DOI: *10.15613/fijrfn/2015/v2i2/96646*
ISSN (Print) : 2349-8897
***FoodSci*: Indian Journal of Research in Food Science and Nutrition,** *Vol 2(2), 56-61 July-December-2015 ISSN (Online) : 2350-1006*

Influence of Different Pretreatments and Drying on Dehydrated Green Banana (*Musa paradiasiaca var. nendran*) and its Compatibility in Rusk

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Abstract

Banana is the second most important fruit crop in India. Bananas, consumed cooked or raw, either as the green, halfripe, or ripe fruit, are one of the most significant sources of calories for the human diet worldwide. One benefit of green bananas is the high resistant starch content. In several studies, the physiological importance of resistant starch in bananas has been investigated mainly with regard to glycemic index, cholesterol lowering capability and colonic effects. In the present study the slices of green nendran bananas were subjected to three different pretreatments such as salt solution, lemon solution, honey solution followed by three different types of drying methods such as sun drying, microwave drying and cabinet air drying. The dehydration ratio, rehydration ratio and co-efficient of reconstitution were studied. The nendran banana attained maximum co-efficient of reconstitution of 1.14 for lemon pretreated cabinet dried sample. The moisture content of dried banana flour was 6.16g% the protein value was 9.30g, the total carbohydrates value was 86.50g and fibre content was 5.90g. The flour was compatible in rusk upto 50% with a good shelf life of two weeks.

Keywords: Drying, Food Formulation, Green Banana, Nutrient Analysis, Pretreatment, Shelf Life Study

1. Introduction

The banana is an edible fruit produced by several kinds of large herbaceous flowering plants in the genus *Musa.* Its year round accessibility, affordability, varieties, taste, nutritive and medicinal value makes it the favourite fruit among all classes of people. Banana can be consumed in fresh form or can be processed or semi-processed into many tasty products. Bananas are only edible for a very short time, unless they are promptly and properly preserved.

The new economic approach is to exploit waste food products for value added innovative products. Converting banana fruit into flour was found to be an effective preservation method [1].

In the green stage, banana is of great value and suggested for many disease conditions. When it is in the green stage, banana is considered to be a functional food of the prebiotic type [2]. The most important factor for considering green bananas as a prebiotic food is its resistant starch content, characterized by the portion of the granule or its degradation products that are not digested or absorbed in the small intestine and are fermented in the large intestine [3, 4].

Flour is one of the main forms of preserving green banana. The clear advantage presented by green banana

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flour includes a high total starch (73.4%), resistant starch (17.5%) and dietary fibre content (~14.5%). Among the four subtypes of resistant starch Resistant Starch, type II (RS II) (i.e that occurs in natural granular form) is present in green bananas which is involved in disease prevention including modulation of glycemic index, diabetes, cholesterol lowering capability and weight management [5]. It improves digestion health by resisting starch hydrolyzing enzymes in the stomach and thus acts as dietary fibre.

Nendran (*Musa paradiasiaca var. Nendran*) is a popular variety in Kerala where it is relished as a fruit as well as used for processing. Commercial cultivation of Nendran has picked up rapidly in Tamil Nadu in the recent past. Fruits have a distinct neck with thick green skin turning buff yellow on ripening. Fruits remain starchy even on ripening.

Drying is one of the traditional method for the preservation of food products. Newer techniques of drying such as heated air drying due to hygienic and economic considerations have been developed [6, 7].

Food scientists have found that by reducing the moisture content of food to between 10 and 20%, bacteria, yeast, mold and enzymes are all prevented from spoiling it. The flavour and most of the nutritional value is preserved and concentrated [8].

Different pre-treatment methods have been developed for fruit drying, among which are lemon juice, salt solution, honey dip, ascorbic acid, sulfuring, osmotic pretreatment, and blanching [9].

The major objectives of this study are i) to assess and compare the effects of different pretreatments and modes of drying on dehydration characteristics of green nendran banana ii) to analyse the nutritional value of green banana flour iii) to develop dietary fiber-enriched baked product (rusk) by incorporation of green banana flour with wheat flour in the formulations and iv) to study the shelf life of the product.

