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# Standardization of blanching and sulphitation technique on physico-chemical parameters for dehydration of banana pseudo stem central core for powder making using cabinet dryer

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**Abstract**
The experiment was conducted to evaluate the performance of "Standardization of blanching and sulphitation technique on physico-chemical parameters for dehydration of banana pseudostem central core for powder making using cabinet dryer" with 16 treatments were fixed including pre-treatment of blanching ($B_1$-0 min., $B_2$-2 min., $B_3$-4 min. and $B_4$-6 min.) and sulphitation ($S_1$-0.0% KMS, $S_2$-0.1% KMS, $S_3$-0.2% KMS and $S_4$-0.3% KMS). The prepared blended powder was stored at room temperature for up to 6 months (0, 3 and 6 months) in 100 g aluminum laminated pouches. The results were statistically analyzed using a completely randomized design with factorial concept. Results indicated that maximum potassium content (4964.25 mg/100g), (3690.77 mg/100g) found in $B_1$ and $S_3$, maximum iron content of (13.31 mg/g) and (11.13 mg/g) found in treatment $B_1$ and $S_2$ respectively. While highest TSS (2.83 ºB), (2.30 ºB), crude fiber (15.51%), (14.05%) and ash content (28.76%), (25.48%) observed in treatment $B_1$ and $S_1$ respectively. The highest $SO_2$ content (72.18 ppm), (40.58 ppm) were found in $B_4$ and $S_4$ respectively although, highest $L^*$ value of (79.42), (71.32) were found in treatment $B_3$ and $S_4$ respectively. Also, the interaction of blanching-sulphitation and storage maximum potassium content (5216.00 mg/100g), iron content (13.67 mg/g) were recorded in $P_1B_1S_3$ and highest TSS (2.90 ºB) in $P_3B_1S_3$ while crude fiber (15.76%) and ash content (29.30%) was observed in $P_1B_1S_1$ although highest $SO_2$ content in $P_1B_4S_4$.

**Keywords:** Banana, pseudostem, blanching, sulphitation, dehydration

## Introduction
Banana (*Musa* spp.) is one of the major fruit crop grown in India. It ranks second in area and production next to mango. It is a monocarpic, monocotyledonous and herbaceous plant belonging to the family Musaceae and order Zingiberales. It has been suggested that cultivated bananas originated from the islands of South-East Asia. Banana is basically a tropical crop being cultivated throughout the warm tropical regions of the world between $30^0$ N and $30^0$ S of the equator. Grand Naine is more popular because of its early yield as compared to other varieties. The pseudostem contains rich quantities of calcium, potassium, sodium, iron, magnesium and chlorides. All these are essential to maintain the balance of body fluids and electrolytes. Central cores have been reported to be effective against liver and kidney parasites and central core is traditional remedy against kidney stone (Jeetendra *et al*., 2020) [7].

Bananas are grown mainly for their fruit, but banana trees also contain stems, leaves, pseudostems, leaf sheaths, inflorescences, and other parts. Therefore, banana farms generate large amounts of underutilized by-products and waste. It has been reported that each ton of bananas collected generates about 4 tons of waste, including 100 kg of waste fruit, 3 tons of pseudostems, 160 kg of stems, 480 kg of leaves, and about 440 kg of inflorescences and skins (Fernandes *et al*., 2013) [5]. However, its high production and short shelf life requires conversion into various value-added products *viz*., banana puree, powder, wafers, flour, wine, jam, canned slice, flakes, vinegar, chutney, pickles, fruit bar, chocolates, *etc*. Apart from fruit, banana crop also generates huge biomass in the form of pseudostem, suckers and leaves, etc. The banana stem is called a pseudostem which is rich in fiber, and has great medicinal value too.

The product could be consumed for its high medicinal value, and high content of phenol and tannin imparting an astringent taste to the beverage (Abirami *et al*., 2014) [1].

At present, biomass is absolutely wasting in most of the states of India and Gujarat is not an exception to this. For disposing of, presently farmers are spending about Rs. 12,000 to 15,000 per hac. Disposal of pseudostem in a routine way is done by dumping on field bunds, burning, disposing in natural drains, *etc*. Thus, causing environmental problems as well as becoming very good host for pathogen and insect growth. Banana pseudostem is mostly restricted to fiber extraction and products like handicrafts, paper production, *etc.* on a small scale. However, Navsari Agricultural University, Navsari has developed products under NAIP scheme funded by ICAR like banana pseudostem core candy, pickles, jam, jelly, squash, nectar, RTS, *etc.* Pseudostem juice is available in huge quantities and rich in potassium, iron and other nutraceutical properties. According to reports of CFTRI, Mysore there are no harmful components present in it and can be used as an edible processed product. In the past NAU scientists have worked on the development of nutraceutical beverages from the banana pseudostem juice and successfully prepared different types of beverages (Anon., 2015) [3].

