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ARTICLE

Prevalence and Comparing of Some Microbiological Properties, Somatic Cell Count and Antibiotic Residue of Organic and Conventional Raw Milk Produced in Turkey

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Abstract

The aim of this study was to investigate the effects of production systems and milk collection periods on the somatic cell count (SCC), some microbiological properties, total aerobic mesophilic bacteria (TAMB), coliform, *Staphylococcus aureus* (*S. aureus*), yeast and mould) and antibiotic residue of milk; in Turkey. Milk samples were collected from 9 conventional farms and 9 organic farms during one year time, at six different months (December 2013 to October 2014), and all farms were selected from the same geographical locations. All organically managed farms had organic production certificates given by the Republic of Turkey Ministry of Food, Agriculture and Livestock. The count of TAMB, coliform, and coagulase positive *S. aureus* were affected by production systems at the level of $p<0.01$; yeast and mold, and somatic cell count (SCC) were affected at the level of $p<0.05$. But, differences according to months were statistically significant only on TAMB ($p<0.01$) and coliform ($p<0.05$) counts. The general means of TAMB, coliform and yeast and mould counts of the organic milk (OM) were significantly lower ($p<0.05$), while the general means of SCC and coagulase positive *S. aureus* count of the OM was significantly higher ($p<0.05$) compared to conventional milk (CM). Antibiotic residue was determined in one of the CM sample and in two of the OM samples. Our study is the first research that compared conventional and organic milk in Turkey. This study indicated that the microbiological quality of OM was the higher in terms of TAMB, coliform and yeast and mould, whereas was the lower in relation to SCC and coagulase positive *S. aureus* counts. But, the quality of both milk types should be improved.

Keywords organic milk, conventional milk, somatic cell count, microbiological properties, antibiotic residue

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Introduction

Organic food is consumed by many people, because consumers believe that organic food is safer, healthier and more quality than conventional products (Hansson *et al.,* 2000; Leu, 2007). The purpose of the production of organic products is to protect the health and quality (Hansson *et al.,* 2000). In animal production, utilization of hormones, antibiotic, synthetic and growth-promoting drugs have negative effects in human health, and have been prohibited in organic animal food (Bennedsgard *et al.,* 2003; Ruegg, 2008). There are many detailed regulations for organic milk (OM) production (Bennedsgard *et al.,* 2003). The organic production rules in Turkey are published by Republic of Turkey Ministry of Food, Agriculture and Livestock (OFL, 2010). These rules are based on EU Regulation 1804/99. Although organic animal production has increased in the world, this increased ratio is relatively lower in Turkey (Ak and Guldas, 2014). First OM production was begun in 2002 and 40 t of milk was produced, and nowadays, its production amount was 16,408 t according to the 2015 data (Anonymous, 2017).

The OM must not include antibiotic residue and other chemical compounds (Bennedsgard *et al.,* 2003). Antibiotic residue in milk is the main cause of mastitis, because antibiotics are used commonly for mastitis therapy in dairy production (Hamilton *et al.,* 2006). Antibiotic residue in milk is an important problem regarding the public health (Rajala-Schultz *et al.,* 2011). But, main goal of organic production is to lessen the utilization of antibiotic. Actually, antibiotic use is restricted by organic production legislations (Hamilton *et al.,* 2006). According to organic production rules, usage of antibiotic have been forbidden for prevention of diseases but for the compulsory diseases, antibiotic can be used for maximum three times in a year. Mastitis is one of the most common problems in organic and conventional farming in worldwide (Hamilton *et al.,* 2006), and mastitis causes serious economic losses (Harmon, 1994; Smith, 1996). Mastitis results from infection of many different microorganisms such as yeasts, bacteria, mycoplasma and algae, and is defined as an inflammatory reaction inside mammary gland (Harmon, 1994). These microorganisms lead to reducing milk synthesis activity, change milk composition and raise somatic cell count (Harmon, 1994).

