EFFECT OF FEED FLOW RATE and ADDITION OF MALTODEXTRIN TOWARDS SPRAY DRYING OF PINEAPPLE

Nurul Afidah bt Mazelan, Syafiza bt. Abd. Hashib

Faculty of Chemical Engineering, Universiti Teknologi MARA

Abstract- Sample of pineapple powder was produced using the LabPlant SD-Basic Spray Dryer under two different conditions. Slurry of flesh, pulp and skin of pineapple were added with 15%, 20% and 25% concentration of maltodextrin (MD) before feeding to the spray dryer at fixed temperature 130°C using 3rpm, 4rpm and 5rpm speed pump. The powder were then analysed for moisture content. The physicochemical properties such as total soluble solids (TSS) and Titratable Acidity (TA) were also determined. The highest yield of powder produced at 3rpm which is in the range of 0.45 L/hr to 0.60 L/hr feed flow rate with 25% addition of maltodextrin. Result showed that lower feed flow rate and increment of maltodextrin content decresing the moisture content of pineapple powder. TA were significantly decrease as the concentration of maltodextrin increase. TSS in pineapple juice significantly increase when turn into powder but was not affected by the increment of maltodextrin and feed flow rate.

Keywords – feed flow rate, maltodextrin, pineapple powder, spray drying

I. INTRODUCTION

Pineapple or its scientific name known as Ananas comosus L. belongs to the Bromeliaceae family, and it is originated from South America. According to the Malaysian Industrial Pineapple Board, Malaysia is in the 9th position globally in the aspect of production and 10th position among the countries of fresh and canned pineapple exporters. There are three types of pineapple that are mostly planted in Malaysia known as Sarawak, N 36, Josapine and Moris. It is commonly consumed as fresh or as processed products such as pineapple juice, which is a popular product due to its pleasant aroma and flavor [2]. Moris pineapple is choose because there is lack of study that use this type of pineapple and it has high sugar content that will have high TSS [3].

Due to the shelf life problem of pineapple and with the help of technology, incentive has been taken to change the fresh pineapple in the form of powder. Spray drying is one of the best drying methods to convert directly fluid into solid or semi solid particles [4]. The main objective of drying is to reduce the amount of moisture content that will help to slow down microbial and enzymatic activities which is the most important part in determining the quality of product [5]. Spray drying technique is chosen because it produce good quality of powder with low water activity [14]. Fruit juice powder have its own advantages such as reduced volume or weight, reduce packaging, easier handling and packaging and much more longer shelf life [6].

There are few parameters need to be considered during spray drying process which are inlet temperature, feed flow rate, concentration of maltodextrin and volume of slurry. Feed flow rate plays important role between the contact

time of the feed and drying air. The high feed flow rate will cause shorter contact time and make the heat transfer less efficient which caused the lower water evaporation and affect the moisture content of powder [1]. Fruit juices powder may present problem in their properties such as stickiness, hygroscopic and low solubility [7]. Addition of maltodextrin can help to overcome the thermoplasticity and hgroscopicity. Total acidity and total soluble solid plays important criteria of the fruit powder in order to evaluate the products behavior. TSS and TA significantly impact by ripening stages. Due to lack of research about physicochemical of fruit powder, this study was carried out with the following objective; (1) to study the effect feed flow rate for pineapple mixed spray drying and (2) to study the physicochemical properties of pineapple mixed powder due to variety maltodextrin amount.

II. METHODOLOGY

A. Materials

Moris pineapples were obtained at the nearby farm in Jalan Kebun, Selangor. The pineapples were washed, peeled and cut into small pieces. Flesh, pulp and skin of pineapple were blend separately and filtered to squeeze the juice.

500 grams of maltodextrin-pineapple solution were prepared by added 75, 100 and 125 grams to the fresh pineapple juice in order to provide 15% 20% and 25% concentration of maltodextrin.

B. Drying Experiment

The solution prepared were change to powder under spray drying process using fixed temperature, 130°C. The pump speed were adjusted to 3, 4 and 5 rpm for every sample. Times taken for 500g maltodextrin-pineapple solution change into powder were recorded to obtain it flow rate (volume/time). The powders collected were weighed and kept in chiller for further analysis.

C. Analysis of Pineapple Powder

Moisture Content Analysis

Moisture content of pineapple powder was determined using moisture analyzer. 5g of powder was weighted in the moisture analyzer at 105ºC for 10 minutes. Then the reading of the moisture content was taken.

Total Soluble Solid

10g of powder was weighted using analytical balance. The sample powder then was diluted in the 10ml distilled water. TSS was determined using refractrometer by taking a direct reading from a drop of the diluted solution.

