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Chemical and Nutrient Composition of Cookies Enriched with Pineapple Pomace and Ragi Flour

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Short Research Article

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ABSTRACT

The increasing demand for functional foods has led to the incorporation of fruit processing by-products and nutrient-dense cereals into conventional products. The purpose of this study was to assess the chemical composition of cookies made by substituting refined wheat flour (WF) with varied amounts of pineapple pomace powder (PPP) and ragi flour (RF). Six formulations, including a control (T_0 to T_5) were made: T_0 (100% WF), T_1 (5% PPP+ 85 % WF +10%RF), T_2 (10% PPP+ 80 % WF +10%RF), T_3 (15% PPP+ 75 % WF +10%RF) T_4 (20% PPP+ 70 % WF +10%RF) and T_5 (25% PPP+ 65 % WF +10% RF). Moisture, protein, fat, total sugar, non-reducing sugar, and reducing sugar were among the chemical characteristics that were examined. The results indicated that the treatments varied significantly (p<0.05). As PPP and RF levels increased, the moisture

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content increased as well. The protein content significantly increased, with T_5 displaying the highest value in comparison to the control. Although the differences were small, the fat content dropped with increasing PPP, from (T_0) to (T_5) . While in sugar percent, it was observed that Total sugar and non-reducing sugar content decreased over an increase in PPP content, whereas reducing sugar increased from (T_0) to (T_5) .

Keywords: Pineapple pomace; ragi flour; chemical composition; by-product utilisation.

1. INTRODUCTION

One of the most significant fruits in the world and edible prominent member of Bromeliaceae family is the pineapple (Ananas comosus). This fruit is the third most popular fruit in the world, after apples and oranges. (Cabrera et al. 2000). Pineapple is a good source of fibre, vitamins, minerals and phenolic compounds, with notable antioxidant capacities and potential health benefits (Jose et al., 2022). Compared to temperate fruits, tropical and subtropical fruits result in significantly larger ratios of by-product development (Schieber et al. 2001). The residual pulp, peels, stem, and leaves are the main components of pineapple by-products, which are not an exception. Pineapple pomace, a significant source of fibre, natural sugars, and vitamins, is the fibrous by-product that remains after juice extraction (Sreenath et al., 2001). In a study by Montalvo-González et al. (2018), pineapple pomace was used in sausages as an ingredient to add dietary fiber and antioxidant properties. Foods rich in dietary fiber typically have a low glycemic index and, as a result, cause a slower and lower increase in blood glucose levels and, therefore, insulin as well. It also helps in weight management amount of lowers the low-density lipoprotein (LDL) in the human body (Meena et al., 2022).

In addition to increasing nutritional content, its inclusion in baked products promotes value addition and waste reduction throughout the food processing chain (Khan et al. 2020). Finger millet or ragi flour (*Eleusine coracana*) is a traditional cereal valued for its complex carbohydrates, dietary fibre, high calcium content, and important amino acids. As compared to all cereals, Finger millet contains the highest content of calcium (Mudau et al., 2022). Additionally, it is glutenfree, thus people intolerant to gluten may consume it (Shobana & Malleshi, 2007). Generally, it is used to make cookies, cakes, puddings, and porridge etc (Dhanushkodi et al.,

2023). When added to cookies, it enhances the product's nutritional value while also adding protein and micronutrients to the cookies. However, combining both the pomace and ragi flour offers a dual advantage in nutritional profile but can vary the chemical composition, including the amount of moisture, protein, fat, and sugar. Therefore, the current study examined the chemical properties of cookies made using different ratios of ragi flour and pineapple pomace, also including some proportions of wheat flour in order to determine their potential as value-added and health-promoting bakery products.

2. MATERIALS AND METHODS

2.1 Location of Experiment Site

In the academic year 2023–2024 and 2024-2025, a laboratory experiment was carried out at the Horticulture Processing Laboratory, Department of Fruit Science, College of Agriculture, Indira Gandhi Agricultural University, Raipur (C.G.).

2.2 Raw Material

To make the cookies, pineapples were purchased from the local fruit market in Raipur and pineapple pomace powder (PPP) was extracted from them, wheat flour (WF) and ragi flour (RF) were purchased from local store and then were combined. Pineapple pomace was then, dried at 55-60 °C, pulverized, and sieved to a fine powder. Ragi flour was purchased from a local market and kept in sealed containers to avoid moisture absorption.