Recently, there has been a change in how banana by-products are managed, with a focus on transforming them into value-added goods. The diverse bioactive chemicals with potential health-promoting benefits have reignited interest in banana by-products. The use of banana by-products for value-added purposes to meet demand in areas such as food alternatives, feed, renewable energy, textiles, and fiber composites is a constant challenge (Rosentrater *et al*., 2009) [11].

## Materials and Methods

The experiment was carried out at the laboratories of Department of Post-Harvest Technology, ASPEE College of Horticulture and Forestry and Banana Pseudostem Processing Unit, Soil and Water Management Research Unit, Navsari Agricultural University, Navsari in year 2021-2022. The pseudostem of banana variety "Grand Naine" procured from fields of Soil and Water Management Research Unit, Navsari Agricultural University, Navsari in the 1st week of October were used in this study. Sixteen treatments with different combinations *viz*., $B_1S_1$ -without blanching and sulphitation, $B_1S_2$ - (without blanching and 0.1% KMS treatment), $B_1S_3$ - (without blanching and 0.2% KMS treatment), $B_1S_4$ - (without blanching and 0.3% KMS treatment), $B_2S_1$ - (2 minutes blanching without sulphitation), $B_2S_2$ - (2 minutes blanching and 0.1% KMS treatment), $B_2S_3$ - (2 minutes blanching and 0.2% KMS treatment), $B_2S_4$ - (2 minutes blanching and 0.3% KMS treatment), $B_3S_1$ - (4 minutes blanching without sulphitation), $B_3S_2$ - (4 minutes blanching and 0.1% KMS treatment), $B_3S_3$ - (4 minutes blanching and 0.2% KMS treatment), $B_3S_4$ - (4 minutes blanching and 0.3% KMS treatment), $B_4S_1$ - (6 minutes blanching without sulphitation), $B_4S_2$ - (6 minutes blanching and 0.1% KMS treatment), $B_4S_3$ - (6 minutes blanching and 0.2% KMS treatment), $B_4S_4$ - (6 minutes blanching and 0.3% KMS treatment) were tried in completely randomized design with factorial concept.

### Methodology for preparation of banana pseudostem central core powder

Washed banana pseudostem central core were sliced using a slicer by adjusting it to an exact thickness of 4 mm. After slicing of banana pseudostem central core they were subjected to blanching at a temperature of 95 °C for 0, 2, 4 and 6 minutes as per treatment and after blanching the slices were immediately placed in cold water to stop the cooking process before subjecting to sulphitation. After treating slices with cold water, they were soaked in a solution of 0.0, 0.1, 0.2 and 0.3 per cent concentration of potassium meta bisulphate (KMS) for ten minutes in order to control browning. Banana pseudostem central core powder was prepared by adopting pre-treatments of blanching and sulphitation. A total 16 treatment combinations were fixed for preparation of powder using different blanching time (minutes) and sulphitation concentrations (% KMS). The blanching temperature of 95 °C, slice thickness of 4 mm and cabinet dryer temperature of 65 °C were kept constant in all the treatments. The banana pseudostem central core powder was stored in aluminum laminated pouches for up to 6 months from October 2021 to March 2022 at room temperature varies from 20 to 35 ºC temperatures.

## Experimental Results and Discussion

### Physico-chemical Parameters

**Potassium Content (mg/100g):** It was observed that the mean highest potassium content of 4964.25 mg/100g and 3690.77 mg/100g was observed in powder prepared by pretreatment of without blanching ($B_1$) and 0.2 per cent KMS ($S_3$). While, significantly the lowest potassium content of 2229.33 mg/100g was observed in powder prepared by pretreatment of 6 minutes blanching ($B_4$). Potassium content decreased significantly over increasing blanching time this might be due to leaching of nutrients with blanching time as potassium is a highly water-soluble mineral (Taiwo *et al*., 2001) [14] similar finding was reported in (Ma *et al*., 2016) [9] in species of *Musa balbisiana* and *Musa acuminate*. Also, storage of central core powder resulted significant decrease in mean potassium content (P) from initial month of 3895.33 to 3453.28 mg/100g at six months of storage. Decrease in potassium content upon storage might be due to interaction between chemical organic constituents of banana pseudostem central core powder induced by high temperature actions during blanching (Taiwo *et al*., 2001) [14]. Interaction of blanching and sulphitation depicted the highest potassium content of 5216.00 mg/100g, 5020.33 mg/100g and 4798.00 mg/100g at 0, 3 and 6 months of storage respectively were observed in treatment combination of $B_1S_3$ (without blanching and 0.2% KMS treatment). Although the interaction of blanching-sulphitation and storage the highest potassium content of 5216.00 mg/100g was recorded in $P_1B_1S_3$ (initial month of storage without blanching and 0.2% KMS treatment).

