The Andhra Agric. J 64 (2): 442-448, 2017

Effect of Maltodextrin Concentrations on Physico-Chemical Characteristics of Pineapple Powder under Different Drying Conditions

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ABSTRACT

A number of pineapple powder specimens were produced using a spray dryer under various drying conditions. Fresh pineapple juices were added with maltodextrin (MD) at 10, 15 and 20% before exposing to the drying temperatures at 130, 140 and 150°C with the feed rate 20 ml/min. The spray-dried pineapple powders were analyzed for moisture content, solubility, TSS, colour and sensory evaluation. The yield of spray drying pineapple powder was highest (10.77%) at higher maltodextrin concentration of 20%, inlet air temperature of 130°C. When inlet temperature and the percentage of maltodextrin increased, the moisture content and solubility decreased. The pH and TSS of spray dried powder samples increases with increase in inlet drying temperatures at different maltodextrin concentrations In the colour appearance the pineapple powder is more lightness, redness and yellowish compare to fresh fruit juice. The pineapple juice added with maltodextrin concentration at 15% and dried at 150°C achieved the highest overall liking score.

Key words: *Instant pineapple juice, Maltodextrin, Pineapple, Pineapple powder, Spray drying.*

Ananas Comosus is a commonly known as pineapple, most economically fruit in the *Bromeliaceae* family. According to the nutrition data, pineapple is rich with vitamin C, magnesium, potassium and other mineral. Usually pineapples are used in cuisines, besides it can be consumed fresh, converted into juice, jam, ice cream and etc. But, this fresh fruit is difficult to ship and the juice which is having high content of ascorbic acid cannot last longer. Therefore, juiced powder is other alternative to consume this fruit in fresh condition.

Spray drying is a process of suspending sprayed liquid particles and moisture removal by hot air to produce high quality products. The high quality of the spray-dried products is due to the protection of the suspended particles by evaporative cooling during the process. Spray dryers are commonly used for powder production of some products such as milk, coffee, tea, egg, enzymes, whey protein, fruits and vegetables extracts, ceramic materials, dyes and detergents.

MD is a carrier which is the most popular in spray drying due to its physical properties such as high water solubility. It described that MD consists of b-D-glucose units linked mainly by glycosidic bonds and are typically classified by glycosidic bonds and are typically classified by their dextrose equivalent (DE). Bhandari *et al.* (2003) pointed out that MD could improve the stability of fruit powder with high sugar content because it reduced stickiness and agglomeration problems during storage. It indicated that the increasing amount of MD could increase the product recovery and the lightness of the fruit juice powder.

The benefit of product development is the elevation of the fresh pineapple demand and consequently helps reducing the pineapple loss caused by the microorganisms, 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 flavoring agent.

Due to the lack of research about spray dried pineapple juice, this study was carried out with the following objectives; (1) to study the feasibility of producing the spray-dried pineapple powders and (2) to determine the optimal quantity of MD and drying condition for spray drying of pineapple juice.

MATERIAL AND METHODS

The process started with selection of raw pineapple visually based on the color hardness and overall condition of the fruit. The selected fruits were peeled, cut, crushed and hydraulically pressed to squeeze out the juice. Maltodextrin can significantly increase the glass transition temperature and reduce the hygroscopicity of dried products (Goula and Adamopoulos, 2008). Hence the carrier agent maltodextrin of 10, 15 and 20% w/v was added to the pineapple juice to increase concentration and to reduce hygroscopicity of the dried powder.

PHYSICO-CHEMICAL ANALYSIS

Moisture content

The moisture content was determined based on AOAC (1984) method by hot air oven. The moisture content of sample were determined and expressed in % (db) by using following formula.

$$\text{Moisture content}(\%, \text{db}) = \frac{\text{Initial weight - Final weight}}{\text{Initial weight}} \times 100$$

Solubility

The purpose of this test was to study the time taken for the powder to fully can dissolve in water. A 50 ml of distilled water was transferred into a beaker and 1g of the powder sample was carefully added. The mixture was left to operate at high velocity for 5 minutes. The measurement was conducted in the room temperature 25°C. The stopwatch was started since stirring and stopped when the powder in the beaker entirely dissolved. This recorded time, namely solubility was indicated in the unit of minutes.

