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PHYSICAL PROPERTIES OF POWDERED ROSELLE-PINEAPPLE JUICE - EFFECTS OF MALTODEXTRIN

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ABSTRACT

A study was conducted using LabPlant SD-06 Spray Dryer to produce spray-dried roselle-pineapple powder. Roselle calyces and pineapples were extracted under optimum condition. Three different maltodextrin DE 10 concentrations (3%, 5% and 10%) were added (w/w) as the encapsulating agent prior to spray drying. Inlet temperatures were varied at 140 °C, 160 °C and 180 °C respectively and the outlet temperature was set at 80 °C. The spray-dried roselle-pineapple powder were analysed for moisture content, dissolution, water activity and hygroscopicity. The results indicated that maldodextrin concentration and inlet temperature had significant effects on the percentage of yield. Extracts with 10% maltodextrin gave the highest percentage of yield and produced less sticky film at the wall of the dryer chamber. At 180 °C, juice with 10% of maltodextrin produced the finest powder. When inlet temperature and the percentage of maltodextrin increased, the moisture content, dissolution and water activity decreased and its hygroscopicity increased.

Keywords: Spray drying; Roselle-pineapple; Maltodextrin; Fruit powder; Physical properties.

INTRODUCTION

Roselle (Hibiscus sabdariffa L.) belongs to the family Malvaceae and is known as sorrel, karkadeh or asam paya. It is a popular tropical plant in Middle Eastern countries (Morton, 1987; Abu-Tarboush et al., 1997) and can be found in most tropical countries such as Malaysia, Indonesia, Thailand and the Philippines (Chewonarin et al., 1999; Rao, 1996). The calyces are rich with anthocyanins and used for making jelly, jam, preserve and beverages (Hirunpanish et al., 2006). Roselle anthocyanins is a good source of antioxidants as well as a natural food colourant. Pineapple (Ananas comosus) is a type of tropical plant originates from the east of South America. It was introduced to Malaya by the Portuguese. Malaysia is one of the world's major producers besides Thailand, Philippines, Indonesia and South Africa. Pineapples have high content of Vitamin C which is needed for health due to healing wound or injury by absorption of iron minerals into blood vessel. Vitamin B (especially B1 and B3) in pineapples controls human's digestive system. In food processing industry, spray drying is a technique to guard food ingredients from volatile losses and premature interaction with other ingredients. Under optimum processing conditions, it has been proven to be an effective method to obtain various products. Transformation of roselle-pineapple extract or other fruit juice into a dry particulate form results in much reduced volume and longer shelf life. The reconstitution quality of spray-dried powder is also good as the product temperature is often elevated above 100 ^{o}C (Adhikari et al., 2004). However, fruit juice powders obtained by spray drying are sticky and hygroscopic. According to Sebhatu et al. (1994), fruit juice powder obtained by spray drying gives the yield of high sugar content solids, most of them present in amorphous state. These sugars are very hygroscopic, having an effect on the functional characteristics of the dehydrated material, mainly its tendency to become sticky (stickiness) and forming high agglomerates. This tendency to agglomeration may become accentuated as the amorphous state sugar transformvs into crystalline sugar through adsorption of small amounts of water (Cano-Chauca et al., 2005)

MATERIALS AND METHOD

Materials

Dried roselle were brought from Chad. The dried roselle were processed traditionally in Chad and were packed carefully. Roselle with average size, brilliant in colour and with no bruises were chosen for the experiment. Fresh, mature and ripe pineapples (Bromeliacea) were purchased from local market. Pineapples with average weight were chosen for the experiment. The maltodextrin DE 10 was from San Soon Seng Food Industries Pvt Ltd, Malaysia.

Preparation of roselle-pineapple extract

Dried roselle were washed with clean water. 80 grams for each sample were placed in a beaker and water was added accordingly. Preliminary experiments were carried out to establish the best extraction procedures to give the best product. Each beaker was filled with 800 ml of water (ratio of roselle:water was 1:10) and was placed in water bath at constant temperature of 60 ^{o}C for 60 minutes. The extract was then filtered through nylon filter and transferred to a beaker. Samples were triplicate for each process. Three fresh pineapples were peeled off and cut into cubes. The cubes were blended using laboratory electrical juice blender (Model JC3000, Waring, USA). The juice produced were filtered through 11 µm nylon net and transferred into a beaker. 800 ml juice was obtained. The juice was stored for approximately 1 hour in refrigerator and then the thin-top layer of the liquid was carefully removed. Extracts of roselle and pineapple were mixed up accordingly (1:1).

