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Research Article

Production and Evaluation of Dried Banana Powder at Different Maturity Stages

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Abstract

Production and development of Cavendish banana fruits powder at different stages of maturity was evaluated in this study in this study. Fruits were collected from the local market, Khartoum north–Sudan during 2010. Banana fruits were treated with lemon juice of 2.5% (total soluble solid) concentration prior to drying. Triplicates trials for each stage has been processed. The fruit components, overall dry ratio, dry ratio and peeling loss, were estimated. Physiochemical properties of the different banana maturity stages and the produced powder such as moisture content, ash content, fibre, protein, total sugar, reducing sugar, ascorbic acid, titrable acidity, total soluble solid (T.S.S) were determined. It was found that banana pulps of different maturity stages retained their quality although, the contents of the mentioned constituents were found to be lesser in the produced powder. Reconstitution characteristics of the processed powder such as wettability, sinkability, flowability, bulk density and solubility rate were also determined. Ripe banana powder have the lowest bulk density (0.70) than the half ripe (0.90) and un ripe (1.05), the full ripe powder have the best flowability (39°) than the half ripe (45°) and un ripe powder (45°). The results of microbial tests of the banana powder revealed that samples are acceptable, hence the powder have an excellent quality attributes which cope with using it as a food supplement.

Keywords: Cavendish banana fruits, Khartoum north–Sudan, total soluble solid, physiochemical properties.

Introduction

Banana belongs to the genus *Musa* of the family Musaceae. In Sudan, banana is the most popular fruit for its nutritive value, low price and availability all-round the year it is grown in almost every state with annual production of 540 thousand metric tons, which accounts for 27% of total production of Arab countries (AOAD, 2008). Banana fruits are highly perishable and subjected to fast deterioration, as their high moisture content and high metabolic activity persist after harvest (Demirel and Turhan, 2003). Almost half of the bananas produced in the world are eaten raw as a dessert fruit, the other half is cooked, usually by frying, boiling, roasting or baking. Virtually all varieties may be either eaten raw when ripe, or cooked when either ripe or green, Cultural preferences govern the choices made. Bananas can also be processed in various ways so that they may be stored for longer periods and utilized for other purpose. New economic strategies are now considered for banana use, such as the production of banana flour to increase utilization of banana, Green banana flour is a low-cost ingredient for food industry and an alternative to minimizing banana wastes (Zhang *et al*., 2005), the advantages of unripe or green banana flour include the content of high resistant starch and dietary fiber that may confer beneficial benefits to human health (Faisant *et al*., 1995; Juarez *et al*., 2006). So that ripe bananas can be dried and stored satisfactorily for years without addition of preservatives, Ripe banana flour can potentially offer new products with standardized composition for various industrial and domestic uses; it also contains a quantity of sugar suitable for incorporation into food products requiring solubility, sweetness and high energy content (Abbas *et al*., 2009). In Sudan 80% of the crop is lost during commercialization because of deficient postharvest handling and lack of banana industry. Therefore, it will be interesting to prepare banana flour to increase utilization of banana and to minimize post-harvest post-harvest losses of the fruits. The aim of this research is to process banana fruits into powder form, which could be used as a supplement, creating its multipurpose uses and improving quality of diets, hence that will increase utilization of the fruits in Sudan and minimize the losses.

Materials and methods

Collection of banana: Unripe, half ripe and fully ripe bananas of (*Cavendish Spp*.) as well as Fresh lemon fruits were purchased from the local market- Shambat, had been used in this study.

Experimental procedure: Banana fruits were sorted from injured and deteriorated fruits. Then were washed under running tap water and weighed.

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Table 1. Drying parameters of banana.

Maturity stage	Drying ratio	Overall drying ratio	Peeling loss (%)
Un ripe	3.9 : 1	9.2 : 1	48
Half ripe	4.6 : 1	7.7 : 1	41
ripe	4.8 : 1	7.3 : 1	36.7

Values represent the means of values.

The Cleaned Fruits were peeled and cut into 1 mm slices thickness using sharp clean stainless steel knives. A lemon juice solution of 2.5% concentration was prepared. The slices were immediately dipped in the lemon solution for 3 minutes.

