Evaluation of Quality Characteristics of Goat Milk Yogurt Incorporated with Beetroot Juice

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***Abstract*-** Production of goat milk has increased worldwide due to its numerous health benefits. Goat milk is a rich source of proteins, vitamins, minerals as well as many short and medium chain fatty acids. Goat milk has better digestibility, lower allergenicity and suitable for those who suffer from lactose intolerance. Considering those health benefits, current study was carried out to produce a goat milk yogurt and identify the plausibility use of beetroot juice to mask the goaty flavor. Yogurt samples were stored at 4^{o}C and physicochemical evaluation was conducted for 21 days at the interval of seven days. Addition of beetroot juice into goat milk increased moisture content and lowered total solid content while fat, protein and ash contents were non-significant during the storage. The titratable acidity of plain goat milk yogurt and beetroot yogurt decreased from 0.91% to 0.80% and 0.85% to 0.84% respectively where as pH increased from 4.45 to 4.54 for plain goat milk yogurt and 4.34 to 4.64 for beetroot yogurt after 21 days of storage. Highest microbial count was observed after 14 days of storage; 18.70 x10^{6} for plain yogurtand 17.56 x10^{6} for beetroot yogurt. Sensory evaluation revealed that 4% is the most preferred beetroot juice concentration out of 4%, 6% and 8%. Ninety eight percent panelists preferred to consume beetroot yogurt and most of them were willing to pay Rs.45/- for the new product.

***Index Terms*-**Yogurt, goat milk, beetroot, physicochemical, health benefits

I. INTRODUCTION

Goat is considered as the poor man's cow. In the developing world, goat can fulfill the difference between malnourished and healthy sustaining diet [1]. Production of goat milk worldwide has increased in recent years. It has many beneficial effects for human health. The nutritional and healthy values of fermented milk and beverages were well-described [2].France is the highest goat milk producing country while Spain, Greece and Turkey are in second, third and fourth respectively[3].

There are many more value added products made of goat milk such as butter, frozen yogurt, and the manufacture of fluid goat milk products including low fat, fortified or flavored milks, cultured products such as buttermilk or yogurt, frozen products such as ice cream, condensed milk and dried milk products[2]. Composition of goat milk varies according to different factors including diet, breed, individuals, parity, season, feeding, management environmental conditions, locality, stage of lactation, and health status of udder [4]. Table 01 shows the composition of goat milk.

Table 01. Average nutrient composition of goat milk

[3] = Yangilar(2013); [10] = Domagala*et al*.,(2007); [11] = Gaddour et al., (2013); [12] = Bano et al., (2011); [13] = Pegler, (2005)

Composition	**[3]**	**[10]**	**[11]**	**[12]**	**[13]**
Fat (%)	3.8	3.2	3.96	4.1	5.14
Solids-non-fat (%)	8.9	7.54		9.91	9.92
Lactose (%)	4.1	4.72		4.38	5.28
Protein (%)	3.4	2.78	3.13	3.96	
Casein (%)	2.4	2.28			4.06
Non-protein N (%)	0.4	0.31			
Ash (%)	0.8	0.82	0.78	0.71	0.93

Goat milk has high protein content, higher vitamin A and B contents, a higher content of free amino acid Taurine, and a higher proportion of short to medium chain fatty acids and considerable amount of calcium and phosphorous. However, the average goat milk consumption is not significantly different from cow milk. Goat milk with its low lactose content is more suitable for those who suffer from lactose intolerance often caused by cow's milk [5]. Overall, adult daily dietary nutrient recommendations for essential amino acids would be met equally or exceeded by a 0.5L goat milk consumption compared to cow milk [6]. Furthermore, caproic, caprylic, capric and other medium chain fatty acids have been used for the treatment of malabsorption-related syndromes,intestinal disorders, coronary diseases, premature infant nutrition,cystic fibrosis and gallstone problems because of their unique metabolic ability to provide energy while at the same time lowering, inhibiting and dissolving cholesterol deposits [3, 7].