Spray-drying

Maltodextrin was added accordingly to the roselle-pineapple extract. The mixture is then stirred for 5 minutes and ready to spray dry. A laboratory scale (LabPlant SD-06) spray dryer was employed for the spray drying process. The unit is self contained and supplied complete and ready for immediate operation. All major components are housed within a stainless steel cabinet. The SD-06 only requires connection to a 13 amp, 220/240 V, 50 Hz power supply. Three inlet air temperatures were investigated (140 ^{o}C, 160 ^{o}C and 180 ^{o}C). Maltodextrin (3%, 5% and 10%) was added according to the mass of the roselle-pineapple extract. The dryer was washed with water at desired parameter settings for 10-15 minutes before spray drying process. The powders produced were collected in a container, sealed, weighed and stored at 4 ^{o}C in dark.

Physical analysis of the spray-dried powder

The spray-dried powders were analysed for their moisture content, dissolution, water activity and hygroscopicity.

Moisture content

The moisture content was determined based on AOAC (1984) method. Each samples of roselle-pineapple powder (20 mg each) were weighed and then dried in a vacuum oven at 70 ^{O}C for 24 hours. The samples were taken out from the oven, cooled in a desiccator and weighed. The drying and weighing processes were repeated until constant weigh were obtained.

Dissolution

The dissolution test was modified from Al-Kahtani and Bakri (1990). About 50 mg of sample was weighed and place in a mini test tube. Then, 1mL of distilled water was added. This was followed by mixing using vortex at half speed. The time (s) to fully reconstitute the powders was recorded using a laboratory timer. Triplicate samples were analysed.

Water activity

Measurement of water activity was carried out using a water activity meter (AquaLab Lite, Australia). Triplicate samples were analysed and the mean reading was recorded.

Hygroscopicity

The hygroscopicity of the powders was determined according to Cai and Corke (2000) with some modifications. Samples (1 g) of each powder were placed in aluminum vials, weighed and equilibrated over a saturated salt solution NaCl (relative humidity of 75.3%) in desiccators at 25 ^{o}C. After seven days, the samples were weighed and the hygroscopicity is expressed as g moisture/100 g solids.

RESULTS AND DISCUSSION

Moisture content

Table 1 shows the physical properties of the spray-dried roselle-pineapple powder. It showed a significant effect on moisture content. Moisture content represents the water composition in a food system. The moisture content of spray-dried powder decreased with the increase in inlet temperature. This is because at higher inlet temperature, the heat transfer between particles is greater which will give a greater driving force for moisture evaporation. Thus, powders with less moisture content were formed. Based on Figure 1, it is clearly observed that increases of maltodextrin percentage resulted in decreases in the moisture content. This was probably die to an increase in solids in the feed and reduced amount of free water for evaporation.

Table 1: Moisture content, water activity and dissolution rate at different temperatures

Inlet temperature (^{O}C)	Outlet temperature (^{O}C)	Maltodextrin (%)	Moisture content	Water activity	Dissolution (s)
140	80	3	2.08	0.24	17
	80	5	1.65	0.23	19
	80	10	1.50	0.22	19
160	80	3	1.94	0.23	17
	80	5	1.56	0.23	19
	80	10	1.34	0.21	23
180	80	3	1.50	0.27	18
	80	5	1.38	0.22	20
	80	10	1.35	0.21	24

