



Potential Use of Aberdeen Angus Cows' Milk for the Production of Low-Fat Yoghurt

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LITTLE information is available on the composition and properties of milk from Aberdeen Angus cow and its potential use in the manufacture of dairy products. This study aimed to produce low-fat yoghurt from the milk of Aberdeen Angus cows (AMY) compared to Friesian cows (FMY) and Baladi cows (BMY). The chemical composition, physical properties, color parameters, microstructure, microbial, and sensory features of resultant yoghurt during storage at $4\pm 1^\circ\text{C}$ for 14 days were evaluated. Results revealed that BMY had higher total solids, fat, protein, lactose, and ash contents than AMY and FMY. Furthermore, AMY retained a significantly higher percentage of serum within its structure, thus being characterized by decreased syneresis and increased water holding capacity. The AMY sample had the highest L^* and a^* values and the lowest b^* value compared to the others. Total viable bacterial and lactic acid bacteria counts were higher in BMY than AMY and FMY samples. In addition, AMY gave a microstructure with a denser and more homogenized matrix as well as a less coarse network. Sensory evaluation results revealed that the most acceptable yoghurt samples were obtained from AMY followed by BMY and FMY. In conclusion, Aberdeen Angus milk seems to be a promising raw material for manufacturing good-quality yoghurt.

Keywords: Aberdeen Angus, Low-fat yoghurt, Microstructure.

Introduction

Milk is a versatile, nutrient-rich fluid with several health benefits. The composition of milk differs between species, breeds, and individual animals. This may be due to genetic variations of breeds which determine the polymorphism of major components of milk proteins, and composition of milk fat but also the composition of fatty acids (Boland, 2003), consequently, milk quality characteristics affecting the quality of the resultant dairy products such as; cheese, yoghurt, ice cream, butter, ghee, powder milk, and many other forms of milk (Khan et al., 2007). Variations in chemical and technological properties of milk and its products have been studied widely among dairy cattle breeds. As for, the beef breeds have not been studied in details. This is due to the majority of available literature on the breeding of beef cattle focuses on meat performance traits and analyzes the factors determining those traits.

Furthermore, there is no enough information on the composition and physicochemical properties of milk.

Aberdeen Angus cattle have been bred in Scotland for more than four hundred years. Angus is an international breed and the dominant breed in the USA, Canada, New Zealand and Argentina (Angus Australia, 2010). Angus cows have been bred primarily for used in meat production. These cattle can be black or red in color however, the polled black breed of cattle characterized by resistance to harsh weather, adaptability, early sexual and compositional maturity, high fertility, precocity and easy calving and good milk ability (Brown et al., 2001). This cows of different total milk-yield levels, classified as high (868 kg) or low (547 kg) as well as, high milk producing cows were more efficient at weaning, and their calves required less milk to produce one kilogram of live weight (Vaz et al., 2016). Aberdeen among the beef

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breeds is commonly used widely in crossbreeding with dairy cows such as Holstein Friesian dairy cows to improve the production, composition, and nutritive quality of milk (Keane & Moloney, 2010). Accordingly, Rodrigues et al. (2014) found at the 210-d of lactation time that Caracu × Angus, and Nelore × Angus cows had greater total milk yield, 1070, and 1116 kg, respectively, as compared to Angus (858 kg). The average daily milk production of 5.1 and 5.3 kg/day for Caracu × Angus and Nelore × Angus but exceeded the values of 4.1 kg/day for Angus during the 210-d lactation period. This crossbreeding of Angus with adapted breeds can be effective in increasing milk yield and nutrient content and, consequently, producing heavier calves at weaning under extensive grazing. Compared to the rest of the herds in this study, the average 305 d lactation period milk yield was 1160, 2098, and 1695 kg, for Baladi cows, Friesian cows, and crossing, respectively (Hussein et al., 2016). Additionally, Rodrigues et al. (2014) found that main component of total solids, protein, fat, and lactose valued 11.58, 3.21, 2.90 and 4.65% in Angus milk, respectively. Ismail & Hamdon (2017) studied the physicochemical characteristics, of Aberdeen Angus milk; they found its milk represents a high source of minerals, low-fat content; the fat globules embedded within the protein network and had the lower acid coagulation time. Finally, they recommend using Aberdeen Angus cows' milk for the production of soft drinks and / or as a base material for low-fat dairy products.

To the best of our knowledge, no investigations in the literature were found regarding using milk of Aberdeen Angus cows in dairy product processing. Therefore, the aim of this study was attempt to prepared low-fat yoghurt from Aberdeen Angus cows' milk and evaluate its physicochemical, rheological, microstructure, microbial, and sensory properties in comparison with milk of Friesian cows and Baladi cows as dairy cattle during storage at 4±1°C for 14 days.

Materials and Methods

Materials

Aberdeen Angus cows' milk samples collected in several sterile bottles (total amount 4 L) from the herd of Animal Production Department, Faculty of Agriculture, New Valley University, Egypt. As well the same amount of Friesian and Baladi cows' milk were collected from different dairy farms of El-Kharga City, New Valley Governorate, Egypt. Yoghurt starter cultures *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* were obtained from Chr. Hansen's laboratory, (Copenhagen, Denmark). The cultures were proliferated separately in sterilized recombined skim milk (11%) at the optimum temperature (*Str. thermophilus* at 38°C and *L. delbrueckii* subsp. *bulgaricus* at 45°C) for 16-18 hrs, and mixed at rate of 1:1 just before adding to yoghurt milk.

