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Effect of Pre-processing Treatment on Physico-chemical Attributes of Unripe Mature Banana Flour

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ABSTRACT

The study was to conducted to examine the effect of pre-processing treatment on flour yield, and physico-chemical properties of unripe mature banana flour. The selected green bananas (GB) were divided into five parts and steam blanched for 10 and 20 min with and without potassium meta-bi-sulphite. After drying all the treatments were ground into flour and separated by 60 and 100 µm sieve size (SS). The experiment was laid out in the completely randomized design with three replications. The results revealed that the total GB flour yield ranged between 95.52 to 97.7%. However, increase in temperature of steam blanching led to decrease in per cent flour yield. It was noted that steam blanching for 10 min had superior water holding capacity and found to be at par with steam blanching for 20 min with 0.25% potassium meta-bi-sulphite and 60 µm sieve size. Steam blanching had a positive effect on protein, fat and mineral content. Therefore, on the basis of the present study, it was concluded that steam blanching for 10 min with 0.25% potassium meta-bi-sulphite had superior protein content with superior physico-chemical properties.

Key words: Steam-blanching, powder, milling, celiac disease, gluten free

INTRODUCTION

Recently, there has been an increase in the demand for gluten-free products due to health reasons (Saito *et al.,* 2022). The global market for gluten-free food is expected to expand considerably from 2022 to 2032, from 6.7 to 14 billion U.S. dollars (Statista, 2023). The clinical application and popularity of the gluten-free diet escalates consumer demand to influence the food market. This is also due to increase in incidents of celiac disease.

Fruits are essential components of a healthy diet due to contents of vitamins and minerals, fiber, and beneficial non-nutrient substances as bioactive compounds. The Indian Council of Medical Research recommends ingestion of at least 400 to 500 g of fruits and vegetables per day (Salis *et al.,* 2021). Low fruit consumption is one of the main risk factors for increased mortality increasing the risk of chronic diseases and poor health quality. Therefore, the regular consumption of fruits can reduce the incidence of some diseases such as diabetes, cardiovascular and gastrointestinal diseases as well as some types of cancer (Aune *et al.,* 2017; Liu *et al.,* 2021). However, almost one-third of all bananas gathered is lost since the population mostly consumes ripe bananas, and it is a climacteric fruit. Ripe bananas are prone to mechanical damage and are perishable during the maturation process, which makes their storage and transport difficult (Al-Dairi *et al.,* 2023). Almost 20% of banana production is not commercialized due to size and appearance flaws, increasing their loss (Al-Dairi *et al.,* 2023).

During drying process of banana, undesirable browning reactions occur due to the presence of polyphenol oxidase and peroxidase. These enzymes cause undesirable browning reactions and loss in nutritional quality (Deng *et al.*, 2017). Thus, inactivation of enzyme can hinder enzymatic browning and related-reactions, consequently, minimizing nutrient

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loss and colour deterioration during processing. Thermal blanching is widely used prior to drying to inactivate oxidative enzymes so as to preserve colour and nutrition of products (Deng *et al.*, 2017). Hot water blanching is the most popular and commercially adopted method as it is simple and inexpensive. However, the soluble nutrients in materials are blanched as dissolved or leach into water (Xiao *et al.*, 2017).

Therefore, processing of green bananas into flour is of interest in view of the surplus fruits often available year around in production areas. This will also provide a means of effective utilization of fruits as well as source of gluten free flour. Therefore, the present investigation was planned to assess the effect of pre-processing treatment on physio-chemical attributes of unripe mature banana flour.