2. Materials and Methods

2.1 Preparation of Green Banana Flour

Good quality green bananas (Musa paradiasiaca var. Nendran) were procured from the local market and used for the present study. Primary processes such as cleaning, washing, peeling, and cutting were done with the fresh unripe bananas. 7.25 g of salt was dissolved in 660ml of water in a bowl. In addition, 255ml of lemon juice was mixed with 255ml of water in another bowl and finally 40ml honey and half cup sugar was measured and added to 495 ml lukewarm water to mix in third bowl. Samples of the sliced bananas are soaked in the different pretreatments for 10 minutes and allowed to drain.One control was also kept without any pretreatment.

The different pre-treated sliced bananas were drained weighed, put on trays and placed onto the racks in the Cabinet dryer and Microwave oven dryer. Sun drying was also carried out by placing the trays in sunlight. The sliced pretreated samples are weighed and kept for drying. In the cabinet dryer it is set up to 65°C for 8 hours and in microwave oven dryer it is set up to 71°C for 30 min and in sun drying the slices was kept until brittle.

When drying was completed the samples were allowed to cool, ground to fine powder in a food processor and packed into a transparent tightly zipped bag and labeled for further analysis and storage.

2.2 Determination of Dehydration and Rehydration Characteristics

The dehydration ratio, rehydration ratio and co efficient of rehydration of green nendran banana flour were calculated by the following formula:

$$\text{Dehydration Ratio} = \frac{\text{Weight of prepared material before drying}}{\text{Weight of dried material}}$$

$$\text{Re hydration Ratio} = \frac{\text{Weight of rehydrated material}}{\text{Weight of dehydrated material}}$$

$$\text{Co-efficient of reconstitution} = \frac{\text{Re-hydration Ratio}}{\text{De-hydration Ratio}}$$

2.3 Proximate Composition Analysis

The best processed banana flour was analyzed for the moisture, ash, fat, protein, fibre contents and total carbohydrate content through AOAC certified methods.

2.4 Compatibility of Banana Flour in Rusk

The acceptability of green banana flour was studied by incorporating at 25%, 50%, 75% and 100% in rusk replacing wheat flour. Panel of 30 semi trained members carried out the sensory evaluation test. A score card was prepared by using 9 point scale on the basis of parameters like appearance, colour, texture, flavor and taste and used for sensory evaluation.

2.5 Shelf Life Study

The most acceptable proportion of banana flour incorporated rusk were kept in air tight zip lock cover and analysed for its shelf life through microbial analysis (enumeration of bacterial count by serial dilution agar plate technique) and sensory evaluation at 2 weeks interval for a period of one month.

3. Results and Discussion

3.1 Effect of Pretreatment and Drying on Dehydration Characteristics of Green Nendran Banana Flour

Table 1 shows that in case of sun drying, the dehydration ratio of salt, lemon and honey treated samples were 3.05, 2.95, and 2.69 respectively. The sample pretreated in salt had gained the highest dehydration ratio of 3.05 and the least dehydration ratio 2.69 was obtained by honey pretreated sample.

In case of microwave drying, the dehydration ratio of salt, lemon and honey treated samples were 2.93, 2.81, and 2.64 respectively. Salt pretreated sample had obtained highest dehydration ratio and honey pretreated sample had the lowest dehydration ratio.

In the case of cabinet oven drying, the dehydration ratio of 3.01 for salt, 2.90 for lemon and 2.64 for honey pre-treated samples was obtained. From the acquired ratios salt pre-treated sample had shown the highest dehydration ratio and honey pre-treated sample had least dehydration ratio. These recorded trends might be attributable to the fact that honey dip forms a sticky coat around the banana slices and the slices do not lose moisture that easily and salt favours rapid drying of the slices. These results resemble the findings reported in earlier studies [7, 10, 11].

Table 1. Dehydration characteristics of pre treated green nendran banana flour

Drying method	Pre-treatment method	Dehydration ratio
Sun drying	control	2.43
	salt	3.05
	lemon	2.95
	honey	2.69
Micro wave oven drying	control	2.54
	salt	2.93
	lemon	2.81
	honey	2.64
Cabinet oven drying	control	2.44
	salt	3.01
	lemon	2.90
	honey	2.64

3.2 Effect of Pretreatments and Drying on Rehydration Characteristics of Green Nendran Banana Flour

From the Table 2 it is clear that, for samples treated with salt, lemon and honey, dried under sun, the rehydration ratios were 2.65, 3.05, 2.59 respectively. For samples treated with salt, lemon and honey and microwave dried, the rehydration ratios were 2.62, 3.12, 2.65 respectively. For samples treated with salt, lemon and honey and dried in cabinet drier the rehydration ratio was 3.25, 3.22, 2.55 respectively. The co-efficient of rehydration for cabinet dried samples pretreated with lemon and honey were 1.04 and 1.00 and were higher than those of other drying and pretreated samples. The observations conclude that banana slices pretreated with lime juice and dried in cabinet drier showed better reconstitution properties than the other techniques of drying and pretreatment. Color index and rehydration ratio of microwave drying method were 7.5% and 30% lower than hot air drying method [12].

