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Application of Baking Technology into Fruit Waste Bio-products: Commercially Viable Healthy Bites

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ABSTRACT

Globally fruit processing industries are at increasing pace generating huge quantities of fruit waste creating lot of environmental pollution addressing for elimination measures. Conversion of bio-waste into value added functional foods turns out into one of the beneficial mode with dual benefits of health and environmental conservation. Baking technology occupies a unique place in food processing industry owing to its versatility and universal acceptability. Based on this background, the present study aimed at the efficient utilization of fruit waste through converting into fruit waste flour and to develop fruit waste based biscuits. Watermelon rind, pineapple pomace, grape pomace and orange pomace are the four selected fruit wastes as byproducts. The fruit waste flours are incorporated at 10 per cent level to the base ingredient of wheat flour and subjected to sensory evaluation to test the acceptability of the food waste bio-products developed as biscuits. The nine-point hedonic scale is adopted and the mean scores revealed above eight mean sensory score for all the sensory parameters. The statistical analysis for the sensory parameters among the four varieties of fruit waste biscuits showed not significant differences indicating well acceptability of all the four biscuits developed. The overall acceptability represented the maximum mean score for pineapple pomace biscuits followed by grape pomace biscuits then more or less nearer mean score for orange pomace biscuits and the minimum for watermelon rind biscuits. The nutrient analysis results showed that the developed biscuits had low moisture content, considerable calorie value and good sources of protein, crude fiber, calcium, iron and β – carotene. The present investigation findings clearly demonstrated that transformation of fruit waste into functional fruit waste biscuits as healthy bites is identified as effective measure to reduce fruit waste disposal. Promotion and encouragement to formulate wide array of fruit waste bio-products might be an in-depth exploratory research to become commercially viable bakery products at an industrial level.

Keywords: *Fruit waste, byproduct utilization, baking technology, bakery products, environmental protection*

1. INTRODUCTION

Baking technology is a unique a dry heat method of cooking with which the dough transforms into nutritionally enhanced food referred as bakery product. The heat is transferred uniformly while baking, reduces moisture content and eventually markedly minimizes the water activity to prevent the microbial spoilage. Application of baking technology leads to desirable physicochemical and biochemical changes results in the production of highly delicious appealing bakery items and more shelf-stable product. The basic principles behind the technology include air cell formation, hydration power, expansion in volume, starch gelatinization, protein denaturation, porous texture, caramelization of sugar and Maillard reaction. The International Market Analysis Research and Consulting Group (IMARC) bakery market analysis reported that the Indian bakeries turnover crossed US$ 11.3 billion and IMARC Group forecasts around US$ 21.2 billion by 2028 evidencing compound annual growth rate (CAGR) about 10.8 per cent between 2023-2028 (Mudgil and Mudgil, 2023).

The proportion of increase in working women exponentially demands for convenient, ready to eat, flexible and affordable healthy foods. Bakery products in such instances occupy a special place in food industrial sector globally with well acceptance among different categories of population owing to the diverse assortment. Interestingly, the bakery products

market has been expanding into functional foods category with high feasibility of incorporation of wide variety of functional food ingredients like oats, soy, flax seeds etc. Addition of tropical fruits such as pineapple, mango, papaya, jack fruit, guava may enhance the taste and aroma which will be beneficial for more consumer preferences in the health conscious target group. On the other hand, utilization of fruit waste may become an effective mode of waste utility and best measure of bringing sustainable waste management strategy to preserve and protect the environment (Mickiewicz and Britchenko, 2022).

Biscuits among the wide range of bakery products receive special attention as popular ready to eat snack typically made of wheat flour, shortening and sugar with combination of other ingredients to improve the functional, nutritional and therapeutic properties. Biscuit making stands as the easy means of bringing innovations with more ease and retention of nutrients and phytochemical constituents. It has gained much importance in the management of various forms of chronic disorders like obese, hypertension, diabetes, cardiovascular diseases etc if appropriate measures arrived in the formulation of different forms of nutritious functional bakery foods. The health seeking consumers prefer to consume healthier functional biscuit products as complementary snacks rather than attracting towards more sweets or hot spicy fast foods with focus on healthy functional ingredients (Goubgou et al., 2021).