Total soluble solids

Total soluble solids was determined by using a digital refractometer (ATAGO make, rang 0-93%). Pineapple was extracted and the sample

Table 1. Effect of different concentrations of maltodextrin and inlet drying temperatures on the yield (%) of pineapple powder.

Inlet air temperature (°C)	Powder yield (%)		
	10%(MD)	15%(MD)	20%(MD)
130	2.67	4.1	10.77
140	3.1	4.3	7.77
150	5.0	5.7	8.1

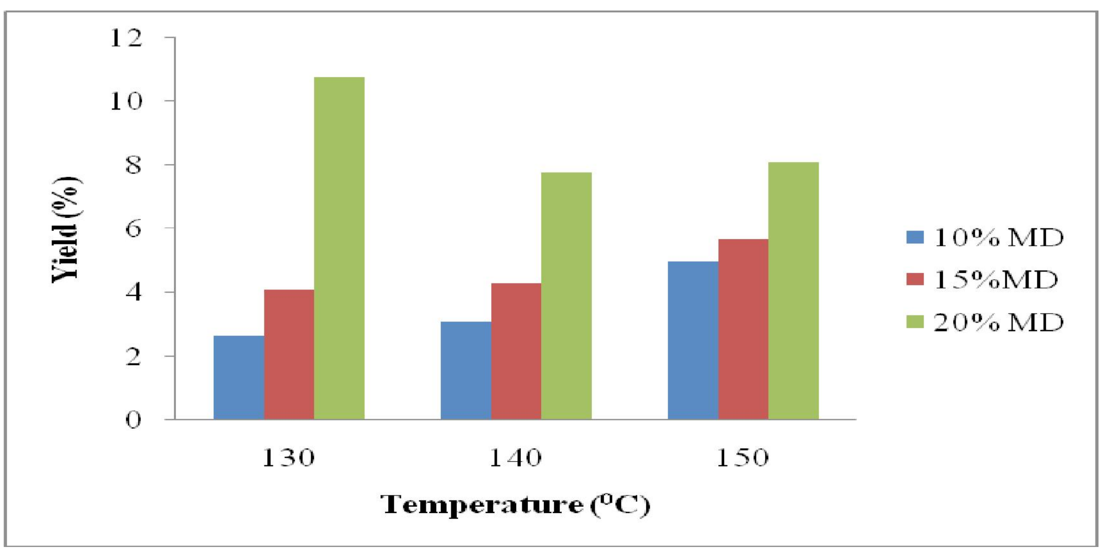

Fig. 1 Effect of different concentrations of maltodextrin and inlet drying temperatures on the yield pineapple powder.

Table 2. Colour of pineapple powder.

Inlet drying temperature (°C)	Maltodextrin content (%)	Colour		
		L*	a*	b*
	10	55.3	4.6	21.6
130	15	51.4	6.1	23.2
	20	64.6	3.7	24.6
	10	56.3	5.2	24.9
140	15	55.1	6.1	25.2
	20	61.2	6.7	25.9
	10	58.8	3.2	25.4
150	15	57.8	5.1	26.2
	20	56.8	6.2	26.7

where, L* value indicates darkness (-) to lightness (+)
a* indicates chromacity on a green (-) to red (+) axis and
b* chromacity on a blue (-) to yellow (+) axis.

Table 3. Sensory test results of spray dried pineapple powder.