Titratable Acidity

10g pineapple powder was transferred to a 500ml erlenmeyer flask. Sample was diluted with 250ml deionised water. 1ml phenolphthalein indicator was added to the diluted sample. Using 0.1N NaOH, the sample was titrated until faint pink end point was observed. The volume of 0.1 N sodium hydroxide used was recorded. The percentage of citric acid was calculated according to the following expression:

% Acid (as anhydrous citric acid) = Volume of 0.1 N NaOH (ml) × 0.64 / 10

III. RESULTS AND DISCUSSION

A. The effect of feed flow rate and addition MD on the amount of powder collected

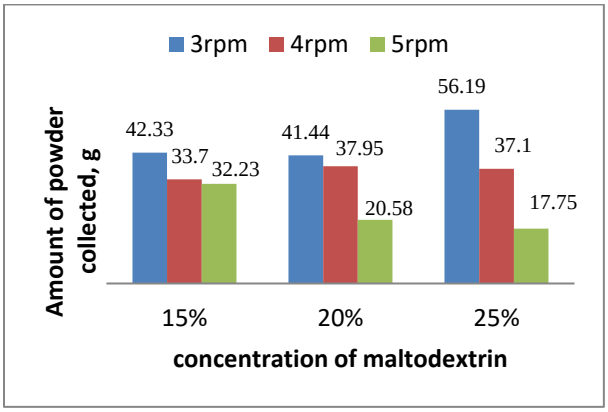

Figure 1: Amount of flesh powder collected

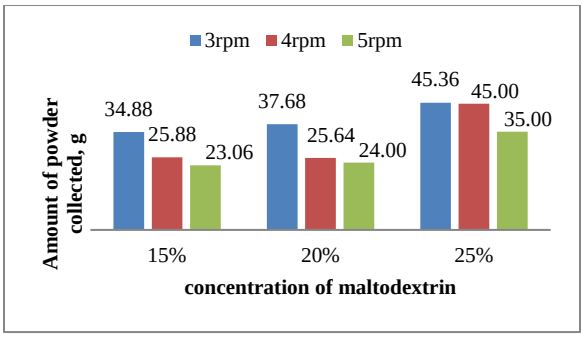

Figure 2: Amount of pulp powder collected

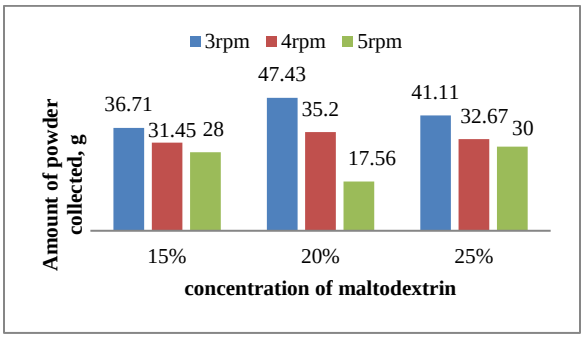

Figure 3: Amount of skin powder collected

Figure 1, 2 and 3 shows the flesh, pulp and skin powder collected after spray drying process. From the graph, the trend show pineapple powders collected were reduced as the speed pump increase. Higher speed pump means higher feed flow rate. From the calculation, at 3rpm speed pump, the feed flow rate is in the range of 0.45 L/hr to 0.60 L/hr. Increase the feed flow rate will decrease the residence time of the product in the drying chamber which means reduce the heat and mass transfer [1]. The result showed that, the powder produce increase as the concentration of maltodextrin increase for flesh and pulp of pineapple which is at 25% concentration of maltodextrin but the result obtained different in the production of skin powder where the highest powder produce at 20% concentration of maltodextrin. Stickiness behavior occurred due to the low molecular weight of sugar such as fructose, sucrose and glucose contain in pineapple fruit. [7]. Maltodextrin helps to minimized the thermoplastic particles from sticking and sticky or less free flowing nature thus increase the production yield [8]. According to the U.S Food and Drug Administration, maltodextrin is known as a food addictive which has been approved as a safe list and act as thickening agent.

B. The effects of feed flow rate and addition of maltodextrin on moisture content of pineapple powder.

Table 2: Moisture content in pineapple powder

Concentration of MD		15% MD	20% MD	25% MD
Sample	Speed Pump (rpm)	Moisture content, %	Moisture content, %	Moisture content, %
Flesh	3	6.49	5.52	5.27
	4	7.00	6.21	6.08
	5	8.24	7.33	7.71
Pulp	3	5.89	5	4.64
	4	6.83	6.41	4.73
	5	7.75	7.04	6.8
Skin	3	5.40	4.38	5.65
	4	8.00	5.97	5.2
	5	6.5	6.19	5.68

