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Short Communication

Utilization of solar energy in dehydration of milk and in the manufacturing of Khoa

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The cow milk was standardized to 4.0 fat and 8.5 milk solid not fat (MSNF) to prepare khoa by solar as well as traditional method. The whole milk was divided into two parts. One kept as control, while the other was used for the preparation of khoa by solar dehydration method. Before the dehydration of milk in solar cooker, cream was separated from milk by using electrically operated cream separator. After dehydration period was over, the milk from each vessel was measured and took in *kadhai* (that is, Iron shallow pan). At the same time calculated quantity of cream (previously separated and pasteurized) added and further stirring cum scrapping process continued until desired body and texture of khoa were obtained. A uniform quality product in respect of flavor, body and texture, color and appearance, overall acceptability and chemical quality was obtained by solar method whereas slightly brown, grainy and with low moisture of the product were obtained by traditional method.

Key words: Solar method, traditional method*, basundi*, Khoa.

INTRODUCTION

Indigenous heat concentrated milk products are *basundi, rabri, khurchan* and *khoa.* Out of these products, khoa is produced on large scale. Out of total milk, produced 5.5% milk is used for khoa production (Chaterjee and Acharya, 1987). Khoa is partially dehydrated whole milk product. It serves as base material for preparation of variety of Indian concentrated dairy products that is, *pedha, burfi* and *gulabjanmun*. Indigenous heat concentrated products are produced in cottage industry by traditional practices without any consideration given to quality of milk and final product.

Hence, there is need to improve the method of production to ensure the quality of the products. The farmers use fire wood, dung cake, etc as source of energy for heat processing of milk product. This leads to deforestation, loss of dung which can be used as good source of farm manure, etc. In cities coal, kerosene and gas are used as sources of energy. Similarly for large scale production of these products, heat exchangers, vaporizers, etc are used which utilize huge amount of conventional energy for working. At this level major source of energy is electricity, coal or diesel, etc. it is now realized that fossil fuel of non renewable nature are gradually coming to an end by the beginning of the next century. Another concerning problem is air pollutions which is mainly due to fire wood, coal, fuel oil, etc. All above problems can be overcome if solar energy can be used as major source of non conventional energy. Solar energy with its endless origin and free from pollution may be the answer to the energy problems of the coming century. In the present work, a new approach is made to develop method for dehydration of milk by using solar energy (Figure 1) to produce the most popular and concentrated indigenous dairy product that is, khoa.

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MATERIALS AND METHODS

The standardized (4.0 Fat and 8.5 MSNF) cow milk were obtained from Doodh Pandhari Dairy Solapur. The whole milk was divided into two parts. One kept as control, while other part of milk was taken in solar cooker for the preparation of khoa. The solar cooker was used to judge whether it is possible to manufacture such a

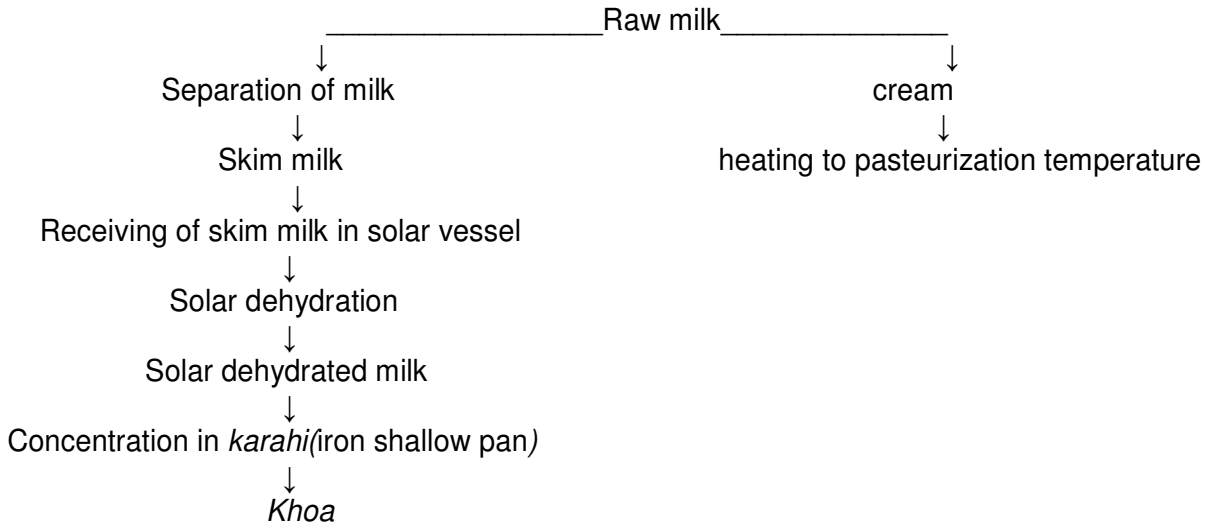

Figure 1. Flow diagram- Manufacturing of khoa using solar energy.

concentrated product or not. The dehydration of milk was done by using domestic solar cooker with one reflector. The two solar cookers marketed by Maharashtra Energy Development Agency (MEDA) with dimensions 56×49×19 cm^3 were used. Domestic type solar cooker consists of rectangular enclosure insulated on the bottom and sided and having two glass covers on the top. Solar radiations enters through the top and heats up the enclosures in which food to be cooked is placed in shallow vessels. The milk was separated by electrically operated cream separator. The required qualities of skim milk and cram were measured. Separation of milk avoids formation of skin above milk surface which facilitates evaporation.

