

# DEVELOPMENT AND QUALITY EVALUATION OF PREBIOTIC YOGHURT FROM GOAT MILK

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## ABSTRACT

*An effort was made to develop functional yoghurt from goat milk by incorporating prebiotic component inulin at 0.5 and 1% level. The goat milk yoghurt without added inulin was used as control sample. The developed functional goat milk yoghurt and control were analysed for physico-chemical, microbiological and sensory qualities by standard procedures. Addition of inulin enhanced the Lactobacillus count of yoghurt samples. Apart from this prebiotic property, inulin was found to have an effect on controlling the development of acidity. Titratable acidity of inulin added yoghurt (1%) was within the legally permissible limit up to two weeks of refrigerated storage; whereas, in control yoghurt, acidity was within the permissible limit up to one week only. Inulin added samples obtained better sensory scores than the control. The addition of inulin to goat milk yoghurt contributed to the improvement of rheological characteristics of the product.*

**Keywords: Goat milk yoghurt, Functional yoghurt, Inulin, Prebiotics, Functional dairy products.**

## INTRODUCTION

Dairy goats produce about 15.2 million metric tons (MT) of milk, accounting for about 2% of the milk produced by livestock species in the world (FAOSTAT, 2008). The largest amount of goat milk is produced in India, followed by Bangladesh and Sudan. There are twenty well defined breeds of goats in India. Although majority of the breeds are meat type, breeds such as Jamunapari, Barbari, Beetal, Surti, Malabari and Jakhrana produce reasonably good amount of milk. The current goat milk production in India is around 4 million metric tones (FAOSTAT, 2008). The contribution of goat milk to the economic and nutritional wellbeing of humanity is indisputable. Goat milk is considered as a nutritional and therapeutic food. Goat milk possesses many

advantages over cow milk. It has better digestibility, lower allergenic properties, better immunological and antibacterial characteristics when compared to cow milk. It contains higher amounts of short-chain and medium chain fatty acids and also rich in important minerals such as calcium, magnesium and phosphorus. Despite all these benefits, goat milk in India is sold at relatively cheaper rates mainly because of the alleged goaty smell. During fermentation goat milk loses its characteristic 'goaty' odour. Moreover, the nutritive value of goat milk increases during fermentation. Therefore, developing a technology to process goat milk in to various fermented products will certainly improve the utilization of goat milk and thereby it will improve the socio economic status of marginal goat farmers.

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Yoghurt is a product which is obtained from fermentation of milk by using *Lactobacillus bulgaricus* and *Streptococcus thermophilus*. The product's acidification happens when lactose, is separated into two simpler components, glucose and galactose, with the production of lactic acid. Functional or beneficial properties of yoghurt can be enhanced by the addition of probiotics, prebiotics, conjugated linoleic acids, polyunsaturated fatty acids and caseino phosphopeptides. Among these, much attention has been focused on probiotics and prebiotics. Probiotic foods contain microorganisms or components of microbial cells that have a beneficial effect on the health and well-being of the consumer host. Prebiotics are non digestible food components that beneficially act on the host by selectively stimulating either the proliferation or the activity of bacterial populations that are desirable in the colon. From the nutritional and therapeutic point of view, the development of fermented caprine milk products containing probiotics/ prebiotics has a great potential to explore.

## MATERIALS AND METHODS

Goat milk for the study was collected from the University Goat and Sheep farm, College of Veterinary and Animal Sciences, Mannuthy. Inulin, a prebiotic powder (Orafti ® HP inulin) manufactured by Orafti, Belgium was gifted by Brenntag Ingredients India Pvt Ltd, Gurgaon. Fat and total solids percentages of goat milk were determined according to the procedure suggested by the Bureau of Indian Standards (Fat -IS: 1224, 1977; Total solids- IS: 12333, 1997). Goat milk yoghurt was prepared as per the method suggested by Maria Vargas *et al.* (2008). The milk was supplemented with 3.5% skim milk powder to increase solids not fat content. Then 6% sugar was added as a sweetening agent. The prebiotic component inulin was added at 0.5% and 1% level. The yoghurt without added inulin was used as control. The milk was pasteurized

at 90°C for five minutes and rapidly cooled to 40 - 42°C by immersing in ice cold water. Then it was inoculated with 3% yoghurt starter culture (NCDC-145, procured from NDRI, Karnal) and incubated at 42°C and fermented until the pH 4.7 was reached. Then the yoghurt was stirred using an electrical blender (Philips HR1453) to obtain desirable consistency. The yoghurt was then stored under refrigeration to study various parameters.

