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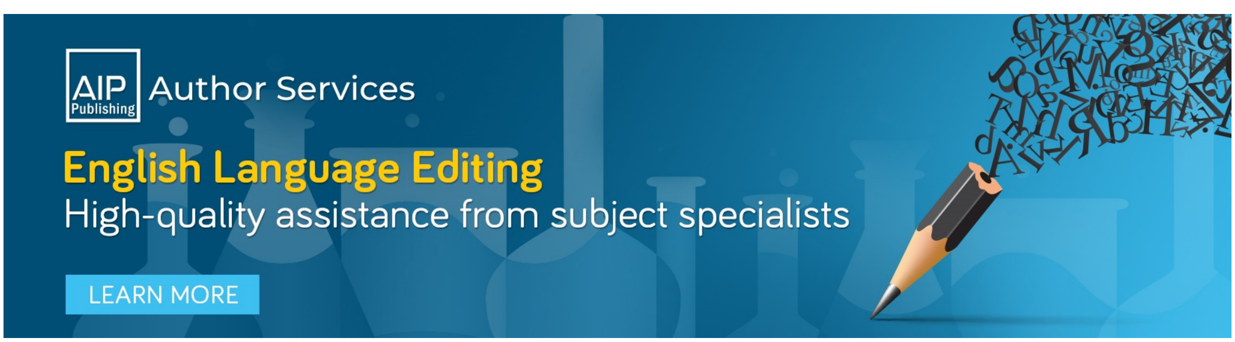

Physicochemical Properties of Bread Prepared using Pink Guava (*Psidium guajava*) Pomace Powder as Substitute to Wheat Flour

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Abstract. Pink guava juice is a famous food product from pink guava fruit, but it will cause the generated off by-products or wastes such as peels, outer leaves, and pulps. Reducing the wastes should be taken by converting the by-products into something useful. The pink guava is also very good to health because it contains high dietary fibre. Thus, this study aims to produce pink guava pomace powder that can substitute wheat flour for bread making. Pink guava pomace powder (PGPP) was prepared by drying and ground into powder. Different percentages (10%, 20% and 30%) of PGPP were used to replace wheat flour in bread making. The bread made with PGPP can be as a potential additional source of dietary fibre in bread. Physicochemical properties of the bread prepared using PGPP were evaluated. Results show that 10% PGPP was the best for dough proofing. The hardness, springiness and chewiness of bread were significantly reduced when higher percentage of PGPP was used. In addition, color measurements showed a significant difference between the control and bread prepared with PGPP. PGPP decreased the lightness of bread. Whereas, the redness and yellowness and moisture content of bread were increased with higher percentage of PGPP in bread.

INTRODUCTION

Psidium guajava L. commonly known as guava, is a native of tropical America and widespread throughout the tropical and subtropical areas [1]. Pink guavas are a rouge-fleshed, tropical variety of *P. guajava*. Guavas tend to be broadly classified according to the color of their flesh; either pink or white. Generally, guava fruits can be divided into two categories: for fresh consumption and processing purposes. As the global production of guava is estimated to be around 500,000 metric tonnes, a considerable amount of waste from this industry is also produced and disposed of to the environment [2]. Many agro-industrial residues from many fruit species are being wasted every year, causing environmental problems. Physical damage of guava fruit also contributes to the problems. The fruit are very delicate and cannot withstand rough handling during harvest and postharvest operations [3]. Some steps have been taken to use residues to produce and grow a range of value-added products, such as bioactive substances used in food, cosmetics, and pharmaceutical industries [4]. Guava pomace is one example of waste produced after the production process and represents up to 15% of the original fruit [2]. It is composed of a mixture of peel, seeds and pulp rich in phenolic compounds with antioxidant potential.

