

Physical Properties of Powdered Pineapple (*Ananas Comosus*) Juice-Effect of Maltodextrin Concentration and Outlet Temperature During Spray Drying

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Abstract

This research study was carried out during May–October 2017 at Processing and food engineering laboratory, DRPCA, Pusa, (Bihar, India); with the objective to evaluate the effects of outlet temperatures of 70, 80 and 90o C and maltodextrin concentration levels at 10 and 20% on the physical properties, hygroscopicity and water activity of spray dried pine apple juice powder. Moisture content and hygroscopicity of powder were significantly affected by outlet temperature and maltodextrin level. However, the time taken for spray drying of one litre of pineapple juice with 10% MD and 20% MD were 4.5 hr and 4 hr, respectively, to reach a final moisture content of 5 and 4 (% wb). The increasing in spray drying temperature and MD concentration resulted in low final moisture content. The final moisture content as well as the water activity of the spray dried pineapple powder were found to be in the range of 4.0–.67% and 0.199–0.368, respectively. Low levels of water activity showed that the prepared powder could be stored safely for longer period of time and microbial activity could be prevented.

Keywords: Pine apple powder; physical properties; Spray drying, maltodextrin

1. INTRODUCTION

Pineapple (*Ananas comosus*) is one of the commercially important fruit crops of India. It is a tropical plant. Cultivation of pineapple originated in Brazil and gradually spread to other tropical parts of world. Other leading producers are Thailand, Philippines, Brazil, China, Nigeria, Mexico, Indonesia, Colombia and USA. In India, pineapple is more commonly called as “Ananas”. India is the seventh largest producer of pineapple. It produced 18.08 lakh t of pineapple on 1.06 lakh

hectare area and average yield of 17.06 MT ha⁻¹ in

2022 (Hanumanthappa and Teggi, 2024).

Although there are a number of pineapple products in the market, the food industry still keeps developing new product from pineapple. The benefit of new product development is the elevation of the fresh pineapple demand and consequently helps reducing the pineapple loss caused by the micro-organisms, chemical and enzymatic reactions during the peak of harvesting season. Pineapple powder is an interesting product because of its long shelf life at ambient temperature, convenience to use and low transportation expenditure. Pineapple powder can be consumed as an instant juice powder or a flavouring agent. So far, there have been merely few studies about the production of pineapple powder. Spray drying is a unit operation by which a liquid product is atomized into a hot drying chamber to instantaneously obtain a powder. The gas generally used is air or more rarely an inert gas as nitrogen. The breakup of bulk liquid into a large number of droplets and due to this, there is enormous increase in surface area for heat and mass transfer so that evaporation is very rapid. The breakup of bulk liquid into a large number of droplets and due to this, there is enormous increase in surface area for heat and mass transfer so that evaporation is very rapid. There are a lot of positive benefits to spray drying. Some of these benefits are to store powder for a longer period of time, maintaining nutritional aspects and also preventing microbial spoilage from occurring.

Maltodextrin [(C₆ H₁₀ O₅)_n.H₂O] is one of the most used carrier agents in the drying of products in spray dryers. It reduces hygroscopicity of powders containing higher concentrations of the agent (Goula, and Adamopoulos, 2010). Maltodextrin also contributes to the rehydration capacity of dry products, due to the reduced stickiness of the particles, which facilitates their solubility in water since the particles' higher contact surface with water will be more extensive (Bhandari and Adhikari, 2008). However, the addition of

maltodextrin has a disadvantage, once it can change product's nutritional profile due to the increase in the proportion of carbohydrates.

Many investigators studied spray drying of fruit juices and the related literature is available to obtain powdered fruit juice, such as watermelon (Oberoi and Sogi, 2015), juçara (Paim et al., 2016), tamarind (Muzaffar and Kumar, 2016), mango (Caparino et al. 2012; Zotarelli et al., 2017), blueberry (Araujo-Diaz et al., 2017), with different carrier agents and in different concentrations. This study was thus carried out to evaluate the effects of outlet temperatures of spray drying and maltodextrin concentration levels on the various quality parameters of spray dried pine apple juice powder. The important objective was to reduce the post-harvest losses in pineapple and develop a valuable good quality spray dried pineapple powder which could be reconstituted in to drinks or other food products round the year for consumption.