### Chemical analysis of goat milk yoghurt

Yoghurt samples were examined for fat (IS: 1224, 1977), total solids (IS: 12333, 1997) and titratable acidity (IS: 11766, 1986) at seven days intervals until 21 days of storage according to the procedure suggested by the Bureau of Indian Standards.

### Microbiological analysis of goat milk yoghurt

Yoghurt samples were examined for *Lactobacillus* count (IS: 18, 1980), coliform count (IS: 18, 1980) and yeast and mold count (IS: 18, 1980) at seven days intervals until 21 days of storage according to the procedure suggested by the Bureau of Indian Standards.

### Sensory evaluation of goat milk yoghurt

The fresh yoghurt samples were evaluated for their sensory characteristics such as colour, appearance, flavour, body & texture and for overall acceptability on a 5-point hedonic scale as per the method recommended by International Dairy Federation (1987). A semi trained panel consisting of seven members belonging to Department of Dairy science has evaluated the yoghurt samples.

### Statistical analysis

The data obtained from various studies were subjected to statistical analysis following the procedure described by Snedecor and Cochran (1994). One way analysis of variance (ANOVA) was done for comparing chemical

and microbiological parameters among different samples. Duncan's Multiple Range Test (DMRT) was carried out for pair wise comparison if F values are found to be significant in ANOVA. With regard to the sensory evaluation data, acceptability of different samples was compared by Friedman's Test. If the chi-square values in the test was found to be significant Wilcoxon Signed Ranks Test was carried out for comparing the treatment group pair wisely.

## RESULTS AND DISCUSSION

The mean fat, SNF and total solids percentage in goat milk were  $4.46 \pm 0.25$ ,  $8.76 \pm 0.58$ ,  $13.21 \pm 0.67$  respectively.

### Fat percentage of yoghurt

The mean fat percentage of control goat milk yoghurt, yoghurt with 0.5% inulin and 1% inulin during the storage are presented in Table 1. In the present study, control yoghurt had a significantly higher fat percentage than yoghurt containing 0.5% and 1% inulin. The fat percentage showed a slight increase during storage. The increasing trend in fat percentage can be attributed to the evaporation of moisture from the samples.

An increase in fat percentage of goat milk yoghurt during storage was also reported by Eissa et al. (2010). The fat percentage of goat milk yoghurt in their study was 4.41, 4.51, 5.00 and 4.83 during 0, 5 10 and 15 days of storage. They have reported a progressive increase in fat percentage up to 10 days of storage. Thereafter, they have noticed a slight decrease in fat percentage.

### Total solids percentage of yoghurt

The mean total solids percentages of control and treatment groups of yoghurt are presented in Table 2. The total solids percentage among yoghurt samples did not have a significant difference in the present study. The increasing trend in total solids percentage was observed during

storage. This can be attributed to the evaporation of moisture from the samples.

Kavas et al. (2003) have reported a progressive increase in total solids percentage in goat milk yoghurt during storage until 14 days. Eissa et al. (2010) have also reported increase in total solids percentage of goat milk yoghurt during storage. The values reported in their study were 13.2, 13.6, 13.2 and 14.5 for 0, 5, 10 and 15 days of storage respectively.

### Titrateable acidity of yoghurt

The mean titrateable acidity percentages of control and treatment groups of goat milk yoghurts during the storage are presented in Table 3. The titrateable acidity among different samples showed significantly higher values for ( $P < 0.01$ ) both control and yoghurt with 0.5% inulin than the yoghurt containing 1% inulin during storage. In the present study, the titrateable acidity of control samples reached beyond the permissible limit after 7<sup>th</sup> day of storage. In yoghurt containing 1% inulin, the acidity was within the legally permissible limit up to 14 days. The samples added with inulin exhibited a slower rate of increase in acidity. Paseephol et al. (2008) did not find any significant difference in pH and titrateable acidity among the samples added with different chain length inulins and control at day one. They have observed a slow increase in acidity and marginal fall in pH during the storage of the yoghurt samples for 28 days at 4°C.

### Lactobacillus count in yoghurt

The mean *Lactobacillus* count of control goat milk yoghurt, yoghurt with 0.5% inulin and 1% inulin during the storage are presented in Table 4. The *Lactobacillus* count among different samples showed significantly higher values for ( $P < 0.01$ ) goat milk yoghurt with 1% inulin than yoghurt containing 0.5% inulin and control. From the above findings, it can be concluded that

the addition of inulin stimulated the growth of *Lactobacillus* in yoghurt.

