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EFFECT OF SPRAY DRYING CONDITIONS ON THE YIELD AND PHYSICOCHEMICAL PROPERTIES OF ROSELLE (*Hibiscus sabdariffa L.*) POWDER.

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ABSTRACT

Roselle extract was spray dried using a maltodextrin of 5 dextrose equivalent (DE) as a carrier material. The influence of a number of process variables, namely, inlet air temperature (130-190 ºC), drying air flow rate (19.39- 22.23 m^3/h) and compressed air flow rate (600-800 L/h) on the yield and the physicochemical properties of the spray dried powder were investigated. The physicochemical properties of the product (moisture content, solubility, bulk density, monomeric anthocyanins content and percent polymeric color) were studied. The increase of the inlet air temperature increased the spray dried powder percent polymeric color and decreased its solubility, moisture content and monomeric anthocyanins content. The yield percentage of roselle powder was increased by increasing the inlet air temperature up to a 170 ºC, and leveled off for higher temperatures. The increase in drying air flow rate increased the powder yield percentage, moisture content, the percent polymeric color and solubility and decreased its monomeric anthocyanins content, while the increase in compressed air flow rate increased the powder yield percentage and monomeric anthocyanins content and decreased its moisture content and solubility. There was no effect of drying air flow rate and compressed air flow rate on the bulk density.

INTRODUCTION

Roselle (*Hibiscus sabdariffa L.*), an annual shrub, is commonly used to makes jellies, jams and beverages. Its brilliant red color and unique flavor make it a valuable food product. The anthocyanin pigments that create the color are responsible for the wide range of coloring in many foods. Recently, the biological activities of anthocyanin, such as its antioxidant activity, protection from atherosclerosis and anticarcinogenic activity have been investigated, and proved to have some beneficial effects in the treatment of diseases (Tsai *et al*., 2002).

Most natural plant pigments, including anthocyanins and betacyanins, are easily affected by temperature, oxygen, light and water activity. Freeze drying is considered to be the best way to dry sensitive plant pigments. However, spray drying, if feasible, would be a more practical and economical method for producing powdered sensitive colorants as the processing cost is 30 to 50 times less than for freeze drying (Cai and Corke, 2000). Spray drying is also the most common method of drying for encapsulation, to entrap a sensitive ingredient in a coating material or ''wall'' for isolation from the environment and to protect against oxidation (Shu et al., 2006).

The advantages of spray drying as a continuous and economic process allowing the production of good quality powders has been proven (Pérez-Correa and Farías, 1995). However, few works of drying of the roselle extract exist; mainly to obtain the coloring (Main et al., 1978) who spray dried anthocyanins from three different sources, Concord grape, cranberry and Roselle calcyces. Al-Kahtani and Hassan (1990) studied the existence of the changes of quality among the roselle extract and the powder obtained by spray drying, settling down that the appropriate temperature of drying for the roselle extract was 198.5 °C. Andrade and Flores (2004) studied the effect of different operating parameters on the quality of spray dried roselle extract powder to establish the best conditions of drying and they concluded that, the spray drying should be managed within the following operating range: temperature 178 to 190 ºC and pressure of the atomizer 5 to 6 bar.

The aim of the present work was to study the effect of different operating conditions (drying air flow rate, compressed air flow rate and drying air inlet temperature) on the yield and quality of the dried product. The ultimate objective was to provide the industry with the best operating conditions that could be used in pilot and full scale operations.

MATERIALS AND METHODS

1. Materials

Dry roselle (Hibiscus sabdariffa L.) calyces were obtained from agriculture research center.

2. Carrier agent for spray drying

Maltodextrin (Glucidex 6) of dextrose equivalent (DE) 5 was obtained from Roquette, Freres, France.

3. Extraction of Roselle calyces

Dry roselle calyces were extracted by water at room temperature using the ratio of 10 water: 1 dry calyces on weight basis as described by Al-Kahtani and Hassan (1990).

4. Concentration of the Roselle extract

The extract was vacuum concentrated until 12 ºBrix. The conditions of the concentration process were within the following ranges: feed total soluble solids (TSS) (2.5-7%), vacuum (100-150 mbar) and the heating medium temperature (100 ºC).

5. Preparation of the feed mixtures

Since roselle extract is rich in organic acids, the addition of a carrier was a prerequisite to avoid stickiness. The carrier agent was added to the concentrated roselle extract with a ratio of 55:45 on total soluble solids basis, respectively.

