



Impact of Adjunct Culture on Colour, Texture, Sensory and Microbiological Parameters of Goat Milk White Brined Cheese during Ripening

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ABSTRACT

Background: The effect of two adjunct cultures (*Lactocaseibacillus casei* and *Lactiplantibacillus plantarum*) on quality parameters of goat milk white brined cheese (GM-WBC) was investigated during ripening.

Methods: Three batches of cheese were prepared as control with blend starter culture, GM-WBC(C) with starter culture + *L. casei* and GM-WBC(P) with starter culture + *L. plantarum*. The control and experimental samples were analysed for their colour, textural, sensory and microbiological characteristics during 60 days of ripening period.

Result: Significant decrease in hardness, adhesiveness, springiness, cohesiveness, chewiness and gumminess led to increased creaminess and smoothness of the product treated with adjunct cultures. Sensory scores were found to improve in adjunct culture treated samples. Significant increase in instrumental colour (L^* value) and sensory attributes with increased ripening resulted in consumer acceptability. Microbiological counts of *Lactococci* and *Lactobacilli* showed a significant ($P < 0.05$) decline in initial days due to its adaptability and then increased, maintaining its viability during all stages of ripening period. While keeping the counts above 10^6 log cfu/ml for the adjunct treated samples compared to control sample. The overall effect of *L. casei* was more promising in enhancing textural and sensory attributes as compared to *L. plantarum* due to its higher proteolytic activity.

Key words: Adjunct culture, Microbiological analysis, Sensory analysis, Texture analysis, White brined cheese.

INTRODUCTION

Goats are considered as poor man's cow due to their low maintenance and survivability under harsh conditions (Popescu *et al.*, 2021). There is a need to promote nutritionally superior goat milk due to its therapeutic benefits and to make goat farmers self-sufficient. India, globally ranks first in terms of total goat milk production contributing to almost 3% of total milk production in India (Department of Animal Husbandry and Dairying, 2023). The higher digestibility, alkalinity, high buffering capacity and therapeutic benefits are the key biological properties possessed by goat milk (de Almeida Júnior *et al.*, 2015; Yadav *et al.*, 2016). Increase in consumer's purchasing power and globalization has raised the demands for value added products, thereby, creating more opportunities for value addition of goat milk. The conversion of goat milk into value added products especially goat cheeses continue to have major significance in terms of economic gains (Verma and Rajkumar, 2021; Hammam *et al.*, 2022).

White brined cheese is a category of brined cheese having slightly acidic and salty flavour which is consumed after a period of 2 months of ripening under brine. Use of goat milk, ewe's milk or their admixture influences the texture profile and quality characteristics of white brined cheese (Alkhalaleh, 2024). The texture is sliceable, soft and smooth having no gas holes or rind (Moatsou and Govaris, 2011). Adjunct cultures are selective non-starter lactic acid bacteria which are intentionally added to improve

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the rate of ripening and overall sensory aspects of the ripened cheese. They consist mainly of mesophilic facultative and obligate heterofermentative lactobacilli species. *Lactobacillus* species are the most commonly used adjunct cultures with GRAS status, used for enhancing sensory qualities of different cheeses (Kumar *et al.*, 2015).

Lactiplantibacillus plantarum, *Lactocaseibacillus casei*, *Lactocaseibacillus paracasei*, *Lactocaseibacillus rhamnosus* are major species belonging to this group (Leroy and De Vuyst, 2004; Levante *et al.*, 2017). These secondary cultures are often added to cheeses to enhance its texture and flavour profile. Some other factors like composition of cheese milk, processing conditions adopted and ripening process also affects cheese texture (Sahingil *et al.*, 2014). Salt in cheeses also alters the physical properties of cheese by changing the water binding capacity of casein structure (Madadlou *et al.*, 2007). The particular flavour of cheese is developed by enzymatic degradation of macromolecules like lipids and proteins in cheese. Different amino acids contribute to development of different flavours in cheese (McSweeney, 2004). In particular, α s1 casein degradation during proteolysis plays an important role in development of final texture of cheese (Sallami *et al.*, 2004). The colour of cheese is decided by the way in which it reflects, absorbs and transmits light. It is also an important factor for consumers acceptability and product quality (Kaya, 2002). The potential ability of non-starter lactic acid bacteria to survive extreme conditions like low pH, presence of salt, low moisture and depleted nutrition helps to increase their count after few months of ripening (Settanni and Moschetti, 2010). Peptides and amino acids formed due to protein degradation are known to provide energy to them during ripening even after depletion of residual lactose (Bancalari *et al.*, 2020). In the present study, the effect of *L. casei* and *L. plantarum* as adjunct culture on instrumental colour, texture, sensory and microbiological profile of goat milk white brined cheese was studied during ripening under brine solution for 60 days at refrigerated condition.