The somatic cell count (SCC) is a major indicator of mastitis and milk quality (Harmon, 1994). At the same time, the SCC is an indirect indicator of hygienic milk production. The SCC must not exceed 400,000 cell/mL according to EC Milk Hygiene Directive (92/46) (Anonymous, 1992) and 500,000 cell/mL according to Turkish Food Codex (2000). The SCC is a risk for human health (Smith, 1996). The SCC value in raw milk is used as indicator of mastitis, and the ratio of SCC is high in mastitic milk (Barbano *et al.,* 2006; Smith 1996). The SCC can affect some chemical properties (i.e., fat, protein, lactose) of milk (Barbano *et al.,* 2006; Malek dos Reis *et al.,* 2013). The SCC causes negative effects on milk and dairy products (Barbano *et al.,* 2006; Smith, 1996). There are also many studies on SCC regarding organic and conventional milk (Hamilton *et al.,* 2002; Hovi *et al.,* 2003; Sato *et al.,* 2005).

One of the important indicators of milk quality is total aerobic mesophilic bacteria. Total aerobic mesophilic bacteria (TAMB) count informs about animal welfare, farming sanitation rules, milking and storage conditions (Pantoja *et al.,* 2009). TAMB count has been stated as ≤ 100,000 CFU/mL in EC Milk Hygiene Directive (92/46) (Anonymous, 1992) and Turkish Food Codex (2000). It is affected by inadequate hygiene conditions of milking equipment, dirty cow udders, insufficient cooled milk and rarely milk of mastitic cows (Pantoja *et al.,* 2009). The count of coliform bacteria is an indicator of fecal contamination in the raw milk (Worku *et al.,* 2012). Coliform bacteria can contaminate milk by dirty udders and tears (Cicconi-Hogan *et al.,* 2013a; Pantoja *et al.,* 2009), soiled water, feces of mouse and bird, insects, dust, unsanitary equipments (Gillespie *et al.,* 2012) and mastitis (Cicconi-Hogan *et al.,* 2013a; Worku *et al.,* 2012). *Staphylococcus aureus* (*S. aureus*) is a pathogen for human and some animal species. When *Staphylococcus* counts reach approximately 10^6 cell/g, staphylococcal enterotoxins can be produced. Produced enterotoxins can lead to intoxication (Linage *et al.,* 2012). Milk and dairy products are generally contaminated with *S. aureus*, and *S. aureus* is an important threat for milk and dairy products (Jamali *et al.,* 2015; Linage *et al.,* 2012).

The aims of this study were: (a) to evaluate the changes of SCC and microbiological properties (TAMB, coliform, *S. aureus*, yeast and mold) in milk samples in terms of the milk collection period and the different production systems, and (b) to investigate antibiotic residue of milk samples. The differences among the collected milk samples were investigated at six different months in a year. There is a lack of knowledge in the literature about comparing SCC, microbiological properties and antibiotic residue between conventional milk (CM) and OM in Turkey. Thus, it is thought that this study will provide a significant contribution to the studies about organic milk in Turkey.

Materials and Methods

Materials

General diet conditions

Nine conventional and nine organic farms were selected. The selected farms were located in the provinces of Gümüşhane, Erzincan and Erzurum in East Anatolia. All farms' owners were contacted by the researchers, before milk collection. All organically managed farms had organic production certificates given by the Republic of Turkey Ministry of Food, Agriculture and Livestock.

In organic farms, animals were fed with maize silage, dry meadow and alfalfa as roughage origin. Organic farms had too little hay in feed regime. Organic farms used concentrates which were organically produced. According to Organic Laws in Turkey, ration of animals must consist of 60% roughage and 40% concentrate (OFL, 2010). Conventional farms used maize silage, dry meadow, alfalfa, clover, large amounts of concentrate and hay for feeding animals. Hay was used only in winter. Cows were occasionally fed with fresh grass during summer. Cattle breeds of organic farms were Holstein-Friesian 90%, and Simmental 10% and it was similar in the conventional farms. In selected farms, robotic milking systems were applied in all organic farms; whereas mechanical or robotic systems were used in conventional farms. Except one (≥ 500 cattles), all organic farms had between 30 and 100 cattles; on the other hand, conventional farms had between 20 and 100 cattles. All farms had milk cooling tanks, except for one conventional farm. Overall organic farms had Clean -In-Place (CIP) system, but only a few conventional farms had it.