P. guajava pomace powder contains a high amount of soluble dietary fibre (SDF), an essential source of fibre content used for bakery product formulations. The fruit dietary fibre (DF) concentrates may improve the nutritional quality of food products due to the presence of significant amounts of associated bioactive compounds (flavonoids, carotenoids, etc.) and their balanced composition of higher fibre content [5]. The nutritional quality of bakery products seems relatively low because of the inferior nutritional composition of the wheat grain. The substitution part of the organic plants such as guava has been advocated for the nutritional enrichment of these products and to utilizing the

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better quality of bread with organic raw materials preferentially. The addition of fruit by-products will improve the physicochemical properties of bread. It is believed that bread created from wheat composite flour incorporates a principal part in nourishment determined from a composition containing micronutrients to boost its nutritional value. This study was carried out to utilize the pink guava pomace for bread making and determine the physicochemical properties of the bread produced.

MATERIAL AND METHODS

Preparation of Pink Guava Pomace Powder

The whole fruit of pink guavas were used in order to mimic the by-product of pink guava. This is because the fruits can become spoiled and rotten shortly after harvested. Fully ripe pink guavas were obtained from Miss Lim Siew Lan pink guava farm in Perak, Malaysia. 3 kg of the sample were washed with tap water and cut into slices (0.2- 0.3 cm). The pink guava slices were dried in the food dehydrator at 65 ºC for 8 hours. Once it reached constant weight, sample was ground into powder and sieved through 500 µm pore size siever. The sample was kept in a zip-lock bag at room temperature for future use.

Dough Formulation, Proofing and Baking

Four dough formulations were prepared in parallel using different percentages of pink guava pomace powder (PGPP); 0% PGPP served as control, 10% PGPP, 20% PGPP, and 30% PGPP. These replaced the wheat flour used for bread making. The dough was prepared by adding all ingredients; PGPP, wheat flour mixed with salt, sugar, milk powder, canola oil, and active dry yeast. The ingredients were kneaded with hands for 10 to 15 mins until it reach a good consistency. The dough was covered with a plastic wrapper to let it rest to rise properly for 1 hour 30 mins as a first proofing. After the first proofing was done, each dough was divided into three loaf pans and covered with a plastic wrapper and let to rest for second proofing for 2 hours at room temperature. A vernier caliper was used to get specific measurements of each dough parameter especially the changes of diameter size after proof. The dough rising for each group was recorded accordingly. Then, the dough was baked at 130- 140 ºC for 20 to 25 mins or until golden brown and bread sounds hollow when tapped. The baked bread was then removed from pans to cool at room temperature for further analysis.

Texture Profile Analysis (TPA)

The texture profiles (hardness, springiness and chewiness) of bread with PGPP 0%, 20%, 40% and 60% were measured using CT3 Texture Profile Analysis (Brookfield, USA). The bread was sliced (30 x 20 x 20 mm^3) from the centre of the loaf. Then, a 75 mm diameter compression platen forced to compress at 75% of the sliced bread height. The measurements were observed for its significant yield point which is the sample was compressed between two flat plates and noted the Newtons of force required to reach the yield point or to measure in Pa-s the resistance to flow of a fluid food. The test speed used was 10.00 mm/s with the speed, 2.00 mm/s. The three TPA parameters; hardness, springiness and chewiness were recorded.

Color Measurement and Moisture Content Analysis

Colors of bread was measured using CR-400/410 Chroma Meter (Konica Minolta, Japan) based on level of lightness (L*), redness (a*) that gives the degree of the red- green color, and yellowness (b*) indicates the degree of the yellow- blue color of the samples. Color measurements were performed on samples treated in triplicates and the mean values together with the standard deviations were recorded.

For moisture content analysis, 1 g of each breadcrumb was dried using Moisture Analyzer MX-50 (A&D, San Jose, CA) at 200 ºC. The time taken for each sample to dry differed due to its moisture content. Moisture content data was recorded 3 times for each sample.