Inlet drying temperature (°C)	Maltodextrin Content (%)	Appearance	Colour	Aroma	Taste	Overall Liking
	10	6.2	6.8	7.1	7.9	7
130	15	8.0	8.3	7.8	7.9	8
	20	7.8	6.8	6.6	6.8	7
	10	6.8	6.6	6.4	8.2	7
140	15	8.2	7.7	8.1	8.1	8
	20	7.8	7.2	6.3	6.7	7
	10	7.9	8.3	8.5	7.3	8
150	15	8.4	8.9	8.6	7.7	8.4
	20	6.2	8.7	6.8	6.3	7

was allowed to settle. A total soluble solid of samples was measured by placing a drop of the juice on the prism of the digital Refractometer and reading was expressed in terms of degree Brix. Correction at 20° C was applied for the observed reading (Ranganna, 1995).

pH

pH is the logarithm of the reciprocal of hydrogen ion concentration is a measure of active acidity which influence the flavour or palatability of a product and also affects its processing requirements. The pH of the pineapple powder sample was determined using a Digital pH meter (HI-98107, Hanna). Each sample was replicated three times and its mean value was taken as pH of the sample.

Colour

The colour of spray dried pineapple powder was measured using Hunter lab colour flex meter (M/s. Hunter lab, Reston, VA, USA; model CFLX-45). The surface colour was quantified in terms of L^*, a^* and b^* values of CIELAB colour space. The CIELAB colour space is organized in a cube form, which expresses colour in coordinates L*, a* and b*, where L* value indicates darkness (-) to lightness (+), a* indicates chromacity on a green (-) to red (+) axis and b* chromacity on a blue (-) to yellow (+) axis.

Sensory Evaluation

Sensory evaluation of pineapple powder was carried out for consumer acceptance and preference using 20 untrained panel lists selected at random from the College of Agricultural Engineering, ANGRAU, Bapatla. Physical appearance, Aroma, taste and overall acceptability and texture of the samples were rated using a 9-point Hedonic scale where 9 and 1 represent like extremely and dislike extremely respectively.

RESULTS AND DISCUSSION

Effect of different concentrations of maltodextrin and inlet drying temperatures on the yield (%) of pineapple powder

The pineapple juice for spray drying was prepared by adding different concentrations of maltodextrin as carrier agent such as 10%, 15% and 20% to the pineapple juice. After adding maltodextrin, the juice was fed into the spray drier at constant feed flow rate of 20 ml/min and dried at different inlet drying temperatures such as 130, 140 and 150°C in a spray dryer. The yields of pineapple powder at different concentrations, and at different inlet drying temperatures were shown in Table 1.

From the observations, maltodextrin helped the powder to be less sticky and less deposited to the chamber wall. There was hardly any powder accumulated if maltodextrin was not added. Therefore, 10%, 15% and 20% of maltodextrin were added prior to spray drying. The powders produced were better and fine with the increase of maltodextrin concentration.

From Fig. 1, it was observed that, at 130°C inlet air temperature, the highest yield (10.77%) was observed in 20% maltodextrin and lowest yield (2.67%) was observed in 10% maltodextrin. At 130°C inlet drying temperature, the yield was highest as compared to 140 and 150°C inlet drying temperatures. The values in Table 1 indicate that all drying conditions provided powder yield in the range of 2.67-10.77%. High powder yield were due to the addition of maltodextrin contents e" 10% that resulted in the non sticky products and subsequently low amount of product seized in the drying chamber and cyclone. Besides, there was a trend of more powder yield along the increasing maltodextrin contents.

The increase of inlet temperature resulted in decreased process yield. But sometimes, the increasing of inlet drying temperature can reduced the yield due to the melting of the powder and cohesion wall. This was accordance with the results obtained by Suzihaque (2015).

