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NUTRITIONAL, FUNCTIONAL AND SENSORY PROPERTIES OF BISCUIT PRODUCED FROM WHEAT-SWEET POTATO COMPOSITE

Onabanjo O.O[1] --- Ighere Dickson A[2]

[1]*Department of Nutrition and Dietetics, Federal University of Agriculture, Abeokuta*

[2]*National Centre for Genetic Resources and Biotechnology (NACGRAB), Moor Plantation Apata, Ibadan, Nigeria*

[3]*Department of Nutrition and Dietetics, Federal University of Agriculture, Abeokuta*

ABSTRACT

Sweet potato was processed into flour and it was used to substitute wheat flour at different ratios (100:0, 90:10, 70:30, 60:40 and 50:50), and was used to prepare biscuits. The nutritional, functional and sensory properties of biscuits produced from different ratios of wheat-sweet potato composite flour was investigated. The results reveal that, the value of protein ranged between 4.50g/100g and 8.92g/100g, and value of fat (10.97g/100g to 18.93g/100g) in the biscuits decreased as the quantity of potato flour used in supplementing wheat flour increased. The crude fiber value ranged between 3.16g/100g and 5.10g/100g, the highest value of crude fiber was present in the sample with ratio 50:50 wheat-potato flour. Moisture content and carbohydrate values increased as more sweet-potato flour was introduced into the biscuits. The mineral values of calcium (26.20mg/100g to 28.10mg/100g), magnesium (7.30mg/100g to 9.60mg/100g), potassium (4.60mg/100g to 6.20mg/100g), sodium (9.77ppm to 11.564ppm) and phosphorus (49.675ppm to 56.322ppm) were higher in biscuits produced from ratio 90:10, 70:30, 60:40 and 50:50 wheat-sweet potato composite flour than biscuits produced from ratio 100:0 of wheat-sweet potato composite flour. Sensory analysis revealed that there were no significant differences ($p \geq 0.05$) in taste between biscuits produced from ratio 100:0, 90:10 and 70:30 of wheat-potato flour, but there were significant differences in taste between biscuits made from ratio 100:0 and biscuits made from ratio 60:40 and 50:50 wheat-potato composite flour. The experiments produced biscuits of acceptable qualities from all ratios of wheat-potato flour that was used.

Keywords: Minerals, Proximate, Flour, Staple food, Pasting properties, Bulk density.

1. INTRODUCTION

In Nigeria biscuits are one of the most consumed cereals food apart from bread, because they are readily available in local shops as ready to eat, convenient and inexpensive food products

containing digestive and dietary principles of vital importance (Kulkarni, 1997). Biscuits are produced as nutritive snacks from unpalatable dough that is transformed into appetizing products through the application of heat in the oven (Olaoye *et al*., 2007).

In Nigeria, ready-to-eat baked products (snacks) consumption is continually growing and there has been increasing reliance on imported wheat (Akpapunam and Darbe, 1999). In Nigeria, staple crops that are grown other than wheat such as cassava, yam or sweet potatoes and cereals can be used for baked foods (Oluwamukomi *et al*., 2011). The economy of any country importing wheat for the production of baked food such as biscuit would be improved if other staple food like sweet potato that are grown locally are used in producing such products. Therefore, efforts are made to partially replace wheat flour with non-wheat flours as a possibility for increasing the utilization of indigenous crops cultivated in Nigeria as well as contribute to lowering cost of bakery products (Ayo and Gaffa, 2002). Horsfall Mepba *et al.* (2007) stated that many researchers have studied the physical and baking properties of composite biscuits from starchy staples like cassava, cocoyam and plantain. Oluwole and Karim (2006) produced biscuit from various blends of Bambara, cassava and wheat flours respectively.

Sweet potato is a member of the Convolvuaceae family, and it is a dicotyledonous root vegetable plant with large starchy, sweet-tasting, tuberous roots. Besides the tubers, the young leaves and shoot are also consumed sometimes as greens. Sweet potato (Ipomoea batatas) is the only member of the over 1,000 species of the Convolvuaceae family and the approximately 50 genera that is of significant importance, some others are used locally, but many are actually poisonous**.** Potato is the world's most widely grown tuber crop and the fourth largest food crop in terms of fresh produce after rice, wheat, and maize (Khaliduzzaman *et al*., 2010). The potato has potentials for a beneficial role in world food production, owing to its status as a cheap and plentiful crop, which can be raised in a wide variety of climates and locales (Wade, 2008). Sweet potato contain complex carbonhydrate, beta-carotene (a provitamin A carotenoid), manganese, vitamin C, vitamin B6, dietary fiber and potassium. Pink, yellow and green varieties are also high in beta-carotene.

