (a Traditional Snack) Produced from Wheat and Tiger Nut (*Cyperus esculentus)* Flour Blends

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Abstract: *Dubla is a snack that is very popular among the people of Northern Nigeria and is usually prepared and served during occasions such as Wedding, Naming ceremonies among others. The method of preparation is similar to chin-chin production using wheat flour as the major ingredient alongside, butter, milk and eggs from which stiff dough is produced and then fried until golden brown and crisp. In this research, wheat and tiger nut flour is used in the production of dubla. The wheat flour was complemented with tiger nut flour in the ratio of 100:0%, 90:10%, 80:20%, 70:30%, 60:40% and 50:50% and were labelled AD, BD, CD, DD, ED and FD respectively of which sample AD served as control. The functional properties and proximate composition of the flour blends was evaluated alongside the proximate composition and sensory quality of the dubla snack. From the results obtained, the Moisture, Fat, Protein, Fiber, Ash, Carbohydrate (by difference) and energy (kcal) content of the flour blends ranged from 11.4 to 14.80 %, 1.5 to 16.4 %, 11.8 to 17.3 %, 0.3 to 6.3 %, 0.5 to 1.9 %, 46.7 to 71.1 % and 345.1 to 403.6 kcal respectively, while the proximate composition for the dubla samples ranged from 2.95 to 5.33% for moisture, 20.03 to 41.03% for fat, 7.43 to 15.01% for protein, 0.30 to 1.25% for ash, 0.20 to 0.78% for fiber, 38.98 to 66.71% for carbohydrate and 476.83 to 585.23 kcals for energy. There were significant differences (p<0.05) on dubla samples as the level of tiger nut increases. There were also significant differences (P>0.05) in sensory attribute analyzed, sample AD and BD with 0% and 10% tiger nut-flour substitution had the best colour attribute rating 7.38 and 7.21 respectively while the least was recorded in sample FD with value 5.62. Sample AD with 0% tiger nut-flour substituion had the best overall acceptability followed by BD (10%) tiger nut.*

Keywords: *Dubla, Tiger nut, Wheat flour, proximate composition, sensory evaluation*

1.0 INTRODUCTION

Food snack is a small service of food mostly eaten between meals which often come in a variety of forms, packages, as well as made from fresh ingredients at home (Freitas and Moretti, 2006; Pallavi *et al.,* 2013). Over the past few years there was a shift in the food consumption patterns from traditional meal habits to processed foods. The rate of Snack consumption has increased significantly in all age groups from 71 to 97% in 2003-2006 (Piernas and Popkin, 2010). Most of the snacks are dense in energy as it has high amount of fat and sugars averaged about 8.7g of fat and 23g sugars (Wildey *et al*., 2000). According to Matz (1993), snacks foods are consumed primarily for pleasure rather than for social or nutritive purpose and not ordinarily used in a regular meal. Karen (2000) reported that snack are usually intended to be eaten to temporally subside hunger, boost energy, the edge off appetite, and most importantly provide useful nutrient needed for healthy growth, development and living. Studies also have shown that snacks can be used to increase the nutritional status of consumer by incorporating nutrient such as protein and fibre from plant sources which have health benefits (Zazueta-Morales *et al*., 2001). Snacks in Nigeria vary with people, culture and geographical locations (Bassey, 1993). In Nigeria snacks are mainly produced and consumed in its areas of production and their production are based on art rather scientific knowledge, vary with people, culture and geographical locations which leads to possession of variable characteristics (Ingbian and Akpapunam, 2005). Several products are classified as "snacks", among which are the mini-pizzas, cookies, popcorn, and snack bars (Bower and Whitten, 2000). Some of the common traditional wheat based snacks in Nigeria are *dubla, funkaso, gurasa, alkubus, alkaki, garabiya, chin chin* among others.

Dubla is a traditional snack mostly consumed in the northern part of Nigeria (Hyelsinta *et al*., 2017). It is prepared mostly on special occasions and festive periods because of its rich value. Method for preparation of *Dubla* varies from one processing to other due to lack of standardized ingredient formulation that would ensure product consistency. *Dubla* is usually produced just like *Chinchin* but with slight modification where whole wheat flour (fine), sugar, oil/butter, egg, milk, baking powder and pint of salt are mixed together, water is added to form stiff dough which is transferred to a work surface and knead for 15 mins. It is cut into small balls; each ball is roll into thin flat layer with rolling pin, fold to desired shape and then deep fat fried in oil until it is golden brown and crispy. Wheat flour is the main raw material and therefore there is need to enrich it with adequate protein and fiber sources.