Processing of banana powder: The treated banana slices were spread on perforated stainless steel trays (45 cm wide, 75 cm long and about 7 cm height) manually. Two kgs of banana slices were loaded on a perforated stainless steel trays and left to dry under shade with the aid of fans for four days. The dried banana slices were collected, reweighed and ground using household grinder and stored at 25-27°C in sealed plastic bags prior to further analysis. Then the overall drying ratio, drying ratio and the peeling loss were calculated as follows:

Overall drying ratio = raw material**:** dry product weight
Drying ratio = prepared material**:** dry material

Peeling loss (%) = weight of peels × 100/weight of raw material

Analytical methods: The raw material and the produced powder have been physically, chemically and microbiologically evaluated. Triplicate samples were analyzed for each of the raw material and the powder for all the parameters tested. The entire chemical analyses are calculated on dry weight basis according to the following equation:

$$\text{On dry base} = \frac{\text{Weight of component} \times 100}{100 - \text{Moisture content of the sample}}$$

Moisture content, crude protein, fiber content, ash content was determined according to the A.O.A.C method (1984). Titrable acidity (T.A.) was determined according to the method described by pearson (1973). Vitamin C content was estimated as ascorbic acid level according to the method described by Ruck (1963). Colour intensity (optical density) was estimated according to the method described by Handel (1950). Total sugars were determined according to Anthrone method and reducing sugars by Nelson–Somog method.

Reconstitution characteristics for the Banana powder: Wettability, sinkability and bulk density (g/L) were estimated according to the method recorded by Neff *et al.* (1967). The method described by Frain (1953) was used to determine flowability. Solubility rate was determined by the method described by king (1966).

Microbiological analysis: Serial dilutions were prepared according to the method described by Nickerson and slinky (1974). Suitable sterilized media were used for detection and enumeration of different microbes (Total viable count, Yeast and moulds) following the method of Harrigan (1998).

Statistical analysis: Analysis of variance (ANOVA), followed by fisher's protected LSD test with a significance level of $P \leq 0.05$ were performed on the data (Gomez and Gomez, 1984).

Results and discussion

Table 1 shows that the overall drying ratio of banana fruit considering different stages of ripening range (7.3:1-9.2:1), drying ratio range (3.9:1-4.8:1) and peeling loss range (36.7-48%) rapidly during storage of banana and also they have reported that Vitamin C in banana decreases from 19.4 to 9.1 mg/100 g during storage. The results obtained (20.16, 18.8, 18.26 mg/100 g for unripe, half-ripe, full ripe fruits respectively) is higher than the value reported by Forster *et al.* (2003) who reported that banana pulp ascorbic acid ranged between 5.35 -13.06. The variability of Vitamin C content in banana fruits is due to the effect of various factors such as genotypic differences, pre-harvest climacteric condition, culture practice, maturity, harvesting method and post-harvest handling procedure as it was reported by Lee and Kader (2000).

As shown in Table 2, fibre content was 8.6%, 8.4%, and 3.17% for green, half-ripe and ripe fruits respectively, the results revealed that fiber value decreases through ripening phases. Furthermore the fibre value of the ripe fruit pulp (3.17%) obtained is coping with the results reported (2.39%) by Forster *et al.* (2003). Sugars content in the fresh banana pulp was 5, 18.4, 23.9% for green, half ripe and full ripe respectively, which is within the range of results reported earlier by Lii *et al.* (1982), who recorded 6% for green banana fruits, 21.4% for half ripe banana fruit and 27.9% for ripe fruits.

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Table 2. Physiochemical compositions of the banana pulps (on dry weight basis).

Maturity Stages	M/C (%)	Fibre (%)	Ash content (%)	Protein (%)	T.A (%)	Total sugars (%)	Reducing sugars (%)	T.S.S (%)	Ascorbic acid (mg/100g)
Unripe	70.8	8.6	7.9	9.9	2.83	5	3.8	17	20.16
Half ripe	75	8. 4	9.8	15.3	2.04	18.4	9	68	18.8
Full ripe	77	3.17	11.04	18.5	1.65	23.9	13.04	92.6	18.26

Values represent the means of values.