Importation of wheat flour has led to high cost of production of baked products like Biscuits. Inadequate wheat is grown locally to meet the demand of industries that uses wheat in making baked foods. Sweet potato is abundantly produced in Nigeria, as a result unconsumed potato are lost due to lack of post harvest storage facilities. Sweet potato is one of the under-utilized crop in Nigeria despite its high nutrition value. Sweet potato farmers are not encouraged; because of lack of patronage from industries that are supposed to be the strength of sweet-potato market.

The objective of this work is to produce Biscuit from Wheat-Sweet potato composite flour and to determine the Nutritional, Functional and Sensory properties of Biscuit produced from Wheat-Sweet Potato composite flour.

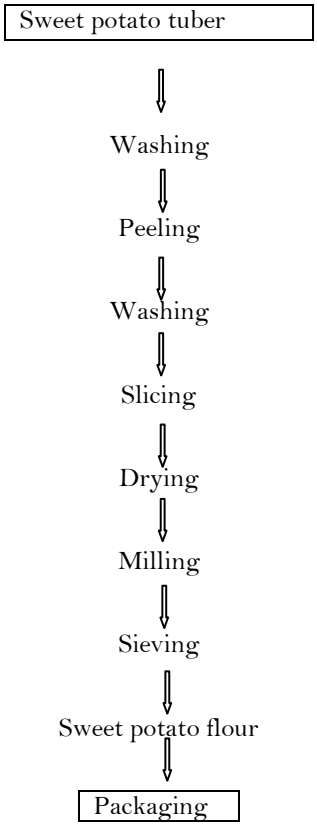
2. MATERIALS AND METHODS

2.1. Preparation of Sweet Potato Flour

The sweet potatoes tubers were purchased from Apata market in Ibadan and the potato skin were peeled off from the tuber, the edible portion of the sweet potatoes were washed in clean tap water, before they were sliced into pieces and sun dried. After two weeks of sun drying, the dried potatoes chips were milled into sweet potato flour and the sweet potato flour were sieved to obtain fine flour and stored in plastic containers with lids in a refrigerator from where samples were drawn for Biscuits preparation. Wheat flour was purchased from local shop where they are sold and were stored in plastic containers with lids in a refrigerator.

2.2. Preparation of Biscuits

Fig-1. Flow chart of sweet potato flour preparation



Sweet potato flour was incorporated into the traditional recipe to replace refined wheat flour at different ratios (100:0, 90:10, 70:30, 60:40 and 50:50) in preparation of biscuits. Biscuits were produced from the five formulations using the method described by Whitley (1970) as shown in Table 3. All the ingredients were weighed accurately. The pre-weighed flour, sugar, salt and baking powder were mixed thoroughly. Then shortening and egg were added and mixed properly to make adequate dough and then the dough was rolled to a uniform sheet of thickness. The sheet

was cut according to the desired shape and size of biscuits with a cutter and baked in the oven, after baking the biscuits were allowed to cool for 30 minutes and the biscuits were stored in airtight plastic container before further analysis. Preparation of biscuit samples were carried out in food processing laboratory of Nutrition and Dietetic department of Federal University of Agriculture, Abeokuta. Analysis was carried out in the central laboratory of Institution of Agricultural Research and Training, Ibadan.

In all the tables, A represents biscuits produced from 100% wheat flour biscuits, B represents biscuits produced from 90% wheat and 10% potato flour, C represents biscuits produce from 70% wheat and 30% potato flour, D represents biscuits produced from 60% wheat and 40% potato flour and E represents biscuits produced from 50% wheat and 50% wheat flour.

