

Spray drying of grape juice as affected by carrier agent concentration and drying parameters

Moser P.* and Telis V. R. N.

UNESP - São José do Rio Preto, Brazil (polianamoser@yahoo.com.br)



INTRODUCTION AND OBJECTIVE

Powdered juices might constitute good alternatives of convenient and healthy food products and ingredients to formulate foods, or to reconstitute natural fruit juices. Spray drying is an appropriate technique to convert fluid foods into powders, resulting in easy storage and transportation. Most of the soluble solids present in fruit juices, however, are low molar mass compounds that, when subjected to a rapid water removal as in spray drying, result in a metastable solid matrix, which is very susceptible to water plasticization followed by glass transition related changes, including stickiness, caking, and collapse (Bhandari 1993).

Part of these problems can be overcome by addition of high molar mass carrier agents, such as maltodextrin, before atomization. Maltodextrin is a low cost drying aid mainly used in sugar rich foods to reduce stickiness, thus improving the product stability (Righetto 2005).

The final characteristics of a powdered product obtained in spray dryer depend on process variables. Therefore, the aim of this work was to study the influence of maltodextrin concentration, drying air temperature, feed flow rate and air flow, on water content, yield, solubility and color of grape juice powders.

MATERIAL AND METHODS

Integral grape juice was purchased from a local market in São José do Rio Preto, Brazil. Maltodextrin DE-10 MOR-REX 1910 (Corn Products, Brazil), was used as carrier agent.

Drying was performed in a mini spray dryer (model B-290, Büchi, Switzerland). The soluble solids content was determined in refractometer. Powder moisture contents were determined gravimetrically by drying in a vacuum oven at 70 °C for 48 hours.

Process yield was calculated as the relationship between total solids content in the resulting powder and total solids content in the feed mixture. The solubility was determined according to Cano-Chauca (2005), where 1 g powder sample was added to 100 mL of distilled water and agitated for 5 min. The solution was centrifuged at 3000×g during 5 min. An aliquot of 25 mL of the supernatant was transferred to Petri dishes and oven dried at 105 °C for 5 h.

Color attributes (L^* , a^* and b^*) were measured using a colorimeter Color Flex EZ, Hunter Lab, USA, with D65 illuminant and 10° observation angle.

To find the best drying conditions, a factorial experimental design was carried out considering four factors (independent variables) with two levels of each variable: inlet air temperature (140 - 170 °C), feed flow rate (2 - 6 mL/min), air flow rate (300 - 500 L/h), and maltodextrin to soluble solids of the juice proportion, MD:SJ (1:1 - 1.5:1), including two trials in the central point. The results were statistically evaluated by analysis of variance (ANOVA) at a 5 % significance level ($p \leq 0.05$).

RESULTS

The soluble solids content present in grape juice was 16.7 °Brix. All the produced powders showed low moisture content, varying from 0.57 % to 2.66 % (dry basis). Increasing feed flow rate negatively affected the moisture content in the juice powder ($p < 0.05$). According to Tonon (2008), higher feed flow rates imply in a shorter contact time between the feed and drying air, making heat transfer less efficient and thus causing lower drying rates.

The air flow rate showed a positive effect on process yield, while the larger feed flow rate showed a negative effect (Figure 1). As it was already expected, a higher air flow rate combined with a lower feed flow favored drying rates, increasing yield.

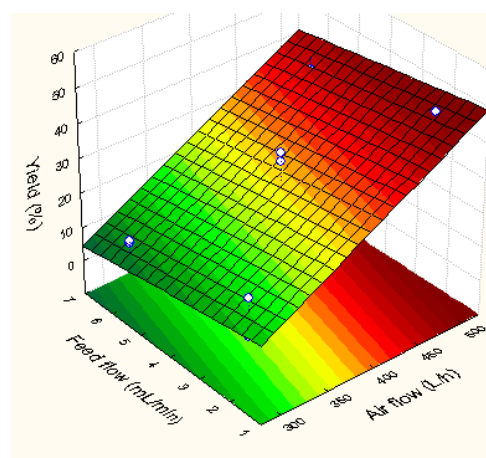
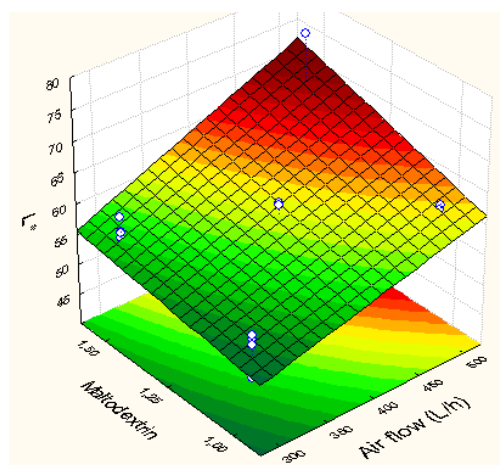


