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ORIGINAL ARTICLE

Compositional and textural properties of goat's milk cheese prepared using *dahi* (yogurt) as the starter culture

Composição e propriedades de textura de queijo de leite de cabra preparado usando dahi (iogurte) como starter

Umair Shabbir[1]*, Nuzhat Huma[1], Ahsan Javed[2]

[1]University of Agriculture, National Institute of Food Science and Technology, Faisalabad - Pakistan
[2]Government College University, Institute of Home and Food Sciences, Faisalabad - Pakistan

***Corresponding Author:** Umair Shabbir, University of Agriculture, National Institute of Food Science and Technology, +38000, Faisalabad - Pakistan, e-mail: umair336@gmail.com

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Abstract

This study aimed to develop goat's milk cheese to conserve the major milk constituents. Household *dahi* (yoghurt) is an inexpensive source of starter cultures that contains several types of microorganism of which most are thermophilic in nature and can be used in the production of goat's milk cheese. Different concentrations of *dahi* (0.5%, 1.0%, 1.5%, 2.0% and 2.5%) were used to prepare the cheeses following the standard procedure for cheese manufacturing. The cheeses were analysed for their physicochemical, textural and organoleptic parameters. The highest yield was recorded for $T_{1.0\%}$ (17.33%) and the lowest for $T_{2.5\%}$ (15.58%). Significant ($p < 0.05$) differences were found for the pH, acidity and moisture content of the different goat's milk cheese samples. The moisture content was highest in $T_{0.5\%}$ (59.30) and lowest in $T_{2.5\%}$ (52.20). The texture profile was significant ($p < 0.05$) for firmness, adhesiveness, gumminess and chewiness between the treatments. The sensory scores indicated that $T_{1.0\%}$ was preferred by the panellists, followed by $T_{1.5\%}$ and then the other treatments. It was concluded that goat's milk cheese could be prepared with good quality characteristics using 1% *dahi* as the starter culture.

Keywords: Cheese; Concentration; Inexpensive; Milk; Texture profile; Organoleptic.

Resumo

Este estudo visou desenvolver queijo de leite de cabra para preservar os principais constituintes do leite. *Dahi* (iogurte) feito em casa é uma fonte barata de culturas do tipo starter que contém vários tipos de microrganismos, a maioria dos quais são termofílicos e podem ser usados para produzir queijo de leite de cabra. Concentrações diferentes de *dahi* (0,5%, 1,0%, 2,0% e 2,5%) foram usadas para preparar os queijos, seguindo o procedimento padrão para a fabricação de queijo. Os queijos foram analisados quanto a parâmetros físico-químicos, texturais e organolépticos. O rendimento maior foi registrado para $T_{1,0\%}$ (17,33%) e o menor para $T_{2,5\%}$ (15,58%). Diferenças significativas ($p < 0,05$) foram encontradas entre as diferentes amostras de queijo de leite de cabra para o pH, a acidez e a umidade. A umidade foi mais alta para $T_{0,5\%}$ (59,30) e mais baixa para $T_{2,5\%}$ (52,20). O perfil de textura foi

significativo (p < 0,05) entre os tratamentos para firmeza, adesividade, gomosidade e mastigação. As notas sensoriais indicaram $T_{1,0\%}$ como sendo a amostra preferida pelos provadores, seguida por $T_{1,5\%}$ e os outros tratamentos. Foi concluído que queijo de leite de cabra pode ser preparado com boas características de qualidade usando-se 1% de *dahi* como a cultura tipo starter.

Palavras-chave: Queijo; Concentração; Baixo custo; Leite; Perfil de textura; Organoléptico.

1 Introduction

The livestock and agricultural sector has a great impact on the economy of countries, by combating the nutritional needs of the people. The agricultural economy of various countries, especially France, Spain and Greece, is highly dependent on the goat population. The goat population and goat's milk production increased 69% and 86%, respectively, in the world from 1991 to 2014 (Food and Agriculture Organization of the United Nations, 2015). Considering the goat population, in 2014 there were 4.25 million goat heads in Greece; 2.70 million in Spain and 1.27 million in France In the same year, goat's milk production was very high in France, Spain and Greece, as high as 604, 447 and 351 million liters, respectively (European Statistics, 2016).

