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Effect of Breed and Method of Preparation on Yield of Goat Milk Mozzarella Cheese

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ABSTRACT

Keywords

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The study was conducted at Goat Products Technology Laboratory of Central Institute for Research on Goats, Makhdoom, Farah, Mathura, Uttar Pradesh and Department of Animal Husbandry and Dairying, R.B.S. College Bichpuri, Agra (U.P.). The goat milk samples were collected early in the morning after the goats were milked completely. The milk samples were analyzed for Fat, Protein, Lactose, Ash, Total Solids and Solids not fat content using Lacto Scan-Automatic Milk Analyzer. Fresh Jakhrana and Jamunapari goat milk was collected within 1.5-2 hour of milking from Livestock Units of Central Institute for Research on Goats, Makhdoom, Farah, Mathura (U.P.). The milk was strained through muslin cloth to remove the dirt. Startar Culture was obtained from National Collection of Dairy Cultures, NDRI, Karnal Haryana, India. The yield of mozzarella cheese made from Jakhrana and Jamunapari goat milk was found to be 10.935 ± 0.079 and 11.201 ± 0.084 respectively. Similarly the yield of mozzarella cheese made by direct acid, starter culture and modified method was found to be 10.853 ± 0.069 , 11.458 ± 0.093 and 10.894 ± 0.104 respectively. The overall average value of yield of goat milk mozzarella cheese was 11.068 ± 0.059 . The statistical analysis revealed that breeds of goat and methods of manufacture significantly affected yield of mozzarella cheese.

Introduction

Cheese manufacture is one of the classical examples of food preservation, dating from 6000 – 7000 BC. Cheese exploits two classical principles of food preservation, i.e. lactic acid fermentation and reduction of water activity through removal of water and addition of NaCl. Establishment of low redox potential and secretion of antibiotics by starter microorganisms contributes to the storage stability of cheese. The biomedical superiority has not been promoted widely in marketing of goat milk, goat yoghurt and goat cheeses, but

has great potential in justifying the uniqueness of goat milk in human nutrition and medicine (Babayan, 1981; Haenlein, 1992) for treating various gastrointestinal disorders and diseases, besides its value in alleviating cow milk allergies.

This includes milk and cheese in northern countries and meat production in countries in the tropics and subtropics. Systems of goat production differ around the world. In the tropics, extensive systems prevail and depend

on grazing of natural range. This depends mainly on diversification and on subsistence activities, the herd composition and the mobility of the herds (Aich *et al.*, 1999).

Much interest has not been shown to produce hard variety cheese from goat milk as it forms soft and fragile curd which poses technological difficulties (Lacasa, Godina, 1986). However, goat milk is the property item for a few varieties of soft and semi hard cheese which are being marketed as premium cheese in many European countries and in Middle East. Interestingly, goat milk cheese established a potential market even in western countries. The greater proportion of medium chain fatty acids present in goat milk offers these premium cheese a sharper flavour for which they have been recognized (Anifantakis, 1986). The gross composition of goat milk appears to be close to that of cow milk. Fat globules in goat milk are smaller (less than 3 microns) than those in cow milk; but lipid composition and properties of globule membrane at both species are quite similar Jenness (1980). The distribution of lipids in goat milk is like that of cow milk.

Attaie and Richter (2000) determined the goat milk fat globule size by laser size particle analysis. Individual globule of fat in milk ranged from 0.73 to 8.58 μ m in diameter. The specific surface area of particle in caprine milk was 21,778 cm²/ml, where as the specific surface area of particle in bovine milk was 17,117cm²/ml.

A study on FFA and amino acids in goat milk cheese revealed that both FFA (Caproic, butyric, caprylic acids) and amino acids (glutamic acid, leucine, lysine, valine) increase during months ripening (Baltedjieva *et al.*, 1985). Interestingly goat milk casein was observed to yield less bitter peptide than those of other milk. The lower bitterness in goat milk cheese was attributed to the absence

of α ₁-casein in the goat milk system (Pellisser and Manchon, 1976).

Goat milk cheese was found to have a mild, pleasant and well accepted flavour and waxy smooth and mellow body and texture characteristics. These had the chemical and microbiological activities similar to that of cow milk cheese (Rathore, 1983).

