ORIGINAL SCIENTIFIC PAPER

Chemical composition and sensory qualities of wheat-sorghum date cookies

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Abstract

Cookies are consumed on a large scale in developing countries such as Nigeria where macro- and micro nutrient malnutrition are prevalent. In this experimental study, functional properties, proximate and selected mineral composition of six formulated composite flours from sorghum flour (SF), wheat flour (WF) and date palm flour (DPF-sweetener) were determined using standard procedures. Four of the formulated composite flour were sweetened with DPF and blended using the following ratio (SF: WF; DPF, 80:20:25, 60:40:25, 40:60:25 and 20:80:25) respectively. The fifth sample (control) contained 100% WF sweetened with 25% sugar (sucrose), while the sixth sample is 100% WF sweetened with 25% DPF. Cookies were produced from 100g of blends of flour and 25g of date palm flour or sugar as sweetener where applicable. Sensory attributes were evaluated using nine point hedonic scale and data obtained were analyzed using Duncan multiple test at $p<0.05$. Loose bulk density ranges from 0.48-0.56g/mL, packed bulk density =0.69-0.74g/mL, water absorption capacity =1.00-1.60g/g and oil absorption capacity =1.18-1.64g/g. Proximate analysis was as follows: moisture =4.32%-5.91%, ash = 1.81%-2.45%, fat =18.94%-20.52%, protein =8.68%-17.97%, fibre =2.72%-3.42% and carbohydrate =52.65%- 64.71%. Mineral compositions are as follows: calcium =6.31-8.10mg/100g, iron =0.08-1.00mg/100g and potassium =1.56-1.75mg/100g. Moisture content of the formulated cookies samples were within acceptable range. Ash, protein and calcium contents of the formulated samples were significantly higher than in control. SF: WF-80:20 sweetened with 25% DF had the highest iron content while SF: WF- 60: 40 sweetened with 25% DF had the highest potassium value. However, control had the highest fat and carbohydrate content. Through sensory evaluation, samples with SF and WF in ratio 60:40, 40: 60 and 20:80 sweetened with 25% date flour were similarly acceptable with the control. In conclusion, enriching wheat flour with sorghum and date palm flour in cookies production improves its nutritional value.

Keywords: *wheat, sorghum, date, sensory qualities, chemical composition, cookies*

Introduction

Cookies are forms of confectionery product with a very low water activity and increased shelf life (Okaka, 2009, Florence et al, 2014). Cookies are part of the bakery products that are consumed extensively all over the world as snack food by children and adults and on a large scale in developing countries such as Nigeria where macro and micro nutrients malnutrition and diseases such as diabetes, obesity are prevalent. Cookies can serve as means of important nutrients if made available to the population. The main ingredient in cookies production include flour, fat, sugar, butter and water, other ingredient added may be optional or added to give organoleptic attribute (Chinma and Gernah, 2007) Wheat-based composite flour is the major flour used in the production of many confectionaries and baked products and is mainly starch which is lacking in other nutrients especially the micronutrients (Florence et al, 2014). Several studies have reported the use of wheat-based composite flour in cookies production (Ajanaku et al., 2011). Due to increased interest in the consumption of functional foods, cookies with high nutritional and sensory properties have been produced from non-wheat-based composite flour and this has been well documented (Okpala and Okoli, 2011; Agriga and Iwe, 2009; Chinma and Gernah, 2007; Akubor and Ukwuru, 2003; Singh et al., 2003). According to WHO/FAO, (2003), it was recommended to reduce the overall consumption of sugar and food with high glucose. Also the cost of importation of wheat for production of snacks is another major concern in Nigeria. All these challenges are being faced by food producers and this has led to sourcing for alternative means of production using indigenous crops in order to meet the nutritional requirements of individuals with health challenges and reduce cost of importation which will eventually have effect on retail prices. Consumer demand snacks, low in sugar, fat, cholesterol with healthy nutritional component such as protein, fibre, carbohydrate etc. Producing less gluten cookies from Wheat-sorghum blend flour with date as sweetener may enhance the nutritional and health status of consumers. However, little gluten can also enhance the acceptability, palatability and appearance of cookies without imposing a significant effect on the consumer's health. Dietary fibre in human diets has been reported to lower serum cholesterol, reduces the risk of heart attack, colon cancer, obesity, blood pressure and many other diseases (Rehinan et al., 2004).