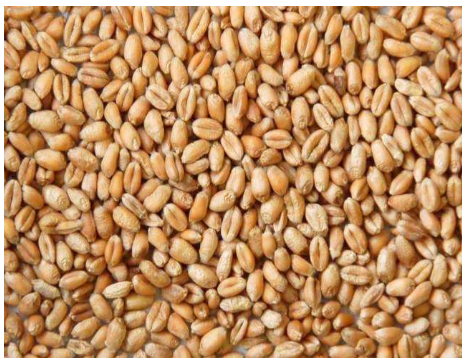
Wheat (*Triticum spp*.) is one of the major grains in the diet of a vast proportion of the world's population. It has therefore a great impact on the nutritional quality of the meals consumed by a large number of people and consequently on their health. Although wheat's ability to produce high yields under a wide range of conditions is one reason for its popularity compared to other cereals, the most important factor is the capability of wheat gluten proteins to form viscoelastic dough, which is required to bake leavened bread in particular.

Tigernut (*Cyperus esculentus*), an underutilized crop, was reported to be high in dietary fibre content, which could be effective in the treatment and prevention of many diseases including colon cancer, coronary heart diseases, obesity, diabetics and gastro intestinal disorders. Tigernut flour is a rich source of quality oil and contains moderate amount of protein. It is also an excellent source of some useful minerals such as iron and calcium which are important for body growth and development (Oladele & Aina, 2007). Tigernut has also been reported to be used in the treatment of flatulence, indigestion, diarrhea, dysentery, and excessive thirst (Abaejoh, *et al*., 2006). Therefore, tigernut, with its dietary and beneficial advantage, could serve as good substitute to cassava in baking industry. This will also reduce cost and promote the use of indigenous crops in food formulation. Information and data on the use of tiger nut in baked goods are quite scanty. The objective of this research work is to evaluate the quality of an enriched *dubla* snack produced from composite wheat-tigernut flour.

2.0 MATERIALS AND METHODS

2.1Materials

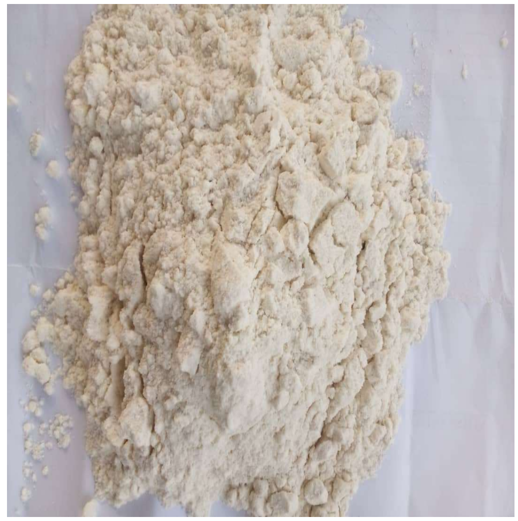
Dry Tiger-nut (C.*esculentus*) seeds with low moisture content were obtained from Bulumkutu market in Maiduguri,Borno State. High quality Commercialized wheat flour ((Golden penny prime, flour mills of Nigeria Plc) and other ingredients such as baking powder, sugar, eggs, butter, evaporated milk and vegetable oil were obtained from Monday market in Maiduguri, Borno state, Nigeria. Other equipments used in production and processing of *Dubla* were all obtained from the Department of Food Science and Technology, University of Maiduguri, Borno state, Nigeria.. The chemical reagents used to analyse the proximate and mineral compositions were obtained from NAFDAC Maiduguri, Borno State, Nigeria.