MATERIALS AND METHODS

Materials

For the present study, pooled goat milk of Beetal breed was collected from Experimental Dairy Plant of the College of Dairy and Food Science Technology, Guru Angad Dev Veterinary and Animal Sciences University (GADVASU), Ludhiana. Microbial rennet (FROMASE-2200 TL granulate) was procured from Essdee Marketing, Pune, Maharashtra, India. Mixed starter culture (mesophilic/thermophilic blend) (*Streptococcus thermophilus*, *Lactococcus lactis* and *Lactococcus cremoris*) was procured from Chr. Hansen (India). Two single strains *i.e.*, *Lactocaseibacillus casei* (NCDC-17) and *Lactiplantibacillus plantarum* were used as adjunct cultures and were collected from National Collection on Dairy Cultures (NCDC) and Molecular Biology Laboratory of ICAR-National Dairy Research Institute, Karnal, Haryana, respectively.

Production of white brined cheese using adjunct cultures

Goat milk white brined cheese (GM-WBC) was prepared from pooled goat milk with casein to fat ratio of 0.69-0.72 as per the method described by Zaravela *et al.* (2021) is

shown in the Fig 1. Control GM-WBC sample was prepared without addition of adjunct cultures while experimental samples were prepared using adjunct cultures such as *L. plantarum* (GM-WBC(P)) and *L. casei* (GM-WBC(C)) at the rate of 0.5%. The control and experimental samples were analysed for their colour, textural, sensory and microbiological characteristics at 15 days interval from 0 to 60 days.

The present study was carried out in the year 2023 at College of Dairy and Food Science Technology, GADVASU, Ludhiana, Punjab, India.

Instrumental colour

The instrumental colour parameters were evaluated by Colour Flex reflectance meter (Hunter Lab, Reston, Virginia, USA) which measured the degree of lightness (L^*), degree of redness or greenness ($\pm a^*$) and the degree of yellowness or blueness ($\pm b^*$). The instrument was calibrated with black and white reference tiles before use.

Texture profile analysis

Textural parameters were evaluated as per the method of Kumar *et al.* (2015) with some modifications using TA-XT2i Plus Texture Analyser (Stable Micro Systems, Surrey, UK) with 5 kg load cell. A cubical shape of side 20 mm of cheese sample was used for calculating hardness, cohesiveness, springiness, chewiness, adhesiveness and gumminess. Sample was placed below the P-75 flat probe and measurements were performed at $25 \pm 1^\circ\text{C}$. Samples were compressed twice. Test conditions set in texture analyser were: Pre-test speed: 2.5 mm/s, Post-test speed: 5 mm/s, Test-speed: 2.5 mm/s and Data acquisition rate: 200 pps.

Sensory analysis

GM-WBC samples were coded and evaluated for flavour, body and texture, colour and appearance and overall acceptability on 0, 15, 30, 45 and 60 days of ripening. Samples were evaluated by a panel of six trained panellists from faculty members of College of Dairy and Food Science Technology, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana using 9-point hedonic scale. Samples were kept at room temperature for 60 minutes before evaluation.

Microbiological analysis

Serial dilutions of GM-WBC samples were prepared and evaluated for counts of *Lactococci*, *Lactobacilli*, standard plate count, *E. coli*, coliform and yeast and mould as per Wehr and Frank, (2004). Samples were examined at every 15 days interval till 60 days of ripening.

Statistical analysis

Statistical Software Package IBM SPSS version 26 was used to compare the results using two-way ANOVA and significant differences between mean values was evaluated by Post Hoc Tukey's test. The significance level (P) was set at 5%. The data was presented as mean $\pm$ standard deviation in Microsoft excel.