**Table 1:** Effect of blanching and sulphitation on potassium content (mg/100g) of pseudostem central core powder during storage

| Potassium content (mg/100g) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Storage (P)** | **Blanching (B)** | **Sulphitation (S)** | | | | **Mean (B × P) Mean (P)** | **Mean (B)** |
| | | **$S_1$ - 0.0%** | **$S_2$ - 0.1%** | **$S_3$ – 0.2%** | **$S_4$ - 0.3%** | | |
| 0 Month (P1) | $B_1$- 0 min. | 5188.83 | 5151.77 | 5216.00 | 5208.33 | 5191.23 | 4964.25<br>4106.22<br>3413.06<br>2229.33 |
| | $B_2$- 2 min. | 4324.76 | 4342.56 | 4307.28 | 4340.89 | 4328.87 | |
| | $B_3$- 4 min. | 3674.74 | 3614.81 | 3592.67 | 3609.01 | 3622.81 | |
| | $B_4$- 6 min. | 2437.00 | 2453.50 | 2444.09 | 2419.07 | 2438.41 | |
| | Mean (S×P) | 3906.33 | 3890.66 | 3890.01 | 3894.33 | 3895.33 | |
| 3 Month ($P_2$) | $B_1$- 0 min. | 4973.81 | 4974.37 | 5020.33 | 4911.00 | 4969.88 | |
| | $B_2$- 2 min. | 4120.94 | 4101.99 | 4122.79 | 4133.57 | 4119.82 | |
| | $B_3$- 4 min. | 3424.71 | 3430.20 | 3419.23 | 3400.92 | 3418.76 | |
| | $B_4$- 6 min. | 2240.96 | 2238.01 | 2237.27 | 2226.71 | 2235.74 | |
| | Mean (S×P) | 3690.10 | 3686.14 | 3699.90 | 3668.05 | 3686.05 | |
| 6 Month (P3) | $B_1$- 0 min. | 4754.33 | 4789.99 | 4798.00 | 4584.67 | 4731.75 | |
| | $B_2$- 2 min. | 3851.59 | 3906.33 | 3890.49 | 3832.95 | 3870.34 | |
| | $B_3$- 4 min. | 3190.01 | 3233.55 | 3212.99 | 3153.57 | 3197.53 | |
| | $B_4$- 6 min. | 2012.67 | 1995.71 | 2028.36 | 2017.36 | 2013.53 | |
| | Mean (S×P) | 3452.15 | 3481.40 | 3482.46 | 3397.14 | 3453.28 | |
| | Mean (S) | 3682.86 | 3686.08 | 3690.77 | 3653.13 | | |
| | B | S | B X S | P | B X P | S X P | B X S X P |
| SEm ± | 11.361 | 11.361 | 22.722 | 9.957 | 19.915 | 19.915 | 39.831 |
| CD at 5% | 32.727 | NS | NS | 28.13 | NS | NS | NS |
| CV% | Main plot factor: 1.85 | | | Sub plot factor: 1.88 | | | |

**Iron Content (mg/g):** It was observed that the mean highest iron content of 13.31 mg/g and 11.13 mg/g was observed in powder prepared without blanching ($B_1$) and 0.1 per cent KMS ($S_2$) respectively while significantly the lowest iron content of 8.41 mg/g was observed in powder prepared by pretreatment of 6 minutes blanching ($B_4$). Iron content decreased significantly over increasing blanching time this might be due to leaching of nutrients with blanching time as iron is a water-soluble mineral. Storage of central core powder resulted significant decrease in mean iron content (P) from initial month of 11.28 to 10.80 mg/g at six months of storage. Decrease in iron content upon storage might be due to interaction between chemical organic constituents of banana pseudostem central core powder induced by high temperature actions during blanching. Similar results were found in (Ma *et al*., 2016) [9] in species of *Musa balbisiana* and *Musa acuminate.* Interaction of blanching and sulphitation depicted the highest iron content of 13.67 mg/g, 13.41 mg/g and 13.17 mg/g at 0,3 and 6 months of storage respectively were observed in treatment combination of $B_1S_3$ (without blanching and 0.2% KMS treatment). Whereas interaction of blanching-sulphitation and storage highest iron content of 13.67 mg/g was recorded in $P_1B_1S_3$ (initial month of storage without blanching and 0.2% KMS treatment).

