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EFFECT OF PRE-HEATING AND PACKAGING ON CHEMICAL AND RECONSTITUTIONAL CHARACTERISTICS OF SPARY-DRIED WHOLE MILK

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The supply of quality milk to consumption centres has failed to meet the requirements. Spoliage, refrigeration and distribution costs of milk are the major problems of the dairy industry. Due to lack of centralized organization of milk collection, processing and distribution, manufacturing dairy products of extended shelf-life appears to be the best solution for overcoming milk spoilage during storage. Manufacturing milk powder involves the application of appropriate treatments to obtain adequate storage stability. Reconstitutability tests indicated better dispersibility in low heat pretreatment of milk powder. Packing in polythylene lined heat sealable aluminium foil bags showed superior quality as regards overall reconstitutability of spray dried milk after 4 months at ambient temperature (25-35°C).

INTRODUCTION

Milk powder manufactured in Pakistan is mostly marketed in polyethylene bags for economic reasons. Off-flavour development and degradation properties relating to reconstitutability of products thus marketed have spotlighted the need for devising such processing changes that could yield flavour stability with good and easy reconstitutability of dried milk,

Maximum solubility of self-dispersion could be obtained only with milk powder having bulk density of less than 0.4 g ml^{-1}. (Harper *et al.*, 1963).

High heat application during processing can cause irreversible denaturation of casein which ultimately affects the dispersibility of dry milk. Furthermore, the rate of solubility index is directly correlated to the time, temperature and moisture content of the dry milk during storoge (Hall and Hedrick, 1966). Dried whole milk packed at temperature above the melting point of fat and

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stored at temperature below the melting point of fat showed the best quality regarding reconsititutability (Jansen and Hansen, 1978). Hanrahan *et al.* (1962) reported that low density structure particles affected most the dry milk dispersibility. Reduction in lysine with formation of hydroxymethyl furfural and casein polymers has been shown to be responsible for colour changes in milk powder (Switka *et al.*, 1978),

Hoffer and Wereteker (1979) showed that increase in moisture content enhanced browing.

MATERIALS AND METHODS

Fresh buffalo milk was stored in insulated tank after chilling to 4°C and then pasteurized by continuous plate type pasteurizer (80°C for 16 seconds) and finally standardized (3 % milk fat and 8 % solid-not-fat).

The milk was evaporated under vacuum (720 mm Hg at 65°C) to obtain an ultimate total soilds of 46% after exposing to two preheating temperatures (65 ± 3°C and 95 ± 3°C). Finally it was spray dried (200°C inlet and 45°C outlet air temperature) after homogenization (2000 psi). Whole milk powder was cooled (4°C) and packed (200 g each) into poly coated heat sealable aluminium foil bag, and polythylene bags for evaluation during storage at ambient temperature (25°-35°C).

The dry milk samples were analysed for moisture, protein, fat, ash and lactose contens according to the standard methods of A.O.A.C. (1975). Wettability and dispersibility tests were adopted from Portugese Standard Methods (Anonymous, 1973) and bulk density tests from Kramer and Twigg (1973). Solubility index and scorched particles were determined using methods of American Dry Milk Institute (1965). The data wera analysed statistically by the Analysis of Variance technique (Steel and Torrie, 1960).

RESULTS AND DISCUSSION

Chemical Composition : The chemical analysis of freshly prepared milk powder by the two pre-heat treatments is shown in Table 1. It was found that the milk powders thus prepared meet the specific grading requirements in respect of moisture, titrable acidity and fat content for dry whole milk. The ash, protein and lectose contents are also within the reported range for this product (Webb *et al.*, 1974).

Dispersibility : Freshly prepared spray dried whole milk powder showed slightly better dispersibility in low heat treatment as compared to that of high heat treatment. This could be due to denaturation of casein of milk on account of high temperature treatment during its preparation as also reported by Hall and Hedrick (1966).

Table 1. *Chemical composition of spray dried whole milk in relation to pre-heat treatment during storage.*

Constituents (%)	Low-heat (65 ± 3°C)		High-heat (95 ± 3°C)	
	Storage time-days		Storage time-days	
	0	120	0	120
Moisture	2.20	2.50	2.20	2.70
Acidity	0.15	0.17	0.15	0.19
Crude fat	28.00	28.00	28.00	28.00
Crude protein	27.00	26.75	26.90	25.50
Lactose	40.30	39.70	40.20	39.70
Ash	5.60	5.60	5.50	5.50

There was a decline in dispersibility of milk powders during storage. However, both types of powder milk prepared differently when packed in polyethylene coated heat sealable aluminium foil bags had superior dispersibility index than that of samples packed in polyethylene bags only as shown in Table 2. Greater exchange of air and moisture vapours in the polyethylene films used for packing samples of whole dry milk powders could be the reason for comparative low dispersibility in the latter. Moisture gain in the milk powder packed in polyethylene bags increased the compactability with reduction in dispersibility. Similar observations were reported by Hanrahan *et al.* (1962) who showed that density of particles had pronounced effect on dispersibility. Aceto *et al.* (1966) stated that in order to obtain better dispersibility, dried milk powder must be of porous structure. In the present study it was observed that the type of packaging had highly significant ($p < 0.01$) effect on despersibility index (see Table 4).

