Science World Journal Vol. 19(No 4) 2024
https://dx.doi.org/10.4314/swj.v19i4.45
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

PHYSICOCHEMICAL AND SENSORY PROPERTIES OF LOCALLY PRODUCED DIGESTIVE BISCUIT FROM TWO VARIETIES OF WHEAT (*TRITICUM* SPP)

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ABSTRACT

Digestive biscuits were produced from two varieties of wheat grain (Reyna-28 and Norman). The grains were processed into whole wheat flour at 100% (g) each with commercial digestive biscuit (Mcvities digestive biscuit) used as control and analyzed for physical properties, functional properties, mineral composition and sensory evaluation using standard methods. Other ingredients such as; margarine, egg, milk, baking powder, and sugar were added. Data obtained were analyzed using Analysis of variance (ANOVA) using Statistical Package for the Social Sciences. Results showed that the digestive biscuits gave good physical properties in terms of weight, height, diameter, thickness and spread ratio. Functional properties ranged from 0.59-0.72g/m^3 for bulk density, Sample B2 exhibited the highest bulk density (0.72), 30.32-34.31g/g for water absorption capacity, with B2 having the highest value (34.31), 4.95-10.12% solubility index. The sodium, potassium, iron and zinc content ranged from 60.23±4.93-71.21±6.18, 91.55±6.00-96.00±5.16, 2.46±0.05-6.74±0.02, 1.43±0.03-2.34±0.05mg/100g respectively. Digestive biscuit from sample B2 had the highest mineral composition. The digestive biscuits produced gave good physical properties in terms of weight, height, diameter, thickness and spread ratio. Sensory properties revealed that there were no significant differences in color, odor, texture, taste between digestive biscuits produced from processed 100% Reyna-28 wheat flour (B2) and the commercial control. In conclusion, digestive biscuits from sample B2 was most preferred than digestive biscuits produced from sample B1, B3 and B4 and was comparable to the commercial control.

Keywords: Digestive Biscuit, Wheat flour, Functional Properties and Mineral Composition.

INTRODUCTION

Biscuits are ready-to-eat cheap and covenant food product that is consumed among all age groups in many countries (Arukwe *et al*., 2023). Biscuit is a flat crisp and may be sweetened or unsweetened according to preferences. Biscuits can be made from hard dough, hard sweet dough or short or soft dough. It is produced by mixing various ingredients like wheat flour, fat sweetener and water to form dough. The dough formed unlike bread is not allowed to ferment, and then it is baked in the oven (Iwegbue, 2012; Zilic, 2013). Biscuits are classified into three broad groups as spongy goods, crackers and sweet dough; based on the method used for their manufacture. Biscuits are divided into two groups, as hard and soft dough. The soft dough biscuits are rich in fat and sugar and include short cakes, short bread and melted biscuits. Other types of biscuits are cream cracker, soda crackers, savory, water biscuits, digestive and short dough biscuits (Okoli *et al.,* 2010). In many parts of Sub-Sahara Africa and most especially in Nigeria advancing prosperity and urbanization coupled with tremendous increase in population in recent years have led to an increase in the consumption of wheat based products especially biscuits and bread (Zilic, 2013). All biscuits are nutritious, contributing valuable quantities of iron, calcium, calories, fiber and some of the B vitamin to our diet and daily food requirement (Uchenna and Omolayo, 2017). This study was designed to produce digestive biscuits locally from two varieties of wheat Reyna-28 and Norman flour and to evaluate the physical and functional properties, mineral composition and sensory properties of the digestive biscuit.

MATERIALS AND METHODS

Material Collection: The wheat grains, Reyna-28 and Norman were purchased and authenticated at Lake Chad Research Institute, Maiduguri, Borno State. Other ingredients such as the milk, egg, salt, margarine, baking powder, and sugar were purchased from Maiduguri Monday Market, Borno State.

Commercial Control: The commercial control Mcvities Digestive biscuit was purchased from Todays Super Market, Maiduguri, Borno State.

