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Proximate and Consumer Acceptability of Biscuits Produced From a Blend of Wheat and Local Sweet Potato Flour

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Abstract: *The purpose of this research was to undertake a proximate composition and sensory evaluation of biscuits made from a blend of wheat and local sweet potato flour. Fifty (50) untrained respondents from the Bolgatanga municipality were used for the sensory. Data were analyzed into frequencies, percentages and cross-tabulation tables as well as one-way analysis of variance using Statistical Package for Social sciences (SPSS 22). The result of the nutritional composition of the biscuits revealed a high percentage content of fat (15.57-29.59%), moisture (1.64-34%) and ash (1.40-2.30%). However, carbohydrate and protein levels reduced from (0.60-0.32%) and (69.01-48.86%) respectively. Findings revealed that the p-value was 0.929, which is greater than the significance level of 0.05. Since there was no observation of the significant difference among the three products, Tukey and post hoc test were used to ascertain the findings. The research concludes that biscuit product made of 100% wheat flour was highly accepted by the respondents followed by the biscuit prepared using 50% wheat flour and 50% sweet potato flour.*

Keywords: sweet potato flour, composite biscuits, recipe formulation, consumer acceptability, proximate composition,

Contribution/Originality: This study contributes in the existing literature by evaluating the consumer acceptability of wheat-sweet potato composite biscuits.

1. INTRODUCTION

Currently, the formation of phenomenal nourishment is seen as an overall investigation. One of the essential examples toward this new way is the mixing method of wheat flour used in the preparation of pastry products with flours derived from various sources, for example, oats or non-grain plants, vegetables, fruits and oily seeds used to make composite flours. The intention of using composite flours in the bakery industry is to discover an adequate level of developing these flours for formulation properties. These composite flours are applied to cereals and grains to improve upon its nutritional values (Mironeasa et al., 2012).

Biscuits are comprehensively recognized and used in practically throughout the world because of its use as snacks and breakfast and have incredible dietary attributes, a wide extent of tastes and a long lifespan (Turksoy and Özkaya, 2011). It is considered as enjoyable snack which is enhanced with the end-product from the winery industry that is rich in bioactive blends. Biscuits are healthy snacks made from different flours with weak gluten content which is developed into dough and baked in a pre-heated oven (Olaoye et al., 2007). The majority of these foods are insufficient in protein and micro nutrients (Akpapunam and Darbe, 1994; Aloba 2001). The formation can be depicted as a mix of flour and water yet contain fat, sugar, and various ingredients mixed together to make dough which is invigorated for a period and thereafter rolled and cut into desirable shapes and baked in the oven (Okaka, 1997).

Customer demand for composite flour based items is increasing because the world population is increasing and individual tastes are also changing, therefore, the use of wheat composite flour products have also increased for the past decades in various part of the world. For climatic reasons many developing countries like Ghana cannot produce its own wheat for the preparation of various flour products. This has caused the country to spend huge sums of monies to import wheat into the country.

Sweet potato is referred to as *Convolvulaceae* and is one of the most significant nourishment crops on the planet. It ranks seventh position in the globe after wheat, rice, maize, potato, grain and cassava (Zuraida, 2003). In 2011, the annual world production of this tuber was 105.1 million tons (Mt). China is the greatest cultivator of sweet potatoes, giving about 70% of the world's ranking (FAOSTAT, 2011). Sweet potato (*Ipomoea batatas*) is a versatile and excellent vegetable that has high dietary benefit (Mohanraj and Sivasankar 2014). Among the world's huge nourishment crops, sweet potato produces the most excellent proportion of consumables per hectare (Sukhcharn et al. 2008). It involves about 70% sugars (dry reason) of which a huge part is starch, which can be utilized as a helpful ingredients in certain preparations (Avula 2005). The sweet potato has opportunities for a valuable job in word's production, inferable from its status as modest and bounteous yield, which can be raised up in a in variety of climate and

locales (Swim, 2008). Sweet potatoes contain complex starch, beta-carotene (a provitamin A carotenoid), manganese, supplement C, supplement B6, dietary fiber and potassium.