Statistical Analysis

Results were analyzed statistically using one-way analysis of variance (ANOVA). The mean values and standard deviation were reported. Then, analysis of variance was performed and results were separated using Duncan's Multiple Range test ($p<0.05$) and paired T-test using the statistical software of Statistical Package for the Social Sciences (SPSS) version 26.0.

RESULTS AND DISCUSSION

Dough Proofing

Bread dough incorporated with 10% PGPP shows the highest after dough proofing data compared to 0% PGPP, 20%, and 30%. Significant values ($p<0.05$) were recorded before and after dough proofing at 0.008 (Table 1, Figure 1). These show bread dough diameter decreased as the percentage of PGPP increased. Most of the bakery products, mainly breads, are made with yeast as a leavening agent. The yeast, *Saccharomyces cerevisiae* ferments the sugars present for the production of ethanol and carbon dioxide when incorporated into the dough. The ethanol is discarded during the subsequent baking phase [6]. The production of carbon dioxide from yeast leads to fill the thousands of balloons-like bubbles in the bread dough, and when the bread dough is baked, the loaf of bread becomes a more airy structure.

The reaction of fermentable sugar to the 10% PGPP bread dough was more effective than other PGPP percentages. The sugars in the flour and the PGPP react with the yeast leading to proofing to rise well. However, lower proofing data were recorded for bread with 20% PGPP and 30% PGPP, which might be due to the high dietary fibre in pink guava. The fibre content affects the creation of the aerated structure, diminishing the appeal of the bread [5]. The fibre content also tends to increase final proofing time [7]. This study also suggests that increase in proofing time for bread dough incorporated with 20% and 30% PGPP may increase the dough diameter and proofing well.

TABLE 1. The proofing of different dough formulations

Percentage of PGPP (%)	Dough proofing for 1 hour 30 mins (mm)	
	Before	After
0	87.55 ± 2.82	138.25 ± 1.18
10	82.65 ± 1.82	150.42 ± 43.46
20	80.35 ± 1.05	88.82 ± 2.93
30	79.92 ± 1.27	81.82 ± 0.15

Results are represented by mean ± standard deviation of three replicates (3n). There is no different letters across the rows indicate significant difference between treatments by Duncan multiple range test and paired samples T-test at ($p<0.05$).

0% PGPP 10% PGPP 20% PGPP 30% PGPP

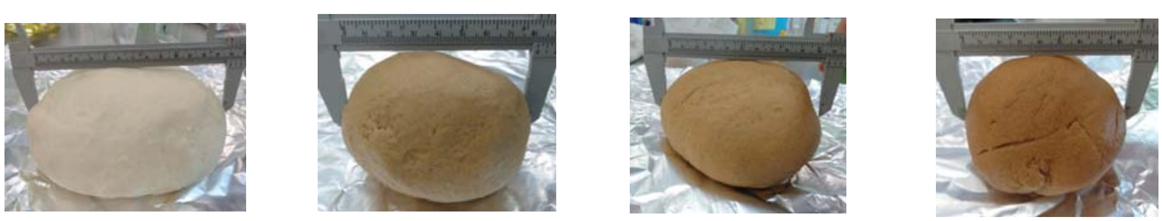

FIGURE 1. The measurement of dough after proofing using a vernier caliper

Texture Profile

The bread texture profiles such as hardness, springiness, and chewiness were examined for possible correlations with bread quality parameters and for their dependence on physicochemical characteristics. Decreasing in bread hardness with increasing percentage of PGPP was observed in all four bread varieties that is significantly difference ($p<0.05$) (Table 2). Bread with 10% PGPP shows greater hardness compared to bread with 20% and 30% PGPP. The hardness of bread might be due to the differences in mixing process, mixing time and the ingredient amounts. Thus, it gives a difference at the end of baked bread quality [8].

