

Research Article

Effect of Inoculum and Temperature on the Fermentation of Goat Yogurt

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Abstract: In order to obtain the optimum parameters of fermentation for goat milk, the effect of inoculum and incubation temperature on the fermentation of yogurt strains was studied by measuring acidity, pH and viable bacterial counts by single factor test. Inoculum (v/v) was 1, 3, 5, 7 and 9%, respectively. Incubation temperature was 37, 39, 41, 43 and 45°C, respectively. The results were as follows: lower or higher inoculum and incubation temperature resulted in adversely influence on overall properties of goat yogurt. The optimum inoculum in goat milk was 3% and incubation temperature 43°C, respectively.

Keywords: Goat yogurt, incubation temperature, inoculum, probiotics

INTRODUCTION

Goat milk is a unique dairy resource, which is well known as “the king of milk” with absorbing easily and rich nutrition (Tamime and Robinson, 2000; Agnihotri and Prasad, 1993). Its nutritional value is more than milk, performance of protein and fat are better than milk, content of vitamins and minerals are in general also higher than milk, which is recognized as the most closest to human milk dairy (Keogh and O’Kennedy, 1998; Kneifel *et al.*, 1993; Haenlein, 2004).

Goat milk products, especially cheeses and yogurt are very popular in the Mediterranean peninsula, the Middle East, southern Russia and the Indian subcontinent (Tamime and Robinson, 2000). To adapt to people with cow’s milk allergies and other gastrointestinal ailments, goat milk products are also growing (Vinderola *et al.*, 2000).

Goat yogurt is an active lactobacillus drink, which was made by fermentation after sterilization and inoculation, because its appropriate acidity can protect the bad blood acid against damage and had a health-promoting effects in the intestinal tract (Vinderola *et al.*, 2000), what’s more, which prevent spoilage and amines adverse effects, So goat yogurt is nutrition with high value health and the unique flavor (Gao *et al.*, 2011).

Lower incubation temperature could also be used to improve probiotic organism growth, because it is optimum for growing probiotic species (Guler-Akin and Akin, 2007; Dave and Shah, 1998).

Currently, the study of yogurt at home and abroad mainly concentrate in cow milk, because of some physical and chemical properties differences between goat milk and cow milk (Wang *et al.*, 2002). In this

study, the purpose of the present work was to study effect of inoculum and incubation temperature on the fermentation of goat yogurt by *Lactobacillus bulgaricus* and *Streptococcus thermophilus* for further optimizing process parameters of goat yogurt. And then provide a theoretical basis for quality control in the goat yogurt.

MATERIALS AND METHODS

Preparation of starter: *Lactobacillus bulgaricus* and *Streptococcus thermophilus* power were inoculated with MRS and M17 medium and incubated at 37°C for 24 h, repeated several times until viability of bacteria stay stable by microscopic judgment and then 3-5% bacteria that had been fully activated was inoculated with sterile skim goat milk in anaerobic tube, mixed and cultivated at 42°C, 3-5% bacteria was inoculated with sterile whole goat milk in the flask after coagulation, mixed and cultivated in the incubators, Which can be used for the production of goat yogurt after coagulation.

Fermentation process of goat yogurt: Fresh goat milk→filtration→physical and chemical properties→heating and mixing→packing→sterilization (90~95°C, 10 min) →cooling→inoculation (Activation of bacteria) →fermentation→refrigeration and after-ripening→ product.

Analysis method: The pH of culture media was directly evaluated through a pH-meter (pHS-3C) at the room temperature and acidity was determined according to the sodium hydroxide titration method and Jill Nieer degrees (°T) described. Morphology of bacteria was

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measured using Toluidine blue staining method, respectively.

There were two ways to determination of viable bacterial counts. One was plate coating method. The process was as follows: The agar medium packed in 250 mL flask was sterilized and 15-20 mL poured onto the plates in a clean bench after cooling to 60°C, 0.1 mL aliquot bacteria dilutions were coated on it after coagulation. And then incubated anaerobic 2-3 days at 37°C, plates containing 30~300 cfu/mL colonies was counted and the results expressed as colony-forming units per mL of sample.

And another way was top agar method. The process was as follows: The agar medium packed in 20 mL anaerobic tubes was sterilized, 1 mL aliquot bacteria dilutions was added after cooling to about 45°C, 0.1 mL aliquot bacteria dilutions was coated on it after coagulation. Shaken upside down and cultured anaerobic 2-3 days at 37°C, plates containing 30~300 cfu/mL colonies was counted and the results expressed as colony-forming units per mL of sample.