6. Spray drying

A Buchi mini spray dryer (Model 190, Buchi Laboratoriums-Technik, Flawil, Switzerland) was employed for the spray drying process. The spray dryer operates co-currently with two fluid spray nozzle having a cap orifice of a diameter 0.5 mm. The BUCHI drying chamber is cylindrical and vertically orientated with a length and diameter of approximately 500mm and 150mm, respectively. The dryer was operated according to the following conditions: the atomizer pressure and the feed rate were kept at 5± 0.5 bar, and 4.16 g/min, respectively. Seven inlet air temperatures (T_{inlet}), 130, 140,150, 160, 170, 180, and 190 ºC (±1 ºC), were used. The drying air flow rate was varied between 19.39 and 22.23 m^3/h, and the compressed air flow rate was varied from 600 to 800 L/h.

7. Analysis of powder

7.1. Moisture content

The moisture content was determined according to the A.O.A.C. method (2000).

7.2. Bulk density

The bulk density of the spray-dried powder was determined by measuring the weight of the powder and the corresponding volume after tapping as described by Nijdam and Langrish (2005). Approximately 1 g of powder sample was placed in a 10-ml measuring cylinder. The cylinder was tapped vigorously by hand until no further change in volume occurred. Then the volume was measured.

7.3. Solubility

Solubility of the spray-dried powder solubility was determined according to the method described by Goula and Adamopoulos (2005c). The solubility of the spray-dried powder was carried out by adding 2 gram of the material to 50 ml of distilled water. The mixture was agitated in a low form glass beaker 100 ml with a magnetic stirrer (ILM Labor) at a fixed position. The time required for the material to dissolve completely was recorded.

7.4. Monomeric anthocyanin pigments, color density, polymeric color and percent polymeric color

The total anthocyanin pigments, color density, polymeric color and percent polymeric color of roselle powder were determined according to the methods described by Mónica-Giusti and Wrolstad (2001). The powder was extracted by mixing 0.5 gm powder with 10 ml of a 1% HCl/methanol. Monomeric anthocyanin pigments were determined by the pH differential method and expressed as delphinidin-3-glucoside as reported by (Du and Francis, 1973 and Wong et al, 2003). Color density and polymeric color were calculated as the sum of the Absorbences at 420 nm and 559 nm of untreated and bisulfite-treated sample respectively. The percent polymeric color was calculated as (polymeric color/color density) × 100.

8. Statistical analysis

The data was analyzed by using Mstat-c software using randomized complete block design with three factors (Inlet temperature, Drying air flow rate, compressed air flow rate). Duncan test at 5% level of probability was used to compare means of treatments.

RESULTS AND DISCUSSIONS

1. Temperature drop through drying chamber

The outlet air temperature was recorded and the obtained results are shown in Table (1), from which it could be concluded that the outlet air temperature increases with the increase of the drying air flow rate due to the increased heat input associated with the increased air flow. Similar trends where observed by Goula and Adamopoulos (2005b).

Table (1): Effect of spray drying operating conditions on outlet temperature.

Exp. No	Inlet Temp. (ºC)	Drying air flow rate (m^3/h)	Compressed air flow rate (L/h)	Outlet Temp. (ºC)[a]
1	130	19.39	600	82.50 (0.50)
2	130	19.39	800	79.33 (0.57)
3	130	20.19	600	84.33 (0.57)
4	130	20.19	800	82.00 (0.50)
5	130	22.23	600	86.50 (0.50)
6	130	22.23	800	85.33 (0.57)
7	140	19.39	600	91.50 (0.50)
8	140	19.39	800	87.83 (0.28)
9	140	20.19	600	89.33 (0.58)
10	140	20.19	800	89.00 (0.00)
11	140	22.23	600	93.50(0.50)
12	140	22.23	800	91.00 (0.00)
13	150	19.39	600	93.50 (0.50)
14	150	19.39	800	90.67(1.00)
15	150	20.19	600	94.50 (0.50)
16	150	20.19	800	95.00 (1.00)
17	150	22.23	600	98.00 (1.00)
18	150	22.23	800	96.00 (1.00)
19	160	19.39	600	102.0 (1.00)
20	160	19.39	800	99.00 (1.00)
21	160	20.19	600	103.5 (0.50)
22	160	20.19	800	99.50 (1.00)
23	160	22.23	600	104.7 (0.75)
24	160	22.23	800	103.5 (0.50)
25	170	19.39	600	105.0 (0.00)
26	170	19.39	800	105.5 (0.50)
27	170	20.19	600	108.0 (0.57)
28	170	20.19	800	107.0 (1.00)
29	170	22.23	600	109.3 (0.58)
30	170	22.23	800	108.3 (0.58)
31	180	19.39	600	109.5 (0.50)
32	180	19.39	800	109.0 (0.00)
33	180	20.19	600	115.0 (0.00)
34	180	20.19	800	113.0 (0.00)
35	180	22.23	600	117.5 (0.50)
36	180	22.23	800	113.5 (0.50)
37	190	19.39	600	119.0 (1.00)
38	190	19.39	800	116.5 (0.50)
39	190	20.19	600	120.0 (1.00)
40	190	20.19	800	119.5 (0.50)
41	190	22.23	600	122.5 (0.57)
42	190	22.23	800	121.5 (1.00)