**Table 2:** Effect of blanching and sulphitation on iron content (mg/g) of pseudostem central core powder during storage

| Iron content (mg/g) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Storage (P)** | **Blanching time (B)** | **Sulphitation (S)** | | | | **Mean (B×P) Mean (P)** | **Mean (B)** |
| | | **$S_1$ - 0.0%** | **$S_2$ - 0.1%** | **$S_3$ – 0.2%** | **$S_4$ - 0.3%** | | |
| 0 Month(P1) | $B_1$- 0 min. | 13.40 | 13.63 | 13.67 | 13.52 | 13.56 | 13.31<br>12.31<br>10.14<br>8.41 |
| | $B_2$- 2 min. | 12.66 | 12.52 | 12.26 | 12.66 | 12.53 | |
| | $B_3$- 4 min. | 10.23 | 10.77 | 10.31 | 10.21 | 10.38 | |
| | $B_4$- 6 min. | 8.83 | 8.52 | 8.81 | 8.47 | 8.66 | |
| | Mean (S×P) | 11.28 | 11.36 | 11.26 | 11.22 | 11.28 | |
| 3 Month(P2) | $B_1$- 0 min. | 13.20 | 13.36 | 13.41 | 13.22 | 13.30 | |
| | $B_2$- 2 min. | 12.40 | 12.37 | 12.11 | 12.41 | 12.32 | |
| | $B_3$- 4 min. | 10.03 | 10.51 | 10.11 | 9.95 | 10.15 | |
| | $B_4$- 6 min. | 8.57 | 8.25 | 8.57 | 8.26 | 8.42 | |
| | Mean (S×P) | 11.05 | 11.13 | 11.05 | 10.96 | 11.05 | |
| 6 Month (P3) | $B_1$- 0 min. | 12.97 | 13.14 | 13.17 | 12.99 | 13.07 | |
| | $B_2$- 2 min. | 12.18 | 12.13 | 11.85 | 12.15 | 12.08 | |
| | $B_3$- 4 min. | 9.79 | 10.24 | 9.89 | 9.71 | 9.91 | |
| | $B_4$- 6 min. | 8.31 | 8.03 | 8.28 | 8.03 | 8.16 | |
| | Mean (S×P) | 10.81 | 10.89 | 10.80 | 10.72 | 10.80 | |
| | Mean (S) | 11.05 | 11.13 | 11.04 | 10.97 | | |
| | B | S | B X S | P | B X P | S X P | B X S X P |
| SEm± | 0.078 | 0.078 | 0.156 | 0.057 | 0.114 | 0.114 | 0.228 |
| CD at 5% | 0.225 | NS | NS | 0.161 | NS | NS | NS |
| CV% | Main plot factor: 4.25 | | | Sub plot factor: 3.58 | | | |

**Total Soluble Solids (ºBrix):** Significantly the highest TSS of 2.83 ºB and 2.30 ºB was observed in powder prepared without blanching ($B_1$) and sulphitation ($S_1$) followed lowest TSS of 1.26 ºB was observed in powder prepared by pretreatment of 6 minutes blanching ($B_4$). Lower values of TSS in blanched samples were recorded which might be due to leaching losses of soluble substances (Sharma *et al*., 2015) [13]. Similar result was found in (Lakshman *et al*., 2015) [8] in banana center core flour. Storage of central core powder resulted significant increase in mean TSS (P) from initial month of 2.24 to 2.32 ºB at six months of storage. Increased TSS during the storage might be due to conversion of polysaccharides like starch, cellulose and pectin substances into simple sugars. Similar results were recorded by (Rehman *et al*., 2014) [10] on storage stability of fruit juice concentrates in blended banana pseudostem juice with papaya during 90 days storage period. Also, the interaction of blanching and sulphitation depicted the highest TSS of 2.86 ºB at initial month, 2.88 ºB at 3 month and 2.90 ºB at 6 months of storage were observed in treatment combination of $B_1S_3$ (without blanching and 0.2% KMS treatment). With interaction of blanching-sulphitation and storage highest TSS of 2.90 ºB was recorded in $P_3B_1S_3$ (6 months of storage without blanching and 0.2% KMS treatment).

