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COMPARISON OF MOZZARELLA CHEESE: PREPARED FROM BUFFALO MILK BY STARTER CULTURE AND DIRECT ACIDIFICATION TECHNIQUES

IZHAR H. ATHAR AND MUHAMMAD ANWAR*

Animal Sciences Institute, National Agricultural Research Centre,Park Road, Islamabad, Pakistan

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The starter culture technique (SCT) and direct acidification technique (DAT) were used for preparation of Mozzarella cheese from buffalo milk. The results indicated that there were significant differences ($P < 0.05$) in the constituents of cheese and whey obtained by SCT and DAT except in ash of cheese and in protein of whey. Higher cheese yields were obtained by using SCT as compared to DAT and the difference in cheese yield was significant ($P < 0.05$). However, organoleptic evaluation indicated that cheese prepared by DAT was liked more as compared to SCT.

Key words: Mozzarella cheese, Buffalo milk, Starter culture, Acidification technique.

Introduction

Buffalo and cow milk although composed of similar constituents, yet distinctly differs in the level of different constituents [1]. Due to difference in composition and chemical make-up of the major constituents, the technique of preparation of various type of hard cheese from buffalo milk posed problem [2,3]. Upadhyay *et al.* [3] reported that since cow milk is the main source of milk supply in Western countries, methods for mozzarella cheese has been standardized for cow milk. The average composition of 120 samples of mozzarella cheese revealed that it contains 47.3% moisture, 42.9% fat in dry matter, 1.3% NaCl and 3.0% ash [4]. Mozzarella cheese prepared with starter culture and direct acidification technique from buffalo milk contained 53.37 and 53.59% protein, 0.44 and 1.28% lactose and 2.52 and 2.54% ash including 1.27– 1.25% NaCl respectively [3].

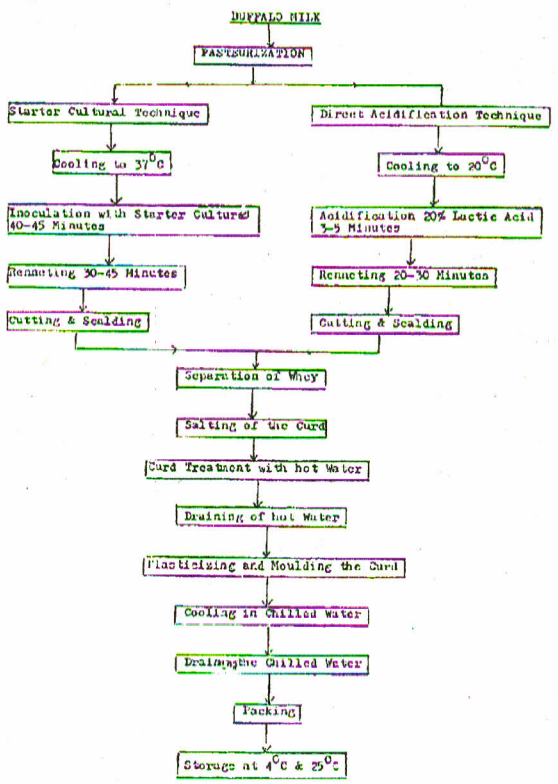
Mozzarella cheese is traditionally made from high fat milk of the water buffalo in Italy. In its natural state, it is used as fresh and is favourite for its place in cooking, particularly as topping the meat dishes and layering the pizza pie. Now a days with the introduction of fast foods system it is becoming popular in developing countries [3,5,6].

Buffalo milk occupies a significant place in term of production and processing in Pakistan. It contributes more than 70 % of the total milk produced in the country [7]. Indigenous cheese is prepared by primitive method on small scale in NWFP and Northern Areas where it is mostly used as an ingredients in cooking the meat and vegetables [8]. Direct acidification process (DAP) and starter culture process (SCP) were studied to improve the technique for indigenous cheese preparation. It was found that cheese prepared by DAP was more acceptable as compared to SCP [9].

Keeping in view these facts, the direct acidification and starter culture techniques were applied in the study for preparation of mozzarella cheese from buffalo milk with the aim to compare these two techniques in respect of chemical composition, yield recovery and preference of mozzarella cheese.

