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Production of *Zabadi*, from Ultrafiltered Buffalo's Milk

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ABSTRACT

Zabadi *was made from ultrafiltered buffalo's milk with concentration factors (CF) of 1·0, 1·5, 2·0 and 2·5. Dry matter, ash, fat, lactose, protein content, pH value and titratable acidity were determined. Organoleptic properties of the resultant* zabadi *were also determined. Lactose content decreased as affected by the increase in dry matter as a result of the UF-process. The initial, as well as the developed, acidity increased proportionally with increasing CF. The initial pH value decreased with increasing CF. A good sensory quality* zabadi *could be obtained from buffalo's milk when it was concentrated to a CF of 1·5 (17% TS).*

INTRODUCTION

Zabadi (yoghurt) is a popular cultured milk in Egypt, which should be free from defects in body, consistency and syneresis. *Zabadi* is usually produced from whole or partially skimmed cow's or buffalo's milk. To improve its consistency, the solids content of the initial milk is usually raised (by adding spray-dried skimmilk) to about 22% TS (Hamdy *et al.*, 1973; El-Shibiny *et al.*, 1977). The use of milk powder, whey powder, sodium caseinate, etc, as ingredients may cause problems and whey powder imparts undesirable flavour. Also, fortification with milk powder can lead to excessive acidity and taste deviation (Tamime & Deeth, 1980).

Furthermore, for the concentration of milk by heat treatment, which is actually used in the conventional procedure of *zabadi* manufacture, the milk is indirectly heated in open containers to 85–90°C for 20 min to a loss of

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about 15% of milk moisture (EOS, 1970) and that causes chemical damage of some milk constituents. The concentration of milk by the ultrafiltration (UF) process is usually carried out at ambient temperature. Thus, the application of the UF-technique in the *zabadi* industry is considered as a better alternative method for milk concentration and protein fortification to give a good consistency, to reduce the lactose level in the final product and hence to improve the keeping quality of the product. Also this makes it possible to avoid (partially or completely) the problem of lactose intolerance (Kosikowski, 1979).

Recently, yoghurt was reported to be made successfully from ultrafiltered cow's milk (Chapman *et al.*, 1974; Jepsen, 1979; Mogensen, 1980) and goat's milk (Abrahamsen & Holmen, 1981).

The aim of this work is to throw some light on the manufacture of *zabadi* from buffalo's milk using the UF-technique, and to find out whether the differences in the total solids contents of products could cause any further effects on pH or acidity development. To this end the incubation period was extended by 2 h.

MATERIALS AND METHODS

Heat-treated buffalo's skimmilk (72°C/20 s) was ultrafiltered using DDS-UF-Lab Unit, Modul 35, Nakskov, Denmark, with membrane area of 2·25 m^2 at a temperature of 50 ± 5°C. The retentates were taken at 1·5, 2·0 and 2·5 concentration factors (CF). Moreover, the resultant permeate was used for diluting to obtain a milk with protein content similar to that of cow's skimmilk.

Fat content was adjusted to 5·5% by adding cream (55% fat) to each of the diluted samples as well as normal skimmilk and retentates. Then 2% of *zabadi* starter (mixed culture of *L. bulgaricus* and *Str. thermophilus*) was added. The inoculated samples were incubated at 40°C for 6 h. Sampling was carried out every hour during the incubation period. Five batches in duplicate of each treatment were done. Figure 1 shows the flow-scheme of *zabadi* manufacture.

Dry matter, ash, fat contents and titratable acidity were determined and pH value was measured according to Ling (1963). Protein content was calculated by the method of Lowry *et al.* (1951). The lactose content was determined according to the colorimetric method of Barnett & Tawab (1957) and the organoleptic properties were scored for *zabadi* obtained after 4 h of incubation, by a regular score panel from the staff members of the Dairying Section according to Nelson & Trout (1951) at room temperature. The results obtained were statistically analysed according to Renner (1981).