[a] **Means of triplicate replicates and standard deviation (in brackets).**

It was also found that higher compressed air flow rate caused a decrease in outlet air temperature. This observation suggests a direct relation of the outlet temperature not only with the inlet temperature but also with the compressed air flow rate, as well. The increase of compressed air flow rate, entering the spray nozzle at room temperature, results in a cooling effect to the fluid mixture.

2. Powder yield

Powder yield [%] was defined as that % weight of the amount of total soluble solids originally present in the atomized liquid feed volume that was recovered from the collecting vessel attached to the bottom of the cyclone.

The effect of different operating conditions on powder yield [%] was significant and illustrated in Fig. 1 and 2. The obtained data indicated that the powder yield [%] varied from 27.7 to 70.3 % and the highest powder yield was achieved at the following operating conditions 22.23 m^3/h, 800 L/h and 170 ^oC for the drying air flow rate, compressed air flow rate and inlet air temperature, respectively.

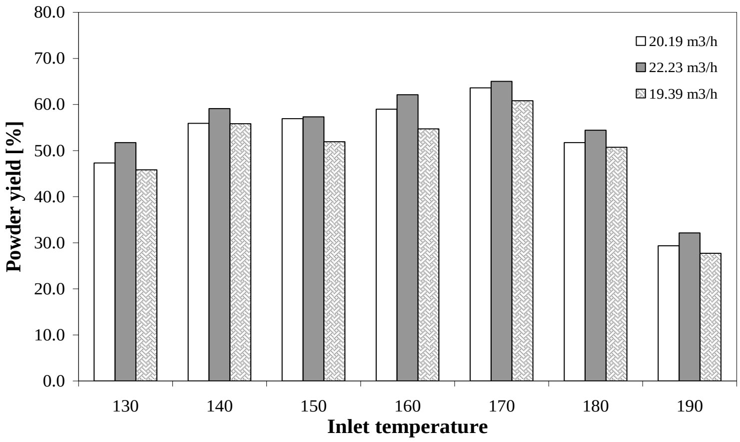

Fig. 1. Powder yield [%] as a function of inlet air temperature and drying air flow rate for compressed air flow rate of 600 L/h.

The powder yield [%] increased with increasing the inlet air temperature up to 170 ^oC and leveled off for higher values. This variation in the powder yield [%] could be referred to the formation of wall deposits on the drying chamber. Master (1997) stated that the Product formation on the walls falls into two categories: semi-wet deposits caused by droplets, which are not sufficiently dry before hitting the wall, and sticky deposits caused by the nature of the product at the dryer temperature.

Semi-wet deposits were observed through temperatures that ranged from 130 ^oC to 170 ^oC due to insufficient drying occurring to the droplets before hitting the wall. This results in partial wetting of the walls with the semi-dried particles causing the accumulation of deposits on the wall. This deposits phenomenon decreases by increasing the temperature in this range and almost disappeared at 170 ºC, where the particles hit the wall in a dry condition. The losses at 170 ºC can be attributed to insufficient cyclone efficiency in capturing the dried particles. Modifications in the cyclone of this experimental setup could lead to further increase in the yield as described by Maury et al. (2005). In pilot and full-scale designs the collection efficiency of the cyclone can be further improved to reach levels higher than 95%.

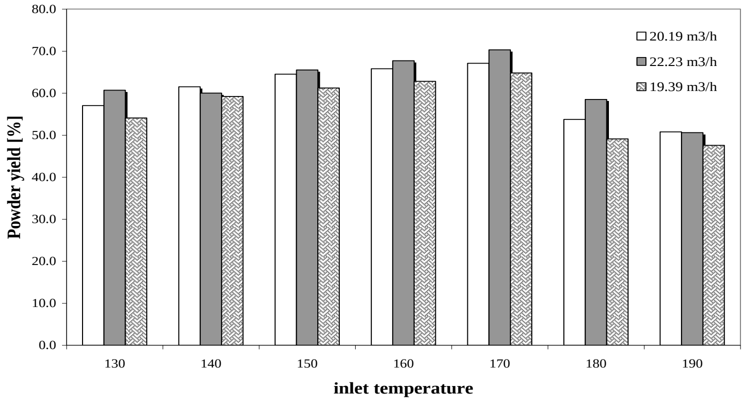

Fig. 2. Powder yield [%] as a function of inlet air temperature and drying air flow rate for compressed air flow rate of 800 L/h.

