Reconstitution Properties of Spray Dried Yoghurt Powder

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Abstract : Yoghurt is a product of lactic acid fermentation of milk by the addition of Lactobacillus bulgaricus and Streptococcus thermophiles as starter culture. Commercial production of yoghurt powder has been carried out by spry drying technique. The spray drying experiments were conducted with different process parameters viz., carrier blend ratio, inlet air temperatures (160, 170 and 180℃) and feed rates (10, 12, 14 rpm). The dried yoghurt powder is shelf-stable and can be stored at ambient temperature. Reconstituted properties of yoghurt powder are an important quality parameter for consumer acceptability and marketing. Reconstitution properties such as solubility and wettability of spray dried yoghurt powder were the main parameters considered in the present study. The lowest value of 335 s was noted for the carrier blend ratio of 3% maltodextrin and 1% corn starch at a temperature of 160℃ and feed rate of 10 rpm. The highest solubility percentage of 71.32 was acquired from carrier blend ratioof3% maltodextrin and 1% corn starch at 160℃ at 10 rpm. As inlet temperature increases, solubility decreases due to the formation of a rigid surface film over the spray dried yoghurt powder and which could be related to poorer wettability. At lower temperature, spray dried yoghurt powder had a higher tendency of agglomeration which helps in the reconstitution property of powder.

Key Words - Yoghurt powder, Spary drying, solubility, wettability

1. INTRODUCTION

The shelf life of yoghurt is short, i.e., one day under ambient condition (25-30℃) and around 5 days at 7℃ which delays its commercialisation (5). On the other hand, it adds to the cost of the product (8). The shelf life of yoghurt can be improved by lowering its water content by drying. The products obtained are in shelf stable powder form which can be stored at ambient temperature (4). At present, modern technologies *viz.,* spray drying, microwave drying, freeze drying etc. are also employed to produce yoghurt powder. But none of the methods got commercialised till now. Spray drying technique has recognised to be highly successful in improving the storage stability of food products. It is the most widely used methods for preservation of perishable liquid products. Poor texture, gel structure and flavor of reconstituted yoghurt are the main problems of yoghurt powder technology and should be improved. Also, the spray drying process parameters need to be standardised. This study will provide a new dimension for preserving yoghurt. It not only increases the sales and meets the requirements of

the consumer, but also helps to reduce the spoilage and increase the availability of nutrient rich food to the consumer at least cost. Reconstitutability indicates the ease with which a powder can be dissolved in water (9).In case of spray dried powdered foods, several properties includes, solubility, wettability, dispersibility, particle properties such as bulk density, tapped density etc influence the overall reconstitution characteristics (8).

2. MATERIALS AND METHODS

2.1 Preparation of yoghurt:

Yoghurt is a fermented milk product that contains microbial cultures viz., *Lactobacilllus bulgaricus* and *Streptococcus thermophilus*. Double toned pasteurized homogenized milk, procured from market was heated to 90℃ for 3-5 minutes and then cooled to 42℃. Cooled milk was then inoculated with two per cent (V/V) starter culture (*Lactobacilllus bulgaricus* and *Streptococcus thermophilus* in 1:1 ratio) and kept for incubation at 42℃ for 4-6 h.

2.2 Spray drying :

Experiments were conducted using a lab scale spray dryer (vertical co-current SMST tall type spray dryer). The process parameters of spray drier were optimised based on the yield, external appearance and quality of the powder. The main blower rpm, outlet temperature and pressure in the drying chamber were kept constant as 2100 rpm, 60-65℃ and 2 kg/cm², respectively. Spray drying of yoghurt was carried out using maltodextrin and corn starch as carrier materials in different proportions B1, B2, B3, B4 and B5 (1:0,3:1, 1:1, 1:3 and 0:1). The mixture was then spray dried at different operating parameters *viz.*, inlet air temperature T_1, T_2 and T_3 (160℃, 170℃ and 180℃) and feed rate F_1, F_2 and F_3 (10 rpm, 12 rpm, 14 rpm). The process parameters were optimised based on the physico-chemical and microbiological properties of the developed yoghurt powder. Yoghurt powder after reconstitution at 10- 40℃ in water at water to powder ratio 1:4 had taste, flavor and nutritional composition like that of fresh yoghurt. Reconstitution properties such as wettability and solubility were carried out using standard procedures as explained below

2.3 Reconstitution properties of spray dried yoghurt powder

2.3.1 Wettability

A glass funnel held on a stand and it was set over the beaker containing 100 ml of distilled water at room temperature. A glass rod was kept inside the funnel to obstruct its lower opening. To this setup, one gram sample was placed around the glass rod and after that the glass rod was lifted. The time taken for complete wetting of powder particles were noted using a stop watch. Determination of wettability was found out thrice for spray dried powder and the average value was considered as wettability of powder (2).