Manufacture of low-fat yoghurt

Yoghurt production was carried out in the manufacturing unit of Dairy Science Department, Faculty of Agriculture, New Valley University, Egypt. Fresh milk of various breeds was adjusted to 1.5% fat to be suitable for low-fat yoghurt production (standard milk chemical composition was shown in Table 1). All milk types were heated to 90°C for 20 min, then cooled to 45°C, and inoculated with 2% (w/w) mixed yoghurt cultures. The milk was filled in 100 ml plastic cups and subsequently incubated at 42°C for 3-3.5 hr until complete coagulation, and stored at 4±1°C for 14 days. Yoghurt samples were classified into three main groups: Aberdeen Angus (AMY); Baladi cow's milk (BMY); Friesian milk (FMY). Yoghurt samples were analyzed for their chemical composition, physical properties, color parameters, microstructure, microbial load, and sensory properties at 1, 7 and 14 days intervals. The experiment was carried out in triplicate.

TABLE 1. Standard milk chemical composition of the different breeds

Milk breed	Components				
	Total solid (%)	Protein (%)	Lactose (%)	Ash (%)	pH value
Aberdeen cows	10.16±0.32 ^a	3.24±0.08 ^b	4.64±0.14 ^a	0.70±0.03 ^a	6.64±0.08 ^a
Baladi cows	10.47±0.21 ^a	3.51±0.04 ^a	4.66±0.04 ^a	0.73±0.02 ^a	6.68±0.01 ^a
Friesian cows	10.01±0.11 ^a	3.13±0.08 ^b	4.60±0.04 ^a	0.68±0.06 ^a	6.60±0.06 ^b

Mean± SD values having different superscript letters in columns are differ significantly (p≤0.05)

Methods

Chemical analysis of milk and yoghurt samples

Total solids, fat, protein, lactose, and ash of different milk samples were determined by Lactoscan apparatus (Ultrasonic milk, Bulgaria). However, total solids, fat, protein, and ash of yoghurt samples were analyzed according to AOAC (2012). Carbohydrates were calculated by the difference of total contents (protein, fat, and ash) from total solids. The pH values of milk and yoghurt were measured using pH meter (Hanna Instrument 8021).

Physical properties of yoghurt

Syneresis measurements

Whey syneresis of yoghurt samples was measured according to the method of Al-Kadamany et al. (2003). Ten grams of the yoghurt sample were placed on a filter paper resting on the top of a funnel. The method was based on spontaneous movement of whey out of yoghurt samples under the force of gravity after 30 min. The percentage syneresis was calculated as follows: Free whey (g/100g) = (weight of initial sample - weight of the sample after filtration/weight of initial sample) × 100.

Water holding capacity measurements (WHC)

WHC of yoghurt samples was determined by the method of Arslan & Ozel (2012). A sample (10 g) of yoghurt was centrifuged at 3000 rpm for 20 min at room temperature. The supernatant was removed and the weight of the pellet was recorded. The WHC was expressed as a percentage of pellet weight relative to the original weight of yoghurt samples.

Color analysis of yoghurt

Color parameters of yoghurt samples were evaluated by using Hunter Lab Color QUEST II Minolta CR-400 (Minolta Camera, Co., Ltd., Osaka, Japan) with illuminate D63 as reference (Mensah, 1997). In this system, the L^* value is a measurement of lightness, ranging from 0 (black) to 100 (white), a^* value ranges from -100 (greenness) to +100 (redness), and the b^* value ranges from -100 (blueness) to +100 (yellowness). The values are the mean of three determinations.

Microstructural analysis of yoghurt samples

The microstructure of yoghurt samples was examined at the Egyptian Mineral Resources Authority Central Laboratories Sector according to Karami et al. (2009) by using a scanning electron microscope (FEI Company, Netherlands)

Model Quanta 250 FEG (Field Emission Gun) attached with EDX Unit (Energy Dispersive X-ray Analyses), with accelerating voltage 20 K.V. During SEM processing, samples were freeze-fractured in liquid nitrogen to approximately 1-mm pieces and these pieces were then mounted on aluminum stubs with silver paint, dried to the critical point and coated with gold for 300 Å in a Sputter-Coater (SCD 005 Sputter Coater) and Scanned under low vacuum condition with pressure chambers 60 pa.

Microbiological examination of yoghurt

The microbiological quality of yoghurt including total viable bacteria, lactic acid bacteria, coliform bacteria, and yeast & mold counts were carried out by method of Marshall (1992).

Sensory evaluation of yoghurt

Sensory profiling of yoghurt samples was carried out by 20 trained panelists selected from the staff, and students of the Department of Dairy Science, Faculty of Agriculture, New Valley University, Egypt. Yoghurt samples were assessed for flavor, texture, and appearance according to the scheme described by Mehanna et al. (2000).