Sticky deposits could be referred to the nature of the produced powder. As in all experiments, roselle extract powder showed a noticeable tendency to stick to internal surfaces, due to the nature of the low molecular weight components (sugars and organic acids) in such product. Spray drying is a fast process, which produces dry product in an amorphous (glassy) form. These components, when in a glassy state, are thermoplastic and very hygroscopic. As a result, during drying they tend to stick to the dryer sidewalls. The main cause of stickiness problem is the low glass transition temperature (T_g) of these products (Bhandari, et al., 1997).

Solids in an amorphous state have a very high viscosity (> 10^{12} Pa.sec) and as the temperature rises during drying, the viscosity decreases to a critical value of around (10^7 Pa.sec) where they first become sticky. This critical viscosity is reached at temperatures 10–20 ºC above T_g and these temperatures decrease with an increase in water content. It can be, therefore, assumed that the temperature of the particle surface during drying should not reach 10–20 ºC above T_g (Roos, 1995). The sticky point of a product depends on both moisture content and temperature (Roos and Karel, 1991). As a consequence, high molecular weight drying aids, which have a very high T_g and by raising the T_g of the feed, are usually added to the spray dryer feed to achieve successful drying at feasible drying temperature conditions. So the increase of inlet air temperature from 170 to 190 ºC resulted in much higher air outlet temperatures (T_{outlet}>109.5 ºC), and led to a decrease of the powder yield [%]. In these experiments, the walls of the drying chamber were not cold enough to cool and solidify the surface of the thermoplastic particles they come in contact with, and the drying droplets remained plastic because of the higher temperature.

The powder yield [%] increased with increases of the drying air flow rate, as the major part of the air entrained into the spray comes from recycling of the air from the lower parts of the drying chamber. This airflow pattern influences droplet trajectories. Smaller droplets are drawn toward the wall by the strong backflow circulation effect, larger ones pass back upward with the backflow before evaporating, whereas medium size droplets strike the wall before evaporating fully, thus causing low powder yield [%] (Goula and Adamopoulos, 2003).

The powder yield [%] was increased by increasing the compressed air flow rate. As the high ratio of compressed air to liquid feed produce smaller droplets size, the droplets strike the wall at the lower parts of the drying chamber, where their moisture content is much lower.

3. Moisture content

Data illustrated in Fig. 3 and 4 show the effect of different operating conditions on the powder moisture content. The obtained data indicated that the powder moisture contents were significantly affected by changing the inlet air temperature, drying air flow rate and compressed air flow rate and varied from 1.91 to 4.20 % (wet basis).

The powder moisture content decreased with increasing inlet air temperature as a result of increased outlet air temperature. Generally, the temperature of the exhaust air leaving the drying chamber controls the residual equilibrium moisture in the powder. Similar trends where observed by Al- Kahtani and Hassan (1990) and Goula and Adamopoulos (2005c).

The powder moisture content increases with an increase in the drying air flow rate. A lower drying air flow rate causes an increase in product residence time in the drying chamber. Increased residence times lead to a greater degree of moisture removal. As a result, an increase in drying air flow rate, decreasing the residence time of the product in the drying chamber, led to higher moisture contents not necessarily reaching the equilibrium value.

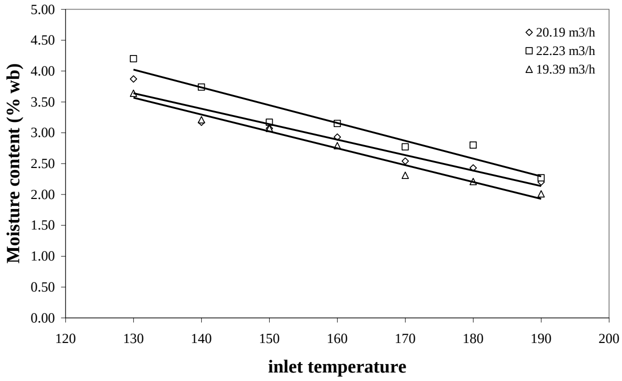

Fig. 3. Powder moisture content as a function of inlet air temperature and drying air flow rate for compressed air flow rate of 600 L/h