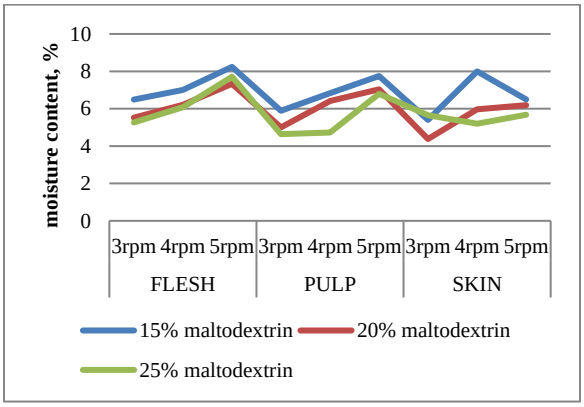

Figure 4: Moisture content in pineapple powder

From the Figure 4 and Table 2, it show that flesh powder contain the highest moisture content followed by pulp and skin. Moisture content of pineapple powder is between 5% to 8.24%. According to the Food and Agriculture Organization of the United Nation, moisture content below than 10% is adequate to ensure that the food powder produced is microbiologically safe. Moisture content decrease as the concentration of MD increase and feed flow rate decrease. Higher feed flow rate reduce the contact time with the hot air. Thus the moisture content will be high [9]. Maltodextrin has the capability to hurdle the sugar in the

fruit powder which have highly hygroscopic nature of absorbing humidity in the surrounding. Thus, increase the MD concentration will decrease the moisture content [10][17].

C. The effects of addition maltodextrin in total acidity

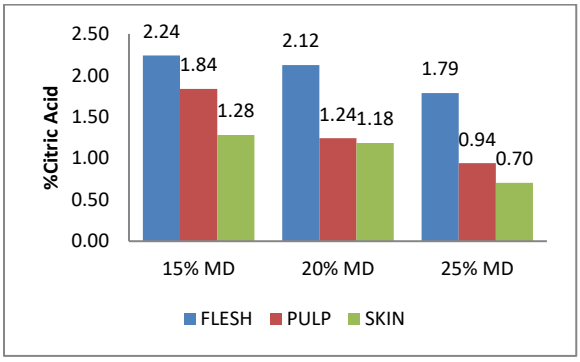

Figure 5: Percent of citric acid contain in flesh, pulp and skin powder of pineapple

From the Figure 5, flesh of pineapple contain the highest percent of citric acid followed by pulp and lastly skin. The highest citric acid contain in flesh is 2.240 %, in pulp is 1.83% and in the skin is 1.280% which obtained in the 15% of maltodextrin concentration. The percent of titratble acidity decrease as the concentration of maltodextrin increase. This is because maltodextrin is a carbohydrate which is product of starch thus reduces the acidity. Total acidity reflecting fruit quality and indicates the sourness [11].

D. The effects of feed flow rate and addition of maltodextrin on total soluble solid of pineapple powder.

In pineapple fruit, total soluble solid which indicating sucrose, fructose and glucose play important roles in flavor characteristic and are major sugars which vary according to the stage of fruit development [12-13]. Before the spray drying process, TSS was tested and the highest TSS obtained in flesh, 8.85% followed b pulp, 8.35% and lastly is skin, 7.79%. Table 3 above shows the amount of TSS after dying process. From the Figure 6, it shows that the range of TSS of pineapple powder is between 28% to 35%. This show that maltodextrin increase the value of TSS as the extract of pineapple consist only 7% to 9% TSS only but there is not affected by the feed flow rate. TSS represents 10 to 20 percent of the fresh fruit's weight and increases as food matures to produce less acidic and sweet fruit [15].

Table 3: TSS in pineapple powder

Pineapple	SPEED PUMP, rpm	Value of TSS In Different Concentration of Maltodextrin, °Brix (%)		
		15% MD	20% MD	25% MD
Flesh	3	30.01	31.70	34.74
	4	30.78	29.47	29.31
	5	28.75	30.23	29.62
Pulp	3	30.64	30.73	31.55
	4	29.38	29.45	31.81
	5	29.66	28.90	31.00
Skin	3	31.03	31.53	31.24
	4	29.84	30.66	31.37
	5	29.00	29.94	31.30

