

RESEARCH ARTICLE

EFFECT OF BLENDING RATIO OF BANANA FRUIT WITH PSEUDOSTEM CENTRAL CORE AND STORAGE PERIOD ON NUTRITIONAL AND PHYSICOCHEMICAL PROPERTIES OF JAM

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Abstract: The experiment was carried out to investigate the nutritional and physicochemical properties of blended jam made from banana fruit and pseudostem central core, focusing on various blending ratios and storage periods. Treatments ranged from 0:100 (banana fruit: pseudostem central core) to 100:0. Each combination were analyzed for key parameters such as iron, potassium, carbohydrates, protein, calorific value, and acidity, were analyzed at three-month intervals starting from immediately after processing and at three and six months of storage. Significant variation in nutrients was observed across the treatments, where T₁ (0:100) showing the highest iron content (3.13 mg/100g) and T₁₁ (100:0) exhibiting the highest calorific value (277.74 KCal). A general decreasing trend in protein, iron, and potassium was noted over the storage period, while slight increases in calorific value and carbohydrates were observed. The study concludes that the blending ratio significantly affects the nutritional composition, with the pseudostem central core contributing to higher mineral content, while banana fruit enhances caloric value. These findings offer valuable insights into the potential of utilizing banana by-products in food processing, contributing to the development of nutritious, sustainable food products.

Keywords: Banana, Pseudostem, Central core, Blended Jam, Storage

INTRODUCTION

Banana (*Musa paradisiaca* L.) is a monocarpic, herbaceous, monocotyledonous plant that belongs to the family Musaceae, originating from the tropical regions of South-East Asia through the hybridization of *Musa acuminata* and *Musa balbisiana*. India is also recognized as a secondary center of origin. Banana is one of the oldest cultivated fruits, with references in ancient Indian texts like the Ramayana (200 BC) and Kautilya's Arthashastra (300-400 BC). It holds immense nutritional, economic, and cultural significance, serving as a staple and versatile crop across tropical and subtropical regions, particularly between 30°N and 30°S latitudes.

Banana (*Musa paradisiaca* L.) is one of the most popular and refreshing fruits globally, offering nourishment and a well-balanced diet to millions. It

plays a crucial role in livelihoods through its production, processing and marketing. Commercially, banana ranks as the fourth most important global food commodity after paddy, wheat and milk in terms of gross value of production, highlighting its significant socio-economic impact. In India, banana is a highly predominant and beloved crop, enjoyed equally by both the rich and the poor. Banana is often referred to as the "Apple of Paradise" in countries like Uganda, Bakauba, and Tanzania, it serves as a staple food and is among the most widely traded tropical fruits globally (Radha and Mathew, 2007). In India, banana is deeply woven into cultural traditions, with its leaves, pseudo-stem, and fruits regarded as highly auspicious during festivals and celebrations. Beyond its role as a food crop, the banana provides fibre, fodder, beverages, fermented sugars, medicines, flavorings, silage, rope, cordage,

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garlands, shelter materials and even roofing, and wall linings, earning it the title *Kalpitharu* (Tree of life). Banana pseudostem, a major agro-waste, contains significant amounts of dietary fiber and bioactive compounds. Its incorporation into food products like jam can enhance nutritional value while promoting waste utilization. Banana fruit, rich in sugars and micronutrients, offers a suitable base for blending. However, the effects of varying pseudostem-to-fruit ratios and storage duration on jam quality remain underexplored. This study evaluates the nutritional and physicochemical properties of banana fruit and pseudostem central core blended jam across different blending ratios and storage periods, aiming to develop a functional product with improved shelf life and sustainability potential. Hence, the present experiment was conducted to study the nutritional and physicochemical properties of blended jam made from banana fruit and pseudostem central core.

MATERIALS AND METHODS

The experiment was conducted at the Banana Pseudostem Processing Unit, Soil and Water Management Research Unit and Post Harvest Technology Laboratory, N.A.U., Navsari. Uniformized three-quarter mature banana fruits (cv. Grand Naine) were harvested along with pseudostem

