**Functional, pasting, nutritional and gluten free muffin making properties of plantain flour**

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**ABSTRACT**

Plantain or unripe banana is a starchy food that contains a high proportion of indigestible compounds, such as resistant starch, non-starch polysaccharides and is gluten free. The objective of this study was to analyze the functional and pasting properties of plantain flour (PF) for preparation of gluten free muffins. Plantain flour had more water absorption (2.62 g/g), oil absorption (1.92 g/g), swelling power(10.75) and better pasting properties as compared to wheat flour (WF). Muffins were prepared from whole plantain flour and compared with wheat flour muffins. Muffins were evaluated for specific volume, color and sensory parameters. PF muffins had more content of Ca (27.18 mg/Kg), Mg (17.21 mg/Kg), K (122.2 mg/Kg), specific volume (2 cc/g), lighter in color and liked more by sensory panel as compared to WF muffins. The possibility of developing gluten free products with PF can expand the product supply for people with celiac disease and contribute to a more diverse diet.

**Key words:** Functional properties, Gluten free, Muffins, Pasting properties, Plantain flour.

**INTRODUCTION**

The word ‘banana’ refers to the fruit of evergreen monocotyledonous, perennial, subtropical herb belonging to the genus Musa from the family Musaceae (Larsoudiere, 2007). Banana is the 5th most important crop in world export trade after coffee, cereals, sugar and cocoa (Aurore, Parfault and Fahrasmane, 2009). India, China, Philippines, Brazil and Ecuador are main banana producing countries of the world (FAOSTAT, 2016). Banana is a climacteric fruit, generally consumed in ripe state, however ripe banana losses are more during commercialization. They are highly perishable and if harvesting, handling and transportation are not done properly, the ripe banana soon gets decomposed and become unwholesome for human consumption. To reduce the losses, one of the most interesting processing method is the production of plantain flour (Rodriguez-Ambriz, et al, 2008). The benefits of plantain flour is that it is rich in resistant starch (42%) (Ovando-Martinez, et al, 2009; Rodriguez-Amaya and Kimura, 2004) and dietary fiber (14.5%) (Alkarkhi, 2011). Resistant starch by definition is a part of the starch that is not broken down by enzymes in small intestine. It enters the large intestine where it is partially or wholly fermented by microorganisms. Resistant starch is generally considered as one of the components that make up total dietary fiber (Ovando-Martinez et al., 2009).

Increasing sensitivity to wheat gluten, increase in number of cases of celiac disease and obesity is the serious public health problems all around the world. Celiac disease (CD) is a life-long autoimmune disease in the small intestine that affect genetically susceptible individuals worldwide. CD is one of the most common genetic disease that result from both environmental (gluten) and genetic (HLA and non-HLA genes) factors (Gujral, et al, 2012). CD is a serious genetic autoimmune disease that damages the villi of small intestine and interferes with absorption of nutrients from food (National Foundation for Celiac Awareness, 2011). There is no pharmaceutical cure for celiac disease. A hundred percent gluten free diet is the only existing treatment for celiac today. The only treatment is being lifelong adherence to a gluten-free (GF) lifestyle. It is necessary to develop consumer acceptable gluten free foods (National Foundation for Celiac Awareness, 2011). Greater awareness of celiac disease throughout the world has led to growing demand for gluten-free products such as cookies, bread, pasta and cakes (Gallagher, et al, 2003).

Plantain flour is a starchy food and it is gluten-free that may contribute to the gluten intolerance problem. Plantain flour was produced by peeled and sliced bananas which were dried, milled, sieved and then stored. This prepared flour can be suitably used as thickeners in soups (Mohapatra, et al, 2010) and as starch based ingredient for extruded and bakery products. Muffins are sweet, spongy breakfast or evening snack food prepared traditionally from wheat flour, sugar, oil/fat, milk and eggs. However, wheat-free muffins are of interest in the present times not only for people who are gluten tolerant, but also for people interested...
MATERIALS AND METHODS
Fresh unripe bananas (Plantains) and wheat flour (WF) were purchased from local market in Ludhiana, Punjab, India. Chemicals and reagents used in the analysis were of analytical grade. Basic ingredients for muffins preparation were purchased from local market.