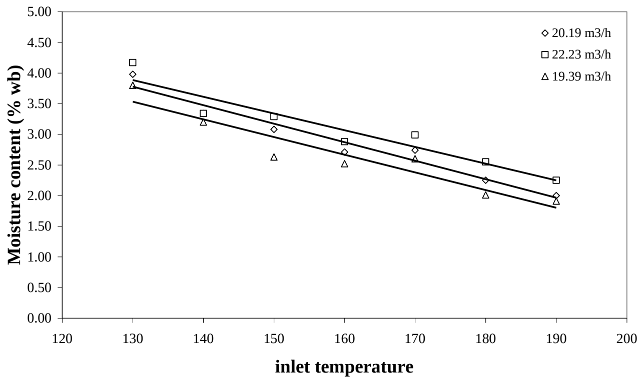

Fig. 4. Powder moisture content as a function of inlet air temperature and drying air flow rate for compressed air flow rate of 800 L/h

Moisture content shows a decrease with an increase in compressed air flow rate due to the effect of this flow rate on mean particle size. Increase in air–liquid flow ratio in a two-fluid nozzle atomizer decreases the mean size of the spray droplets. Drying is facilitated by smaller particle sizes for two reasons. First, larger surface area provides more surfaces in contact with the heating medium and more surface from which the moisture can escape. Second, smaller particles reduce the distance heat must travel to the centre of the particles and reduce the distance through which moisture in the centre of the particles must travel to reach the surface and escape (Goula and Adamopoulos, 2003).

4. Powder solubility

The effects of different operating conditions on the powder solubility were significant and are illustrated in Fig. 5 and 6. The obtained data indicated that the powder solubility varied from 91 to 178.3 sec.

The required time for the powder dissolution increased with increasing the inlet air temperature. Data showed that at lower inlet temperatures, the times taken for the powders to fully dissolve in water were relatively shorter. This phenomenon was probably related to the moisture content of the powder produced. At lower inlet temperature, the evaporation rate was slower, producing powders with higher moisture content, which helped to increase the dissolution of the powders. This is in agreement with the finding of Goula and Adamopoulos (2004), Al- Kahtani and Hassan, (1990) and Bhandari et al. (1993).On the other hand, at higher inlet temperature, a hard surface layer might be formed over the powder particle. This could prevent water molecules from diffusing through the particle, consequently decreased the wettability of the particle and reduced the dissolution of the powder (Chegeni and Ghobadian, 2005).

The required time for the powder dissolution decreased with increasing the drying air flow rate. The effect of drying air flow rate on powder solubility depends on its effect on moisture content, as high moisture content seems to be associated with fast dissolution (less time) as discussed in the previous paragraph.

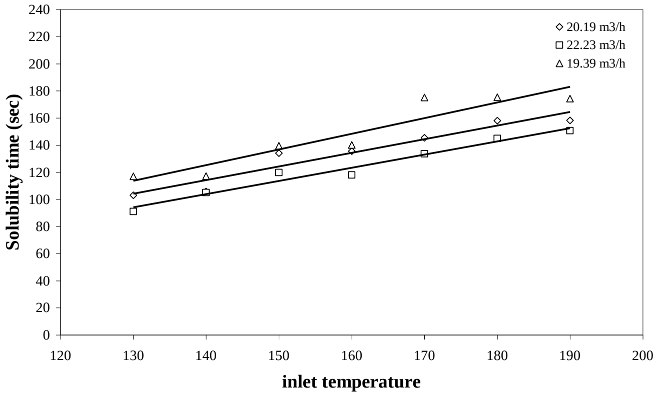

Fig. 5. Powder solubility as a function of inlet air temperature and drying air flow rate for compressed air flow rate of 600 L/h

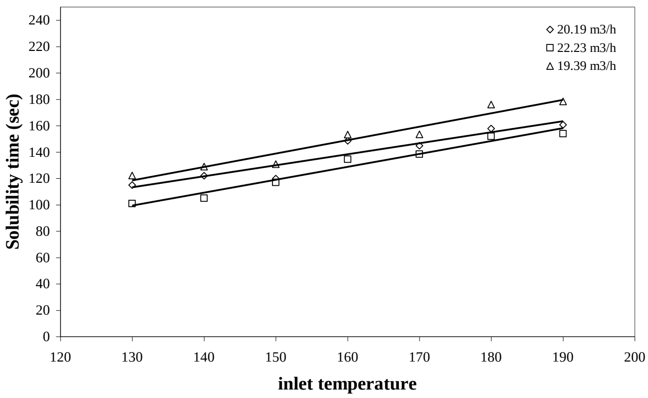

Fig. 6. Powder solubility as a function of inlet air temperature and drying air flow rate for compressed air flow rate of 800 L/h

The time required for the powder to dissolve was found to increase with an increase in compressed air flow rate, since particle size affects solubility rate. Large particles may sink, whereas small ones are more dusty and generally float on water making for uneven wetting and reconstitution. This is in agreement with (Goula and Adamopoulos, 2005 c).

