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Lactic Acid Bacteria Viability and Sensory Evaluation of Yogurt Prepared From Different Breeds Goat Milk

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Abstract

THIS STUDY was conducted on six breeds of dairy goats (Nubian, Cross Nubian And Saidi, Aradi, Shami, Sheraky) To investigate the In-Breeding Differences On the milk composition produced from each breed. The gross components of the six breeds milk were analyzed by Milk Scan And The Yogurt Was Prepared From Each. The viability of two strains of starters (*Lactobacillus bulgaricus* And Streptococcus thermophilus) were used in manufacturing of the yogurt was measured, As well as the sensory and rheological properties of the produced yogurt. The results obtained by milk scan reflected that the fat and total solids percentages were higher in 2 breeds goat milk (Nubian And Shami) than the other breeds, by 4.47, 06.97% for fat and 11.86, 18.48 % for total solids, respectively. The viability of *lactobacillus (L.) bulgaricus* in yogurt at day 12 of storage was The Highest In The Yogurt Of Nubian And Shami Goat Milk 1.9x 107 And 2.1 X 107 Colony forming unit Cfu/G, respectively, while, the strain *Streptococcus thermophilus* showed The viability rate at day 12 of 5.0 X 108 and 505 X 109 Cfu/G in cross Nubian and Shami yogurt, respectively. The Sensory Evaluation And Over All Acceptability Were High In Yogurt Of Cross Nubian And Nubian and Shami breeds, respectively, The study observed a strong connection between Ts percentage and Yogurt production, but the acceptability of Yogurt was varying across breeds. The aim of this study was to declare the differences and produce a suitable yogurt acceptable to consumers to get complete benefits from goat breeding.

Keywords: Goat milk, Yogurt, Lactic Acid Bacteria, Starter.

Introduction

Goats, often referred to as the "poor person's cow," were among the earliest farm animals to be domesticated. They are versatile animals, providing meat, milk, hide, and fiber, which are utilized across various industries. [1, 2]. They are more adapted for survival in varying environmental conditions and different nutritional regimes than cattle, buffalo or sheep due to their mobile upper lip and higher digestive efficiency for cellulose [3, 4].

In Egypt, the goats are classified into several breeds, such as Zaraibi (Nubian), Baladi, Sinawi or Bedouin, Barki and Saidi. The most common goat breeds are Baladi, Barki and Zaraibi breeds [5, 6]. However, the widely spread goat breeds in Kingdom of Saudi Arabia (KSA) are mainly Ardi, Jabali and Shami goats [7].

Goats are usually reared in extensive, semi-intensive and smallholder holdings as mixed flocks with sheep and other farm animals like cattle and buffaloes [8]. The main reasons for keeping goats were for meat, milk, cash and the use of goats for social roles values and exchange for cows [9, 10]. Goat milk contains 3.8% fat, 3.4% protein, 4.1% lactose, 0.8% ash, 8.9 % SNF and 87% water. Goat milk has various superior benefits in human nutrition and food security than other dairy species [11]. immune stimulation and disease prevention due to

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the presence of higher amounts of conjugated linoleic acids and better digestibility of the lipids of goat milk [12, 13]. The most important effect of goat milk proteins is low allergic reaction and low lactose contents comparing to cow milk [14]. In contrast, goat milk rich in oligosaccharides is important in its protective function of intestinal flora against pathogens. In addition, it contains higher Vitamin A content, which is almost similar to human milk, compared to cow milk [15]. Yogurt, as a fermented food, is a source of probiotics with beneficial effects in gastrointestinal and systemic health [16]. Additionally, it increases the bioavailability of nutrients as vitamin B-12, calcium, and magnesium that is needed by children and elderly people [16].

Lactic acid bacteria (LAB) have been used for food production. It includes the genera Lactobacillus sp. Bifidobacterium sp., Lactococcus sp., and some to Bacillus sp. All species of the Lactobacillus genus are known to inhibit the growth of pathogenic bacteria, stimulate immune function, and enhance the bioavailability of food ingredients and minerals [17, 18]. Furthermore, yogurt containing Lactobacilli considered to be able to reduce pathogenic bacteria in the human gut [19].

Due to several therapeutic values of goat milk and benefit of yogurt as fermented dairy product. Therefore, awareness about advantage of consumption of goat's milk should be popularized so that production and utilization of goat milk could be enhanced [20].