Preparation of Samples

Preparation of Whole Wheat Flour: The whole wheat flour was produced by first, washing the wheat with distilled water to remove dirt, stones and other extraneous materials, milling the wheat grain to powder and sieving through a 0.35mm mesh sieve to obtain fine homogenized flour. The flour was sealed in a cellophane bag and stored (Chandra *et al*., 2015)

Preparation of Processed Whole Wheat Flour: The processed whole wheat flour was prepared by washing to free it from debris. It was soaked in 20 liters of distilled water for 30 minutes. It was drained using sieve. The seeds were sprouted for 72 hours and allowed to sun-dried completely. The dried sample was then milled into powdered form and sifted using sieve of aperture 0.35mm to remove extraneous materials from the flour. The fine wheat flour obtained was put in tightly plastic container for further use (Chandra *et al*., 2015).

Production of Digestive Biscuits:

Digestive biscuits from Unprocessed (B1) and Processed (B2) Reyna 28 and Unprocessed (B3) and Processed (B4) Norman wheat flour were produced according to the method described by Bala (2015). Approximately 40g of sugar and 30g of margarine were mixed in a Kenwood mixer until fluffy. To this was added 100g

https://dx.doi.org/10.4314/swj.v19i4.45

of wheat flour, 10g of egg, 10g of milk, 1.5g of baking powder, 0.5g of vanilla and 90ml of water. Each sample was mixed until uniform dough is obtained. This was then rolled to a sheet of 0.25cm thickness on a board using a rolling pin. Cookies cutter were used to cut the sheet into desired shapes and sizes which were subsequently baked in an oven at about 150°C for 20min, allow to cool, packed and stored at ambient condition.

Determination of Physical Properties of the Digestive Biscuits
Determination of Diameter and Weight of the Biscuits: The modified method of Ayo *et al*. (2007) was used to determine the diameter and weight of biscuits. The weight of the baked biscuits was determined by weighing each biscuit unit on electronic weighing balance. The biscuit unit was randomly selected 11 and weighed several times and the average taken. The biscuit diameter was determined by measuring each biscuits unit randomly picked using a calibrated ruler, and the average taken.

Determination of Thickness of biscuit: The method according to Mcwatters *et al*. (2003) was used. The thickness of biscuits was measured by placing six biscuits on top of each other, followed by triplicate reading recorded by shuffling biscuits. All the measurements were done in three replicates of six biscuits each and all the readings were divided by six to get the value per biscuit.
Determination of Spread Ratio of biscuits: The spread ratio was determined by calculation method. The diameter of each biscuits was divided by its thickness. Spread Ratio = Diameter of biscuit of biscuit thickness of biscuit. Mcwatters *et al*. (2003)

Determination of Functional Properties of the Digestive Biscuits Produced
Determination of Bulk Density: The bulk density was determined by the method of Onwula (2018). Five (5g) gram of the sample was weighed into 25ml graduated measuring cylinder. The samples were packed by gently tapping the cylinder on the bench top 10 times from height of 5cm. The volume of the sample was recorded. Bulk density (g/ml) = Weight of Sample/Volume of sample after tapping.

Determination of Swelling Power: Swelling power was determined by the method described by Onwula (2018). It involves weighing 1g of flour sample into 50ml centrifuge tube; 10ml of distilled water was added and mixed gently. The slurry was heated in a water bath at a 12 temperature of 100°C for 15 minutes. During heating, the slurry is stirred gently to prevent clumping of the flour. On completion of 15 minutes, the tube containing the paste is centrifuged at 3000rpm for 10 minutes. The supernatant will be decanted immediately after centrifuging. The weight of the sediment is then taken and recorded. The moisture content of the sediment gel was used to determine the dry matter content of the gel. Swelling power = $Weight\ of\ wet\ mass\ sediment$ /$Weight\ of\ dry\ matter\ in\ gel$

Determination of Dispersibility: Dispersibility was determined using the method described by Kulkarni *et al.* (1991). Ten grams of the sample was weighed into 100ml measuring cylinder, water was added to each volume of 100ml. The set up stirred vigorously and allowed to stand for three hours. The volume of settled particles was recorded and subtracted from 100. The differences reported as percentage Dispersibility. % Dispersibility = 100 - volume of settled particle