Materials and Methods

Eight liters of buffalo milk was pasteurized at 62° for 30 mins in stainless steel container and divided into two equal portions for making Mozzarella cheese by using two different techniques with seven replicates. Each technique is depicted in flow diagram. The same is detailed below:



Flow diagram for Mozzarolla cheese preparation using starter culture and direct acidification technique.

* Asian Network for Biotechnology in Animal Production and Health, Animal Sciences Institute, National Agricultural Research Centre, Park Road, Islamabad.

(i) Starter culture techniques. Four liters of pasteurized milk was taken in stainless steel sanitized container and cooled down to 37° before adding 2% *starter culture (consisting of *Streptococcus thermophilous* and *Lactobacillus bulgaricus* in equal proportion) after half an hr. The liquid **rennet was added at the rate of 0.2 ml/liter and mixed thoroughly. The coagulum (gel) thus obtained within 30-45 mins was cut and scalding was done by gradually raising the temperature of the curd to 40°. The curd and whey was held at this temperature with intermittent stirring for a period of about 1 to 1-1/2 hr to decrease the pH upto 5.2. The curd and whey was separated. The curd was salted by dry salting methods as followed in cheddar cheese making [6]. In this method, though loss of salt occurs in moulding water, yet is preferred in lieu of bringing the cheese at the end as it ensures uniform distribution of salt in the cheese. To compensate the loss of salt a little higher rate of salting was done. The salt (NaCl) was added at the rate of 1.5–2.0% in the curd. After about 5 mins, the salted curd was plasticized by treating with boiling water. Sufficient quantity of boiling water was added to cover the curd and a contact time of about 4-5 mins was allowed. Hot water was removed completely and plasticized the hot curd manually with a wooden worker by giving it angular motion till the curd gained elasticity. The curd was moulded in rectangular slabs by placing the hot curd in a suitable size hoops. The moulded cheese was dipped in pasteurized chilled water at about 4-5° for 1 to 1 and 1/2 hr. Cheese was removed from chilled water and placed on stainless steel wire mesh at 10° for about 2 hrs or until the dripping of water has practically stopped. Hence mozzarella cheese obtained was packed in clean, sanitized polyethylene bags and stored in at 5° and 25° for further keeping quality evaluation.

(ii) Direct acidification technique. Four liters pasteurized milk was taken in sanitized stainless steel container. Before adding the rennet, the temperature of milk was adjusted to 20° and pH decreased to 5.0–5.1 by adding gradually 10% (w/v) *lactic acid with agitation. Then **rennet was added at the rate of 0.20 ml/liter of milk and mixed thoroughly. The coagulum (gel) was obtained within 30-35 mins. During setting, the tempeature of milk was gradually increased from 20–30°. The gel was cut and stirred gently after 5 mins. Then cooking was started. The temperature raised upto 37° should accomplished gradually in 30 mins with constant agitation. After cutting and scalding the curd, the rest of the steps of preparation of mozzarella cheese were identical to those described under starter culture technique. The most of parameters followed in both techniques for preparation of studies conducted by earlier worker [3,10,11]. Cheese was weighed, sampled and stored at 5° and 25° for further evaluation. Samples of milk, cheese and whey were analysed for total solids, total protein, fat and ash by official methods of analysis [12]. Curd protein was determined in accordance with the procedure of Mickelson [13]. Lactose content was determined by difference. Each sample of cheese was evaluated by panel of 7 judges (from the scientific staff of Animal Sciences Institute) on hedonic scale (1–10) for flavour/taste and body/texture and given score for each attribute of sample. Statistical analysis of the data was carried out using analysis of variance technique and comparison mean difference was made by applying t-test [14].

* Isolated from indigenous yoghurt and propagated in skim milk media (11% total solids) in Dairy Technology Lab. Animal Sciences Institute, NARC, Islamabad.

** Calf Rennet (Single Strength extract) Marschall Division Miles Laboratories, Madison Ltd. WI. USA.

\+ Commercial Food Grade

++ Calf Rennet, Marschall Division, Miles Laboratories Madison, WI, USA.

Results and Discussion

Milk composition. The chemical composition of buffalo milk used in the study for 7 replicates is given in Table 1. The composition indicated that milk contained 6.15% fat, 15.28% total solids, 3.7% protein , 4.7% lactose and 0.74% ash . As the level of constituents of milk significantly accounts for variation in cheese composition [9], therefore, in this study same composition of buffalo milk was used in both the techniques for preparation of mozzarella cheese.