Goat's milk is in 3rd position in the total milk production (0.89 MT/annum), with 72.2 million heads, ranking first in the total animal population in Pakistan (2017). People living in rural areas the world over consider the goat as a source of milk and meat. Many scientists called it the poor man's cow due to economical production and ease in rearing (Leitner et al., 2007). Almost 2% of the total milk production per year is produced by goats, which plays a very significant role in the health and financial well-being of mankind. Goat's milk can easily be used by people who are hypersensitive to cow's milk (Park, 2007).

Various types of goat's milk products such as curd, frozen yoghurt, milk powder, butter, skimmed milk, enriched milk and fermented milk products are available on the market (Park, 2007). Besides all these products, goat's milk cheese is a very rare and nutritious type of cheese, which is soft in texture and white in colour, palatable to the taste and enriched with vitamins (Ayar et al., 2009).

Cheese is a coagulated and concentrated milk product that has a wide range of flavours, textures, forms and varieties. The starter cultures required for cheese production are very expensive and not easily available in Pakistan. *Dahi* (yoghurt), which is a local fermented product can easily be prepared at home and is also available on the local market rather than imported cultures. *Dahi* contains several thermophilic bacteria but the dominant forms are *Streptococcus thermophilus* and *Lactobacillus ssp.* (*Lb. delbruccki subsp. bulgaricus*). There is little knowledge about goat's milk cheese manufacturing in Pakistan. The goats are mainly reared by small farmers or small land holders in Pakistan who use the goats milk for their own consumption, very little being commercialized. So, the conservation of the milk in the form of cheese could be an option for small farmers. The present study aimed to use good quality homemade *dahi* as the starter culture for the production of goat's milk cheese, representing a good initiative on the scientific side of industry. This small effort will definitely increase the economy of dairy industry and help poor farmers to establish their own small-scale businesses.

2 Material and methods

2.1 The search for the raw material

Goat's and buffalos were obtained in Faisalabad-Pakistan. Goat's milk cheese was prepared using *dahi* as the starter culture at concentrations of 0.5% ($T_{0.5\%}$), 1.0% ($T_{1.0\%}$), 1.5% ($T_{1.5\%}$), 2% ($T_{2.0\%}$) and 2.5% ($T_{2.5\%}$) for cheese production, and the enzyme coagulant rennet (Chr. Hansen) for curd formation was obtained on the local market. The trials were carried out using 5 ± 0.05 liters of goat's milk.

2.2 Preparation of *dahi*

Dahi was prepared from skimmed buffalo milk; the milk was first pasteurized at 72 °C for 15 seconds, cooled to 42 °C, 2% already prepared *dahi* added and incubated for 4 hours. The prepared *dahi* was used as the starter culture.

2.3 Physicochemical analyses of milk

The acidity, total solids, ash and protein contents of the milk samples were determined according to Association of Official Analytical Chemists (2012), pH value according to Ong et al. (2007) and the fat content according to Marshal (1993).

2.4 Cheese preparation

Figure 1 shows the method of cheese manufacturing.