5. Bulk density

Data presented in Table (2) showed the effect of different operating conditions on the powder Bulk density. The obtained data showed that, for temperature range from 130 to 140 ^{o}C the bulk density of powder varied from

0.331 to 0.379 gm/mL (first range) and for temperature range from 150 to 190 ºC the bulk density of powder varied from 0.394 to 0.458 gm/mL (second range). Within each of both ranges there was no significant variance in bulk density for different operating conditions.

The low bulk density in the low-temperature range could be attributed to the higher moisture content that may create particle agglomerates resulting in larger interspaces and consequently larger bulk volume.

Table (2): Effect of various operating conditions on powder bulk density (gm/mL)

Drying air flow rate (m^3/h)	Compressed air flow rate (L/h)	Inlet temperature (C◦)						
		130	140	150	160	170	180	190
19.39	600	0.346^{ef} ± (0.024)	0.328^{f} ± (0.034)	0.414^{abcd} ± (0.046)	0.417^{abcd} ± (0.035)	0.422^{abc} ± (0.035)	0.420^{abcd} ± (0.015)	0.40^{abcde} ± (0.030)
	800	0.328^{f} ± (0.016)	0.323^{f} ± (0.037)	0.399^{abcde} ± (0.041)	0.416^{abcd} ± (0.041)	0.401^{abcde} ± (0.049)	0.421^{abc} ± (0.020)	0.394^{abcde} ± (0.045)
20.19	600	0.357^{def} ± (0.035)	0.347^{ef} ± (0.018)	0.420^{abcd} ± (0.025)	0.429^{abc} ± (0.035)	0.428^{abc} ± (0.035)	0.427^{abc} ± (0.035)	0.433^{ab} ± (0.012)
	800	0.345^{ef} ± (0.012)	0.331^{f} ± (0.042)	0.406^{abcde} ± (0.047)	0.429^{abc} ± (0.055)	0.422^{abc} ± (0.017)	0.415^{abcd} ± (0.017)	0.419^{abcd} ± (0.018)
22.23	600	0.375^{bcdef} ± (0.033)	0.351^{ef} ± (0.024)	0.427^{abc} ± (0.025)	0.419^{abcd} ± (0.055)	0.450^{a} ± (0.010)	0.458^{a} ± (0.010)	0.451^{a} ± (0.024)
	800	0.366^{cdef} ± (0.033)	0.353^{ef} ± (0.026)	0.416^{abcd} ± (0.041)	0.438^{ab} ± (0.043)	0.418^{abcd} ± (0.020)	0.439^{ab} ± (0.020)	0.436^{ab} ± (0.024)

Means of the same letters are not significantly different at 0.05 level of significance

6. Monomeric anthocyanins content

The effects of different operating conditions on the powder content of monomeric anthocyanins were significant and are illustrated in Fig. 7 and 8. The powder content of monomeric anthocyanins varied from 80.6 to 102.8 mg/L.

It is clear from obtained data the powder content of monomeric anthocyanins decreased with increasing of inlet air temperature. These decreases can be attributed to higher outlet temperature as Main et al. (1978) who stated that a little degradation of anthocyanin pigments occurred when outlet temperature was below 90 ºC and considerable degradation of the grape anthocyanin pigments system was caused when outlet temperature was greater than 100 ºC. Similar trends were observed by Ersus and Yurdagel (in press).

The reduced monomeric anthocyanins content were likely due to its thermal degradation and oxidation. Goula and Adamopoulos (2005a) reported that the spray-dried powders produced at lower inlet temperature had a tendency to undergo agglomeration because of their higher moisture content. Agglomeration would lower the exposure of powders to oxygen and therefore, protecting the anthocyanins from destruction.

The powder content of monomeric anthocyanins decreased with increases in drying air flow rate. This may be attributed to the higher air outlet temperatures resulting from the higher drying medium rates.

Higher compressed air flow rate caused a decrease in anthocyanins loss due to its effect on air outlet temperature, which decreased inversely with increasing the compressed air flow rate. In addition, the effect of compressed air flow rate on anthocyanins loss is also influenced by its effect on droplet moisture content. Generally, chemical reactions are slower as the water content decreases, and thus, a decrease in compressed air flow rate, causing an increase in moisture content, should make the anthocyanins loss increases.