Preparation of plantain flour (PF): Plantain flour was prepared according to the method of Mohapatra et al., (2010) with little modifications. Unripe banana was peeled, cut into slices of approximately 1 cm thickness and rinsed in citric acid solution (0.3% w/v) to reduce enzymatic browning. The slices were dried at 50±2°C in convection oven for overnight, ground by using a commercial grinder and stored at 25°C in sealed plastic container.

Functional properties of banana flour
Water and Oil Absorption Index: Water absorption index (WAI) and Oil absorption index (OAI) were determined according to the method of Niba, et al (2001) with some modifications. Flour sample (3 g) was suspended in 30 ml of water for WAI and 30 ml vegetable oil for OAI in a centrifuge tube. The slurry was shaken on a platform tube type rocker for 1 min at room temperature and centrifuged at 2500 rpm for 15 minutes. Supernatant was decanted and discarded. The remaining water and oil was removed and reweighed. WAI and OAI were expressed as the weight of sediment divided by the initial weight of flour sample and expressed in g/g.

Foam capacity and foam stability: Foam capacity (FC) and foam stability (FS) was determined according to the method of Narayana and Narasinga Rao (1982). 2 g of flour sample was added to 50 ml distilled water at room temperature in 100 ml measuring cylinder. The suspension was mixed and shaken properly to foam and the volume of foam after 30 s was recorded. The FC was recorded as percentage increase in volume. The foam volume was recorded 1 hr after whipping to determine the FS as percentage of the initial foam volume.

Bulk density: Bulk density was determined by standard AOAC (2012) method. 50 g sample was put into a 100 ml measuring cylinder. The cylinder was tapped continuously until a constant volume was obtained. The bulk density (g cm⁻³) was calculated as weight of flour (g) divided by flour volume (cm³).

Swelling power: Swelling power was determined according to the method described by Tharise, et al (2014). 1 g of flour sample was mixed with 10 ml distilled water in a centrifuge tube and heated at 45°C for 30 minutes with constant stirring and cooled. Centrifuged the suspension at 3000 rpm for 10 min and decanted the supernatant and the weight of the paste taken. The swelling power was calculated as the weight of the paste/weight of dry flour.

Pasting properties: Pasting properties of flour were evaluated with Rapid Visco Analyzer (RVA, Model Tec master Newport Scientific, Australia). A suspension of 3g (14% w.b.) of flour in 25 ml distilled water underwent a controlled heating and cooling cycle under constant shear where it was held at 50°C for 1 minute, heated from 50 to 95°C at 6°C/min, and held at 95°C for 5 min. The following parameters were obtained from the plotted graphs: peak viscosity, pasting temperature, set-back viscosity, breakdown viscosity, cold paste viscosity (Final viscosity), hot paste viscosity, stability ratio, and setback ratio.

Muffin formulation and processing: For making muffins, the formula according to Jyotsna, et al (2011) was followed with slight modifications. Eggs, vegetable oil, milk, water were creamed in a mixture. The dry ingredients were sifted and then mixed with the liquid ingredients. Liquid flavor vanilla was added in WF muffins but not in 100% PF formulation and dough was mixed. About 30 gram portions of the dough were poured into muffin cases and baked at 220°C for 15 minutes until a light brown color was obtained. Careful attention was paid for keeping the mixing preparation time constant, placing of dough into muffin cases, and baking conditions.

Proximate analysis: The Muffins were analyzed for moisture, ash, protein, fat and mineral according to standard AOAC (2012) procedures.

Specific Muffin volume by rapeseed displacement method: The muffin volume was measured by rapeseed displacement. Muffins were weighed and placed in a pan. After the rapeseeds are poured over the muffins, those seeds that were displaced by muffin measured as the volume of the muffins.

Determination of crust and crumb color: The objective measurement of the muffin color was carried out with a Hunter Labscan II colorimeter, and the results were expressed according to CIELAB system. The measurements were performed through a 6.4 mm diameter diaphragm containing an optical glass. The parameters determined were L* (L* = 0 [black] and L* = 100 [white]), a* (-a* = greenness and + a* = redness), b* (-b* = blueness and +b*+ yellowness). Each muffin was cut in two halves to measure the crumb color and crust color; all the measurements were made by placing the sample directly on the colorimeter diaphragm.