Determination of Water Absorption and Water Solubility Index: Water absorption and water solubility index were determined using a method described by Onwula (2018). The crucibles and centrifuge tubes were dried in the oven at a temperature of 105°C for 20mins and allowed to cool in a desiccator, after cooling, the crucible and the centrifuge tubes were weighed. 1g each of the sample was weighed into the tube and 10mls of distill water was added and stirred gently with a stirring rod for 30mins. The tube containing the paste is centrifuged at 4000rpm for 15mins, on completion of the 15mins; the supernatants were decanted into crucibles and dried an oven at a temperature of 105°Cuntil the supernatant is dried off. The residue remaining in the tubes were weighed and the crucible after drying with the supernatant. Water absorption index was calculated as;
(**Weight of tube + residue after centrifuge**) – **Weight of empty tube Weight of sample** x 100 Water solubility index was calculated as; Weight of crucible after drying – weight of empty crucible **Weight of sample** x 100

Determination of Mineral Content of the Digestive Biscuits: The mineral content of the test samples was determined by the ash acid extraction method described by James (1995). A measured weight of each sample (5 g) was burnt to ashes in a muffle furnace at 550°C. The resulting ash was dissolved in l0 ml of 2M HCL solution and diluted to l00 ml in a volumetric flask using distilled water, and then filtered. The filtrate was used for the mineral analysis (phosphorus, zinc, potassium, sodium and iron).

Sensory Evaluation of the Digestive Biscuits: Produced Sensory evaluation was carried out using 40 main panelists to assess the organoleptic attributes of the bread samples. The organoleptic attributes assessed were: the color, odor, taste, texture and overall acceptability. The panelist where selected randomly from 14 the student of the university. They were made to carry out the organoleptic assessment under control environment to avoid biased result. The each of the biscuit sample wrapped with transparent polythene bags were presented in small sliced and coded identical white paper. The panelists were instructed rate the biscuit base on 7point Hedonic scale ranging from 9=like extremely to 1=dislike extremely. The raw scores were assembled and statistically analyzed using the method described by Iwe (2014).

Data Analysis: All analysis was carried out in triplicates. Data obtained were analyzed using Analysis of variance (ANOVA) using Statistical Package for the Social Sciences.

RESULTS
Physical Properties of Digestive Biscuit Produced from Processed and unprocessed Wheat Flour and Control are presented in table 1. The weight of the digestive biscuit produced ranges from 12.89cm to 14.79cm. Digestive biscuit produced from Sample B2 (14.79) was comparable to the commercial control (14.67). There was no difference in terms of diameter between the digestive biscuit produced and the commercial control. Thickness of digestive biscuit from sample B1 (1.68), B2(1.64), B3 (1.59) and B4 (1.36) showed no difference, however a difference was observed between the samples produced and the commercial control (0.71). The spread ratio of B2 (5.30) was same as that of the commercial control (5.34).

Table 1: Physical properties of Digestive Biscuit Produced from two Varieties of Wheat Flour

Parameters (mg/100g)	Samples B1	B2	B3	B4	Commercial Control
Weight	13.79	14.79	13.04	12.89	14.67
Diameter	5.24	5.42	5.36	5.40	5.92
Thickness	1.68	1.64	1.59	1.36	0.71
Spread	3.11	5.30	3.37	4.70	5.34

Key: B1: Digestive biscuit from unprocessed Reyna – 28 wheat
B2: Digestive biscuit from processed Reyna – 28 wheat
B3: Digestive biscuit from unprocessed Norman wheat
B 4: Digestive biscuit from processed Norman wheat
Control: Commercial digestive biscuit (Mcvities digestive biscuit)

Functional properties of digestive biscuits produced from unprocessed and processed wheat flour are presented on Table 2. The bulk density of sample B2 (0.74) was higher than that of the commercial control (0.78). Results of the dispersibility of samples B1(61.00), B2(61.00), B3(61.00) and B4(61.00) showed no difference. Samples B2 (34.31) had a Water absorption capacity higher than samples B1 (30.32), B3(31.90), B4(32.38) and commercial control (33.01). Solubility index ranged from 4.95 to 10.12, the values of sample B2(9.52) and B3(9.90) showed no difference. Ample B2 (3.12) had a swelling capacity which was same as that of the commercial control (3.50).