Sorghum (*Sorghum bicolor* (L.) Moench) is one of the most important staple crops in Africa and is uniquely adapted to sub-tropical and semi-arid climatic condition of the continent (Doggett, 1988). Sorghum is cultivated in the warmer

climatic areas across the world. In the amount produced, it is the world's 5th largest most important cereal grain, after wheat, maize, rice and barley. It is called by a variety of names in different regions in West Africa, it is called Guinea corn, and the grain is considered as a major food source and forms the staple diet for large populations (Mohammed et al, 2016) The most common indigenous food gotten from sorghum are thick and thin porridge and flat breads. However, the absence of gluten in sorghum gives a significant importance to treat the present day Celiac Disease (Kasarda 2001)

Therefore, the use of sorghum flour as composites for confectionaries products is of great potential for food industries in Nigeria due to the fact that wheat-based composite flour suitable for the production of confectionaries is not readily available in the country.

Phoenix dactylifera (date or date palm) is a palm in the genus Phoenix, cultivated for its edible sweet fruit. In Nigeria it is called Dabino. Dates provide a wide range of essential nutrients, and are a very good source of dietary potassium. Fruits of the date palm were reported to contain a high percentage of carbohydrate (total sugars, 44–88%), the remainder consists of protein, fiber, and trace elements including boron, cobalt, copper, fluorine, magnesium, manganese, selenium, and zinc. Dried varieties of date palm fruit are higher in sucrose which is the inverted form of glucose and fructose (Al shahib and Marshall, 2003, Chandrasekaran and Ali 2013, Walid et al., 2003). The date fruit pulp is abundant in phytochemicals like sterols, phenolic, carotenoids, procyanidins, anthocyanins and flavonoids and these phytochemicals increase the nutritional and sensory properties of date fruit (Abdul and Allaith 2008). Considering the health benefit of date, and sorghum, this study aimed at producing cookies from sorghum flour and wheat flour as composite blends using date palm flour as sweetener.

Materials and Methods

The materials used for the study were purchased in a local market in Ilorin Kwara State Nigeria. The materials include; Sorghum (white), Dates palm fruits(dried), Wheat flour (white flour), shortening, sugar, salt, milk powder, baking powder (*Sodium bicarbonate*).

Production of sorghum flour

The sorghum flour was prepared according to the method described by Mazaher et al. (2009). During the preparation, sorghum grains were cleaned to remove stones and other contaminants, washed and dried. The dried grains were milled and sieved. The fine flour produced was packaged in a polyethylene bags for use in production of cookies.

Production of date palm flour

This was done by blending method as described by Butter (2013). The date palm fruits were cleaned to remove dirt, seeds were removed and the fruits were cut into smaller pieces, the cut pieces were air dried and milled into fine flour using blender

Production of Cookies

The cookies were produced based on the mixture outlined in Table 1below and date palm flour was used as sweetener, while the control was made from 100% composite flour and sugar. The cookies were produced by the method described by AACC 10-53.01, (2000). Ingredients used were 100g of flour blends, 25g of sugar, 35g of fat (margarine), 1g of sodium bicarbonate, 1g of salt, 2 teaspoonful of milk and varying proportion of water. Sieved wheat-sorghum flour, sugar, common salt, sodium- bicarbonate, milk powder were mixed together in a bowl for 3 minutes, fat was added and mixed until fluffy, water was added and mixed properly to make a dough. The dough was kneaded on a flat board sprinkled with some flour to a uniform thickness using a wooden rolling pin. The cookies were cut using a cookies cutter, placed on a greased baking tray and kept at ambient temperature for an hour to allow proper dough leaving. The samples were baked in an oven at 180° C for 15-20mins, until a light brown color was formed. Cookies were removed from the oven and cooled. Date palm flour (25g) was used to replace sugar as a sweetener at different blends of flour..

Table 1: *Blends of flours for cookies production.*

Samples	Sorghum flour (%)	Wheat flour (%)	Date	Sugar
Sample A	80	20	25	
Sample B	60	40	25	
Sample C	40	60	25	
Sample D	20	80	25	
Samples E	-	100		25
Sample F	-	100	25	

Quality Evaluation

Determination of Water and oil Absorption Capacity

Water and oil absorption capacity of the flour were determined following methods of Sosulski et al., (1976). One gram of flour sample mixed with 10 mL distilled water and 10 mL of refined soybean oil (specific gravity 0.9092) for water and oil absorption capacity respectively. The mixture was allowed to stand at room temperature for 30 min and then centrifuged at 2000g for 30 min. Water absorption capacity was expressed as gram of water bound per gram of flour and oil absorption capacity as gram of oil bound per gram of flour.