Milk samples

The milk samples were collected from 18 farms (nine conventional and nine organic) at intervals of two months from December 2013 to October 2014 for a total of 97 samples. Samples were taken in the bulk tanks with sterile instruments. Milk samples were placed into the sterile screw-topped bottles (200 mL). Milk samples were collected from conventional and organic farms in the same week and transported at 4°C in a car refrigerator (ICEPEAK 60 DC Refrigerator). During milk collection period, some organic farms and some conventional farms had stopped the milk production. Thus, data shortcomings have occurred.

Methods

The SCC was determined by DeLaval cell counter (DCC, DeLaval International AB, Sweden). A disposable cassette that was specially produced for DCC was utilized. DCC cassette was filled up with milk sample. It was placed in the DCC machine and the results were showed as cell/mL.

Milk samples (1 mL) were dispersed in 9 mL of 0.85% (w/v) sterile NaCl solution. Decimal serial dilutions were prepared. The counts of total aerobic mesophilic bacteria (TAMB) were determined using plate count agar (Oxoid, England) after incubation at 30°C for 48 h (Messer *et al.,* 1985). Coliforms were enumerated on violet red bile agar (Oxoid) and incubated at 35°C for 48 h (Speck, 1976). Yeasts and moulds were enumerated on potato dextrose agar acidified with 10% tartaric acid (Oxoid) at 25°C after 5 d of incubation (Koburger and Marth, 1984).

S. aureus was counted on Baird-Parker agar and incubated at 37°C for 48 h. After being incubated, typical colonies (black, circular, convex, shiny, in 1-1.5 mm diameter, extending to 2.0-2.5 mm, clear and opaque zones) were picked. Selected colonies were transferred to tubes containing brain heart infusion (BHI) broth and incubated at 37°C for 20-24 h (Pichhardt, 2004). For detection of coagulase positive *S. aureus*, rabbit plasma was used. 0.1 mL of turbid BHI broth was mixed with 0.3 mL of rabbit plasma in the sterile tube. The mixture tubes was incubated at 37°C for 4-24 h. The tubes were controlled at 4 h intervals. It is accepted as coagulase positive, if the clot is formed in the tubes (Tesfaye *et al.,* 2010).

Antibiotic residue was determined by Charm MRLBL3. It is a 3-min beta-lactam test and specifically engineered to meet EU/CODEX MRL levels (Anonymous, 2016). Milk sample was added to ROSA strip (Charm Science, USA) and incubated for 3 min. After that, the results were recorded by reader. The results were indicated to qualitative (positive and negative).

Statistical analysis

The experimental design was composed of a completely randomized design infactorials: two production systems (conventional and organic production), six collection periods (December, February, April, June, August and October months) and nine replicates (farm number: 9 different conventional farms and 9 different organic farms). All samples were collected constantly from same farms. Statistical analyses were carried out using statistical software program, version 17 (SPSS) (SPSS Inc., USA). ANOVA and Duncan's multiple range test was used to evaluate effect of collecting period (months). A Student's test was used to know the statistical differences between production systems (conventional and organic production). Homogeneity was carried out using the Levene's test.

Results and Discussion

TAMB count and SCC are important indicators for the raw milk's quality (Pantoja *et al.,* 2009). Increase of TAMB

Table 1. Changes in TAMB counts (Log CFU/mL) of conventional and organic milk relating to milk collecting period