Goat milk has many special characteristics that can be attributed to number of health benefits. Goat milk`s nutritional properties and lower allergenicity in comparison to cow milk, especially in non-sensitized children, has led to an increased interest in goat milk as a functional food, and it now forms a part of thecurrent trend to healthy eating in developed countries [3].Furthermore, it has beneficial effects for health maintenance, physiological

functions, in the nutrition of children and elderly people. Goat milk has better digestibility,alkalinity, buffering capacity and certain therapeutic values in medicine and human nutrition. There are some technological advantages of goat milk in comparison to cow milk, for instances; smaller fat globule size, which provides a smoother texture in derived products, lower amount of α_{s1}-casein , resulting in softer gel production, a higher water holding capacityand a lower viscosity[3].

Beetroot (*beta vulgaris*) containspotassium, magnesium,iron, vitamin A,B_6 and C, folic acid, carbohydrates,protein, antioxidants and soluble fiber. Beta-cyanin is the compound that gives beetroot its purplish red colour and is also a powerful antioxidant. It helps to reduce the oxidation of LDL-cholesterol and does not allow it to deposit on the walls on artery. This protects the heart from potential heart attacks and stroke. Beta-cyanincontainin beetroot also helps to slow the growth of tumors andgive protectionagainst cancers. Coles and Clifton (2012) have found that, 500g of beetroot everyday reduces a person's blood pressure within six hours [8]. Nitrate is the special ingredient in beetroot which lowers blood pressure and may help to fight heart disease. Additionally, drinking beetroot juice could boost brain power and may treat dementia through increasing oxygen uptake by the body. On the other hand, yogurt is one of the most popular fermented milk product manufactured from milk of different animal species including goatwith a number of promising health effects and was originated in 6000 B.C.[9].

Hence, it can be hypothesized that the incorporation of beetroot juice into goat milk yogurt can enhance nutritional value of the yogurtin addition to the health benefits.Therefore the aim of the current study was to incorporate beetroot juice into the goat milk yogurt in order to mask the goaty-flavor of milk as well while attractingmore consumers by using the colourof beetroot and to determine the physical, chemical, microbiological and sensory characteristics of the new product.

II. MATERIALS & METHODS

Yogurt preparation

Fresh raw goat milk was obtained from local farms in Sandalankawa and Bibiladeniya, North Western province, Sri Lanka. Food- grade ingredients including sugar, gelatin and beetroot were purchased from a grocery shop in Makandura. Yogurt preparation was carried out at the laboratory of Food Science and Technology, Wayamba University of Sri Lanka.

The beetroot was washed, peeled off and chopped into small pieces. The juice was extracted by blending and straining respectively. The beetroot juice was then heated at 80^{o}C for 15 minutes.Three concentrations; 4%, 6%,and 8% were prepared using the heat treated beetroot juice.

The goat milk was cream separated in order to obtain the desired fat content(2.5%) for the yogurt which was then pasteurized at 85^{o}C for 30 minutes. Eight percent (8%) of sugar was added during the last 5 minutes of the pasteurization. The heated milk was mixed with 1% gelatin and then cooled to 43-45^{o}C. The commercial yogurt starter culture (0.2 g/1L) contains 1:1 ratio of *Streptococcus thermophilus and Lactobacillus bulgaricus*was inoculated to the mixture. The raw milk was divided into four equal portions;one for control and the other three for the experiments. Beetroot juice was added to the experimental milk samples at 4%,6% and 8% levels. The samples were then incubated at 45^{o}C for nearly 5 hours and stored in a refrigerator at 4^{o}C until used.

Sensory evaluation

Two sensory evaluations were carried out using untrained panel including 50 panelists from Wayamba University of Sri Lanka. Yogurt samples were served in randomized order in yogurt cups coded with three random digits. The most preferred goat milk yogurt incorporated with different beetroot juice concentrations (4%,6%,8%) was determined during the first sensory evaluation using a ranking test according to the preference.

