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Effect of Drying Methods on Organoleptic Quality of Banana Powder

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ABSTRACT: An experimental was conducted to determine the effect of different drying methods on consumer acceptability of banana powder. Banana slices was pre-treated with lemon solution followed by different drying in tray with perforation and solid tray and multipurpose tray dryer. Banana powder was packed in PP bag. The organoleptic qualities like taste, colour, aroma, texture and overall acceptability of powder were analyzed through 9-Hedonic scale and physicochemical parameters like moisture, carbohydrate, fat and ash content were analyzed using FCRD model. It can be concluded from the study that multi-purpose tray dryer is best suitable for drying of banana slices to get good quality powder with higher organoleptic scores with retention of quality parameters.

KEYWORDS: Banana, Drying, Dehydration, Physicochemical properties.

I. INTRODUCTION

Banana (*Musa spp.*) belongs to family Musaceae. It is known since the dawn of ancient history as one of the delicious fruits in the world. The fruit is soft, sweet and pleasantly flavoured. The fruit is eaten in the fresh form and also as cooked vegetable in the tropics. It is also used for the preparation of popular products like banana, fig, banana powder, banana beer, starch and yeast.

According to [1], at least 35 to 45% of production of fruits and vegetables in country is lost due to wastage. The post-harvest losses estimated to the tune of 40,000 crores per annum. This huge wastage of valuable horticultural commodities can be checked successfully, if they are processed into different value added products. Moreover, due to changing the lifestyle of population, the food processing industries are rapidly emerging that required good amount quality raw material to run the plant economically.

The Gujarat account for 7.8 % of banana fruits produced in India, and ranks second in the production of banana fruit after Andhra Pradesh in 2019-20. In Gujarat, the area under banana cultivation was about 896.81 metric hectares and produced about 32596 tons of bananas during the year 2019-20 [2]. The wide variety of banana fruits grown is the main reason for this first position of India in production of banana in the world. Though India is the largest producer of banana, but the processing of banana is less than 2% and the post harvest losses of banana are estimated to be more than 25%. As banana is available throughout the year in tropical countries, like India, there is a vast need to utilize for proper processing techniques. It could be processed into different value added products like powder, chips, wine and fig etc. Normally bananas contain significantly higher amount of potassium, i.e., 400 mg/100 g pulp and trace amount of sodium and iron [3].

Banana fruit is having high initial moisture content of about 72 to 77% (w.b.), there are more chances of the fruit getting spoiled or deteriorated. Also, banana is a highly perishable fruit, it has comparative short shelf life and

marketing of fresh fruits to different places is very difficult. Therefore, it is necessary to convert it into value added products which retain its colour, flavour and nutrients with longer shelf life. So to increase the shelf life of banana, the fruit is converted into various processed products like powder, dried slices, pulp, juice, RTS, beverages, etc. Banana powder is used in cake, bread, cookies, baby food, ice-cream, flavoured milk, shrikhand, chocolates etc [4]. A possible alternative solution to this problem is the storage and the transport in powder form. There are many drying techniques available to dry banana, such as tray dryer, hot air oven dryer, multi tray dryer, sun and solar drying, microwave drying, osmotic dehydration, freeze drying, and convective air drying. The process of dehydration results in changes in the quality specially the concentration of nutrients, sensory changes like color, texture and aroma. It is essential to test the quality of processed produce to ensure the utilizability for nutritional benefit.

Banana powder is prepared by different drying methods (tray drying, oven and multi-purpose tray dryer) is a very interesting alternative to recombine the fruit with practically all the properties of the natural product. Preparation of good quality banana powder by giving pretreatment of dipping in lemon solution (1:1) will retain the colour, flavour, aroma, texture and taste in the final product. Dehydration prior to hot air drying will also reduce the moisture content, drying time and energy consumption. Subsequent hot air drying will give the dried product of an excellent quality. Banana powder by different drying methods will be checked for nutrients, colour, flavour, and texture often indistinguishable from the original product. A process for the comparative drying of banana fruit will be developed. The best operational conditions will be identified, so that high performance is achieved both in terms of operation time and quality of the dried banana powder. Finally, the dried banana powder will be packed by vacuum packaging in a flexible plastic material to extend the shelf life of the products as well as to prevent the deterioration of the product during the long term storage. In view of the above facts, the present investigation was focused on drying characteristics of banana powder in tray dryer with perforated and solid plates and multi-purpose tray dryer at temperature range at 70, 75 & 80°C.

