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PRODUCTION OF EGG POWDER ON COMMERCIAL SCALE

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Pilot scale experiments on the production of egg powder from yeast treated pulp were carried out using the foam-mat drying technique. The technological aspects of different unit operations and equipment have been described. Data on bulk dehydration of whole egg melange is included. A comparison has been made between storage at room temperature and under refrigeration. From the results of pilot experiments, cost studies were developed provided a prospective on the feasibility of the production of egg powder in Pakistan.

Key words: Drying, Dehydration, Egg powder.

Introduction

Eggs are a delicate and highly perishable product. Preservation of eggs by foam-mat drying was reported in a previous publication [1] in which processing conditions and quality attributes of the product were discussed.

The present paper deals with the commercial scale production of egg powder on a plant suiting to the local technology and conditions of processing. Studies were also carried out to determine the storage stability of egg powder produced by the foam-mat technique.

Materials and Methods

Liquid egg was convered into foam using a machine designed and developed locally. The foam of optimum density (0.20-0.26 g/ml) and drainage (5-10% in 100 mins at 25°) [1] was obtained by adjusting the inflow of egg pulp. The foam was dried in the commercial dehydrator described by Jamil *et al.* [2] in which the false-bottom 'Sarkanda' trays were replaced by the nonperforated stainless steel trays.

A general sequence of unit operations involved in the process of egg dehydration is shown in the flow sheet (Fig. 1).

Shell eggs of high candle grade were procured from the local fmarket, washed by water and dried by hot air current. The clean eggs were broken and contents separated. To obtain a uniform pulp whites and yolks were stirred and passed through a strainer with 0.024-in perforations to remove shell fragments, membranes etc. The liquid content was desugarized by the yeast fermentation process after Kline and Sonoda [3] with a slight modification as follows:

0.2 Gram Engedura Bakers yeast per 100 ml of whole egg melange was added to the pulp in the form of 10% water suspension and temperature adjusted to 30±1°. Stirring was confined to a period of about 15 mins after the yeast addition. The fermentation process was deemed complete when glucose was not detected by the Somogyi's quick test [3].

The pulp was received in a steam jacketted tank equipped with an agitator and pasteurised at 57° for 15 mins [4]. It was cooled to room temperature using refrigerated water and converted into foam by the machine described earlier. The egg foam was received in the dryig trays evenly spread and levelled so that a uniform sheet of foam of about 7 mm thickness was always applied on the drying surface of the tray.

Foam-loaded trays were stacked on trolleys and dried in the tunnel dehydrator [2]. However, the introduction and withdrawal of trolleys were carried out at intervals of 10 mins. instead of 30 mins. and that the temperatures of the tunnel dehydrator (hot end) and finishing dryer were maintained at 70° and 60° respectively. At the end of the drying cycle, the trays were shifted to a low-temperature, low-humidity room (15°, 25% RH) where the material was cooled to about 20° and scrapped off the trays. The dried egg with a moisture content of 2-3% was densified by passing through a pair of rolls (clearance 3 mm) and packed in hermetically sealed tin containers.

For storage studies the packed samples were held at room temperature (20-30°) as well as under refrigeration (5-8°). Solubility and organoleptic characteristics were evaluated

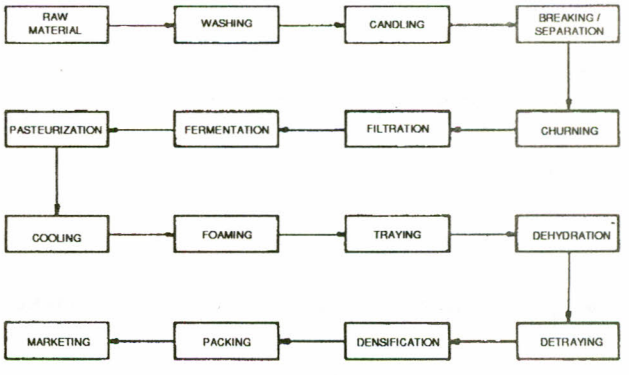

Fig. 1. Flow sheet for foam-mat drying of eggs.

after a storage period of 0, 3, 6, 9 and 12 months according to the methods described earlier [1].

Results and Discussion

Some physical data on bulk dehydration of whole egg melange using the commercial plant described above are listed in Table 1.

In our early small scale batches, desugarization egg melange was carried out by the enzymatic fermentation using glucose oxidase-catalase enzyme system. Although glucose was removed quite effectively but it proved to be a complex and expensive method. It was, therefore, replaced by the equally effective yeast fermentation method which also was relatively simple and less expensive. The progress of fermentation was observed by the quick Somogyi test performed on aliquots of pulp withdrawn at various intervals of time. The presence of sugar was indicated by the formation of a precipitation to a light yellow green during the last stages. Finally, non-appearance of precipitate was indicative of the absence of glucose. It was found that the fermentation of sugar was completed 3 hrs, which is in accordance with that quoted by Stadelman and Cotteril [4].

The results with respect of solubility and organoleptic evaluation of the egg powder before and after storage at room temperature and under refrigeration, are presented in Table 2.