Statistical analysis

All yoghurt samples were analyzed in triplicate (Mean ±SD) and the data were statistically analyzed by the one-way analysis of variance (ANOVA) using SPSS (version 20 SPSS Inc., Chicago, IL, USA) with probability ($P \leq 0.05$) level of significance.

Results and Discussion

Physicochemical properties of yoghurt samples

The chemical composition of processed yoghurt samples is illustrated in Table 2. Comparing the composition of yoghurt types, it was noticed that BMY had the highest levels of total solids, fat, protein, lactose, and ash followed by AMY and the FMY was the lowest one. Furthermore, pH values were lower in FMY than AMY and BMY types. FMY revealed slight significant differences ($p \leq 0.05$) for the abovementioned items. The chemical composition of yoghurt is mainly depending on the composition of raw milk used.

In general, the chemical composition including total solids, fat, protein, and ash of AMY and BMY samples was somewhat similar and significantly different from that of the FMY sample. Slight increases in total solids, fat protein, and ash contents were noticed during the storage

for all yoghurt samples. These increases may be due to the evaporation of some water during the storage period (El Batawy, 2012). However, decreases in lactose contents and pH value were observed which could be attributed to the metabolic activity of yoghurt starters that produce lactic acid by fermenting lactose (Hussain, 2004).

Physical properties of yoghurt samples

Whey syneresis

Whey syneresis is related to the instability of the gel network and the impossibility of trapping the serum phase in its gel network. It is an important physical property of yoghurt quality because it affects consumer acceptance. A higher level of whey syneresis indicates that the yoghurt is of low quality. Whey syneresis of AMY was lower than that of BMY and FMY (Fig 1). This

might be due to the different fractions of protein between dairy cattle and beef cattle. The obtained results are in line with Myburgh et al. (2012) who found that the content of whey proteins and NPN of beef cattle were lower and casein was higher than that of dairy breeds. During coagulation step in yoghurt manufacturing, destabilized casein micelles and calcium-phosphate bonds form a network, which in turn entraps fat and other solids (Costa et al., 2015). The speed of casein network formation is directly influenced by protein content, mainly casein, resulting in greater aggregation rate with firmer curd development (Dimassi et al., 2005). Milk production from Friesian cows is characterized by a low protein content, poor coagulation properties a low frequency of the κ -casein, and low casein number

TABLE 2. Changes in physiochemical properties of low- fat yoghurt made from milk of different cow breeds during storage at $4\pm 1^\circ\text{C}$ for 14 days.

Contents	Storage period (days)	Yoghurt breed		
		AMY	BMY	FMY
Total solids (%)	1	10.27 \pm 0.37 ^{aA}	10.52 \pm 0.35 ^{aA}	10.03 \pm 0.15 ^{aA}
	7	10.44 \pm 0.30 ^{aA}	10.63 \pm 0.31 ^{aA}	10.12 \pm 0.28 ^{aA}
	14	10.60 \pm 0.32 ^{aA}	10.74 \pm 0.37 ^{aA}	10.24 \pm 0.35 ^{aA}
Fat content (%)	1	1.54 \pm 0.02 ^{aA}	1.57 \pm 0.03 ^{aB}	1.52 \pm 0.02 ^{aA}
	7	1.61 \pm 0.06 ^{abA}	1.65 \pm 0.04 ^{aA}	1.56 \pm 0.03 ^{bA}
	14	1.65 \pm 0.09 ^{aA}	1.69 \pm 0.03 ^{aA}	1.60 \pm 0.06 ^{aA}
Protein content (%)	1	3.45 \pm 0.03 ^{bC}	3.58 \pm 0.03 ^{aB}	3.25 \pm 0.02 ^{bC}
	7	3.53 \pm 0.02 ^{bB}	3.65 \pm 0.06 ^{aAB}	3.32 \pm 0.03 ^{cB}
	14	3.65 \pm 0.02 ^{aA}	3.72 \pm 0.04 ^{aA}	3.41 \pm 0.04 ^{bA}
Carbohydrates (%)	1	4.48 \pm 0.38 ^{aA}	4.54 \pm 0.38 ^{aA}	4.47 \pm 0.14 ^{aA}
	7	4.45 \pm 0.28 ^{aA}	4.45 \pm 0.38 ^{aA}	4.42 \pm 0.26 ^{aA}
	14	4.40 \pm 0.35 ^{aA}	4.42 \pm 0.30 ^{aA}	4.36 \pm 0.32 ^{aA}
Ash content (%)	1	0.80 \pm 0.05 ^{aB}	0.83 \pm 0.02 ^{aC}	0.79 \pm 0.01 ^{aC}
	7	0.86 \pm 0.03 ^{bAB}	0.88 \pm 0.02 ^{aB}	0.82 \pm 0.02 ^{bB}
	14	0.89 \pm 0.01 ^{bA}	0.92 \pm 0.02 ^{aA}	0.87 \pm 0.01 ^{bA}
pH value	1	4.61 \pm 0.03 ^{aA}	4.55 \pm 0.03 ^{aA}	4.51 \pm 0.02 ^{aA}
	7	4.58 \pm 0.01 ^{aA}	4.51 \pm 0.03 ^{aAB}	4.49 \pm 0.03 ^{bAB}
	14	4.51 \pm 0.02 ^{abB}	4.48 \pm 0.03 ^{aB}	4.45 \pm 0.02 ^{bB}

Mean (\pm SD) with small letters^(abc) indicate significant differences among yoghurts made from milk of different cow breeds (in rows), $P < 0.05$.