RESULTS AND DISCUSSION

Instrumental colour

Instrumental colour was evaluated by three parameters viz. L^* , a^* and b^* value and represented in the Table 1. A significant ($P<0.05$) increase in L^* value after 15th day of storage was observed in all samples. L^* value depicts lightness index, an increase in moisture leads to increased light scattering centres and hence increased whiteness (Rahimi *et al.*, 2013). Kaya (2002) reported an initial steep decrease in L^* value (whiteness) with increase in salt concentration (5-25%) in Gaziantep cheese in short term brining (14 days). They found the whiteness to be dependent upon salt content of cheese and that L^* value increased after 2nd day which did not change after attaining equilibrium in salt content. a^* value showed a significant ($P<0.05$) decrease followed by an increase throughout the ripening. b^* value also increased significantly ($P<0.05$) throughout ripening. Highest b^* value (yellowness) was observed in adjunct cultures added samples than control after 45 days of ripening. Türkmen and Güler (2022) reported a decrease in whiteness index during later stages due to increased hydration of proteins and decreased free moisture that reflected reduced degree of light scattering. In solid material like cheese, light is scattered by whey pockets and milk fat globules.

Texture profile analysis

Table 2 depicts the textural parameters of GM-WBC samples. There was a significant ($P<0.05$) decrease in hardness, adhesiveness, springiness, cohesiveness, chewiness and gumminess values throughout the ripening. Addition of adjunct culture also significantly affected ($P<0.05$) the textural parameters. This might have been due to the degradation of protein into smaller fractions which resulted in more water binding due to formation of new ionic groups having water binding effect. The hardness values dropped more in case of GM-WBC(C) since *L. casei* known to have good proteolytic activity than *L. plantarum*. The reduction in hardness might be due to increase in moisture content that has weakened the protein network (de Moraes *et al.*, 2018). No significant ($P<0.05$) effect was observed on springiness values among samples due to addition of adjunct culture. Also, decrease in springiness and cohesiveness with ripening might be due to increase in acidification which caused changes in protein aggregates (de Moraes *et al.*, 2018). Chewiness is the force and energy that is required to bring the cheese to the stage suitable for swallowing, also decreased due to increased production of lactic acid and organic acids which directly influence the texture by making cheese more fragile

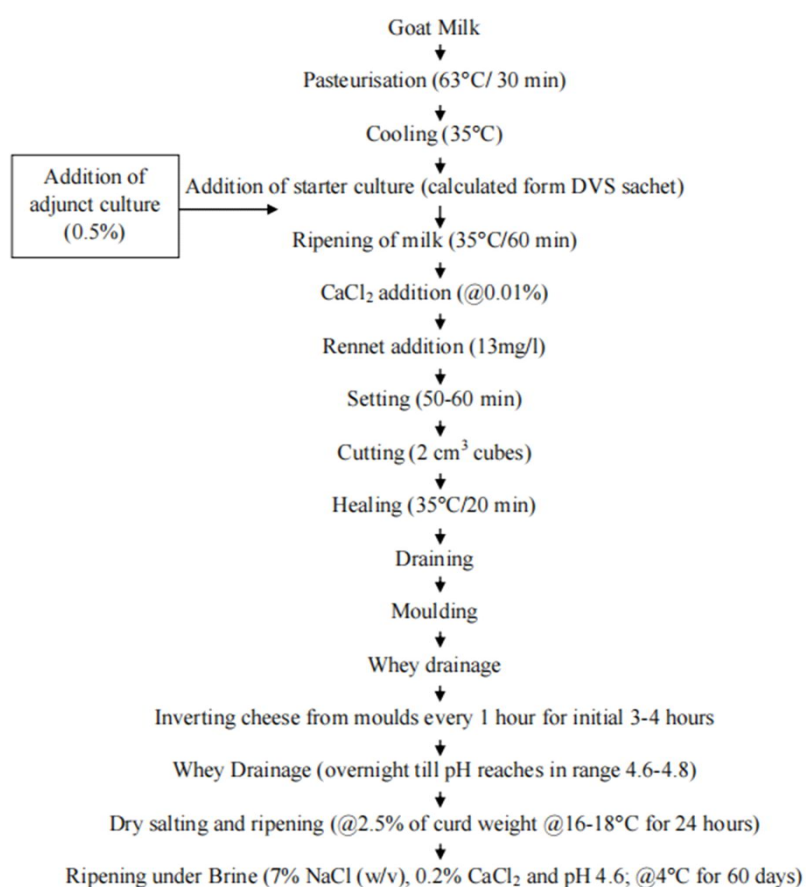


Fig 1: Flow diagram for preparation of goat milk white brined cheese (GM-WBC).