TABLE 2. Texture profiles of bread incorporated with or without PGPP

PGPP percentage (%)	Bread texture profiles (gram/s)		
	Hardness	Springiness	Chewiness
0	5168.33 ± 23.75	1.64 ± 0.09	638.47 ± 115.30
10	5133.67 ± 38.37	1.05 ± 0.18	358.63 ± 80.20
20	5085.00 ± 32.90	0.69 ± 0.08	256.10 ± 15.52
30	5083.50 ± 22.98	0.66 ± 0.20	232.90 ± 56.89

Results are represented by mean ± standard deviation of three replicates (3n). There is no different letters across the rows indicate significant difference between treatments by Duncan multiple range test and paired samples T-test at ($p<0.05$).

The differences in the bread hardness are due to the water content, energy mixing requirements, and protein composition [9]. This also may correlate to the expansion of the dough during dough proofing that makes up the bread structure at the end. The decreased in the hardness of bread enriched with PGPP may relate to the increase of free water in dough or the rigid nature of fibre content [10].

The bread springiness was significantly reduced when a higher percentage of PGPP added to the bread, resulting a less springy and difficult to chew bread being produced. Springiness in TPA is related to the height that the food recovers during the time that elapses during the end of first bite and the start of the second bite. If springiness is high, it requires more mastication energy in the mouth [11]. A higher springiness value of 1.05 was obtained from bread incorporated with 10% PGPP. Increasing the percentage of PGPP in the dough resulted in less springy bread and difficult to chew. Chewiness is the energy needed to chew solid food in a state of readiness for swallowing and is directly related to hardness [12]. Bread chewiness decreased with increasing amount of PGPP (Table 2). Results show that chewiness was positively correlated with hardness. When the hardness of bread decreased, the chewiness of bread also decreased. The higher bread chewiness may reflect an increase in the number of covalent bonds [13]. Thus, showing the bread quality either in good texture or not; higher hardness and chewiness produced low quality bread. The amount of time for dough kneading may also affect the texture and sensory properties [14]. Fermentation process in bread also gives good textural properties such as hardness, springiness and gumminess respectively.

Colour Measurement

Overall appearance, colour, structure, and the evaluation of various types of bread, which predominantly have the property of colour that influences consumer' minds, are the most essential sensory aspects of bakery products. The bread without PGPP shows the most lightness, 66.83 ± 1.76 (Table 3). This could be due to the higher protein content of composite breads, affecting the Maillard reaction in the crust of bread [9]. The lightness, L* of bread decreases with the increasing percentage of PGPP. However, all bread was acceptable concerning color (Fig. 2).

TABLE 3. Colour profiles of bread incorporated with or without PGPP

PGPP percentage (%)	Colour profiles		
	Lightness (L*)	Redness (a*)	Yellowness (b*)
0	66.83 ± 1.76	2.58 ± 0.19	24.79 ± 0.92
10	45.11 ± 0.22	12.28 ± 0.12	34.99 ± 0.98
20	41.23 ± 1.33	13.86 ± 0.32	38.19 ± 1.03
30	38.37 ± 0.58	14.02 ± 0.45	36.99 ± 0.80

Results are represented by mean ± standard deviation of three replicates (3n). There is no different letters across the rows indicate significant difference between treatments by Duncan multiple range test and paired samples T-test at ($p<0.05$).

Whereas the redness, a*, increases with the increasing percentage of PGPP in the bread. This is due to the high amount of carotenoids pigment that gives the same compound to carrots and tomatoes their distinct red color [15]. Guava fortified beverage contained lycopene pigment as a source of natural color that improved the nutritional and sensory quality of the beverage [16].

