International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; 8(10): 251-254
www.biochemjournal.com
Received: 01-07-2024
Accepted: 04-08-2024

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Studies on physico-chemical properties of banana (*Musa* spp) papad

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DOI: https://doi.org/10.33545/26174693.2024.v8.i10d.2442

Abstract
The present investigation on "Studies on Physico-chemical properties of Banana (*Musa* spp) papad'' was carried out at Department of Post-Harvest Management, College of Horticulture, Dr. Y.S.R Horticultural University, Venkataramannagudem, Andhra Pradesh during 2023-24 under Factorial Completely Randomized Design (FCRD) with two factors, Factor I include 4 different varieties (Kovvuru bontha, Tella chakkarakeli, Karpura chakkarakeli and Grand naine), Factor II include flour treatments (control, urad flour, jack seed flour and soya flour), 16 treatment combinations replicated thrice. They were evaluated on the basis of physical parameters such as recovery (%) and drying time (hours) while, biochemical parameters *i.e.*, starch content (%), total sugars (%) and vitamin-c (mg/100 g). The results revealed that V_2T_1 exhibited the highest vitamin-C content (8.12 mg/100 g) and the shortest drying time (5.12 hours). However, high starch content (54.18%) was reported in V_1T_1 and maximum recovery percent was found to be in V_1T_2. Highest percentage of total sugars was noticed in V_4T_1.

Keywords: Banana, papad recovery, flour sources, starch content, drying time

Introduction
The banana plant (*Musa* spp.), native to South East Asia's humid tropics, is a perennial herb of the Musaceae family. This fruit known as "Apple of Paradise" and "Tree of Wisdom," is a nutrient-dense food, providing calcium, phosphorus, magnesium, potassium, iron, vitamin B_6 and C (Netshiheni *et al.*, 2019) [10]. It is rich in fibre and antioxidant levels contribute to their association with chronic disease prevention (Singh *et al.*, 2016) [14] and anti-tumor activity (Borges *et al.*, 2014) [2]. Due to its climacteric nature and perishability results in significant post-harvest losses exacerbated by low market prices following bountiful harvests.
To mitigate these losses various value-addition techniques are employed transforming bananas into diverse products such as chips, candy, flour, juice, fruit bars, biscuits, jam, jelly, puree, wine and vinegar (Emaga *et al.*, 2007) [4]. Moreover, non-edible plant parts can be converted into valuable items like compost, animal feed, handmade crafts including textiles and accessories. As emphasized by (Mohapatra *et al.*, 2010) [9] banana play a vital role in ensuring food security, promoting health and enhancing farmer livelihoods.
Papad is a staple savory food in Indian households providing essential nutrient serving as a popular preserved and dried food product (Kulkarni *et al.*, 1996) [7]. Typically, roasted or fried papads are enjoyed as a side dish and comes in various forms made from diverse flours like black gram, soya bean. Jackfruit seeds a nutrient-rich under-utilized resource provides an affordable alternative protein source (5.3-6.8%) to prevent malnutrition (Chrips *et al.*, 2008) [3]. With their sweet, milky flavour, ripe jackfruit seeds are edible and commonly consumed roasted and salted. Furthermore, jackfruit seed flour can be incorporated into baked food items and papad, boosting dietary benefits and addressing protein and calorie gaps in Indian diets.

Materials and Methods
The present investigation "Studies on Physico-chemical properties of Banana (*Musa* spp) papad" was carried out at Post Harvest Laboratory, College of Horticulture, Dr. Y.S.R Horticultural University, Venkataramannagudem, Andhra Pradesh during 2023-24. The experiment was conducted in FCRD with three replications comprising 16 treatment

combinations with two factors at four levels. Banana varieties include; Kovvuru bontha, Tella chakkarakeli, Karpura Chakkarakeli and Grand naine and the treatments includes; control (no flour), urad flour, jack seed flour, soya flour. Raw materials such as bananas, flour and papad masasla were procured from the Local market.

Preparation of papad

Green mature bananas were selected and processed through steam boiling in a pressure cooker. After peeling the fruits were converted into a paste, mixed with flour and papad masala according to treatment specifications and formed into a smooth dough. The dough was kneaded into 10 g ball each flattened into thin circular shapes using a papad press and dried in a cabinet dryer at 55 °C. Finally, the papads were packed and stored under ambient conditions.