Production Systems (farms)	Collecting Period (mon)					
	December	February	April	June	August	October
C1	6.04	6.60	9.46	7.00	5.70	6.39
C2	6.52	7.35	7.83	7.31	-	-
C3	6.30	5.85	8.39	7.03	6.30	6.32
C4	6.59	7.37	7.34	8.07	7.21	6.85
C5	5.84	6.84	6.34	6.34	5.95	7.69
C6	6.16	6.39	6.57	6.75	6.99	7.12
C7	7.28	6.98	9.83	9.83	-	-
C8	5.85	8.27	9.94	9.94	6.28	6.00
C9	6.61	5.60	6.14	7.81	5.70	4.92
O1	7.48	6.64	5.22	7.76	6.07	7.27
O2	4.69	5.34	-	5.44	5.76	6.09
O3	6.52	6.50	7.79	5.47	-	-
O4	5.38	5.83	5.96	6.45	7.21	7.22
O5	4.64	4.15	4.76	5.79	6.74	5.96
O6	5.05	5.27	4.93	5.40	5.54	6.42
O7	6.10	4.78	6.58	6.58	5.52	7.36
O8	4.75	5.88	8.53	7.52	6.03	7.47
O9	7.34	5.74	-	-	-	-

C, Conventional; O, Organic.

count is related to many pathogenic bacteria such as *E. coli,* coliforms and *S. aureus* (Millogo *et al.,* 2010). The data of TAMB counts are shown in Table 1. Although TAMB count was between 4.64-8.53 Log CFU/mL in OM, it was between 4.92-9.94 Log CFU/mL in CM. The mean of TAMB count of milk samples differed depending upon production system and milk collection period (p<0.01). The OM had a lower TAMB count in February, compared to in April and July months in CM (Table 2). The TAMB count of CM was rather higher in April than in July and August (p<0.05). The TAMB count did not indicate a significant difference during the collection period. General mean of the CM (6.99 Log CFU/mL) were higher than the OM (6.10 Log CFU/mL) (p<0.01; Table 2).

Table 2. Effect of time and production system on TAMB[1] counts (Log CFU/mL) of milk samples

Collecting Period (mon)	Production Systems	
	Conventional	Organic
December	$6.35\pm0.46^{a.A}$	$5.77\pm1.13^{ab.A}$
February	$6.81\pm0.82^{ab.A}$	$5.57\pm0.79^{ab.B}$
April	$7.98\pm1.50^{c.A}$	$6.25\pm1.46^{ab.B}$
June	$7.79\pm1.30^{bc.A}$	$6.30\pm0.94^{ab.B}$
August	$6.31\pm0.60^{a.A}$	$6.12\pm0.63^{ab.A}$
October	$6.47\pm0.89^{a.A}$	$6.83\pm0.65^{b.A}$
G. Mean	6.99 ± 1.19^{A}	6.10 ± 1.01^{B}

$^{a\text{-}c}$Values are means±SD; Significant differences are indicated in the same column by superscript letters.
^{A,B}Values are means±SD; Significant differences are indicated in the same row by superscript letters.
[1]Total Aerobic Mesophilic Bacteria.

Cermanová *et al.* (2011) reported that TAMB count was higher in the CM (4.66 Log CFU/mL) compared with the OM (4.31 Log CFU/mL). But this change was not statistically significant (p<0.05). Kouřimská *et al.* (2014) found that TAMB counts of the OM and CM were 4.45 Log CFU/mL and 4.28 Log CFU/mL, respectively. They said that TAMB counts were affected by production system (p<0.01), but TAMB counts were not affected by time (p>0.05). The TAMB counts of the OM were determined between 5.58-5.76 Log CFU/mL by Man *et al.* (2004). Results were generally higher than those reported by Man *et al.* (2004), Cermanová *et al.* (2011) and Kouřimská *et al.* (2014). The TAMB count is affected by many factors such as storage conditions and containers, udder health, milking equipments and processes, the quality of the water used in the farm, environmental effects (Chye *et al.,* 2004; Millogo *et al.,* 2010) and magnitude of farm (Kouřimská *et al.,* 2014). Our results may have affectedusage of milk cooling equipment and CIP system in the cleanness of milking equipments in the organic farming. But, cooling system is rarely used because of high electric cost in conventional farms. Another factor is that, there is no CIP system in the conventional farming. Therefore, these fac-

Table 3. Changes in coliform counts (Log CFU/mL) of conventional and organic milk relating to milk collecting period