Second sensory evaluation was conducted using a 5 point hedonic scale in which a cow milk yogurt along with a plain goat milk yogurt were used as controls against the beetroot juice added goat milk yogurt products. The intention was to evaluate the sensory parameters including colour, body and texture, goaty flavor, odor and overall acceptability.

Proximate analysis

The yogurt samples were analyzed for moisture and fat content using sand pan technique[14] and Gerber method[15]. Whereas the crude protein, ash content and total soluble solids contents were determined according to the AOAC Protocols[16].

Chemical analysis

The pH of the yogurt samples were measured using a pH meter(Eutech instrument, model 510, Malaysia), whereas acidity was determined by titration with 0.1N NaOH[16]. Yogurt samples were monitored for pH and acidity after fermentation for 1,7,14 and 21days at 4^{o}C of storage.

Microbiological analysis

Prepared yogurt samples were analyzed for total bacterial count, total coliform count, and yeast and mold count after fermentation for 1,7,14 and 21 days. One gram of yogurt sample was diluted with 9mL of distilled water. Peptone water was used for the serial dilution. Total bacterial count was determined using plate count agar, and incubated at 37^{o}C for 48h. Colony counter was used for the enumeration of total bacterial count. Culture tubes with MacConkey broth was used as the medium for the determination of coliform, and incubated at 37^{o}C for 48h. Presence of air bubbles in the Durham tubes or any colour change indicated the positive results of coliform. Yeast and mold count was determined by inoculating the samples on potato dextrose agar and incubated at 25^{o}C for 5 days.

Statistical analysis

Yogurt samples were analyzes statistically for chemical and proximate analysis using t-test by SAS 9.2 version. Sensory evaluation was recorded with five point hedonic scale and data obtained were analyzed using Chi-square in SAS 9.2 version and Kruskal-Wallis Test in MINITAB 15. All the significances were determined at $\alpha = 0.05$.

III. RESULTS & DISCUSSION

Sensory evaluation

The results of the first sensory evaluation shown that most preferred beetroot juice added yogurt was the one with the lowest concentration(4%) of beetroot juice having a significant difference ($P<0.05$) compared to 6% and 8% concentrations. Results from the sensory tests for the colour, body and texture, goaty flavor, odor and overall acceptabilityof yogurts are shown in Table 02. The panelists were able to distinguish a significant difference ($P<0.05$) in all attributes among the three yogurt samples. Cow milk yogurt gained higher acceptance for all attributes tested. Beetroot juice was added to the goat milk yogurt with the intention of enhancing the colour and it was proved by gaining a higher score for the colour of beetroot yogurt (3.82) than the plain goat milk yogurt (3.6).

A reduction of the scores for body and texture was observed in both goat milk and beetroot yogurt. A higher score for goaty flavor in beetroot yogurt than goat milk yogurt was observed indicating a higher acceptability for the flavor of the new product. It may be due to the masking ability of the peculiar flavor by the addition of beetroot juice. Analysed results for odor showed slightly higher score for beetroot yogurt than goat milk yogurtindicating that through the incorporation of beetroot juice, the odor has decreased up to some extent. Average overall acceptability scores ranged from 3.24 to 4.38 among the three yogurt samples. Moreover, theresults showed that the overall acceptability of beetroot yogurt was not significantly different ($P>0.05$)from goat milk yogurt although beetroot yogurt gained a higher overall acceptability.

According to Berridge (1996), preference assessments are dependent on the psychological or functional components of pleasure of eating as complexity of neuron system, determined the liking extent unconsciously [17].However,98% of the panelists preferred to consume beetroot yogurt. From those who preferred, 74% were willing to pay Rs.40/- for the new product whilst 18%, 2% and 6% were willing to pay Rs.45/-, Rs.50/- and Rs.55/- respectively.