Determination of bulk density

The method of Mpotokwane et al. (2008) was adopted for the determination of bulk density with slight modification. A measuring cylinder (100mL) was filled with flour to mark (100mL), and the content weighed. The tapped bulk density was also obtained by following the same procedure but tapping for 50 times prior to weighing. Bulk density was calculated as the ratio of the bulk weight and the volume of the container (g/mL) (Asoegwu et al., 2006).

Determination of Physical Properties of the Cookies

Physical properties of the cookies were determined according to AACC (2000) methods. Six cookies were weighed on an electronic weighing balance..

The diameter was determined by placing six cookies edge to edge using a ruler. The cookies were rotated at an angle of 90 degrees for duplicate readings. The height was measured by placing six cookies on top of one another using a ruler. The spread factor was expressed as the ratio of the diameter to the thickness of the cookies. All measurements were carried out in triplicate.

Proximate analysis

The cookies samples were ground with pestle and mortar before chemical analysis. Proximate analysis including moisture content, crude protein, crude fat, total ash, crude fibre, and carbohydrate, using the standard AOAC methods (AOAC, 2000).

Determination of Mineral Content

Mineral composition (calcium, iron and potassium) of cookies were determined using the procedure described by AOAC (1990).

Sensory Evaluation

Sensory evaluation forms in form of a questionnaire was used to determine the qualities and level of acceptability of the cookies, using 15 semi-trained panelists who are familiar with cookies which consist of students of Faculty of Agriculture, Art and Sciences of University of Ilorin, Kwara State. The cookies were presented in coded plates. The Panelists were asked to evaluate the coded samples for aroma, taste, crispiness, color, texture and overall acceptability using hedonic scale of 1-9,where 1=dislike extremely and 9=like extremely(Ihekoronye and Ngoddy,1985). The data collected was analyzed statistically.

Statistical Analysis

All analyses were conducted in duplicates. Data were subjected to analysis of variance, and Duncan multiple range test was used to separate the means (Duncan, 1955)

Results and discussion

Functional properties of wheat and wheat-sorghum composite flours

Both loose bulk density (LBD) and packed bulk density (PBD) of the flours varied significantly. The LBD ranged between 0.48 and 0.56g/ml. All the composites flours had relatively higher LBD than 100% wheat (white) flour (sample E) except sample D which has same LBD as sample E and sample B which has same LBD as sample F. The PBD ranged between 0.69 and 0.74g/mL for wheat flour and composite flours respectively with sample E having the lowest. Composite flour showed significantly higher LBD and PBD than wheat (white) flour. The higher bulk densities of the composite flour demonstrated greater compactness and possible mixed effect caused by the interaction of the molecules of the sorghum flour and wheat flour. The higher bulk density observed for the composite flour implies that a solid, thick and compact packaging material may be required for this product as reported by Osundahunsi and Aworh (2002) in the preliminary study on the use of Tempe-based formula as a weaning diet in Nigeria. According to Odedeji and Oyeleke (2011), bulk density gives information on the porosity of a product and can influence the choice of packaging materials and its design.

The water absorption capacity (WAC) varied between 1.00 and1.60 g water / flour. Sample A and B had higher water absorption capacity (WAC) than the control sample E with sample C having a similar value as the control and sample D having the lowest value (1.00g water / flour). Variation in particle size distribution may also have influenced the WAC.

Similarly, oil absorption capacity (OAC) varied from 1.18-1.64 g oil/g flour respectively. According to Abu et al.,(2006), oil absorption in starch relies predominantly on the physical entrapment of oil within the starch structures as starch does not poses nonpolar sites compared to those found in proteins According to Falade and Kolawole (2011), oil absorption capacity of flours is also important for the development of new food products and influences to a great extent their storage stability.

