Nat. Volatiles & Essent. Oils, 2022; 9(1): 1934-1943

NVEO
Natural Volatiles & Essential Oils

# Quality Characteristics And Sensory Evaluation Of Wheat Bread Partially Substituted With Cocoyam And Bambara Groundnuts Flour

**Osei-Agyemang Millicent**

St. Monica's college of Education, Department of Vocational and Technical Education P. O. Box 250, Mampong Ashanti, Ghana.

**Abstract**

The influence of cocoyam and Bambara groundnuts flour substitution on the properties of wheat bread was explored in this study. Five different flour samples were formulated by incorporation of cocoyam and Bambara groundnut flour into wheat flour at varying proportions of 100:0:0; 80:12:8; 70:18:12; 60:25:15 and 50:30:20. One hundred percent (100%) of wheat flour (WF) was used as control. A straight dough method adopted by AACC was used in the production of the various bread samples with minor adjustment. The study employed a nine-point hedonic scale to evaluate the bread samples using twenty panelists. The data were analysed with the Analysis of Variance (ANOVA). Proximate compositions of the various bread samples were determined using AOAC method. The moisture and ash contents of the samples varied from 20.25-67.28% and 0.78-1.45% respectively. Fat and fiber contents of the bread samples were 5.28-7.10 % and 0.60-1.80%. Protein and carbohydrate contents were 11.34-16.38% and 53.65-75.86%. Sensory analysis of the bread samples was also performed on flavour, colour, texture, taste, and overall acceptability. When the cocoyam and Bambara groundnut flour content in the composite bread was increased, the results demonstrated an increase in Ash, fiber, protein, and carbohydrate content. Sensory examination demonstrated significant ($p<0.05$) differences in sensory attributes between the 100% wheat and 70%, 18%, and 12% wheat-cocoyam-Bambara groundnut flour composite bread. This study concludes that using cocoyam and Bambara groundnut flours in bread production is possible and that incorporating composite flours up to 18% and 12% into wheat flour will help improve the bread quality.

**Keywords:** Composite flour, Bambara groundnut, cocoyam, bread, proximate analysis, Sensory evaluation

## Introduction

Bread is a major staple food in many parts of the world, as well as one of the most widely used cereal products (Callejo et al., 2016). Wheat and a few other popular cereal grains are the only grains used to make bread. Wheat flour quality is critical in bread production since wheat (Triticum aestivum L.) is the world's most important cereal crop and the major ingredient in bread making (Manisseri and Gudipati, 2010). Wheat flour is used in bread making because of its gluten, which gives the dough elasticity by causing it to stretch and trap the carbon dioxide created by yeast during fermentation (Mepba et al., 2007). However, because wheat production in tropical nations is limited, wheat flour must be imported to meet local demand (Giami et al., 2007). Wheat is imported by countries with harsh climatic conditions (Aziah et al., 2009). As a result, wheat imports use a large amount of foreign exchange in such importing countries. According to Ojinnaka and Nnorom (2015), many farmers are starting to switch from growing wheat to growing additional profitable crops like cocoyam, Bambara beans, and soybeans, which can serve as industrial and household use. Celiac illness is linked to gluten ingestion, which is found in wheat and wheat-based products and therefore causes this condition in people who are naturally inclined to it (Caio et al., 2019). As a result, using gluten-free cocoyam to make food products would be safe for gluten-free people to eat. In spite of the wheat related issues, there have been studies on the use of various local raw materials in bread manufacturing (Yue et al., 2007). This research found that using 2 to 10% non-wheat flour in bread does not result in adverse changes in bread properties or sensory features.

The edible root crop cocoyam (Colocasia esculenta) is endemic to the tropics, with Ghana being a major producer and it belongs to the Araceae family (Ihekoronye & Ngoddy, 1985). After yam and cassava, cocoyam is the third most important root crop in West Africa (Obomeghevie et al., 1998). Cocoyam has a higher protein and amino acid profile than other tropical root or tuber crops, according to Key (1987), giving it a nutritional edge. Cocoyam granules are small and high in starch, making them easy to digest (Huang et al., 2000). Cocoyam is not used to its full potential; it is only used in soups and a few indigenous dishes as a thickening agent. As a result, its transformation into flour could be useful in the baking industry.