Fruit consumption is associated with several health benefits and surprisingly huge amounts of pomace produced from the beverage and pulp industry which has been discarded as waste possess rich bio-chemicals. The prime objectives of sustainable development goals towards zero hunger and ensuring health and well-being are major concerns in developing and underdeveloped nations particularly rural and urban slum areas. The interesting fact that the effective utilization of pomace produced as by-product as raw materials may play key role in mitigating world hunger owing the potential source of essential nutrients and various phytochemical constituents with significant functional and nutraceutical properties. Addition of pomace from pineapple, grape, apple, tomato, orange etc. as such or either as their extracts or powder form in to variety of foods seems to lower glycemic index and increase in the contents of dietary fibre and total phenolic compounds possessing antioxidant activity providing more health benefits (Kumar et al., 2024).

The research on formulation of bakery products with the incorporation of fruit waste as functional ingredient is limited. The present investigation is focused on the utilization as fruit waste with the application of baking technology to enhance functional and health benefits in the form of biscuits. Water melon rind and pomace of pineapple, grape and orange are selected to develop fruit waste bio-products for transforming the normal biscuit into value added functional biscuit as the incorporation of fruit waste remarkably enhance the bioactive compounds as they are rich sources of phytochemical constituents.

2. METHODOLOGY

Study area

The present study is aimed at the formulation of fruit waste bio-products using baking technology to convert the waste into healthy functional food products. Biscuits found to be the best possible products to incorporate the fruit waste feasibly as it is the widely consumed bakery product irrespective the age group and geographical area. In view of this beneficial aspect, the current investigation is intended to develop functional biscuits with the addition of fruit waste flour made from watermelon rind, pomace of pineapple, grape and orange. The research is carried out at the Food Science and Food Chemistry laboratories at Department of Home Science of Sri Padmavati Mahila Visvavidyalayam, Tirupati in the state of Andhra Pradesh, India.

Biscuit making

The fruit waste flour was prepared by thorough cleaning of waste, cutting into pieces, drying and ground to fine powder to convert to fruit waste flour. The wheat flour, fruit waste flour, skim milk powder and baking powder are sieved together to incorporate air into the mixture. Butter is rubbed till resembles bread crumbs and then added sugar powder. Water is added gradually to make smooth pliable dough, rolled, cut into pieces using biscuit cutter and baked in oven at 160^{o}c till desirable texture is obtained.

Testing acceptability

Four varieties of biscuits viz., watermelon rind, pineapple pomace, grape pomace and orange pomace biscuits are developed by substituting wheat flour with fruit waste powder at 10 per cent level. The respective biscuits are coded as WRB, PPB, GPB and OPB respectively and used for the interpretation of the data results. The developed bio-products were tested for their acceptability using 9-point hedonic rating scale by a panel of 30 members. The human ethical clearance was received from the Institutional Ethics Committee of Sri Padmavati Mahila Visvavidyalayam, Tirupati.

Nutrient analysis

The nutrient analysis was carried out through moisture estimation, proximate principles analysis (protein, fat and crude fiber), minerals (calcium and iron) and the selected vitamin, β-carotene. The nutrients were analysed using standard protocols in duplicate to arrive at nutrient composition of the biscuits.

3. RESULTS AND DISCUSSION

The present study is focused on the development of biscuits with the incorporation of fruit waste flour and evaluated for the acceptability through sensory evaluation. The results on sensory evaluation and nutrient analysis were discussed separately under different sub-heads.

Sensory evaluation

The mean sensory scores of the selected sensory characteristics are interpreted and tabulated in table 1 and the overall acceptability mean scores in figure 1.