2. MATERIALS AND METHODS

2.1. Procurement and juice preparation

This research study was carried out during (May-October 2017) at Processing and food engineering laboratory, College of Agricultural Engineering, Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar, India. Geographically, Pusa is located at 25.9780° North latitude, 85.6488° East with an elevation of 52 m from mean sea level. Fresh and good quality pineapples were procured from local Pusa market. It was properly washed in running water. The pineapples were then peeled off manually using knife. These were then cut into pieces to extract juice using a juice extractor available in the Processing and Food Engineering Laboratory. Different by-product like peels and pulps were weighed to find out mass balance. Extracted juice was collected and total soluble solids were measured by using a refractometer (HI 96801).

A pre-calculated amount of Maltodextrin powder was mixed to pineapple juice to increase the TSS and to reduce the stickiness of the dried powder. Samples were prepared by mixing 100 g and 200 g of Maltodextrin to obtain the concentration of 10% and 20%, respectively. The total soluble solid (TSS) of prepared juice samples was measured by the refractometer.

2.2. Experimental variables

Independent parameters

Outlet temperatures: - 70° C, 80° C and 90° C

Concentration of maltodextrin: - 10% and 20%

Dependent parameter

Moisture content of powder, Bulk density, Colour, Texture, Hygroscopicity, Drying time and Water activity.

There were 6 experiments obtained to conduct experiment on spray drying of pineapple juice with various outlet temperature (70° C, 80° C & 90° C) & concentration of MD (10 & 20%).

2.3. Spray drying of pineapple juice

Prepared pineapple juice samples were spray dried using a laboratory spray dryer (Model-SPD-P-111). The setting for all the parameters was done by touch screen control system. The inlet temperature and feed rate were kept constant at 180° C and 4 ml min⁻¹. The air pressure was fixed at 1.5 kg cm⁻². The aspirator speed was varied to control the outlet temperature at desired value. The feed rate was controlled at constant feed rate 4 ml minute⁻¹. At the end of drying, the pineapple powders were collected, weighed, packed in air tight polythene bag and kept in desiccator for quality determination. The total weight value of powder collected from each drying run.

2.4. Determination of moisture content

The moisture content of prepared spray dried powder was determined using standard hot air oven method (Jittanit et al., 2010). Two gram of spray dried powder was kept in hot air oven at 105° C for 2 h. Subsequently, each sample was cooled in a desiccator, weighed and re-dried for 2 h. The process was repeated until the change in weight between successive drying cycles at 2 h intervals was not more than 2 mg. The weight loss after drying in the

oven was used to calculate the moisture content of the powder and was expressed on a wet basis (wb).

$$\text{Moisture content(wb)} = \frac{W_1 - W_2}{W_1} \times 100$$

Where, W₁= initial weight of powder

W₂= final weight of powder

2.5. Determination of water activity (a_w)

Water activity is an important parameter for spray dried powder due to its effect on the shelf life of product. The water activity of prepared pineapple powder was measured using a water activity meter (Rotronic Hygropalm- AW 1) model available in the laboratory.

2.6. Determination of bulk density

A known quantity of spray-dried pineapple juice powder was loaded into a 10 ml graduated cylinder and the volume occupied was recorded. Bulk density (ρ_b) of spray dried powder was recorded as weight per unit volume (kg m⁻³). The bulk density (ρ_b) was calculated by tapping the cylinder for 5 min on a soft rubber base. The final volume was then read and used to calculate the bulk density.

$$\text{Bulk density } (\rho_b) = \frac{\text{weight(g)}}{\text{volume(cm}^3\text{)}}$$

2.7. Determination of hygroscopicity

Hygroscopicity is defined as the ability of the food powder to absorb environmental moisture. It was evaluated based on the method described by (Cai and Corke ,2000) with modifications. A total of 2 g of the sample was placed in a container at 25° C with a saturated NaCl solution. Samples were weighed after one week, and hygroscopicity was expressed as grams of adsorbed moisture 100 g⁻¹ of dry matter.