II. MATERIALS AND METHODS

Experiments were carried out at Department of Processing and Food Engineering, College of Agricultural Engineering & Technology, Anand Agricultural University, Godhra, Gujarat. There are different varieties of banana grown in Panchmahal or nearby Godhra region. Locally available variety of banana was selected for its sweet taste, whitish pulp as well as higher pulp to peel ratio.

1. Physical parameters of fresh banana fruit

Various physical parameters of the fresh ripe banana fruit such as fruit weight, maximum and minimum diameter of fruit with and without peel, length, skin thickness, puncture operation, and pulp to peel ratio were recorded.

2. Experimental procedure for pre-treatment of banana slices

Ripe banana fruits and lemon were procured from the Godhra local fruit market and taken for the preparation of banana powder in the experimental laboratory of PFE department of CAET, Godhra. The freshly collected banana fruits and lemon were washed with tap water to remove impurities such as surface dirt, dusts or any other foreign particles. Manually peeling was done with knives. After proper trimming of fresh banana fruits, they were manually sliced to a 5-7mm thickness with the help of SS knife. The slices of banana fruits were dipped in the solution of lemon and water with the proportion 1:1 for 10 minutes to minimize the enzymatic browning. After that, they were kept out and placed into the filter paper for soaking up to the 10 minute.

3. Experimental procedure for drying of banana powder

Weight accurately 100gm of the banana slice for drying in tray dryer with perforated tray, tray dryer with solid plates and multi-purpose tray dryer. Drying experiments were performed at temperatures of 70, 75 and 80°C. The thickness of the sample was about 5 to 7mm which loaded in tray. The weight of sieve with the sample was measured with a digital balance and recorded at 1 hours interval for all temperature and velocity ranges selected for

the study. For measuring the weight of the sample during experimentation, the sieve with sample was taken out of the drying chamber, weighed on the digital top pan balance and placed back into the chamber. The digital top pan balance was kept very close to the drying unit. Each process of weight measurement lasted about 8.25 ± 0.25 s. The drying procedure was continued till the moisture content of the sample reduced to about 18-22%. Banana powder was prepared from slices and packed in 250 gauge PP bags and stored at ambient conditions.

4. Organoleptic quality evaluation

Quality is the ultimate criterion of desirability of any product, the consumer acceptability of banana powder depends on the nutritional and sensory analysis was conducted on all samples. 15-panelist were asked to assess the expanded powder for taste, aroma, color, texture and over all acceptability and to mark on 9- hedonic scale (1-dislike extremely, 5-neither like nor dislike and 9-like extremely) in accordance with their opinion. The panellist score were compiled and checked for standard deviation and the percentage of dislike for every dryer [5].

III. RESULT AND DISCUSSIONS

5. Physical parameters of fresh banana fruit

The weight of selected banana fruits ranged between 98 to 120 gm and the mean value of fruit weight was 111.24 gm. The maximum and minimum diameter of banana fruits ranged from 35.00 to 41.00 mm and 31.00 to 35.00 mm. and the mean values of maximum and minimum diameter of banana fruits were 37.14 mm and 33.19 mm for whole fruit with peel and 27.99 mm and 25.40 for the fruits after peeling. It can be observed the pressure at center top and bottom portion of the banana fruits were varied from 4.00 to 7.80 lb, 4.0 to 10.85 lb and 4.25 to 10.00 lb, with an average value of 5.06, 5.32 and 6.30 respectively. The pulp to peel ratio for banana fruits was ranges from 1.27 to 1.43. The mean value of pulp to peel ratio was found 1.35.

6. Effect of Dehydration on Nutrients Composition

6.1. Carbohydrate content of the dehydrated banana powder

Carbohydrate content of dehydrate banana powder as shown in the Table 1 indicate that the banana powder after dehydration in tray dryer with perforated plate possessed significantly higher amount (78%) at 80°C temperature for 7mm slices samples ,as compared to other two drying methods. The carbohydrate content was highest amount (75%) in tray dryer with solid plates at 70°C for 5mm slices and multi-purpose tray dryer (68%) at 75°C for 5mm slices.