Table 1: Different varieties and flour sources

Varieties of Banana	Treatments (Flours)
V_1- Kovvuru bontha	T_1 – Control (no flour)
V_2 – Tella chakkarakeli	T_2 – Urad flour
V_3 – Karpura Chakkarakeli	T_3 – Jack seed flour
V_4 – Grand naine	T_4 – Soya flour

Table 2: Treatment combinations of banana papad

Treatment combinations	Pulp: Flour
V_1T_1	100:00
V_1T_2	50: 50
V_1T_3	50: 50
V_1T_4	50: 50
V_2T_1	100:00
V_2T_2	50: 50
V_2T_3	50: 50
V_2T_4	50: 50
V_3T_1	100:00
V_3T_2	50: 50
V_3T_3	50: 50
V_3T_4	50: 50
V_4T_1	100:00
V_4T_2	50: 50
V_4T_3	50: 50

Results and Discussion

1. Recovery percent: Recovery percentage of the banana papad were represented in the Table 3 in which it varied significantly among banana varieties and treatments. Kovvuru bontha (V_1) and Karpura chakkarakeli (V_3) recorded recovery rates of 47.20% and 45.30% respectively whereas, Grand naine (V_4) had the lowest recovery (41.56%). Urad flour treatment (T_2) yielded the highest recovery (51.16%) followed by jack fruit seed flour (T_3) (46.95%) while, (T_1) (no flour treatment) had the lowest recovery (33.43%). The V_1T_2 combination achieved the highest recovery (53.13%) whereas V_4T_1 had the lowest (30.62%).

The variety Kovvuru bontha (V_1) demonstrated the highest recovery rate largely due to its high starch content and dry matter. This observation is consistent with earlier studies on various crops including potato (Grewal and Uppal, 1989; Uppal, 1999) [5, 15], banana (Olorunda, 1993; Shere *et al.*, 1993) [11, 13], and jackfruit (Jagadeesh *et al.*, 2007) [6] which reported similar relationships between starch content, dry matter and recovery percentage.

2. Drying time (hrs): Drying time varied significantly among banana varieties, flour sources, and their interactions as presented in Table 3, Among the varieties Tella chakkarakeli (V_2) and Grand naine (V_4) showed drying times of 7.57 and 8.08 hours respectively while, Kovvuru bontha (V_1) required the longest drying time (10.05 hours). Control treatment (T_1) exhibited the shortest drying time (6.15 hours) followed by urad flour (T_2) (8.43 hours). while, jack fruit seed flour (T_3) took the longest (10 hours). The V_2T_1 achieved the shortest drying time (5.12 hours) whereas, V_1T_4 had the longest (12.54 hours).

Papads prepared with soya flour, urad flour and jack seed flour required longer drying times compared to control papads made from pure pulp. Drying time was influenced by papad thickness and moisture content which is comprised of bound (colloidal) and free water as reported by Lisinska and Leszezynski (1989) [8]. Free water is easily removable through drying or frying whereas, colloidal water is more resistant. The variation in moisture content among papads likely results from differences in the proportions of these two water forms.

Table 3: Effect of different varieties and flour source on the recovery percent and drying time of banana papad

	Recovery percent					Drying time				
	T_1	T_2	T_3	T_4	Mean V	T_1	T_2	T_3	T_4	Mean V
V_1	36.72	53.13	49.65	49.31	47.20	7.34	8.06	12.25	12.54	10.05
V_2	32.16	50.21	45.33	46.34	43.51	5.12	8.38	9.29	7.47	7.57
V_3	34.21	52.12	47.09	47.76	45.30	6.55	9.56	9.19	8.40	8.42
V_4	30.62	49.16	45.71	40.73	41.56	5.58	9.21	9.25	8.28	8.08
Mean T	33.43	51.16	46.95	46.04	44.39	6.15	8.43	10.00	9.17	8.53
Factors	SE(m) ±		C.D at 5%			SE(m) ±		C.D at 5%		
V	0.09		0.27			0.12		0.34		
T	0.09		0.27			0.12		0.34		
Vx T	0.18		0.53			0.23		0.67		

3. Starch content (%): The study found that significant differences in starch content among banana varieties and treatments was represented in the Table 4. Kovvuru bontha (V_1) exhibited the highest starch level at 51.55% followed by Karpura chakkarakeli (V_3) at 36.90%, while, Grand naine (V_4) had the lowest at 32.73%. The treatment (T_1) yielded the highest starch content at 40.43% followed by urad flour (T_2) at 39.15% whereas, soya flour (T_4) contained the least starch at 37.39%. The interaction between (V_1T_1) resulted in the highest starch content at 54.18% while, (V_2T_4) had the lowest at 31.82%.