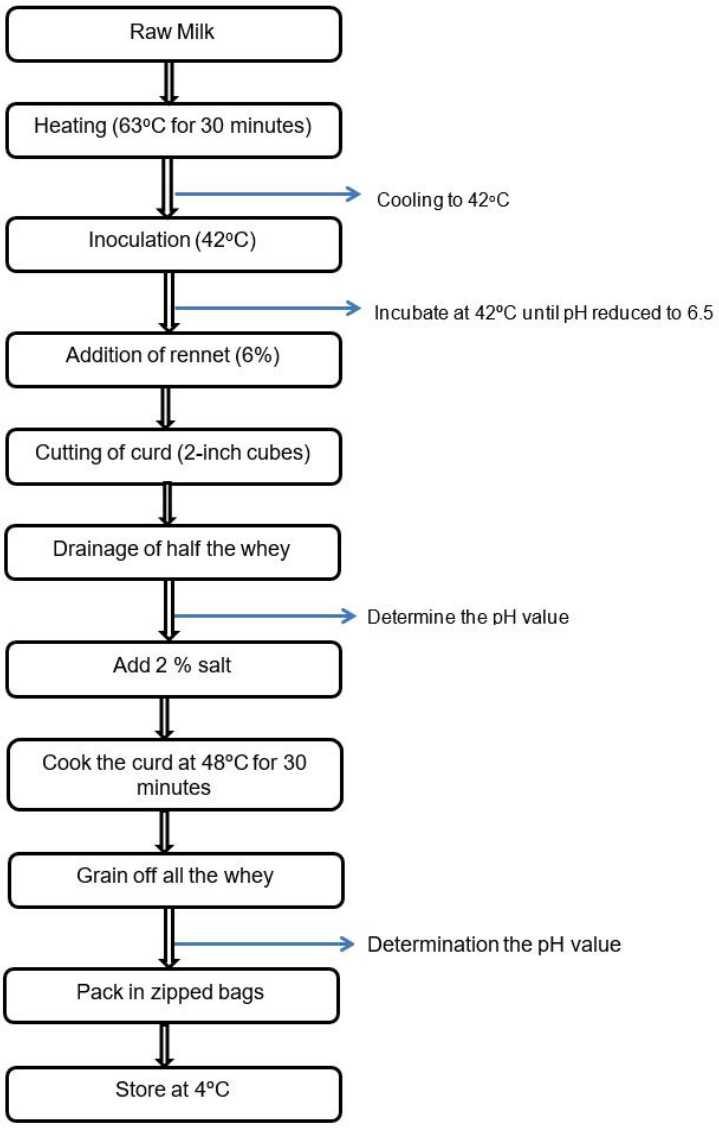

Figure 1. Goat's milk cheese production.

2.5 Cheese yield

After drainage the cheese yield was calculated according to the Equation 1 given below:

$$Yield\ (\%) = \frac{Cheese\ weight\ (kg)}{Milk\ weight\ (kg)} \times 100 \quad (1)$$

2.6 Physicochemical analyses of the cheese

The acidity, pH, fat and protein contents of the cheese samples were determined using the same methods given for the physicochemical analyses of the milk, and the cheese texture was characterised using the Texture Profile Analyzer as described by Guinee et al. (2007). The method of Clark et al. (2009) was used for the sensory evaluation of the cheeses.

2.7 Organoleptic evaluation

Small cubes (2 cm) of cheese samples were placed on white plates at ambient (25 ± 2 °C) and presented to the panellists. Five trained panellists, all highly familiar with cheese, evaluated the cheese samples. The sensory evaluation was recorded using a 9-point hedonic scale.

2.8 Statistical analysis

All the analyses were carried out with 6 replicates and the results subjected to the statistical parameters according to CRD (Steel et al., 1997).

3 Results and discussion

3.1 Chemical analyses of the milk

The results obtained for the goat's milk used to manufacture the cheese were: pH (6.61 ± 0.04), acidity (0.17 ± 0.01), fat (3.8% ± 0.07%), protein (3.3% ± 0.11%), ash (0.70% ± 0.01%) and total solids (12.21% ± 0.14%). The fat (3% to 5%), protein (2.4% to 4.1%), total solids (6.61% to 6.85%) and ash (0.69% to 0.74%) contents of the goat's milk used here were comparable to those of Guo et al. (2001). The total solids showed variations that might have been due to changes in the fat, protein, lactose and mineral contents of the milk. Seasonal variations and changes in the genotypes of the animals can also lead to variations in the goat's milk composition.

3.2 Yield and physicochemical composition of cheese

The different concentrations of *dahi* added as the starter culture had a significant effect on the cheese yield. $T_{1.0\%}$ provided the highest percent yield (17.33 ± 0.61). A lower cheese yield was found with increasing culture concentration, which may have been due to the development of greater acidity, creating unfavourable conditions for the microbes and enzymes to work efficiently and expelling more whey. Hamad & Ismail (2012) reported a goat's milk cheese yield of between 17.13% and 17.47%, which is comparable to that obtained in the current study.

Table 1 shows the results obtained for the physicochemical analyses of the goat's milk cheese. With respect to the different culture concentrations, significant differences ($p < 0.05$) were detected for pH and acidity, and the moisture and fat contents and non-significant differences for the protein content. The pH values were between 5.74 ± 0.25 and 5.00 ± 0.24 and the lactic acid concentration between 0.40% ± 0.01% and 0.58% ± 0.02%. The increase in lactic acid concentration and decrease in the pH value were due to the increasing concentrations of *dahi* culture added to the cheese, which promoted acidity. The fat content was

between 16.14% ± 0.74% and 18.34% ± 0.90%. Hayaloglu et al. (2013) prepared goat's milk cheese using starter free, mesophilic and thermophilic cultures and obtained fat contents between 16.82% and 17.04%, in agreement with the current studies. The protein content of the cheese samples was between16.21% ± 01.41% and 17.61% ± 0.84%. Santos et al. (2016) reported a protein content of between 15.45% ± 4.32% and 16.54% ± 4.75% for fresh cream goat's milk cheese, values in agreement with those obtained in the present study.