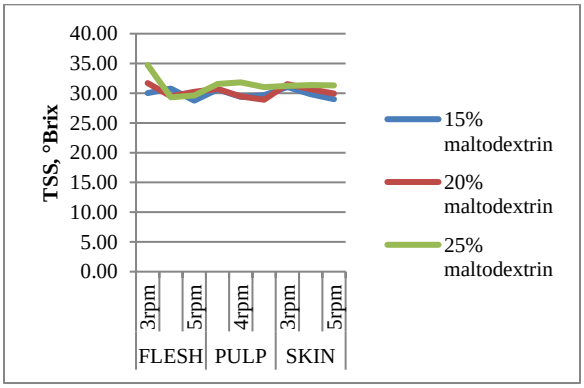

Figure 6: TSS in pineapple powder

IV. CONCLUSION

From the results, it showed the practicability of producing pineapple powder using spray dryer. Obviously feed flow rate and addition of maltodextrin significantly affect the product quality. Increasing the concentration of maltodextrin and reducing the feed flow rate will increase the product yield. The spray drying is cost effective and

also prolong the shelf life of the fruit while maintain its quality. Maltodextrin is a carbohydrate which is product of starch helps to improve the spray drying process by reducing the moisture content thus produce a less stick powder. The feed flow rate is also important parameter. Low feed flow rate is will increase the contact time of solution with the drying air thus increase the product yield. The physicochemical powder of the pineapple powder shows a high total soluble solid and less citric acid. It shows a good quality powder of pineapple fruit which contain high value of sucrose, fructose and glucose. As a conclusion, this study is successfully conducted to determine the optimum feed flow rate and concentration of maltodextrin in order to produce higher product yield.

Acknowledgment

I would like to express my sincere appreciation and gratitude to my supervisor, Madam Syafiza Hashib for the guidance, motivation, advice and valuable knowledge also to Universiti Teknologi Mara (UiTM) Shah Alam for the great facility.

REFERENCES

[1] Phisut, N. (2012). Spray drying technique of fruit juice powder: some factors influencing the properties of product.

[2] Wong, C. W., Pui, L. P. and Ng. J. M. L. (2015). Production of spray-dried Sarawak pineapple *(Ananas comosus)* powder from enzyme liquefied puree. International Food Research Journal, 22,1631-1636.

[3] A. E. De Silva, M. A. Kadir, M. A. Aziz, S. Kadzimin. (2008). Callus induction in pineapple (Ananas Comosus L.) cv. Moris and josapine. International journal of agricultural research, 3, 261-267.

[4] Caliskan, G. and Dirim S.N. (2013). The effects of the different drying conditions and the amounts of maltodextrin addition during spray drying of sumac extract. Food and bioproducts processing, 91, 539–548.

[5] Sabarez H. (2016). Drying of food material.

[6] Fazaeli M., Zahra Emam-Djomeh, Ahmad Kalbasi Ashtari, Mahmoud Omid. (2012). Effect of spray drying conditions and feed composition on the physical properties of black mulberry juice powder. Food and bioproducts processing, 90, 667–675.

[7] Syafiza A.H, Norazah A.B, Suzihaque, M.U.H, Ummi K.I, Nur Ezzah H. (2015). Effect of slurry concentration and inlet temperature towards glass temperature of spray dried pineapple.

[8] Kwapinska, M. and Zbicinski, I. (2005). Prediction of final product properties after co-current spray drying. Drying Technology 23: 1653–1665.

[9] Wang W., Dufour C., & Zhou, W. (2015). Impacts of spray-drying conditions on the physicochemical properties of soy sauce powders using maltodextrin as auxiliary drying carrier.

[10] Tonon, V.R., Brabet, C. and Hubinger, M. (2008). Influence of process conditions on the physicochemical properties of acai powder produced by spray drying. Journal of Food Engineering 88: 411-418.

[11] Nadya Hajar, Zainal S., Nadzirah., K.Z., Siti Roha, A.M., Atikah, O., Tengku Elizad, T.Z.M. (2012). Physicochemical Properties Analysis of Three IndexesPineapple (*Ananas Comosus)* Peel Extract Variety N36.

[12] Tehrani M, Chandran S, Hossain ABMS, Nasrulhaq-Boyce A. (2011). Postharvest Physico-Chemical and Mechanical Changes in Jambu Air (*Syzygium Aqueum Alston*) Fruits. *Australian Journal of Crop Science.* 2011; 5(1): 32-38.

[13] Ngarmnij C., Niran J., Arunee E., Wallop A. and Surin P. (2007). Changing in TSS, TA and Sugar Contents and Sucrose Synthase Activity in Ethephon-Treated 'Pattavia' Pineapple Fruit.

[14] McKinnon M. (2014). Thermo gravimetric analysis (TGA) & differential scanning calorimetry (DSC).

[15] Phebe and Yei. (2010). Physicochemical characteristics of dabai (*Canarium odontophyllum* Miq.) fruit.

[16] S. Santhalakshmy, S. J. D., Bosco, Francis, S., M. Sabeena. (2015). Effect of inlet temperature on physicochemical properties of spray-dried jamun fruit juice powder. Powder Technology, 274, 37–43.

[17] Suzihaque, M.U.H., Syafiza A. H. and Ummi K. I. (2015). Effect of Inlet Temperature on Pineapple Powder and Banana Milk Powder. Procedia - Social and Behavioral Sciences, 195, 2829 – 2838.