Mean (\pm SD) with capital letters^(ABC) indicate significant differences among yoghurts samples during storage (in columns), $P < 0.05$.

AMY, Aberdeen cow's milk yoghurt; BMY, Baladi cow's milk yoghurt and FMY, Friesian cow's milk yoghurt

(De Marchi et al., 2008). Thus, whey syneresis of FMY increased remarkably compared with other AMY and BMY samples. This demonstrates the high influence on whey syneresis caused by the differences in casein content and micelle structure between different types of milk. For all yoghurt samples, the syneresis was found to be increased throughout the storage until 7th days and a downward trend thereafter at the end of storage. The decrease in whey syneresis may be attributed to higher acidity of yoghurt samples led to a contraction in the casein particles resulting in an increase in water-binding capacity (WHC) of proteins and resistance to the syneresis (Celik and Bakirci 2003). It has been reported by Izadi et al. (2015) that syneresis of set yoghurt decrease during storage because of higher total solids and interactions between fat globules and gel network. Walstra et al. (1999) also reported that lower temperature of storage which led to more binding between the gel particles or their numbers are greater.

Water holding capacity (WHC)

Curd stability is one of the most important physical properties of yoghurt. The WHC measures the amount of water absorbed in the protein structure of the yoghurt. A large amount of water expelled would mean a weak and less cohesive network but high water holding capacity, which in turn may reduce or eliminate the wheying off. From Fig. 1, it can be seen that the AMY sample had the highest WHC. This might be due to the nature of proteins and thereby the development of a denser yoghurt structure capable of holding

more water. Sodini et al. (2004) reported that an increase in casein concentration can favor its micelles interaction as well as leading to decrease of matrix pore dimensions and an increase of its density. In addition, BMY samples were higher than FMY samples. Potentially due to greater total solids and milk proteins content in BMY samples which increases yoghurt gel network density, and consequently the WHC (Krasaekoopt et al., 2004). The chemical composition of yoghurt was largely depends on the composition of raw milk used to make it. Yoghurt made of milk with higher total solids has lower degree of syneresis (Shaker et al., 2000). However, the WHC of yoghurt was affected by the storage period for BMY and FMY but there is no significance effect for AMY. Keogh & O'Kennedy (1998) stated that attachment of whey protein molecules to the surface of the casein micelles could increase the entrapment of serum in gels. As the time of storage increased, the WHC of yoghurt samples showed a decrease up to 7th day then increased again on the 14th day of storage. The WHC progressively increased in all yoghurt types with advanced storage, which may be attributed to a slight increase of total solids content and acidity development as well as the complete setting of curd during storage. These results are confirmed with El-Nagar et al. (2007).

Color parameters

The color of yoghurt has a significant influence on consumer acceptance and considers as an indicator of the changes in its quality characteristics such as sensory attributes during storage. The CIE color values (L^* , a^* , b^*) of

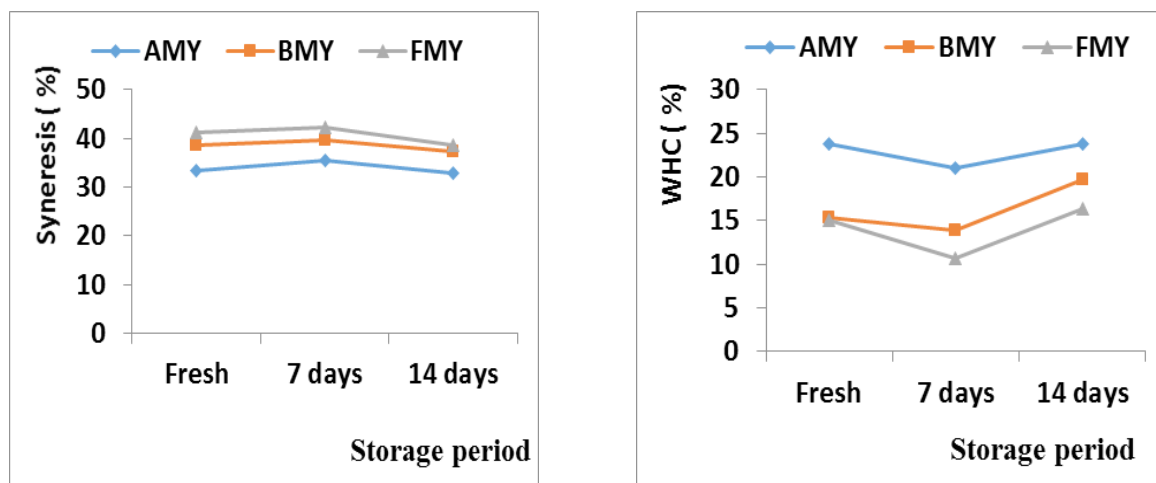


Fig. 1. Syneresis and water holding capacity (WHC) of low-fat yoghurt made from milk of different cow breeds during storage at $4\pm 1^\circ\text{C}$ for 14 days; AMY, Aberdeen cow's milk yoghurt; BMY, Baladi cow's milk yoghurt and FMY, Friesian cow's milk yoghurt