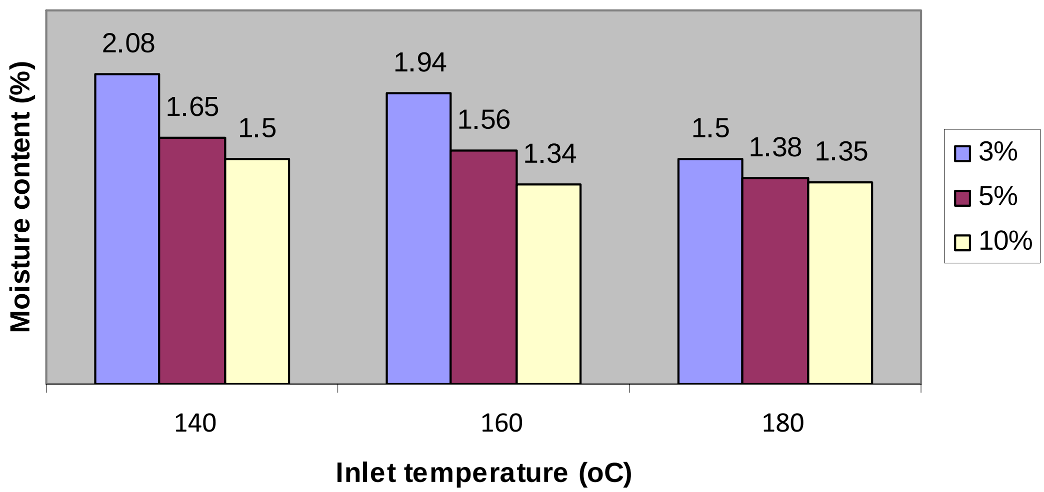


Figure 1: Moisture content of spray-dried powder

Water activity

Water activity (a_w) is a very important index for spray-dried powder as it determines the shelf-life of powder produced. Water activity is defined as the ratio of vapour pressure of water in a food system to vapour pressure of pure water at the same temperature. Water activity measures the activity of free water in a food system which is responsible for any biochemical reactions. Higher water activity indicates that there is more free water available for biochemical reactions and thus the shelf-life is shorter. Basically, food with a_w less than 0.6 is microbiologically stable. From Table 1, the water activity of the powder produced is in the range of 0.21-0.27. This showed that all the treatments are microbiologically stable.

Dissolution

Dissolution test is a measurement of the powder to fully reconstitute in water by using vortex mixer. Time was recorded during this process. The results indicated that at lower inlet temperature, the times taken for the powder to fully reconstitute are relatively shorter.

This is because at lower temperature, the powders were higher in moisture content due to the slower evaporation rate. This type of powder had a higher tendency to agglomerate which helped to increase the reconstitution of the powder. Figure 2 showed the dissolution test for various maltodextrin percentages. Higher percentage of maltodextrin resulted in higher time taken for the powder to reconstitute. This was because of the same reason discussed above.

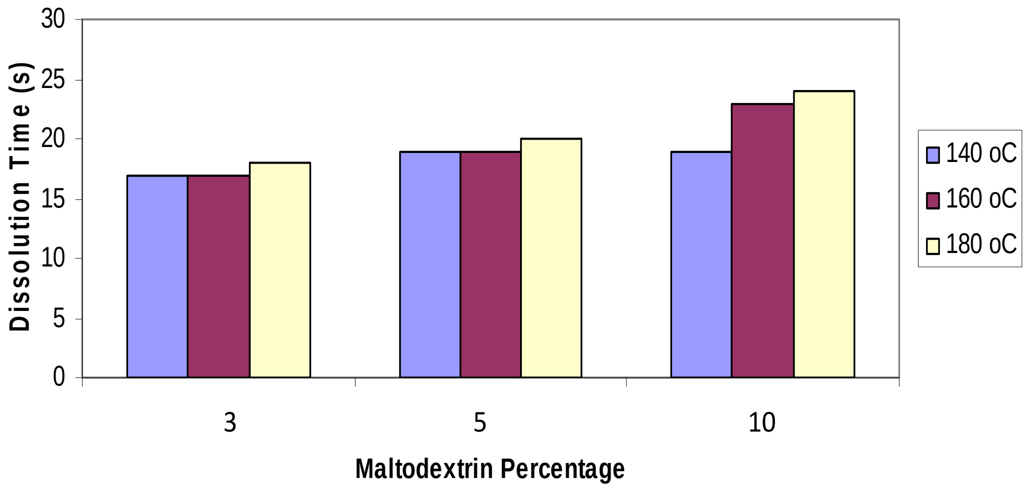
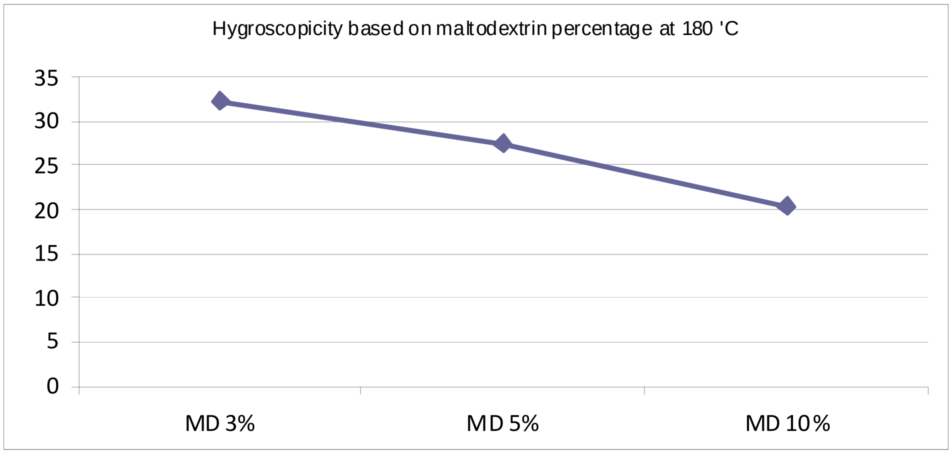