(Buriti *et al.*, 2005). Our findings were supported by results of Kumar *et al.* (2015) who reported a significant decrease ($P<0.05$) in the hardness, cohesiveness, gumminess, springiness and chewiness values of buffalo milk feta cheese ripened for 60 days made with *L. helveticus* and *L. casei*. Decrease in textural attributes was reported due to release of calcium ions from caseinate molecules and hydrolysis of protein which caused weakening of cheese structure. Sahingil *et al.* (2014) also reported a significant ($P<0.05$) decrease in the values of hardness, springiness, gumminess and cohesiveness values of white brined cheese prepared using *L. helveticus* and *L. casei*. Cheese made with *L. casei* had lowest hardness value among all throughout the ripening period of 120 days at both 6°C and 12°C. Oluk (2023) observed a significant ($P<0.05$) decrease in hardness, cohesiveness, springiness, chewiness and gumminess values of Turkish white cheese made from low-fat cow milk added with starter and ripened for 180 days under 6% brine. They reported the decrease due to hydrolysis of caseins or dissolution of colloidal calcium phosphate in casein matrix, changes in pH, increased proteolysis which decreases the cohesion among casein micelles.

Sensory analysis

The results of sensory evaluation of GM-WBC are given in the Table 3. The complexity of sensory perception is affected by several parameters like number of flavouring compounds present, texture and the appearance of the cheese (Smit *et al.*, 2005). The flavour profile of GM-WBC(C) sample attained the maximum scores after 60 days of

ripening. Panellists reported soft and creamy texture along with slight bitterness in sample GM-WBC(C) after 30 days of ripening which might be due to the biochemical changes occurring during ripening especially increased proteolysis. Also, formation of free fatty acids must have produced different aromas in the ripened cheese influencing the overall flavour. No significant differences ($P>0.05$) were observed in the score of colour and appearance and body and texture of GM-WBC samples. This was a good sign that addition of adjunct culture had no effect on colour as well as body and textural attributes. The colour was white throughout the ripening and must have become brighter due to presence of calcium in brine solution. Overall acceptability of GM-WBC(C) was higher at the end of the ripening period. The creaminess and rich flavour of GM-WBC(C) had masked the goaty odour from the cheese. The mean scores of flavour profile of adjunct culture treated cheese samples were reported higher by Hashemi *et al.* (2009) who incorporated *L. helveticus* adjunct culture in Iranian white brined cheese. They also reported slight bitterness after 45 days of ripening. Sahingil *et al.* (2014) also reported similar observations in sensory profile of white brined cheese prepared using *L. helveticus* and *L. casei* as adjunct cultures. Both samples had higher level of bitterness than control sample after ripening. They reported the presence of methionine, lysine, valine, proline, isoleucine and tryptophan amino acids at higher levels in cheese made with *L. helveticus* which were found to give bitter taste to the cheese. They observed the higher notes of bitterness at 12°C than at 6°C ripening temperature in adjunct treated samples.

Table 1: Instrumental colour of GM-WBC during 60 days of ripening period.