Therefore, this work was deigned to give insight on the impact of the milk from six breeds of goat (Nubian (NUB), cross Nubian (CrN) and Saidi (SAD), Aradi (ARD), Shami (SHM), Sheraky (SRK) were widely distributed in Egypt and Saudi Arabia on chemical and sensory constructions of produced yogurt, as well as lactic acid bacteria viability.

Material and Methods

Goat milk samples

Raw milk from six goat breeds were obtained, three of them were from Egypt, Nubian (NUB), cross Nubian (CrN) and Saidi (SAD) and the other three breeds were from Saudi Arabia Aradi (ARD), Shami (SHM) and Sheraky (SRK) (Photo 1.). The milk was collected in all breeds by direct milking and after two weeks of parturition.

Chemical analysis of raw milk

The Raw milk samples from each breed were examined by the milk scan (MCCW Milkotronic Ltd, Bulgaria) at department of food hygiene, faculty of veterinary medicine, Mansoura University. The sampling was carried out to detect fat, solid non- fat (SNF), total solids (TS), density, protein, lactose, added water, freezing point, conductivity, pH, and salts.

Preparation of yogurt

Starter culture

Tow strains of *Lactobacillus (L.) bulgaricus* and *Streptococcus (S.) thermophilus* (YoFlex® Express 2.0 Chr Hansen, Hørsholm, Denmark) were used to manufacture traditional yogurt by inoculating the starter bacteria in a previously pasteurized temperate milk (40°C) at a ratio of 1:1000 and mixed by electronic mixer. After that, the milk was incubated at 42°C until formation of suitable curd and\or reaching to 4.5 pH.

Lactic acid bacterial count

The viability of both *L. bulgaricus* and *S. thermophiles* was investigated by determining the colony forming unit (CFU/g) during a period of 12 days with 72 h intervals. During the sampling period the yogurt was reserved in the refrigeration. The pour plating technique on MRS (De Man–Rogosa–Sharpe agar, HiMedia, India) agar medium was used to enumerate *L. bulgaricus*. Briefly, five grams of previously mixed yogurt sample were suspended in 45 mL sterile saline solution (0.9% NaCl), and serially diluted by a factor of 10 until 10^9. A 100 µL of each diluted yoghurt sample were mixed with 15 mL liquid MRS agar (45 °C). The plates were left to solidify, then, incubated at 37°C for 48h. After incubation, the viable count of *L. bulgaricus* was calculated (CFU/gm) and expressed by the means of three replicates [21]. From the same dilutions, the counting of *S. thermophilus* was performed by using M17 (HiMedia Laboratories, India) agar supplemented with lactose solution 10% [22]. A 0.1 mL of prepared yogurt sample dilution was placed on the M17 agar and spread using a sterile glass spreader then incubated at 37°C for 48 h. After incubation period, the viable microbial count (*S. thermophilus*) was calculated taking into consideration the dilution rate. The count values are expressed by the means of three replicates.

Sensory evaluation

Coagulation time

Coagulation time was determined to each goat breed yogurt sample by calculating the time in minutes passed from inoculation of starter till formation of curd and reaching pH 4.5 [23].

Water holding capacity

The water holding capacity (WHC) of yogurt developed from goat milk was detected according to Everett and McLeod [24]. From each yogurt sample (30 g) were centrifuged at 200 rpm for 10 mints. After centrifugation, the amount of the supernatant was measured in mL and expressed the amount of syneresis. The evaluation was based on the lower

serum content indicated the lower syneresis and good WHC and vice versa.

Rheological properties

The color, taste, firmness, mouth felling and over all acceptability of coded yogurt samples were measured by seven-point scorecard (1 = dislike very much and 7 = like very much). A total of 31 non experienced panelists (12 men and 19 women) aged between (20-35 years) were asked to score the quality of coded yoghurt samples on the evaluation score card [25].

Discussion

The various milk samples collected from all the six goat breeds under investigation are examined for milk composition, Viability of LAB in yogurt, Coagulation time, Sensory evaluation of produced yogurt. the results mentioned in the tables and figures showed the following:

Milk composition

The average gross composition of the six-goat milk used to prepare the yogurts is given in Table 1. The results showed variations in milk composition for each goat breed. The fat percent was differing across the six breeds, Shami breed showing a very high fat percent (6.97%), while this amount was 2.28% in Saidi breed. This fat percent may be responsible for characteristic aroma of goat milk and yogurt. Referring to the TS percent, it was higher in Shami breed too (18.48%), this explains the good firmness and the short coagulation time of yogurt for this breed [3, 26, 27]**.** Shami goat milk also has the lowest pH 6.02, which is excellent for initiate fermentation in yogurt.