Wheat grain Tiger nut

2.2 preparation of tiger nut flour

Tiger nut flour was prepared using the method described by (Adeyemi 1988) and (Adejuyitan 2011) with slight modification. The Tiger nut seeds were cleaned properly. It was sorted out by hand picking in order to remove unwanted materials like dirt, stones, pebbles and foreign seeds before being washed with tap water and drained. The cleaned nuts were then oven dried to 12% moisture content, toasted mildly under low heat with continuous stirring to prevent burning; this was done to help improve flavour. The toasted tiger nut was then milled using attrition grinder to obtain the tiger nut flour, which was sieved through 100 mm aperture size sieve afterwards to obtain finer flour and the resultant flour was packed in polythene bags and were stored for further use. The flow chart indicating the process of preparation is shown below



Tiger nut flour commercialized wheat flour

Tigernut
↓
Sorting and cleaning
↓
Washing
↓
Draining
↓
Drying (moisture level of 12%)
↓
Toasting
↓
Dry milling (attrition milling)
↓
Sieving (100mm sieve mesh)
↓
Fine Tigernut flour

Fig 2.2 Flowchart indicating the preparation of tigernut flour.

Source: Adapted from (Adeyemi 1988), (Adejuyitan 2011) with slight modification.

2.3. Formulation of composite flour blend

The formulation of blends were done to obtain composite flours of tiger nut and commercialized wheat flour (Golden Penny wheat flour) mixed together at variable ratios; 90:10%; 80:20%, 70:30%; 60:40%; 50:50% respectively and 100% wheat flour which serve as the control as shown in Table 2.3 . A total of six samples were obtained, including one control representing 100% wheat flour. A KitchenAid Artisan stand mixer (KSM 150, manufactured in China) was used for mixing the samples to achieve uniform blends.

Table 2.3. Formulation of blends (Wheat and tiger nut per 100 grams)

Ingredients	Sample AD 100:0	Sample BD 90:10	Sample CD 80:20	Sample DD 70:30	Sample ED 60:40	Sample FD 50:50
Wheat(g)	100	90	80	70	60	50
Tiger nut(g)	0	10	20	30	40	50
Salt(g)	0.3	0.3	0.3	0.3	0.3	0.3
Sugar(g)	20	20	20	20	20	20
Butter(g)	10	10	10	10	10	10
Baking powder(g)	0.3	0.3	0.3	0.3	0.3	0.3
Egg(whole)	1	1	1	1	1	1
Milk(ml)	15	15	15	15	15	15
Water(ml)	25	25	25	25	25	25

Source: Adapted from Hyelsinta *et al.*, 2017

2.4 *Dubla* preparation

Dubla was produced using method described by Hyelsinta *et* al., (2017), first the composite flour and baking powder was mixed in a large bowl, and butter was then added and was mixed for 15 minutes. Egg, water and milk were also added and thoroughly kneaded to give stiff dough using sheathing board. The kneaded dough was then made into a flat thin layer using local pasta making machine, cut into smaller piece, rolled and folded into required shape followed by frying in deep hot vegetable oil until a golden brown colour was obtained. The oil was drained followed by cooling and packaging in high density polyethylene bags for storage until the *dubla* was evaluated. The process was repeated for all the blended flour samples. The flow chart indicating the process of preparation of *dubla* is shown below:

Composite flour
↓
Addition of baking powder
↓
Mixing
↓
Addition of butter
↓
Mixing
↓
Addition of egg, water and milk
↓
Kneading (dough formation)
↓
Rolling (into desirable shape)
↓
Deep frying (vegetable oil until it turns golden brown colour)
↓
Straining
↓
Packaging/ serving

Fig 2.4 Flowchart indicating method of preparation of *dubla*
Source: Adapted from Hyelsinta *et al.*, (2017).

Sample AD

Sample AB

Sample AC

Sample AD

Sample AE

Sample AF

2.4.1. Proximate composition

Protein, fat, crude fibre, moisture and ash were determined by the methods of Analysis of the
Association of Official Analytical Chemists (2005) Triplicate determination was carried out and the result averaged while the percentage carbohydrate was calculated by difference where all other constituent of food such as moisture, fat, protein, and ash were summed and subtracted from 100.

2.4.2. Functional properties

Water absorption capacity and oil absorption capacity were determined using Wang and Kinsella (1976) method. Bulk density was determined using the Onwuka (2005) method. Swelling capacity was determined using the method of Ukpabi and Ndimele (1990) and pH was determined by using Analysis of the Association of Official Analytical Chemists (2000).