Effect of inlet drying temperature on moisture content of pineapple powder

Moisture analysis was test to identify the amount of the water content in the powder. The

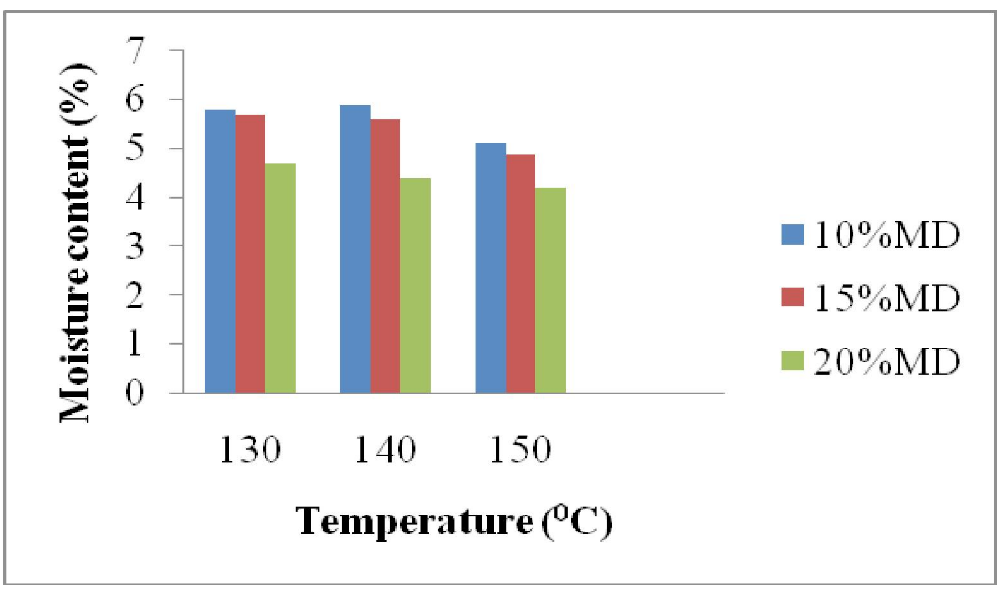

Fig. 2. Variation of moisture content at different concentrations under different inlet drying temperatures of pineapple powder.

moisture content is important since it can keep the quality of the powder. High moisture content will decrease the quality of the product since it lower down the activity of bacteria in the food product. In a spray dryer the water content of the feed will affect the final moisture content of the powder produced.

Fig. 2 shows the variation of moisture content for each temperature at the different concentration of maltodextrin. From the figure, it was observed that the moisture contents of the powders were in the range of 4.2-5.9%. The increasing drying temperatures and maltodextrin content resulted in the lower moisture product. The moisture content was decreased by increase the inlet drying temperature. This is due to the faster heat transfer between the product and drying air. The higher inlet drying temperatures, the greater temperature gradient between the atomized feed and drying air and it will give the greatest driving force for water evaporation (Phisut, 2012).

Effect of inlet drying temperature on solubility of pineapple powder

For the solubility of the pineapple powder, the effect of the inlet temperature was unclear but the solubility of the pineapple powder is decrease if the concentration of the maltodextrin is increase (Jittanit, 2010).

Fig. 3 shows the variation of solubility for each temperature at the different concentration of maltodextrin. The values of solubility of powder at 10%, 15% and 20% maltodextrin contents were 7.2, 6.4 and 2.5 min. under 130°C inlet drying temperature. At 140°C inlet drying temperature, the values of solubility of powder at 10%, 15% and 20% maltodextrin contents were 4.8, 4.3 and 3.1min. The values of solubility of powder at 10%, 15% and 20% maltodextrin contents were 7.1, 6.0 and 4.2 min. under 150°C inlet drying temperature.

Total soluble solids

The total soluble solid content of fresh pineapple juice was 11° Brix. Fig. 4 shows the variation of total soluble solids (%) for each temperature at different concentrations of maltodextrin. The soluble solid content of the pineapple is higher than the fresh pineapple juice. The soluble solid content was increase as the addition of the maltodextrin in the sample (Phisut, 2012). The solid soluble content of the pineapple powder does not depend on the inlet temperature as there does not have a constant trend of increasing or decreasing solid soluble content as the inlet temperature increase.

pH and Colour

Fig. 5 shows that the variation of pH for each temperature at different concentrations of maltodextrin. The pH of fresh pineapple juice was 2.3. It was observed that the pH of all samples increases with increase in inlet drying temperatures at different concentrations (Jittanit, 2010). Besides that, the pH of the pineapple powder was higher than the fresh pineapple juice. The increasing of the pH value for each experiment was not constant but the increasing of the pH value was because the addition of the concentration maltodextrin into the sample which the maltodextrin pH was 4.7.