3. RESULTS AND DISCUSSION

3.1. Effect of temperature and concentration on final M.C. of spray dried pineapple powder

The pineapple juice samples of 10% as well as 20% MD concentration were spray dried at 70,

80 and 90° C outlet temperatures. The final M.C. of spray dried powders is presented in figure 1. Moisture content is an important parameter because it determines the shelf life of the product. The results showed that the M.C. of the powder were in the range of 4.0–5.67% except one case (10% MD, 70° C) in which M.C. was 6.67%. These moisture levels were similar to the moisture contents of dried tea powder and pineapple juice powder products which were 3–5% and 4–5.8% respectively by other researchers (Sinija et al., 2007; Jittanit et al., 2010; respectively). Below 6% moisture content is safe to store powder and prevent microbial attack (Jittanit et al., 2010).

In both cases the bars clearly showed that increasing drying temperature or MD concentration resulted in the low moisture product. The high drying air temperature led to high temperature gradients at the surface of feed drops. This directly expedited the heat transfer rate and also the moisture evaporation from the liquid drops in drying chamber resulting in the low moisture level of dried product (Nastaj, 2000).

3.2. Effect of temperature and concentration on bulk density of spray dried powder

The Bulk density of spray dried powders is presented in Figure 2. The tapped bulk density is significant characteristics of powder product in terms of storage and ease of transportation. The results showed that the tapped bulk density of powder ranged from 0.606 g ml⁻¹ to 670 g ml⁻¹. The B.D of orange powders produced by Chegini and Ghobadian (2005) that ranged from 0.34 g ml⁻¹ to 0.95 g ml⁻¹ (Khuenpet et al., 2016). These results are similar to that of orange powder (Chegini and Ghobadian, 2007).

The results show that elevation in the drying temperature at similar MD resulted in lower

bulk density. Furthermore, at the same drying temperature, the higher proportion of MD raised the bulk density of the powder.

3.3. Effect of temperature and concentration on water activity of spray dried powder

The water activity of spray dried powders is presented in Figure 3. Water activity measures the availability of free water, hence, higher water activity indicates more free water available for biochemical reactions, which leads to shorter shelf life (Quek et al., 2000). The water activities of powders ranged between 0.199 to 0.368. Among the powders only those dried at an outlet temperature of 70° C irrespective of concentration of MD had water activity values higher than 0.30. Powders with water activity lower than 0.3 regarded as microbiologically and chemically safe (Bicudo et al., 2015). The other powders can be considered microbiologically safe for long term storage. Moreover, it appeared that the powder produced with higher MD concentration had less water activity and also the higher outlet temperature resulted lesser water activity.

3.4. Effect of temperature and concentration on hygroscopicity of spray dried pineapple powder

The pineapple juice samples of 10% as well as 20% MD concentration were spray dried at 70, 80 and 90° C outlet temperature. The hygroscopicity of spray dried powders is presented in Figure 4. The hygroscopicity was found to increase from 18.6 g to 28.5 g absorbed water 100 g⁻¹ with increase in outlet temperature from 70–90° C. MD concentration was providing the different powder hygroscopicity. High concentration of maltodextrin reduces the hygroscopicity of powder (Tonon et al., 2008).

The lowest hygroscopicity values were obtained when the highest MD concentration were used.

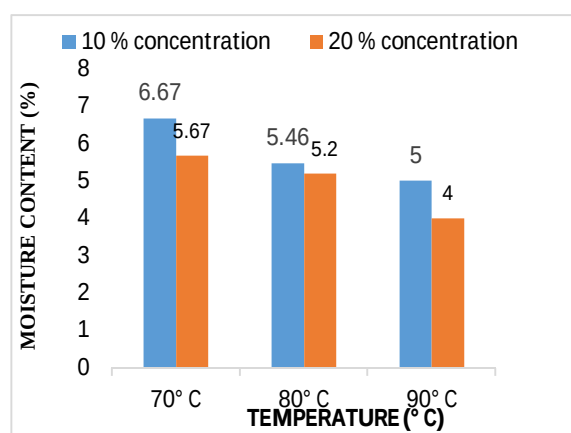


Figure 1: Variation in final M.C. of spray dried pineapple powder with concentration and temperature