2.4.3. Sensory evaluation

The sensory attributes of the *dubla* was determined by using hedonic tests as described by Meilgard *et al.*, (2007). This was done using a 15-member panel comprising of students and staff of the department of Food Science and Technology, University of Maiduguri, Borno State, Nigeria, who were familiar with the sensory attributes of the *dubla* snack. Each panelist was asked to score each attribute on a 9-point hedonic scale where 1 and 9 represent dislike extremely and like extremely, respectively. The attributes that were evaluated includes colour, taste, texture, crispness and overall acceptability.

2.4.4. Statistical analysis

All data generated were subjected to Analysis of Variance (ANOVA) using computer assisted software (Statistical Tool for Agricultural Research, STAR) version 20.1 at 5% level of probability. Significant means were separated using Duncan Multiple Range Test (DMRT) using the same software.

3.0 RESULTS AND DISCUSSION

3.1. Proximate composition of wheat-tiger nut composite flour

The proximate composition of the composite flour is presented in Table 3.1. From the result it shows that, the carbohydrate content of the composite flour decreased from 71.1 to 46.7% indicating low carbohydrate content of the tiger nut flour particularly sugar. The protein and fat content of the composite flour increased from 12.7 to 17.4%, 3.8% to 16.5% respectively with increase in tiger nut flour complementation. There was also a notable enhancement of fiber content as well as ash content of the composite flour. The notable increase in fat content of the composite might be due to high fat content of the tiger nut flour about 24.00% as recorded by Basman & Koksel, (2003). Defatting the tiger nut before utilization may yield better result. The moisture content of the composite flour ranged from 11.4±0.02 to 14.80±0.01%. Moisture provides a measure of the water content and an index of storage stability of the food. Sanni *et al*., (2006) reported that the lower the moisture content of a product to be stored, the better the shelf stability of such products.

Table 3.1 Proximate Composition of Wheat-tiger nut Flour.

Sample	Moisture(%)	Fat (%)	Protein(%)	Fiber(%)	Ash(%)	CHO(%)	Energy (kcal)
AD	**14.8±0.01^{a}**	**1.5±0.01^{a}**	**11.8±0.0^{a}**	**0.3±0.4^{a}**	**0.5±0.03^{a}**	**71.1±0.1^{a}**	**345.1±0.01^{a}**
BD	**14.5±0.01^{b}**	**3.8±0.02^{b}**	**12.7±0.3^{b}**	**0.9±0.1^{b}**	**0.8±0.01^{a}**	**67.3±0.1^{b}**	**354.2±0.02^{b}**
CD	**14.4±0.00^{b}**	**6.3±0.02^{c}**	**13.3±0.3^{b}**	**1.3±0.1^{b}**	**1.0±0.00^{a}**	**63.4±0.0^{c}**	**363.5±0.03^{c}**
DD	**14.0±0.02^{b}**	**8.6±0.01^{d}**	**13.6±0.4^{b}**	**2.1±0.3^{c}**	**1.3±0.00^{a}**	**60.4±0.0^{d}**	**373.4±0.02^{d}**
ED	**13.8±0.01^{c}**	**14.0±0.02^{e}**	**15.6±0.0^{c}**	**4.7±0.1^{d}**	**1.7±0.03^{b}**	**50.2±0.2^{e}**	**389.2±0.01^{e}**
FD	**11.4±0.02^{d}**	**14.5±0.01^{e}**	**17.4±0.3^{d}**	**6.3±0.1^{e}**	**1.9±0.01^{b}**	**46.7±0.1^{f}**	**403.6±0.00^{f}**

Notes: AD = 100%WF, BD = 90%:10%, CD = 80%:20%, DD = 70%:30%, ED = 60%:40%, FD = 50%:50% wheat:tigernut.
Values are represented as mean ± standard deviation of triplicate samples. Mean values with the same letter within the same column are not significantly different ($p > 0.05$).