Mozzarella cheese composition. Average chemical composition of mozzarella cheese prepared in this study is presented in Table 2. The results showed that mozzarella cheese prepared with starter culture techniques contained higher total solids, total protein and ash, whereas fat content and lactose was comparatively lower than the cheese obtained from direct acidification technique. The possible reason for the low contents of lactose in starter culture techniques was conversion of

TABLE 1. COMPOSITION OF BUFFALO MILK USED IN PREPARATION OF MOZZARELLA CHEESE.

Replicate	Moisture (%)	Total solids (%)	Fat (%)	SNF (%)	Protein (%)	Lactose (%)	Ash (%)
1.	84.47	15.53	6.2	9.33	3.8	4.6	0.73
2.	86.68	15.32	6.1	9.22	3.7	4.8	0.72
3.	84.66	15.34	6.2	9.14	3.7	4.7	0.74
4.	84.57	15.43	6.3	9.13	3.6	4.8	0.73
5.	84.96	15.04	6.0	9.04	3.8	4.5	0.74
6.	84.85	15.15	6.2	8.95	3.6	4.6	0.75
7.	84.86	15.14	6.1	9.04	3.7	4.6	0.74
Average	84.72	15.28	6.15	9.12	3.7	4.7	0.74
standard error	±0.07	± 0.07	± 0.38	± 0.05	±0.03	±0.05	±0.004

lactose to lactic acid during curd formation [3]. Lower fat might be due to more fat separation in SCT during treating the curd with hot water and could be due to the recovery of skim milk starter solids in cheese. The significant differences ($P < 0.05$) were observed among the constituents of mozzarella cheese obtained from SCT and DAT except for ash content. Almost similar observations were made by Upadhyay *et al.* [3] and Athar *et al.* [9].

Whey composition. The average composition of whey is shown in Table 3 which revealed that total solids, fat, total protein, lactose and ash contents were higher in whey than that resulted from cheese, prepared with direct acidification techniques. There was significant difference in the whey resulting in 2 techniques in respect of all the constituents except total protein contents. The non-significant difference in total protein contents of whey obtained from SCT and DAT indicated that there were less chances of loss of fine particles of curd in the whey obtained from both techniques. However, high total solids in whey obtained from DAT showed more loss of cheese constituents in whey that ultimately effect on the yield of cheese. The results substantiate with the results of other researchers [3,9,15,16].

TABLE 2. AVERAGE CHEMICAL COMPOSITION OF CHEESE PREPARED FROM BUFFALO MILK USING S. CULTURE AND D. ACIDIFICATION TECHNIQUES.

Constituents (%)	B (SCT)	C (DAT)	D (XD)	E (SD)	t (value)
Total solid	47.00	46.00	0.442	0.273	2.240**
Fat	22.41	22.61	0.194	0.091	5.642**
Total protein	21.14	20.10	1.034	0.174	15.738**
Lactose	0.86	1.19	0.331	0.139	6.373**
Ash	2.59	2.53	0.007	0.390	0.523^{NS}

A. Of 7 Replicates, B. Starter culture, C. Direct acidification technique, D.Mean of difference, E.Standard deviation of difference.

TABLE 3. AVERAGE CHEMICAL COMPOSITION OF WHEY RESULTING FROM PREPARATION OF CHEESE USING S. CULTURE AND D. ACIDIFICATION TECHNIQUES.

Constituents (%)	B (SCT)	C (DAT)	D (XD)	E (SD)	t (value)
Total solid	7.18	7.46	0.281	0.186	4.014**
Fat	0.96	1.04	0.079	0.039	5.310**
Total protein	0.67	0.70	0.033	0.121	0.717^{NB}
Lactose	4.94	5.05	0.114	0.063	4.750**
Ash	0.61	0.67	0.063	0.029	5.727**

A. Of 7 Replicates, B.Starter Culture, C.Direct Acidification Technique, D.Mean of Difference, E.Standard Deviation of Difference.

Mozzarella cheese yield. Average yield is represented in Table 4. It was calculated on basis of kilogram cheese (50% moisture) per 100 kg of milk and expressed in percentage. Mozzarella cheese production ranges from 15.15–17.20% in case of starter culture technique and from 15.12–16.20% by direct acidification technique.