Table 2. Reconstitution characteristics of green nendran banana flour

Drying method	Pre-treatment method	Rehydration ratio	Co-efficient of rehydration
Sun drying	control	2.11	0.78
	salt	2.65	0.87
	lemon	3.05	1.04
	honey	2.59	0.95
Micro wave oven drying	control	2.05	0.80
	salt	2.62	0.89
	lemon	3.12	1.04
	honey	2.65	1.00
Cabinet oven drying	control	2.74	1.07
	salt	3.25	1.10
	lemon	3.22	1.14
	honey	2.55	0.96

3.3 Proximate Analysis of Green Nendran Banana Flour

From the Table 3 it is clear that, the moisture content of dried banana flour was 6.16 g as against 69.6g in fresh banana with 11.3 times reduction after drying.

The protein content of fresh banana was 10.0 g and it reduced to 9.30 in dried banana flour. Ash content of 3.20 g in fresh banana reduced to 0.04 g in dried banana flour. The ash content in fresh peppers differed significantly ($P > 0.05$) from peppers subjected to drying, which may have resulted from the temperatures applied, which degrade the micro-nutrients represented in the analysis of the ashes [14]. The decrease in protein content of food due to the application of heat could be as a result of the effect of tannins that form complexes with protein reducing their availability [15].

Table 3. Nutrient content of fresh and cabinet dried green nendran banana(g/100g)

S.No	Parameters	Fresh banana*	Green Nendran Banana Flour
1.	Moisture	69.6	6.16
2.	Fat	0.14	0.0
3.	Protein	10.0	9.30
4.	Ash	3.20	0.04
5.	Total Carbohydrates	80.50	86.50
6.	Fibre	5.25	5.09

*Source: (Thilagavathi, 2013) [13]

The fat value in fresh banana was 0.14 g which was oxidised completely on drying. The total carbohydrates of fresh banana was 80.50 g and it increased to 86.50 in the dried banana flour. Fibre content was 5.25 g in fresh banana which decreased to 5.09 in dried banana flour. The decrease in the fat observed in the study could be a result of lipid oxidation. The increase in the total carbohydrates observed in the study might have due to the removal of moisture which tends to increase the concentration of the nutrients [16].

The chemical compositions of ripe and unripe flour were investigated [17]. The following results were obtained for ripe plantain flour; moisture contents 61.3%, protein contents 3.15%, ash contents 6%, fat contents1.2%, crude fibre 1.11%, sugar contents 12.8%, carbohydrate 27.24%, and total solid 38.7g / 100g. while the following results were obtained for unripe plantain flour; moisture contents 38.5%, protein contents 2.8%, ash contents 3.8%, fat contents 0.2%, crude fibre 0.7%, sugar contents 5.53%, carbohydrate 54% , and total solid 61.5g/100g.

3.4 Compatability of Green Nendran Banana Flour in Rusk

The details regarding the mean sensory scores obtained by unripe nendran banana flour incorporated rusk is given in Figure 1.