3.2 Functional properties of the composite wheat-tigernut flour

The results of the functional properties of the composite wheat-tigernut flour are shown on Table 3.2. The functional properties are those attributes that determine the application and end use of food materials for various food materials. The results show that there is significant difference ($p<0.05$) in the water absorption capacity and the oil absorption capacity of the composite flours Water absorption capacity (WAC) gives an index of water absorbed or retained increased with increase in tigernut addition. Result showed an increase in WAC as tiger nut flour ratio increases. Blend ratio 50:50 (6.78 g/g) has the highest value while the lowest recorded in sample AD (4.20g/g). This value of WAC reduces gradually as the ratio of tiger nut decreases (6.78, 6.60, 6.41, 5.53, 5.46, and 4.20 g/g for 50:50, 60:40, 70:30, 80:20, 90:10 and 100:0 respectively). This could be as a result of the addition of tiger nut flour to wheat flour improves the reconstitution ability. High water absorption is of a disadvantage as it reduces the absorption of nutrients (Olaitan *et al*., 2014).

According to Oyarekua and Adeyeye (2009) water absorption capacity is desirable for improving mouth feel and reducing the viscosity of products. High WAC means that the food material may have more hydrophilic parts (polar amino acids) also high WAC is attributed to lose structure of starch polymers while low values indicate the compactness of the structure Adebowale *et al*., (2005). Increase in WAC implies increase in digestibility of the product (Ayele & Nip,1994). The decrease in WAC of the composite flour as the ratio of tiger nut decreases could also be attributed to presence of higher amount of fibre; this is because fibre has good ability to associate with water under limited water conditions. High water absorption capacity of composite flours suggests that the flours can be used in formulation of some foods such as bakery products dairy products and meat products (Hasmadi *et al.,* 2020).

The results for bulk density ranged from 0.59±0.01 to 0.81±0.10 g/ml with 100:0 having the lowest and 50:50 having the highest value. Nutritionally, low bulk density promotes digestibility of foods especially in children with immature digestive systems while high bulk density decreases the caloric and nutrient intake of children resulting in growth faltering (Olaitan *et al*., 2014). Low bulk density also implies that the product can easily be packaged for economic use. According to Nnam (2001) low bulk density has nutritional and economic significance as more of the products can be eaten thus leading to high energy and nutritional density. The bulk densities of the flour blends FD, ED and DD were not significantly different from one another ($P>0.05$) while flour blends CD, BD and AD also showed no significant difference between them. Sample FD had the highest (0.81±0.10a) while the least was sample AD (0.59±0.01b). The bulk density in this study agrees with the values reported by Ohizua *et al*., (2016) for unripe banana, pigeon pea and sweet potato flours and that of Adebayo-Oyetoro *et al*., (2017) for chin-chin composite flour from wheat and tiger nut . Bulk density is generally affected by the particle size of the flour and initial moisture content, which plays a crucial role in the determination of requirements for packaging, material handling and wet processing application in the food industrial sector (Adebowale *et al*., 2008, Ajanaku *et al*., 2012) Generally, high bulk density is desirable for its great ease of dispensability and reduction of paste thickness which is an important factor in convalescent child feeding, while in contrast, low bulk density would be an advantage in the formation of complementary foods (ijarotimi., 2022).

The results for swelling capacity ranged from 19.73±0.13a to 12.74±0.30e in which sample FD recorded the least value 12.74±0.30 while sample AD recorded the highest value. There was significant ($p<0.05$) difference between all the samples. This result indicated that with increase in tiger-nut flour complementation, the swelling capacity of the samples decreased, this could be attributed to the fact that swelling capacity of flours depend on the particle sizes, variety and type of processing method or unit operation. The higher the water absorption capacity, the lower the swelling capacity and the more readily digestible the product will be.

The high swelling capacity observed in 100% wheat may be as a result of gluten which is a protein found in wheat which contributes to the viscoelastic properties of wheat flour dough. for Oil absorption. The order of oil absorption capacity is in the following order AD> BD > CD > DD >ED>FD. This is as a result of high level of oil present in tigernut. The major component affecting oil absorption capacity is protein, which is composed of both hydrophilic and hydrophobic parts (Jitngarmkusol *et al*., 2008). The results obtained from functional properties showed that flour with high protein content, for example wheat-tigernut and other high protein quality flour could be used as functional ingredient in foods such as whipped topping, sausages, chiffon dessert, angle and sponge cake (Kaushal *et al*.,2012).
For the result of P^H value, there was an increase in p^H value as the ratio tiger nut increases and the value ranged between 5.78 and 6.12. the highest value was recorded in sample FD with 6.12±0.02 while the least recorded in sample AD (5.78±0.02). Adebayo-Oyetoro *et al*., (2017) AND Chinma and Ocheme (2007) had earlier reported the pH of wheat and tiger nut and cassava flour as 6.08 and 6.55 respectively.