Sensory evaluation test using nine hedonic scales: The method for sensory evaluation of nine hedonic scales was used to evaluate the sensory quality of the muffins prepared. Sensory analysis was carried out in individual air-conditioned booths with white light. Normal taste water was provided for cleansing. Hedonic scale of nine numerical values
indicates the range of likes from extremely like to extremely dislike. In Hedonic test, 3 formulations of muffins were served to the 10 panelists. They were evaluating the muffins based on the characteristics given using the hedonic scale. Characteristics of the muffins evaluated were appearance, taste, texture, color and overall acceptance.

Analysis of variance (ANOVA) was used for statistical analysis of data (Gomez and Gomez 2010).

RESULTS AND DISCUSSIONS

Functional properties: Functional properties of flours play an important role in the manufacture of bakery products. Functional properties of plantain flour and wheat flour are presented in Table 1. Water absorption index describes flour-water association ability under limited water supply. Plantain flour displayed stronger affinity for water than oil, but it was more than wheat flour. Water absorption index is an important parameter and it has implications for viscosity. It is also essential in bulking and consistency of products, as well as in baking applications (Niba et al., 2001). The result suggests that plantain flour may find applications in baked products. Oil absorption index was important as oil acts as flavor retainer and increase in mouth feel of foods, palatability improvement and extension of shelf life particularly in bakery products where fat absorption is desired (Aremu, et al., 2007).

The foam capacity of PF and wheat flour varied non significantly and foam stability of the wheat flour was significantly higher than the plantain flour. The swelling power shows the degree of water absorption of the starch granules in the flour. Starch granules of plantain flour have more affinity towards water than wheat starch granules. Swelling power of plantain flour was observed almost twice than wheat flour which resulted in puffer texture of the product during baking.

Pasting properties: When food samples having starch was heated followed by cooling, a series of physical changes in the starch suspension takes place and this can be assessed using a Rapid Visco Analyser (RVA).

Pasting properties including PV (peak viscosity), BV (breakdown viscosity), cold paste viscosity (CPV) and HPV (hot paste viscosity) were observed more for plantain flour than wheat flour, but setback viscosity was observed more for wheat flour than plantain flour (Table 2). These observations could be attributed to the high amount of starch content. As the temperature of starch suspension increased, starch granules absorbed large amount of water and this induced granular swelling. The swollen starch granules occupied more space in the system. Hence flow of water was restricted by the loss of free water and is eventually led to rapid increase in viscosity over a range of temperatures (Srichuwong, et al., 2005). Viscosity continues to increase with temperature until a certain point, marked as peak viscosity (PV). Starch granules were disrupted as the starch suspension subjected to a period of constant high temperature (95°C) and mechanical shear stress. As a result, starch granules ruptured and more soluble amylase leached out into the system as shown by the breakdown in viscosity to a holding strength or trough. The rate of the breakdown is dependent on temperature, shear stress applied to the system, and the nature of the starch tested. As the mixture was cooled, starch molecules got re-associated to form gel network and this leads to the increase in viscosity. PV indicates the ability of starch granules to absorb water and swell during cooking (Sandhu and Singh, 2007). PV recorded in this study was 1239cP and 6255cP for wheat flour and plantain flour respectively.

Breakdown viscosity (BV) is indicated by the susceptibility of cooked starch granules to disintegrate (Lee, et al., 1995). WF exhibited the lowest BV (565cP), whereas PF exhibited the highest (3398cP). Final viscosity (FV) represents the particular quality of the starch, reflecting the stability of the cooked paste and the ability to form a viscous paste or gel after cooling (Ikegwu, et al., 2010) while setback viscosity (SB) represents the syneresis of starch upon cooling of the cooked starch paste (Sandhu and Singh, 2007). FV of PF was higher than WF and SB of the WF was higher than PF. Therefore, confirming the expected characteristics of PF to have higher tendency for retrogradation as compared to those of WF. These findings suggest that a firm gel like product could be developed using PF by providing sufficient amount of starch.

Pasting temperature (PT) is the minimum temperature required in cooking the sample (Kaur, et al., 2009). PT of WF was significantly higher than that of PF. The insoluble carbohydrates do not compete with starch for available water, thus a lower energy was required for gelatinization. Ng, Abbas, Tan & Azhar (2014) observed the pasting curves of RBF (ripe banana flour), wheat flour (WF) and WF-RVF and concluded that high RVF substitution makes the gels softer.