Table 2: *Functional properties of wheat and wheat-sorghum composite flours.*

	Sample* Loose bulk density (g/mL)	Packed-bulk density (g/mL)	Water absorption capacity (g water/g flour)	Oil absorption capacity (g water/g flour)
A	0.56^{a}	0.71^{b}	1.60^{a}	1.64^{a}
B	0.49^{bc}	0.70^{bc}	1.40^{b}	1.46^{b}
C	0.50^{b}	0.74^{a}	1.20^{c}	1.18^{d}
D	0.48^{c}	0.73^{a}	1.00^{d}	1.43^{c}
E	0.48^{c}	0.69^{c}	1.20^{c}	1.43^{c}
F	0.49^{bc}	0.70^{bc}	1.20^{c}	1.43^{c}

Means with the same superscripts along a column are not significantly different ($p<0.05$)

Physical characteristics of cookies

The physical properties of cookies prepared from wheat-sorghum flour bends sweetened with date, as well as 100% wheat flour sweetened with sugar and 100% wheat flour sweetened with date is presented in Table3. The diameter, thickness and spread ratio of cookies ranged from 19 to 23.7 cm, 3.0 to 4.4 cm and 4.3 to 7.5 cm, respectively. Sample B (40% wheat

and 60% sorghum flour) exhibited the least spread ratio of 4.32. The cookies made from 80% sorghum and 20% wheat flour which is (sample B) had the highest spread ratio value of 7.5 while the control which is 100% wheat flour with sugar (Sample E) had spread ratio of 5.64, and 100% wheat flour with date had 4.92. Spread ratio is an indication of ability of the cookie to raise, hence the lower the value the better the ability. The potential factors contributing to smaller dimensions of cookies may include the lower amounts of starch and higher amounts of fiber according (Chinma et al., 2012). in effect of extrusion cooking on functional properties and in vitro starch digestibility of barley-based extrudates from fruit.

Table 3: *Physical characteristics of cookies*

Samples	Thickness (cm)	Diameter (cm)	Spread factor
A	3.0	22.5	7.5
B	4.4	19.0	4.3
C	3.4	21.6	6.4
D	3.5	19.2	5.5
E	4.2	23.7	5.6
F	3.9	19.2	4.9

Proximate composition of wheat-sorghum date cookies

The proximate composition of cookies produced as presented in Table 4 varied significantly ($p<0.05$) with a range of 4.55-5.91%, 1.81-2.45%, 8.67-17.97%, 18.94.- 20.52%, 2.72-3.42% and 52.65-64.71% for moisture, ash, protein, crude fat, crude fibre and carbohydrate respectively Sample B had the highest moisture content, Sample E which is the control had the lowest moisture content. The type of sweetener (date or sugar) used in the production of cookies did not affect the moisture content of the cookies significantly. The moisture content of the cookies are higher than those reported by Imran et al., (2011) for cookies supplemented with mungbean flour but lower than values reported by Akpapunam and Darbe (1994) in production of cookies from maize-bambara flour blends. However, the moisture contents of the cookies were generally low; values were less than 10%, and as such, moisture in the cookies is unlikely to cause any adverse effect on the quality attributes of the product.

Sample B also had the highest ash content while sample E had the lowest. The ash content of all the cookies were significantly higher than the control. Generally, protein content varies significantly among the samples. All the formulated cookies samples had high protein content than the control which conformed to the minimum FAO/ WHO recommended value of 10%. Sample E which is the control had the highest fat content.

The fiber contents of the cookies were significantly different ($p<0.05$) but were within the recommended range of not more than 5g dietary fiber per 100g dry matter (FAO/ WHO,1994).Sample C had the lowest (2.70%) and sample A had the highest (3.42%) content. This results indicates that substituting wheat with sorghum and also the use of date fruit as sweetener can be used to improve the nutritional properties of cookies especially protein and crude fibre which is of health benefits to consumers because protein is needed for physiological functioning and reducing protein-energy malnutrition; crude fibre is anti- diabetic while vegetable fat is a good source of energy and helps in absorption of most fat soluble vitamins and minerals (WHO, 2004; Okaka and Isieh 1990).

Table 4: *Proximate composition of Wheat-sorghum date cookies*

Sample	Moisture (%)	Protein (%)	Ash (%)	Fat (%)	Crud fib.(%)	Carb. (%)
A	4.55^{e}	17.97^{a}	2.32^{b}	19.54^{e}	3.42^{a}	60.37^{b}
B	5.91^{a}	16.24^{b}	2.45^{a}	19.92^{c}	2.79^{e}	52.65^{f}
C	5.13^{c}	15.88^{c}	2.02^{c}	19.81^{d}	2.72^{f}	54.43^{e}
D	4.76^{d}	13.02^{d}	2.04^{c}	18.94^{f}	3.07^{b}	58.12^{c}
E	4.32^{f}	8.67^{f}	1.81^{d}	20.52^{a}	2.93^{c}	64.71^{a}
F	5.63^{b}	11.93^{e}	2.03^{c}	20.32^{b}	2.90^{d}	57.14^{d}

Means with the same superscripts along a column are not significantly different ($p<0.05$)

*Carb, mean Carbohydrate

Mineral Composition of Wheat-Sorghum date cookies.