Production Systems (farms)	Collecting Period (mon)					
	December	February	April	June	August	October
C1	2.85	3.73	2.15	2.34	3.23	3.18
C2	3.36	3.98	5.57	5.08	-	-
C3	3.02	3.73	4.81	5.37	4.10	3.25
C4	6.35	5.50	5.45	5.35	5.62	5.21
C5	3.16	3.64	3.08	3.55	4.47	4.46
C6	2.42	4.18	5.27	4.22	5.51	3.94
C7	4.21	4.13	6.91	4.88	-	-
C8	1.85	4.09	7.05	5.94	4.59	2.34
C9	3.51	3.38	3.38	2.11	2.16	2.19
O1	4.04	4.20	2.52	6.32	4.73	5.20
O2	1.39	1.28	-	4.13	4.20	2.83
O3	3.30	4.13	2.60	3.76	-	-
O4	3.48	3.31	2.67	5.14	4.56	4.60
O5	1.15	1.18	2.09	3.11	2.61	1.92
O6	3.52	3.91	2.94	3.72	3.78	2.90
O7	4.10	2.96	4.12	3.90	2.64	2.85
O8	2.72	1.23	2.35	5.58	4.74	2.88
O9	4.17	2.25	-	-	-	-

C, Conventional; O, Organic.

tors can affect the bacterial counts.

The coliform counts of CM varied from 1.85 Log CFU/mL to 7.05 Log CFU/mL, whereas coliform counts of OM changed from 1.15 Log CFU/mL to 6.32 Log CFU/mL (Table 3). The coliform counts were affected by production systems (p<0.01) and time (p<0.05). The mean of coliform count is shown in Table 4. The coliform counts obtained in April were higher than in October in the CM. The coliform counts of OM significantly increased in April (p< 0.05). The coliform counts of the OM were higher than the CM at February and April. The average of coliform counts in conventional milk was higher than that of organic milk. Similarly, Cermanová *et al.* (2011) found the higher (p<0.01) coliform count of the CM (2.58 Log CFU/mL) compared to the OM (1.48 Log CFU/mL). In this study, the results were higher than those reported by Cermanová *et al.* (2011). On the other hand, Kouřimská *et al.* (2014) reported that coliform counts of CM and OM were found as 2.68 Log CFU/mL and 2.65 Log CFU/mL, respectively and coliform count was not affected by production system and time (p<0.05). Coliform bacteria are one of the important indicator microorganisms (Chye *et al.,* 2004). The existence of coliform shows nonsufficient sanitation and hygiene applications in milking, storage and carriage process (Chye *et al.,* 2004; Pantoja *et al.,* 2009). Unclean udders (Pantoja *et al.,* 2009), soil, manure and soiled water are important causes for increasing coliform counts in the milk (Gillespie *et al.,* 2012).

Table 4. Effect of time and production system on coliform counts (Log CFU/mL) of milk samples

Collecting Period (mon)	Production Systems	
	Conventional	Organic
December	3.41±1.29$^{ab.A}$	3.09±1.13$^{a.A}$
February	4.04±0.61$^{ab.A}$	2.72±1.27$^{a.B}$
April	4.85±1.69$^{b.A}$	2.76±0.66$^{a.B}$
June	4.32±1.37$^{ab.A}$	4.46±1.10$^{b.A}$
August	4.24±1.23$^{ab.A}$	3.89±0.93$^{ab.A}$
October	3.51±1.10$^{a.A}$	3.31±1.15$^{ab.A}$
G. Mean	4.08±1.30^{A}	3.35±1.20^{B}

$^{a-c}$Values are means±SD; Significant differences are indicated in the same column by superscript letters.
^{A,B}Values are means±SD; Significant differences are indicated in the same row by superscript letters.