A significant difference in starch content was observed among treatment combinations. Soya and jack papads recorded the lowest starch percentages attributed to their elevated fiber content whereas, control (no flour treatment) and urad flour papads showed higher starch levels. This

finding is consistent with Azmi *et al.* (2015) [1] study which found maximum starch content in kutki-fortified papads.

4. Total Sugars (%): The total sugar content of the papad prepared from banana was illustrated in the Table 4.

The total sugar content showed significant variation among varieties and treatments. Grand naine (V_4) had the highest sugar content (11.06%) followed by Tella chakkarakeli (V_2) (10.13%) while, Kovvuru bontha (V_1) had the lowest (9.22%). The treatment (T_1) exhibited the highest sugar content (11.63%) followed by urad flour (T_2) (10.89%) whereas, soya flour (T_4) had the lowest (8.65%). The interaction between varieties and treatments revealed significant effects with (V_4T_1) having the highest sugar content (12.83%) whereas, (V_1T_4) having the lowest (7.92%).

The variation in total sugar content among banana papad varieties can be attributed to genetic diversity and treatment influences. Grand naine papads demonstrated the highest sugar content (11.06%) which, according to Ravi (2010) [12] plays a crucial role in determining papad quality, including texture, color, appearance, taste and flavor.

Table 4: Effect of different varieties and flour sources on starch content and total sugars of banana papad

	Starch content					Total Sugars				
	T_1	**T_2**	**T_3**	**T_4**	**Mean V**	**T_1**	**T_2**	**T_3**	**T_4**	**Mean V**
V_1	54.18	53.45	48.39	50.19	51.55	10.51	10.16	8.29	7.92	9.22
V_2	35.28	33.38	32.59	31.82	33.27	11.95	10.87	9.17	8.54	10.13
V_3	38.56	37.08	36.26	35.70	36.90	11.24	10.43	8.93	8.32	9.73
V_4	33.71	32.69	32.66	31.87	32.73	12.83	12.12	9.46	9.82	11.06
Mean T	40.43	39.15	37.47	37.39	38.61	11.63	10.89	8.96	8.65	10.03
Factors	SE(m) ±		C.D at 5%			SE(m) ±		C.D at 5%		
V	0.07		0.02			0.02		0.05		
T	0.07		0.02			0.02		0.05		
Vx T	0.14		0.05			0.03		0.10		

5. Vitamin- C content: Vitamin-C content varied significantly among banana varieties and treatments were represented in the Table 5. Among the varieties Tella chakkarakeli (V_2) had the highest vitamin C content (6.55 mg/100 g) followed by Grand naine (V_4) (6.12 mg/100 g) while, Kovvuru bontha (V_1) had the lowest (5.49 mg/100 g). Among the treatments (T_1) exhibited the highest vitamin C content (7.48 mg/100 g) followed by urad flour (T_2) (6.49 mg/100 g) whereas, soya flour (T_4) had the lowest (3.68 mg/100 g). The treatment combination (V_2T_1) yielded the highest vitamin C content (8.12 mg/100 g) while, flour (V_1T_4) had the lowest (3.08 mg/100 g).

Table 5: Effect of different varieties and flour sources on vitamin-c content (mg/100 g) of banana papad

	Vitamin-C content				
	T_1	**T_2**	**T_3**	**T_4**	**Mean V**
V_1	7.06	6.76	5.06	3.08	5.49
V_2	8.12	6.34	6.25	5.47	6.55
V_3	7.25	6.29	5.98	3.83	5.84
V_4	7.47	6.16	6.22	4.64	6.12
Mean T	7.48	6.49	6.10	3.68	5.94
Factors	SE(m) ±		C.D at 5%		
V	0.02		0.06		
T	0.02		0.06		
VxT	0.04		0.11		

Conclusion

Among the treatment combinations higher recovery percent was noticed in V_1T_2, starch content was maximum in V_1T_1, Total sugar content was higher in the treatment combination V_4T_1. Lower drying time and higher vitamin-c content was recorded in V_2T_1.

Acknowledgments

The authors would like to express their gratitude to Dr. YSR Horticultural University, Venkataramannagudem for the facilities provided during the experiment.

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