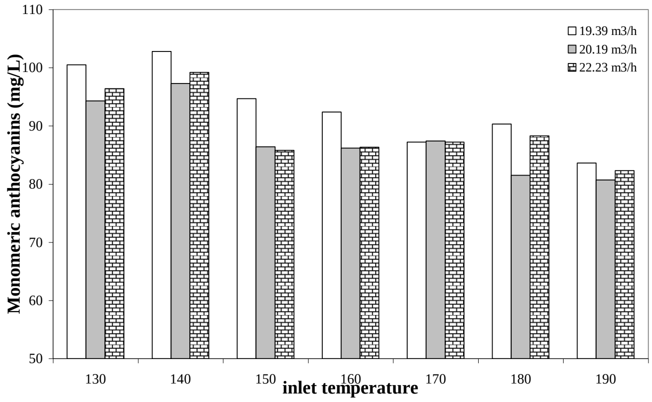

Fig.7. Powder monomeric anthocyanins content as a function of inlet air temperature and drying air flow rate for compressed air flow rate of 600 L/h

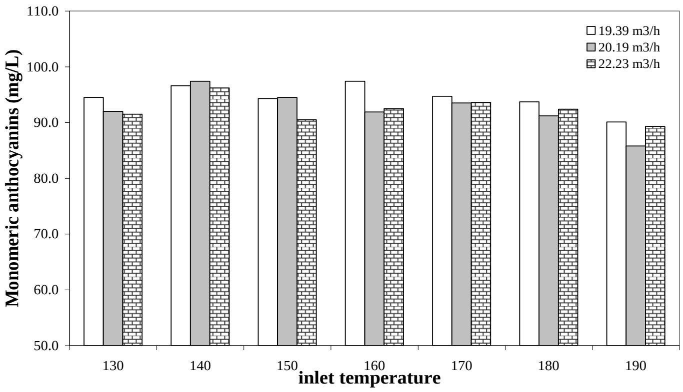

Fig. 8. Powder monomeric anthocyanins content as a function of inlet air temperature and drying air flow rate for compressed air flow rate of 800 L/h

7. Color density, polymeric color and percent polymeric color

The color density and polymeric color of the powder was varied from 8.8 to 13 and from 0.742 to 1.553, respectively. The effect of different operating conditions on the percent polymeric color were significant and illustrated in Fig 9 and 10. The percent polymeric color varied from 6.36 to 17.59 %.

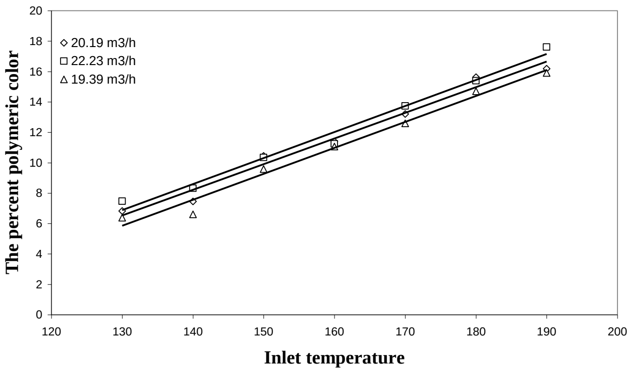

Fig. 9 the percent polymeric color as a function of inlet air temperature and drying air flow rate for compressed air flow rate of 600 L/h

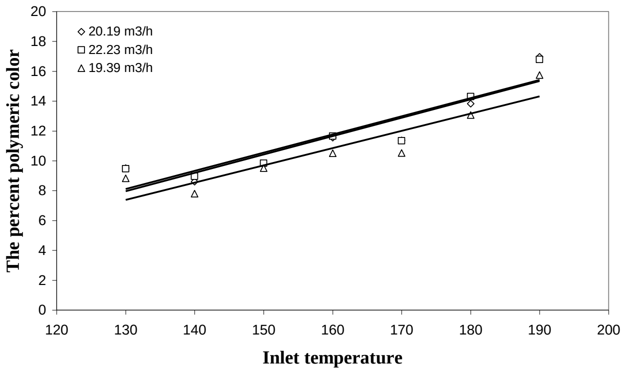

Fig. 10 the percent polymeric color as a function of inlet air temperature and drying air flow rate for compressed air flow rate of 800 L/h

An increase in inlet air temperature resulted in increase of the percent polymeric color. This is in agreement with the findings of Main et al. (1978) who investigated the effect of the drying inlet temperature on the grape anthocyanins and they found that as the outlet temperature increased from 100 to 120 °C the degradation index of anthocyanin pigments increased from 1.25 to 2.30.

The percent polymeric color increased with increases in drying air flow rate. This may be attributed to the higher air outlet temperatures resulting from the higher drying medium rates. However, the increase in compressed air flow rate decreases the percent polymeric color due to its effect on the outlet temperature.