The data of coagulase positive *S. aureus* counts are given in Table 5. *S.aureus* counts in CM and OM were between <1 Log CFU/mL and 1.65 Log CFU/mL, and between <1 Log CFU/mL and 2.96 Log CFU/mL, respectively. As shown in Table 6, *S. aureus* counts in milk showed statistically significant differences during collecting period (p< 0.01). But, *S. aureus* count was not affected by production systems (p>0.05). *S. aureus* count of OM was higher than the CM only in February. *S. aureus* counts of both kinds of milk did not show a significant difference over

Table 5. Changes in coagulase positive *S. aureus* counts (Log CFU/mL) of conventional and organic milk relating to milk collecting period

Production Systems (farms)	Collecting Period (mon)					
	December	February	April	June	August	October
C1	<1	<1	<1	<1	<1	<1
C2	<1	<1	<1	<1	-	-
C3	1.44	<1	<1	<1	<1	1.65
C4	1.35	<1	<1	<1	<1	<1
C5	<1	<1	<1	<1	<1	<1
C6	<1	<1	<1	<1	<1	<1
C7	<1	<1	<1	<1	-	-
C8	<1	<1	<1	<1	<1	<1
C9	<1	<1	<1	<1	<1	<1
O1	1.73	<1	1.34	<1	<1	<1
O2	2.96	1.78	-	<1	<1	<1
O3	<1	1.95	2.60	<1	-	-
O4	1.67	2.00	<1	2.20	<1	<1
O5	<1	<1	1.37	<1	<1	<1
O6	1.83	<1	<1	<1	1.78	2.21
O7	<1	<1	<1	<1	<1	<1
O8	<1	1.78	<1	<1	2.40	<1
O9	<1	<1	-	-	-	-

C, Conventional; O, Organic.

time. The general means of the CM was lower than the OM in terms of the coagulase positive *S. aureus* ($p<0.05$). The general means of the coagulase positive *S. aureus* count showed similarity with SCC. Since, SCC of CM was lower than the OM's. *S. aureus* is one of the main causes of intramammary infections (mastitis) (Boynukara *et al.,* 2008; Cicconi-Hogan *et al.,* 2013b). On the other hand, *S. aureus* is resistant against antibiotics. Therefore, this bacterium is a serious problem for the milk cow (Cicconi-Hogan *et al.,* 2013b).

Yeast and mould counts of milk samples varied from 1.45 Log CFU/mL to 5.85 Log CFU/mL (Table 7). The mold and yeast counts of milk samples significantly differed depending upon the production system ($p<0.05$), but the effect of time was not statistically significant ($p>0.05$). There were no statistically different results between two types of milk during milk collection times except for February (Table 8). The general mean was higher in CM (3.58 Log CFU/mL) than the OM (3.17 Log CFU/mL). During milk collection time, yeast and mould counts of the CM were similar. The yeast and mould counts of the OM were lower in the June, August and October compared to February. These results are similar to that of Kesenkaş and Akbulut (2010), who reported the yeast and mould counts of milk samples as 3.33 Log CFU/mL. Results were generally lower than those reported by Beykaya (2010) and Engin *et al.* (2009). The yeast and moulds can be contamined to milk by dirty mat- erials and air. Thus, the microbial load of ambient air is the most important for contamination (Saltan Evrensel *et al.* 2003). Especially, the conventional farms have ignored air conditioning of the barn according to the organic farms. For this reason, the yeast and mould counts may be higher in the CM.

Table 6. Effect of time and production system on coagulase positive *S. aureus* counts (Log CFU/mL) of milk samples

Collecting Period (mon)	Production Systems	
	Conventional	Organic
December	$0.31±0.61^{a.A}$	$0.91±1.14^{a.A}$
February	$<1^{a.A}$	$0.83±0.99^{a.B}$
April	$<1^{a.A}$	$0.76±1.03^{a.A}$
June	$<1^{a.A}$	$0.28±0.78^{a.A}$
August	$<1^{a.A}$	$0.60±1.04^{a.A}$
October	$0.24±0.62^{a.A}$	$0.32±0.84^{a.A}$
G. Mean	$0.09±0.36^{A}$	$0.63±0.96^{B}$

$^{a-c}$Values are means±SD; Significant differences are indicated in the same column by superscript letters.
^{A,B}Values are means±SD; Significant differences are indicated in the same row by superscript letters.