Table 1 : Quality parameters of dehydrated banana powder

Quality parameters	Fresh Banana	Tray dryer with perforated plates	Tray dryer with solid plates	Multi-purpose tray dryer
Carbohydrate (% , per 100gm powder)	27.2	78.0	75.0	68.0
Fat content (% , per 100gm powder)	1.2	5.6	4.0	3.0
Ash content (% , per 100gm powder)	2.50	5.12	5.12	5.00
pH content	4.9	4.4	4.5	4.7
Moisture Content (%)	74 -77	74.00	80.95	80.30

6.2. Fat content of the dehydrated banana powder

Fat content of the dehydrated banana powder samples were in the range of 1.2 to 5.6% .The fat content was highest in the tray dryer with perforated plates, tray dryer with solid plates and multi-purpose tray dryer at 80, 70 & 75°C for 7mm, 7mm, 5mm slices samples respectively (Table 1). The fresh sample of banana fruits contains 1.2 gm per 100gm of the fat. This tray dryer sample was the least one the fat content was about 2.5 times more than in fresh banana fruits.



6.3. Ash content of the dehydrated banana powder

Ash content of the dehydrated banana powder samples were in the range of 2.5 to 5.12% (Table 1). The ash content was highest in the tray dryer with perforated plates at 80°C for 7mm slices and tray dryer with solids plates dried at 75°C for 7mm slices samples. In multi-purpose tray dried sample, highest amount of ash at 75°C for 7mm slices samples. The fresh sample of banana fruits contains 2.5gm per 100gm of the ash. Multi-purpose tray dryer sample was the least one the ash content was about 50% more than in fresh banana fruits.

6.4. pH Content of the Dehydrated Banana Powder

pH content of the dehydrated banana powder samples were in the range of 4.4 to 4.7% (Table 1).The pH content was highest in the multi-purpose tray dried samples at 75°C for 7mm slices and in tray dried sample with perforated and solid plates at 80 and 75°C temperature for 7mm and 7mm slices, respectively. The fresh banana fruits samples recorded 4.9 pH.

6.5. Moisture content of the dehydrated banana powder

Moisture content of the dehydrated banana powder samples were in the range of 70 - 80.95% (Table 1). Maximum moisture content of banana in tray dryer with perforated plates, tray dryer with solid plates and multi-purpose tray dryer at temperature 80°C for 7mm, 5mm & 7mm slices respectively. It can be seen that the moisture was reduced to the 74-77% of banana fruits.

6.6. Organoleptic evaluation of dehydrated banana powder

It was observed from the Table 2 that the banana slices dried in Multi-purpose tray dryer have obtained the highest sensory score within the experimental range of different dryers. This may be due to the different drying capabilities of dryers

Table 2: Organoleptic Evaluation of Banana Powder

Qualities	Tray dryer with perforated plates	Tray dryer with solid plates	Multi-purpose tray drying
Taste	6.36	7.00	8.18
Color	5.83	6.58	8.33
Aroma	7.00	7.00	7.82
Texture	7.17	7.17	7.83
Overall acceptability	6.59	6.93	8.04

6.7. Drying Rate of Banana Slices Dried with Different Dryers

Drying rate indicated the extent of removal of moisture periodically from the fruits. When the slices dried in multi-purpose tray dryer, the removal of moisture was maximum in first 1 hour of exposure which reduced to a constant weight by 8 hour 30minute for 5mm banana slices and 9 hour for 7mm slices at 70°C temperature in multipurpose tray dryer. Whereas, the drying time taken by tray was 23 hour for 7mm slices and 20 hour for 5mm slices, and in tray dryer with perforated plates 22 hour for 7mm slices and 20 hour for 5mm slices. The other three temperature data (at 75 & 80°C) are shown in table below (Table-3);