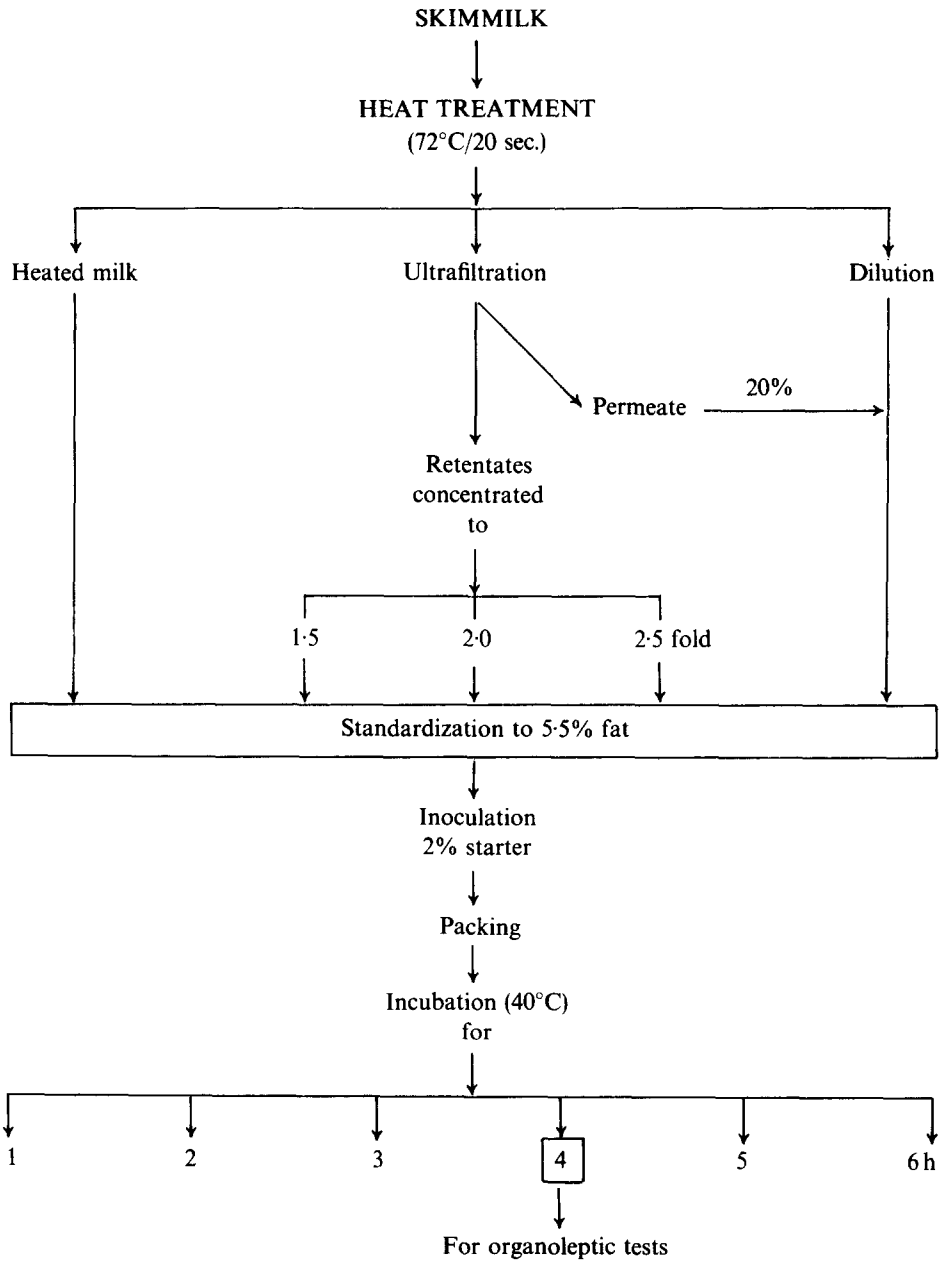

Fig. 1. The flow-scheme of *zabadi* manufacture.

RESULTS AND DISCUSSION

Figure 2 illustrates the relationship between the concentration factor and both dry matter and protein contents of skimmilk. Although the dry matter, as well as the protein content, increased gradually with increasing CF (the correlation coefficient of both is 0·98), the rate of increase in the latter was greater than that in the former, due to the full retention of the protein, while some other solids such as lactose and soluble salts can pass through the membrane. The linear analysis shows that the slope of CF and protein had a higher value (4·4) than the slope of CF and dry matter (4·1). The results are in accordance with those reported by Kessler (1981).