As shown in Table 9, the SCC changed from $6×10^4$ cell/mL to $13×10^5$ cell/mL during milk collection period. The SCC was affected by production systems ($p<0.05$). The SCC mean values are presented in Table 10. A significant

Table 7. Changes in yeast and mould counts (Log CFU/mL) of conventional and organic milk relating to milk collecting period

Production Systems (farms)	Collecting Period (mon)					
	December	February	April	June	August	October
C1	2.30	3.16	1.00	2.88	3.09	2.98
C2	4.92	4.55	5.85	4.70	-	-
C3	2.83	2.87	2.87	3.17	3.06	2.85
C4	3.00	4.18	4.72	4.26	4.53	5.25
C5	2.56	2.96	4.36	5.37	3.96	4.14
C6	4.39	2.90	2.94	2.69	4.48	2.91
C7	3.34	4.42	5.56	4.79	-	-
C8	2.48	3.45	3.28	3.92	4.53	4.36
C9	3.18	2.87	2.39	2.75	2.32	3.11
O1	4.06	2.38	4.07	3.77	3.24	3.90
O2	3.02	1.59	-	3.39	4.29	3.90
O3	2.99	3.04	2.66	3.96	-	-
O4	3.78	3.20	3.39	4.04	4.54	3.65
O5	2.65	1.45	1.66	2.42	2.25	1.90
O6	2.15	2.15	2.00	2.52	2.68	2.51
O7	2.24	2.65	2.90	4.90	4.70	4.68
O8	2.15	1.92	2.72	4.50	4.20	4.06
O9	4.39	3.78	-	-	-	-

C, Conventional; O, Organic.

difference between the CM and OM were not obtained during collection period. However, general average of SCC values in CM was lower than OM ($p<0.05$). The SCC of the milk samples were higher than those found by Sato *et al.* (2005) and Cicconi-Hogan *et al.* (2013b) for conventional and organic milk. Olivo *et al.* (2005) found the higher SCC compared with the present study. Cicconi-Hogan *et al.* (2013b) and Ellis *et al.* (2005) reported that the SCC of OM (195,000 cell/mL, 227,000 cell/mL) was higher than the CM (182,000-166,000 cell/mL, 172,000 cell/ml). In contrast, Olivo *et al.* (2005) found the lower values in OM (505,000) than CM (967,000 cell/mL). Some researchers found that there was effect of production system on SCC (Cicconi-Hogan *et al.* 2013b; Ellis *et al.* 2005; Olivo *et al.* 2005). Ellis *et al.* (2006) found that SCC of the OM (227,000 cell/mL) was higher compared with the CM (172,000 cell/mL) and the results were affected by production system and month. Especially, dry-off period is the most sensitive period for mammary infection (Ruegg, 2008). But, at this period, antibiotic therapy is limited in organic farms. As a result of restricted usage of antibiotics during lactation and dry-off period in organic farms, SCC values in OM may be higher than CM (Ruegg, 2008). On the other hand, the SCC increases due to poor conditions of cow and bedding hygiene, use of dirty water, the litter, the lack of barn facilities (Sant'Anna and Paranhos da Costa, 2011). Our results showed that SCC and *S. aureus* counts of the OM were higher than the CM, and these changes were statistically significant. Cicconi-Hogan *et al.* (2013b) reported a similar result.

Table 8. Effect of time and production system on yeast and mould counts (Log CFU/mL) of milk samples

Collecting Period (mon)	Production Systems	
	Conventional	Organic
December	$3.22±0.89^{a,A}$	$3.05±0.85^{ab,A}$
February	$3.49±0.70^{a,A}$	$2.46±0.78^{a,B}$
April	$3.66±1.58^{a,A}$	$2.77±0.81^{ab,A}$
June	$3.84±1.00^{a,A}$	$3.69±0.88^{b,A}$
August	$3.71±0.89^{a,A}$	$3.70±0.97^{b,A}$
October	$3.66±0.93^{a,A}$	$3.51±0.96^{b,A}$
G. Mean	$3.58±1.01^{A}$	$3.17±0.95^{B}$

$^{a-c}$Values are means±SD; Significant differences are indicated in the same column by superscript letters.
^{A,B}Values are means±SD; Significant differences are indicated in the same row by superscript letters.