different yoghurt samples are presented in Table 3. L^* value is a key of luminosity and therefore, the higher the L^* value the lighter the sample. Whiteness in fluid milk results from the presence of colloidal particles, such as milk fat globules and casein micelles, capable of scattering light in the visible spectrum (Garcia-Perez et al 2005). Significant differences were noticed in L^* values (whiteness/lightness) for AMY, BMY, and FMY samples, this indicates that L^* values were affected by milk types. The AMY sample had the highest L^* value followed by FMY and the lowest value was for BMY. One of the studies found that the Angus milk is much lighter in color than Jersey milk and butter made from it is almost white as compared with the recognized yellow color of Jersey butter. The higher L^* value for AMY may be due to the light scattering properties of coagulated casein micelles for Aberdeen Angus milk. Same results stated by Cheng et al (2017) reported that variation in CN%TP had much large effect on L^* -value. For FMY samples probably Friesian milk has white color due to the efficiency of cow to convert carotene yellow pigment to Vit. A is a colorless substance. The decrease in L^* value during storage may be due to the increase in acidity and proteolysis that occurs during the storage period and the transformation of casein into a more soluble state which may lead to a decrease in whiteness (Chudy et al., 2020). Furthermore, no differences were noticed in L^* values among the yoghurt samples during storage.

All yoghurt types showed negative a^* values (redness/greenness) which indicates a greenness proportion. Significantly higher a^* values, showing the greener value, were obtained for AMY and FMY compared to the BMY sample. a^* values of yoghurt were influenced by microbiological, biochemical, chemical, and physical changes that happen during processing and storage. Farkye et al. (2001) reported that the decline in a^* value over the storage time, probably due to the oxidation of fatty acids and protolytic activity naturally occurring in yoghurt.

On the other hand, BMY had a significantly ($p \leq 0.05$) higher b^* value (yellowness/blueness) than AMY and FMY samples. The yellow color could be the result of the presence of carotenoid pigments such as β -carotene in the fat globules of the cow milk which was more concentrated in Baladi cow milk. The differences in the b^* value of all yoghurt types can be attributed to the molecular structure as well as the amount of β -carotene pigment present (Ścibisz et al., 2019). The b^* values for all yoghurt samples were increased throughout the storage; probably due to destabilization of casein micelles in the pasteurization process (Mousavi et al., 2019). In general, genetic (breed) and non-genetic (feeding, milking time, stage of lactation, parity) factors are closely related to milk color parameters (L^* , a^* , b^*) (Scarso et al., 2017).

TABLE 3. Color parameters of low- fat yoghurt made from milk of different cow breeds during storage at $4 \pm 1^\circ\text{C}$ for 14 days.

Color parameter	Storage period (days)	Yoghurt breed		
		AMY	BMY	FMY
L^* value	1	94.38 \pm 1.12 ^{aA}	87.76 \pm 0.78 ^{cA}	91.67 \pm 0.90 ^{bA}
	7	94.09 \pm 1.07 ^{aA}	87.18 \pm 0.83 ^{cA}	91.34 \pm 1.00 ^{bA}
	14	93.90 \pm 1.04 ^{aA}	86.68 \pm 0.82 ^{cA}	91.17 \pm 1.02 ^{bA}
a^* value	1	-3.77 \pm 0.12 ^{cA-}	-1.72 \pm 0.06 ^{aB-}	-3.01 \pm 0.13 ^{bB-}
	7	-3.45 \pm 0.16 ^{cB}	-1.60 \pm 0.08 ^{aB}	-2.68 \pm 0.19 ^{bAB-}
	14	-3.22 \pm .11 ^{cB}	-1.37 \pm 0.14 ^{aA-}	-2.44 \pm 0.26 ^{bA-}
b^* value	1	5.36 \pm 0.24 ^{cB}	7.57 \pm 0.18 ^{aB}	5.96 \pm 0.08 ^{bA}
	7	5.71 \pm 0.16 ^{cAB}	7.83 \pm 0.14 ^{aAB}	6.06 \pm 0.08 ^{bA}
	14	5.85 \pm 0.18 ^{bA}	7.98 \pm 0.17 ^{aA}	6.13 \pm 0.09 ^{bA}

Mean (\pm SD) with small letters^(abc) indicate significant differences among yoghurts made from milk of different cow breeds (in rows), $P < 0.05$.