Gustaw et al. (2011) studied the influence of prebiotics on the growth of LAB. They have reported that prebiotics such as Fructooligosaccharides and inulin when added to bio-yoghurt exhibited stimulatory effect on the growth of *L. acidophilus* and *Bifidobacterium* sp. Mazloomi et al. (2011) reported that the addition of inulin increased the viability of *L. acidophilus*, *S. thermophilus* and *L. delbrueckii* ssp. *bulgaricus* during the storage of synbiotic yoghurt.

### Coliform count in yoghurt

The mean coliform count of control goat milk yoghurt, yoghurt with 0.5% inulin and 1% inulin during the storage are presented in Table 5. From 7<sup>th</sup> day of storage onwards coliforms were not detected in all the three groups of yoghurts. The coliform count among different samples revealed significantly higher values for ( $P < 0.01$ ) control than goat milk yoghurt containing 0.5 and 1% inulin.

### Yeast and mold count in yoghurt

The mean yeast and mold count of control and treatment groups of goat milk yoghurt are presented in Table 6. The yeast and mold count among different samples showed significantly higher values for ( $P < 0.01$ ) control than goat milk yoghurt containing 1% and 0.5% inulin during 14<sup>th</sup> and 21<sup>st</sup> days of storage. In the present study, yeast and mold count increased in all yoghurt samples during storage. It may be attributed to the fact that an increase in acidity and/or reduction in oxidation reduction potential may have provided suitable conditions for the growth of yeast and molds.

Eissa et al. (2010) reported that the yeast and mold count of goat milk yoghurt were  $2.5 \times 10^4$ ,  $2.4 \times 10^4$ ,  $7.95 \times 10^7$  and  $1.3 \times 10^5$  for 0, 5, 10 and 15 days of storage respectively.

### Sensory evaluation of yoghurt

The mean appearance & colour, body & texture, flavour and overall acceptability scores of control and treatment groups of yoghurt are presented in Table 7. The sensory scores among different samples showed significantly higher values for goat milk yoghurt with 1% and 0.5% inulin ( $P < 0.01$ ) than control.

In the present study, inulin incorporated yoghurt samples scored better than control. The addition of inulin improved the organoleptic qualities such as texture and mouth feel characteristics and there by enhanced the overall acceptability of goat milk yoghurt.

Spiegel et al. (1994) reported that the overall acceptability of yoghurt containing inulin was higher than control. Inulin was found to positively influence the sensory properties of yoghurt making it more preferred when compared to the yoghurts without inulin

Kip et al. (2006) found that inulin contributed to an improved creamy mouth feel and also had a positive effect on thickness and stickiness of yoghurt during cold storage.

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**Table 1. Fat percentage (Mean± SE) of yoghurt samples during storage**

Sample	1 <sup>st</sup> Day	7 <sup>th</sup> Day	14 <sup>th</sup> Day	21 <sup>st</sup> Day
Control	4.94±0.12 <sup>a</sup>	5.02±0.91 <sup>a</sup>	5.14±0.08 <sup>a</sup>	5.28±0.07 <sup>a</sup>
T <sub>1</sub> (0.5% Inulin)	4.66±0.11 <sup>ab</sup>	4.74±0.10 <sup>ab</sup>	4.88±0.14 <sup>ab</sup>	4.92±0.13 <sup>b</sup>
T <sub>2</sub> (1% Inulin)	4.42±0.13 <sup>b</sup>	4.42±0.12 <sup>b</sup>	4.52±0.11 <sup>b</sup>	4.56±0.12 <sup>c</sup>
F-value	4.269*	7.638**	6.858**	9.624**

\*\* Significant at 0.01 level; \*significant at 0.05 level (Means bearing same superscript are homogeneous)

**Table 2. Total Solids percentage (Mean± SE) of yoghurt samples during storage**

Sample	1 <sup>st</sup> Day	7 <sup>th</sup> Day	14 <sup>th</sup> Day	21 <sup>st</sup> Day
Control	36.80±1.15	37.40±1.43	38.60±1.32	40.00±1.37
T <sub>1</sub> (0.5% Inulin)	35.80±1.35	37.00±1.37	38.20±1.28	39.80±1.28
T <sub>2</sub> (1% Inulin)	35.60±1.32	36.00±1.41	37.20±1.24	38.40±1.40
F-value	0.251 <sup>ns</sup>	0.262 <sup>ns</sup>	0.316 <sup>ns</sup>	0.415 <sup>ns</sup>

ns non-significant at 0.05 level

**Table 3. Titratable acidity (percent Lactic acid) of yoghurt samples (Mean± SE) during storage**

Sample	1 <sup>st</sup> Day	7 <sup>th</sup> Day	14 <sup>th</sup> Day	21 <sup>st</sup> Day
Control	1.04±0.02 <sup>a</sup>	1.21±0.02 <sup>a</sup>	1.29±0.01 <sup>a</sup>	1.44±0.01 <sup>a</sup>
T <sub>1</sub> (0.5% Inulin)	1.05±0.35 <sup>a</sup>	1.18±0.02 <sup>a</sup>	1.31±0.01 <sup>a</sup>	1.41±0.01 <sup>a</sup>
T <sub>2</sub> (1% Inulin)	0.94±0.02 <sup>b</sup>	1.04±0.03 <sup>b</sup>	1.24±0.11 <sup>b</sup>	1.32±0.02 <sup>b</sup>
F-value	4.467*	8.60**	10.12**	24.111**