MATERIALS AND METHODS

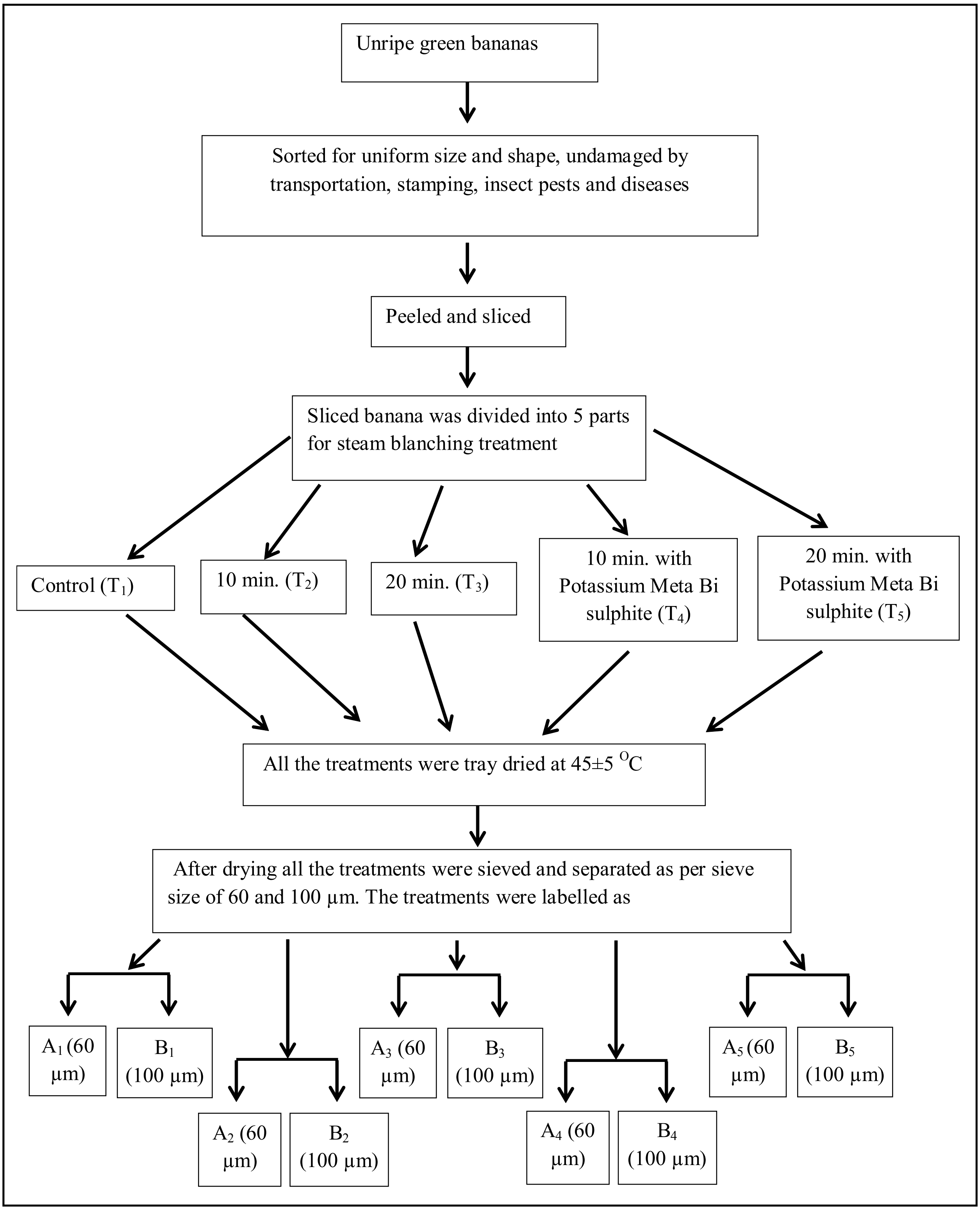
The present investigation was carried out during December 2022 to May 2023 at Postharvest Management Laboratory, School of Agriculture, ITM University, Gwalior. Fresh and unripe green bananas (*Musa paradisiaca* var. Grand nain) were procured from orchard located at Anantpur District, Andhra Pradesh. The uniform sized, insect-pests, diseases-free and undamaged green bananas were selected for transportation. The selected green bananas (GB) were manually peeled and cut into 0.5 cm thick slices. The cut slices of GB were divided into five parts for the treatments. The slices of GB were steam blanched for 10 min, 20 min, 10 min with 0.25% potassium meta bi-sulphite; 20 min with 0.25% potassium meta bi-sulphite (KMS). After drying all the treatments were ground into flour and separated on the basis of 60 and 100 µm sieve size (Flow chart 1). The per cent flour yield of the sieve size (SS) was also recorded. All the treated BF were further packed into an air tight container and labelled for 60 µm SS as A_1 (Control), A_2 (10 min steam blanched), A_3 (20 min steam blanched), A_4 (10 min steam blanched with 0.25% potassium meta-bisulphate) and A_5 (20 min steam blanched with 0.25% potassium meta-bisulphate). Whereas for 100 µm SS containers with BF were labelled as B_1 (Control), B_2 (10 min steam blanched), B_3 (20 minutes steam blanched), B_4 (10 min steam blanched with 0.25% potassium meta-bisulphate) and B_5 (20 min steam blanched with 0.25% potassium meta-bisulphate).