Mean (\pm SD) with capital letters^(ABC) indicate significant differences among yoghurts samples during storage (in columns), $P < 0.05$

AMY, Aberdeen cow's milk yoghurt; BMY, Baladi cow's milk yoghurt and FMY, Friesian cow's milk yoghurt

Microstructure of yoghurt

Scanning electron microscopy (SEM) seems to be a useful technique to explain the physical properties of curd at the microstructure level. As can be observed, the protein network was the fundamental structure of yoghurt. As seen in Fig. 2, the micrographs show obvious variations in the yoghurt microstructural properties between the three yoghurt samples from different milk breeds. In the first day, AMY had a dense structure and more homogenized matrix with a less coarse network (Fig. 2 A1). However, BMY had a protein aggregates network characterized with a porous structure accompanied by many bridges and some voids (Fig. 2 B1). In addition, in the FMY base, the gel organization appeared to be irregular, with short and individualized casein filaments and had numerous very small pores that were very heterogeneous in size, that give porous, open, sponge-like structure and varying amounts of serum (Fig. 2 F1). Chains of casein structure of FMY were less apparent and coarser than AMY and BMY samples. These results were in agreement with the physical properties, which showed that stronger and firmer gels were formed in AMY and BMY. These explanations support the strong link between yoghurt gel microstructure and textural properties. AMY exhibited greater water-holding capacity, and lower syneresis index values than BMY and FMY. These differences in the microstructure are reflected in the different casein fractions and protein content between milk types. Phadungath (2005) demonstrated that casein micelles play an important role in milk acid coagulation. These structural modifications may be due to the induced capability of protein cross-linking in AMY and BMY, which resulted from the relatively high contents of protein. Thus, the observed differences among AMY, BMY, and FMY for their structure and textural properties are potentially attributed to differences in milk physicochemical characteristics such as total solids content, the concentration of lactose, calcium, and fat globules. These findings were in line with that reported by Nguyen et al. (2014).

In 7th day of storage, the gel microstructure was greatly changed, showed large and extensively fused micelles found in AMY and much thicker chains of the casein network for BMY (Fig. 2 A2 and 2 B2). Moreover, the disintegration of the casein matrix with fewer and smaller pores in FMY (Fig. 2 F2).

At 14th day of storage, the micrographs

showed higher fusion of protein matrix with more whey retention in all yoghurts samples. The characteristic of microstructure for AMY showed that more fusion of casein micelles, finer network, and more homogenized matrix (Fig. 2 A3). The relatively high levels of fused proteins and casein sheets can be seen in the BMY sample (Fig. 2 B3).

However, the microstructure of FMY was an open network with larger pores, more ragged and less homogeneous contained numerous small holes (Fig. 2 F3). The decrease in yoghurt gel permeability causes a more compact microstructure with smaller pores embedded in clusters of protein, and consequently, more water is entrapped in the yoghurt gel network (Moon & Hong, 2003). In general, this microstructural information supported the obtained results for the physical properties of all yoghurt samples.

Microbial quality of yoghurt

The microbiological quality of yoghurt samples during storage at $4\pm 1^{\circ}\text{C}$ for 14 days is given in Table 4. There were significant differences for microbial load among fresh yoghurt samples and during storage. The highest total viable counts were noticed for BMY followed by AMY and FMY was the lowest. These results could be due to the higher amounts of total solids in yoghurts. Mahdian & Tehrani (2007) reported that increasing of milk total solids may improve the growth and activity of starter bacteria. The total count of bacteria may be affected by several factors, including milk constituents and storage period. The variations in total bacterial count may be due to the advanced acidity and/or toxic products (Al-kadamany et al., 2003). All yoghurt samples showed the highest bacteria counts at day 7 and the least for day 14 compared to when processed fresh. Decrease in bacteria growth during storage can be explained by the decrease in the amount of remaining lactose in yoghurt and resulting in fewer nutrients for their growth promotion (Nezhad et al., 2013).

Lactic acid bacteria play a major role in the production of yoghurt with several benefits for consumer's health. The result of lactic acid bacteria indicated that BMY had the highest count followed by AMY and the lowest count was for FMY. According to Mahdian & Tehrani (2007), that is the increase of milk total solids lead to increasing the growth of starter culture. A decrease in lactic acid bacteria was observed in the present study at the end of the storage period. According to Khalafalla & Roushdy (1996), the