Viability of LAB in yogurt

In this experiment, the viable counts of *L. bulgaricus* and *S. thermophiles* for all 6 types of yogurt declared to reduce at the end of storage period (by day 12) Table 2. This reduction in starter counts may be due to related to reduction of product pH by storage [18, 26].

L. bulgaricus initial counts at the end of fermentation time varied from 1.5×10^6 to 2.2×10^6 CFU/mL; the differences are probably due to the initial inoculum and the fermentation time required for each breed yogurt [23].

Probiotic cell viability depends on the strain type, the storage conditions, and the culture mixture. *L. albicans* and *L. bulgaricus* had an effect on the depletion of *L. acetophilus* due to the effects of post-acidification [18]. That may be due to the anti-probiotic effect of *L. albicans* on probiotics. Hydrogen peroxide produced by lactobacillius partially damages the probiotic cells [11].

The count of *S. thermophilus* counts for tested goat yogurt at the end of fermentation (at pH=4.5) were 2.2×10^8, 2.0×10^8, 2.0×10^8, 2.1×10^8, 2.5×10^8, 2.0×10^8 CFU/mL in NUB, CrN, SAD, ARD, SHM and SRK breeds respectively. At the end of the storage period, after 12 days, the counts varied from 1.0×10^8 CFU/mL to 5.5×10^9 CFU/mL for examined yogurt samples in SAD and SHM breeds, respectively.

The current results also reflected a slight or even no reduction in the starter *S. thermophilus* count in all types of goat breeds except Shami breed, an increase in *S. thermophilus* count was observed (1.5×10^9: 5.5×10^9 CFU/mL) from day 4 to day 12. This may be explained due to high concentration of total solids in Shami goat milk, which provides a renewable nutrition source for starter and protect it against destructive effect of cold storage [18, 23]. Previous of studies have shown a slight rise in the number of *S. thermophilus* in goat's milk yogurt over a storage period of up to 7 days and a subsequent decrease of approximately one log cycle [17].

The vitality of starter strains appears to vary between different breeds of goats, and very different from other species of dairy animals. This may be due to the difference in the nature of the goat, the nature of its milk that contains high total solids [21, 22]. Also, could be due to differences in yogurt production methods, storage environments, and probiotic strain selection.

Coagulation

Coagulation of milk results from the precipitation of milk protein (casein) in acidic conditions at a pH of around 4.6. Table 3 shows that, the Shami goat yogurt has the lowest coagulation time (3 hours) followed by Aradi breed. The longest coagulation time was recorded for Saidi breed with more than 6 hours. The variation in the coagulation time may be attributed to the TS in raw milk and activity of starter.

Sensory evaluation

The yogurt from the six breeds of goat were evaluated for sensory traits, that including examination of color, taste, firmness, mouth felling and over all acceptability (Fig.2).

The data of the sensory analysis (Fig.2) revealed that, there are no obvious differences among the six types of yogurt samples regarding to its color. Concerning the taste and mouth felling, Sheraky yogurt was the worst and unaccepted by plainness. In the current study, firmness, taste and mouth felling were going parallel with OAA. These parameters were largely influenced by breed of goat. The cross-nub breed showed the highest degree of firmness and OAA followed by Nub breed. It was obvious that the three Egyptian breeds have acceptable tastes than Saudi breeds. This may be due to the nature of feeding, the anatomical structures and climatic conditions that influences milk composition

especially total solids. Interestingly that the yogurt samples showed the highest firmness was made from milk of high total solids (Table1). Parallel results obtained by Everett et al, 2005 and Eisaa et al 2010 [24, 26,27].

Conclusion

The variances of the milk composition among the goat breeds are very wide. The characters of the yogurt developed from such milk are difference too. The way of rearing, character of feed at the rearing area as well as the surrounding climate may affect the composition of milk and resulted in variation in the yogurt obtained from such milk. Further studies on goat breeds milk are needed to declare the differences and produce a suitable yogurt acceptable to consumers to get complete benefits from goat breeding.

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Conflict of interest

The authors declare that there is no conflict of interest.

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Declaration of Conflict of Interest

Ethical of approval

This study follows the ethics guidelines of the Faculty of Veterinary Medicine, Aswan University, Egypt (ethics approval 29/11/2023).

Photo 1. Goat breeds, taken by authors, a. Nubian, b. Saidi, c. Aradi, d. Shami.

TABLE 1. The gross composition of the raw goat milk from six breeds using milk scan.