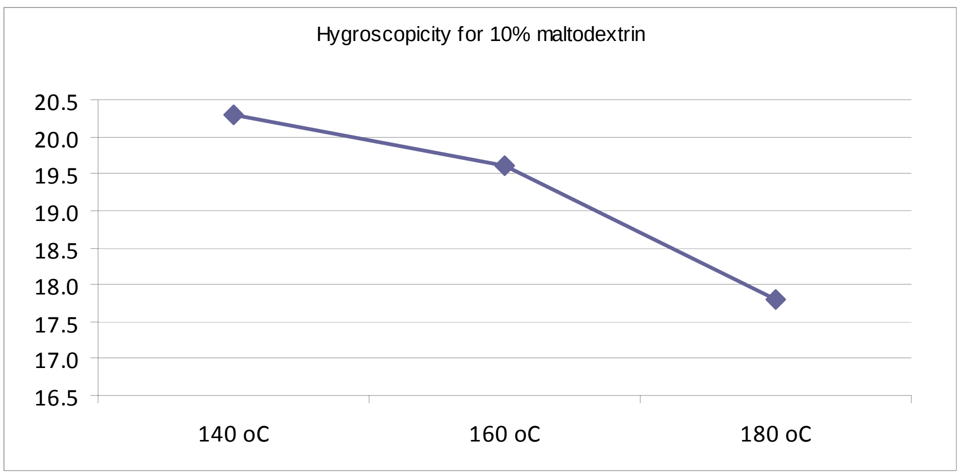
Figure 2: Dissolution time for various maltodextrin percentages

Hygroscopicity

Based on Figure 3, the addition of maltodextrin as drying aid significantly affected powder hygroscopicity. The higher hygroscopicity of the powders produced at lower temperatures seems to be related to their higher moisture content. A major factor affecting powder stability is moisture content, since a small amount of water is able to depress the temperature enough to increase the mobility of the matrix during storage (Bhandari & Hartel, 2005; Roos, 2002; Roos and Karel, 1992). Increasing the maltodextrin percentage reduced powder hygroscopicity.



(a)



(b)

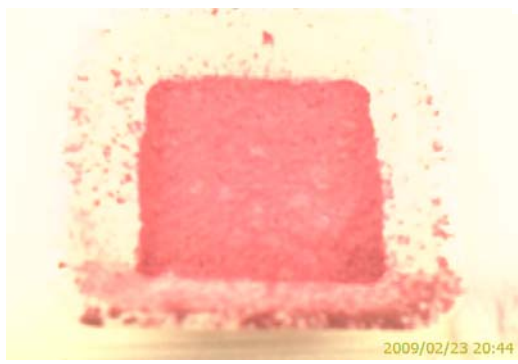
Figure 3: Graph of hygroscopicity for (a) different maltodextrin concentration and (b) different temperatures.

Effects of maltodextrin

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, 3%, 5% and 10% of maltodextrin were added prior to spray drying. This was done to investigate the effect of adding maltodextrin to the physical properties of the powder. Maltodextrin with DE 10 was used because of it has better nutrient binding properties (Cai & Corke, 2000). Based on Figure 4 it is observed, that addition of 10% maltodextrin gave the better powder properties and finest powder. Addition of 3% of maltodextrin produced agglomerated powders. The powders produced were better and fine with the increase of maltodextrin concentration. Increases in maltodextrin concentration resulted in decreases in moisture content. This is because of addition of solid particles in the juice (feed) and reduces the amount of free water for evaporation. Maltodextrin could correct the surface stickiness of low molecular weight sugars and organic acid, therefore, facilitated drying and reduced the stickiness of the powder produced. If there was too much of maltodexrin (>10%), the colour of the powder produced is less attractive (pale red).

(a)

(b)



(c)

Figure 4: (a) Powder with maltodextrin 3%, (b) powder with maltodextrin 5% and (c) powder with maltodextrin 10%

CONCLUSION

Addition of 10% maltodextrin DE 10 was an effective drying aid for roselle-pineapple extract. It reduced stickiness at the dryer chamber and gave the better physical properties of the produced powders. The results also indicated that as temperature increase, the moisture content and water activity decreased. The hygroscopicity of the product decreased with the decrease of inlet temperature and maltodextrin percentage.

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