Greater part of the tubers grown in Ghana goes waste in light of poor storage conditions. Notwithstanding the attributes or qualities of sweet potato, its use by the Ghanaians is on the low side regardless of its being readily available during certain seasons. This situation has realized high postharvest losses which fill in as a disincentive to the ranchers. There is therefore, the need to enhance the local sweet potato production to make it increasingly alluring and furthermore boosts up patronage by transforming and using it in composite flour so that it can be used on multi-purpose basis other than solely cooking or frying it. To this effect the objective of the paper was to evaluate the consumer acceptability of biscuits made of wheat and sweet potato flour blends.

2. MATERIALS AND METHODS

Preparation of Sweet Potato Flour

The sweet potatoes tubers were purchased from Sumbrungu market in Bolgatanga Municipal. 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 oven dried at 60^{o}C, the dried potatoes 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.

2.1 Formulation of Composite Flour and other Ingredients for biscuits Production

Three different samples of biscuits were produced and coded as A, B and C. Sample A served as the control, containing 100% wheat flour. Samples B and C consisted of wheat and sweet potato flours. The control sample of biscuits (A) was prepared using only wheat flour (100%). Sample (B) was produced using 50% wheat flour, and 50% local sweet potato flour. Sample (C) was prepared using 60% of wheat flour and 40% sweet potato flour.

Table 1: Recipe Formulation

INGREDIENTS	A	B	C
Wheat flour (soft) (%)	100	50	60
Sweet Potato flour (%)	0	50	40
Margarine (g)	40	40	40
Sugar (g)	40	40	40
Vanilla essence (ml)	3	3	3
Salt (g)	0.5	0.5	0.5
Baking powder (g)	1	1	1
Milk Powder (g)	2	2	2
Water (ml)	15	15	15

2.3 Method of preparation

Sweet potato flour was incorporated into the traditional recipe to partially replace refined wheat flour at different ratios (100:0, 50:50 and 60:40) in preparation of biscuits. Biscuits were made from the three preparations using the method described by Whitley (1970) with minor modifications. All the ingredients were weighed accurately. First, the pre-weighed flour, and margarine were rubbed together to resemble fine bread crumbs. Baking powder was added to the mixture and thoroughly mixed evenly. Sugar, salt and were mixed thoroughly before adding the milk powder. A whole egg was whisked and incorporated into the dissolved sugar and the mixture was incorporated into the flour and mixed properly to make adequate dough. 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 at temperature of 240^{o}C for 15-20 minutes, after baking the biscuits were allowed to cool for 20 minutes and were stored in airtight plastic container before further analysis. Preparation of biscuit samples were carried out in food processing laboratory of Kwame Nkrumah University of Science and Technology.

2.4 Proximate composition

The proximate composition of the biscuits was determined using the method adopted by (AOAC, 2010).

2.5 Sensory Analysis

The sensory attributes such as texture, colour, taste, flavour and overall acceptability were evaluated by fifty (50)-member panels. Ranking test was used to evaluate the perceptible differences in intensity of an attribute among samples. Samples were presented in identical disposable plastic dishes, coded with 3 - digit random numbers. Each sample was given a different code number. All the samples were simultaneously presented to each panelist in a balanced or random order. Untrained panelists were asked to rank the coded samples for the intensity of a specific characteristic, by ordering the samples from the most intense to the least intense. The panelists were allowed to re- evaluate the samples necessary to make the required comparisons among them.

2.6 Data Analysis

The data from the respondents were analyzed to enable discussions to be made on the subject. The results were presented in charts and tables. Statistical package for social sciences (SPSS version 22) software design was utilized to carry out the analysis using the (ANOVA) to determine the critical degree of all parameters that were estimated. Tukey Test was employed to discover where the significant disparity of the considerable number of tests in every parameter lies. The means were separated by Least Significant Difference (LSD) Test.