The moisture content varied from 52.20% ± 1.40% to 59.30% ± 1.49%, the difference in moisture content being due to acid development in the cheese samples, the acidity working as a moisture expeller from the cheese. Thus, more development of acid more will be the moisture loss in cheese. The moisture content of goat's milk cheese reported by Kondyli et al. (2016) was from 54.51% to 57.3%, results comparable to those of the current study.

Table 1. Physicochemical analyses of the goat's milk cheese.

Treatments	Moisture (%)	Acidity (%)	pH	Fat (%)	Protein (%)
$T_{0.5\%}$	59.30 ± 1.49^{A}	0.40 ± 0.01^{D}	5.74 ± 0.25^{A}	18.34 ± 0.90^{A}	17.61 ± 0.84^{A}
$T_{1.0\%}$	56.69 ± 0.72^{B}	0.45 ± 0.02^{C}	5.60 ± 0.24^{AB}	18.02 ± 0.90^{AB}	17.48 ± 0.80^{A}
$T_{1.5\%}$	55.25 ± 1.27^{BC}	0.49 ± 0.02^{B}	5.35 ± 0.24^{ABC}	17.53 ± 1.15^{ABC}	17.09 ± 0.88^{A}
$T_{2.0\%}$	53.80 ± 0.93^{CD}	0.52 ± 0.02^{B}	5.20 ± 0.23^{BC}	16.56 ± 0.82^{BC}	16.62 ± 0.80^{A}
$T_{2.5\%}$	52.20 ± 1.40^{D}	0.58 ± 0.02^{A}	5.00 ± 0.24^{C}	16.14 ± 0.74^{C}	16.21 ± 1.41^{A}

The superscripts A-D indicate means that significantly differ at $p < 0.05$ within the same parameter.

3.3 Texture profile analysis

Table 2 shows the texture parameters determined for the goat's milk cheese. It can be seen that the values obtained for firmness (N), gumminess (N), chewiness (mJ) and elasticity (mm) in the cheese sample showed a trend to increase with increasing culture concentration, whilst the values obtained for adhesiveness (mJ) and cohesiveness (%) decreased with increasing culture concentration. The addition of different concentrations of starter culture significantly ($p < 0.05$) affected the firmness, adhesiveness, gumminess and cohesiveness of the cheeses, while non-significant changes in elasticity were observed. The highest values for firmness (N) were observed for $T_{2.5\%}$ (3.00 ± 0.13) and the lowest values (2.10 ± 0.09) for $T_{0.5\%}$. Adhesiveness (mJ) showed the maximum value (0.46 ± 0.02) for $T_{0.5\%}$ and minimum value (0.29 ± 0.04) for $T_{2.5\%}$. The highest value for cohesiveness (%) (0.46 ± 0.02) was found for $T_{0.5\%}$ and the lowest (0.32 ± 0.02) for $T_{2.5\%}$. Maximum values for elasticity (mm) (3.39 ± 0.03) were observed for $T_{2.5\%}$ and the lowest (2.99 ± 0.13) for $T_{0.5\%}$, whilst the values for gumminess (N) and chewiness (mJ) were also higher in $T_{2.5\%}$ and lower in $T_{0.5\%}$.

According to Kumar et al. (2014), the more elastic the cheese, the greater its resistance to breakage and therefore the greater the cohesiveness, the values reported in this study for the elasticity and cohesiveness of the cheeses agreeing with this information. The adhesiveness and cohesiveness decreased with increasing culture concentration due to the decrease in moisture concentration.

Table 2. Values of the texture profile analyses.