**Table 3:** Effect of blanching and sulphitation on TSS (ºB) of pseudostem central core powder during storage

| TSS (ºB) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Storage (P)** | **Blanching (B)** | **Sulphitation (S)** | | | | **Mean (B ×P) Mean (P)** | **Mean (B)** |
| | | **$S_1$ - 0.0%** | **$S_2$ - 0.1%** | **$S_3$ – 0.2%** | **$S_4$ - 0.3%** | | |
| 0 Month (P1) | $B_1$- 0 min. | 2.82 | 2.77 | 2.86 | 2.79 | 2.81 | |
| | $B_2$- 2 min. | 2.64 | 2.62 | 2.55 | 2.60 | 2.60 | |
| | $B_3$- 4 min. | 2.39 | 2.33 | 2.28 | 2.30 | 2.33 | |
| | $B_4$- 6 min. | 1.25 | 1.22 | 1.36 | 0.97 | 1.20 | |
| | Mean (S×P) | 2.29 | 2.23 | 2.25 | 2.17 | 2.24 | |
| 3 Month (P2) | $B_1$- 0 min. | 2.80 | 2.82 | 2.88 | 2.83 | 2.83 | |
| | $B_2$- 2 min. | 2.69 | 2.66 | 2.60 | 2.64 | 2.65 | 2.83 |
| | $B_3$- 4 min. | 2.42 | 2.37 | 2.32 | 2.35 | 2.37 | 2.64 |
| | $B_4$- 6 min. | 1.29 | 1.27 | 1.39 | 1.09 | 1.26 | 2.37 |
| | Mean (S×P) | 2.30 | 2.28 | 2.29 | 2.23 | 2.28 | 1.26 |
| 6 Month (P3) | $B_1$- 0 min. | 2.79 | 2.86 | 2.90 | 2.88 | 2.86 | |
| | $B_2$- 2 min. | 2.73 | 2.69 | 2.64 | 2.70 | 2.69 | |
| | $B_3$- 4 min. | 2.47 | 2.42 | 2.37 | 2.39 | 2.41 | |
| | $B_4$- 6 min. | 1.33 | 1.30 | 1.44 | 1.24 | 1.33 | |
| | Mean (S×P) | 2.33 | 2.32 | 2.34 | 2.30 | 2.32 | |
| | Mean (S) | 2.30 | 2.28 | 2.29 | 2.23 | | |
| | B | S | B × S | P | B × P | S ×P | P × B × S |
| SEm± | 0.024 | 0.024 | 0.048 | 0.023 | 0.046 | 0.045 | 0.091 |
| CD at 5% | 0.069 | NS | NS | 0.065 | NS | NS | NS |
| CV% | Main plot factor: 6.36 | | | Sub plot factor: 6.92 | | | |

**Crude Fiber (%):** It was observed that the highest crude fiber of 15.51 and 14.05 per cent was observed in powder prepared without blanching ($B_1$) and sulphitation ($S_1$) respectively followed by lowest crude fiber of 12.48 per cent was observed in powder prepared by pretreatment of 6 minutes blanching ($B_4$). Crude fiber decreased significantly with an increase in blanching time this might be due to the degradation of pectin or other fiber such as cellulose or hemicelluloses during the blanching process hence reducing the crude fiber content of blanched sample (Sengkhamparn *et al*., 2013) [13]. Interaction of blanching and sulphitation depicted the highest crude fiber of 15.76 per cent at initial month, 15.73 per cent at 3 month and 15.52 per cent at 6 months of storage were observed in treatment combination of $B_1S_1$ (without blanching and sulphitation). Although interaction of blanching-sulphitation and storage highest crude fiber of 15.76 per cent was recorded in $P_1B_1S_1$ (initial month of storage without blanching and sulphitation treatment).

**Table 4:** Effect of blanching and sulphitation on crude fiber (%) of pseudostem central core powder during storage

| Crude fiber (%) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Storage (P)** | **Blanching (B)** | **Sulphitation (S)** | | | | **Mean (B×P) Mean (P)** | **Mean (B)** |
| | | **$S_1$ - 0.0%** | **$S_2$ - 0.1%** | **$S_3$ – 0.2%** | **$S_4$ - 0.3%** | | |
| 0 Month(P1) | $B_1$- 0 min. | 15.76 | 15.63 | 15.58 | 15.53 | 15.62 | |
| | $B_2$- 2 min. | 14.88 | 14.52 | 14.64 | 14.31 | 14.59 | |
| | $B_3$- 4 min. | 13.74 | 13.77 | 13.88 | 13.39 | 13.70 | |
| | $B_4$- 6 min. | 12.59 | 12.56 | 12.63 | 12.86 | 12.66 | |
| | Mean (S×P) | 14.24 | 14.12 | 14.18 | 14.03 | 14.14 | 15.51 |
| 3 Month (P2) | $B_1$- 0 min. | 15.73 | 15.59 | 15.53 | 15.45 | 15.57 | 14.47 |
| | $B_2$- 2 min. | 14.74 | 14.52 | 14.37 | 14.41 | 14.51 | 13.45 |
| | $B_3$- 4 min. | 13.39 | 13.50 | 13.72 | 13.09 | 13.43 | 12.48 |
| | $B_4$- 6 min. | 12.40 | 12.38 | 12.46 | 12.56 | 12.45 | |
| | Mean (S×P) | 14.06 | 14.00 | 14.02 | 13.88 | 13.99 | |
| 6 Month (P3) | $B_1$- 0 min. | 15.52 | 15.28 | 15.32 | 15.23 | 15.34 | |
| | $B_2$- 2 min. | 14.55 | 14.16 | 14.35 | 14.17 | 14.31 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | $B_3$- 4 min. | 13.05 | 13.30 | 13.58 | 12.98 | 13.23 | |
| | $B_4$- 6 min. | 12.32 | 12.37 | 12.36 | 12.25 | 12.32 | |
| | Mean (S×P) | 13.86 | 13.78 | 13.90 | 13.66 | 13.80 | |
| | Mean (S) | 14.05 | 13.97 | 14.03 | 13.86 | | |
| | B | S | B X S | P | B X P | S X P | B X S X P |
| SEm± | 0.062 | 0.062 | 0.123 | 0.047 | 0.095 | 0.095 | 0.191 |
| CD at 5% | 0.179 | NS | NS | NS | NS | NS | NS |
| CV% | Main plot factor: 2.65 | | | Sub plot factor: 2.37 | | | |

