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A comparative study on dahi powder prepared from spray dried and vacuum tray dried process

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Abstract
The study was aimed to extend shelf life of dahi by conversion to dahi powder by spray drying and vacuum drying process. The best process was selected based on the properties of powder like total solids, pH, acidity, survival ratio of lactic acid bacteria, yield obtained, insolubility index, colour change and sensory score for overall acceptability. There was significant difference in all properties except survival ratio of lactic acid bacteria between the spray dried and vacuum tray dried dahi powder. Spray dried powder had more total solids (96.1±0.66%) content, insolubility index (3.23±0.15 ml) and overall sensory acceptability score of 8.3. Based on findings, it was concluded that spray dried dahi powder was the best when compared to vacuum tray dried dahi powder. Hence spray dried process can be used in large scale production of dahi powder.

Keywords: Dahi, dahi powder, spray drying, vacuum tray drying

1. Introduction
Dahi is a popular indigenous fermented milk product which has been the part of Indian diet from ancient times. It is a semi-solid product, obtained from pasteurized or boiled milk by souring (natural or otherwise) using a harmless lactic acid or other bacterial cultures with minimum percentage of fat and S.N.F as the milk from which it is prepared (Aneja *et al*., 2002) [1]. The product has low keeping quality i.e., 24 to 48 hours under ambient conditions and less than 7 days under refrigerated conditions. In order to extend the shelf life of product, it can be converted into dried form i.e. dahi powder and hence the transportation and storage costs can be reduced. Freeze drying is considered to be the most effective method for drying fermented milk products without affecting the culture viability but the high cost limits its application in large scale production (Kumar and Mishra, 2004) [6]. So in the current study dahi powder was prepared by spray drying and vacuum tray drying process. The powder obtained from both the process was compared and selected based on the physico- chemical, microbial, functional and sensorial properties.

2. Materials and Methods
Dahi was prepared from cow milk procured from University Dairy Plant, Mannuthy. The Sagar brand skim milk powder was used for standardization. The milk was standardized with 3% fat and 8.5% SNF. NCDC Culture was used for making Dahi. All the reagents used for analysis were AR grade.

2.1 Preparation of Dahi
Dahi was prepared as per procedure by Aneja *et al*., (2002) [1]. The standardized milk was heated to 60 °C and subjected to single stage homogenization at a pressure of 176 kg/cm^2. Then heated in an open vessel to a temperature of 90 °C for 15 minutes and later cooled to 40 °C. Milk was inoculated with 1 percent mixed lactic culture containing *Lactococcus lactis* ssp. *lactis and Lactobacillus delbrueckii ssp. bulgaricus* in aseptic conditions. After inoculation, the milk was kept in a closed stainless steel vessel and kept for incubation at 40 °C for 6 hours till the final acidity of 0.7-0.8 percent lactic acid was obtained. Then the product was cooled to 5 °C or below and stored at that temperature till the time of drying. The prepared dahi was then subjected to vacuum tray drying and spray drying process.

2.1.1 Vacuum tray drying
The Vacuum tray dryer (Milk-Tech Engineers, Bangalore) as shown in Figure 1 available in the University Dairy Plant, Mannuthy was used for the study.

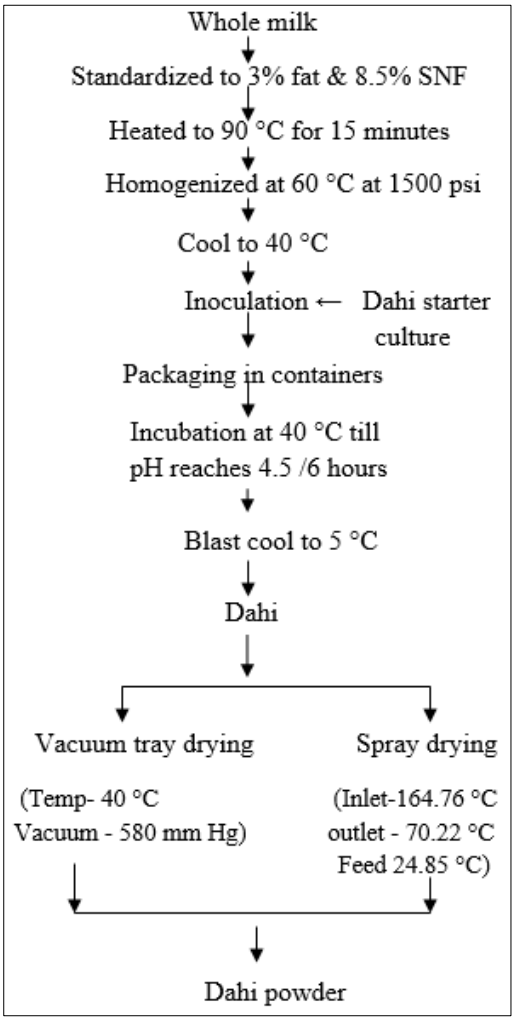
Prepared dahi was uniformly spread over the trays as thin layer. The dryer was set at a temperature of 40 °C and 580 mm Hg vacuum was applied. These conditions were maintained till the final drying stage was reached. After maximum moisture removal, the product was scraped off from the trays as flakes. The flakes were converted to powder form with the help of a mixer grinder.