All the treatments were analyzed for pH, total soluble solids (TSS), titratable acidity (TA), water holding capacity (WHC), oil holding capacity (OHC) and swelling capacity (SC) by using the protocols suggested by Pataiya *et al.* (2023). Proximate composition viz., moisture, ash, crude fat, crude fiber, protein, carbohydrate (CHO) and energy were determined according to the standard protocols (Pataiya *et al.,* 2023) by the calculation method. All the analyses were done in triplicates. The results obtained during the investigation were statistically analyzed through analysis of variance at 55% level of significance (Bender, 2020).

RESULTS AND DISCUSSION

The total GB flour yield ranged between 95.52 to 97.7% (Table 1). Whereas it was observed that with increase in temperature of steam blanching led to increase in per cent flour yield. However, steam blanching for 20 min had shown contrary results. For sieve size higher per cent of GB flour yield was recorded for100 µm sieve size and ranged between 71.53 to 83.98%. This phenomenon was probably due to steam with high temperature. During processing through steam blanching coupled with increase in time duration led into swelling of the cell wall structure as well as adhesion bonding between cell wall (Tabtiang *et al.,* 2022). This led into distraction of cell component resulted into reduced flour yield per cent.

The results of the physio-chemical properties for 60 and 100 µm sieve size are presented under Tables 2 and 3, respectively. The pH, TSS, titratable acidity, water holding capacity, oil holding capacity and swelling capacity were noted highest for A_2 (6.4), A_1 (0.42 ^{O}B), A_3 (0.47%), A_5 (3.27 g/g), A_2 (1.38 g/g) and A_5 (6.637%), respectively. Whereas wide variation was noted for 100 µm sieve size and found maximum pH for B_5(6.40), titratable acidity for B_4 (0.55%), water holding capacity for B_4 (2.33 g/g) and swelling capacity for B_5 (5.71%). Steam blanching treatment changes the structure of cell wall, such as cellulose, hemicellulose, pectin, etc. by degrading and loss. Thermal pre-treatments can cause the disintegration of the



Flow chart 1. Pre-processing treatment of green banana for flour preparation.

middle lamellar layer due to depolymerization of pectin chains contained inside it (Rinaldi *et al.*, 2021). The depolymerization and increase in cell wall led into increase in void volume. Therefore, it increased in WHC and swelling capacity, whereas OHC was decreased. However, it was noted that with increase in temperature affected the TSS adversely. It was

Table 1. Per cent flour yield of pre-processed green mature banana

Treatment	Total yield	60 µm SS	100 µm SS
T_1–Control	95.81	16.11	79.70
T_2–10 min blanching	96.02	13.57	82.45
T_3–20 min blanching	95.52	24.02	71.53
T_4–10 min blanching and 0.25% KMS	97.7	13.75	83.95
T_5–20 min blanching and 0.25% KMS	96.33	12.35	83.98

also noted that this phenomenon was decreased with increase in sieve size (Tables 2 and 3).

Moisture content ranged between 5.34 (A_2) to 3.43% (A_4). Whereas highest ash, fiber content and protein were noted for A_4, A_1 and A_5 for 60 µm sieve size, respectively (Table 4). For 100 µm sieve size ash, fat, fiber, protein, carbohydrate and energy content ranged between 2.46 to 3.06%, 0.34 to 1.61%, 3.35 to 4.71%, 3.27 to 4.32%, 81.54 to 83.73% and 346.61 to 351.34 Kcal/100 g, respectively (Table 5). The present study revealed that the blanching treatment had positive effect of the energy content for 100 µm sieve size.

Overall results revealed that steam blanching for 10 min had superior water holding capacity and found to be at par with steam blanching 20 min with 0.25% potassium meta-bi-sulphite for 60 µm sieve size. Tabtiang *et al.* (2022) noted that hot water or steam pre-treatments caused pronounced cells damage and swelling of the cell wall region. This destruction of cell wall might be the reason for decrease in fiber content and increase in protein content. Afolabi *et al.* (2021) conducted study on sweet potato and found that water blanched samples had high water absorption capacity and swelling capacity, with remarkable pasting characteristics. Highest protein, mineral and fiber content was noted for 60 µm sieve size banana flour. However, maximum carbohydrates and energy content were noted in 60 µm sieve size banana flour. Other researches revealed that unripe mature banana had high carbohydrates specially starch content 70-80% on a dry weight basis. Heat treatment modified the starch might also alter its digestibility of resistant starches and demonstrated reduced glycemic response, reduced hunger, increased satiety parameters and insulin sensitivity (Hoffmann *et al.,* 2016). Therefore, the products prepared by using unripe banana flour with steam blanching treatment may be used for the development of different processed products, especially for the patients with celiac disease. Tabtiang *et al.* (2022) also noted that hot water or steam pre-treatments had positive effect on the colour. Similar observations were recorded in present study also. However, sieve size also had a positive effect on the banana flour and noted comparatively bright colour for 100 µm sieve size banana flour. The negative impact on colour was attributed to heat-driven non-enzymatic browning which was more pronounced during hot water blanching than during steam blanching. Additionally, a