Antibiotic residue was observed in only 1 sample among 50 samples of the CM, but it was detected in 2 out of 47 samples of the OM. Antibiotic residue was determined in the 2% of CM samples and in the 4.26% of OM samples. Antibiotics are especially used as treatment for mastitis (Bradley 2002; Ergin-Kaya and Filazi, 2010; Ruegg, 2008). Antibiotic residue in the milk may result from insufficient knowledge about use of correct dose and the disappear-

Table 9. The raw datas of changes in somatic cell count (SCC) values of conventional and organic milk relating to milk collecting period (x1000, cell/mL)

Production Systems (farms)	Collecting Period (mon)					
	December	February	April	June	August	October
C1	395	153	685	193	458	224
C2	210	152	131	216	-	-
C3	537	407	691	870	971	435
C4	277	755	343	243	622	231
C5	162	209	172	162	118	104
C6	291	205	76	98	360	306
C7	247	109	258	275	-	-
C8	60	143	202	239	215	129
C9	287	328	427	672	162	238
O1	360	703	356	959	229	652
O2	520	650	-	169	220	125
O3	350	325	676	877	-	-
O4	97	238	184	220	892	212
O5	372	300	597	495	326	1,362
O6	387	250	376	207	91	201
O7	106	506	152	403	455	193
O8	343	121	558	1,104	1,050	769
O9	136	136	-	-	-	-

C, Conventional; O, Organic.

ance time of antibiotic. There is negative effect of drug residue on the public health (Tesfaye *et al.,* 2010). Besides, drug residue leads to problems in the production of fermented dairy products (Ergin-Kaya and Filazi, 2010). While organic milk was collected from the organic farm after antibiotic residue test, antibiotic test of CM was performed in the dairy plant. There was an antibiotic monitoring system in the organic farm, but conventional farms did not have this system.

Conclusion

The results of this study indicated that production systems had significant effects on TAMB, coliform and *S. aureus* counts in the $p<0.01$ level, and SCC and yeast and mould counts in the $p<0.05$ level. TAMB count and coliform count were affected by milk collection period, while the milk collection period did not have significant effect on SCC, yeast-mould and *S. aureus* counts ($p>0.05$). While TAMB, coliform and yeast and mould counts of the OM were lower than the CM, SCC and *S. aureus* counts were higher. Antibiotic residue was found in 2 OM samples and 1 CM sample. Differences between microbiological properties of milk samples resulted from organic and conventional production rules. The microbiological quality of OM was the higher than CM because, there are legal restrictions in the organic farming management and organic farms are periodically under control. Hygienic conditions in barns and milking should be improved. Farmers and their workers should be trained about hygienic conditions at the farms. The quality control systems can be established from farms to consumer for improving the quality of the milk and dairy products in Turkey (Kürekci *et al.* 2016). Further researches are needed to improve microbiological quality of organic milk, especially in Turkey.

Table 10. Effect of time and production system on SCC (x1000, cell/mL) of milk samples

Collecting Period (mon)	Production Systems	
	Conventional	Organic
December	$274.00\pm135.76^{a,A}$	$296.77\pm147.80^{a,A}$
February	$273.44\pm204.5^{a,A}$	$358.77\pm212.77^{a,A}$
April	$331.66\pm228.19^{a,A}$	$414.14\pm203.81^{a,A}$
June	$329.77\pm260.11^{a,A}$	$554.25\pm373.65^{a,A}$
August	$415.14\pm302.51^{a,A}$	$466.14\pm365.48^{a,A}$
October	$238.14\pm110.69^{a,A}$	$502.00\pm455.65^{a,A}$
G. Mean	309.06 ± 212.26^{A}	425.74 ± 301.59^{B}

[a-c]Values are means±SD; Significant differences are indicated in the same column by superscript letters.
[A,B]Values are means±SD; Significant differences are indicated in the same row by superscript letters.
[1]Somatic cell count.

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