Table 3. Physiochemical compositions of the banana powder (on dry weight basis).

Maturity Stages	M/C (%)	Fibre (%)	Ash content (%)	Protein (%)	T.A (%)	Total sugars (%)	Reducing sugars (%)	Ascorbic acid (mg/100g)
Unripe	$5.00^{b} \pm 0.2$	$2.84^{a} \pm 0.2$	$2.5^{b} \pm 0.4$	$3.1^{c} \pm 0.3$	$1.21^{a} \pm 0.03$	$2.0^{c} \pm 0.3$	$1.21^{c} \pm 0.3$	$6.84^{a} \pm 0.3$
Half ripe	$5.38^{b} \pm 0.02$	$1.79^{b} \pm 0.2$	$2.58^{b} \pm 0.05$	$3.98^{b} \pm 0.02$	$0.94^{b} \pm 0.02$	$5.17^{b} \pm 0.03$	$2.53^{b} \pm 0.03$	$5.49^{b} \pm 0.2$
Full ripe	$6.56^{a} \pm 0.02$	$0.95^{c} \pm 0.02$	$2.63^{a} \pm 0.08$	$4.54^{a} \pm 0.6$	$0.81^{b} \pm 0.04$	$6.1^{a} \pm 0.1$	$3.31^{a} \pm 0.1$	$5.03^{b} \pm 0.3$

Mean bearing different superscripts are significantly different ($p<0.05$).

Table 4. Physiochemical compositions of the banana powder (on dry weight basis).

Maturity Stages	Wettability (sec)	Sinkability (sec)	Angle of repose (degree)	Bulk density (g/mL)	Solubility rate (sec)	Colour (O.D)
Unripe	750	2	45	1.05	820	0.91
Half ripe	800	4	45	0.90	680	1.1
Full ripe	950	5	39	0.70	600	1.34

Values represent the means of values.

The data obtained cope with what have been confirmed by Palmer (1971) who proposed that sugar content increases through ripening stages as a result of hydrolysis of starch into sugars. Reducing sugars was 3.8, 9, 13.04% for green, half-ripe and ripe banana respectively (Table 2), which is within the range of results reported earlier by Lii *et al.* (1982), who recorded 1.3% for green banana fruits, 11.5% for half ripe banana fruit and 12.4% for ripe fruits.

Results of physiochemical characteristics of produced banana powder are shown in Table 3. There is no significant differences between the un ripe and half ripe powder in M/C, the unripe powder shows the lowest value (5%) followed by 5.38% for half ripe and 6.56% for ripe banana powder. The data obtained is found to be within the range of results recorded by Rodriguez-Ambriz *et al.* (2008), who reported 6% for unripe Thailand banana flour and found to be a bit lower than the value obtained by Abbas *et al.* (2009), who recorded 8.17% for ripe banana flour. Total sugars content shows remarkable significant differences among the powder of the three stages, the results was 2, 5.17 and 6.1% for green, half ripe and ripe powder respectively.

The results for reducing sugars were 1.21, 2.53 and 3.31% which indicate remarkable difference between the powders of the three stages. There is a variation between the stages in vitamin C content, the lowest value recorded by the ripe powder (5.03 mg/100g), the value for the half ripe powder was 5.49 mg/100g) and the highest value was recorded for the unripe powder (6.84 mg/100g). The physical and reconstitution properties of banana powder are shown in Table 4. It shows that the bulk density of the unripe powder (1.05) is better than the powder of the half ripe and full ripe powder (0.90, 0.70 respectively), this may be due to that the unripe and half ripe powder have very fine texture, while the full ripe powder is coarser in texture. Microbiological tests of powder of different stages revealed that samples have good microbiological qualities (total bacterial counts less than 10^{2}/g, moulds and yeast were not detected).

Conclusion

From the study, it was concluded that banana powder of different maturity stages could be used as enrich stuff and an excellent improved supplement of diet. Comprehensive utilization of dried banana fruit studies will minimize material losses and environmental pollution.

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