All the cookies samples had significantly higher calcium content than the control. The calcium content ranges between 6.3-8.1mg/100g respectively. The iron content varied significantly among the cookies with sample A having the highest value. This may be due to the high amount of iron contained in sorghum. However, the potassium content of sample B was significantly higher than other cookies. Minerals are required for normal growth; cellular activity and oxygen transport (Fe), fluid balance and nerve transmission (K) as well as the regulation of blood pressure and strengthening of bones (Ca and K).

Table 5: *Mineral composition of wheat-sorghum date cookies*

Samples	Calcium (mg/100g) Ca	Iron (mg/100g)Fe	Potassium (mg/100g)K
A	7.2^{b}	1.0^{a}	1.70^{b}
B	8.1^{a}	0.93^{b}	1.75^{a}
C	7.19^{b}	0.85^{c}	1.64^{c}
D	7.2^{b}	0.17^{d}	1.71^{b}
E	6.31^{c}	0.11^{d}	1.74^{a}
F	7.21^{b}	$0.0\ 8^{e}$	1.56^{d}

Means with the same superscripts along a column are not significantly different ($p<0.05$)

Mean Sensory Scores

The mean sensory scores of the cookies produced from wheat-sorghum flour blends at different proportion are shown in Table 6. Cookies produced from 100% wheat flour sweetened with sugar (sample E) which is the control were better accepted by panel members. However, sample D compares favorably well with the control in aroma, taste, crispiness color, and overall acceptability likewise sample A too in terms of aroma, crispiness, texture and overall acceptability and sample B in terms of aroma, crispiness, texture and overall acceptability. Generally, sample F which is produced from 100% wheat sweetened with date ranked the least in all the sensory attributes. The low rating recorded could be due to the date powder used as sweetener and its brown color must have affected the overall sensory attribute of the cookies. Although, Ihekoronye and Ngoddy, 1985 stated that wheat flour is common for its unique baking property. However, the substitution of wheat flour up to about 60% with sorghum flour and the replacement of sugar with date in this study produced good results

Table 6: *Mean sensory scores of Wheat- Sorghum Date Cookies*

Samples	Aroma acceptability	Taste	Crispiness	Color	Texture	Overall
A	5.80^{ab}	6.47^{b}	$7.07^{`a}$	6.20^{b}	6.87^{ab}	6.47^{ab}
B	6.33^{ab}	6.93^{ab}	6.27^{ab}	6.13^{b}	6.33^{b}	6.60^{ab}
C	6.07^{ab}	5.80^{bc}	7.07^{a}	6.47^{ab}	6.13^{b}	5.93^{b}
D	6.13^{ab}	6.87^{ab}	6.40^{a}	6.60^{ab}	6.20^{b}	6.40^{ab}
E	6.80^{a}	7.87^{a}	7.27^{a}	7.60^{a}	7.73^{a}	7.60^{a}
F	5.13^{b}	5.07^{c}	5.00^{b}	5.47^{b}	$5.8\ 7^{b}$	6.40^{b}

Means with the same superscripts along a column are not significantly different ($p<0.05$)

Conclusions

This study has shown that acceptable cookies can be produced from wheat flour and sorghum flour and also with the use of date as sweeteners in replacement of sugar. Cookies made from composite blend sweetened with date had acceptable quality similar to that made from 100% wheat flour (white) sweetened with sugar. Cookies made from 80% wheat flour and 20% sorghum flour sweetened with date was more acceptable then the control (100% wheat and sugar). The use of date as sweetener does not have negative effect on the cookies produced with composite flour and was acceptable to the taste panel.

However, substitution of sorghum flour up to 60% with date as sweeteners can still be encouraged because from this study, it also compete well with the control. From the study, it was observed that cookies produced from composite flour blends sweetened with date had high calcium and iron content. Therefore, enriching wheat flour with sorghum and date palm flour in cookies production improves its nutritional value. Substitution of sorghum flour and replacement of sugar with date palm fruit could be adopted by industries in production of cookies as this will not only reduce the retail cost of cookies but will also serve as a means of delivering highly nutritious cookies to the population.

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