The yellowness, b* bread without PGPP was at 24.79 ± 0.92 lower than bread incorporated with PGPP. It is significantly different ($p<0.05$) with the change in the percentage of PGPP. However, the yellowness, b* of bread incorporated with 20% PGPP was higher than bread with 10% and 30% PGPP, resulting in duller pink color. This might be due to the yellow pigment of PGPP. Moreover, the perceived darker pink color may have been due to the greater reflectance from a solid material (press cake) compared to that of a fluid substance (puree) [17]. The overall results show that PGPP influenced the bread's color. A more pronounced non-enzymatic browning when wheat flour is replaced with fibre with different sugar compositions [18]. Thus, pink guava that is rich in dietary fibre tends to influence the color measurement in bread. The crust tends to be browner with higher dietary fibre content.

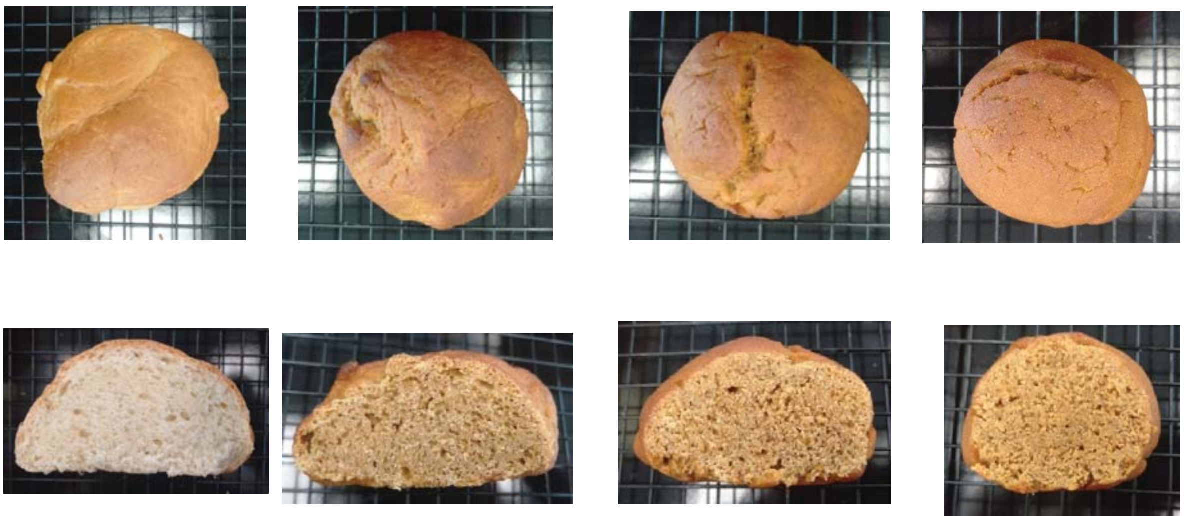

FIGURE 2. The color of bread prepared with PGPP compared to the control bread

Moisture Content

The effect of PGPP on bread quality was determined based on the amount of PGPP and water absorbed into the bread. Therefore, the moisture content of bread was obtained using a moisture analyzer machine instead of the oven drying method. The moisture analyzer machine functions as sample heating by absorption of infrared radiation from the halogen radiator. It was a continuous mass determination during the drying process. The difference in weight determines the percentage of moisture content before and after drying [19]. The moisture content of bread is significantly different ($p<0.05$) when incorporated with different percentages of PGPP throughout the time taken. The moisture content of bread increased with the increasing percentage of PGPP and time taken (Table 4). The increase in protein from the flour affects water activity [20].

TABLE 4. The moisture content on different types of bread within 25 minutes

Percentage of PGPP (%)	The moisture content of bread and the time taken	
	Bread moisture (%)	Time taken (min)
0	25.25 ± 3.48	6.57 ± 1.00
10	27.13 ± 0.50	12.53 ± 1.42
20	28.78 ± 1.37	16.10 ± 2.82
30	35.32 ± 1.31	21.80 ± 3.80

Results are represented by mean ± standard deviation of three replicates (3n). There is no different letters across the rows indicate significant difference between treatments by Duncan multiple range test and paired samples T-test at ($p<0.05$).