A = 100: 0 ratio of wheat-potato flour in biscuits

B = 90: 10 ratio of wheat-potato flour in biscuits

C = 70: 30 ratio of wheat-potato flour in biscuits

D = 60: 40 ratio of wheat-potato flour in biscuits

E = 50: 50 ratio of wheat-potato flour in biscuits

Table-1. Recipe for all biscuit produced

Ingredients	Samples (g)				
	A	B	C	D	E
Wheat	100	90	70	60	50
Potato flour	0	10	30	40	50
Powdered sugar	30	30	30	30	30
Shortening	15	15	15	15	15
Milk powder	5	5	5	5	5
Soybean oil	10	10	10	10	10
Salt	0.5	0.5	0.5	0.5	0.5
Baking powder	1.5	1.5	1.5	1.5	1.5
Egg	30	30	30	30	30

Source: Whitley (1970)

3. LABORATORY ANALYSIS

The biscuits produced were milled to get fine evenly distributed particles and stored in plastic containers with lids in a refrigerator from where samples were drawn for laboratory analysis.

3.1. Proximate Analysis

The proximate value (protein, moisture, crude fibre, fat, ash and carbohydrate) of the biscuits samples were determined using the method that was described by AOAC (1995).

3.2. Mineral Analysis

Mineral (calcium, potassium, zinc, phosphorus, iron, magnesium and sodium) contents of biscuits samples were determined as described by AOAC (1995). The samples were digested in

concentrated HNO3. The digest was quantitatively transferred to a 25 ml volumetric flask with deionized water and made up to volume with deionized water. A blank digest was carried out in the same way.

3.3. Functional Properties

Pasting properties was determined using rapid visco analyzer. 2.5g of wheat sweet potato composite were weighed into a dried empty canister; then 25 ml of distilled water was dispensed into the canister containing the sample. The suspension was mixed thoroughly and the canister was fitted into the rapid visco analyzer. Each suspension was kept at 50 ^{0}C for 1 min and then heated up to 95 at 12.2 ^{0}C min-1 and held for 2.5 min at 95 ^{0}C. It was then cooled to 50 at 11.8 ^{0}C min-1 and kept for 2 min at 50 ^{0}C.

Water Absorption Capacity: 15 ml of distilled water was added to 1 g of the wheat-sweet potato composite in a weighed 25 ml centrifuge tube. The tube was agitated on a vertex mixer for 2 min. It was centrifuged at 4000 rpm for 20 min. The clear supernatant was decanted and discarded. The adhering drops of water was removed and then reweighed. Water absorption capacity is expressed as the weight of water bound by 100 g dried flour.

Bulk density: 50 g wheat-sweet potato flour sample was put into a 100 ml measuring cylinder. The cylinder was tapped several times on a laboratory bench to a constant volume. The volume of sample is recorded.

$$\text{Bulk density (g/cm}^3\text{)} = \frac{\text{Weight of Sample}}{\text{Volume of sample after tapping}}$$

3.4. Sensory Evaluation

Sensory evaluation of the biscuits samples was carried out by a team of ten (10) panelists. The panelists were instructed to evaluate the coded samples for Taste, Colour and Overall acceptability. Each sensory attribute was carried out, with panelist adopting the multiple comparison test system. The data gotten from the panelist's evaluation on Taste, Colour and Overall acceptability were analyzed using analysis of variance.

4. RESULTS

Table 2 show the Proximate values of biscuit produced from wheat-potato composite flour. From the results, it was observed that protein content ranged from 4.50g/100g to 8.92 g/100g, the concentration of fat in the biscuits range between 10.90g/100g and 18.93g/100g. The value of ash range between 2.22g/100g and 4.58g/100g, while the value of Crude Fibre ranges from 3.16g/100g to 5.10g/100g), Carbohydrate value ranges between 56.52g/100g and 64.75g/100g.

Table 3 showed the Mineral content of biscuit produced from wheat-potato composite flour. The results reveal that, the value of calcium as recorded in table 5, ranged between 26mg/100g and 28mg/100g, while the value recorded for Magnesium range between 9.60mg/100g and

7.30mg/100g and Potassium range between 6.20mg/100g and 4.60mg/100g respectively. The results also reveal that the value of Iron range between 1.23mg/100g and 3.86mg/100g, while the value of Zinc range between 0.69mg/100g and 1.83mg/100g. The value of Sodium recorded in the biscuits range between 9.773ppm and 11.564ppm, while the value of Phosphorus recorded range and 49.675ppm and 56.322ppm.