**Ash Content (%):** Data showed that the mean highest ash content (B) of central core powder is 28.76 per cent was observed in powder prepared without blanching ($B_1$) while significantly the lowest ash content of 20.41 per cent was observed in powder prepared by pretreatment of 6 minutes blanching ($B_4$). The decrease in ash content with increase in blanching time may be due to leaching out of minerals from the central core during hot water blanching pre-treatments. It was observed that the maximum ash content of 25.48 per cent was observed in without sulphitation ($S_1$). Interaction of blanching and sulphitation depicted the highest ash content of 29.30 per cent at initial month, 29.20 per cent at 3 month and 28.74 per cent at 6 months of storage were observed in treatment combination of $B_1S_1$ (without blanching and sulphitation). Whereas interaction of blanching-sulphitation and storage highest ash content of 29.30 per cent was recorded in $P_1B_1S_1$ (initial month of storage without blanching and sulphitation). (Ho *et al*., 2012) [6] and (Aziz *et al*., 2011) [4] reported lower ash contents, which were 6.75 per cent and 10.08 per cent. Higher ash content in this study indicates higher mineral content. It is possible that the usage of different parts of the banana pseudostem resulted in different mineral contents. The pseudostem utilized in this study was the tender core. It is likely that minerals are concentrated in the tender core of the pseudostem. Another possibility is that the banana species used in this study were different from those mentioned in the above references.

**Table 5:** Effect of blanching and sulphitation on ash content (%) of pseudostem central core powder during storage

| Ash content (%) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Storage (P)** | **Blanching (B)** | **Sulphitation (S)** | | | | **Mean (B ×P) Mean (P)** | **Mean (B)** |
| | | **$S_1$ - 0.0%** | **$S_2$ - 0.1%** | **$S_3$ – 0.2%** | **$S_4$ - 0.3%** | | |
| 0 Month(P1) | $B_1$- 0 min. | 29.30 | 28.68 | 28.70 | 28.43 | 28.78 | 28.76 |
| | $B_2$- 2 min. | 27.74 | 27.69 | 27.69 | 27.48 | 27.65 | 27.62 |
| | $B_3$- 4 min. | 24.92 | 24.35 | 24.64 | 24.32 | 24.56 | 24.56 |
| | $B_4$- 6 min. | 20.11 | 20.53 | 20.61 | 20.58 | 20.46 | 20.41 |
| | Mean (S×P) | 25.52 | 25.31 | 25.41 | 25.21 | 25.36 | |
| 3 Month(P2) | $B_1$- 0 min. | 29.20 | 28.76 | 28.81 | 28.98 | 28.94 | |
| | $B_2$- 2 min. | 27.96 | 27.72 | 28.04 | 27.29 | 27.75 | |
| | $B_3$- 4 min. | 25.02 | 24.51 | 24.79 | 24.45 | 24.69 | |
| | $B_4$- 6 min. | 20.33 | 20.74 | 20.78 | 20.50 | 20.59 | |
| | Mean (S×P) | 25.63 | 25.43 | 25.60 | 25.31 | 25.49 | |
| 6 Month(P3) | $B_1$- 0 min. | 28.74 | 28.44 | 28.60 | 28.44 | 28.56 | |
| | $B_2$- 2 min. | 27.76 | 27.45 | 27.51 | 27.21 | 27.48 | |
| | $B_3$- 4 min. | 24.85 | 23.96 | 24.64 | 24.29 | 24.44 | |
| | $B_4$- 6 min. | 19.80 | 20.38 | 20.35 | 20.25 | 20.19 | |
| | Mean (S×P) | 25.29 | 25.06 | 25.27 | 25.05 | 25.17 | |
| | Mean (S) | 25.48 | 25.27 | 25.43 | 25.19 | | |
| | B | S | B X S | P | B X P | S X P | B X S X P |
| SEm± | 0.093 | 0.093 | 0.186 | 0.069 | 0.137 | 0.137 | 0.274 |
| CD at 5% | 0.268 | NS | NS | NS | NS | NS | NS |
| CV% | Main plot factor: 2.21 | | | Sub plot factor: 1.87 | | | |