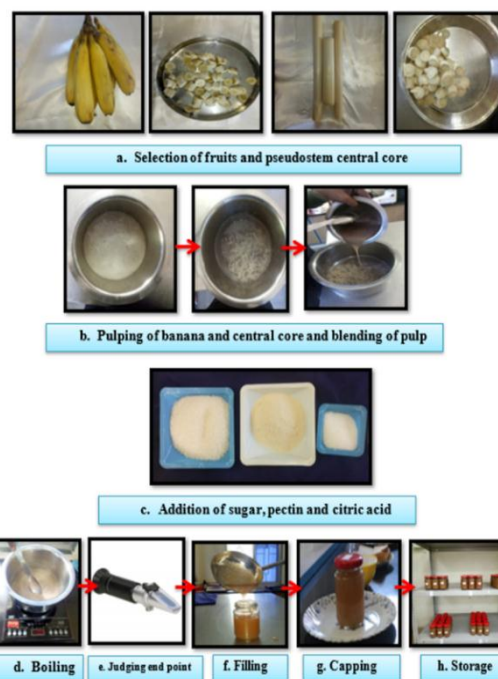
immediately after bunch harvest in February. The pseudostems were washed, split and the central core was sliced and pulped. The experiment consisted of eleven treatments (T₁ to T₁₁), each varying in the proportion of banana fruit pulp to pseudostem central core. The proportion of banana fruit (BF) increased gradually from T₁ to T₁₁, while the proportion of pseudostem central core (PCC) decreased correspondingly. In Treatment T₁, the formulation contained 0% banana fruit and 100% central core. This was followed by T₂ with 10% banana fruit and 90% central core, T₃ with 20% banana fruit and 80% central core. The trend continued with T₄ (30% BF:70% PCC), T₅ (40% BF:60% PCC), T₆ (50% BF:50% PCC), T₇ (60% BF:40% PCC), T₈ (70% BF:30% PCC), T₉ (80% BF:20% PCC), and T₁₀ (90% BF:10% PCC). Finally, Treatment T₁₁ consisted of 100% banana fruit and 0% central core. This systematic variation allowed for the assessment of changes in quality parameters and acceptability as the proportion of banana fruit increased in the formulation. With each treatment maintaining a 1:1 pulp to sugar ratio, constant acidity (0.5%), pectin (0.75%) and TSS (68%). The principal steps followed for preparation of blended jam is given below and schematically presented in Figure 1.