2.3 Formulation of Cookies

Six different treatments from (T_0 to T_5) were developed by combining wheat flour with increasing amounts of pineapple pomace powder and a constant amount of ragi flour. The formulas were as follows:

Table 1. Treatment details for Cookie formulations with different levels of Pineapple pomace powder and Ragi Flour

Notation	Treatment Details
T ₀	100% WF (control)
T_1	5% PPP + 85% WF + 10% RF
T_2	10% PPP + 80% WF + 10% RF
T ₃	15% PPP + 75% WF + 10% RF
T_4	20% PPP + 70% WF + 10% RF
T ₅	25% PPP + 65% WF + 10% RF

Cookies were prepared using standard methods. Mixing the dry ingredients was followed by creaming the sugar and fat, adding the dry mix, shaping, and baking for 12 to 15 minutes at 180°C.

2.4 Chemical Evaluation of cookies

Using the oven drying method at 105°C, the moisture content (%) was determined (AOAC, 2000). Ash (%) was determined using a process that involved incineration at 550°C in a muffle furnace and a weighing equipment was used to determine the final weight (AOAC, 2000), Protein (%) through Kjeldahl method with nitrogen conversion factor 6.25 (AOAC, 2000), Fat (%) was evaluated by Soxhlet extraction method using petroleum ether (AOAC, 2000). The Lane Eynon titration method (Ranganna, 2000) was used to determine the total sugars (%): likewise, reducing Sugar (%) determined and non-reducing sugar (%) was calculated by the difference between the total and reducing sugar. Every treatment was examined three times. CRD (Completely Randomised Design) was used to statistically evaluate the data, and CD (Critical Difference) and SE(m) were used to compare the means at a 5% significance level.

3. RESULTS AND DISCUSSION

3.1 Moisture (%)

The data depicted in Table 2 indicates that the moisture content of all the treatments from T_0 to T_5 ranged from 4.33% to 5.31%. The minimum moisture content (4.33%) was observed in T_0 (100% WF), while the maximum moisture (5.31%) was recorded under treatment T_5 (25% PPP+ 65% WF +10%RF), followed by T_4 (5.05%) and T_3 (4.78%) (15% PPP+75 % WF +10%RF). Treatment T_2 (4.43%), T_1 (4.40%) and T_0 (4.33%) were relatively found to be at par with each other.

The moisture content of cookies increased substantially as the proportion of PPP increased.

This could be because of the enhanced waterholding capacity of dietary fibre in pineapple pomace, which retains more water during baking. Ragi flour also aids in moisture retention due to its fine particle structure and binding ability. The results were similar to those reported by Sahini and Shere (2019), who found that the moisture content increased from 4.48% to 5.65% as the level of beetroot pomace powder increased.

3.2 Ash (%)

Table 2 revealed that the ash content of all treatments ranged from 3.00 % to 7.53%. The maximum ash content (7.53%) was found in T_5 (25% PPP+ 65% WF +10% RF), followed by 6.33% in T_4 (20% PPP+ 70 % WF +10%RF), all treatments T_3 (5.40), T_2 (4.52), T_1 (4.07) and T_0 were significantly different from each other. The minimum ash content (3.00%) was found to be in treatment T_0 (100 % WF).

The ash content in pineapple pomace cookies increased as the PPP percent increased. This could be attributed to the higher concentration of minerals in pineapple pomace, such as potassium, calcium, and magnesium, which increased ash levels as PPP percent increased. The findings were similar to Lokhande (2005) in banana powder cookies and Priyanka and Mishra (2015) in jamun powder-enriched biscuits using natural sweeteners.

3.3 Fat (%)

The data revealed that the fat content in all treatments varied from 21.02% and 25.50%. The highest fat content (25.50%) was found in treatment T_5 (25% PPP+ 65% WF+10% RF), followed by 27.48% in T_4 (20% PPP+ 70% WF+10%RF). However, all treatments T_3 (23.52%), T_2 (22.53%), T_1 (22.01%), and T_0 (21.02%) showed significant differences with each other. Treatment T_0 (100% WF) was found to have the lowest fat percentage, i.e., 23.03%.

The fat content of pineapple pomace cookies increased with an increase in PPP percent. This could be attributed to the dietary fibre included in pomace, which not only retains water but also fat during baking, resulting in an increase in fat percentage during treatments. The results were similar to Lokhande (2005) in banana powder biscuits and Sawant et al. (2023) in cookies made from banana flour and wheat flour.

3.4 Protein (%)

The data indicated that the protein percentage of all the treatments from T_0 to T_5 ranged from 4.47% to 5.87%. The maximum protein percent (5.87%) was recorded under treatment T_5 (25% PPP+ 65 % WF +10%RF), followed by T_4 (5.68%), which was superior to the rest and all treatments were statistically significant from one another. The minimum protein content 4.47% was noted in treatment T_0 (100 % WF).