3. RESULTS AND DISCUSSIONS

3.1 Proximate Composition of the composite biscuits

Table 2: Results for proximate analysis

Products	Moisture%	Ash%	Fat%	Protein%	Carbohydrate%
Product A	2.83±0.04	1.40±0.14	26.49±0.39	0.32±0.00	69.01±0.22
Product B	34.00±0.23	1.81±0.04	15.57±1.05	0.60±0.13	48.86±1.38
Product C	1.64±0.01	2.30±0.04	29.59±2.24	0.37±0.01	66.11±2.18

Product A-(100% wheat and 0% sweet potato); Product B-(50% wheat and 50% sweet potato); Product C-(30% wheat and 70% sweet potato)

The biscuit samples B and C had moisture content of 34.00% and 1.64 as compared to the control sample of 2.83%. The high moisture content has been related with short timeframe of realistic usability of composite potato flour as they support microbial multiplication that stimulates decay (Chiejina and Ukeh, 2012). Again, the percentages of ash in the biscuits stood at 1.40% for product A; 1.81% for product B and 2.30 for product C. it can be seen from this that the content of ash in the biscuit samples has been raised and this could be as a result of the blends of wheat and potato flour used. This increase is in line with the findings by (Woolfe, 1992; Antonio et al., 2011) that the increase in the ash enhances the products mineral elements. The fat absorption was between the range of 26.49% and 29.59%; with most remarkable concentration of fat (29.59%) seen the biscuit produced using proportion 30:70 wheat and potato flour. This outcome demonstrated that fat substance decreases as the amount of potato flour increases. The control sample (A) had fat substance of 26.49% while product (B) had the most reduced fat. The high fat substance of the composite flour can influence the rack steadiness of the product (Weiss, 2000; Potter and Hotchkiss, 2006). The protein content as appeared by the outcomes uncovered that protein ranges from 0.32% to 0.37%. The result shows that, biscuit delivered from proportion 30:70 wheat and potato flour have the most important protein content, with the measure of protein lessening as the amount of potato flour diminishes. This might be because of the way that when potato flour is added to wheat flour its protein content raises. This examination affirms the finding by (Bennion and Scheule 2008), that rare wheat has low degree of protein content. The starch content were high in product A (69.01%) and product C (66.11%). Product B had the most reduced substance of 48.86%. The low starch was because of combining the potato flour 70% and wheat flour of 30%.

Table 3: Descriptive statistics of proximate analysis

	N	Mean	Std. Deviation	Minimum	Maximum
Moisture	3	12.8233	18.34918	1.64	34.00
Ash	3	1.8367	.45059	1.40	2.30
Fat	3	23.8833	7.36452	15.57	29.59
Protein	3	.4300	.14933	.32	.60
Carbohydrate	3	61.3267	10.89338	48.86	69.01
Total	15	20.0600	24.61372	.32	69.01

In the current study, panelists rated the various proximate analysis between 0.43 to 23.8833, with respect to moisture, ash, fat, protein and carbohydrate, fat rated as the carbohydrate followed by fat, moisture, ash and protein. Similarly to this findings further revealed that product protein has the least variation among the proximate analysis and moisture has wider variability.

Table 4: **Test of Homogeneity of Variances**

Levene Statistic	df1	df2	Sig.
8.482	4	10	.003

From table 4, it is clear that the variance across proximate analysis of the moisture, ash, fat, protein and carbohydrate, are statistically significant and this implies that the combination of proximate analysis differs. This means that Homogeneity of Variances assumption is not met, and therefore Robust Tests of Equality of Means table need be described in ANOVA

Table 5: ANOVA

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	7462.055	4	1865.514	18.296	.000
Within Groups	1019.639	10	101.964		
Total	8481.695	14			

Source: Field work, 2020

This is the table that shows the output of the ANOVA analysis and whether there is a statistically significant difference between proximate analysis means. We can see that the significance value is 0.000 (i.e., $p = .000$), which is below 0.05 and, therefore, there is a statistically significant difference in the mean of the proximate analysis on moisture, ash, fat, protein and carbohydrate. This is great to know, but we do not know which of the specific proximate analysis that differed. Luckily, we can find this out in the Multiple Comparisons table which contains the results of the Tukey and post hoc test. Details are shown in table 6

Table 6: **Robust Tests of Equality of Means**

	Statistic[a]	df1	df2	Sig.