TABLE 4. MOZZARELLA CHEESE YIELD (%) DERIVED FROM BUFFALO MILK USING SC AND DA TECHNIQUES.

	S.C.T.*			D.A.T.		
Yield ranges (%)	15	15-17	20	15	12-16	20
Average yield (%)		16.25			15.56	
XD			0.687			
SD			0.097			
t value			18.568**			

XD =Mean of difference, SD = Standard deviation of difference,
* =This includes mass of starter culture also.

The results indicated that more mozzarella cheese was obtained from starter culture technique and difference between both the techniques was highly significant ($P > 0.05$). Yield of cheese might be influenced by addition of skim milk starter in SCT., composition of milk, pre-heat treatment employed and losses of milk constituents in whey, hot water and molding water[3, 9, 15, 16].

Sensory evaluation and keeping quality of mozzarella cheese. The panel of 7 judges indicated that mozzarella cheese prepared from starter culture technique has smooth, shining and soft body and texture whereas cheese prepared by direct acidification technique was waxy* less shining with firm body and texture. Such results were also reported by Scot [5] and Lelievre *et al.* [17]. The keeping quality of cheese was found satisfactory at 5° except the hardness of surface during storage of 14 days whereas at 25°, it remained good organoleptically for 4 days only. Cheese obtained by direct acidification technique was more acceptable as compared to starter culture technique on the basis of organoleptic test which revealed that preference of 60% recorded in case of cheese prepared by DAT and 40% in case of cheese obtained in using SCT. The results are in line with the findings of other workers [18,19[.

On the basis of results obtained in this study, it is recommended that procedure of indigenous cheese preparation can be improved and replaced through applying the techniques of mozzarella cheese preferably direct acidification on cottage scale in the country particularly in North West Frontier Provinces (NWFP) and Northern Areas.

* When worked between the fingers, molds well like wax with no indication of cracking/breaking loosening etc.

References

1. N.C. Ganguli, Report on Chemistry of Buffalo Milk, Pub. No. 143, NDRI, ICAR. Karnal, India (1978).
2. M.R. Srinivasan and S.D. Burde, Publication-85, NDRI, ICAR. Karnal, India (1979).
3. K.G. Upadhyay, G.C. Patel, M.N. Vaghela and M. Ravi Sunder, Indian Dairyman, **38**, 10 (1986).
4. T.Z. Schiftan and I. Komatsu, Dairy Sci. Abst., **42** (5), 3073, (1980).
5. R.I. Scot, *Cheese Making Practices* (Applied Sci. Publishers Ltd., London, UK, 1988).
6. F.V. Kosikowski, *Cheese and Fermented Milk Foods*, (Booktondale, New York, 14817-0139, 1982), 2nd ed.
7. S.M. Anjum, L. Kamil and A.A. Raza, Special Report, Series: 14 EAN/USAID Islamabad (1989).
8. I.H. Athar and T. Masud, J.A.H.P., 9(1-2), (1989).
9. I.H. Athar, T. Masud and A. Ali, Pak. j. sci. ind. res., **32**(5), (1989).
10. E. Parente, F. Villane, R. Coppola and S. Coppola, Dairy Sci. Abst., **52**(3), 1913 (1990).
11. D.C. Shukla and B.C. Ladkani, Dairy Sci. Abst., **52** (10), 7102 (1990).
12. *Official Methods of Analysis* (Assoc. Offic. Agri. Chem. Washington D.C. USA., 1984), 14th ed.
13. R. Mickelson, Contribution No. 903, Dept. Dairy and Poultry Sci. (Kansas State University, Manhattan, KS (1974).
14. R.G.D. Steel and J.H. Torrie, *Principles and Procedures of Statistics* (McGraw Hill Book Co. Inc., New York, 1980).
15. M.P. Thompson, Dairy Sci. Abst., **41** (4), 1740 (1979).
16. W.M. Breene, W.V. Price and C.A.J. Ernstrom, Dairy Sci., **47**, 1173 (1964).
17. I. Lelievre, R.R. Shaker and M.W. Taylor, J. Soc. Dairy Tech., **43** (1), 21 (1990).
18. M. Nagesware Rao, B.V.R. Rao and T.J. Rao, Indian J. Dairy Sci., **37**(1), (1984).
19. H.R. Covacevich and F.V. Kowsikowski, J. Dairy Sci., **58**, 701 (1978).