Table 1 presents the gross compositions and organoleptic scores of *zabadi* made from milks with different protein contents.

The data show that lactose content decreased due to increase in dry matter as a result of the ultrafiltration. However, the increase in ash content, as a function of the increase in CF is due to the retention of the protein-bound salts. Similar observations in UF-retentates were reported by Thomasow (1975), Maubois (1980) and Fayed (1986).

Figure 3 pictures the acidity development in *zabadi* during the incubation period as affected by the protein content. The initial acidity increased proportionally on increasing the protein content by the UF-process, while the pH value at zero time (Table 2) decreased for the same reason. Many authors have reported this and ascribed it to concentration of proteins and colloidal salts during the UF-process (Covacevich & Kosikowski, 1977;

TABLE 1

The Gross Composition and Total Organoleptic Score of Zabadi made from Buffalo's Milk with Different Concentration Factors (CF)

CF of zabadi *milk*	*Dry matter* (%)	*TN* (%)	*Lactose* (%)	*Fat* (%)	*Ash* (%)	*Organoleptic score/100*[c]
0·8[a]	14·4 ± 0·30	0·51 ± 0·02	4·8 ± 0·08	5·5 ± 0·10	0·85 ± 0·02	85 ± 2·0
1·0[b]	15·2 ± 0·21	0·64 ± 0·01	4·5 ± 0·07	5·6 ± 0·12	0·96 ± 0·01	95 ± 2·0
1·5	17·1 ± 0·15	0·97 ± 0·02	4·2 ± 0·08	5·4 ± 0·19	1·25 ± 0·02	100 ± 0·0
2·0	18·9 ± 0·31	1·30 ± 0·03	3·8 ± 0·09	5·5 ± 0·08	1·33 ± 0·01	95 ± 3·0
2·5	20·8 ± 0·18	1·62 ± 0·01	3·6 ± 0·05	5·5 ± 0·09	1·38 ± 0·01	90 ± 3·0
TCZ	15·1 ± 0·40	—	—	4·5 ± 0·30	—	76 ± 5·0

[a] Diluted buffalo's milk.

[b] Normal buffalo's milk (corresponds to the control).

[c] The scoring was done for 4 h-incubated *zabadi* only.

TCZ, Typical commercial *zabadi* (Mehanna, 1981).

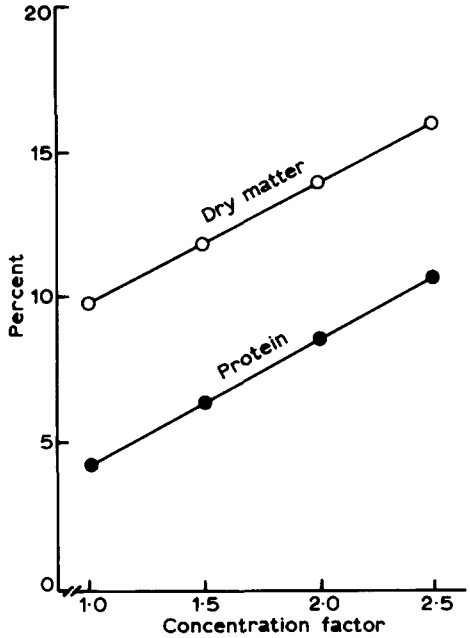

Fig. 2. The relationship between the concentration factor and dry matter or protein contents.

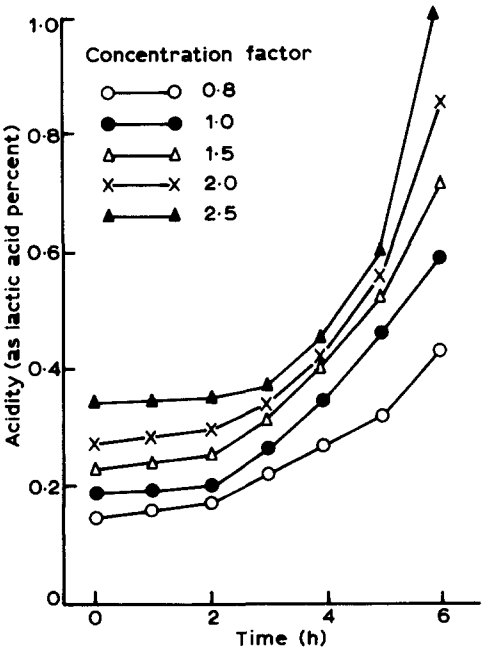

Fig. 3. Acidity development in *zabadi* as affected by the concentration factor of *zabadi* milk.