Welch	25.551	4	4.188	.003
Brown-Forsythe	18.296	4	3.987	.008

Source: Field work, 2020

Table 7: **Multiple Comparisons**,

	(B) samples	(C) samples	Mean Difference (B and C)	Std. Error	Sig.
LSD	moisture	Ash	10.98667	8.24475	.212
		Fat	-11.06000	8.24475	.209
		Protein	12.39333	8.24475	.164
		Carbohydrate	**-48.50333***	**8.24475**	**.000**
	Ash	Moisture	-10.98667	8.24475	.212
		Fat	-22.04667*	8.24475	.023
		Protein	1.40667	8.24475	.868
		Carbohydrate	**-59.49000***	**8.24475**	**.000**
	Fat	Moisture	11.06000	8.24475	.209
		Ash	**22.04667***	**8.24475**	**.023**
		Protein	**23.45333***	**8.24475**	**.017**
		Carbohydrate	**-37.44333***	**8.24475**	**.001**
	protein	Moisture	-12.39333	8.24475	.164
		Ash	-1.40667	8.24475	.868
		Fat	-23.45333*	8.24475	.017
		carbohydrate	-60.89667*	8.24475	.000
	carbohydrate	Moisture	48.50333*	8.24475	.000
		Ash	59.49000*	8.24475	.000
		Fat	37.44333*	8.24475	.001
		Protein	60.89667*	8.24475	.000

* The mean difference is significant at the 0.05 level.

Table 7 shows that there are variances among the moisture, ash, fat, protein and carbohydrate contents in the biscuits. Multiple Comparisons shows which of the proximate analysis is different from the other. The Tukey post hoc test is generally the preferred test for conducting post hoc tests on a one-way ANOVA. We can see from the table that there is a statistically significant difference among the proximate exploration regarding the moisture, ash, fat, protein and carbohydrate content (p = 0.000), as well

as between the carbohydrate and moisture, ash, fat, protein (p = 0.000). However, there were no differences between moisture, ash, fat and protein (p = 0.212, .209 and 0.164).

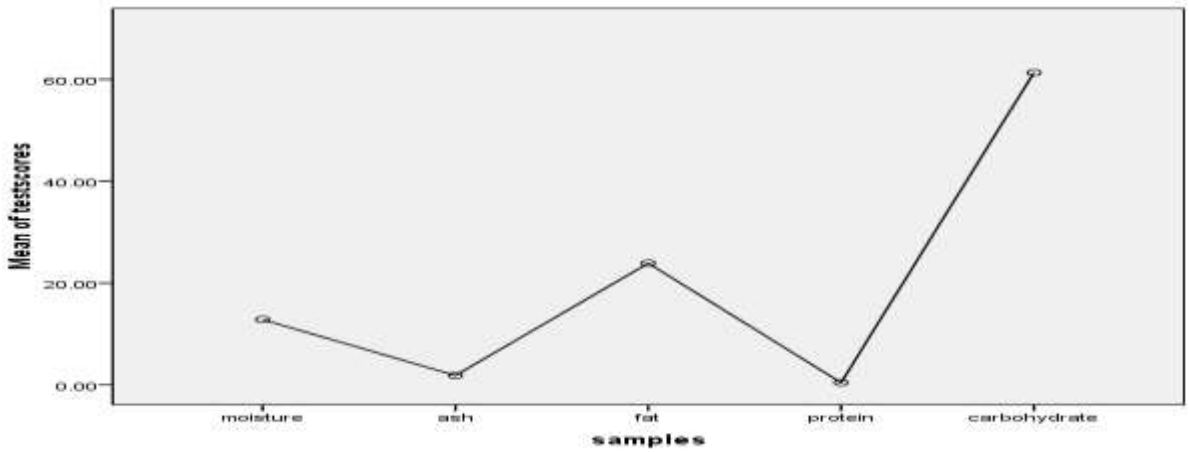

Figure 1: mean plot proximate analysis

From figure 1, it appears that carbohydrate has the highest mean rating and this implies that the amount of carbohydrate present in the proximate analysis is high as compare to the rest of the proximate attributes. This implies that majority of the consumers had accepted food product that contains energy.