Sensory Evaluation of spray dried pineapple powder

Sensory evaluation of pineapple powder was carried out for consumer acceptance and preference using 20 untrained panel lists selected at random from the College of Agricultural Engineering, ANGRAU, Bapatla. Sensory characteristics like texture, appearance, aroma, taste and overall acceptability of the powder were rated by using a 9-point Hedonic scale where 9 and 1 represent "like extremely" and "dislike extremely" respectively.

From Table 3, it could be observed that highest rating of overall acceptability was given for 15% maltodextrin content under 150°C inlet drying temperature at constant feed flow rate 20 ml/min.

CONCLUSIONS

The yield of spray drying pineapple powder was highest at 20% maltodextrin concentration of 130°C at constant feed flow rate of 20 ml/min. The moisture content will decreased by increase the inlet drying temperature. The solubility of the pineapple powder depends on the concentration of the maltodextrin where the increasing the concentration of maltodextrin could reduce the hygroscopicity of the powder. The soluble solid content is increase as the addition of the maltodextrin in the samples.

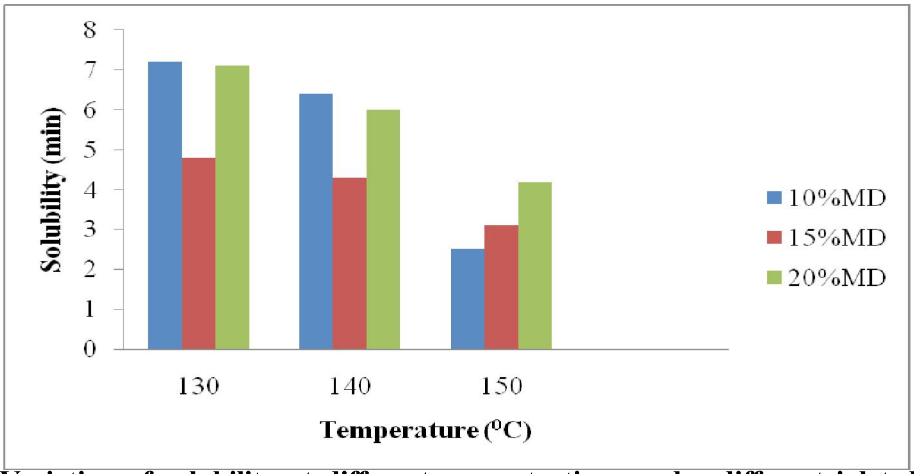

Fig. 3. Variation of solubility at different concentrations under different inlet drying temperatures of pineapple powder.