Table-2. Proximate value of Wheat-sweet potato flour Biscuits

Nutrient content (g/100g)	A	B	C	D	E
Protein	8.92	8.88	6.84	5.51	4.50
Fat	18.93	16.24	14.25	13.10	10.97
Ash	2.42	4.58	3.11	2.22	2.72
Crude fiber	3.16	3.22	4.98	3.44	5.10
Moisture content(%)	9.34	10.55	11.12	10.96	12.71
Total Carbohydrate	57.23	56.52	59.70	64.75	64.00

Table-3. Mineral content of biscuit produced from wheat-sweet potato flour composite

Components(mg/100g)	A	B	C	D	E
Ca	26.20	28.10	27.20	27.60	27.90
Mg	7.30	9.60	8.00	7.80	8.40
K	4.60	6.20	6.00	5.10	5.80
Fe	3.83	3.86	2.98	1.23	1.99
Zn	1.83	1.79	1.14	0.69	1.02
P(ppm)	49.675	56.322	50.654	50.023	52.694
Na(ppm)	9.773	11.089	11.109	11.564	10.732

Table 4 presented the result of Functional properties of wheat-sweet potato composite flour mixed. The results showed that, the value recorded for Bulk Density ranged from 0.7407g/cm^3 to 0.9091g/cm^3 with the highest value seen in flour mixture of ratio 100:0 wheat-potato composite flour, while the lowest value was recorded in flour mixture of ratio 60:40 wheat-potato composite flour.

Water Absorption Capacity values ranged between 1.88g/g and 2.41g/g, the sample with ratio 100:0 wheat-potato flour recorded the highest Water Absorption Capacity, while the mixed of ratio 60:40 has the lowest Water Absorption Capacity. The pasting properties of Biscuits produced from wheat-potato composite flour are shown in Table 5. Peak viscosity ranged from 366.83RVU to 407.50 RVU (Relative Visco-Analyser Unit).

The values recorded for Trough are between 236.33RVU to 291.08RVU, while the values recorded for Breakdown ranged between 54.67 RVU to 89.08 RVU. Final Viscosity ranged from 286.33 RVU to 329.25 RVU, values recorded for Setback ranged from 70.33 RVU to 107.58 RVU, Peak Time values ranged from 7.50mins to 8.89mins, and Pasting Temperature values ranged between 68.35 and 91.40 ^{0}C. Table 6 shows the mean values for Sensory evaluation on Taste, Colour and Overall acceptability of biscuits prepared from wheat-sweet potato composite and 100% wheat biscuits.

The mean values of the results of evaluation by panelist were analyzed statistically to assess the significant difference among the five biscuits that were produced. The results reveal that biscuits of ratio 100:0 are not significantly different in taste from biscuits produced from ratio 90:10 and ratio 70:30, there were no significant difference in colour and overall acceptability in all samples.

Table-4. Functional properties of Wheat-sweet potato flour

	Bulk density (g/cm^3)	Water absorption Capacity (g/g)
A	0.9091	2.41
B	0.8696	2.22
C	0.7692	2.01
D	0.7407	1.88
E	0.8333	2.22

Table-5. Pasting properties of wheat-sweet potato flour composite Biscuits

	Peak (RVU)	Trough (RVU)	Breakdown (RVU)	Final Viscosity (RVU)	Setback (RVU)	Peak Time (min)	Pasting Temp (^{0}C)
A	380.67	273.00	54.67	286.33	70.33	7.50	68.85
B	407.50	291.08	59.33	329.25	95.17	8.93	91.40
C	376.86	291.01	64.64	298.42	97.67	7.62	70.02
D	371.39	248.89	78.82	292.69	101.43	7.75	69.87
E	366.83	236.33	89.08	286.92	107.58	7.89	68.35

Table-6. Mean value of sensory evaluation on Taste, Colour and Overall acceptability of biscuit produced from wheat-sweet potato composite

	A	B	C	D	E
Taste	3.2^a	4.5^{ab}	4.4^{ab}	6.3^b	6.0^b
Colour	2.8^a	3.2^a	3.0^a	3.6^a	4.0^a
Overall Acceptability	3.2^a	3.0^a	3.8^a	4.1^a	4.7^a

Mean values bearing the same superscript in the same row are not significantly different ($p \geq 0.05$), while mean values bearing different superscript in the same row are significantly different ($p \leq 0.05$).