3.2 Further Analysis on the three Proximate Products

The researchers further conducted a study to investigate whether there is statistically significant different among the three products. This means that the researcher wants to know whether the three biscuits products differ in term of the ingredients used in the preparation processes

Table 8: Summary statistics and ANOVA

Groups	*Count*	*Sum*	*Average*	*Variance*
A	5	100.05	20.01	868.0428
B	5	100.84	20.168	438.9049
C	5	100.01	20.002	813.4542

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.08764	2	0.04382	6.2E-05	**0.999938**	3.885294
Within Groups	8481.607	12	706.8006			
Total	8481.695	14				

Source: Field work, 2020

In the current study, panelists rated the various biscuits products between 20.002 to 20.168, analysis with respect to A, B and C where product B was rated as the best followed by A and C. From the hedonic scale, product B was rated like extremely whiles the rest was rated like very much. The B was significant different from the rest of the products. Similarly, these findings further revealed that product B has the least variation among the ingredients used in the preparation processes and C has wider variability. The ANOVA further revealed that there is no statistically significant difference among three products being tested in the proximate analysis. This implies that multiple comparisons were not appropriate because no significant difference observed among the three products.

Table 9: Sensory Properties of the Biscuits Produced

Samples	Colour	Aroma	Texture	Taste	Level of acceptability
A	4.18±1.04	3.80±1.21	3.68±1.32	3.82±1.24	4.8±0.40
B	3.02±1.40	3.32±1.50	3.38±1.37	3.54.84±1.53	3.08±1.07
C	3.70±1.19	3.10±1.22	2.84±1.24	3.54±1.37	2.96±1.14
LSD	1.138	0.80	0.924	0.859	0.875

Source: Field work, 2020

The biscuit produced from 100% wheat flour had the most significant score for texture, while the one made of 70% replacement of potato flour had the least score for texture. Regarding the smell and colour, a substantial variance of ($p < 0.05$) was seen in the aroma and colour in the biscuits made from the composite flour blends of wheat and sweet potato flour. The colour and aroma of the three biscuit samples were 3.70 to 4.18% and from 3.10 to 3.80 respectively. This means that the biscuit prepared using 100% wheat flour had the most remarkable score for both aroma and colour, while the one made of 70% replacement of sweet potato flour had the least score for aroma and taste.

In the same way, the flavour of the composite biscuits ranged from 3.54 to 3.82, with the biscuit prepared from 100% wheat flour having the most important taste, while the biscuit made with 30% and 70% replacement of composite flour (wheat and sweet potato flour) had the least taste score. The general agreeableness went from 2.96 to 4.8. The biscuit made of 100% wheat flour was generally liked while the 70% replacement was least desired. In light of the considerable number of replacements for composite biscuits, the expansion of sweet potato flour was accepted. In this way, the combination of sweet potato flour up to (50%) could be commendable for biscuits preparation.

Table 10: descriptive statistics of the sensory attributes

Test scores

	N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Product A	5	4.0560	.45594	.20390	3.68	4.80
Product B	5	3.2680	.21568	.09646	3.02	3.54
Product C	5	3.2280	.37379	.16716	2.84	3.70
Total	15	3.5173	.51801	.13375	2.84	4.80

Source: Field work, 2020

In the current study, panelists rated the various sensory attribute between 3.2280 to 4.0560, with respect to product A, product B and product C. Product A was rated as the best followed by product B and product C. Similarly, these findings further revealed that product B has the least variation among the sensory attributes and product A has wider variability.

Table 11: Test of Homogeneity of Variances

Levene Statistic	df1	df2	Sig.
1.527	2	12	.257

From table 11, it is clear that the variance across the three products with respect to ingredients used in preparation processes is statistically not significant and this implies that the three products have same or similar ingredients. This means that Homogeneity of Variances assumption is met for the three products and ANOVA is appropriate in this study. Below is the ANOVA table

Table 12: ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.180	2	1.090	8.298	.005
Within Groups	1.576	12	.131		
Total	3.757	14			

Source: Field work, 2020

Table 12 shows the output of the ANOVA analysis and whether there is a statistically significant difference between the three products means. We can see that the significance value is 0.000 (i.e., p = .000), which is below 0.05 and therefore, there is a statistically significant difference in the means of the three products with respect to ingredients used in the preparation processes. This is great to know, but we do not know which of the specific three products that differed. Luckily, we can find this out in the Multiple Comparisons table which contains the results of the Tukey and post hoc test below