Parameters	Days	Cheese samples		
		GM-WBC	GM-WBC (C)	GM-WBC (P)
L* value	0	85.32±0.18 ^{dAB}	84.75±0.23 ^{EB}	85.86±0.43 ^{dA}
	15	92.63±0.09 ^{AA}	92.35±0.37 ^{AA}	92.51±0.23 ^{AA}
	30	89.91±0.16 ^{CA}	89.28±0.23 ^{DB}	88.77±0.15 ^{CB}
	45	89.98±0.23 ^{CA}	90.35±0.09 ^{CA}	89.51±0.13 ^{CA}
	60	91.17±0.04 ^{BA}	91.33±0.15 ^{BA}	90.43±0.31 ^{BB}
a* value	0	-0.85±0.04 ^{AA}	-0.86±0.12 ^{BA}	-0.86±0.07 ^{DA}
	15	-0.69±0.01 ^{BB}	-0.72±0.04 ^{AC}	-0.59±0.11 ^{AA}
	30	-0.86±0.04 ^{AB}	-0.83±0.08 ^{BB}	-0.73±0.06 ^{CA}
	45	-0.81±0.07 ^{AC}	-0.74±0.04 ^{AB}	-0.66±0.02 ^{BA}
	60	-0.84±0.02 ^{AB}	-0.77±0.01 ^{AA}	-0.71±0.02 ^{AB}
b* value	0	8.04±0.10 ^{BA}	8.03±0.06 ^{DA}	8.03±0.04 ^{CA}
	15	8.74±0.01 ^{AB}	9.84±0.08 ^{AA}	9.47±0.16 ^{AB}
	30	8.85±0.06 ^{AA}	8.68±0.16 ^{CA}	8.81±0.16 ^{BA}
	45	8.72±0.06 ^{AC}	8.99±0.06 ^{BC}	9.41±0.03 ^{AB}
	60	8.69±0.10 ^{AB}	9.46±0.25 ^{AB}	9.73±0.22 ^{AA}

Values (mean±SD, n=3) with different superscript 'abcd' within column indicates that the days of ripening, has significant ($P<0.05$) effect on dependent variables.

Values (mean±SD, n=3) with different superscript 'ABC' within row indicates that the type of adjunct culture, has significant ($P<0.05$) effect on dependent variables.

Microbiological analysis

Fig 2 shows the standard plate count (SPC), *Lactococci* and *Lactobacilli* counts during 60 days ripening in control and experimental samples. The SPC of GM-WBC showed a decrease initially and increase in later stages depending on the conditions in brine. Lack of substrate, low pH and high salt content might have led to a decrease in the SPC counts. While an increase in counts was suspected due to the formation of amino acids and degradation products in cheese from proteolysis which might have supported their growth. Similar trend was observed with *Lactococci* and *Lactobacilli* counts. *E. coli*, coliform and yeast and mould counts were found nil during the sampling of GM-WBC during different stages of ripening. Zaravela *et al.* (2021) also reported a significant ($P<0.05$) effect on *Lactococci*

counts due to addition of *L. helveticus* and *L. casei* as adjunct cultures in white brined cheese. They reported slight decrease in the *Lactobacilli* counts due to cell lysis and release of enzymes at 60th day of ripening in adjunct treated samples which also improved casein degradation. They reported an increase in *lactobacilli* count in case of cheese made with *L. helveticus* adjunct culture at 120th day of ripening. Dabevska-Kostoska *et al.* (2015) also reported similar results where counts of *L. casei* in traditional white brined cheese decreased during initial days due to its adaptability and then increased, maintaining its viability during all stages of ripening period. Çetin *et al.* (2024) observed a slight increase in the counts of *lactococci* spp. and *lactobacilli* spp. characterized from Kırklareli white brined cheese with highest counts observed at 90 days of ripening.

Table 2: Textural parameters of GM-WBC during 60 days of ripening period.