The samples were organoleptically assessed by five panelists, tasted and described the surface appearance of the product, organizational state, taste, smell, whey precipitation and other sensory properties, who were trained on the basis of normal sensory acuity and consistency, scoring standard was as follows: the properties evaluated included:

- Four terms describing color (no criticism: 0.75~1.00; creamy/milky: 0.50~0.75; light yellow: 0.25~0.50; gray/atypical color: 0~0.25)
- Four terms describing smell (no criticism: 2.25~3.00; pure: 1.50~2.25; flat: 0.75~1.50; lack of favor: 0~0.75)
- Four attributes for taste (no criticism: 2.25~3.00; acid/sweet: 1.50~2.25; smell/bitter: 0.75~1.50; corruption/moldy: 0~0.75)
- Four characteristics of organization state (no criticism: 2.25~3.00; gel-like: 1.50~2.25; whey precipitation: 0.75~1.50; bubble: 0~0.75)

RESULTS AND DISCUSSION

Effect of inoculum on the acid-producing and growth of yogurt strains: The effect of inoculum on the production of acid and growth of bacteria showed in Fig. 1 to 3.

From the above we can see that with the increasing inoculum the total bacterial counts increased gradually and then reached a peak and kept a basic leveling. the total bacterial counts of 1, 3, 5, 7, 9% inoculum reached maximum 3.73, 3.92, 3.49, 3.60 and 3.60 ($\times 10^9$ cfu/mL), respectively.

Different inoculum had an effect on the rate of acid production. The greater the inoculums, the faster the speed of acid production. The speed of acid production of 1% inoculum increased slowly within 2 h and then increase rapidly, began to decrease until 4 h. Five, seven

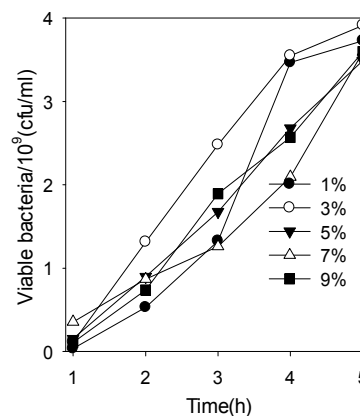


Fig. 1: Effect of inoculum on total number of viable bacteria in goat milk

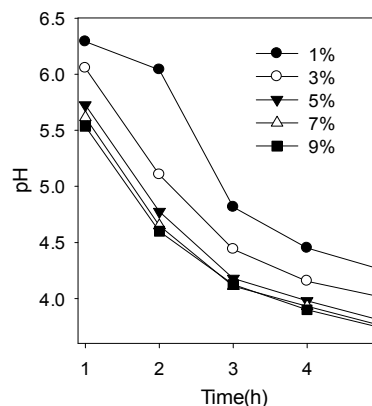


Fig. 2: Effect of inoculum on pH in goat milk

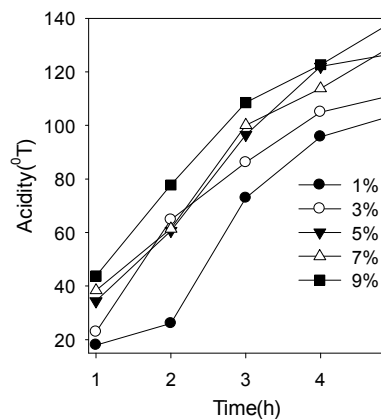


Fig. 3: Effect of inoculum on acidity in goat milk

Table 1: The sensory evaluation of goat yogurt fermented under different inoculum

Inoculation (%)	Color	Smell	Taste	State	CE*
1	0.88	1.87	1.80	2.05	6.61
3	0.89	1.73	2.21	2.14	6.97
5	0.90	1.75	2.14	2.15	6.94
7	0.90	1.95	1.87	2.10	6.82
9	0.91	1.88	1.83	2.08	6.69

*: Comprehensive evaluation

and nine percent of the inoculum tend basically to be a faster speed of acid production. Which indicated that 3% inoculum was just moderate. acidity, pH value and total bacterial counts of 3% inoculum was 105°T, 4.16 and 3.92×10^9 CFU/mL, respectively. These results could be attributed to 1% inoculum was too little, resulting in bacteria slow-growing, However, 5, 7 and 9% inoculum was excessive, which inhibited bacteria growth and produced more acid.

Effect of inoculum on sensory evaluation of goat yogurt: The sensory evaluation of goat yogurt fermented under different inoculum showed in Table 1, according to five panelists' comprehensive evaluation in Table 1, inoculation had no obvious influence on the color and smell of goat yogurt. However, had a significant effect on the taste and organization state. The sour of goat yogurt was lighter and solidified softly in 3% inoculum. When the inoculum was more than 7%, goat yogurt was too sour and coagulated roughly and a small amount of whey was precipitated at the same time. sweet and sour of goat yogurt was moderate and had a good coagulation in 3-5% inoculation, This result could be related to the inoculation, lower incubation led to slow bacteria growth and metabolism, less acid and poor curd, However, higher incubation resulted in excessive acid, which cause the serious dehydration of protein in curd, more whey precipitation and rough texture, which affected the flavor of products.