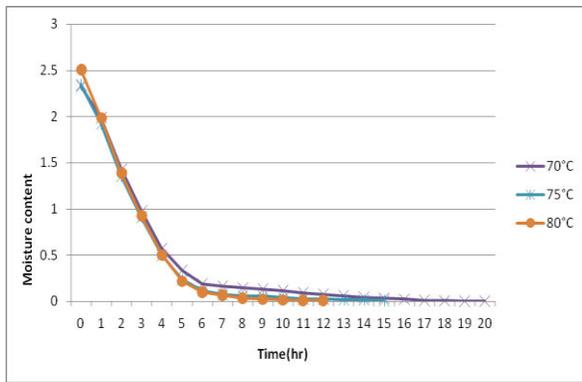
6.7.1 Variation of moisture content with time

The banana slices dried at temperature of 70, 75 & 80°C in the tray dryer with solid plates, tray dryer with perforated plates and multipurpose tray dryer with thickness of about 5 and 7mm. The initial moisture content of banana slices was 82.20 % (w.b). In drying experiment, the moisture content of banana slice reduced with the drying duration due to conversion of slices water in vapor through increase in the energy. The moisture content variation with drying time for banana slice is presented graphically below (Fig. 1);

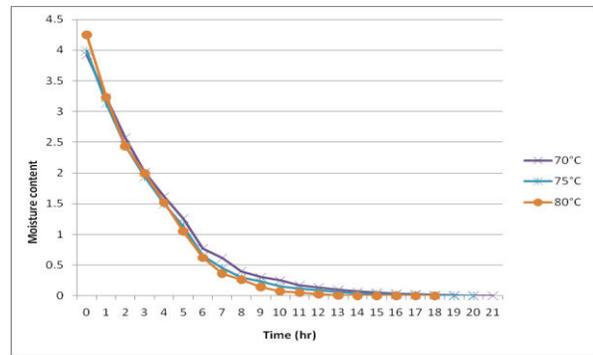


Table 3: Drying Rate of banana slices at different temperature in different dryers

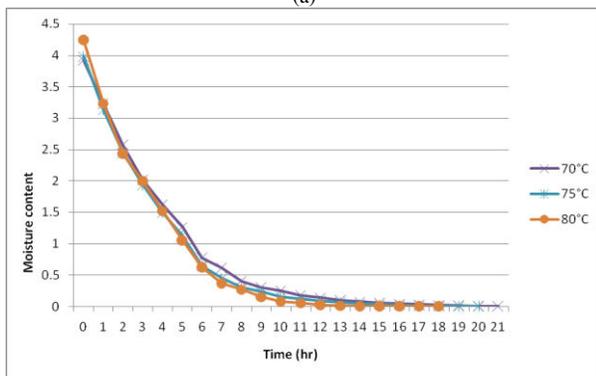
Name of dryer	Temperature (°C)	Drying time (5mm)	Drying time (7mm)
Tray dryer with perforated plates	70	20	22
	75	17	17
	80	12	12
Tray dryer with solid plates	70	20	23
	75	18	18
	80	14	14
Multi-purpose tray dryer	70	11	12
	75	7	10
	80	6	7



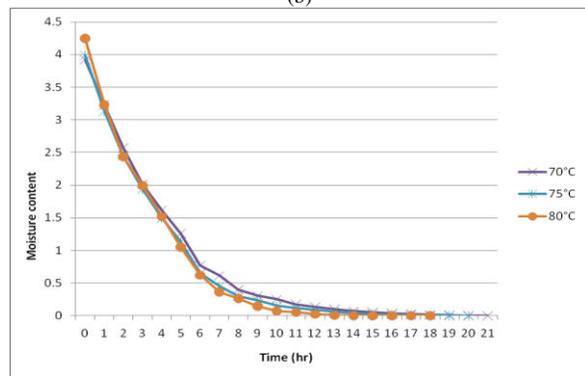
(a)



(b)



(c)



(d)