The solubility of the freshly produced egg powder was 91.5% which decreased at a faster rate to reach a value of 32% after 9 months storage at room temperature. Contrary to this, the solubility was well preserved in the samples stored under refrigeration and decreased at a comparatively lower rate so that it was 59.3% after 9 months and 47.2% after a storage period of 12 months.

The colour, texture and taste scores decreased during room temperature storage as well as during storage under refrigeration. The decline was, however, more pronounced in the case of room-temperature storage. These samples were quite acceptable upto 6 months with colour, texture and taste ratings of 6.8, 6.5 and 6.3 respectively. Although, colourwise, the samples were satisfactory after 9 months storage (colour score=5.5), yet they were 'poor' with texture and taste scores of 4.0 and 3.6 respectively. On the other hand, samples stored under refrigerated conditions were quite good after 6 months and acceptable after 12 months storage period; their colour, texture and taste scores being 6.0, 5.8 and 5.8 respectively. These findings are in accordance with those quoted in the

TABLE 1. PHYSICAL DATA ON DEHYDRATION OF WHOLE EGG (BATCH SIZE, 400 kg EGG MELANGE).

No. of eggs processed per batch	9273
Weight of shell eggs	463.65 kg
Weight of shells	55.64 kg
Weight of pulp	408 kg
Moisture content of pulp	74.4%
Processing loss	8 kg
Weight of dehydrated product	100 kg
Moisture content of egg powder	2.8%
Density of egg powder (compressed)	0.55 g/cc
Yield (shell egg basis)	21.6%
Dehydration ratio (pulp : powder)	4 : 1

TABLE 2. SOLUBILITY AND ORGANOLEPTIC EVALUATION OF FOAM-MAT DRIED EGG DURING STORAGE (1,2,3).

Storage condition	Characteristics	Storage period (months) 0	3	6	9	12
At room temperature (20–30°)	Solubility(%)	91.5	44.0	37.2	32.0	—
	Colour	7.5	7.2	6.8	5.5	—
	Texture	7.2	7.0	6.5	4.0	—
	Taste	7.5	7.0	6.3	3.6	—
Under refrigeration (5 – 8°)	Solubility(%)	91.5	75.5	62.3	59.3	47.2
	Colour	7.5	7.5	7.2	6.5	6.0
	Texture	7.2	7.2	7.0	6.5	5.8
	Taste	7.5	7.2	7.0	6.7	5.8

(1) Mean of 6 judgements: 9–10 excellent, 7–8 good, 5–6 satisfactory, 3–4 poor, 1–2 inedible. (2). Values for fresh egg: Solubility – 100%, colour – 7.5, texture – 8.0, taste – 8.0. (3). Samples packed and hermetically sealed in tin containers.

TABLE 3. SUMMARY OF INVESTMENT AND PRODUCTION COST.

		Rs.
1.	Fixed capital cost	55,00,000
2.	Working capital	95,00,000
3.	Total investment	1,50,00,000
4.	Production cost	3,15,00,000
5.	Sales	3,81,00,000
6.	Fixed cost	66,10,000
7.	Variable cost	2,48,90,000
8.	Contribution	1,32,10,000
9.	Break-even	1,90,65,000
		(50% to sales/capacity)
Cost per kg of egg powder		
1.	Raw material and packing	75.00
2.	Direct manufacturing cost	10.50
3.	Indirect manufacturing cost	4.20
4	Manufacturing cost	89.70
5	General expenses	15.20
6.	Production cost	105.00
7.	Estimated sale price	127.00
8.	Profit on sales	17.32

literature [4,5]. The drop in solubility values appears to be related to the drop in colour, texture and taste scores.

Economics. On the basis of the data obtained from the commercial plant cited above, economic calculations were carried out for a scaled up production of 1 tonne egg powder per 3 shifts a day. A techno-economic feasibility report has been published [6]. A summary of the investment and production cost is given in Table 3 and break-even chart shown in Fig. 2.

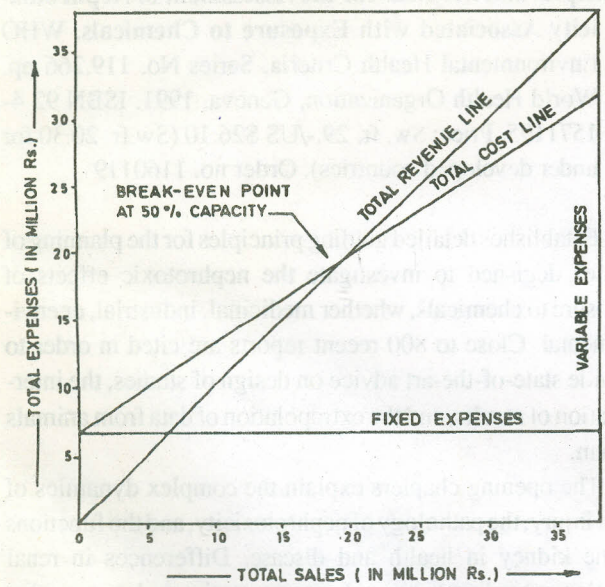

Fig. 2. Break-even chart.

It will be seen that a revenue of Rs. 38,100,000 yields a return of 17.32% against the production cost of Rs. 31,500,000 and based on the fixed cost of Rs. 24,890,000, a break-even is reached at Rs. 19,065,000 which represents 50% to sales/ capacity.

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