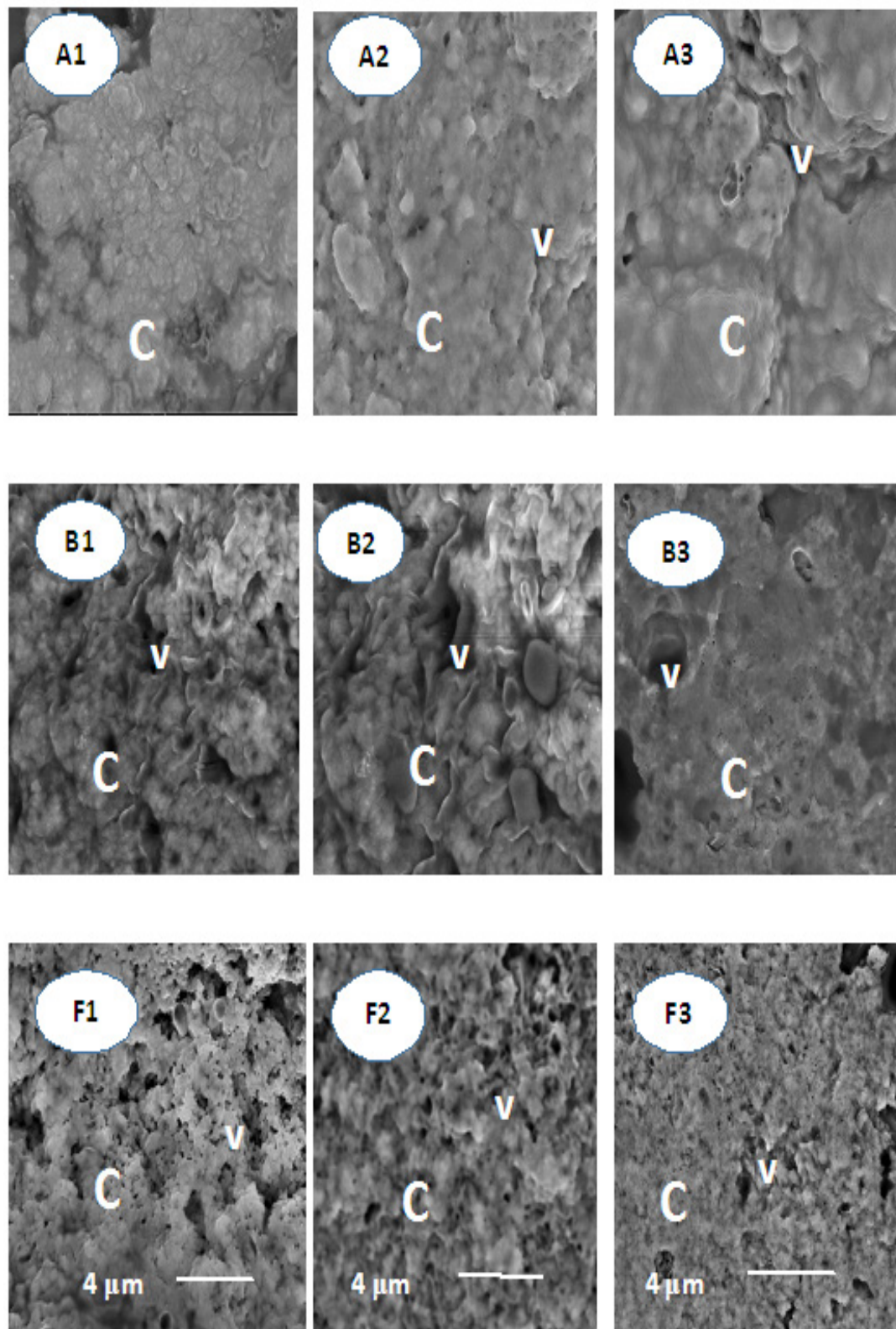


Fig. 2. SEM micrographs of low-fat yoghurt made from milk of different cow breeds during storage at $4\pm 1^\circ\text{C}$ for 14 days; Aberdeen Angus cows' milk (A 1, 2,3), Baladi cows' milk (B 1, 2, 3) and Friesian cows' milk (F 1,2,3). V: void space and C: casein.

interval of storage plays important role in the growth of lactic acid bacteria, and the decrease in numbers may be due to the accumulation of ambient lactic acid which affects its activity. The coliform bacteria count in all yoghurt samples was not detected when fresh or during storage. This may be due to the combined effect of high heat treatment of milk and the suppressive effect of the using LAB culture during the manufacture of yoghurt, which associated with their ability to produce some of the acidity and antimicrobial compounds led to disappear the coliform bacteria count in all yoghurt samples when fresh or during storage. These results are in the same trend reported by Abd El-Aty et al. (1998).

Yeasts and molds are major causes of spoilage in yoghurt and other fermented dairy products in which the low pH provides a selective environment for their growth. No Yeast and mold counts were detected in all fresh yoghurts and it reaches the highest number on day 7, and then gradually decreased until reached the minimum count at the end of the storage period. The reduced

counts of yeast and mold at the end of storage could be due to the unfavorable conditions for microbial growth. This was supported by Ismail et al. (2016).

Sensory features of yoghurt

Consumer preference for yoghurt depends mainly on its organoleptic quality; therefore, high importance is placed on the flavor and body & texture of yoghurt products. Sensory attributes of the yoghurts are shown in Table 5. All yoghurt samples gained the highest scores until the 7th day of storage and declined thereafter during storage. That corresponds with the statement of Ebrahimi et al. (2015). At the beginning of storage, AMY clearly presented positive values on all sensory properties, which were characterized by smooth texture, no wheying off, and white shining surface as described by the panelists. In contrast, FMY exhibited brittle and weak structure with observed whey out on yoghurt surface. Moreover, low free whey had yellowness color in BMY was observed.

Sensory characteristic throughout storage

TABLE 4. Bacteriological counts of low- fat yoghurt made from milk of different cow breeds during storage at 4±1°C for 14 days.