2.1.2 Spray drying

A pilot type spray drier (ANHYDRO, Denmark.) of capacity 10 liters per hour as shown in Figure 2 of University Dairy Plant, Mannuthy was used for the study. The dahi was stirred well to break the coagulum. The process conditions were kept as inlet temperature of 165 ℃, outlet temperature of 70 ℃ and feed temperature of 25 ℃. All the parameters were selected by trial and error method in accordance with the preliminary work. Dahi was supplied through the feed pump into the drying chamber. The final product was collected and stored in a polythene bag lined with aluminium foil. The flowchart of preparation of dahi powder is given in Figure 3.

Fig 1: Vacuum Tray Drier

Fig 2: Spray Drier



Source: Aneja *et al*., 2002 [1]

Fig 3: Flowchart for the preparation of Dahi powder

2.2 Analysis of Dahi powder

Sampling of dahi powder was done as per the procedure described for milk powder and other related products in IS: 1165:2002. The total solids and titratable acidity in the powder samples were determined by the method of IS 1165: 2002. The pH of powder sample was determined by reconstituting 10 g of powder in 100 ml of distilled water and dipping the pH electrode (Eutech, Model- EC510).

2.2.1 Insolubility index

Insolubility index was determined by the method of Thompkinson (2012) [7]. 13 g of powder was weighed and transferred to a 250 ml jar. To that powder 100 ml of distilled water was added at 40 ℃ and mixed for 5 minutes. The liquid was filled into 50 ml graduated centrifuge tubes and the tubes were centrifuged at 3000 rpm for 5 minutes. After decanting the supernatant, water was added up to the mark and centrifuged the contents for 5 minutes. The volume (ml) of sediment in the tube will give the insolubility index.

2.2.2 Survival ratio of Lactic acid bacteria

Survival ratio of lactic acid bacteria was enumerated as per the procedure suggested by Kim and Bhoumik (1990) [4]. The dried samples were rehydrated to the initial solids of level of

fresh dahi with distilled water. One gram of reconstituted dahi powder was mixed with normal saline and serial dilutions were prepared. For the enumeration of lactic acid bacteria, the double-layer inoculated MRS plates (de Man Rogosa Sharpe Agar) were incubated anaerobically at 37 °C for 72 h. The average counts were calculated and the results were expressed in cfu/g dry matter. Survival ratio was calculated as N/N_0 where N_0 and N are the number of surviving lactic acid bacteria before and after drying respectively.

2.2.3 Color characteristics

Color of the powder samples was measured by reflectance spectroscopy technique employing reflectance meter, color flex (Hunter lab Miniscan XE plus Spectrocolorimeter, Virginia, USA) with geometry of diffuse/8° (sphere-8 mm view) and an illuminant of D65/10°. Before the test, the instrument was calibrated with standard black glass and white tile as specified by the manufacturer. The light source was dual beam xenon flash lamp. Data were received from the software in terms of L* [Lightness, ranges 0 (black) to 100 (White)], a* [Redness, ranges from +60 (red) to -60 (green)], and b* [Yellowness, ranges from +60 (yellow) to -60 (blue)] in values of the international color system. The colour change was expressed as ΔE and it is calculated by the formula

$$\Delta E = \sqrt{(L^*)^2 + (a^*)^2 + (b^*)^2}$$

2.3 Sensory Evaluation

The dahi powder samples were evaluated organoleptically after reconstitution for different quality attributes like flavour, body and texture, colour and appearance and the sensory score for overall acceptability was assessed by a selected panel of five judges using a 9 point hedonic scale score card.