Parameters	Days	Cheese samples		
		GM-WBC	GM-WBC (C)	GM-WBC (P)
Hardness (g-force)	0	2153.13±11.7 ^{aa}	2078.89±12.4 ^{aa}	2155.87±11.3 ^{aa}
	15	1929.66±205.1 ^{ba}	1835.04±195.1 ^{bb}	1763.31±198.0 ^{bc}
	30	1768.25±101.24 ^{ca}	1623.55±125.1 ^{cc}	1684.89±108.3 ^{cb}
	45	1682.25±120.21 ^{da}	1531.5±139.1 ^{dc}	1576.71±125.6 ^{db}
	60	1667.81±94.57 ^{ea}	1511.82±102.7 ^{ec}	1571.75±93.9 ^{eb}
Adhesiveness (g-sec)	0	-88.75±2.50 ^{ea}	-85.28±5.38 ^{ea}	-87.68±3.95 ^{ea}
	15	-75.65±24.26 ^{dc}	-72.40±20.74 ^{db}	-71.12±23.41 ^{da}
	30	-58.36±23.99 ^{cb}	-54.87±21.6 ^{ca}	-56.20±20.36 ^{ca}
	45	-33.50±22.36 ^{ba}	-35.36±25.81 ^{bb}	-36.28±23.14 ^{bb}
	60	-28.67±21.95 ^{ab}	-25.27±21.93 ^{aa}	-27.39±23.22 ^{ab}
Springiness	0	0.831±0.11 ^{ab}	0.845±0.11 ^{ab}	0.834±0.11 ^{ab}
	15	0.777±0.09 ^{bb}	0.812±0.09 ^{ab}	0.828±0.09 ^{ab}
	30	0.759±0.093 ^{ba}	0.758±0.097 ^{ba}	0.731±0.095 ^{ba}
	45	0.683±0.099 ^{ca}	0.645±0.093 ^{ca}	0.664±0.098 ^{ca}
	60	0.612±0.093 ^{da}	0.615±0.102 ^{ca}	0.615±0.099 ^{ca}
Cohesiveness	0	0.356±0.037 ^{aa}	0.338±0.034 ^{aa}	0.343±0.032 ^{aa}
	15	0.326±0.054 ^{ba}	0.292±0.053 ^{bc}	0.308±0.049 ^{bb}
	30	0.265±0.045 ^{ca}	0.249±0.055 ^{cb}	0.255±0.048 ^{cab}
	45	0.204±0.056 ^{da}	0.211±0.048 ^{ca}	0.202±0.049 ^{da}
	60	0.184±0.052 ^{da}	0.175±0.046 ^{db}	0.175 ±0.043 ^{eb}
Gumminess	0	668.07±35.18 ^{aa}	662.79±42.62 ^{aa}	665.21±25.37 ^{aa}
	15	536.93±105.84 ^{ba}	521.74±100.36 ^{bc}	553.01±102.08 ^{bb}
	30	480.24±80.35 ^{ca}	455.83±86.41 ^{cb}	471.50±75.91 ^{ca}
	45	376.48±54.21 ^{da}	356.05±53.09 ^{da}	363.83±50.81 ^{da}
	60	337.23±29.46 ^{ea}	326.53±36.17 ^{ec}	331.55±52.01 ^{eb}
Chewiness (g-force)	0	530.09±35.24 ^{aa}	525.71±55.26 ^{aa}	528.19±21.57 ^{aa}
	15	455.50±103.89 ^{bb}	432.89±106.47 ^{bc}	475.58±98.64 ^{ba}
	30	375.66±95.19 ^{ca}	354.16±73.77 ^{cb}	356.19±85.24 ^{cb}
	45	298.48±75.21 ^{da}	284.67±84.16 ^{dc}	295.93±79.88 ^{db}
	60	215.71±98.21 ^{ea}	205.87±74.32 ^{eb}	200.74±86.17 ^{ec}

Values (mean±SD, n=3) with different superscript 'abcde' within column indicates that the days of ripening, has significant ($P<0.05$) effect on dependent variables.

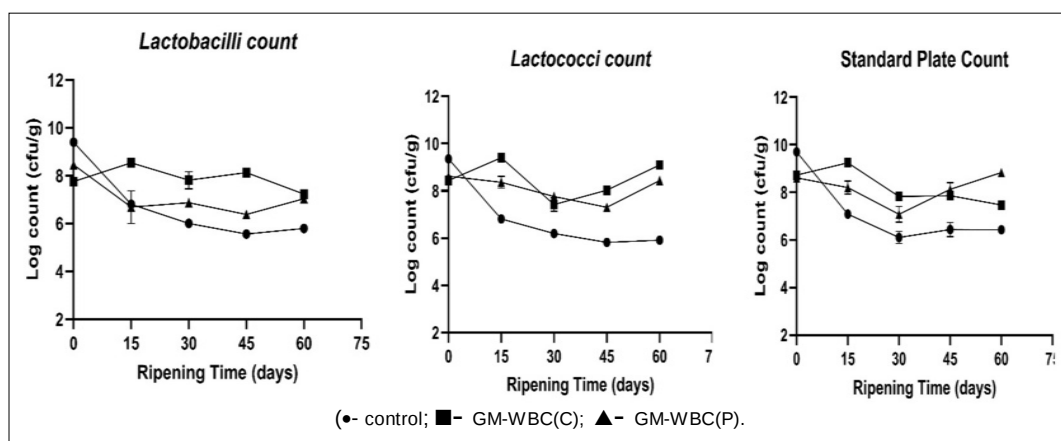
Values (mean±SD, n=3) with different superscript 'ABC' within row indicates that the type of adjunct culture, has significant ($P<0.05$) effect on dependent variables.