Table 1: Functional properties of plantain flour and wheat flour.

| Properties | Water absorption Index (g/g) | Oil absorption Index (g/g) | Foam capacity (%) | Foam stability (%) | Bulk density (g/cm³) | Swelling power |
|------------|-------------------------------|---------------------------|------------------|-------------------|---------------------|---------------|
| PF         | 2.62±0.03a                    | 1.92±0.03a                | 21.5±1.38a       | 14.5±1.94a        | 0.80±0.07a         | 10.75±0.94a   |
| WF         | 2.08±0.01b                    | 1.87±0.007a               | 21.62±1.10b      | 15.87±0.87b       | 0.69±0.12a         | 5.37±0.78b    |

Values are mean of duplicate ±SD and means followed by different subscripts in the same column are significantly different at p=0.05.
Proximate and mineral analysis of muffins: Muffins prepared from wheat flour and plantain flour was evaluated for moisture, protein, fat and ash content. The chemical composition of muffins with different formulations is presented in Table 3. The moisture content of muffins with wheat flour was observed more than plantain muffins. This pattern is related to the decrease in fat content and protein content as well. Difference in moisture content may be due to lack of network produced by gluten in composite flour and PF and consequently the separation of water during the cooking is higher. A similar trend was found by Ovando-Martinez et al. (2009), who reported that moisture content decreased when banana flour added to the product. Low moisture content is important in the shelf-life of the products. Ash content was observed more in PF muffins as compared to control muffins.

Total sodium, potassium, magnesium and calcium content were the highest in muffins prepared from 100% plantain flour composition. Table 3 shows that muffins had sodium content between 30 to 35.31 mg/kg, 75 to 122.2 mg/kg of potassium and 18.35 to 27.18 mg/kg of calcium being significantly different from each other. The zinc content in the samples was ranging between 0.84 to 0.811 mg/kg. The maximum amount of potassium and calcium was recorded for muffins with 100% plantain flour which showed that plantain flour contains good amount of sodium, calcium and potassium. Tanwar and Dhillon (2017) developed gluten free cookies utilizing bajra, buckwheat and ragi and reported that these cookies are more nutritious than refined cookies.

Muffin baking and color quality: The muffin volume of the PF was more i.e. 53 ml as compared to WF muffins (Table 4.). The specific muffin volume, which is the ratio of muffin volume to muffin weight, has been generally adopted in the literature as a more reliable measure of muffin size. The results showed that the highest specific volume was observed for plantain flour muffins and there was significant difference in specific volume of WF muffins and PF muffins. Work was reported by other scientists for preparation of gluten free products. Majzoobi, et al., 2016 prepared gluten free sponge cake by adding carrot pomace powder (CPP) at various levels in rice and corn flour (1:1w/w) as base. It was observed that addition of 30% CPP resulted in an acceptable gluten free cake. Singh, et al., (2016) explored application of black carrot pomace dietary fibre concentrate (BCF) and xanthan gum (XG) in gluten free rice muffins and observed that BCF and XG can be used as viable functional ingredient in the preparation of gluten free muffins.

Color of a baked product can be attributed to the individual ingredients present in it and their interactions. Consumers intercept darker muffins as being healthier than the light ones (Walker, et al., 2014). The variations in the color parameters are shown in Table 4. The Crust lightness
Table 4: Muffin making and color quality of muffins.

| Muffins | Weight (g) | Volume (cc) | Specific volume (cc/g) | Color | L (Crust) | Crumb (Crust) | a | b | Crumb (Crust) | a | Crumb (Crust) | a |
|---------|------------|-------------|------------------------|-------|-----------|-------------|---|---|-------------|---|-------------|---|
| WF      | 26.06±0.70a | 45.8±0.28b  | 1.757±0.03b            |       | 40.66±0.54a | 59.32±0.80b  | 18.68±0.27b | 8.85±0.44b | 28.38±0.58b | 26.77±0.49a |
| PF      | 26.4±1.41a  | 53±4.94a    | 2.00±0.07a             |       | 38.33±0.36b | 40.59±0.32b  | 15.47±0.33a | 3.74±0.23a | 25.87±0.20b | 14.63±0.13c |

Values are mean of duplicate ±SD and means followed by different subscripts in the same column are significantly different at p=0.05.