The Bambara groundnut is a Fabaceae vegetable. The leguminous crop (Vigna subterranea (L.) is a semi-dry African native (Adjetey and Sey, 1998), an underutilized auxiliary food crop that is regularly found in Ghana and Nigeria (Atiku, 2000). Ghanaians eat this vegetable cooked and it has potential in horticulture as cover crops, green excrement, and straw since it supplies nitrogen to the soil. Bambara groundnut (Vigna subterranea (L.) is high in carbohydrate and protein (15-27%), with a lot of amino acids, especially lysine and methionine, which are known to be low in cereals and numerous different vegetables (Arise et al., 2017). The beans have the potential to serve as a substitute and provide a balanced diet in areas where animal protein is scarce and the growth of other vegetables is hazardous due to high levels of pesticides. Using native harvests, for example, cocoyam and Bambara groundnut in bread preparation will add to lessening the reliance on wheat flour in numerous non-wheat developing regions. Furthermore, it would likewise add to advancing the appropriateness of the yields as modern unrefined components. The aim of this study, therefore, was to determine the nutritional composition and sensory properties of bread made from wheat flour supplemented with cocoyam and Bambara groundnut composite flour.

## Materials and Methods

### Material Collection

The experiment was conducted at the Mycotoxin and Food Analysis Laboratories, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana, in February, 2020. Fresh cocoyam and Bambara groundnut were obtained from the Kumasi Central Market alongside wheat flour, sugar, salt, yeast, margarine and nutmeg.

### Processing of Cocoyam into Flour

Oti and Akobundu (2007) described a method for processing cocoyam comels into flour. Cocoyam cornels were peeled, sliced, and washed with portable water. The slices were blanched for 15 minutes at 75°C. The blanched slices were oven-dried for 9 hours at 60°C before being milled into flour, which was then sieved to produce flour with a fine texture.

**Preparation of the Bambara groundnut flour**

The flour was treated with minor changes using the method adopted by Mune et al., (2011). Extraneous debris and damaged seeds were removed from Bambara groundnut seeds during sorting. The seeds were then steeped for 24 hours at room temperature. In a moisture extraction oven, it was mechanically dehulled in an attrition mill and dried for 24 hours at 60 degrees Celsius. To make the flour, the dried seeds were finely milled and sieved for their intended purpose.

**Formulation of composite flour**

Five different bread samples were produced from wheat, cocoyam, and Bambara groundnut flour blends in the ratios, 100:0:0, 80:12:8, 70:18:12, 60:25:15, and 50:30:20. The control sample was bread made entirely of wheat flour.

**Table 1: Formulation of ingredients for bread making**

| INGREDIENTS | $T_1$ | $T_2$ | $T_3$ | $T_4$ | $T_5$ |
|---|---|---|---|---|---|
| Strong wheat flour (g) | 100 | 80 | 70 | 60 | 50 |
| Cocoyam flour (g) | 0 | 12 | 18 | 25 | 30 |
| Bambara groundnut flour (g) | 0 | 8 | 12 | 15 | 20 |
| sugar (g) | 12 | 12 | 12 | 12 | 12 |
| Yeast (g) | 10 | 10 | 10 | 10 | 10 |
| Salt (g) | 1 | 1 | 1 | 1 | 1 |
| Margarine (g) | 10 | 10 | 10 | 10 | 10 |
| Nutmeg (g) | 1 | 1 | 1 | 1 | 1 |
| Water (ml) | 100 | 100 | 100 | 100 | 100 |

Values represent means and standard deviation replicate readings for various parameters. Values in the same column with different superscripts are significantly different (p>0.05). Keys: $T_1$(100% wheat flour), $T_2$(80% wheat, 12% Cocoyam and 8% Bambara groundnut flour ), $T_3$ (70% wheat, 18% Cocoyam and 30% Bambara groundnut flour), $T_4$ (60% wheat, 25% Cocoyam and 15% Bambara groundnut flour ), and $T_5$(50% wheat, 30% Cocoyam and 20% Bambara groundnut flour).