Cheese is a fermented milk product. Technology of fermentation has occupies a place of pride in the food preservation practices since time memorial. Fermented milk products have been reported to have therapeutic, anticholesterolmic, anticarcinogenic and anticariogenic properties. Since it is a fermented product, the off flavour character of goat milk disappears completely. Mozzarella variety of cheese being used most often due to the increased popularity of pizza (International Dairy Foods Association, 2003). The ability of cheese to be cut, sliced, diced or cubed into various shapes, grated, ground and dried offers more versatility for cheese to be used in various cuisines and food application.

Goat milk had a shorter rennet coagulation time than in cow milk (Remuf and Lenoir, 1987; storry *et al.*, 1983; Rathore, 1983), which could be due to higher β -casein and lower α _s-casein, larger micelle size and higher mineralization level. Storry *et al.*, (1983) reported that rennet coagulation time is negatively correlated with β -casein & total calcium content and positively with α _s/ β -casein ratio.

Coagulum strength is strongly related to total casein concentration, but is unaffected by total fat content or by casein/ fat ratio. However, goat milk has consistently lower curd strength than cow milk despite having similar quantity of casein smaller micelle size give rise to firmness curd than larger micelles,

at same total casein concentration (Grandison, 1986). This could be the reason for weaker curd in goat milk, which has larger micelle casein as compared to cow and buffalo milks. Curd firmness was also dependent on proportion of α_S -casein (Grandison *et al.*, 1985), which was less in goat milk as compared to β -casein. Jairam *et al.*, (1980) and Garnot *et al.*, (1981) reported that fat content of milk had little effect on curd strength.

The specific gravity content and fat percentage in the milk of Jakhrana as well as Jamunapari goat breeds under farm rearing conditions was significantly higher than that of field rearing conditions. It is due to better feeding in farm rearing conditions but the protein, lactose, ash, total solids and solids-not-fat in the milk of Jakhrana as well as Jamunapari goat breeds under field rearing conditions were higher than that of farm rearing conditions (Singh and Sharma, 2013).

The conventional method of Mozzarella preparation using rennet is expensive and requires longer time for its preparation. Use of direct acidification method has been popular, since the Mozzarella cheese prepared by this method properly. But it reduces the manufacturing time only to some extent. The present study has been undertaken to reduce the manufacturing time of Mozzarella cheese and to produce rennet free Mozzarella cheese in order to reduce the cost of manufacturing.

A modified method for preparation of Mozzarella cheese was developed to eliminate the use of costly rennet and the maintenance of specific cultures in addition to considerable reduction in the manufacturing time. The process involved pasteurization of goat milk, coagulation using citric acid solution, temperatures manipulation and stretching etc. Therefore, the study has been planned with the following objectives:

Effect of breed and method of preparation on yield of goat milk mozzarella cheese

Methodology

The study was conducted at Goat Products Technology Laboratory of Central Institute for Research on Goats, Makhdoom, Farah, Mathura, Uttar Pradesh and Department of Animal Husbandry and Dairying, R.B.S. College Bichpuri, Agra (U.P.).

Fresh Jakhrana and Jamunapari goat milk was collected within 1.5-2 hour of milking from Livestock Units of Central Institute for Research on Goats, Makhdoom, Farah, Mathura (U.P.). The milk was strained through muslin cloth to remove the dirt.

Analysis of milk samples

The goat milk samples were collected early in the morning after the goats were milked completely. The milk samples were analyzed for Fat, Protein, Lactose, Ash, Total Solids and Solids not fat content using Lacto Scan-Automatic Milk Analyzer.

Startar Culture was obtained from National Collection of Dairy Cultures, NDRI, Karnal Haryana, India. Meito: Microbial rennet produced by *Mucor pusillus* Var. Lindt., Tokyo, Japan and used at the rate of 1g/100 l of milk. Commercial grade TATA fine salt was used. Calcium chloride was obtained from Qualigens fine chemicals, Glaxo India Ltd. Mumbai. Sodium citrate was obtained from Ranbaxy Laboratories L.td., Chemical division, SAS Nagar. 90% Gerbers sulphuric acid of specific gravity 1.84 was obtained from S.D. Fine chemical L.td. Mumbai. Amyl alcohol for milk testing of Ranbaxy laboratories L.td. SAS Nagar was used. All the chemicals and biological reagents were of analytical grade and were procured from Bangalore Genei; Hi-Media; SRL Pvt. Ltd.,

RFCL limited, Glaxo, Qualigens; Fisher chemicals, Sigma chemicals, SD Fine chemicals etc.