Table No-1: Mean sensory scores of the developed fruit waste flour incorporated biscuits and level of significance

S.No.	Sensory parameter	Mean ± SD				F-Value	P-value
		WRB	PPB	GPB	OPB		
1	Appearance	8.30±0.84	8.63±0.65	8.47±0.78	8.03±1.27	2.38047	0.073189^{NS}
2	Colour	8.13±0.82	8.60±0.67	8.43±0.77	8.33±0.61	2.18177	0.093916 ^{NS}
3	Crispiness	8.20±0.81	8.30±0.79	8.27±0.79	8.20±0.85	0.11483	0.951267 ^{NS}
4	Taste	8.03±0.89	8.50±0.63	8.40±0.77	8.13±0.86	2.2911	0.081886 ^{NS}
5	Odour	8.20±0.76	8.37±0.76	8.23±0.86	8.30±0.75	0.26614	0.849684 ^{NS}

Note: ^{NS} – No significant difference

The results from the table revealed that the fruit waste flour incorporated biscuits were well acceptable with the excellent appeal, attractive colour, good crispiness, delicious taste and pleasant odour. The mean sensory scores showed not significant differences irrespective of the sensory parameter indicating the successful incorporation of the fruit waste flour by substituting with the base ingredient of wheat flour at 10 per cent level. The pineapple pomace based biscuit had scored the maximum sensory scores owing to the unique taste and aroma associated with the pineapple. The remaining biscuits though scored relatively low mean scores were not differed significantly denoting the mean score differences with minimum narrow range within acceptable limits.

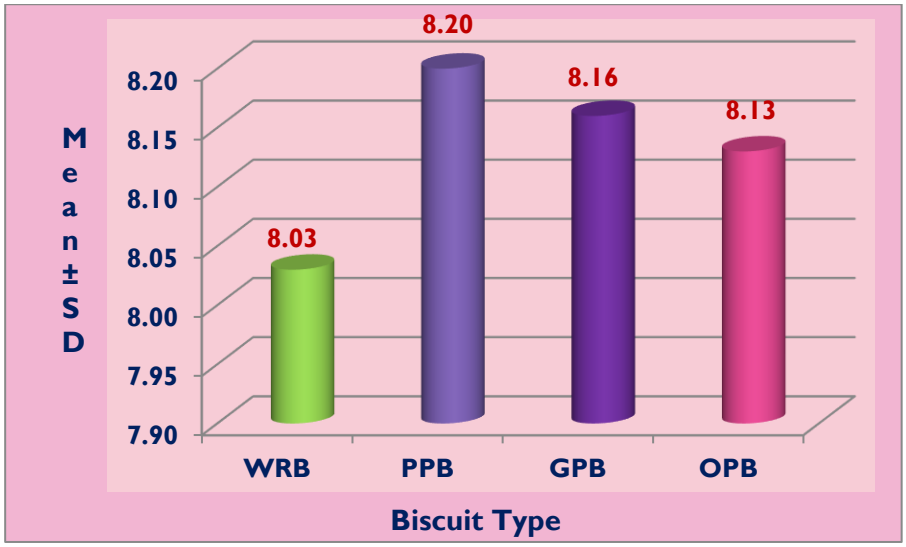

Figure No-2: Overall mean acceptability scores of the developed fruit waste flour incorporated biscuits

The data on the overall acceptability from the figure represented that the pineapple pomace biscuits had scored the maximum mean score (8.20). The biscuits prepared from grape and orange pomace had more or less similar mean overall acceptability scores as 8.16 and 8.13 respectively. The overall acceptability of watermelon rind flour biscuits scored relatively low but found to be in well acceptable mean score indicating as successful blend. The findings clearly demonstrated the promotion of incorporation of fruit waste flours into the bakery products can be an effective mode of utilizing fruit waste to transform the waste into health and wealth.