**Bread making process**

The straight dough method was used to make bread from composite flours and 100% wheat flour using the (AACC, 2000) method with slight modifications. The following blending ratios were utilised to mix the wheat, cocoyam, and Bambara groundnut flours: 100:0:0, 80:12:8, 70:18:12, 60:25:15, and 50:30:20, with the wheat flour serving as the control. As illustrated in Table 1, the bread was made with a composite flour of cocoyam, Bambara groundnut, wheat, and other ingredients. All the ingredients were manually combined in a bowl with the addition of water to form soft dough, then kneaded and sheared for 15 minutes until uniform dough was made. For 60 minutes, the dough was fermented in a bowl covered with a plain polyethylene bag in a cabinet kept at 27°C and 75% relative humidity. The dough was punched back after 60 minutes to release any trapped oxygen. It was then returned to the cabinet for a second fermentation for 15 minutes. The dough was then taken out of the cabinet and divided into 100 g pieces, molded by hand, proofed for 20 minutes, placed in a greased pan, and baked for 20 minutes at 200°C. The baked bread was then taken out of the oven, allowed to cool, and placed in polyethylene bags for proximate and sensory evaluation.

**Proximate Composition**

The composite bread and control samples' proximate analyses were determined using the AOAC (2000) method. The researcher measured the moisture, ash, fat, crude fiber, crude protein, and carbohydrate (by difference).

### Sensory Analysis

A 9-point hedonic scale ranked 1–9 was used to assess the bread's sensory qualities (1 = very dislike and 9 = extremely like). The evaluation included 20 semi-trained panelists who assessed flavour, colour, texture, taste, and overall acceptability (Iwe 2002). The bread samples were sliced into uniform thickness (2 cm) pieces, coded with single random alphanumeric and served to the panelists in a randomized order with distilled water for mouth rinsing after each sample taste. The panelists were asked to rate the attributes expressing their level of like or dislike.

### Statistical Analysis

The data was subjected to a one-way analysis of variance (ANOVA). The Statistical Package for the Social Sciences (SPSS) version 20 was used to separate the means using Duncan's Multiple Range Test (IBM SPSS Statistics). $P<0.05$ was used as the significance level.

## Results and Discussion

### Proximate compositions of the bread samples

The proximate compositions of the bread samples made from a combination of wheat, cocoyam, and Bambara groundnut flour are shown in Table 2. Moisture content ranged from 20.78% to 27.68%. The highest moisture level (27.68%) was found in bread sample T1 (100% wheat bread), whereas the lowest moisture content was bread sample T5 (50% wheat, 30% Cocoyam, and 20% Bambara groundnut flour) with 20.78%. As the amount of cocoyam and Bambara groundnut flour substituted increased, the moisture content of the bread samples reduced intensely. The moisture content of the control wheat bread (100:0:0) differed substantially from the other bread samples ($P<0.05$). This finding is consistent with that of (Mepba et al., 2007), however it differs from that of (Njintang et al., 2008). Again, the moisture content measured differed considerably ($P >0.05$) from that reported on wheat-yam bread samples by Adebowale et al. (2009). It is possible that the change is due to the inclusion of Bambara groundnut flour.

The ash content was 0.78% for 100% wheat bread (T1) 1.21%, (T2) 1.31%, (T3) 1.38%, (T4) 1.45% and (T5) which showed significance increase in the ash content as the cocoyam and Bambara groundnut flour substitution levels increased. Because of the higher ash content, cocoyam and Bambara groundnut-based bread is more nutrient-dense than wheat-based bread. The larger amounts of ash in cocoyam flour compared to wheat flour could explain the increase in ash content. The control (whole wheat bread) and their composites showed a significant difference ($p<0.05$) in statistical analysis. The mean percentage of fat ranged from 5.28 to 7.10 %, with the control bread sample (100 % wheat) having the highest mean value of 7.10% and the composite bread sample T5 having the lowest fat content (5.28% ). The fat content of the wheat, cocoyam, and Bambara groundnut bread dropped as the composite flour increased (Table 2), which could be attributed to their low fat contents, as described by (Eddy et al., 2007). The control bread sample, which has the highest fat level, is susceptible to rancidity during storage, but the composite bread sample T5 may be less susceptible because of its low fat concentration. High-fat content in food considerably increases the amount of energy required by people. High-fat flours can also be used as flavour enhancers and to improve the palatability of dishes (Aiyesanmi, et al., 1996). The findings revealed a significant difference (p< 0.05) between the whole wheat bread and the composite bread samples.