Table 13: **Multiple Comparisons**

	(I) product	(J) product	Mean Difference (I-J)	Std. Error	Sig.
Tukey HSD	Product A	Product B	.78800*	.22924	.013
		Product C	.82800*	.22924	.009
	Product B	Product A	-.78800*	.22924	.013
		Product C	**.04000**	**.22924**	**.983**
	Product C	Product A	-.82800*	.22924	.009
		Product B	**-.04000**	**.22924**	**.983**
LSD	Product A	Product B	.78800*	.22924	.005
		Product C	.82800*	.22924	.004
	Product B	Product A	-.78800*	.22924	.005
		Product C	**.04000**	**.22924**	**.864**
	Product C	Product A	-.82800*	.22924	.004
		Product B	**-.04000**	**.22924**	**.864**

*. The mean difference is significant at the 0.05 level.

From table 13, we know that there are statistically significant differences between the three products with respect to the ingredients used in the preparation processes as a whole. The Multiple Comparisons show which of the three products that differed from each other. The Tukey post hoc test is generally the preferred test for conducting post hoc tests on a one-way ANOVA. The table reveals that there is a statistically significant difference among the three products with respects to ingredients used in the preparation processes (p = 0.000), as well as between the product A, product B and product C (p = 0.000). However, there were no statistical significant differences between product B and product C (p = 0.864).

3.3 Further analysis on sensory attributes of the composite biscuits

The researchers further conducted study to investigate whether there is statistically significant different among the five products. This means that the researcher wants to know whether the five biscuits products differ in term of the ingredients used in the preparation processes. The descriptive table (see below) provides some very useful descriptive statistics, including the mean,

standard deviation and 95% confidence intervals for the dependent variable (biscuits) for each separate group (A, B and C), as well as when all groups are combined (Total).

Table 14: Descriptive statistics of the sensory attributes of the composite biscuits

	N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Colour	3	3.6333	.58287	.33652	3.02	4.18
Aroma	3	3.4067	.35796	.20667	3.10	3.80
Texture	3	3.3000	.42568	.24576	2.84	3.68
Taste	3	3.6333	.16166	.09333	3.54	3.82
overall acceptability	3	3.6133	1.02943	.59434	2.96	4.80
Total	15	3.5173	.51801	.13375	2.84	4.80

Source: Field work, 2020

In the current study, panelists rated the various biscuits products between 3.3 to 3.6333 with respect to sensory attributes of the three products; colour and taste were rated as the best followed by overall acceptability, aroma and texture. From the hedonic scale, colour and taste was rated like extremely whiles the rest was rated like very much. The taste was significant different from the rest of the sensory attributes. Similarly, these findings further revealed that taste has the least variation among the ingredients used in the preparation of the sensory attributes and overall acceptability has wider variability.

Table 15: **Test of Homogeneity of Variances**

Levene Statistic	df1	df2	Sig.
3.433	4	10	**.052**

Source: Field work, 2020

From table 15, it is clear that the variance across sensory attributes of the three products with respect to ingredients used in preparation processes is statistically not significant and this implies that the three products have same or similar ingredients. This means that Homogeneity of Variances assumption were met for the three products and detail of the ANOVA table is shown below

Table 16: ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.287	4	.072	.207	.929
Within Groups	3.470	10	.347		
Total	3.757	14			

Source: Field work, 2020

The table 15 shows the output of the ANOVA analysis and whether there is a statistically significant difference between the five biscuits means. We can see that the significance value is 0.929 (i.e., p = .929), which is away greater 0.05 and therefore, there is no statistically significant difference in the mean of the three products with respect to ingredients used in the preparation processes. Since there is observation of the significant difference among the three products then Tukey and post hoc test is not applicable here.

3.4 Conclusion

The research produced biscuits of standard Nutritional and Sensory attributes from all formulations of wheat and sweet potato flour blends used; therefore, these findings have revealed new ways of using sweet potato to prepare variety of other products in order to prevent postharvest losses. Therefore, local sweet potato flour could be incorporated into wheat flour up to 50% without affecting its nutritional values.

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