**$SO_2$ Content (ppm):** It was observed that the highest $SO_2$ content of 72.18 ppm and lowest 71.44 ppm, was observed in 6 minutes blanching ($B_4$) and without blanching ($B_1$) respectively. While, lowest $SO_2$ content 00.00 ppm and highest 40.58 ppm were observed in powder prepared without sulphitation ($S_1$) and 0.3 per cent KMS ($S_4$) respectively. Increase in $SO_2$ content with increase in per cent KMS treatment is due to increase in amount of $SO_2$ content which is present more in higher concentration of KMS than in lower concentration. Interaction of blanching and sulphitation depicted the highest $SO_2$ content of 45.76 ppm at initial month in treatment combination of $B_2S_4$ (2 minutes blanching and 0.3% KMS), 41.92 ppm at 3 month and 36.56 ppm at 6 months of storage were observed in same treatment combination of $B_4S_4$ (6 min. blanching and 0.3% KMS) interaction of blanching and sulphitation found non-significant. With interaction of blanching-sulphitation and storage highest $SO_2$ content of 44.88 ppm was recorded in $P_1B_4S_4$ (initial month of storage with 6 min. blanching and 0.3% KMS).

**Table 6:** Effect of blanching and sulphitation on $SO_2$ content (ppm) of pseudostem central core powder during storage

| $SO_2$ content (ppm) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Storage (P) | Blanching time (B) | Sulphitation (S) | | | | Mean (B×P) Mean (P) | Mean (B) |
| | | $S_1$ - 0.0% | $S_2$ - 0.1% | $S_3$ – 0.2% | $S_4$ - 0.3% | | |
| 0 Month(P1) | $B_1$- 0 min. | - | 28.24 | 35.28 | 44.34 | 26.97 | 71.44 |
| | $B_2$- 2 min. | - | 27.17 | 34.22 | 45.76 | 26.79 | |
| | $B_3$- 4 min. | - | 28.56 | 35.37 | 44.65 | 27.15 | |
| | $B_4$- 6 min. | - | 27.32 | 35.36 | 44.88 | 26.89 | |
| | Mean (S×P) | - | 27.82 | 35.06 | 44.91 | 26.95 | |
| 3 Month(P2) | $B_1$- 0 min. | - | 24.35 | 31.22 | 40.72 | 24.07 | 71.72 |
| | $B_2$- 2 min. | - | 24.55 | 31.48 | 41.16 | 24.30 | |
| | $B_3$- 4 min. | - | 24.32 | 31.42 | 40.34 | 24.02 | |
| | $B_4$- 6 min. | - | 23.36 | 32.76 | 41.92 | 24.51 | 71.58 |
| | Mean (S×P) | - | 24.15 | 31.72 | 41.04 | 24.23 | 72.18 |
| 6 Month(P3) | $B_1$- 0 min. | - | 19.11 | 27.15 | 35.32 | 20.40 | |
| | $B_2$- 2 min. | - | 19.35 | 27.16 | 36.02 | 20.63 | |
| | $B_3$- 4 min. | - | 19.08 | 27.26 | 35.28 | 20.41 | |
| | $B_4$- 6 min. | - | 19.12 | 27.44 | 36.56 | 20.78 | |
| | Mean (S×P) | - | 19.17 | 27.25 | 35.80 | 20.55 | |
| | Mean (S) | - | 23.71 | 31.34 | 40.58 | | |
| | B | S | B X S | P | B X P | S X P | B X S X P |
| SEm± | 0.120 | 0.139 | 0.240 | 0.150 | 0.260 | 0.300 | 0.520 |
| CD at 5% | 0.450 | 0.401 | NS | 0.401 | NS | NS | NS |
| CV% | Main plot factor: 2.25 | | | Sub plot factor: 2.83 | | | |