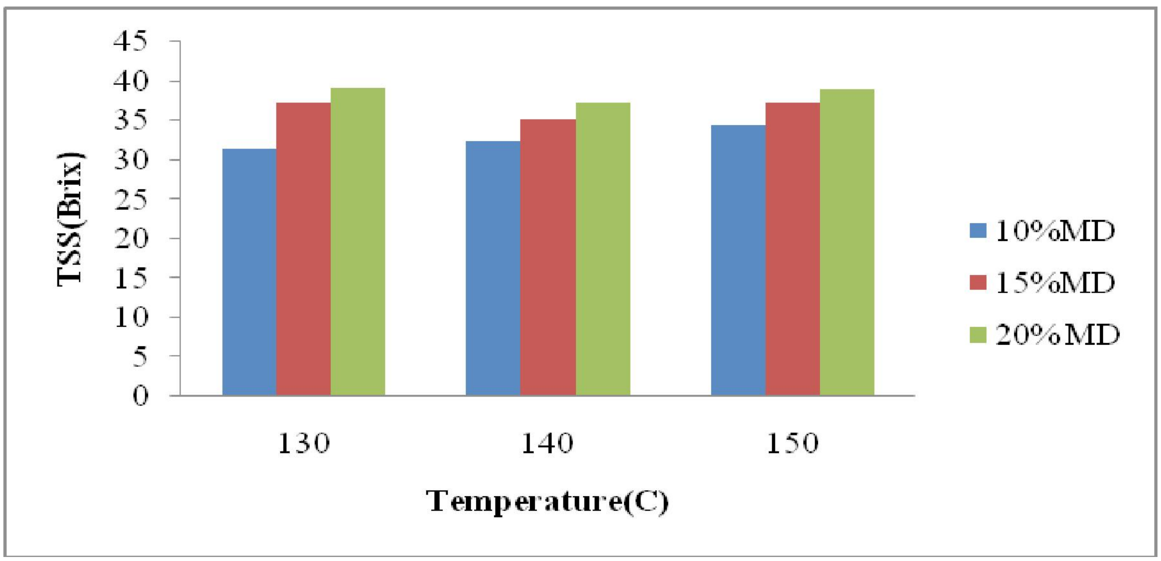

Fig. 4. Variation of TSS at different concentrations under different inlet drying temperatures of pineapple powder.

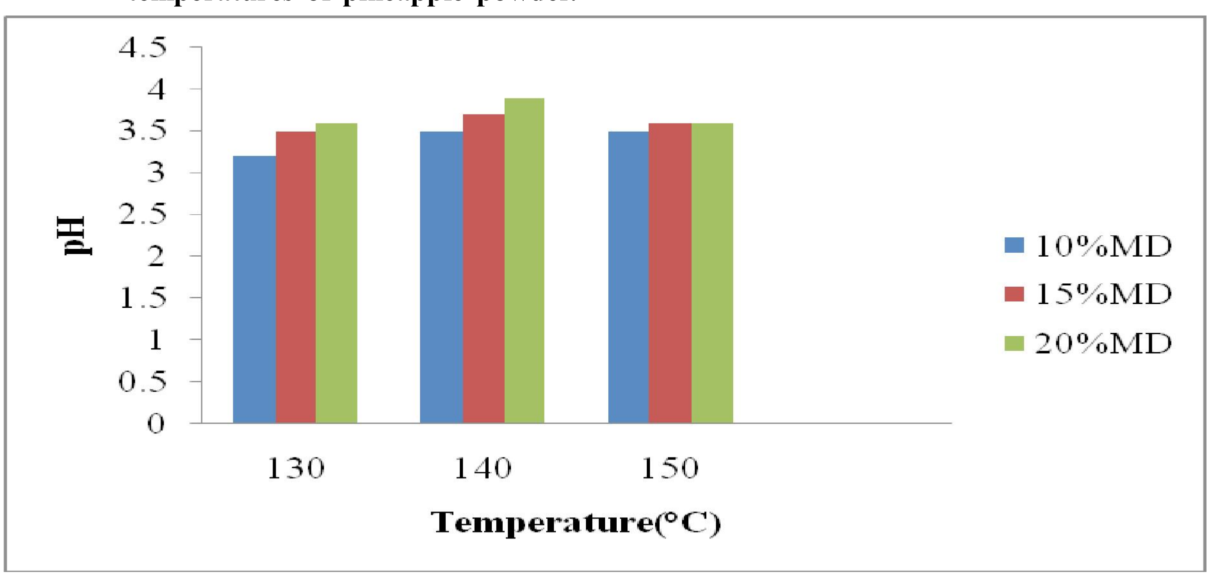

Fig. 5. Variation of pH at different concentrations under different inlet drying temperatures of pineapple powder.

The pH of spray dried powder samples increases with increase in inlet drying temperatures. In the colour appearance, the pineapple powder is more lightness, redness and yellowish compare to fresh fruit juice. It was concluded that the pineapple juice added with maltodextrin concentration at 15% and dried at 150°C achieved the highest overall liking score.

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(Received on 16.07.2016 and revised on 03.01.2017)