In line with previous research by Farzana & Mohajan, (2015), fiber content was improved from 0.60 percent to 1.80% in sample T5 by increasing cocoyam and Bambara flour contents by 30% and 20%, respectively. This type of fiber may be present in greater quantities in cocoyam and Bambara flour than in wheat flour. With a p<0.05 significance level, the analysis of variance on all proximate analysis results revealed significant differences between the bread samples. The increase in crude fiber content may be due to the fact that the 100% wheat flour bread had lower fiber content (0.60%) as compared to the wheat, cocoyam, and Bambara groundnut composite flour bread. Fiber is a form of roughage that aids digestion (Marer and Martin, 2003), and it could be used as a supplement in foods that are high in fiber. The percentage of protein in the samples ranged from 11.34 to 16.38% (Table 2). The control bread had the lowest mean value (11.34%) and the highest mean value (16.388%) was composite bread sample T5. In terms of protein content, there was a significant (p<0.05) difference between the bread samples. It was discovered that increasing the quantity of cocoyam and Bambara groundnut flours in the composite bread samples resulted in an increase in protein levels. The increase in protein content of the samples gives the cocoyam and Bambara groundnut products a nutritional benefit and this rise can be connected to the enzymatic protein and microbial activities during bread fermentation and baking (Dubey et al., 2008).

The carbohydrate content varied from 53.65% to 75.86% (Table 2). The carbohydrate content of the control bread samples T1 (53.65%), T2 (70.50%), T3 (71.30%), T4 (73.80%), and T5 (75.86%) increased significantly as the cocoyam and Bambara groundnut flour substitution levels increased, indicating a significant increase in carbohydrate content. Cocoyam and Bambara groundnut-based bread is more nutrient-dense than 100% wheat bread, as seen by the rise in carbohydrate content. Cocoyam includes carbohydrates in the form of starch, according to Onyeike (2008). Blending with cocoyam flours increased carbohydrate content, according to Eddy et al., (2007). In roots and tubers, carbohydrate predominates over all other solid nutrients (Okon et al., 2007).

**Table 2: Proximate composition of the bread**

| **Samples** | **Moisture** (%) | **Ash** (%) | **Fat** (%) | Fibre | **Protein** (%) | **CHO** (%) |
|---|---|---|---|---|---|---|
| **$T_1$** | $27.68^a$ | $0.78^e$ | $7.10^a$ | $0.60^e$ | $11.34^e$ | $53.65^e$ |
| **$T_2$** | $25.40^b$ | $1.12^d$ | $6.31^b$ | 1.05d | $12.35^d$ | $70.50^d$ |
| **$T_3$** | $23.78^c$ | $1.31^c$ | $6.52^c$ | $1.28^c$ | $13.34^c$ | $71.30^c$ |
| **$T_4$** | $23.55^d$ | $1.38^b$ | $5.86^d$ | $1.39^b$ | $13.52^b$ | $73.80^b$ |
| **$T_5$** | $20.25^e$ | $1.45^a$ | $5.28^e$ | $1.80^a$ | $16.38^a$ | $75.86^a$ |

Values represent means and standard deviation replicate readings for various parameters. Values in the same column with different superscripts are significantly different (p>0.05). Keys: $T_1$(100% wheat flour), $T_2$(80% wheat, 12% Cocoyam and 8% Bambara groundnut flour ), $T_3$ (70% wheat, 18% Cocoyam and 30%

Bambara groundnut flour), $T_4$ (60% wheat, 25% Cocoyam and 15% Bambara groundnut flour ), and $T_5$(50% wheat, 30% Cocoyam and 20% Bambara groundnut flour).