Bacteria count (log CFU/g)	Storage period (days)	Yoghurt breed		
		AMY	BMY	FMY
Total viable bacterial count	1	6.46±0.06 ^{bb}	6.69±0.05 ^{ab}	5.88±0.09 ^{cb}
	7	7.38±0.07 ^{ba}	7.62±0.06 ^{aA}	6.56±0.08 ^{cA}
	14	5.43±0.06 ^{bc}	5.63±0.03 ^{ac}	5.13±0.1 ^{cC}
Lactic acid bacteria	1	6.45±0.06 ^{ba}	6.66±0.06 ^{aA}	5.60±0.08 ^{cA}
	7	5.19±0.07 ^{bb}	5.31±0.05 ^{ab}	4.40±0.07 ^{cb}
	14	4.50±0.04 ^{bc}	4.67±0.02 ^{ac}	4.29±0.03 ^{cC}
Coliform bacteria	1	ND	ND	ND
	7	ND	ND	ND
	14	ND	ND	ND
Mold and yeast	1	ND	ND	ND
	7	2.97±0.07 ^{ba}	3.12±0.05 ^{aA}	2.69±0.09 ^{cA}
	14	1.00±0.04 ^{bb}	1.18±0.03 ^{ab}	0.82±0.07 ^{cb}

Mean (±SD) with small letters (^{abc}) indicate significant differences among yoghurts made from different milk species (in rows), P<0.05.

Mean (±SD) with capital letters (^{ABC}) indicate significant differences among yoghurts during storage times (in columns), P<0.05

ND, not detected; AMY, Aberdeen cow's milk yoghurt; BMY, Baladi cow's milk yoghurt and FMY, Friesian cow's milk yoghurt

TABLE 5. Sensory properties of low- fat yoghurt made from milk of different cow breeds during storage at 4±1°C for 14 days.

Yoghurt type	Storage period (days)	Appearance	Texture & Body	Flavor	Total
		(10)	(30)	(60)	(100)
AMY	1	8.33±0.58 ^{Aa}	28.33±0.58 ^{Aa}	57.00±1.00 ^{Aa}	93.83±0.76 ^{Aa}
	7	8.33±0.58 ^{Aa}	29.00±1.00 ^{Aa}	57.33±1.00 ^{Aab}	94.67±0.76 ^{Aa}
	14	7.33±0.58 ^{Aa}	26.00±1.00 ^{Ab}	54.50±1.53 ^{Ab}	88.00±1.04 ^{Ab}
BMY	1	7.67±0.58 ^{Aa}	27.67±0.58 ^{Aa}	55.00±1.00 ^{Aa}	90.17±1.04 ^{Aa}
	7	8.00±1.00 ^{ABab}	28.33±0.58 ^{Aa}	55.67±1.15 ^{Aa}	92.17±0.29 ^{Ba}
	14	6.00±0.00 ^{Bb}	25.33±1.15 ^{Ab}	52.33±0.58 ^{Ab}	83.67±0.58 ^{Ab}
FMY	1	6.33±0.58 ^{Ba}	21.33±1.53 ^{Ba}	56.33±1.15 ^{Aa}	83.99±2.75 ^{Ba}
	7	6.33±0.58 ^{Ba}	21.67±1.15 ^{Ba}	56.67±1.00 ^{Aa}	84.67±1.26 ^{Ca}
	14	5.67±0.58 ^{Ba}	17.33±1.53 ^{Bb}	53.33±1.15 ^{Ab}	76.33±2.65 ^{Bb}

Mean (±SD) with small letters^(abc) indicate significant differences among yoghurts made from different milks (in rows), P<0.05.

Mean (±SD) with capital letters^(ABC) indicate significant differences among yoghurts during storage times (in columns), P<0.05

AMY, Aberdeen cow's milk yoghurt; BMY, Baladi cow's milk yoghurt and FMY, Friesian cow's milk yoghurt

showed that there were no significant differences between AMY and BMY on appearance and texture & body and had significant differences in flavor. It is evident that the flavor analysis revealed that AMY yoghurt had a higher score than the other two yoghurt types. Inversely FMY had significantly different ($p \leq 0.05$) for appearance and texture & body from AMY and BMY types. As the storage period progressed, the sensory score values of all yoghurt samples were decreased gradually. Farahat and El-Batawy (2013) showed that decrease scores of all the samples may be due to the acidity development or the production of microbial metabolites which slightly harmed the rheological and sensory properties of the product. The development of acidity leads to decreased flavoring characteristics and microbial hydrolysis of yoghurt components during storage were found to be the key-deterioration factors to taste, color, flavor, and texture (Tarakci, 2010). Sensory evaluation revealed that AMY yoghurt was more accepted followed by BMY and the worst score was for yoghurt produced from Friesian milk (FMY).

Conclusion

Aberdeen Angus characters make it more efficient animal adapted to the productive systems, with greater production in less time and at lower costs, as well as was kept for meat production. Several studies have reported that milk production of Aberdeen cows and its effect on calf weights, however, studies on the value of milk composition and the use of their milk in the industry are scanty. The major aim of this paper was to open perspectives for more comprehensive investigations on the application of Aberdeen Angus cows' milk. Especially after it proved highly successful in crossbreeding with dairy cows cause in increase milk yield and nutrition value. The results showed that making yoghurt from Aberdeen Angus cows' milk has the highest acceptability and an advantage in its physical properties and sensory quality compared to Friesian cows' milk and Baladi cows' milk under the study. Therefore, further investigations are needed to improve the interpretations about biochemical of milk and physiochemical properties of dairy products that may process from Aberdeen Angus cows' milk.

Compliance with ethical standards

Conflict of interest .The author declares no conflict of interest.

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