Figure 1: Influence of air flow and feed flow rates on yield. ($T_{\text{air}} = 140\text{ °C}$; MD:SJ 1:1)

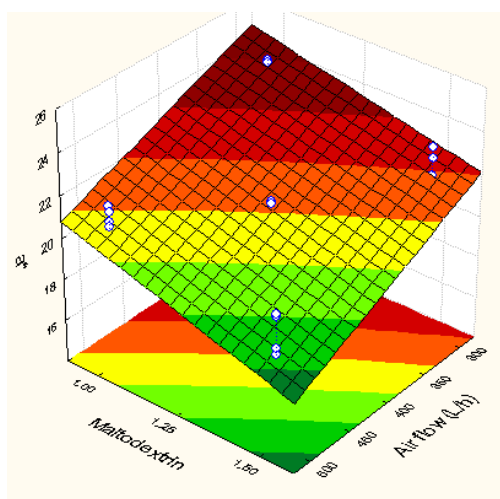
None of the independent variables had a significant ($p < 0.05$) effect on the solubility of samples, which was in the range of 95 to 100 %. According to Cano-

Chauca (2005), maltodextrin is mainly used in spray drying due to its physical properties, such as high solubility in water. The air temperature was the only variable that did not significantly affected any of the studied responses, probably because the selected range was narrow and was around the optimum temperature condition.

The lightness of samples (L^*) was affected ($p < 0.05$) by MD:SJ ratio and air flow rate (Figure 2a). The interaction between air flow and feed flow were also significant, with lower values of these variables leading to lower L^* . Lower maltodextrin content and lower air flow resulted in powders with lower lightness, i.e. with more dark color. The increase in lightness with higher carrier agent concentration occurs because maltodextrin is white, and thus dilutes the juice purple color (Tonon 2009).

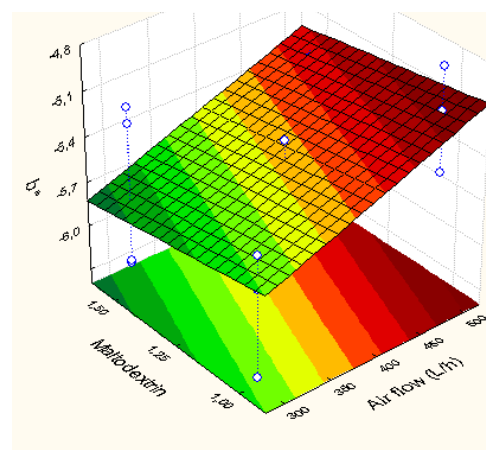


(a)



(b)

The air flow rate and MD:SJ ratio negatively influenced a^* value, indicating a decrease in red color. The interaction between air flow and drying air temperature were also significant, with lower values of these variables leading to higher a^* . The independent variables did not significantly affected the b^* coordinate of samples, however, there was a trend of more negative b^* values at low air flow rates.



(c)

Figure 2: Influence of air flow and maltodextrin on parameters (a) L^* ; (b) a^* ; (c) b^* . ($T_{\text{air}} = 140\text{ }^{\circ}\text{C}$; Feed flow rate = 2 mL/min)

CONCLUSIONS

The drying conditions that resulted in higher yields were obtained at lower feed flow rate and higher air flow. Nevertheless, higher air flow negatively affected the product color. Lower maltodextrin content resulted in lower lightness and increased red color.

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