Effect of temperature on the acid-producing and growth of yogurt strains: The effect of temperature on the production of acid and growth of bacteria showed in Fig. 4 to 6.

From above total bacterial counts had the same basically growth trend at each temperature, increased rapidly within 3 h and then increased slowly. The total bacterial counts at 37, 39, 41, 43 and 45°C was 1.26, 1.36, 1.8, 1.85, 1.65 ($\times 10^9$ cfu/mL), respectively. And acidity had a grown trend continuously at 41 and 43°C, increased gradually in the first 4 h until tend to stable in the 4 h at 37, 39 and 43°C, respectively. The acidity in the fermentation 4 h at each temperature was 95.2, 97, 103, 102.2 and 100°T, pH was 4.1, 4.03, 4.04, 4.00 and 4.0, respectively. Which indicated that 43°C was just moderate. Acidity, pH value and total bacterial counts at 43°C were 102.8°T, 4.02, 1.85×10^9 CFU/mL, respectively. These results could be related to the fact that the optimum growth temperature of LB and ST was 42-45 and 40-42°C, respectively. The bacteria growth was inhibited at 37-39°C low temperature and at 45°C high temperature and bacteria grown vigorous when incubated at 43°C.

Effect of temperature on sensor of goat yogurt: The sensory evaluation of goat yogurt fermented under different temperature showed in Table 2.

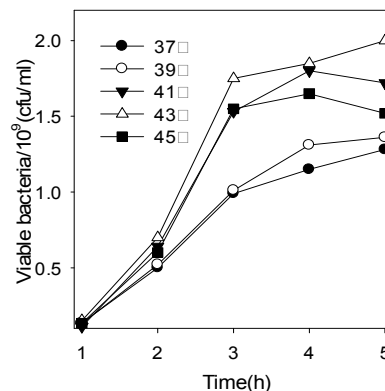


Fig. 4: Effect of temperature on total number of viable bacteria in goat milk

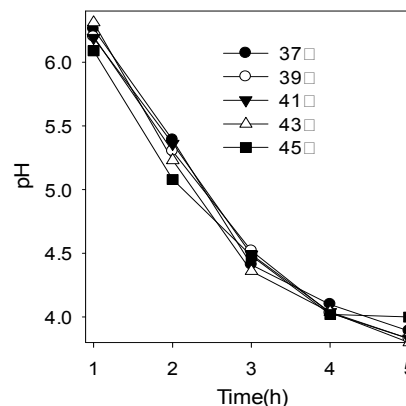


Fig. 5: Effect of temperature on pH in goat milk

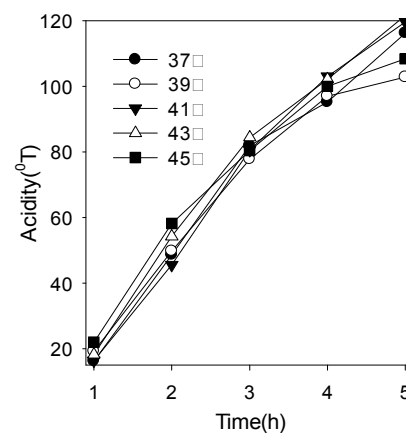


Fig. 6: Effect of temperature on acidity in goat milk

Table 2: Sensory evaluation of goat yogurt fermented under different temperature

Temperature (°C)	Color	Smell	Taste	State	CE*
37	0.93	2.01	1.64	1.83	6.41
39	0.91	1.93	1.95	2.10	6.89
41	0.91	1.93	1.90	2.11	6.85
43	0.93	1.97	2.07	2.15	7.12
45	0.93	1.88	1.88	2.08	6.77

*: Comprehensive evaluation

Five panelists' comprehensive evaluation in Table 2 showed that the sour of goat yogurt was slightly lighter and there was a slight smell, solidified softly at 37-39°C; sweet and sour of goat yogurt was moderate and the texture was even at 39-43°C, goat yogurt was too sweet and a small amount of whey was separate out at 45°C. This could be associated with the temperature, low temperature led to slow bacteria growth and metabolism and less acid; high temperature resulted in adversely producing fragrant and affected the formation of flavor compounds.

CONCLUSION

Inoculation and incubation temperature had significant effects on acidity, pH value and the total bacterial counts in the goat yogurt. The optimum inoculum in goat milk was 3% and the acidity, pH value and the total bacterial counts were 105°T, 4.16 and 3.92×10^9 CFU/mL; The optimum incubation temperature was 43°C and the acidity, pH value and the total bacterial counts were 102.8°T, 4.02, 1.85×10^9 CFU/mL, respectively.

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