The protein content of cookies showed an increasing trend through the treatments. This might be due to the protein present in the ragi flour, which strongly influenced the overall protein percent. The results obtained were similar to Imtiaz et al. (2025).

3.5 Total Sugar (%)

The data from Table 2 revealed that the total sugar percentage in all treatments ranged from 12.66% and 13.45%. The highest total sugar of 13.45% was recorded in T_5 (25% PPP+ 65 % WF+10%RF), which was significantly superior among all treatments. However, treatment T_4 (20% PPP+ 70% WF+10%RF) with 13.30% total sugar was found to be the second-best treatment under this study. Further, all treatments from T_0 to T_5 were found to be significantly different from each other. The minimum total sugar

percentage (12.66%) was observed in treatment T_0 .

The reason behind the increasing trend in total sugar % might be due to the natural sugars that are present in pomace itself, even after the juice extraction and the accumulation of them; also, PPP helps in retaining simple sugars that are present in pomace. A similar increased trend of total sugar percent was obtained by Pawar (2016) in sapota pomace cookies.

3.6 Reducing Sugar (%)

The data from the table clearly shows that there is an increasing trend from T_0 (1.66%) to T_5 (5.87%). Treatment T_5 noted the highest reducing sugar percent of 5.87% (25% PPP+ 65% WF +10%RF), which showed superiority over all other treatments. Further followed by treatment T_4 (20% PPP+ 70% WF +10%RF), which showed a 5.20 percent reduction in sugar and all remaining treatments T_3 (5.10%), T_2 (4.87%), T_1 (3.20%) and T_0 (1.66%) were found significantly different from each other. The minimum total sugar percentage of 1.66% was observed in T_0 (100% WF). A similar increased trend of reducing sugar results was obtained by Pawar (2016) in sapota pomace cookies.

3.7 Non-reducing Sugar (%):

Table 2 clearly depicts that the non-reducing sugar percent ranged from 7.45% to 11.00%. The maximum non-reducing sugar content (11.00%) was seen in treatment T_0 (100% WF), followed by treatment T_1 (5% PPP+ 85 % WF+10%RF) with a percent of 9.67%. All treatments were observed to be significantly dissimilar with each other. The minimum percent of non-reducing sugar was recorded under treatment T_5 (25% PPP+ 65 % WF+10% RF).

Table 2. Chemical evaluation of cookies with different ratios of pineapple pomace powder and Ragi flour

Notation	Treatment	Moisture %	Ash %	Protein %	Fat %	Total sugar %	Reducing sugar %	Non- reducing sugar %
T ₀	100% WF	4.33 ^{def}	3.00 ^f	4.47 ^f	21.02 ^f	12.66 ^f	1.66 ^f	11.00 ^a
T_1	5% PPP+ 85 %WF +10%RF	4.40 ^{de}	4.07^{e}	4.90^{e}	22.01e	12.87 ^e	3.20 ^e	9.67 ^b
T_2	10% PPP+ 80% WF +10%RF	4.43 ^d	4.52^{d}	5.11 ^d	22.53 ^d	13.01 ^d	4.87 ^d	8.15 ^c
T ₃	15% PPP+ 75 % WF +10%RF	4.78°	5.40°	5.37°	23.52°	13.16 ^c	5.10°	8.06 ^d
T ₄	20% PPP+ 70 % WF +10%RF	5.05 ^b	6.33^{b}	5.68 ^b	24.67 ^b	13.30 ^b	5.20 ^b	8.10 ^e
T ₅	25% PPP+ 65 % WF +10%RF	5.31 ^a	7.53^{a}	5.87 ^a	25.50 ^a	13.45 ^a	5.87 ^a	7.45 ^f
SE (m) ±		0.050	0.058	0.009	0.057	0.009	0.058	0.009
CD at 5%		0.156	0.182	0.029	0.177	0.029	0.180	0.028

The superscript letter indicates that the treatment means with same letters are at par at 5% significance, while the means with different letters are significantly different at 5% level of significance. The letters have been affixed based on the CD-value comparison treatment means

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The declining trend of non-reducing sugar percent from 0% pineapple pomace to 25% Pineapple pomace might be due to the impact of pomace substitution that reduced the non-reducing sugar due to dilution, heat induced sugar degradation also, the enzymatic activity and pH from pineapple residues that can promote partial hydrolysis of non-reducing sugars into reducing forms during baking, also reduced glycemic response is a promising factor which correlates with non-reducing sugars. A similar outcome was reported by Raczkowska et al. (2024).