**Sensory attributes of the wheat, cocoyam and Bambara groundnut blended bread**

The flavour, texture, colour, and overall acceptability of 100% wheat and composite bread are presented in (Table 3). The flavour of the wheat and supplemented bread ranged from 7.15 to 9.14, with the 100% wheat bread scoring the highest at 9.14, and bread sample T5 scored the lowest at 7.15. There was a statistical difference (p<0.05) between the flavour of the composite bread T2, T3, T4, T5 and the control bread (100% wheat flour). The results of this investigation are consistent with those published by IITA (1995), who positively substituted flour made from 297 genotypes of DAF (D. alata) for good quality bread at a 40% WF replacement. The results differed from those of Balogun et al. (2012), who found that tapioca meal enriched with defatted soy flour had the best organoleptic properties.

The texture of the wheat and composite bread samples varied from 8.11 to 9.26 with the control sample T1 having the highest mean score of 9.26, followed by composite bread sample T2 with 9.14 and the lowest texture (8.11) was for sample T5 (50% wheat, 30% cocoyam and 20% Bambara groundnut flour). The results revealed a statistical difference (p<0.05) between the whole wheat and the composite bread. The texture of the bread manufactured from 100% wheat flour (control) was superior to that of the cocoyam-Bambara groundnut bread samples. The colour of the bread went from 9.25 to 9.48. The bread sample (T1) made of 100% wheat flour had the least colour mean score (9.25), while the bread sample T5 recorded the most remarkable mean score for colour (9.48). The huge expansion in mean colour scores for composites bread at increasing cocoyam and Bambara groundnut replacement levels goes in accordance with the discoveries by Raid and Klein 1983 who noticed that as the degree of non-wheat flour in mixes is expanded, the crust colour of the bread changes from creamy white to dull brown or dim. There was a significant difference (P<0.05) between the control bread sample and the composites.

The bread samples had a taste range of 8.50 to 9.45, with bread sample T3 having the highest mean taste score (9.45) followed by the control bread sample (9.41). At 12% and 18% substitution levels of Bambara groundnut and cocoyam blended flour, the taste of the composite bread was considerably improved (p<0.05). There was no significant difference (p>0.05) between composite bread samples (T2, T3, and T4) and the control (T1) when cocoyam and Bambara groundnut flour were added at 18 and 12% respectively, however, there was a significant difference (P<0.05) between the control (T1) and the T5. In almost all of the sensory tributes tested, the substitution of cocoyam and Bambara flour at levels of 18 and 12% appeared to produce a loaf with acceptable sensory qualities that were comparable to the score of the control bread.

**Table 3: Sensory attributes of the wheat, Cocoyam and Bambara groundnut flour bread**

| Samples | Flavour | Texture | Colour | Taste | Overall Acceptance |
|---|---|---|---|---|---|
| **$T_1$** | $9.14^a$ | $9.26^a$ | $9.30^d$ | $9.41^b$ | $9.40^b$ |
| **$T_2$** | $8.45^b$ | $9.14^b$ | $9.40^b$ | $9.40^b$ | $9.39^b$ |

| | | | | | |
|---|---|---|---|---|---|
| **$T_3$** | $8.30^c$ | $9.13^c$ | $9.48^a$ | $9.46^a$ | $9.46^a$ |
| **$T_4$** | $8.35^d$ | $9.07^d$ | $9.36^c$ | $9.38^b$ | $9.38^b$ |
| **$T_5$** | $7.15^e$ | $8.11^e$ | $8.95^e$ | $8.50^e$ | $8.10^e$ |

Values represent means and standard deviation replicate readings for various parameters. Values in the same column with different superscripts are significantly different ($p>0.05$). Keys: $T_1$(100% wheat flour), $T_2$(80% wheat, 12% Cocoyam and 8% Bambara groundnut flour ), $T_3$ (70% wheat, 18% Cocoyam and 30% Bambara groundnut flour), $T_4$ (60% wheat, 25% Cocoyam and 15% Bambara groundnut flour ), and $T_5$(50% wheat, 30% Cocoyam and 20% Bambara groundnut flour).