2.3.2 Solubility

One g of powder was blend with 100 ml of water at room temperature for 30 min. A 10 ml aliquot of the supernatant solution was placed to a 15 ml centrifuge tube and centrifuged for 30 min at 3000 rpm. The aliquot of the supernatant was then taken in a pre-measured aluminum moisture dish, evaporated on a steam bath and dried in an oven at 105°C for 4h.

$$\text{Solubility (\%)} = \frac{10 \times \text{Solid in supernatant (g)}}{\text{sample weight (g)}} \times 100$$

3. RESULTS AND DISCUSSION

3.1 Effect of spray drying parameters on Solubility

The effect of spray drying parameters on solubility is shown in Fig. 1, Fig. 2 and Fig. 3. From the figures, it is observed that solubility of yoghurt powder decreased with increase in inlet air temperature for all feed rates. But, a reverse effect was observed with feed rate. Fig.1 shows the solubility of yoghurt powder at 10 rpm feed rate. Highest solubility value of 71.32 percent was acquired from carrier blend ratio B2 at 160°C and lowest value of 67.87 percent was obtained from carrier blend ratio B3 at 180°C. The solubility of powder sample considerably decreased with the increase in inlet air temperature. It could be due to high degree of protein denaturation at high inlet temperature. Fig. 2 and Fig. 3 shows the effect of variables on solubility at feed rates 12 and 14 rpm. It was observed that, yoghurt powder made from carrier blend ratio B2 (3:1), feed rate 12 rpm (F_2) and inlet air temperature 160°C (T_1) showed the maximum solubility of 71.02 percent and minimum solubility value of 68.66 per cent was observed for sample made from carrier blend ratio B1 at temperature 180°C. Similarly, the minimum and maximum solubility obtained for sample made at feed rate 14 rpm were 68.71 per cent and 71.00 per cent, respectively for B3.

The decreasing trend of solubility with increase in inlet temperature could be due the result of inlet air temperature on particle size [1]. Elevated air temperature

helps in forming larger particle size that expanded the dissolving time of the powder. This was due to the formation of a rigid surface film just above the powder particles. Similar findings were detected on spray dried watermelon powder (7). They described it by the higher tendency of agglomeration at lower inlet temperatures, resulted in more reconstitution of the powders.
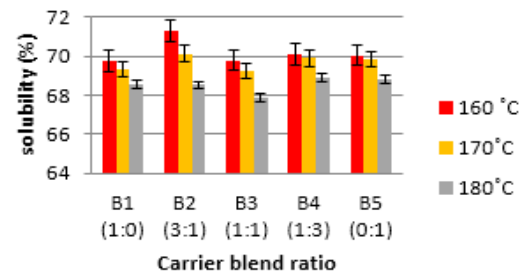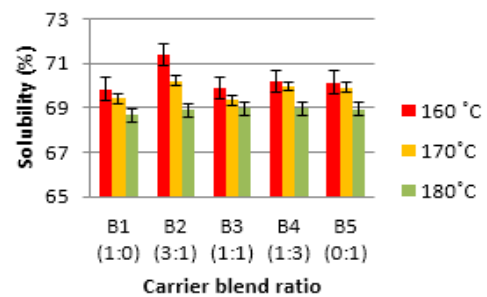

Fig 1 – Solubility at 10 rpm
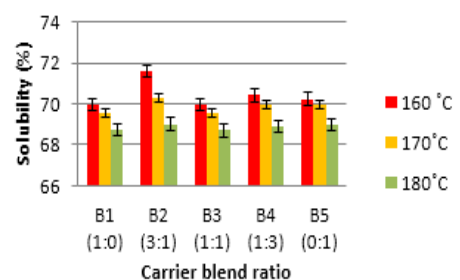

Fig 2 – Solubility at 12 rpm

Fig 3 – Solubility at 14 rpm

3.2 Effect of spray drying parameters on wettability

Wettability is the time required to achieve complete wetting of spray dried powder. The effect of spray drying parameters on wettability of yoghurt powder at feed rates 10, 12 and 14 rpm are shown in Table 1. From the table, it is shown that the wettability increased with an increase in inlet air temperatures, concentration of maltodextrin and feed rates. The maximum and minimum wettability values at different feed rates were 611 and 335 s, respectively.

Table 1- Wettability (Sec) of spray dried yoghurt powder

Ratio	Feed rate (10 rpm)			Feed rate (12 rpm)			Feed rate (14 rpm)		
	160 °C	170℃	180℃	160°C	170°C	180°C	160°C	170°C	180°C
B$_1$	386	466	575	390	470	581	400	481	591
B$_2$	335	439	540	347	440	550	357	458	560
B$_3$	396	456	580	399	476	595	410	462	611
B$_4$	350	440	550	357	440	552	367	450	565
B$_5$	352	445	558	360	445	558	377	453	567

At 10 rpm, highest value of 580 s was observed at 180°C having carrier blend ratio B3 and lowest value of 335 s was noted for the carrier blend ratio B2at 160°C. Similar trend was recorded for feed rates of 12 rpm and 14rpm. Maximum wetting time of 595 s and minimum wetting time of 347 s were observed at 12 rpm (F$_2$). At 14 rpm (F$_3$), 357 s to 611 s variation was observed. Some studies were concluded that moisture content variation in powder and lower dissolution property of maltodextrin were the cause for increased wettability [3] and also the poorer wettability is due to the lower dissolution rates and it could be related to the decreased solubility of the denatured protein [6].

3. CONCLUSIONS

The reconstituted yoghurt samples prepared from spray dried yoghurt powder were evaluated in terms of solubility and wettability. The lowest value of 335 s was noted for the carrier blend ratio of 3% maltodextrin and 1% corn starch at a temperature of 160°C and feed rate of 10 rpm. The highest solubility percentage of 71.32 was acquired from carrier blend ratio of 3% maltodextrin and 1% corn starch at 160°C at 10 rpm. As inlet temperature increases, solubility decreases due to the formation of a rigid surface film over the spray dried yoghurt powder and which could be related to poorer wettability. At lower temperature, spray dried yoghurt powder had a higher tendency of agglomeration which helps in the reconstitution property of powder.

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