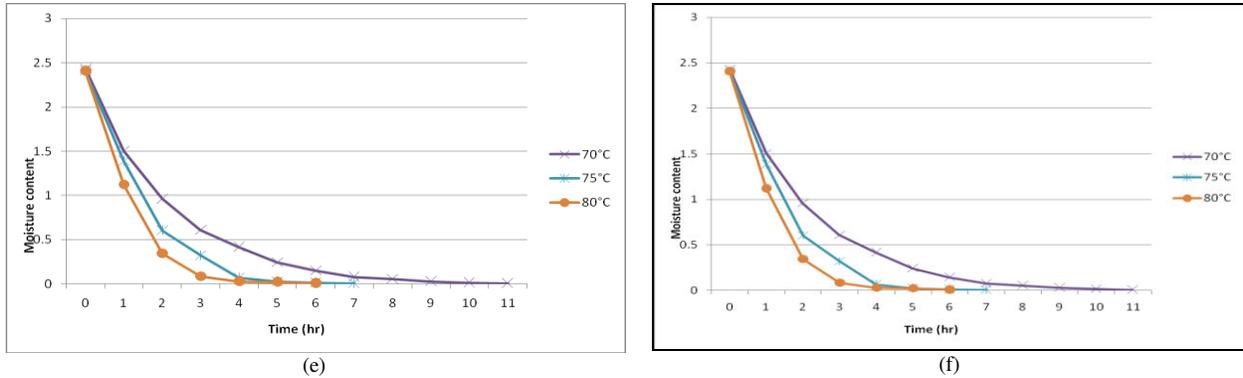
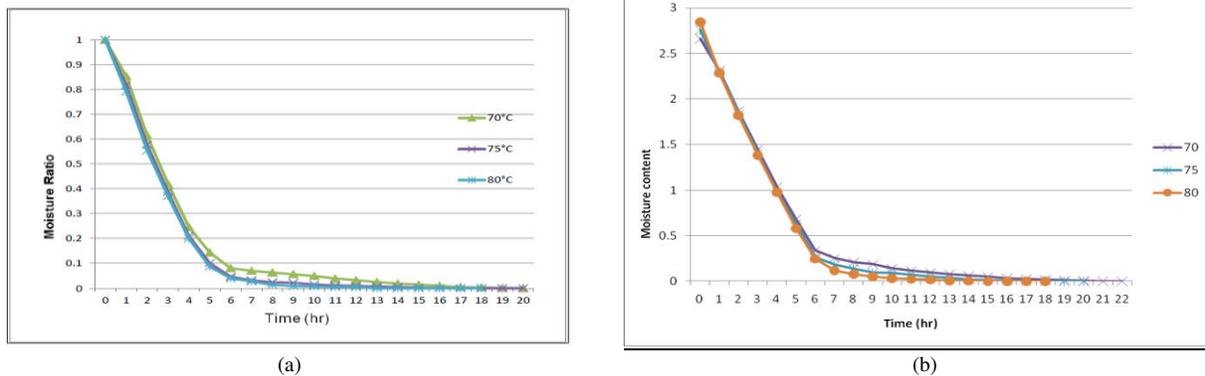


Fig. 1 Variation of M.C (Kg water/Kg dry matter) with Respect to Drying Time in banana slices (a) 5mm in tray dryer with perforated plates, (b) 7mm in tray dryer with perforated plates, (c) 5mm in tray dryer with solids plates (d) 7mm in tray dryer with solids plates, (e) 5mm in Multi-purpose Tray Dryer and (f) 7mm in Multi-purpose Tray Dryer

It can be observed from the data that the drying time to reach the equilibrium moisture content for the 5 & 7mm banana slices varied from 20, 25, 20, 22, 17, 17 & 12, 12 hour in tray dryer with perforated plates at temperature of 70, 75 & 80°C, respectively. Similarly the other eight temperature data are shown in table. Fig. 2 & 3 shows that the moisture content dropped faster in the starting, whereas it becomes slow in the last phase at all the temperatures considered in the study. It was also observed that within a certain temperature range (75-80°C), increasing drying temperature speeds up the drying process, thus shortening the drying time. Similar findings have been reported for fruit and vegetable products drying [6][7][8].

6.7.2 Variation of moisture ratio with time

The curves in Fig.2 indicate that moisture ratio decreases continuously as the drying progresses. It took 3 to 4 hours to remove the first half moisture from 5 and 7mm banana slices at 70, 75 & 80°C in tray dryer with perforated plates. The time required to reduce first half moisture was 30 & 50% of total time in banana slices. The same condition was observed for drying of banana slices in tray dryer and multi-purpose tray dryer. They took 3 hours and 2 hours respectively, to remove the first half moisture (moisture ratio = 0.5) at 65, 70, 75 & 80°C, which shows the 18-15% and 18-30% of total time was in banana slices.