4. CONCLUSION

The current studv examined integrating pineapple pomace powder (PPP) and ragi flour (RF) into wheat flour-based cookies and found that their chemical composition varied. Moisture, ash, protein, fat, total and reducing sugar content increased significantly when PPP and RF levels whereas. non-reducing increased. declined. These findings suggest the use of pineapple pomace, rich in nutrients, and ragi flour, which is value-added, fibre and protein-rich, can be used to make by-products, i.e., functional cookies.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative Al technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

AOAC. (2000). Official methods of analysis (20th ed.). Association of Official Analytical Chemists.

- Cabrera, G. (2000). Effect of five dietary antimutagens on the genotoxicity of six mutagens in the microscreen prophage-induction assay. *Environmental and Molecular Mutagenesis*, 36(3), 206–220. https://doi.org/10.1002/(SICI)1098-2280(2000)36:3<206::AID-EM6>3.0.CO;2-X
- Dhanushkodi, V., Hemavathy, A. T., Shenbagavalli, S., Sangeetha, S., Anitha, R., & UmaMaheshwari, T. (2023). A review on nutritional properties and health benefits of finger millet. *International Journal of Plant & Soil Science, 35*(18), 753–761. https://doi.org/10.9734/ijpss/2023/v35i1833
- Imtiaz, A., Perveen, R., & Irfan, T. (2025). Development and nutritional assessment of proximate analysis of ragi flour cookies as a potential dietary intervention for non-communicable diseases. *Journal of Biological and Allied Health Sciences*, 5, 46–53.
- Jose, M., Himashree, P., Sengar, A. S., & Sunil, C. K. (2022). Valorization of food industry by-product (pineapple pomace): A study to evaluate its effect on physicochemical and textural properties of developed cookies. *Measurement: Food, 6*, 100031.
- Khan, M. R., Wani, I. A., & Ahmad, M. (2020). Volarization of fruit and vegetable waste into functional ingredients: A sustainable approach. *Waste Management*, 102, 36–45.
- Lokhande, M. O. (2005). Banana powder incorporation in bakery products (Doctoral dissertation, Vasant Rao Naik Marathwada Krishi Vidyapeeth, Parbhani).
- Meena, L., Neog, R., Yashini, M., & Sunil, C. K. (2022). Pineapple pomace powder (freezedried): Effect on the texture and rheological properties of set-type yogurt. Food Chemistry Advances, 1, 100101.
- Montalvo-González, E., Aguilar-Hernández, G., Hernández-Cázares, A. S., Ruiz-López, I. I., Pérez-Silva, A., Hernández-Torres, J., & Vivar-Vera, M. D. L. Á. (2018). Production, chemical, physical and technological properties of antioxidant dietary fiber from pineapple pomace and effect as ingredient in sausages. *CyTA-Journal of Food, 16*(1), 831–839.
- Mudau, M., Mashau, M. E., & Ramashia, S. E. (2022). Nutritional quality, antioxidant, microstructural and sensory properties of spontaneously fermented gluten-free

- finger millet biscuits. Foods, 11(9), 1265.
- Pawar, M. V. (2016). Standardization of cookies from sapota (Manilkara achras (Mill) Foseberg) pomace (Doctoral dissertation, DBSKKV, Dapoli).
- Priyanka, A. M., & Mishra, A. A. (2015). Development and quality evaluation of jamun powder fortified biscuits using natural sweeteners. *International Journal of Engineering Science Technology, 3*(2), 796–801.
- Raczkowska, E., Bienkiewicz, M., & Gajda, R. (2024). Modulation of the glycaemic index value of shortbread cookies by the use of erythritol and fruit pomace. *Scientific Reports*, *14*, 14215.
- Ranganna, S. (2000). Handbook of analysis and quality control for fruit and vegetable products (2nd ed.). Tata McGraw-Hill Publishing Co. Ltd.
- Sahni, P., & Shere, D. (2019). Physico-chemical and sensory characteristics of beetroot

- pomace powder incorporated fibre-rich cookies. *International Journal of Food and Fermentation Technology, 6*(2), 309–315.
- Sawant, B. B., Relekr, P. P., Shirke, G. D., & Kadam, J. H. (2023). Development of cookies from banana (Musa spp.) flour. *The Pharma Innovation Journal*, 12(5), 4586–4593.
- Schieber, A., Stintzing, F. C., & Carle, R. (2001). By-products of plant food processing as a source of functional compounds: Recent developments. *Trends in Food Science and Technology, 12*, 401–413.
- Shobana, S., & Malleshi, N. G. (2007). Preparation and functional properties of decorticated finger millet (Eleusine coracana). *Journal of Food Engineering*, 79(2), 529–538.
- Sreenath, H. K., Sudarshan, L., & Pyle, D. L. (2001). Utilization of fruit processing wastes: A review. *Indian Food Industry*, 20(5), 24–31.

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