CONCLUSION

Spray drying of roselle extract concentrate and production of powder using maltodextrin as drying aid agent was studied. The effect of different operating parameters was studied and the results show that the powder yield [%] increased with increasing of inlet air temperature up to 170 ^{o}C and leveled off for higher temperature due to its effect on the wall deposits. The increase in drying air flow rate and compressed air flow rate resulted in increase in the powder yield [%] due to its effect on the droplets trajectories through drying chamber and droplets size.

The quality of spray dried powder was much dependent on outlet air temperature. The outlet temperature is positively related to required time for solubility, bulk density and the percent polymeric color (coefficient 0.873, 0.617 and 0.932, respectively) and negatively related to moisture content and monomeric anthocyanins content (coefficient -0.845 and -0.620, respectively). Depending on the previous results the operating conditions (eg, inlet air temperature, drying air flow rate, feed flow rate…..) affecting the outlet temperature must be considered during spray drying of roselle extract to obtain powder with superior quality.

Table (3) .The correlation between outlet air temperature, moisture content, solubility, bulk density, monomeric anthocyanins and the percent polymeric color.

	T_{out}	Moisture content	Solubility	Bulk density	Mono ACN	% poly. color
T_{out}	1					
Moisture content	-0.845**	1.000				
Solubility	0.873**	-0.666**	1.000			
Bulk density	0.617**	-0.521**	0.662**	1.000		
Mono ACN	-0.620**	0.448**	-0.558**	-0.445**	1.000	
% poly. color	0.932**	-0.793**	0.860**	0.603**	-0.714**	1.000

***,** Significant at 5%, and 1% levels, respectively; T_{out}: outlet temperature; mono ACN: monomeric anthocyanin and % poly. Color: the percent polymeric color.**

The best operating conditions for producing roselle powder were 160 ^{o}C, 22.23 m^3/h and 800 L/h for inlet air temperature, drying air flow rate and compressed air flow rate, respectively.

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تـأثير عمليـة التجفيـف بـالرزاز علـى العائـد و الخـواص الفيزوكيميائيـة لمسـحوق الكركديه(*Hibiscus sabdariffa L.*) .

يحيـــى إبـــراهيم ســـلام ,عـــلاء عبـــد الســـلام فهمـــى* , محمـــد حســـن علـــى و إكرام عبد السلام عبد السلام

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*** قسم الهندسة الكيميائية - كلية الهندسة – جامعة القاهرة**

أجريت تلك الدراسة بهدف دراسة تأثير الظروف المختلفة التي تتم عليها عملية التجفيف بالرزاز لمستخلص الكركديه المركز المضاف إلية مالتودكسترين(مكافئ الدكستروز لـه ٥) علـى كمية العائد وكذلك الصفات الفيزوكيميائية للمسحوق الناتج و شملت دراسة تـأثير كل من العوامل التالية درجة حرارة هواء التجفيف (١٣٠-١٩٠° م) معدل تدفق هواء التخفيف (١٩,٣٩- ٢٢,٢٣ م٣ / ساعة) معدل تدفق الهواء المضغوط (٦٠٠-٨٠٠ لتر /ساعة) علـى المحتوى الرطوبى ، الذوبانية, الكثافة, محتوى الانثوسيانين وكذلك النسبة المئوية للون الناتج من البلمرة.

وقد أوضحت النتائج ما يلي:-

تؤدى زيادة درجة الحرارة إلى انخفاض المحتوى الرطوبى , الذوبانية والمحتوى من الانثوسيانين فى حين أنها تؤدى إلى زيادة النسبة المئويه للون الناتجة من البلمرة فى المسحوق النـاتج. النسبة المئوية للعائد تزيد بزيادة درجة الحرارة والتى تصل لأقصاها عند درجة حرارة ١٧٠° م وتنخفض بزيادة درجة الحرارة عن ذلك.تؤدى زيادة معدل تدفق هواء التجفيف إلى زيادة النسبة المئوية للعائد والمحتوى الرطوبى والذوبانية والنسبة المئوية للون الناتج عن البلمرة فى حين أنها تؤدى إلى انخفاض محتوى المسحوق من الانثوسيانين. بزيادة معدل تدفق الهواء المضغوط تزداد النسبة المئوية للعائد وكذلك المحتوى من الانثوسيانين فى حين أن المحتوى الرطوبى و الذوبانية تنخفض بزيادتها , كما وجد أنه لايوجد تأثير لكل من معدل تدفق هواء التخفيف والهواء المضغوط على الكثافة .

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