Table 2: Functional Properties of Digestive Biscuits Produced from two Varieties of Wheat Flour

Parameters	Samples B1	B2	B3	B4	Commercial Control
Bulk density (g/cm^3)	0.72	0.74	0.59	0.68	0.78
Dispersibility (%)	61.00	61.00	61.00	61.00	72.00
Water absorption capacity (g/g)	30.32	34.31	31.90	32.83	33.01
Solubility index (%)	4.95	9.52	9.90	8.41	10.12
Swelling capacity (%)	1.80	3.12	1.94	2.70	3.50

Key: B1: Digestive biscuit from unprocessed Reyna – 28 wheat
B2: Digestive biscuit from processed Reyna – 28 wheat
B3: Digestive biscuit from unprocessed Norman wheat
B 4: Digestive biscuit from processed Norman wheat
Control: Commercial digestive biscuit (Mcvities digestive biscuit)

Mineral Composition of Digestive Biscuits Produced from two Varieties of Wheat Flour. The sodium level of the digestive biscuit ranges from 60.23±4.93 to 71.21±6.1^b Sodium level in B2(71.21±6.18^b) is higher than that of samples B1 (60.23±4.93), B3(62.75±3.09) and B4(68.75±5.46). There is no significant difference observed in the potassium level of B2 (96.75±5.16) and B4 (96.00±5.11). Sample B4 had the higher Phosphorus content when compared to samples B1, B2 and B3. No significant difference was observed in the Iron content of B2 (6.74±0.02) and commercial control (6.18±0.21). Samples B1, B2, B3 and B4 were lower in terms of Zinc when compared with the commercial control. Zinc is higher in sample B2 (2.17±0.04) and sample B4(2.34±0.05) compared with Samples B1 and B3..

Table 3: Mineral Composition of Digestive Biscuits Produced from two Varieties of Wheat Flour

Parameters (mg/100g)	B1	B2	Samples B3	B4	Commercial Control
Sodium	60.23±4.93^a	71.21±6.18^b	62.75±3.09^c	68.75±5.46^d	74.09±3.78^e
Potassium	94.68±6.08^a	96.75±5.16^b	91.55±6.00^c	96.00±5.11^b	102±7.00^d
Phosphorous	136.41±4.50^a	138.80±9.02^b	121.78±10.03^c	141.26±5.06^d	161.29±3.70^e
Iron	2.46±0.05^a	6.74±0.02^b	3.35±0.06^c	4.75±0.15^d	6.18±0.21^b
Zinc	1.43±0.03^a	2.17±0.04^b	1.95±0.04^a	2.34±0.05^b	3.20±0.08^c

Data are expressed as mean ± SEM of three determinations. Values in the same row with different superscript are significant different (P<0.05).

Key: B1: Digestive biscuit from unprocessed Reyna – 28 wheat
B2: Digestive biscuit from processed Reyna – 28 wheat
B3: Digestive biscuit from unprocessed Norman wheat
B 4: Digestive biscuit from processed Norman wheat
Control: Commercial digestive biscuit (Mcvities digestive biscuit)

Sensory Properties of Digestive Biscuits Produced from two varieties Wheat Flour. The result of sensory evaluation is presented on Table 4 the result of the sensory evaluation, which revealed that there were no significant differences between samples B1, B3, and B4 in terms of color and odour. Samples B2 and the commercial control were comparable in terms of color and odour. The commercial digestive biscuit is the highest in terms of texture than the digestive biscuits produced from sample B1, B2, B3 and B4. Digestive biscuit produced from Sample B2 was highest in terms of overall acceptability and most preferred than the other digestive biscuits produced.