5. DISCUSSION

The protein content as revealed by the results showed that protein ranges from 4.50g/100g to 8.92 g/100g. The result revealed that, biscuits produced from ratio 100:0 wheat-sweet potato flour has the highest protein content, with the amount of protein decreasing as the quantity of potato flour increases. This may be because of the fact that raw wheat contains more protein than raw potato. This result is in line with the work of Khaliduzzaman *et al.* (2010) which states that wheat flour contains more protein than potato flour. The concentration of fat in the biscuits ranged between 10.90g/100g and 18.93g/100g, with highest concentration of fat (18.93g/100g) seen in biscuits produced from ratio 100:0 wheat-potato flour. This result showed that fat concentration decreases as the quantity of potato flour increases, this result is in agreement with

the work of Idowu *et al.* (1996) which stated that the nutritional qualities decreases as the level of starchy staples increases. However, biscuits with reasonable concentration of fat were produced from all ratios of wheat-sweet potato composite flour. The value of ash ranged between 2.22g/100g and 4.58g/100g, with the highest value (4.58g/100g) seen in biscuits produced from 90:10 ratio of wheat-potato flour, and lowest value of ash was recorded in biscuits made from ratio 60:40 wheat-potato composite flour. The ash content of food material could be used as an index of mineral constituents of the food because ash is the inorganic residue remaining after the water and organic matter have been removed by heating in the presence of an oxidizing agent (Sanni *et al.*, 2008). The value of crude fiber (3.16g/100g to 5.10g/100g) increases as more potato flour is added to wheat flour in biscuit production. The highest value (5.10g/100g) of crude fiber was seen in biscuits produced from ratio 50:50 wheat-potato flour. These results suggest that potato flour has more crude fibre than wheat flour. Biscuits made from ratio 50:50 wheat-sweet potato flour recorded the highest value (12.71%) of moisture; the lowest moisture content (9.34%) was recorded in biscuit made from 100:0 ratio of wheat-sweet potato composite flour. There was increase in moisture as more potato flour is added to wheat flour; this result is in agreement with the work of (Khaliduzzaman *et al.*, 2010) when he supplemented wheat flour with 20% potato flour in making biscuits. Carbohydrate value range between 56.52g/100g and 64.75g/100g; the highest value was recorded in 100:0 ratios of wheat-sweet potato biscuit.

Despite the fact that mineral content of raw wheat are higher than mineral content of raw sweet potato, it was observed from the results that the mineral value of calcium, magnesium, potassium, sodium and phosphorus are higher in biscuits made from ratio 90:10, 70:30, 60:40 and 50:50 wheat- sweet potato composite flour than biscuits made from ratio 100:0 of wheat-sweet potato composite flour. These results suggest that biscuit of good mineral content can be produced when wheat flour is substituted with sweet potato flour.

The bulk density is a reflection of the load the samples can carry if allowed to rest directly on one another. The results showed that flour mixture of ratio 100:0 wheat-sweet potato composite flour has higher value (0.9091g/cm^3) of Bulk Density, while the lowest value (0.7407g/cm^3) of bulk density was recorded in flour mixture of ratio 60:40 wheat-potato composite flour. The particle size and the density of flour or flour mixtures generally affect the bulk density and it is very important in determining the packaging requirement, raw material handling and application in wet processing in the food industry (Adebowale *et al.*, 2008; Ajanaku *et al.*, 2012). Flour of ratio 100:0 wheat-potato composite flour has the highest (2.41g/g) Water Absorption Capacity, and the mixed of ratio 60:40 has the lowest (1.88g/g) Water Absorption Capacity. Flour of ratio 100:0 wheat–sweet potato, has higher affinity for water, which is informed by its lower moisture content 9.34%. This could be indicative of the fact that wheat flour confers high water binding capacity than potato flour, which causes the reconstitution ability and textural properties of dough obtainable from wheat composite flour to be better than that of wheat-sweet potato flour composite. However, wheat-sweet potato flour composites display acceptable binding properties during preparation, which suggest that the combination of wheat-sweet potato composite can be

use in making biscuit. The lose structure of starch polymers causes it to possess high water absorption capacity while products with low value indicates the compactness of such product structure.