Table 3.2 Functional Properties of wheat-tigernut flour

Sample	WAC (g/g)	Bulk density (g/ml)	Oil absorption (g/g)	Swelling capacity (g/g)	P^H
AD	4.20	0.59	2.13	19.73	5.78
BD	5.46	0.62	1.90	18.91	5.89
CD	5.53	0.63	1.87	17.55	5.95
DD	6.41	0.71	1.76	15.90	6.03
ED	6.60	0.78	1.69	14.65	6.10
FD	6.78	0.81	1.66	12.74	6.12

Notes: AD = 100%WF, BD = 90%:10%, CD = 80%:20%, DD = 70%:30% , ED = 60%:40%, FD = 50%:5% wheat:tigernut, WAC- Water Absorption Capacity.
Values are represented as mean ± standard deviation of triplicate samples. Mean values with the same letter within the same column are not significantly different ($p > 0.05$).

Proximate composition of *Dubla*

Table 3.3 shows the results for proximate composition of the *Dubla* Snack from composite wheat-tigernut flour. Significant differences ($p < 0.05$) existed in the moisture, ash, protein, fat and total carbohydrate contents of the snack as expected, the ash, protein, and fat content increased as the percentage of tiger-nut flour increased.
The moisture content of the snack ranged from 2.95±0.04 to 5.33±0.02% ,The values were within the range reported to have no adverse effect on quality attribute of the product (Mepba *et al*., 2007).

Moisture provides a measure of the water content and an index of storage stability of the food. Sanni *et al*., (2006) reported that the lower the moisture content of a product to be stored, the better the shelf stability of such products. Therefore, the low moisture content of the *Dubla* snacks produced make them less liable to microbial attack thereby improving their shelf stability. The variation in moisture content can be attributed to environmental and experimental factors (Obasi *et al*., 2012). The low moisture content is desirable not just for the prevention of microbial activities but also for extension of the shelf-life of the snack (*Dubla*) if protected from further absorbing moisture through proper packaging.

The protein content of the *dubla* samples increases as the quantity of tigernut flour increases in the mixture, the values ranged from 7.43 to 15.01%. Significant differences ($p < 0.05$) were observed amongst the samples when compared. The high protein content in the samples is in accordance with high level of protein in tiger-nut (9.4% - 15.1%) reported by Ade-Omowaye *et al*., 2008. The *Dubla* from the 100% wheat flour had the least protein content, but with the addition of tiger-nut, it resulted to significant increase ($P<0.05$) in protein content of the dubla snack.

The ash content (%) of the sample increased with decrease in the ratio of wheat flour in the samples. The ash content of the snack ranged between 0.30±0.02 and 1.25±0.01%, with sample FD having the highest mean value. Ash gives an indication of inorganic elements that are present in a food as minerals. The ash content in this study was within the standard limit of < 5% (SON) as reported by Adedokun *et al*., (2014), though lower than 1.5% reported by Ukwuru *et al.,* (2011). The Increase in ash content justifies high level of ash content (0.89% - 1.57%) in tiger-nut as reported by Dada *et al*., (2012). The ash content of any food material represents the inorganic elements obtained after the combustion of the organic materials in the food and these inorganic materials are composed of mineral element (calcium, magnesium, iron, phosphorus, etc.) which are important for building rigid structures and regulatory functioning of the body as reported by Akajiaku *et al*., (2018). The results show ed there were significant increase in the fat content as the ratio of tigernut increases. This may be due to high amount of fat in tigernut as reported by Bamishaiye and Bamishaiye (2011).The fat content of the snack ranged from 25.40±0.03 to 41.03±0.02% for samples made from composite flours and 20.03±0.01% for 100% wheat. The fat content of the *dubla* samples is relatively high when compared to pearl millet (7.6%) and quinoa (6.3%) (Oshodi *et al*., 1999), pigeon pea flour (1.80%) (Okpala and Mammah, 2001) and wheat flour (3.10%) (Akubor and Badifu, 2004) but low compared to some commonly consumed oil seeds in Nigeria; Pentaclethra macrophylla (46.0%), *Telfairia occidentalis* (49.2%) according to Oladele and Aina (2007). Tiger-nut is rich in fat (25.50%) (Belewu and Abodunrin, 2006) and the reduction in the value may be attributed to extraction treatments in the course of processing. The increased substitution of tiger-nuts flour increased the fat content of the *dubla* . The fat content could also be a function of the butter used during production of *Dubla*. High-fat content can create the challenge of rancidity during storage, although fat facilitates absorption of fat-soluble vitamins, provides essential fatty acids and important volatile compounds for flavor and sensory qualities (FAO 2001; Musa and Lawal, 2013).