Glass wares / Plastic wares

The glass wares/plastic wares (bottles, glass plates, conical flasks, glass pipette, beakers, measuring cylinder, test tubes, micro pipettes, polythene bags, centrifuge tubes, Crucible, Kjeldahl flask and blue cap bottles etc.) used in present study, were procured from reputed manufacturers (Axygen, Nunc, Tarson, Borosil and ASGI).

Manufacture of Mozzarella Cheese

Fresh goat milk used for cheese preparation was standardized to 3.5% fat and 8.5% solids-not-fat (SNF). Cultures of *Streptococcus thermophiles* and *Lactobacillus bulgaricus* and rennet were procured from the Dairy Microbiology Division, National Dairy Research Institute, Karnal. The chemicals used were of analytical grade.

Methods of Mozzarella Cheese preparation

In each trial, three types of mozzarella cheese were prepared by Direct Acid Method, Starter Culture Method and Modified Method using 4 litres of milk for each type of cheese and were replicated 5 times.

Standardization of milk

Standardization of milk was done by addition of skim milk or cream with higher or lower fat percentage. Sometimes the addition of skim milk will do to solve the problem. It is necessary to find the relative amount of the original material and the standardizing material to be mixed together to give a product with the desired fat content. Once these relative proportions have been determined, it is easy to calculate the exact

amount of each which must be mixed together to give the exact amount of standardizing material. The “Pearsons square” method used to find the relative quantities of the material involved in a standardizing problem.

Procedure for Direct Acid Method

Mozzarella cheese was made from goat milk using Direct Acid Method as described by Pal and Agnihotri, 2000.

Procedure for Starter Culture Method

Mozzarella cheese was prepared using 3.00-4.00 litres of milk in each batch following the methods described by (Pal and Agnihotri, 2000) with slight modifications. Goat milk was pasteurized by the holding method (63°C for 30 minutes) and cooled to 35°C Calcium chloride @ 0.02% was added to milk Add starter culture (*S.thermophilus* and *L.bulgaricus* in the ratio of 1:1) collected from National Collection For Dairy Cultures, NDRI, Karnal. was added at the rate of 2% for 90 minute to achieve pH 5.4. Rennet (Meito Sangyo Co. Ltd., Tokyo, Japan) was added at the rate of 1.0g/100 l of milk and content kept for 45 minutes. The rennet was diluted 40 times with water before addition. After setting the curd was cut and left undisturbed for 10 minute. The curd was then heated gradually with continuous stirring till the curd became slightly hard. The cooking temperature was raised to 38-47°C slowly and curd was cooked at this temperature till firm. The whey was drained off completely, after which the curd was immersed in hot water at 83-84°C. After about a minute, the curd was kneaded, stretched and moulded for proper body and texture development. The hot plastic mass was moulded into ball and then immersed in brine solution (20% v/w) at 4±1°C. The cheese was taken out from the brine after 3 h and dried. Weight was taken and yield on milk weight basis was recorded. Three trials

were conducted. The product was evaluated for sensory, microbiology and physicochemical parameters.

Yield of mozzarella cheese was recorded and expressed in percentage. Statistical analysis was carried out with the two way RBD (Randomised Block Design) computer statistical programme to see the effect of breed and method of manufacture and their interaction on different quality traits of cheese.

Results and Discussion

The data obtained on effect of breed and methods of preparation on yield of goat milk mozzarella cheese are presented in Table - 1.

It is observed from Table - 1 that the yield of mozzarella cheese made from Jakhrana and Jamunapari goat milk was found to be 10.935 ± 0.079 and 11.201 ± 0.084 respectively. Similarly the yield of mozzarella cheese made by direct acid, starter culture and modified method was found to be 10.853 ± 0.069 , 11.458 ± 0.093 and 10.894 ± 0.104 respectively. The overall average value of yield of goat milk mozzarella cheese was 11.068 ± 0.059 . The interaction between different breeds and methods of manufacture are also presented in above table.

The statistical analysis (Table-2) revealed that breeds of goat and methods of manufacture significantly affected yield of mozzarella cheese. The yield was observed significantly higher in cheese made from Jamunapari goat milk than Jakhrana goat milk. Similarly higher yield of mozzarella cheese was obtained in case of starter culture method followed by modified and direct acid method. The methods of preparation of mozzarella cheese had no significant influence on yield of mozzarella cheese and the values are

comparable with the published reports (Kosikowski, 1982). It is possible that similar amount of fat losses in whey and moisture content gave rise to similar yield values by the three methods of manufacturing.