## Conclusion

The proximate composition of the composite bread samples revealed a high level of ash, fiber, protein, and carbohydrate content, which is comparable to wheat flour. This recommends that wheat flour might be substituted with up to 18% cocoyam and 12% Bambara groundnut flour to produce bread with good nutritional and sensory properties. The present study concluded that replacing cocoyam and Bambara groundnut flour with wheat at 18% and 12% respectively, enhanced the nutrient content of cocoyam and Bambara groundnut flours, particularly protein, ash, fiber, and carbohydrate, and thus the combination of these raw materials into wheat produced a more nutritionally balanced and acceptable bread that was cheaper and more readily available. The study indicates that cocoyam and Bambara groundnut flour have the potential to boost cocoyam and Bambara groundnut production and expansion in Ghana and other African countries.

## References

**[1].** AACC (2000). International. Approved methods of the American Association of Cereal Chemists. St Paul, MN (USA): American Association of Cereal Chemists;

[2]. AOAC (2000). Association of Official Analytical Chemists, (4th edn), Washington D.C., USA

[3]. Adebowale, Y.A Schwarzenbolz, U. Henle, T. (2011). Protein isolates from Bambara groundnut (Voandzeia subterranean L.): chemical characterization and functional properties. International Journal of Food Properties, 14 (4) (2011), pp. 758 775, 10.1080/10942910903420743

[4]. Adjetey, J.A., & Sey, S. (1998). Assessment of Nitrogen requirement of Bambara groundnut in coastal Savanna ecological zone. Applied Plant Science, 12(2), 36 38

[5]. Aiyesanmi, A. F. and Oguntokun, M. O. (1996). Nutrient composition of Dioclea reflexa seeds an underutilized edible legume: Rivista Italiana delle Sostanze Grasse. Vol. 73 pp. 521–523.

[6]. Arise, A.K. Alashi, A.M. Nwachukwu I.D., Ijabadeniyi, O.A, Aluko, R.E. and Amonsou E.O. (2017). Inhibitory properties of Bambara groundnut protein hydrolysate and peptide fractions against angiotensin-converting enzymes, renin and free radicals. Journal of the Science of Food and Agriculture, 97 (9), pp. 2834-2841, 10.1002/jsfa.8112

[7]. Atiku A.A. (2000). Bambara groundnut processing and storage practices in North Eastern Nigeria. Postgraduate seminar paper, Dept. Agric. Engr., University of Maiduguri, Nigeria.

[8]. Aziah, N. A. A., & Komathi, C. A., (2009). Acceptability Attributes of Crackers Made from Different Types of composite Flour. International Food Research Journal, 16, 479-482

[9]. Balogun M.A., Karim O.R., Kolawole F.L. (2012). Quality attributes of tapioca meal fortified with defatted soy flour. Agrosearch 12: 61–68

[10]. Caio, G., Volta U., Sapone A., Leffler D.A., Giorgio R. De., Catassi C. (2019). Celiac disease: a comprehensive current review: BMC medicine; 17(142).

[11]. Callejo, M.J., Benavente, E., Ezpeleta, J.I., Laguna, M.J., Carrillo, J.M. and Rodríguez-Quijano, M. (2016). Influence of teff variety and wheat flour strength on bread making properties of healthier teff-based breads. Journal of Cereal Science, Vol. 68, pp. 38-45.

[12]. Dubey C.F., Khan, C., and Srivastava A. (2008). Nutritional and antinutritional evaluation of forest and hybrid legumes seeds. Electronic Journal of Environmental, Agricultural and Food Chemistry. 7: 2900–2905

[13]. Farzana, T., & Mohajan, S. (2015). Effect of incorporation of soy flour to wheat flour on nutritional and sensory quality of biscuits fortified with mushroom. Food Science & Nutrition, 3, 363–369.