Parameters	$T_{0.5\%}$	$T_{1.0\%}$	$T_{1.5\%}$	$T_{2.0\%}$	$T_{2.5\%}$
Firmness (N)	2.10 ± 0.09^{C}	2.22 ± 0.99^{C}	2.64 ± 0.11^{B}	2.94 ± 1.28^{A}	3.00 ± 0.13^{A}
Adhesiveness (mJ)	0.46 ± 0.02^{A}	0.40 ± 0.02^{B}	0.36 ± 0.03^{C}	0.33 ± 0.01^{C}	0.29 ± 0.04^{D}
Cohesiveness (%)	0.46 ± 0.02^{A}	0.45 ± 0.02^{A}	0.40 ± 0.18^{B}	0.36 ± 0.01^{BC}	0.32 ± 0.02^{C}
Elasticity (mm)	3.39 ± 0.03^{A}	3.30 ± 0.14^{A}	3.20 ± 0.14^{AB}	3.15 ± 0.14^{AB}	2.99 ± 0.13^{B}
Gumminess (N)	0.89 ± 0.02^{C}	0.94 ± 0.01^{BC}	0.98 ± 0.01^{B}	1.05 ± 0.01^{AB}	1.08 ± 0.21^{A}
Chewiness (mJ)	2.94 ± 0.13^{D}	2.63 ± 0.38^{C}	3.00 ± 0.13^{B}	3.23 ± 0.14^{A}	3.25 ± 0.14^{A}

The superscripts A-D indicate means that significantly differ at $p < 0.05$ within the same parameter.

3.4 Organoleptic evaluation

The maximum sensory scores were awarded to $T_{1.0\%}$ (shown in Figure 2), being 6.39 for colour, 6.38 for flavour, 7.24 for taste, 6.38 for texture and 7.27 for overall acceptance, followed by $T_{1.5\%}$ with 6.12 for colour, 6.44 for flavour, 6.99 for taste, 5.9 for texture and 7.05 for overall acceptability. Hence, the $T_{1.0\%}$ samples were preferred by the panellists, followed by $T_{1.5\%}$.

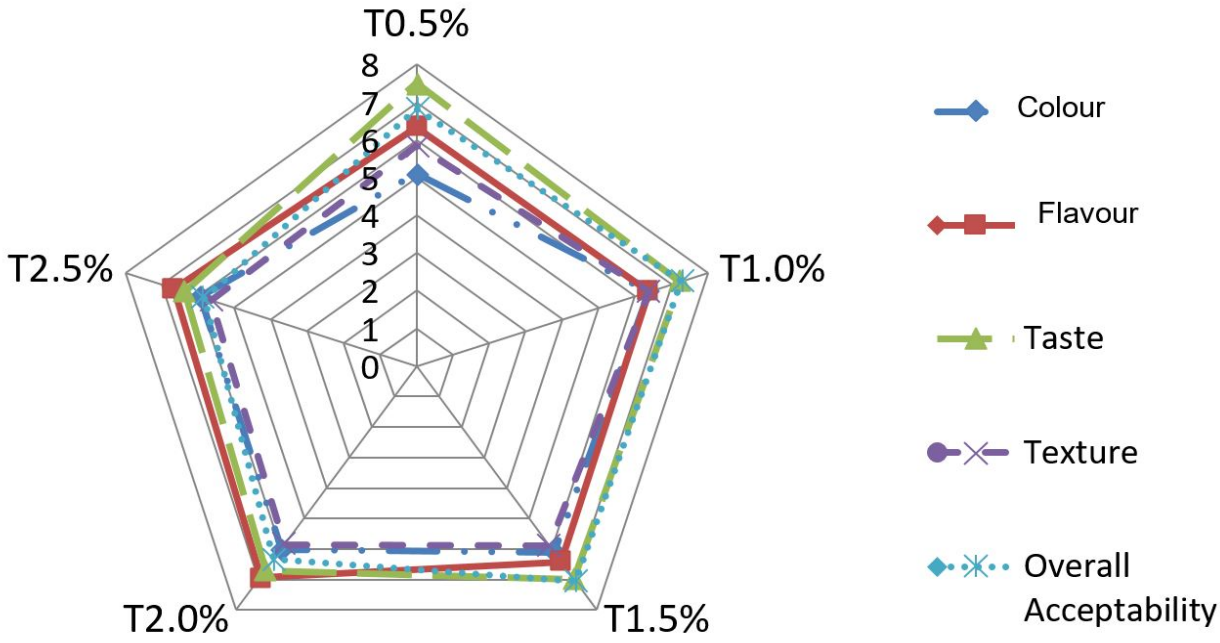

Figure 2. Sensory scores for goat's milk cheese.

4 Conclusion

It was concluded that *dahi* could be used as the starter culture in the production of goat's milk cheese, a concentration of 1% being the most suitable. More work is required to optimize the conditions for cheese making. The use of *dahi* as the starter culture will help small manufacturers since it has a negligible price, and the cheeses can be prepared economically by poor people.

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