\*\* Significant at 0.01 level; \* significant at 0.05 level (Means bearing same superscript are homogeneous)

**Table 4. *Lactobacillus* count (Mean± SE) of yoghurt samples (log cfu/g)**

Sample	1 <sup>st</sup> Day	7 <sup>th</sup> Day	14 <sup>th</sup> Day	21 <sup>st</sup> Day
Control	16.89±0.15	18.80±0.06 <sup>c</sup>	19.64±0.05 <sup>b</sup>	19.92±0.02 <sup>b</sup>
T <sub>1</sub> (0.5% Inulin)	16.76±0.09	19.29±0.076 <sup>b</sup>	19.76±0.05 <sup>b</sup>	20.04±0.04 <sup>b</sup>
T <sub>2</sub> (1% Inulin)	16.83±0.09	19.50±0.04 <sup>a</sup>	19.94±0.052 <sup>a</sup>	20.23±0.55 <sup>a</sup>
F-value	0.314 <sup>ns</sup>	31.06**	8.57**	14.03**

\*\* Significant at 0.01 level; ns non-significant at 0.05 level (Means bearing same superscript are homogeneous)

**Table 5. Coliform count (Mean± SE) of yoghurt samples during storage (log cfu/g)**

Sample	1 <sup>st</sup> Day	7 <sup>th</sup> Day	14 <sup>th</sup> Day	21 <sup>st</sup> Day
Control	3.45±2.03 <sup>a</sup>	Nil	Nil	Nil
T <sub>1</sub> (0.5% Inulin)	3.36±2.16 <sup>ab</sup>	Nil	Nil	Nil
T <sub>2</sub> (1% Inulin)	3.06±3.07 <sup>b</sup>	Nil	Nil	Nil
F-value	4.60**	Nil	Nil	Nil

\*\* Significant at 0.01 level; (Means bearing as superscript are homogeneous)

**Table 6. Yeast and Mold count (Mean± SE) of yoghurt samples during storage (log cfu/g)**

Sample	1 <sup>st</sup> Day	7 <sup>th</sup> Day	14 <sup>th</sup> Day	21 <sup>st</sup> Day
Control	1.46±0.45	4.69±0.07	11.34±0.07 <sup>a</sup>	13.40±0.05 <sup>a</sup>
T <sub>1</sub> (0.5% Inulin)	1.46±0.62	4.60±0.08	11.17±0.08 <sup>ab</sup>	13.19±0.07 <sup>b</sup>
T <sub>2</sub> (1% Inulin)	1.50±0.62	4.48±0.09	10.95±0.91 <sup>b</sup>	12.99±0.070 <sup>b</sup>
F-value	0.123 <sup>ns</sup>	1.615 <sup>ns</sup>	5.199 <sup>*</sup>	9.359 <sup>**</sup>

\*\* Significant at 0.01 level; \* significant at 0.05 level; ns non-significant at 0.05 level Means bearing same superscript are homogeneous

**Table 7. Sensory evaluation (Mean± SE) of yoghurt samples**

Sample name	Appearance and colour	Body and texture	Flavours	Overall scores
Control	3.43±0.3 <sup>b</sup>	3.00±0.30 <sup>b</sup>	3.29±0.18 <sup>b</sup>	13.00±0.87 <sup>b</sup>
T <sub>1</sub> (0.5% Inulin)	4.57±0.20 <sup>a</sup>	4.07±0.170 <sup>a</sup>	4.21±0.24 <sup>a</sup>	17.00±0.85 <sup>a</sup>
T <sub>2</sub> (1% Inulin)	4.36±0.21 <sup>a</sup>	3.86±0.18 <sup>a</sup>	4.07±0.25 <sup>a</sup>	16.43±0.79 <sup>a</sup>
Chi-square value	9.33 <sup>**</sup>	6.87 <sup>*</sup>	7.58 <sup>*</sup>	9.55 <sup>**</sup>

\*\*Significant at 0.01 level; ns non-significant at 0.05 level  
(Means bearing same superscript are homogeneous)