Nutrient analysis

The nutrient analysis results are expressed as proximate composition as denoted in table 2, minerals (calcium and iron) in table 3 and β – carotene in figure 2.

Table No-2: Proximate composition of the developed fruit waste flour incorporated biscuits

S.No.	Biscuit Type	Proximate Composition			
		Moisture(g)	Protein(g)	Fat (g)	Crude fiber
1	WRB	5.13	11.72	19.28	4.32
2	PPB	6.27	10.81	17.76	6.44
3	GPB	6.46	12.34	18.63	7.59
4	OPB	7.29	11.33	18.06	8.77

Biscuit is basically baked product which involved dry heat method and hence low in moisture content with a range of 5.13g (watermelon rind flour biscuits) to 7.29g (Orange pomace flour biscuits). The developed biscuits found to be good source of protein probably due the ingredients used such as wheat flour, fruit waste flour and skim milk powder which varied from 10.81g (pineapple pomace biscuits) to 12.34g (grape pomace biscuits). The fat content altered from 17.76 (pineapple pomace biscuits) to 19.28 (watermelon rind biscuits) indicating as source of energy which was mainly due to butter content used along with other ingredients mentioned. The fruits are generally good source of fiber and becomes highly concentrated source of crude fiber with the incorporation of fruit waste flour as evidenced by 4.32g (watermelon rind biscuits) to 8.77g (orange pomace biscuits) of crude fiber content in the developed fruit waste flour incorporated biscuits.

Table No-3: Calcium and iron contents of the developed fruit waste flour incorporated biscuits

S.No.	Biscuit Type	Minerals	
		Calcium(mg)	Iron (mg)
1	WRB	123.46	4.43
2	PPB	111.54	3.96
3	GPB	109.23	5.99
4	OPB	134.42	3.61

The results from the table 3 denoted that the developed fruit waste biscuits found to be good sources of the important minerals viz., calcium and iron. The calcium content ranged from 109.24mg (grape pomace biscuits) to 123.46mg (watermelon rind biscuits) and iron from 3.61mg (orange pomace biscuits) to 5.99mg (grape pomace biscuits). The findings thus highlighted that inclusion of fruit waste into the regular conventional biscuits might be advantageous in combating the highly prevalent iron deficiency anaemia and calcium deficiency.

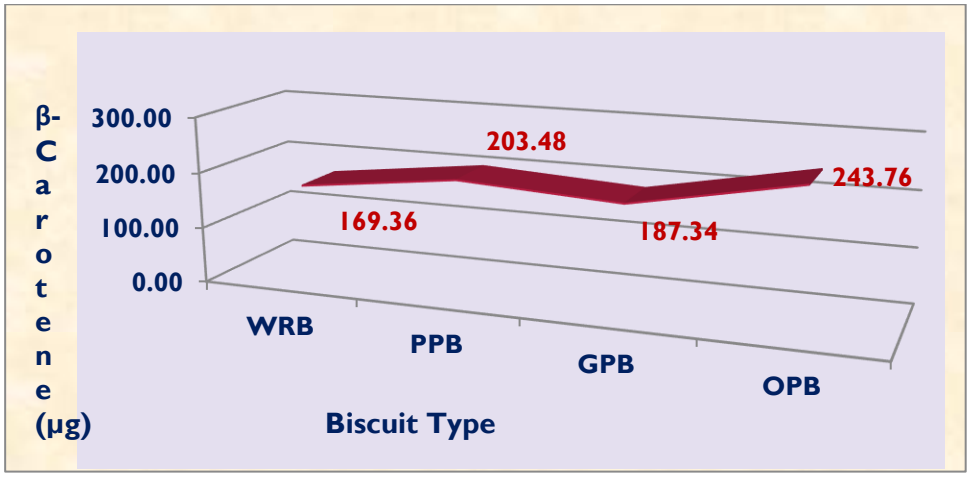

Figure No-2: β – carotene of the developed fruit waste flour incorporated biscuits

The data depicted in figure 2 illustrated that the developed fruit waste based biscuits had good amounts of β – carotene indicating considerable source of vitamin A. Encouraging the consumption of such fruit waste products might be helpful for eight sight and to minimize the prevailing vitamin-A deficiency for reducing further associated consequences.