Table 4: Sensory Properties of Digestive Biscuits Produced from two Varieties of Wheat Flour

Parameters (mg/100g)	Samples B1	B2	B3	B4	Commercial Control
Colour	6.90±0.14^{a}	7.87±0.31^{b}	6.93±0.28^{a}	6.60±0.28^{a}	7.93±0.26^{b}
Odour	6.77±0.21^{a}	7.40±0.31^{b}	6.80±0.24^{a}	6.47±0.33^{a}	7.17±0.24^{b}
Taste	5.97±0.20^{a}	7.40±0.34^{b}	5.83±0.38^{a}	6.90±0.33^{c}	7.57±0.22^{b}
Texture	5.60±0.18^{a}	6.60±0.35^{b}	5.97±0.33^{a}	5.17±0.34^{a}	7.63±0.23^{c}
O/A	5.97±0.12^{a}	7.90±0.35^{b}	6.63±0.27^{c}	6.90±0.35^{c}	8.90±0.16^{d}

Data are expressed as mean ± SEM of three determinations. Values in the same row with different superscript are significant different (P<0.05).

Key: B1: Digestive biscuit from unprocessed Reyna – 28 wheat
B2: Digestive biscuit from processed Reyna – 28 wheat
B3: Digestive biscuit from unprocessed Norman wheat
B 4: Digestive biscuit from processed Norman wheat
Control: Commercial digestive biscuit (Mcvities digestive biscuit)

DISCUSSION

Physical Properties

The increase in weight observed in Sample B2 might be due to the processing of wheat flour, this agrees with the work reported by Apotiola and Fashakin (2013). The values of thickness in this study was consistent with the work of Erukwe *et al.* (2023). The increase in thickness may be as a result of decrease in diameter (Hawa *et al*., 2018). Sample B2 had the highest spread ratio than digestive biscuits produced from B1, B3 and B4. The values were same as the commercial control. Spread ratio is used to determine the quality of flour used in preparing the biscuits and the ability of the biscuits to rise (Abiodun and Eheme, 2018)

Functional Properties

Bulk density of flour is the density measured without the influence of any compression (Suresh *et al*., 2014). Similar finding was reported by Elfayet *et al*. (2011). Therefore, the highest bulk density from Sample B2 indicates its stability for use in dispersibility is an index of the ease of reconstitution of flour (Adebowale *et al*., 2015). The values observed in this study were relatively high in all samples this agrees with the work of Adebowale *et al*. (2015). Water absorption capacity is the ability of flour or starch to hold water (Akoja and Coker, 2018). The increase in water absorption capacity could be attributed to the processing of wheat flour which lose structure of starch polymers. Chandra (2015); and Mosood *et al*. (2011) reported similar findings. The high swelling capacity observed in sample B2 showed that the variety and method of processing are suitable for food production. Akoja and Cooker (2018) reported that the high swelling capacity of flour depends on the quality of flour, type, size of particle and the method of processing.

Mineral Element Composition

The high Potassium and low sodium recorded in this study is an advantage, because it protects against arterial hypertension and also potassium is the most intracellular electrolyte and plays a role in fluid balance and osmotic pressure. (Patricia *et al*., 2023). The value of iron was comparable to the commercial digestive biscuit, Islamiyat *et al*. (2016) reported similar findings. Iron is a major component of Hemoglobin, it carries oxygen to all part of the cell Islamiyat *et al*., (2016) and Isah, (2022). Digestive biscuit produced from Sample B2 and B4 had the highest zinc content. Similar reports in high zinc content of biscuits were noted by Bello *et al*. (2017).

Sensory Properties

There was no difference in terms of color, odour and taste of digestive biscuits produced from sample B2 and the commercial digestive biscuit. Color and taste are vital quality attribute of food and plays an important role in sensory and consumer acceptance of products (Purlis, 2010; Abiodun and Ehimen, 2017). The values of taste obtained from this study agrees with earlier work reported by Charity *et al*. (2019). Sample B2 was most preferred in terms of taste and overall acceptability. Iwe (2007) reported similar findings.

Conclusion

The study showed that digestive biscuit produced from processed 100% Reyna-28 wheat flour (B2) was comparable to the commercial digestive biscuit in terms of functional properties, mineral composition and sensory evaluation, and hence, can be produced locally at home and reduce cost.

Recommended

It is recommended that microbial analysis of the digestive biscuits produced should be carried out.

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