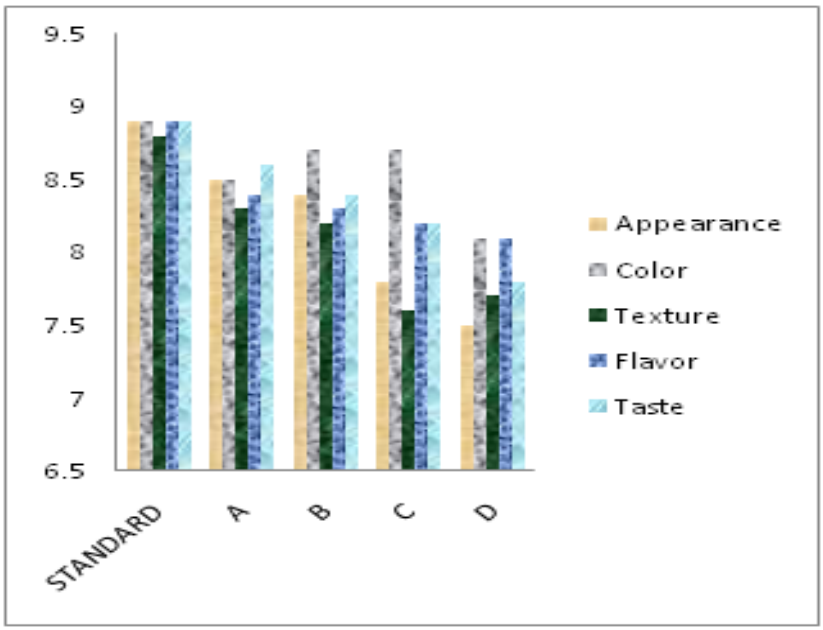

Figure 1. Mean sensory scores obtained by green nendran banana flour incorporated rusk.

The overall acceptability of mean score obtained for standard, sample A (25 % banana flour), sample B (50% banana flour), sample C (75 % banana flour) and sample D (100% banana flour) were 8.88, 8.36, 8.52, 7.09 and 6.28 respectively. Sample B is selected as most compatible in rusk and chosen for further studies. From the results it can be concluded that incorporation of nendran banana flour blended well upto 50 % level, after which its acceptability in rusk deteriorated.

3.5 Shelf Life Study of Green Nendran Banana Flour Incorporated Rusk

3.5.1 Microbial Analysis of Green Nendran Banana Flour Incorporated Rusk on Storage

The details regarding the microbial load of the standard and selected proportion of unripe nendran banana flour incorporated rusk on 1st, 6th and 14th day of storage is given in Table 4.

The acquired results from the Table reveals that, there was no microbial count in the product on the 1st day. On the 6th and 14th day of storage standard rusk had shown 40 CFU and 150 CFU in 10^{-3} dilution respectively. The nendran banana flour incorporated rusk showed a microbial load of 60 CFU in 10-4 dilution. From the obtained results only bacillus contamination were identified and no potentially hazardous microbes were isolated. Thus it is concluded that the product had a good shelf life for 14 days in zip lock cover.

3.5.2 Organoleptic Evaluation of Green Nendran Banana Flour Incorporated Rusk on Storage

The details regarding the sensory analysis of green nendran banana flour incorporated rusk on 1st, 7th and 15th day of storage is given in Table 5.

From the results it can be concluded that nendran banana flour incorporated rusk had a good shelf life up to 15 days when packed in zip lock cover.

Table 4. Microbial load of the standard and selected proportion of green nendran banana flour incorporated rusk on storage

S.NO	Standard Plate Count (CFU / gram)	1ST DAY		6TH DAY		14TH DAY	
		Std Rusk	Sample B	Std Rusk	Sample B	Std Rusk	Sample B
1.	10^{-3}	-	-	40	91	150	202
2.	10^{-4}	-	-	-	-	37	60
3.	10^{-5}	-	-	-	-	-	-
4.	10^{-6}	-	-	-	-	-	-
S/M/US/PH		S	S	M	M	M	M
Organism obtained		Only Bacillus contaminations were identified and no potentially hazardous microbes were isolated.					

– = No growth
TNTC = Too numerous to count
TFTC = Too few to count
Satisfactory = S; Marginal = M; Unsatisfactory = US; Potentially Hazardous = PH

Table 5. Sensory analysis of green nendran banana flour incorporated rusk on 1st, 7th and 15th day of storage.

Criteria	Score	Immediate Mean ±SD		7th Day Mean ±SD		15th Day Mean ±SD	
		Std	Sample B	Std	Sample B	Std	Sample B
Appearance	9	8.9±0.1	8.4±0.6	8.9±0.1	8.2±0.8	8.8±0.2	8.0±0.6
Color	9	8.9±0.1	8.7±0.3	8.8±0.2	8.5±0.5	8.7±0.3	8.4±0.3
Texture	9	8.8±0.2	8.2±0.4	8.8±0.2	8.1±0.4	8.6±0.4	8.0±0.7
Flavor	9	8.9±0.1	8.9±0.1	8.9±0.1	8.2±0.5	8.7±0.3	8.0±0.6
Taste	9	8.9±0.1	8.4±0.4	8.9±0.1	8.1±0.5	8.7±0.1	7.9±0.7

4. Conclusion

From the study it can be concluded that, lemon pretreatment and cabinet drying were best processing, methods for nendran banana with better reconstitution characteristics. The nendran flour retained good nutritional value and blended well in rusk with satisfactory shelf life. Green banana flour is a good alternative to reduce banana wastes and it is also a low cost raw material for food industry.