Proximate Analysis

Higher moisture content was observed in beetroot juice added goat milk yogurt than in the control (Table 03). Water contained in the beetroot juice contributed to the final moisture content of the yogurt. A certain amount of moisture in the milk and beetroot juice was lost during the heating process. Similar results were reported for goat's milk *dadih* incorporated with tropical- fruit puree [5]. Bonding between the water and the milk protein occurred to a certain extent and it might resulted in lower amounts of moisture, compared with the actual moisture content. The fat content was not significant between the yogurt samples. The beetroot used for the incorporation with the yogurt, contained very low levels of fats. The fat content of the beetroot juice added goat milk yogurt was contributed primarily by the fat present in the goat milk. Jenness (1980) has mentioned that the fat content in goat milk(4.1%) varies according to the breed and there is a higher digestibility of goat milk compared to cow milk due to the smaller size of the fat globules, having a great surface area, and lipase in the gut supposedly able to attack the lipids faster [4].

The protein content of the yogurt samples were not significant as the protein in beetroot was not considerable enough to contribute for the evaluated yogurt sample. No significant differences in ash content were observed among the yogurt samples. Total solid content was significantly higher ($P<0.05$) in the control yogurt which is probably due to the higher amount of lactose present in the control (Table 03). Moreover, the beetroot juice contained more water than solid matters which contributed to a low total solid content.

Table 02.Sensory attributes of cow milk, goat milk and beetroot juice incorporated yogurt samples

Attributes	Cow milk yogurt	Goat milk yogurt	Beetroot yogurt
Colour	4.08 ± 0.82^{a}	3.6 ± 1.16^{b}	3.82 ± 0.74^{ab}
Body & Texture	4.08 ± 0.90^{a}	3.56 ± 0.99^{b}	3.18 ± 0.97^{b}
Goaty flavor	4.18 ± 0.85^{a}	2.94 ± 0.85^{b}	3.18 ± 0.96^{b}
Odor	4.22 ± 0.76^{a}	3.16 ± 1.02^{b}	3.22 ± 0.85^{b}
Overall acceptability	4.38 ± 0.63^{a}	3.24 ± 0.89^{b}	3.42 ± 0.95^{b}

Mean values in the same row with different letters are significantly different ($P<0.05$). n=50

Table 03.Physicochemical characteristics of plain and beetroot incorporated goat milk yogurt

Composition	Plain goat milk yogurt	Beetroot yogurt
Moisture (%)	75.04 ± 0.43^{a}	79.08 ± 0.60^{b}
Fat (%)	2.36 ± 0.05^{a}	2.46 ± 0.05^{a}
Protein (%)	4.47 ± 0.01^{a}	4.59 ± 0.09^{a}
Ash (%)	0.92 ± 0.06^{a}	0.93 ± 0.02^{a}
TS (%)	23.56 ± 0.40^{a}	20.42 ± 0.22^{b}

Mean values in the same row with different letters are significantly different ($P<0.05$).

Chemical analysis

The results of the changes in pH during the storage period of two yogurt samples are illustrated in the Figure 1. A significant difference in the pH change was observed at day 7 of storage at $4^{o}C$; whereas the results showed that the addition of beetroot juice into goat milk did not make a significant effect ($P>0.05$) during the rest of the storage period. Seelee*et al.,* (2009)reported that goat milk supplemented with 3% skim milk powder had a

slight decrease in pH during the storage at 4°C over three weeks[18]. The decrease of pH was observed throughout the storage period and this may be due to the growth of bacteria that converts lactose into lactic acids.

Titratable acidity (TA)of beetroot juice added yogurt increased gradually compared to the control during the storage at 4°C for 3 weeks (Figure 2). The rich source of sugar provided by the beetroot juice may serve as a suitable substrate for the growth of microbes. The TA of the two yogurt samples were significantly high (P<0.05)at the first day and similar changes were observed for at 1,7,14 and 21 days of storage.