TABLE 2
The pH Value of *Zabadi* made from Buffalo's Milk with Different Concentration Factors (CF) during Incubation Period

Incubation period (*h*)	*CF of* zabadi *milk*				
	0·8[a]	*1·0*[b]	*1·5*	*2·0*	*2·5*
0	6·50 ± 0·03	6·45 ± 0·05	6·45 ± 0·04	6·30 ± 0·05	6·20 ± 0·04
1	6·30 ± 0·03	6·30 ± 0·04	6·30 ± 0·05	6·20 ± 0·05	6·15 ± 0·05
2	6·05 ± 0·04	6·05 ± 0·03	6·00 ± 0·03	6·15 ± 0·05	6·10 ± 0·03
3	5·18 ± 0·05	5·10 ± 0·05	5·15 ± 0·04	5·90 ± 0·03	5·75 ± 0·03
4	4·90 ± 0·05	4·90 ± 0·03	4·65 ± 0·04	5·60 ± 0·03	5·55 ± 0·05
5	4·60 ± 0·04	4·65 ± 0·03	4·40 ± 0·04	5·10 ± 0·04	5·50 ± 0·05
6	4·35 ± 0·04	4·35 ± 0·05	4·20 ± 0·05	4·95 ± 0·04	5·40 ± 0·04

[a] Diluted Buffalo's milk.
[b] Normal Buffalo's milk (corresponds to the control).

Schmutz & Puhan, 1979; Mehaia & Cheryan, 1983). It should be noted that the UF-process was conducted at a temperature of 50°C, at which the factor of bacterial multiplication is reduced to less than one (Maubois *et al.*, 1971).

It is noteworthy that the lower pH value (the higher acidity) was at zero time. This changed, either during, or at the end of, the incubation period, especially with increase in protein content, reflecting a buffering effect. Brule *et al.* (1974), Mocquot (1979) and Green *et al.* (1981) reported that concentration of milk by the UF-process increases the buffering capacity in retentate. Increase in the developed acidity, as a function of the incubation period, increased with the increase in dry matter of the *zabadi.* Similar observations in yoghurt were reported by Pulay & Krasz (1974), Hickey *et al.* (1983) and Renner & Eiselt-Lomb (1985).

Statistical analyses proved that all variances in either acidity or pH values of samples caused as a function of either the concentration factor or the incubation period were highly significant ($P \leq 0{\cdot}01$).

The results of our control are in agreement with those reviewed by El-Shibiny *et al.* (1977) and Fayed (1981) and in accordance with the commercial *zabadi* presented in the Cairo Governorate Market (Mehanna, 1981).

The UF-technique yielded *zabadi* with a better organoleptic quality, and the consistency of the *zabadi* was significantly improved ($P \leq 0{\cdot}05$) especially at the CF of 1·5, which had the best body. The unconcentrated milk gave a coagulum with a much lower firmness. On the other hand, a too-firm body resulted when the CF was increased more than 1·5. Moreover, the flavour of UF-*zabadi* was significantly better than that of *zabadi* made from either unconcentrated or diluted milk ($P \leq 0{\cdot}05$). The appearance of UF-*zabadi* did

not vary from that of the control but *zabadi* made from diluted milk had a lower appearance score.

Generally it could be concluded that a good sensory quality could be obtained when *zabadi* made from UF-buffalos milk had about 17% total solids (TS) (CF 1·5). Rasic & Kurmann (1978) and Tamime & Deeth (1980) reported that cow's milk needs to be concentrated to 18–20% TS by ultrafiltration to produce a good quality yoghurt. The lower TS content required in this study (17%) may be because the buffalo's milk normally has a protein content higher than that of cow's milk. Thus it is necessary to lower TS content when buffalo's milk is concentrated to produce UF-*zabadi.*

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