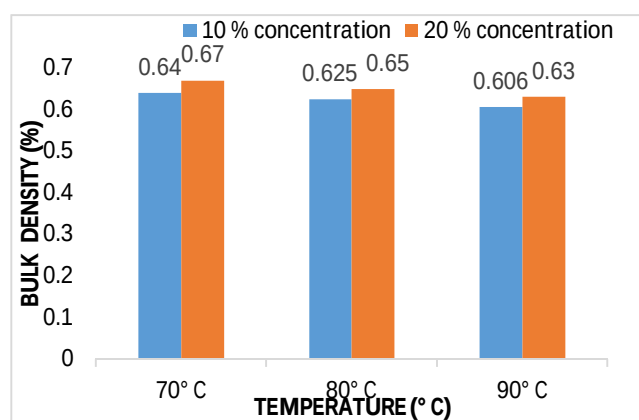


Figure 2: variation in bulk density of spray dried pineapple powder with concentration and temperature

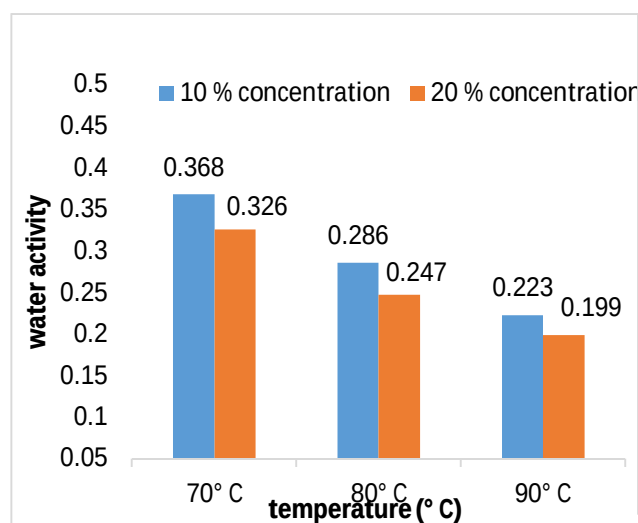


Figure 3: Variation in water activity of spray dried pineapple powder with concentration and temperature

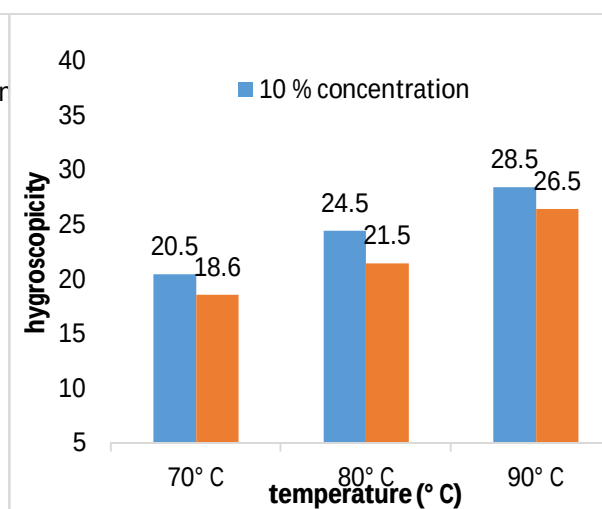


Figure 4: Variation in Hygroscopicity of spray dried pineapple powder with concentration and temperature

4. CONCLUSION

Spray drying of pineapple can be done so that it could be available round the year for consumption and be converted to potential value added product when it is available in surplus. The time taken for spray drying of one litre of pineapple juice with 10% MD and 20% MD were 4.5 hr and 4 hr, respectively, to reach a final moisture content of 5 and 4 (% wb). The Increasing in spray drying temperature and MD concentration resulted in low final moisture content. The final moisture content as well as the water activity of the spray dried pineapple powder were found to be in the range of 4.0–

5.67% and 0.199–0.368, respectively. Low levels of water activity showed that the prepared powder could be stored for longer period of time and microbial activity could be prevented.

5. Data Availability Statement: we agree to make available the data when necessary.

6. Conflict of Interests: We declared that, there is no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

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