The vessels containing milk were transferred to solar cooker in the morning at about 9 am and kept up to 4 to 5 pm. Small glass rods were kept horizontally on each vessels and lid was kept over it to facilitate the removal of vapors. Glass covers of solar cooker was closed and tightened by using adjustable screw. Solar has very small capacity, but the investigation was carried out to judge whether it is possible to prepare such concentrated dairy product on small scale. Finally solar cooker was set up by adjusting mirror with sun rays falling on the vessels. The position of solar cooker was changed as per position of the sun. Thermometer was kept inside cooker for recording temperature at hourly interval during solar dehydration of milk. The milk was dehydrated up to dough stage. After dehydration period was over the milk from each vessel was measured and took in *kadhai* (that is, Iron shallow pan). At the same time calculated quantity of cream (which was previously pasteurized) added and further stirring cum scrapping process continued till desired body and texture of khoa were obtained. Schematic flow diagram of solar dehydration process for manufacture of khoa is presented in following flow diagram (Figure 1), whereas control samples of khoa was prepared by traditional method as described by De (1980).

Sensory quality of khoa prepared by solar and traditional method

Sensory evaluation of khoa prepared by solar and traditional method was carried out by panel of six judges. They were evaluated for flavour, body and texture, color and appearance and overall acceptability. Nine point hedonic scales were used.

Chemical analysis

The khoa was prepared by solar dehydration method and traditional method were subjected to chemical analysis viz. moisture, fat, total solids and acidity as recommended by Indian standards (Sp: 18, part XI, 1981).

Statistical analysis

Statistical analysis of mean values was carried out as per, Steel and Torrie (1980). The experiment had 3 replications.

RESULTS AND DISCUSSION

Sensory evaluation of khoa prepared by solar as well as traditional method

Sensory score awarded by the judges were given in Table 1. There was no change in the original color of milk until *basundi* (condensed milk) stage in all replications. This was achieved because while dehydration of milk, there was uniform distribution of heat which prevented over heating of milk. After addition of cream, color was slightly changed to cream yellow in solar treatment; therefore judges awarded 8.4±0.21 score to color and appearance. Brown to slightly brown color at *basundi* (condensed milk) stage in conventional khoa making was recorded. This was due to drastic and uneven heat treatment. Joshi (1987) also reported superior quality of product by solar treatment. Flavor of khoa by solar method (before addition of cream) showed flat flavor. This might be due to the absence of fat during solar dehydration. Milk fat imparts rich and pleasing flavor, soft and smooth body and texture to both condensed and evaporated milk as pointed out by De (1980). After addition of cream to solar dehydrated milk the product

Table 1. Sensory evaluation of khoa prepared by solar and traditional method.

S/no	Method	Flavor (9)	Body and texture (9)	Color and appearance (9)	Overall acceptability (9)
1	Solar	8.1±0.81	8.0±1.25	8.4±0.21	8.2±0.33
2	Traditional	7.8±0.46	8.1±0.28	8.3±0.42	8.1±0.57

Mean values ± Standard deviation are based on 3 trials.

Table 2. Chemical composition of khoa prepared by solar and traditional.

S/no	Method	Moisture	Fat	Total solids	Acidity
1	Solar	37.10±34	15.27±10	62.00±11	0.54±06
2	Traditional	32.23±28	16.61±14	67.00±09	0.49±03

Mean values ± Standard deviation are based on 3 trials.

had registered slightly cream flavor (8.1±0.81). Flavor at *basundi* (condensed milk) stage by conventional method (7.8±0.46) was slightly cooked to nutty. Joshi (1987) observed superior flavor in sun treated milk products. The body and texture of khoa prepared by solar method had uniform surface with smooth texture and slight pasty therefore scored lower (8.0±1.25) than that of traditional method (8.1±0.28). The khoa prepared by solar dehydration appreciated by all the judges given more score (8.2±0.33) than the khoa prepared by traditional method (8.1±0.57) for the overall acceptability attribute. Joshi (1987) also reported that superior quality product was made by solar dehydration. The findings of present investigation corroborates with that of Mulley and Ladkani (1973) who reported that khoa prepared from homogenized milk was soft and light brown in color and superior than homogenized milk.

Chemical quality of khoa prepared by traditional and solar method

Chemical quality of khoa prepared by solar and traditional method is presented in Table 2. The moisture percentage (37.10±34%) in solar method is comparatively more (32.23±28%) on an average than that of conventional method. Therefore, it can be inferred that, the direct heat treatment in conventional method removed more moisture percentage in khoa. Dastur and Lakhani (1971), Ghodekar et al. (1974) Borade (1986) observed lowest moisture removal in their experiments. Khoa prepared by solar dehydration method showed 15.27±10% of fat while that of traditional method it observed 16.61±14%, it might be due to in traditional method more moisture evaporated due to uncontrolled heating therefore it leads to high percentage of fat. This happened with all constituents present in the khoa prepared by traditional and solar method. The highest titratable acidity (0.54±06) in khoa was observed in solar method and then followed by traditional method (0.49±03); it might be due that solar method required more time for dehydration therefore, might be responsible to increase the acidity of final product.

Conclusion

The following conclusions are made from the present investigation

1. More amount of moisture from the milk can be removed in conventional method than the solar method of dehydration.
2. Labor cost can be saved.
3. A high and uniform quality product in respect of color flavor, body and texture, color and appearance and overall acceptability can be obtained by solar method.
4. Atmospheric pollution can be minimized by using solar dehydration of milk.

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