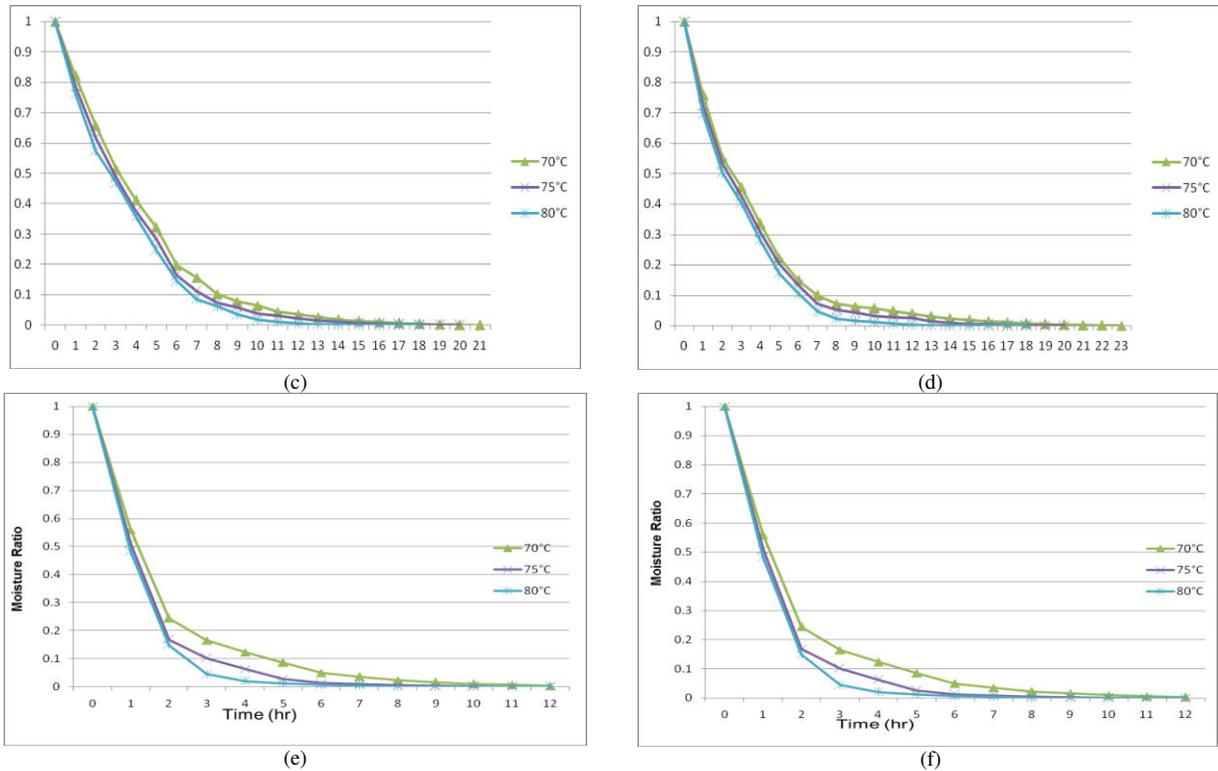


Fig. 2 Variation of Moisture Ratio (M/Mo) with Respect to Drying Time in Banana slices (a) 5mm in tray dryer with perforated plates, (b) 7mm in tray dryer with perforated plates, (c) 5mm in tray dryer with solids plates (d) 7mm in tray dryer with solids plates, (e) 5mm in Multi-purpose Tray Dryer and (f) 7mm in Multi-purpose Tray Dryer

IV. CONCLUSIONS

Carbohydrate content of dehydrated banana powder in Tray dryer with perforated plates possessed significantly higher amount (78%) at 80°C temperature for 7mm slice thickness. The fat content was highest in the Tray dryer with solid plates at 80°C temp. for 7mm slice thickness. Ash content of the twenty two samples was in the range of 4.1 to 5.12 %. The ash content was highest in the oven at 80°C for 7mm slices and tray dried at 75°C for 7mm slices samples. The 7-mm slices dried at 75°C in Multi-purpose tray dryer have obtained the highest sensory score within the experimental range of different dryers. It can be concluded from the study that multi-purpose tray dryer suits the best for drying of banana slices among the three dryer to get good quality banana powder.

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