(L*) of the muffin samples varied from 37.27 to 40.66 being significantly different from each other. Highest value of crust lightness was observed for wheat flour muffins. Same trend was observed for crumb lightness also. The decrease in lightness was because of loss of characteristic white color of the plantain flour. As we replaced wheat flour with plantain flour the same observations were also recorded for yellowness and redness for crust and crumb of muffins with significant difference in values.

Sensory analysis of muffins: In the present study, the sensory evaluation of muffins prepared from PF was carried out with the WF muffins for choosing the best quality muffins. The mean sensory liking scores for color, texture, taste, flavor and overall acceptability of muffins are shown in Fig 1. The sensory characteristics of muffins prepared from PF varied significantly for color, texture, taste, flavor and overall acceptability. The overall acceptability of the samples varied from 7.41 to 8.03. The high value obtained for the samples might be contributed for all other attributes. Besides, the PF muffins was observed to be more preferred with mean score 8.03. Singh, et al., 2015 prepared antioxidant rich gluten free eggless muffins from rice flour and blended it with jambolan fruit pulp and xanthan gum. Sensory analysis revealed that jambolan fruit pulp and xanthan gum improved the texture, volume and crumb structure of muffins.

CONCLUSION

The preparation of plantain flour may be an alternative to the use of this food crop for production of gluten free products. The present study concluded that PF is suitable for preparation of gluten free muffins. PF can be successfully used at 100 per cent level for preparation of muffins with acceptable sensory attributes and improved nutritional profile. Pasting properties like peak viscosity, breakdown viscosity, cold paste viscosity, hot paste viscosity and swelling power were observed more for plantain flour than WF. PF muffins had higher calcium, magnesium, sodium and potassium content than control muffins. Hence, development and utilization of such functional foods will not only improve the nutritional status of the population, but also helps those suffering from celiac disease. The finding of this study may help generate technology to diversify the use of PF by the food processing enterprises, specially baking industries. More studies should be conducted to investigate the possibility of using PF as an ingredient in other food products in order to increase application of such value-added food ingredients.

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REFERENCES

Alkarkhi, A.F.M., Ramli, S.B., Yong, Y.S. and Easa, A.M. (2011). Comparing physicochemical properties of banana pulp and peel flours prepared from unripe and ripe fruits. Food Chem., 129: 312-318.

AOAC, Association of official analytical chemists (United States of America). (2012). Official methods of analysis (19th edition), Washington, DC: AOAC.

Aremu, M.O., Olafode, O. and Akindayi, E.T. (2007). Functional properties of some Nigerian varieties of legume seed flours and flour concentration effect on foaming and gelation properties. J. Food Technol., 5: 109-115.
Aurore, G., Parfait, B. and Fahrasmane, L. (2009). Bananas, raw materials for making processed food products – review. Trends Food Sci. Technol., 20: 78–91.

FAOSTAT (2016). Statistical Database of the Food and Agriculture Organization of the United Nations. http://faostat.fao.org

Gallagher, E., Gormley, T.R. and Arentd, E.K. (2003). Crust and crumb characteristics of gluten free breads. J. Food Eng., 56:153-161.

Gomez, A.K., and Gomez, A.A. (2010). Statistical Procedures for Agricultural Research. John Wiley and Sons, New York, USA. Pp 680

Gujral, N., Freeman, H.J., and Thompson, A.B. (2012). Celiac disease: Prevalence, diagnosis, pathogenesis and treatment. World J. Gastroenterology, 18: 6036-6059.

Ikegwu, O.J., Okechukwu, P.E. and Ekumankana, E.O. (2010). Physico-chemical and pasting characteristics of flour and starch from achi Brachystegia eurycoma seed. J. Food Technol., 8: 58–66.

Jyotsna, R., Soumya, C., Indrani, D. and Rao, G.V. (2011). Effect of replacement of wheat flour with finger millet flour (Eleusine corcana) on the batter microscopy, rheology and quality characteristics of muffins. J. Texture Stud., 42: 478–489.