**Color ($L^*$ value):** It was observed that the mean $L^*$ value (B) of central core powder varied from 59.54 (less white) to 79.42 (more white), significantly the highest $L^*$ value of 79.42 was observed in powder prepared by pretreatment of 4 minutes blanching ($B_3$) while lowest $L^*$ value of 59.54 was observed in 6 minutes blanching ($B_4$). The $L^*$ value increased with an increase in blanching time this might be due to inactivation of PPO (polyphenol oxidase) enzyme which causes browning of a central core. Banana pseudostem samples dried without blanching had brown color and samples blanched for 6 minutes also showed less white color this might be due to browning of the banana pseudostem is also linked to non-enzymatic browning. Thermal degradation may occur during blanching process. (Akissoe *et al*., 2003) [2] reported that browning associated with thermal degradation of originally colorless complex phenolics (e.g., proanthocyanidins and lignins) to colored phenols (e.g., anthocyanidins). In 0.3 per cent KMS treatment ($S_4$) highest $L^*$ value of 71.32 was observed and lowest $L^*$ value of 64.29 was observed in powder prepared without sulphitation ($S_1$). The $L^*$ value increased with increase in per cent KMS concentration this might be due to inactivation of PPO (polyphenol oxidase) enzyme which causes browning of a central core. Interaction of blanching and sulphitation with highest $L^*$ value of 84.99, 81.95 and 77.68 at 0,3 and 6 months of storage were observed in treatment combination of ($B_3S_4$) while, the lowest $L^*$ value of 55.65, 54.56 and 49.69 at 0,3 and 6 months of storage were observed in treatment combination of ($B_1S_1$) However, interaction effect of blanching and sulphitation remained non-significant.

**Table 7:** Effect of blanching and sulphitation on color ($L^*$) value of pseudostem central core powder during storage

| Color ($L^*$) value | | | | | | | |
|---|---|---|---|---|---|---|---|
| Storage (P) | Blanching (B) | Sulphitation (S) | | | | Mean (B×P) Mean (P) | Mean (B) |
| | | $S_1$ - 0.0% | $S_2$ - 0.1% | $S_3$ – 0.2% | $S_4$ - 0.3% | | |
| 0 Month (P1) | $B_1$- 0 min. | 55.65 | 60.68 | 64.44 | 68.14 | 62.23 | 59.92 |
| | $B_2$- 2 min. | 70.80 | 74.89 | 77.05 | 78.53 | 75.32 | |
| | $B_3$- 4 min. | 79.29 | 81.40 | 82.40 | 84.99 | 82.02 | |
| | $B_4$- 6 min. | 57.52 | 61.13 | 62.68 | 65.28 | 61.65 | |
| | Mean (S×P) | 65.81 | 69.53 | 71.64 | 74.23 | 70.30 | |
| 3 Month (P2) | $B_1$- 0 min. | 54.56 | 59.11 | 63.15 | 64.98 | 60.45 | 73.66 |
| | $B_2$- 2 min. | 70.18 | 74.26 | 75.56 | 76.64 | 74.16 | |
| | $B_3$- 4 min. | 76.92 | 78.55 | 81.45 | 81.95 | 79.72 | |
| | $B_4$- 6 min. | 57.46 | 60.60 | 61.92 | 62.11 | 60.52 | 79.42 |
| | Mean (S×P) | 64.78 | 68.13 | 70.52 | 71.42 | 68.71 | 59.54 |
| 6 Month (P3) | $B_1$- 0 min. | 49.69 | 56.33 | 60.01 | 62.36 | 57.10 | |
| | $B_2$- 2 min. | 69.22 | 70.09 | 71.60 | 75.03 | 71.49 | |
| | $B_3$- 4 min. | 75.34 | 75.69 | 77.41 | 77.68 | 76.53 | |
| | $B_4$- 6 min. | 54.94 | 55.78 | 56.81 | 58.24 | 56.44 | |
| | Mean (S×P) | 62.30 | 64.47 | 66.46 | 68.33 | 65.39 | |
| | Mean (S) | 64.29 | 67.38 | 69.54 | 71.32 | | |
| | B | S | B X S | P | B X P | S X P | B X S X P |
| SEm± | 0.475 | 0.475 | 0.949 | 0.463 | 0.926 | 0.926 | 1.852 |
| CD at 5% | 1.368 | 1.368 | NS | 1.308 | NS | NS | NS |
| CV% | Main plot factor: 4.18 | | | Sub plot factor: 4.71 | | | |

## Conclusion

From the foregoing results, it can be concluded that the best quality powder with potassium content, iron content, TSS, crude fiber, and ash content with 0.2 per cent KMS pre-treatment without blanching while $SO_2$ content and color $L^*$ value with 0.3 per cent KMS. It can be stored successfully for 6 months in aluminum laminated pouches at ambient temperature. Therefore, it will be helpful for profitable utilization of banana pseudostem central core and also for development of different value added products.

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