The carbohydrate content of the samples was found to decrease as the ratio of wheat flour decreases. There were significant differences in FD which had the lowest value when compared with all other samples ($p < 0.05$). The carbohydrate content of the Snack (*Dubla*) ranged from 62.81% to 38.98% in composite flours and 66.42% in 100% wheat flour. The high carbohydrate content of the 100% wheat flour snack was as a result of low protein, fat and ash content of the sample since carbohydrate is a function of the difference between the proximate components. At ($p<0.05$) level of significance, there was a significant difference in carbohydrate content of the snacks. The addition of tigernut flour in the composition at the level of 10–50% resulted in a notable increase in the crude fibre contents (%) of the product. The highest value was recorded in sample FD.

Table 3.3 Proximate composition of *dubla* from wheat tigernut flour blends

Sample	Moisture (%)	Fat (%)	Protein (%)	Ash (%)	Crude fiber (%)	CHO (%)	Energy (Kcal)
AD	5.33±0.02[a]	20.03±0.04[a]	7.43±0.01[a]	0.30±0.02[a]	0.20±0.04[a]	66.71±0.20[a]	476.83
BD	3.72±0.03[b]	23.40±0.03[b]	8.95±0.00[b]	0.59±0.02[b]	0.53±0.01[b]	62.81±0.11[b]	497.64
CD	3.50±0.06[b]	27.90±0.02[c]	9.70±0.11[c]	0.70±0.01[c]	0.57±0.06[b]	57.63±0.01[c]	520.42
DD	3.03±0.04[c]	35.63±0.02[d]	11.60±0.03[d]	1.05±0.01[d]	0.67±0.02[c]	48.02±0.02[d]	559.15
ED	3.00±0.02[c]	39.56±0.02[e]	13.03±0.03[e]	1.13±0.00[d]	0.71±0.02[c]	42.57±0.03[e]	578.44
FD	2.95±0.00[c]	41.03±0.01[f]	15.01±0.03[f]	1.25±0.12[d]	0.78±0.02[c]	38.98±0.00[f]	585.23

Notes: AD = 100%WF, BD = 90%:10%, CD = 80%:20%, DD = 70%:30%, ED = 60%:40%, FD = 50%:50% wheat:tigernut.
Values are represented as mean ± standard deviation of triplicate samples. Mean values with the same letter within the same column are not significantly different ($p > 0.05$).

3.4. Sensory evaluation of the *Dubla* snack.

Table 3.4 shows the results of sensory evaluation of wheat-tiger nut *dubla* samples. There were significant differences in all the attributes measured. The results for colour, taste and crispiness follows the same trends which show a decrease in values as the ratio of tigernut flour increases except for flavour. The mean and standard deviation for colour were obtained as 7.38 ± 0.62, 7.21 ± 0.88, 7.00 ± 1.0, 6.43±0.01, 6.02±0.55 and 5.62 ± 2.03 for AD, BD, CD, DD, ED and FD respectively. The high value observed from 100% wheat flour may be as a result of changes in appearance and colour of *dubla* due to addition of tigernut which had effect on both the appearance and colour, compare to whitish colour usually obtained for all-purpose wheat flour for sample with 100% wheat flour.. The result of colour for this study was lower than the result obtained for *dubla* obtained from wheat and soya bean by (Hyelsinta *et al*., 2017).