Crust softening and crumb hardening is related to the redistribution of moisture (crumb-crust migration) during storage. However, the higher the moisture, the slower the firming rate [21]. The separation of crumbs from crust eliminates water migration and may maintain the original crumb moisture during storage but may not prevent the crumb from firming. However, the firming rate would be lower [21]. Increased moisture content in bread containing dietary fibre could retard browning by diluting the sugar and amino acid.

CONCLUSION

PGPP significantly affects the physicochemical properties of bread. The highest proofing was recorded when dough incorporated with 10% PGPP. It also predicted that the fibre content in PGPP tend to increase the proofing time. The increases in the hardness of bread enriched with PGPP may relate to the decrease of free water in dough or the rigid nature of fiber. In conclusion, this study demonstrated that bread with good physicochemical properties can be produced with substitution of wheat flour by PGPP.

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REFERENCES

1. C. Chopda and D. Barrett, J. Food Process. Preserv. **25**(6), 411-430 (2001).
2. A. Jiménez-Escrig, M. Rincón, R. Pulido and F. Saura-Calixto, J. Agric. Food Chem. **49**(11), 5489-5493 (2001).
3. S. P. Singh, Fresh Produce **4**, 36–48 (2010).
4. A. Schieber, F. C. Stintzing and R. Carle, Trends Food Sci. Technol. **12**(11), 401-413 (2001).
5. A. Quiles, G. M. Campbell, S. Struck, H. Rohm and I. Hernando, Food Rev. Int. **34**(2), 162-181 (2016).
6. S. Veluppillai, K. Nithyanantharajah, S. Vasantharuba, S. Balakumar and V. Arasaratnam, Rice Sci. **17**(1), 51-59 (2010).
7. K. Katina, Bread Making **23**, 487-499 (2003).
8. E. Armero and C. Collar, Zeitschrift fur Lebensmitteluntersuchung Und-Forschung A **204**(2), 136-145 (1997).
9. A. S. Sivam, D. Sun-Waterhouse, S. Quek and C. O. Perera, J. Food Sci. **75**(8), R163–R174. (2010).
10. R. Chang, C. Li and S. Shiau, Czech J. Food Sci. **33**(No. 2), 180-185 (2016).
11. M. S. Rahman and A. I. Al-Mahrouqi, Int J Food Sci Nutr **60**, 229–242 (2009).
12. E. Eriksson, C. Tortoe, P. T. Akonor and C. Oduro-Yeboah, Food and Public Health **4**(5), 214-222 (2014).
13. B. Smerdel, L. Pollak and D. Novotni, J. Food Nutr. Res. **51**(4), 242-253 (2012).
14. K. Kaack, L. Pedersen, H. N. Laerke and A. Meyer, Eur. Food Res. Technol. **224**(2), 199-207 (2006).
15. H. E. Khoo, K. N. Prasad, K. W. Kong, Y. Jiang and A. Ismail, Molecules (Basel, Switzerland) **16**(2), 1710–1738 (2011).
16. V. Pasupuleti and S. Kulkarni, J. Food Sci. Technol. **51**, 12th ser., 4126-4131 (2014).
17. A. S. Hodgson, H. T. Chan, C. G. Cavaletto and C. O. Perera, J. Food Sci. **55**(6), 1757-1758 (1990).
18. P. Fradinho, M. C. Nunes and A. Raymundo, J Food Sci Technol. **52**(8), 4830-40 (2015).
19. M. Toledo, M. Retrieved on January 08, 2021, from https://www.mt.com/ch/en/home/library/white-papers/laboratory-weighing/Drying_Oven_vs_Halogen_Moisture_Analyzer.html
20. I. Pasha, M. Rafiq Khan, A. Ali, M. Jahangir Chughtai, S. Ahmad and M. Adnan Nasir, Pak. J. Food Sci. **25**(1), 26-36 (2015).
21. M. Baik and P. Chinachoti, Cereal Chem. **77**(4), 484-488 (2000).