One of the most important properties that influence quality and aesthetic considerations in the food industry is the pasting property, and they affect texture and digestibility as well as the end use of starch-based food commodities. Peak viscosity which ranged between 366.83RVU to 407.50 RVU is an index of the ability of starch-based fruits to swell freely before their physical break down (Sanni *et al*., 2006). The Trough value ranges from 236.33RVU to 291.08RVU, with biscuits made from ratio 90:10 wheat-sweet potato flour having the highest value and biscuits made from ratio of 50:50 wheat-sweet potato flour having the lowest value. Trough is the minimum viscosity value in the constant temperature phase of the RVA pasting profile and it measures the ability of the paste to withstand break down during cooling (Adebowale *et al*., 2012). The highest Break Down Viscosity (89.08 RVU) was recorded on biscuit produced from ratio 50:50 wheat-sweet potato composite flour, while biscuits produced from ratio 100:0 wheat-sweet potato composite flour has the lowest breakdown viscosity (54.67 RVU). The Final Viscosity ranged between 286.92RVU and 329.25 RVU with biscuit of ratio 90:10 wheat-sweet potato composite flour having the highest value and biscuits of ratio 50:50 wheat-sweet potato flour having the lowest value (329.25RVU). Final viscosity is commonly used to define the quality of particular starch-based flour, since it indicates the ability of the flour to form a viscous paste after cooking and cooling (Adebowale *et al*., 2012). The setback value ranged between 70.33RVU to 107.58RVU.

There was an increase in setback value as the percentage of sweet potato flour increases in the biscuit. The higher the setback viscosity the lower the retro-gradation of the flour paste during cooling and the lower the staling rate of the product made from the flour (Adeyemi and Idowu, 1990). The Peak time is a measure of the cooking time, and it ranged between 7.50min and 8.93 min, with biscuits produced from ratio 90:10 wheat-sweet potato composite flour having the highest value and biscuits made from ratio 100:0 wheat-sweet potato flour having the lowest value of 7.50min. Pasting temperature ranged from 68.35^{O}C to 91.40°C, and the highest pasting temperature was recorded in biscuits made from ratio 90:10 wheat-sweet potato composite flour. Adebowale *et al*., 2008 stated that a higher pasting temperature is an indication of higher water binding capacity, higher gelatinization tendency and lower swelling property of starch-based flour as a result of high degree of association between starch granules.

The results of Sensory evaluations reveal that biscuits produced from ratio 100:0 wheat-sweet potato composite are not significantly different ($p \geq 0.05$) in taste from biscuits made from ratio 90:10 and 70:30 wheat-sweet potato composite flour, but there was significant difference ($p \leq 0.05$) in taste between biscuits made from ratio 100:0 and biscuits produced from ratio 60:40 and 50:50 wheat-sweet potato composite flour. The results of the evaluation also reveal that there were no significant ($p \geq 0.05$) difference in colour and overall acceptability between biscuits produced from ratio 100:0 wheat-potato composite flour and biscuit made from ratio 90:10, 70:30,

60:40 and 50:50 wheat-potato composite. During evaluation, most of the panelist shown that biscuits made from ratio 100:0 and 90:10 are more acceptable, when they where ask to comment freely on the products, however, no significant differences was seen when the results were analyzed statistically.

Chinma *et al.* (2012) got a similar result in his sensory evaluation when he used unripe plantain to supplement wheat flour in the production of cookies; these results suggested that wheat flour could be supplement with other staple food samples in the production of biscuits and other baked food.

6. CONCLUSION

This research work was carried out in order to test for the nutritional, functional and sensory qualities of wheat-potato composite biscuits. The use of potato in supplementing wheat flour in biscuit production has significant benefits in countries where inadequate wheat is grown. Therefore, incorporation of sweet potato flour in biscuit production will reduce the quantity of wheat that will be imported, thereby reducing the cost of production of biscuits. Supplementing wheat with sweet potato flour in biscuits production will reduce over reliance on the use of wheat flour in biscuits production and other baked products, and it will enhance the utilization of sweet potato in the Nigeria. If wheat importation is reduced, and attention is given to potato farming, it will help strengthen the economy of the nation and provide income to farmers. A substantial amount of potato is spoiled and wasted due to inadequate cold storage facilities and insufficient post-harvest handling facilities in many developing countries. The experiments produced biscuits of acceptable Nutritional, Functional and Sensory qualities from all ratios of wheat-potato flour that was used; therefore, these research findings have unveil new windows for further utilization of sweet potato.

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