5. References

1. Muzanila Y. C., and Mwakiposa V. "Assessment of nutritional status of traditionally prepared banana flour Khenyangwa", *African Crop Science Conference Proceedings, Sokoine University of Agriculture*, vol. 6, p. 564–567, 2003.
2. Mastro N. L., Taipina M. S., Cohen V. H., Rodas M. A. B., and Garbelotti M. L. "Avaliação critica da polpa de banana (Musa spp) verde", *Revista Higiene Alimentar, São Paulo*, vol. 21, p. 39–45, 2007.
3. Teixeira M. A. V., Ciacco C. F., Tavares D. Q., and Bonezzi A. N. "Occurrence and characterization of resistant starch in corn starch and banana", *Food Science and Technology*, vol. 2, p. 243–253, 1998.
4. Acevedo E. A., Hernandez J. J. I., Vargas G. P., Diaz P. O., and Perez L. A. B. "Starch digestibility and glycemic index of cookies partially substituted with unripe banana flour", *Food Science and Technology,* vol. 46(1), p. 177–182, 2012.
5. Thakorlal J., Perera C. O., Smith B., Englberger L., and Lorens A. "Resistant starch in Micronesian banana cultivars offers health benefits", *Pac Health Dialog*, vol. 16, p. 49–59, 2010.
6. Das I., Das S. K., and Bal S. "Specific energy and quality aspects of infrared (IR) dried parboiled rice", *J Food Eng*, vol. 62, p. 9–14, 2004.
7. Motevali A., Minaeiy S., Khoshtaghazaz M. H., Kazemi M., and Nikbakhtyy A. M. "Drying of pomegranate arils: Comparison of predictions from mathematical models and neural networks", *Int. J. Food Eng,* vol. 6(3), Article 15.
8. Dennis S. "Improving Solar Food Dryers", *Home Power Magazine*, vol. 69, p. 24–34, 1999.
9. Karim O. R. *Effect of Pre-treatment on Drying Kinetics and Quality Attributes of Air - Dehydrated Pineapple Slices* [PhD. Thesis]. University of Agriculture, Abeokuta, Ogun State, Nigeria, 2005.
10. Kostaropoulos A. E., and Saravacos G. D. "Microwave pre-treatment for sun-dried raisins", *J. Food Sci.* vol. 60(2), p. 344–347, 2006.
11. Abano., and Sam-Amoah. "Effects of different pretreatments on drying characteristics of banana slices", *ARPN Journal of Engineering and Applied Sciences*, vol. 6(3), p. 121–129, 2011.
12. Fabiano A. N., Rodrigues F., Odisseia C. P., and Gaspareto L. "Optimization of osmotic dehydration of banana followed by air-drying", *Journal of Food Engineering,* vol. 24, p. 75–83, 2005.
13. Thilagavathi T. "Nutriet Content of Banana Varities on Dehydrated by Various Methods". *International journal of innovative researches and studies*. Vol. 2(11), p. 225–231, 2013.
14. Reis R. C., Castro V. C., Devilla I. A., Oliveira C. A., Barbosa L. S., and Rodovalho R. "Effect of drying temperature on the nutritional and antioxidant qualities of cumari peppers from Pará (Capsicum chinense Jacqui)", *Brazilian Journal of Chemical Engineering*, vol. 30(2), p. 337–343, 2013.
15. Wiriya P., Paiboon T., and Somchart S. "Effect of drying air temperature and chemical pretreatments on quality of dried chilli", *Int. Food Res.*, vol. 16, p. 441–454, 2009.
16. Morris A., Barnett A., and Burrows O. "Effect of Processing on nutrient content of foods", *Cajarticles,* vol. 37, p. 160–164, 2004.
17. Egbebi A. O., and Bademosi T. A. "Chemical Compositions of Ripe and Unripe Banana and Plantain", *International Journal of Tropical Medicine and Public Health*, vol. 1(1), p. 1–5, 2012.