Principal steps used for extraction of banana pulp



Principal steps used for extraction of central core pulp



Principal steps used for blended jam preparation

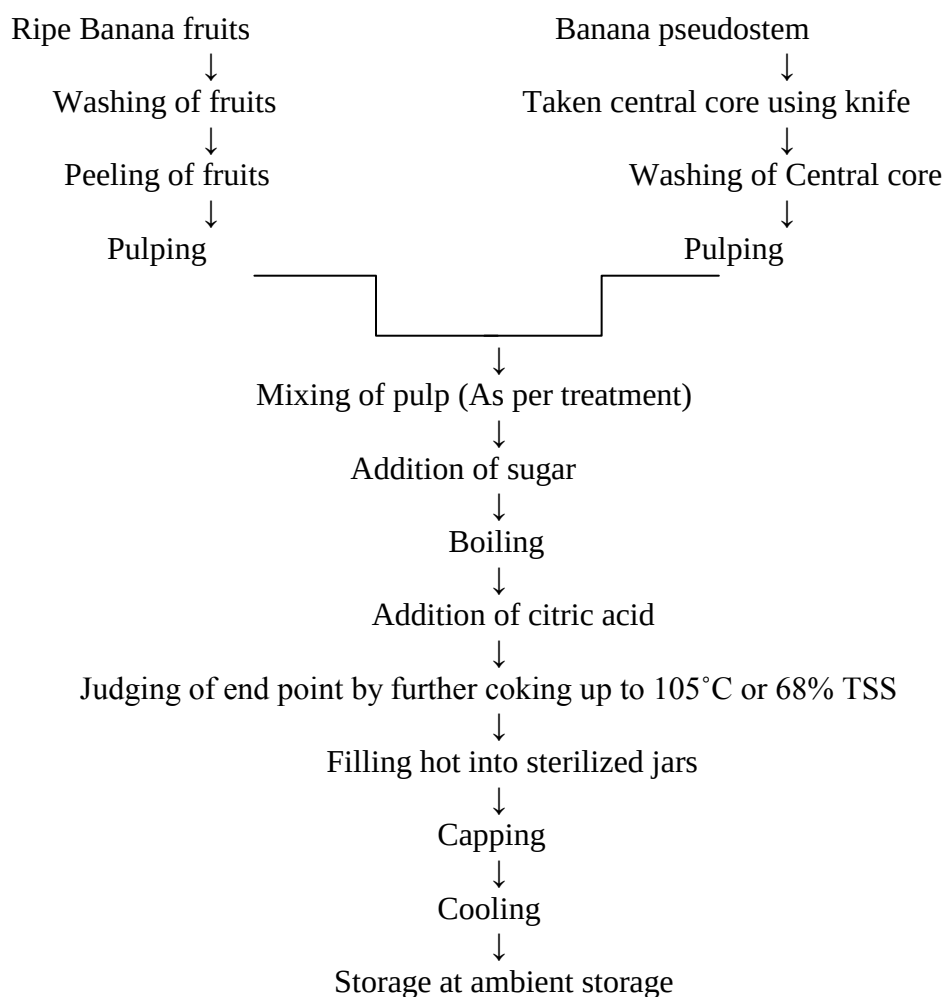


Figure 1. Principal step used for preparation of blended Jam

The 200g jam was stored in glass jars at room temperature (20 to 35°C) and evaluated for chemical and organoleptic properties at 0, 3, and 6 months (Feb–July 2018). Parameters like carbohydrates, protein (Sadasivam and Manickam, 1991), iron, potassium (Ranganna, 1986), calorific value (Eneche, 1991) and microbial load (Ranganna, 1986) were analyzed. Treatment differences were analyzed using the 'F' test based on the null hypothesis. The standard error of mean (S.E.m) was calculated for each parameter, and the critical difference (CD) at the 5% probability level was determined to assess statistical significance.

RESULTS AND DISCUSSION

Carbohydrates (%)

Carbohydrate content in blended jam recorded over 6 months is presented in Table 1. Significant variation was observed among treatments, ranging from 53.95% to 68.08% with a general increasing trend with increasing the ratio of banana flesh. The highest carbohydrate content was in T₁₁ (68.08%) and the lowest in T₁ (53.95%). Over the storage period, the period mean carbohydrates slightly increased from

61.60% to 62.14% overall, with a marginal upward trend (Table 1). The increase in carbohydrates over storage might be due to the hydrolysis of polysaccharides into simple sugars, as noted by Oyleke et al. (2013). The non-significant interaction effects were observed between the treatment of blending and storage intervals (Table 1).

Protein (%)

Protein content in blended jam varied significantly across treatments and storage periods (Table 2). Treatment mean protein values ranged from 0.47% (T₁: 00:100) to 1.11% (T₁₁: 100:00), with T₁₀ (1.02%) and T₂ (0.52%) following. A significant decrease in period mean protein was observed, from initially 0.80% to 0.74% after 6 months of storage. Significant treatment × period (T×P) interaction effects were noted. The highest protein was in T₁₁P₁ (1.16%) followed by T₁₁P₂ (1.14%), while the lowest was in T₁P₃ (0.46%) followed by T₁P₂ (0.47%) (Table 2). Protein declined over storage, with the least reduction in T₁ (0.49 to 0.46%) and higher in T₁₁ (1.16 to 1.03%). Overall, protein content decreased gradually over 6 months. This trend was also reported by Reddy and Chikkasubbanna (2009) in aonla jam storage, Karanjalkar *et al.* (2013) in

guava nectar with soy milk, and in banana central core jam.

Iron (mg/100 g)

The Iron content of banana fruit and pseudostem central core blended jam showed significant variation across treatments and storage periods (Table 3), with a decreasing trend over 6 months. Treatment means ranged from 0.75 mg/100g (T_{11} : 100:00) to 3.13 mg/100g (T_1 : 00:100), with the lowest iron in T_{11} (0.75 mg/100gm) and the highest in T_1 (3.13mg/100gm). Over storage period, mean iron content decreased significantly from 1.78 to 1.51 mg/100g. Among the interactions, highest iron was recorded in T_1P_1 (3.24 mg/100g), while the lowest was in $T_{11}P_3$ (0.63 mg/100g). Over period of storage, minimum decrease in iron was occurred in T_{10} (0.87 to 0.69 mg/100g), while the maximum was observed in T_2 (2.85 to 2.42 mg/100g). The decrease in iron content in storage might be due to higher iron content pseudostem central core decline during storage. Similar results were found by Kumar *et al.* (2012).

Potassium (mg/100 g)

Potassium content of blended jam varied significantly across treatments, ranging from 34.03 to 42.37 mg/100g (Table 4). T_1 (42.37 mg/100g; 00:100) had the highest, while T_{11} (34.03 mg/100g; 100:00) had the lowest. Storage and treatment $\times$ period interactions were non-significant, but a

general decrease in potassium was observed (Table 4). Similar trends were reported by Patel (2016). The non-significant interaction effects were observed between the treatment of blending and storage intervals (Table 4).