Table 2. Physico-chemical properties of banana flour at different pre-processing treatment for 60 µm

Treatment	pH	TSS (°B)	TA (%)	WHC (g/g)	OHC (g/g)	SC (%)
A_1	5.72	0.42	0.42	2.41	1.38	4.84
A_2	6.41	0.30	0.34	2.47	1.07	6.18
A_3	5.43	0.27	0.47	2.68	0.93	5.41
A_4	5.32	0.33	0.42	2.63	0.95	4.963
A_5	5.82	0.23	0.29	3.27	0.83	6.637
C. D. (P=0.05)	0.162	0.121	0.171	0.071	0.103	0.069

Table 3. Physico-chemical properties of banana flour at different pre-processing treatments for 100 µm

Treatment	pH	TSS (°B)	TA (%)	WHC (g/g)	OHC (g/g)	SC (%)
B_1	6.52	0.17	0.47	2.13	0.76	3.52
B_2	6.35	0.13	0.34	2.01	0.58	4.94
B_3	6.27	0.27	0.29	2.05	0.57	4.53
B_4	5.98	0.17	0.55	2.33	0.53	5.59
B_5	6.40	0.23	0.29	2.027	0.567	5.71
C. D. (P=0.05)	0.1	N/A	0.136	0.182	N/A	0.295

Table 4. Proximate parameters of banana flour at pre-processing treatment for sieve size 60 μm (g/100 g)

Treatment	Moisture	Ash	Fat	Fibre	Protein	CHO	Energy (Kcal.)
A_1	4.95	3.79	0.52	9.92	4.67	76.15	327.93
A_2	5.34	3.79	0.43	9.27	5.19	75.97	328.58
A_3	5.21	3.43	1.07	9.00	4.44	76.87	334.81
A_4	3.43	4.09	1.45	9.69	5.72	75.63	338.43
A_5	4.78	2.99	1.38	9.04	6.13	75.68	339.70
C. D. (P=0.05)	0.17	0.373	0.227	0.599	0.22	0.14	1.12

Dry weight basis.

Table 5. Proximate parameters of banana flour at pre-processing treatment for sieve size 100 μg (g/100 g)

Treatment	Moisture	Ash	Fat	Fibre	Protein	CHO	Energy (Kcal.)
B_1	7.41	2.78	0.72	3.70	3.85	81.54	348.06
B_2	6.39	2.91	1.47	3.35	4.14	81.61	346.61
B_3	5.72	2.46	1.59	3.58	4.32	82.13	351.34
B_4	5.42	3.06	0.34	4.65	3.27	83.73	351.10
B_5	5.11	2.88	1.61	4.71	3.62	82.39	346.89
C. D. (P=0.05)	0.285	N/A	N/A	0.759	0.222	1.396	10.835

Dry weight basis.

negative impact of water blanching on taste, texture, odor and appearance was observed, being related to protein break down and dehydration at the mushroom surface. The results of this study showed that peeling and blanching significantly affected the proximate compositions, physico-chemical, anti-nutritional properties and mineral profiles of plantain flours (Akinjayeju *et al.,* 2020).

CONCLUSION

The pre-processing treatment of unripe mature banana flour with the 0.25% meta bi-sulphite along with sieving the banana flour with 60 and 100 μm sieve had a significant effect on physico-chemical and proximate composition of banana flour. Among all treatments, sieve size was inversely proportional with the nutritional composition.

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REFERENCES

Afolabi, K. A., Taiwo, K. A., Morakinyo, T. A. and Badiora, O. A. (2021). Studies on physico-chemical, mineral, and sensory properties of sweet potato flour. *Europ. J. App. Sci.* **9**: 094-109.