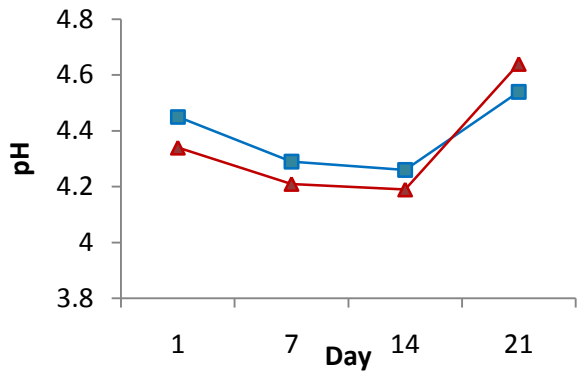

Figure 1.Changes of pH of control yogurt(□) and beetroot incorporated yogurt (△during storage.

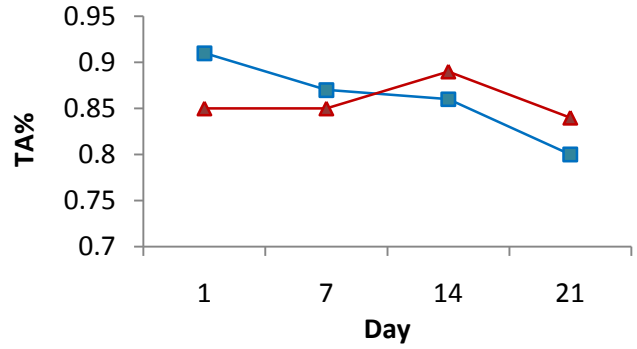

Figure 2. Changes in titrable acidity of control yogurt (□) and beetroot incorporated yogurt(△during storage.

Microbiological analysis

The data on the total microbial count in control and beetroot juice incorporated yogurt samples showed (Table 04) an insignificant difference during the day 1 and 21, whereas the means for the total bacterial count were significantly different (P<0.05) during day 7 and 14. Peak of the total microbial count was observed at 14 days of storage for control and beetroot juice added yogurt (18.70 $x10^6$ ±0.10 $x10^6$ and 17.56 $x10^6$± 0.11 $x10^6$)respectively. Total microbial count showed a reduction after 21 days of storage (6.96 $x10^6$± 0.15 $x10^6$ and 6.66 $x10^6$± 0.15 $x10^6$). This may be due to the inhibition of the growth of microorganisms as a result of acid production. According to Tamime (1990) as cited in Seelee (2009) during fermentation,*S.thermophilus* produced lactic acid and formic acid which activate the growth of *L.bulgaricus* that produced diacetyl and acetaldehyde. These compounds reported to give the typical yogurt flavor [18].Coliform were absent during the 21 days of storage life whilst 1-2 yeast and mold colonies were observed during the latter part of the storage period.

Table 04. Results for the microbial count of plain and beetroot juice added goat milk yogurt

	Plain goat milk yogurt			**Beetroot incoporated goat milk yogurt**		
Day	TPC ($x10^6$) CFU/g	Coliform	Yeast & mold	TPC ($x10^6$) CFU/g	Coliform	Yeast & mold
1	4.76 ±0.05	Nil	Nil	4.70 ±0.10	Nil	Nil
7	8.10 ±0.10	Nil	Nil	11.03 ±0.05	Nil	Nil
14	18.70 ±0.10	Nil	Nil	17.56 ±0.11	Nil	Nil
21	6.96 ±0.15	Nil	Nil	6.66 ±0.15	Nil	Nil

IV. CONCLUSION

Results suggest that the incorporation of beetroot extract could mask the goaty-flavor and goaty-odor of the yogurt made from goat milk. Four percent (4%) incorporation level of beetroot juice preferred most by the panelists against 6% and 8%. Moreover, addition of beetroot juice did not change the pH and titratable acidity significantly compared to plain yogurt made from goat milk. Based on the results it can be concluded that the inclusion of beetroot juice increase the consumer preference. Therefore, it can be concluded that the incorporation of beetroot juice may be a promising method to mask the goaty-flavor and goaty-odor associated with goat milk yogurt while enhancing the consumer preference.

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