2.4 Statistical Analysis

The results of physical, chemical, microbial and sensory analyses of both powders were compared by using independent paired t test (with equal variances). Values corresponding to each parameter were mean ± standard error of 6 observations.

3. Result and Discussions

Dahi powder obtained from two methods *viz*. vacuum tray drying and spray drying as shown in was subjected to physico-chemical, functional, sensory and microbial attributes. The results of these analyses were compared by using independent t test and are summarized in Table 1. The obtained spray dried dahi powder and vacuum tray dried dahi powder are shown in Figure 4.

Table 1: Comparison of properties of dahi powders obtained by Spray drying and Vacuum tray drying

Characteristics	Spray dried Dahi powder	Vacuum tray dried Dahi powder	Tα
Total solids (%)	96.1±0.66	90.73±0.15	0.019**
Titratable acidity (% LA)	0.33±0.01	0.29±0.00	0.03*
pH	4.31±0.03	4.29±0.02	0.02*
Survival ratio (N/N_0)	2.03±0.02	2.14±0.03	0.56^{ns}
Yield (%)	9.5±0.29	12.5±0.5	0.01*
Insolubility index (ml)	3.23±0.15	4.75±0.35	0.01*
Colour change (ΔE)	7.3±0.21	4.75±0.35	0.006**
Sensory score for overall acceptability	8.3±0.16	6.75±0.25	0.01**

Data are expressed as mean ± standard deviation of 6 observations
**-significant at one percent level (p<0.01),
*- significant at five percent level (p<0.05),
ns- non-significant

(a) (b)

Fig 4: (a) Spray dried dahi powder (b) Vacuum tray dried powder

From the Table 1, we can infer that there is significant difference in dahi powder obtained by two methods except the survival ratio of lactic acid bacteria (p>0.05). The non significant t value for survival ratio of lactic acid bacteria between two processes indicates that the percentage of survival in both process were almost similar.

The vacuum tray dried powder showed minimum colour change as compared to spray dried powder. The ΔE value for spray dried powder was found to be 7.3±0.21, which was significantly higher than that of vacuum tray dried powder i.e. 4.75±0.35. A‘t’ value of 0.006 also indicates the same. This may be due to the exposure of product to a higher temperature during spray drying. The values for titratable acidity and pH are significantly lower for vacuum tray dried powder as compared to spray dried one. This may be due to lower total solids and higher moisture content in tray dried powder.

There was significant difference in total solid content between these powders. A total solid value of 96.1±0.66% implies that the moisture content in spray dried powder is below 5 percent, where as in tray dried powder it comes to above 9 percent, which is a very high value to be accepted for a powder. The reason may be attributed to lower water evaporation rate at reduced pressure. Debnadh *et al*. (2002) [2] reported a moisture content of 1.9 percent on free basis for vacuum tray dried onion powder, the huge difference in moisture content may be due to the difference in applied vacuum. The percentage of yield obtained from vacuum tray drying was more when compared to spray drier. This may be due to the fact that more product loss was there during the removal of final product because of higher temperature in the drier surface which leads to sticking of powder on the walls of the drier which cannot be recovered (Kothakota *et al*., 2014) [5].

Insolubility index gives the portion of powder that remains insoluble after reconstitution. The insolubility index values for spray dried powder and tray dried powder were 3.23±0.15

ml and 4.75±0.35 ml respectively, with a significant t value of 0.01(<0.05) which suggest that spray dried powder is more soluble in water when compared to vacuum tray dried powder. The spray dried powder had significant overall acceptability score with a mean value of 8.3 which recommends the use of spray drier for dahi drying.

4. Conclusion

The best quality dahi powder was obtained from spray drying process when compared with vacuum tray drying process on the basis of properties like total solid percentage, insolubility index and sensory acceptability and most importantly the time taken for drying was lower with almost similar survival ratio of lactic acid bacteria. So spray drying could be selected as a better process for industrial drying of dahi. But the process parameters have to be optimized to reduce the colour change and to maximize the survival ratio. The spray drying process was selected as a better process for industrial drying of dahi.

5. Acknowledgments

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