Akinjayeju, O., Badrudeen, A. O. and Soretire, M. Q. (2020). Effect of peeling and blanching on proximate compositions, mineral profile, physico-chemical and anti-nutritional properties of plantain (*Musa* AAB) flours. *J. Res. Food Sci. Nutri.* **1**: 013-023.

Al-Dairi, M., Pathare, P. B., Al-Yahyai, R., Jayasuriya, H. and Al-Attabi, Z. (2023). Postharvest quality, technologies and strategies to reduce losses along the supply chain of banana: A review. *Tren. Food Sci. Tech.* **134**: 177-191. *doi: 10.1016/j.tifs.2023.03.003.*

Aune, D., Giovannucci, E., Boffetta, P., Fadnes, L. T., Keum, N., Norat, T., Greenwood, D. C., Riboli, E., Vatten, L. J. and Tonstad, S. (2017). Fruit and vegetable intake and the risk of cardiovascular disease, total cancer and all-cause mortality–A systematic review and dose-response meta-analysis of prospective studies. *Int. J. Epidemiol.* **46**: 1029-1056.

Bender, F. E. (2020). *Statistical Methods for Food and Agriculture.* CRC Press.

Deng, L. Z., Mujumdar, A. S., Zhang, Q., Yang, X. H., Wang, J., Zheng, Z. A. and Xiao, H. W. (2017). Chemical and physical pre-treatments of fruits and vegetables: Effects on drying characteristics and quality attributes–A comprehensive review. *Crit. Rev. Food Sci. Nutri.* **59**:1408-1432. *Doi: 10.1080/10408398.2017.1409192.*

Hoffmann Sardá, F. A., Giuntini, E. B., Gomez, M. L. P. A., Lui, M. C. Y., Negrini, J. A. E., Tadini, C. C., Lajolo F. M. and Menezes, E. W. (2016). Impact of resistant starch from unripe banana flour on hunger, satiety and glucose homeostasis in healthy volunteers. *J. Func. Foods* **24**: 63-74.

Liu, W., Hu B., Dehghan, M., Mente, A., Wang, C., Yan, R., Rangarajan, S., Tse, L.A., Yusuf, S., Liu, X., Wang, Y., Qiang, D., Hu, L., Han, A., Tang, X., Liu, L. and Li, W. (2021). Fruit, vegetable and legume intake and the risk of all-cause, cardiovascular, and cancer mortality: A prospective study. *Clin. Nutr.* **40**: 4316-4323.

Pataiya, V., Bhati, D., Singh, S. K., Maurya, D., Tyagi, D. B. and Sharma, S. (2023). Effect of different drying treatments on functional and nutritional composition of oyster mushroom (*Pleurotus ostreatus*) powder. *Indian J. Eco.* **50**: 478-481.

Rinaldi, M., Santi, S., Paciulli, M., Ganino, T., Pellegrini, N., Visconti, A., Vitaglione, P., Barbanti, D. and Chiavaro, E. (2021). Comparison of physical, microstructural and antioxidative properties of pumpkin cubes cooked by conventional, vacuum cooking and sous vide methods. *J. Sci. Food Agri.,* **101**: 2534-2541.

Saito, K., Okouchi, M., Yamaguchi, M., Takechi, T., Hatanaka, Y., Kitsuda, K., Mannari, T. and Takamura, H. (2022). Quality improvement of gluten-free rice flour bread through the addition of high-temperature water during processing. *J. Food Sci.* **87**: 4820-4830. *doi: 10.1111/1750-3841.16333.*

Salis, S., Virmani, A., Priyambada, L., Mohan, M., Hansda, K. and Beaufort, C. D. (2021). Old is gold: How traditional Indian dietary practices can support pediatric diabetes management. *Nutrients* **13**: 4427.

Statista (2023). Global gluten-free food market size 2022-32. Statista. Seen on 28/08/2023.

Tabtiang, S., Umroong, P. and Soponronnarit, S. (2022). Comparative study of the effects of thermal blanching pre-treatments and puffing temperature levels on the microstructure and qualities of crisp banana slices. *J. Food Pro. Eng.* **45**: e13931. *doi: 10.1111/jfpe.13931.*

Xiao, H, Pan, Z., Deng, L, El-Mashad, H., Yang, X., Mujumdar, A. S., Gao, Z. and Zhang, Q. (2017). Recent developments and trends in thermal blanching – A comprehensive review. *Inf. Pro. Agri.* **4**: 101-127.