Kaur, S., Singh, N., Sadhi, N.S. and Rana, J.C. (2009). Diversity in properties of seed and flour of kidney bean germplasm. Food Chem., 117: 282–289.

Lassoudiere, A. (2007). Le bananier et sa culture. France: Editions QUAE

Lee, N.H., Hettiarachchy, N.S., McNew, R.W. and Gnanasambandam, R. (1995). Physicochemical properties of calcium-fortified rice. Cereal Chem., 72: 352–355.

Majooobi, M., Poor, Z.V., Jamalain, J. and Farahnaky, A. (2016). Improvement of the quality of gluten-free sponge cake using different levels and particle sizes of carrot pomace powder. Int. J. Food Sci. Technol., 51: 1369-77.

Miguel, N.G., Boladeras, E.C. and Belloso, O.M. (1999). Development of high-fruit-dietary-fibre muffins. Eur. Food Res. Technol., 210: 123-128.

Mohapatra, D., Mishra, S., Singh, C.D. and Jayas, D.S. (2010). Banana and its by product utilization: An overview. J. Sci. Indus. Res., 69: 323-329.

Nachay, K. (2010). Gluten-free offerings increase. Food Technol., 64: 13–14.

Narayana, K. and Narasinga Rao, M.S. (1982). Functional properties of raw and heat processed winged bean flour. J. Food Sci., 47:1534-1538.

Niba, L.L., Bokonga, M.M., Jackson, E.L., Schlimme, D.S. and Li, B.W. (2001). Physiochemical properties and starch granular characteristics of flour from various Manihot esculenta (cassava) genotypes. J. Food Sci., 67:1701-1705.

Ng, K.F., Abbas, F.M.A., Tan, T.C. and Azhar, M. E. (2014). Physicochemical, pasting and gel textural properties of wheat-ripe Cavendish banana composite flours. Int. Food Res. J., 21: 655-662.

Ovando-Martinez, M., Sayago-Ayerd, S., Agama-Acevedo, E., Goni, I. and Bello-Perez, L.A. (2009). Plantain flour as an ingredient to increase the undigestible carbohydrates of pasta. Food Chem., 113:121–126.

Rodriguez-Ambriz, S.L., Islas-Hernandez, J.J., Agama-Acevedo, E., Tovar, J. and Bello-Perez, L.A. (2008). Characterization of a fibre-rich powder prepared by liquefaction of plantain flour. Food Chem., 107:1515-1521.

Saifullah, R., Abbas, F.M.A., Yeoh, S.Y. and Azhar, M.E. (2009). Utilization of green banana flour as a functional ingredient in yellow noodle. Int. Food Res. J., 16:373-379.

Sandhu, K.S. and Singh, N. (2007). Some properties of corn starches II: Physicochemical, gelatinization, retrogradation, pasting and gel textural properties. Food Chem., 101: 1499–1507.

Singh, J.P., Kaur, A., Shevkani, K. and Singh, N. (2015). Influence of jambolan (Syzygium cumini) and xanthan gum incorporation on the physicochemical, antioxidant and sensory properties of gluten free eggless rice muffins. Int. J. Food Sci. Technol, 50: 1190-1197.

Singh, J.P., Kaur, A. and Singh, N. (2016). Development of eggless gluten-free rice muffins utilizing black carrot dietary fibre concentrate and xanthan gum. J. Food Sci. Technol, 53: 1269-1278.

Srichuwong, S., Sunarti, T.C., Mishima, T., Isono, N. and Hismatsu, M. (2005). Starches from different botanical sources II: Contribution of starch structure to swelling and pasting properties. Carbohydrate Polymers, 62: 25–34.

Tanwar, B. and Dhillon, M. (2017). Preparation and nutritional quality evaluation of gluten-free cookies. Asian J. Dairy Food Res, 36:63-66.

Tharise, N., Julianti, E. and Nurminah, M. (2014). Evaluation of physico-chemical and functional properties of composite flour from cassava, rice, potato and xanthan gum as alternative of wheat flour. Int. Food Res. J., 21: 1641-1649.

Walker, R., Tseng, A., Cavender, G., Ross, A. and Zhao, Y. (2014). Physicochemical, nutritional, and sensory qualities of wine grape pomace fortified baked goods. J. Food Sci., 79: 1811–1822.