	Egyptian			Saudi		
	Nubian	Cross Nubian	Saidi	Aradi	Shami	Sheraki Baladi
Fat	04.47	02.81	02.28	02.67	06.97	03.77
SNF	07.39	07.79	08.20	08.52	11.52	06.85
TS	11.86	10.60	10.48	11.19	18.48	10.62
Density	25.13	28.04	30.06	31.01	39.16	23.60
Protein	02.70	02.85	03.00	03.12	04.21	02.50
Lactose	04.06	04.28	04.51	04.69	06.33	03.76
Added water	09.61	05.96	01.15	00.00	00.00	17.30
Freezing point	-0.470	-0.489	-0.514	-0.538	-0.792	-0.430
Conductivity	05.53	06.17	06.44	08.24	06.02	06.08
pH	07.07	07.09	07.80	07.05	06.02	06.56
Salts	00.60	00.64	00.60	00.70	00.95	00.56

TABLE 2. The viability of Lactic Acid bacteria* (CFU/gm) from yogurt across 12 days at 4°C.

Day	*Lactobacillus bulgaricus*				*Streptococcus thermophiles*			
	0	4	8	12	0	4	8	12
Nub	1.5×10^{6}	1.0×10^{7}	2.4×10^{7}	1.9×10^{7}	2.2×10^{8}	5.5×10^{8}	3.0×10^{8}	2.5×10^{8}
CrN	2.2×10^{6}	8.5×10^{6}	8.6×10^{6}	3.5×10^{6}	2.0×10^{8}	6.0×10^{8}	6.0×10^{8}	5.0×10^{8}
SAD	1.8×10^{6}	2.0×10^{6}	1.5×10^{6}	1.5×10^{5}	2.0×10^{8}	6.5×10^{8}	2.5×10^{8}	1.0×10^{8}
ARD	1.5×10^{6}	3.0×10^{6}	6.5×10^{6}	3.5×10^{6}	2.1×10^{8}	8.0×10^{8}	6.5×10^{8}	1.5×10^{8}
SHM	2.0×10^{6}	4.5×10^{7}	4.0×10^{8}	2.1×10^{7}	2.5×10^{8}	1.5×10^{9}	5.5×10^{9}	5.5×10^{9}
SRK	1.5×10^{6}	3.0×10^{6}	3.5×10^{6}	1.0×10^{6}	2.0×10^{8}	2.5×10^{8}	4.0×10^{8}	5.0×10^{7}

*Values are the means of three replicates.

Egyptian breed: Nubian: NUB, Cross Nubian: CrN and Saidi: SAD

Saudi Arabia breed: Aradi: ARD, Shami: SHM and Sheraky: SRK

TABLE 3. The coagulation time and water holding capacity (WHC) and overall acceptability (OAA) of yogurt from different goat breeds.

	Egyptian			Saudi		
	Nubian	Cross Nubian	Saidi	Aradi	Shami	Sheraki Baladi
Coagulation *time hh:mm*	05:30	05:40	06:20	04:30	03:00	04:45
WHC (1:5)	4/5	5/5	4/5	3/5	4.5/5	2.5/5
OAA (1:7)	6/7	7/7	5/7	3.5/7	5/7	3.5/7

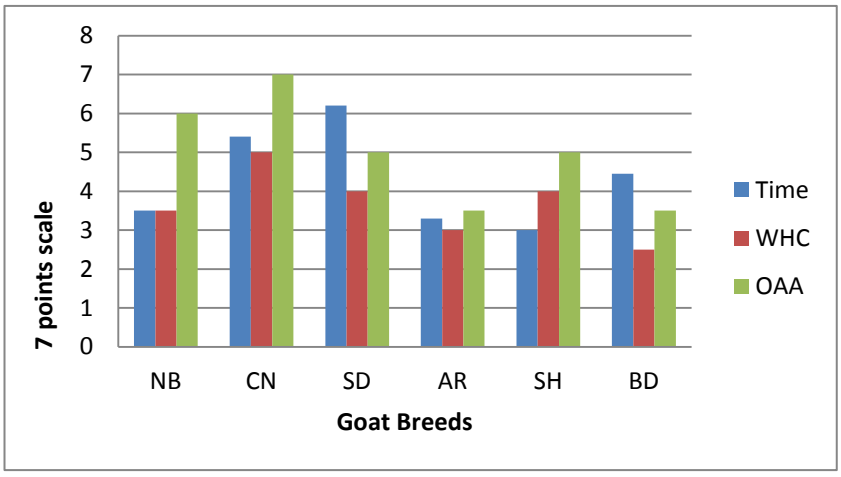

Fig. 1. The coagulation time and water holding capacity (WHC) and overall acceptability (OAA) of yogurt from different goat breeds, measured on seven points rating scale.