Table 3: Sensory analysis of GM-WBC during 60 days of ripening period.

Parameters	Days	Cheese samples		
		GM-WBC	GM-WBC (C)	GM-WBC (P)
Flavour	0	8.05±0.06 ^{aA}	8.03±0.5 ^{aA}	8.03±0.8 ^{aA}
	15	8.11±0.9 ^{aA}	8.15±0.7 ^{aA}	8.11±0.9 ^{aA}
	30	8.15±0.5 ^{aA}	8.18±0.6 ^{abB}	8.15±0.8 ^{aA}
	45	8.17±0.6 ^{aA}	8.23±0.7 ^{abB}	8.17±0.5 ^{aB}
	60	8.23±0.5 ^{aA}	8.34±0.7 ^{bB}	8.25±0.9 ^{bC}
Body and texture	0	8.18±0.9 ^{aA}	8.18±0.9 ^{aA}	8.18±0.5 ^{aA}
	15	8.18±0.9 ^{aA}	8.19±0.8 ^{aA}	8.18±0.8 ^{aA}
	30	8.18±0.7 ^{aA}	8.19±0.6 ^{aA}	8.18±0.6 ^{aA}
	45	8.18±0.8 ^{aA}	8.20±0.9 ^{aA}	8.18±0.7 ^{aA}
	60	8.18±1.0 ^{aA}	8.22±0.7 ^{aA}	8.18±0.9 ^{aA}
Colour and appearance	0	8.26±0.5 ^{aA}	8.26±0.8 ^{aA}	8.26±0.9 ^{aA}
	15	8.26±0.6 ^{aA}	8.26±0.5 ^{aA}	8.26±0.5 ^{aA}
	30	8.26±0.5 ^{aA}	8.26±0.6 ^{aA}	8.26±0.6 ^{aA}
	45	8.26±0.5 ^{aA}	8.25±0.7 ^{aA}	8.26±0.5 ^{aA}
	60	8.26±0.7 ^{aA}	8.26±0.5 ^{aA}	8.26±0.5 ^{aA}
Overall acceptability	0	8.05±0.8 ^{aA}	8.03±0.6 ^{aA}	8.04±0.5 ^{aA}
	15	8.11±1.0 ^{aA}	8.15±0.5 ^{aA}	8.12±0.7 ^{aA}
	30	8.23±0.5 ^{aA}	8.25±0.8 ^{abB}	8.23±0.5 ^{abA}
	45	8.25±0.6 ^{abA}	8.31±0.6 ^{abB}	8.28±0.7 ^{bC}
	60	8.35±0.9 ^{bA}	8.4±0.8 ^{bB}	8.33±0.9 ^{bC}

Values (mean±SD, n=3) with different superscript 'ab' within column indicates that the days of ripening, has significant ($P<0.05$) effect on dependent variables.

Values (mean±SD, n=3) with different superscript 'ABC' within row indicates that the type of adjunct culture, has significant ($P<0.05$) effect on dependent variables.

**Fig 2:** Lactobacilli, Lactococci and Standard plate count of GM-WBC during 60 days of ripening period.

CONCLUSION

This study evaluates the influence of two adjunct cultures on the textural, instrumental colour, water activity, microbiology and sensory profile of goat milk white brined cheese ripened for 60 days. Significant differences were found among the samples with respect to textural parameters. The changes were attributed as a result of increased proteolysis especially for GM-WBC(C). Also,

there was a significant improvement in the developed flavour after ripening in case of both adjunct treated samples. The improvement in the brightness and whiteness of instrumental colour of all samples was found to be an effect of bleaching action of added calcium in brine solution. In conclusion, the adjunct culture *L. casei* showed a great potential for its use in goat milk white brined cheese in improving sensory characteristics and also the textural profile of the product.

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Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Informed consent

All animal procedures for experiments were approved by the Committee of Experimental Animal care and handling techniques were approved by the University of Animal Care Committee.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish, or preparation of the manuscript.

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