Wettability : Wettability index of freshly manufactured whole dry milk powder differed with intensity of preheat treatment of fresh milk as is evident from the results in Table 2. Packaging in the aluminium foil lined bags showed better index of wettability as compared to the polyethylene baged uring storage.

Table 2. *Dispersibility, wettability and solubility index of spray dried milk powder during storage.*

Treatments	Quality artibute	Storage period - days					
		0	15	30	60	90	120
Packaged in polycoated heat sealable aluminium foil-low heat treated	Dispersibility (Sec)	49.00	49.00	49.00	49.80	50.00	50.20
	Wettability (min)	240.00	240.00	240.00	248.00	250.00	250.00
	Solubility index(ml)	0.30	0.30	0.30	0.30	0.30	0.30
Packaged in polycoated heat sealable aluminium foil-high heat treated	Dispersibility (Sec)	50.00	50.00	50.00	58.20	60.40	60.50
	Wettability (min)	250.00	250.00	250.00	260.00	260.00	260.00
	Solubility index(ml)	0.30	0.30	0.32	0.32	0.35	0.35
Packaged in polyethylene bags-low heat treated	Dispersibility (Sec)	49.00	49.00	60.00	60.00	70.00	70.00
	Wettability (min)	240.00	240.00	250.00	260.00	270.00	276.00
	Solubility index(ml)	0.30	0.30	0.35	0.36	0.37	0.38
Packaged in polyethylene bags-high heat treated	Dispersibility (Sec)	50.00	50.00	60.00	70.00	70.00	80.00
	Wettability (min)	250.00	260.00	260.00	270.00	280.00	286.00
	Solubility index(ml)	0.30	0.31	0.36	0.38	0.38	0.38

Low heat = 65 ± 3°C

High heat = 95 ± 3°C

Table 3. *Bulk density and scorched particles of spray dried milk powder during storage.*

Treatments	Quality attribute		Storage period - days					
			0	15	30	60	90	120
Packed in poly coated heat-sealable aluminiem foil bags-low heat treated	Bulk density	(g ml^{-1})	0.50	0.50	0.50	0.50	0.50	0.50
	Scorched particles	(mg)	7.50	7.50	7.50	7.50	7.50	7.50
Packed in poly coated heat-sealable aluminium foil bags-high heat treated	Bulk density	(g ml^{-1})	0.40	0.40	0.40	0.40	0.40	0.40
	Scorched particles	(mg)	7.50	7.50	7.50	7.50	7.50	7.80
Packed in polpethylene bags-low heat treated	Bulk density	(g ml^{-1})	0.50	0.50	0.50	0.61	0.64	0.66
	Scorched particles.	(mg)	7.50	7.50	7.50	7.50	7.50	15.00
Packed in polyethylene bags-high heat treated	Bulk density	(g ml^{-1})	0.40	0.40	0.46	0.50	0.60	0.66
	Scorched particles.	(mg)	7.50	7.50	7.50	7.50	15.00	15.00

Low heat = 65 ± 3°C
High heat = 95 ± 3°C

Milk grade	A	B	C	D
Scorched (mg) particles	7·50	15.00	22.50	32.50

When the data were analysed statistically, it was found that preheat treatments, type of packaging and storage intervals had highly significant effect ($P < 0.01$) on this parameter as shown by the results in Trble 4.

Solubility Index : A high solubility index refers to an above normal amount of insoluble components in the dried milk. Though initially solubility iedex was same in all the treatments, but on storage low and high heat spray dried milks packed in plain polyethylene bags showed an increase in solubility index (Table 2). Accordingly the rate of solubility index increased in dry milk during storage and was directly correlated to the time and temperature of storage and also to moisture content of dried milk (Hall and Hedrick, 1966). The high solubility index of samples observed in the case of polyethylene bage could be due to permeability of film to air exchange which led to absorption of moisture. This coupled with high storage temperature could be responsible for casein denaturation into a form which did not yield a stable dispersion on combining with water.