Calorific value (Kcal)

Calorific values of blended jam ranged from 218.79 to 277.74 KCal (Table 5), with the highest in T_{11} (277.74 KCal; 100:00) and the lowest in T_1 (218.79 KCal; 00:100). A slight increase in period mean calorific value was observed, from 250.60 to 252.51 KCal after 6 months. The treatment $\times$ period interaction was non-significant, and a stable, slight increase in calorific value during storage was noted (Table 5). The findings align with those of Anonymous (2015) in banana central core jam.

Microbial growth

No microbial growth was observed in any of the treatments throughout the storage period up to 6 months, and the microbial test results consistently yielded a nil outcome. The Total Plate Count (TPC) test revealed that, quality of blended jam did not deteriorate during the storage period at room temperature. There was no bacterial growth was found in the product up to 6 months. These kinds of observations were also recorded by Reddy and Chikkasubbanna (2009) in aonla jam, Sharma (2014) in mango-jamun blended jam.

Table 1. Effect of banana fruit and pseudostem central core blended jam on carbohydrates (%) during storage.

Treatments	Storage periods (P)			Mean (T)
	P ₁ (Initial)	P ₂ (3 month)	P ₃ (6 month)	
T_1 (0% BF:100% PCC)	53.68	53.96	54.22	53.95
T_2 (10% BF:90% PCC)	55.71	55.99	56.25	55.98
T_3 (20% BF:80% PCC)	56.83	57.14	57.40	57.12
T_4 (30% BF:70% PCC)	59.39	59.67	59.99	59.68
T_5 (40% BF:60% PCC)	61.00	61.28	61.54	61.27
T_6 (50% BF:50% PCC)	62.35	62.63	62.83	62.60
T_7 (60% BF:40% PCC)	64.45	64.72	64.98	64.72
T_8 (70% BF:30% PCC)	64.81	65.10	65.34	65.08
T_9 (80% BF:20% PCC)	65.48	65.72	65.98	65.72
T_{10} (90% BF:10% PCC)	66.06	66.37	66.64	66.36
T_{11} (100% BF:0% PCC)	67.81	68.09	68.33	68.08
Mean (P)	61.60	61.88	62.14	
	Treatment (T)	Period (P)	T$\times$P	
S.Em$\pm$	0.156	0.078	0.334	
CD at 5%	0.459	0.222	NS	
CV % (a)	0.437	CV % (b)	1.10	

Table 2. Effect of banana fruit and pseudostem central core blended jam on protein (%) during storage.

Treatments	Storage periods (P)			Mean (T)
	P ₁ (Initial)	P ₂ (3 month)	P ₃ (6 month)	
T_1 (0% BF: 100% PCC)	0.49	0.47	0.46	0.47
T_2 (10% BF: 90% PCC)	0.55	0.51	0.50	0.52

T₃ (20% BF: 80% PCC)	0.66	0.63	0.59	0.63
T₄ (30% BF: 70% PCC)	0.68	0.67	0.64	0.66
T₅ (40% BF: 60% PCC)	0.73	0.69	0.68	0.70
T₆ (50% BF: 50% PCC)	0.82	0.80	0.77	0.80
T₇ (60% BF: 40% PCC)	0.85	0.83	0.81	0.83
T₈ (70% BF: 30% PCC)	0.88	0.84	0.80	0.84
T₉ (80% BF: 20% PCC)	0.93	0.91	0.89	0.91
T₁₀ (90% BF: 10% PCC)	1.05	1.03	0.98	1.02
T₁₁ (100% BF:0% PCC)	1.16	1.14	1.03	1.11
Mean (P)	0.80	0.77	0.74	
	Treatment (T)	Period (P)	T×P	
S.Em±	0.005	0.003	0.009	
CD at 5%	0.014	0.007	0.024	
CV % (a)	1.74	CV % (b)	1.85	

Table 3. Effect of banana fruit and pseudostem central core blended jam on iron (mg/100 g) during storage.