The food waste from the sources of kitchens, hotels, fast food centres, restaurants and food processing industries is a significant valuable organic waste. The Food Waste Index Report 2021 reported that 17 per cent is being thrown into dustbins and its utilization is challenging to meet the hunger of the exponential population growth (Forbes et al., 2021). Around 1.33 billion tons food waste is produced each year worldwide which can reach to 2.2 billion tons by 2025. Several studies reported optimal utilization of food waste for the development of bakery products is an innovative strategy in food waste management interventions (Upadhyay et al., 2023; Melini et al., 2020). Formulation of low cost affordable food waste bakery products may become potential processing technology to meet the sustainable development goals and play crucial role in the nation's economic growth and development.

4. CONCLUSION

The physico-chemical, functional, nutritional and rheological properties of the biscuits are greatly influenced by the raw ingredients employed and the unit operations in the production process. There is clear cut evidence in the improvement of essential nutrients mainly proteins, vitamins and minerals as well as dietary fiber and bioactive compounds with lowering of hydrolysis index, sugar and fat contents with the development of tailor-made functional bakery products. The clinical studies on the influence of bioactive compounds of biscuits in relation to different health conditions are lacking for the proven results which need to be explored further. Several clinical studies are required on a long term basis to understand the role of health benefits of healthy functional biscuits using fruit waste.

The current investigation had shown with beneficial outcome as the baking technology employed in the development of healthy fruit waste bio-products in the form of biscuits provided successful results. Several varieties of ready to eat snack bites especially bakery products as biscuits and cookies are familiar and widely consumed. In such instances, popularization and applying suitable marketing strategies to formulate several other fruit waste biscuits become commercially viable healthy bites.

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REFERENCES

[1] Forbes, H.; Quested, T.; O'Connor, C. Food Waste Index Report 2021; United Nations Environment Programme: Nairobi, Kenya, 2021.

[2] Goubgou, M., Songre-Ouattara, L.T., Bationo, F. *et al.* 2021.Biscuits: a systematic review and meta-analysis of improving the nutritional quality and health benefits. Food Prod Process and Nutr 3, 26, https://doi.org/10.1186/s43014-021-00071-z.

[3] Kumar, H., Guleria, S., Kimta, N., Nepovimova, E., Dhalaria, R.,Dhanjal, D.S., Sethi, N., Alomar, S.Y., andKuca, K. 2024. Selected fruit pomaces: Nutritional profile, health benefits, and applications in functional foods and feeds. Current Research in Food Science,9,2024,100791,https://doi.org/10.1016/j.crfs.2024.100791.

[4] Melini, V., Melini, F., Luziatelli, F., & Ruzzi, M. (2020). Functional Ingredients from Agri-Food Waste: Effect of Inclusion Thereof on Phenolic Compound Content and Bioaccessibility in Bakery Products. *Antioxidants, 9*(12), 1216.

[5] Mickiewicz, B,B,A. And Britchenko, I. 2022. Main trends and development forecast of bread and bakery products market. VUZF Review, 7(3), DOI: 10.38188/2534-9228.22.3.11.

[6] Mudgil, D. and Mudgil, S. 2023. Unit Operations in Food Processing. Chapter 18, Baking, Scientific Publishers, New Delhi, 323–348.

[7] Upadhyay, S., Tiwari, R., Kumar, S., Gupta, S. M., Kumar, V., Rautela, I., Kohli, D., Rawat, B. S., and Kaushik, R. 2023. Utilization of Food Waste for the Development of Composite Bread. *Sustainability, 15(*17), 13079.