When data were analysed statistically a significant difference ($p < 0.05$) of two pre-heat treatments was observed, whereas highly significant ($p < 0.01$) effects of storage period and type af packaging on the solubility index of dried whole milk was observed (Table 4).

Bulk Density : Pre.heat treatments during preparation and packaging had significant ($P < 0.05$) effect on the bulk density of whole dried milk as shown by the results in Table 4. Harper *et al.* (1963) indicated that maximum sobubility by self dispersion could be achieved only with milk powders having bulk density less than 0.4 g ml^{-1}.

The products manufactured for this study initially had 0.4 to 0.5 g ml^{-1} bulk density. Bulk density of samples packed in polyethylene bags increased on storage as indicated in Table 3. Besides solubility, the bulk density has a pronounced influence on cost of packaging. Level of pre-heat treatment and type of packaging has statistically significant effects ($p < 0.05$) on bulk density (Table 4).

Scorched Particles : Scorched particles in dried milk are overheated or burnt particles with light brown to black colour. In this study, it was observed that the milk samples contained 7.5 mg of scorched particles which is required for A-grade under standards for dry milk (Table 3). Samples packed in polyethylene bags showed a substantial increase in scorched particles (15 mg which is equivalent to B-grade) after 4 months of storage period. Possibly the number of brown particles incrased due to millard reaction occurring on storage at ambient temperature.

Table 4. *F-ratio values for various characteristics of spray dried whole milk powder affected by preheat treatment, packaging and storage.*

Due to	Bulk Density	Wettability	Dispersibility	Solubility Index	Scorched particls
Preheat treatments	13.8689*	24.500**	42.856NS	4.8980*	0.4999NS
Packaging treatments	14.8837*	28.8165**	19.1605**	25.1429**	4.4999*
Storage Intervals	2.7738NS	10.6936**	6.5231*	7.1837**	2.0992NS

NS = Non-significant

* = Significant at $p \leqslant 0.05$

** = Highly significant at $p \leqslant 0.01$

Type of packaging showed a significant ($p < 0.05$) effect on increase in the scorched particles as is evident from the results in Table 4.

REFERENCES

Aceto, N.C., J.C. Craig, R.K. Eskew and F.B. Talley, 1966. Storage aspects of continuous vacuum foam-dried whole milk. International Dairy Congress, 17th, Munich, Proceeding 189-196

American Dry Milk Institute, 1965. Standards for grades of dry milk inluding methods of analysis. Bulletin 916 (Revised). American Dry Milk Institute Inc., Chicago. Illions, U.S.A.

Annonymous, 1973. Dry milk, water immersion test. Portugal IGPAI. Reparticao de normalizacao· Portuguese Standard NP-985, Ip. and NP-986 Tp.

A.O.A.C. 1975. Official methods of analysis of the Association of Official Analytical Chemists. Washington, D.C., U.S.A.

Hall, C.W and T.I. Hedrick, 1966. Drying milk and milk products. AVI Publishing Company, Inc., Westport, Connecticut, U.S.A.

Hanrahan, F.P., A. Tamama; K.K. Fox and M.J. Pallansch, 1962. Production and properties of spray dried whole milk powder. J. Dairy Sci. 14 : 27-31.

Harper, M.K; V. Holsinger; K.K. Fox and M.J. Pallansch. 1963. Factors influencing the instant solubility of milk powder. J. Dairy Sci. 46 : 1192.

Hoffer, H. and M. Werteker. 1979. Evaluation of heat damage to dried milk and milk concentrates by colour measurements. Milchwirtschaftliche Berichte aus den Bundesantelten Wolf passing und Rotholz. 58 : 73-80. (Food Sci. Technol. Abst., 12(3) : 12p 1321; 1980).

Jansen, G.K. and P.S. Hansen. 1978 The influences of packing and storage temperatures on the reconstitutability of instant whole milk powder. Gov. Res. Institute Dairying Industry, Hilleroed, Denmark : 730-732. (Common Wealth Agri. Bureau Slough U.K. : 1696, 1983).

Kramer, A. and B.A. Twigg. 1973. Quality control for the Food Indusfry. Part II. The AVI Pub. Co. Inc., Westport, Conn., U.S.A.

Steel. R.G.D. and J.H. Torrie. 1960. Principles and procedure of statistics. McGraw Hill Book Co. Inc., New York.

Switka, J., J. Kisza and H. Zbik. 1978. Effect of storage conditions on the development of the Maillard Reaction in dried skim milk. XX International Dairy Congress. 1019-1020. (Food Sci. Technol. Abst., 10(10) 10p 1259, 1978).

Webb, B.H., A.H. Johnson and J.A. Alford. 1974. Fundamentals of Dairy Chemistry. AVI Publishing Company Inc., Westport, U.S.A.