Treatments	Storage period (P)			Mean (T)
	P₁ (Initial)	P₂ (3 month)	P₃ (6 month)	
T₁ (0% BF: 100% PCC)	3.24	3.19	2.95	3.13
T₂ (10% BF: 90% PCC)	2.85	2.81	2.42	2.69
T₃ (20% BF: 80% PCC)	2.57	2.39	2.32	2.43
T₄ (30% BF: 70% PCC)	2.10	2.01	1.83	1.98
T₅ (40% BF: 60% PCC)	1.85	1.79	1.46	1.70
T₆ (50% BF: 50% PCC)	1.62	1.54	1.31	1.49
T₇ (60% BF: 40% PCC)	1.42	1.23	1.14	1.26
T₈ (70% BF: 30% PCC)	1.18	1.07	0.97	1.07
T₉ (80% BF: 20% PCC)	1.07	1.01	0.84	0.97
T₁₀ (90% BF: 10% PCC)	0.87	0.84	0.69	0.80
T₁₁ (100% BF:0% PCC)	0.83	0.79	0.63	0.75
Mean (P)	1.78	1.70	1.51	
	Treatment (T)	Period (P)	T×P	
S.Em±	0.012	0.005	0.018	
CD at 5%	0.035	0.015	0.051	
CV % (a)	1.90	CV % (b)	1.86	

Table 4. Effect of banana fruit and pseudostem central core blended jam on potassium (mg/100 g) during storage.

Treatments	Storage period (P)			Mean (T)
	P ₁ (Initial)	P ₂ (3 month)	P ₃ (6 month)	
T ₁ (0% BF: 100% PCC)	42.49	42.37	42.24	42.37
T ₂ (10% BF: 90% PCC)	41.63	41.53	41.43	41.53
T ₃ (20% BF: 80% PCC)	40.50	40.12	39.69	40.10
T ₄ (30% BF: 70% PCC)	39.37	39.24	39.12	39.24
T ₅ (40% BF: 60% PCC)	39.35	39.25	39.14	39.25
T ₆ (50% BF: 50% PCC)	38.27	38.25	38.18	38.22
T ₇ (60% BF: 40% PCC)	37.59	37.46	37.24	37.43
T ₈ (70% BF: 30% PCC)	36.35	36.26	36.14	36.25
T ₉ (80% BF: 20% PCC)	35.00	34.60	34.47	34.69
T ₁₀ (90% BF: 10% PCC)	34.44	34.29	34.22	34.32
T ₁₁ (100% BF:0% PCC)	34.05	34.02	34.00	34.03
Mean (P)	38.10	37.95	37.80	
	Treatment (T)	Period (P)	T×P	
S.Em±	0.278	0.102	0.337	
CD at 5%	0.808	NS	NS	
CV % (a)	2.18	CV % (b)	1.54	

Table 5. Effect of banana fruit and pseudostem central core blended jam on calorific value (KCal) during storage.

Treatments	Storage periods (P)			Mean (T)
	P ₁ (Initial)	P ₂ (3 month)	P ₃ (6 month)	
T ₁ (0% BF: 100% PCC)	217.76	218.80	219.80	218.79
T ₂ (10% BF: 90% PCC)	226.12	226.90	227.99	227.00
T ₃ (20% BF: 80% PCC)	230.95	232.07	232.95	231.99
T ₄ (30% BF: 70% PCC)	241.27	242.35	243.51	242.38
T ₅ (40% BF: 60% PCC)	247.91	248.87	249.87	248.88
T ₆ (50% BF: 50% PCC)	253.67	254.71	255.39	254.59
T ₇ (60% BF: 40% PCC)	262.19	263.19	264.15	263.18
T ₈ (70% BF: 30% PCC)	263.75	264.75	265.55	264.68
T ₉ (80% BF: 20% PCC)	266.63	267.51	268.47	267.54
T ₁₀ (90% BF: 10% PCC)	269.43	270.59	271.47	270.50
T ₁₁ (100% BF:0% PCC)	276.87	277.91	278.43	277.74

PCC)				
Mean (P)	250.60	251.60	252.51	
	Treatment (T)	Period (P)	T×P	
S.Em±	0.555	0.423	1.40	
CD at 5%	1.638	1.22	NS	
CV % (a)	0.38	CV % (b)	1.12	

CONCLUSION

In conclusion, the study on banana fruit and pseudostem central core blended jam revealed significant variations in nutritional and physicochemical properties based on blending ratios and storage periods. The iron, potassium, carbohydrate, and protein content showed a general decrease over 6 months. The findings highlight that blending ratios and storage conditions significantly impact the nutritional profile, suggesting that optimized combinations can enhance specific components in the jam. Additionally, the study emphasizes the importance of balancing the fruit and pseudostem central core ratios for maximizing nutrient retention, while also contributing valuable insights into the effects of storage on product quality. These results can guide future research and product development in the field of food processing using banana and pseudostem resources.

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