The statistical analysis revealed that breeds of goat and methods of manufacture significantly affected yield of mozzarella cheese. The yield was observed significantly higher in cheese made from Jamunapari goat milk than Jakhrana goat milk. Similarly higher yield of mozzarella cheese was obtained in case of starter culture method followed by modified and direct acid method.

Agrawal and Bhattacharya (1978) recorded the yield and composition of milk of Black Bangal, Barbari and Black Bangal \times Barbari nannies for 90 days from day 7 to 97 of lactation period. The average daily milk yield in Black Bangal, Barbari and their crosses was 3.44, 4.2, 665.76 and 564.68 g respectively. The mean percentage of milk constituents of Black Bangal, Barbari and cross-bred nannies were respectively: total solids, 15.23, 12.66 and 14.29; fat 4.66, 3.83 and 4.92; protein 5.84, 4.13 and 5.07; lactose 4.40, 4.44 and 4.42; and ash 0.77, 0.72 and 0.87.

Kosikowski (1982) reported that the average yield of commercial Mozzarella cheese is 11.5% containing 53.6% moisture made from 3.0 of fat cow milk cheese yield and fat content were significantly higher when buffalo milk alone was used (Bonassi *et al.*, 1982).

Ghosh (1987) also reported that yield of buffalo milk cheese is 14.98% where as that of cow milk cheese is 12.4% the cow milk cheese contained slightly higher level of moisture; fat and salt, when as buffalo milk cheese had higher protein and ash.

Table.1 Effect of breed and method of preparation on yield of goat milk mozzarella cheese

MEAN & S.E. FOR BREED NO. 1	10.935	0.079 (45)
MEAN & S.E. FOR BREED NO. 2	11.201	0.084 (45)
MEAN & S.E. FOR METHOD NO. 1	10.853	0.069 (30)
MEAN & S.E. FOR METHOD NO. 2	11.458	0.093 (30)
MEAN & S.E. FOR METHOD NO. 3	10.894	0.104 (30)
MEAN & S.E. OVER ALL	11.068	0.059 (90)
MEAN & S.E. FOR BREEDNO.1 x METHOD NO. 1	10.903	0.024 (15)
MEAN & S.E. FOR BREEDNO.1 x METHOD NO. 2	11.311	0.138 (15)
MEAN & S.E. FOR BREEDNO.1 x METHOD NO. 3	10.592	0.145 (15)
MEAN & S.E. FOR BREEDNO.2 x METHOD NO. 1	10.803	0.136 (15)
MEAN & S.E. FOR BREEDNO.2 x METHOD NO.2	11.605	0.116 (15)
MEAN & S.E. FOR BREEDNO.2 x METHOD NO.3	11.197	0.105 (15)

Note: Figure in parenthesis indicated number of observations.

Table.2 Analysis of Variance

SOURCE OF VARIATION	D.F.	S.S.	M.S.S.	F-VALUE	REMARK
1 BETWEEN BREED	1	1.592	1.592	7.043	H.SIG. 1%
2 BETWEEN METHOD	2	6.859	3.429	15.171	H.SIG. 1%
3 ERROR	86	19.441	0.226	-----	
TOTAL	89	27.891			

NO.OF OBS. SE CD AT 5% CD AT 1%

BETWEEN TWO BREED NO.1	2	45	45	0.100	0.205	0.276
BETWEEN TWO METHOD NO.1	2	30	30	0.123	0.251	0.338
BETWEEN TWO METHOD NO.1	3	30	30	0.123	0.251	0.338
BETWEEN TWO METHOD NO.2	3	30	30	0.123	0.251	0.338

Demott (1983) studied that yield of Mozzarella cheese made by adding station culture and direct acid and observed that the cheese made by adding starter culture gave higher recovery of fat protein and total solids

than that made by direct acid, in both fresh and recombined milk. Rottigni and Batello (1989) reported that yield of 'pasta filata' cheese such as Mozzarella increased by 0.1 to 0.2% when freeze dried *S. thermophilus*

cultures were used for direct inoculation into the vat. Sabikhi and Kanawjia (1992) reported that yield of Mozzarella cheese prepared from direct acidification method from goat milk was 11.80 %.

Pal and Agnihotri (2000) observed 12.27 % yield of Mozzarella cheese manufactured from pure goat milk by direct acid method.

In conclusion, the statistical analysis revealed that breeds of goat and methods of manufacture significantly affected yield of mozzarella cheese. The yield was observed significantly higher in cheese made from Jamunapari goat milk than Jakhrana goat milk. Similarly higher yield of mozzarella cheese was obtained in case of starter culture method followed by modified and direct acid method.

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