For taste there was also significant difference observed for all the samples. Sample FD had the lowest value (5.31) while sample AD had the highest (7.45) .The mean values obtained for flavour ranged between 6.65-7.80, and sample ED had the highest value while sample AD had the lowest value, the result did not follow a trend of either increasing or decreasing as the ratio of tiger nut increases and could be as a result of preference from the panalist . There was Significant differences ($p < 0.05$) observed for crispness of *dubla* sample. AD had the highest value 7.70 for the attribute crispness, while FD had the lowest crispness value of 5.21. This result compares favourably with result obtained from modified cocoyam-wheat composite *chin-chin* (Akusu, Kiin-Kabari, & Ebere, 2016), *dubla* obtained from composite flour of wheat and soya bean (Hyelsinta *et al*., 2017) and *chin chin* from composite flour from wheat and tiger nut (Adebayo- Oyetoro *et al*., 2017). (AD) with 100% wheat flour was most preferred in terms of overall acceptability, followed by 90:10 (BD), 80:20 (CD) , 70:30 (DD), 60:40 (ED) and 50:50 (FD) with the following scores 7.52 ± 0.09, 7.21 ± 0.08, 7.00 ± 0.41, 6.82±0.05, 6.58±0.01 and 5.33 ± 0.01 respectively. The result of the sensory evaluation revealed that *Dubla* made from 100% wheat flour and those produced from composite flour with 10 and 20% tigernut flour were rated closely in almost all the quality attributes evaluated indicating the feasibility of adding tigernut to our snack. This result suggests the potential application of tigernut flour either as full fat (complete) or defatted (removal of the fat) flour in food manufacturing companies as well as the inclusion in the production of other snack in order to encourage the use of tiger nut been an underutilized crop.

Table 3.4 Sensory Evaluation of *Dubla* from the blend of wheat tiger

Sample	Colour	Taste	Flavour	Crispness	Overall acceptability
AD	7.38±0.62^{a}	7.45±0.01^{a}	6.65±0.71^{a}	7.70±0.04^{a}	7.52±0.05$_{a}$
BD	7.21±0.88^{a}	7.28±0.10^{b}	6.75±0.03^{a}	7.55±0.55^{a}	7.21±0.00^{b}
CD	7.00±0.03^{b}	7.02±0.03^{c}	6.93±0.11^{a}	7.33±0.34^{a}	7.00±0.50^{c}
DD	6.43±0.01^{c}	6.72±0.00^{c}	7.34±0.21^{b}	6.20±0.60^{b}	6.82±0.11^{d}
ED	6.02±0.55^{d}	6.20±0.01^{d}	7.80±0.05^{d}	5.70±1.71^{c}	6.58±1.01^{d}
FD	5.62±2.03^{e}	5.31±0.02^{e}	7.61±0.08^{c}	5.21±0.04^{d}	5.33±0.99^{e}

Notes: AD= 100%WF, BD = 90%:10%, CD = 80%:20%, DD = 70%:30% , ED = 60%:40%, FD = 50% :50% wheat:tigernut.
Values are represented as mean ± standard deviation of triplicate samples. Mean values with the same letter withinthe same column are not significantly different ($p > 0.05$).

Conclusion

Based on the methodology, findings and analysis discussed in this work, this final chapter presents a brief summary and recommendations for further action and studies. The objectives of the research were achieved. The main objective of the study was to produce *dubla* traditional snack using wheat and tiger nut flour blend. The results obtained shows that wheat flour can be substituted with tiger nut flour up to 50% level but that ability for *dubla* to be rolled and folded into a required shape was not possible because the gluten level of the wheat flour reduced as the level of tiger nut increases. The gluten in wheat is a protein naturally found in some grains, it acts like a binder, holding food together and adding a stretchy quality. There was a notable increase in fiber, protein, fat and ash contents with a decrease in carbohydrates content in composite *dubla* snack and this serve an advantage because most of the snacks consumed in Nigeria are from 100% wheat flour. The results of the sensory evaluation conducted on the colour, taste, flavour and overall acceptability of *dubla* snack give good credence, although for crispness it decreases as the quantity of tiger nut increases. So in order to obtain a crispy *dubla* the substitution with tiger nut should not be more than 20%.

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