[14]. Giami S.Y, Amasisi T. and Ekiyor G. ( 2004). Comparison of bread mkaing properties of composite flour from kernels of roasted and boiled African breadfruit (Treculia Africana decne) seeds. Journal of Raw Material Research; 1: 16-25.

[15]. Huang, A. S., Titchenal, C. A., & Meilleur, B. A. (2000). Nutrient, Composition of Taiwan Taro Corms and Breadfruit. J. Food Comp. Anal., 13, 859-864. https://doi.org/10.1006/jfca.2000.0936.

[16]. IITA (1995). International Institute for Tropical Agriculture, Yam Research at IITA: 1971–1993. IITA, Ibadan4–7.

[17]. Ihekoronye, A.I., Ngoddy, P.O. (1985). Integrated Food Science and Technology for the Tropics. Macmillan Pub, London.

[18]. Iwe, M.O. (2002). Handbook of Sensory Methods and Analysis. Rejoint Communication Service Ltd., Enugu, 7–12

[19]. Key, A. J. (1987). Some Factors in influencing the Protein Content of Root Crops. Papua New Guinea Crops Conference, Department of Agriculture, Port Moresby (pp. 63-74)

[20]. Manisseri, C. and Gudipati, M., 2010. Bioactive xylo-oligosaccharides from wheat bran soluble polysaccharides. LWT–Food Science and Technology, Vol. 43 No. 3, pp. 421-430

[21]. Marer, E. and Martin, A. (2003). Fibre feast lowers cancer risk, Health (Time Inc. Health); Vol. 17 Issue 7, p58

[22]. Mepba, H. D., Eboh, L., and Nwaojigwa, S. U. (2007). Chemical composition, functional and baking properties of wheat-plantain composite flours. African Journal of Food Agriculture, Nutrition and Development,7(1): 1-22

[23]. Mune, M.A.M., Minka, S.R., Mbome, I.L. and Etoa, F.X. (2011). Nutritional potential of Bambara bean protein concentrate. Pakistan Journal of Nutrition, Vol. 10 No. 2, pp. 112-119

[24]. Obomegheive, A. A., Obafemi, M. O., & Oyibo, S. (1998). Processing Parameters for Cocoyam Flour Production. In Proceeding, 22nd Annual Conference of Nigerian Institute of Food Science and Technology (NIFST), Abeokuta (pp. 131-132).

[25]. Ojinnaka, M. C., & Nnorom, C. C. (2015). Quality Evaluation of Wheat-Cocoyam-Soybean Cookies. Nigerian Journal of Agriculture, Food and Environment, 11(3), 123-129.

[26]. Njintang NY., Carl MF., Facho B., Pierre K., and Joel S. (2008). Effect of taro Colocasiaesculenta) flour addition on the functional and alveographic properties of wheat flour and dough. Journal of the Science of Food and Agriculture. 88: 273-279.

[27]. Okon, B. I., Obi M.B and Ayuki, A.A. (2007). Performance of Quails (Coturnix Japonica) Feed Graded Levels of Boiled sun-dried Taro Cocoyam (Colocosia esculenta) as Replacement for maize. Agricultural Journal, 2 (6): 654-657.

[28]. Onyeike, E. N., Akaninwor, J. O., and Jonathan, C. I. (2008). Effect of heat processing on the proximate composition and energy values of selected Nigerian staple foods from oil producing areas of the Niger delta. Nigerian Society for Experimental Biology., 20 (1): 1-9.

[29]. Oti, E., & Akobundu, E. N. T. (2007). Physical, Functional and Amylograph Pasting Properties of Cocoyam-Soybean Crayfish Flour Blends. Nigerian Food Journal, 25(1), 1616-1625. https://doi.org/10.4314/nifoj.v25i1.33665

[30]. Raidi M.A and Klein B.P. (1983). Effect of soy or field pea flour substitution on physical and sensory characteristics of chemically leavened quick breads. Journal of Cereal Chemistry; 60: 367-370

[31]. Yue P., Hettiarachchy N., and D'appolonia B.L., (1991). Native and succinylated sunflower proteins use in bread baking. Journal of Food Science; 56: 992-998.