WHC: Water holding capacity, OAA: Over all acceptability, Egyptian breed: Nubian: NUB, Cross Nubian: CrN and Saidi: SAD , Saudi Arabia breed: Aradi: ARD, Shami: SHM and Sheraky: SRK

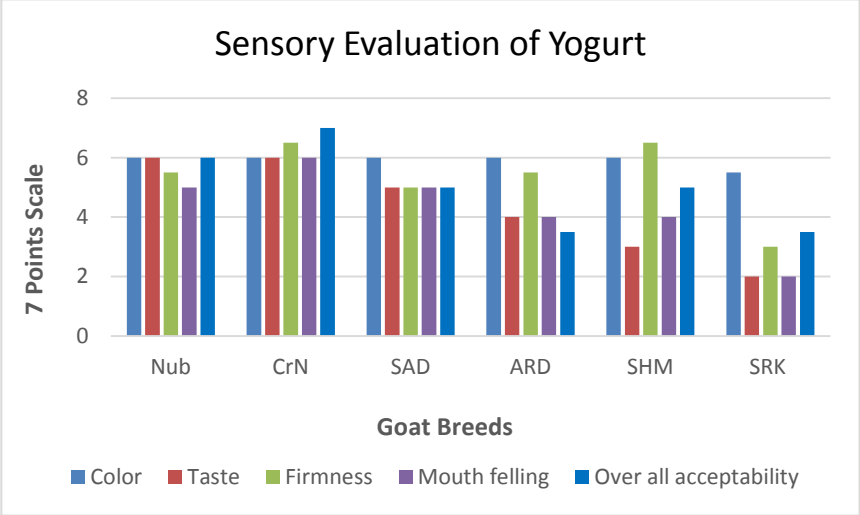

Fig. 2. The sensory evaluation of yogurt prepared from the six goat breeds milk measured on seven points rating scale.

Egyptian breed: Nubian: NUB, Cross Nubian: CrN and Saidi: SAD , Saudi Arabia breed: Aradi: ARD, Shami: SHM and Sheraky: SRK

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تقييم حيوية البادئات والخواص الريولوجية للزبادي المصنع من ألبان أنواع مختلفة من سلالات الماعز

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الملخص

أجريت هذه الدراسة على ستة سلالات مختلفة من الماعز الحلوب (النوبي، الهجن النوبي والصعيدي، العرضي، الشامي، الشيراكي) لمعرفة تأثير نوع السلالة في تركيبة الحليب المنتج من كل سلالة. تم تحليل المكونات الإجمالية للبن السلالات الستة بواسطة جهاز فحص الحليب وتم تحضير الزبادي من كل منها. تم قياس حيوية سلالتين من البادئات (*Lactobacillus bulgaricus* و *Streptococcus thermophilus*) في تصنيع الزبادي، وكذلك الخصائص الحسية والريولوجية للزبادي المنتج. أظهرت النتائج التي تم الحصول عليها عن طريق فحص الحليب أن نسبة الدهن والمواد الصلبة الكلية كانت أعلى في سلالتي حليب الماعز (النوبي والشامي) مقارنة بالسلالات الأخرى بنسبة 4.47، 06.97% للدهون و11.86، 18.48% للمواد الصلبة الكلية على التوالي. كانت حيوية بكتيريا (L.) *Lactobacillus bulgaricus* في الزبادي في اليوم 12 من التخزين هي الأعلى في لبن الماعز النوبي والشامي 1.9×107 و2.1×107 وحدة مستعمرة CFU/جم على التوالي، بينما أظهرت سلالة *Streptococcus thermophilus* معدل الحيوية في اليوم 12 هو 5.0 × 108 و505 × 109 وحدة مستعمرات/جم في الزبادي النوبي والشامي على التوالي. كان التقييم الحسي والقبول العام مرتفعين في الزبادي من السلالات النوبية والشامية على التوالي، وقد لاحظت الدراسة وجود علاقة قوية بين نسبة الجوامد الكلية TS وإنتاج الزبادي، ولكن قبول المستهلك الزبادي كانت تختلف باختلاف السلالات. كان الهدف من هذه الدراسة هو توضيح الفروقات بين سلالات الماعز، وإنتاج زبادي مناسب ومقبول لدى المستهلكين للحصول على الفوائد الكاملة من تربية الماعز.

الكلمات الدالة: لبن الماعز ، الزبادي ، الخمائر، البادئات.