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Research article

EFFECT OF SOMATIC CELLS ON THE PHYSIC-CHEMICAL AND MICROBIOAL PROPERTIES OF RAW MILK IN DIFFERENT SEASONS

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ABSTRACT: Mastitis disease is an inflammatory response in milk-producing glands in animals that is considered the most important factor in increasing the somatic cells counts. This disease causes enormous economic losses to the dairy industries. Increasing of microbial load of milk and decreasing of lactose, fat, casein and minerals like calcium and potassium and also increasing the somatic cell count will occur by this disease. Due to the damaging effects of Mastitis disease and its prevalence, this study aimed to investigate the effect of increasing somatic cell on composition and chemical - microbial features of raw milk in different seasons of a year. In this study 240 samples of milk were randomly selected from 10 milk collection centers and industrial farms in Khorasan Razavi Province (Iran) and examined. Significant difference was found between the number of somatic cells in summer and other seasons and the highest number of somatic cells was indicated in August. The results showed that the amount of fat, lactose, somatic cells count was decreased by increasing acidity. Positive significant relationship was observed between the number of somatic cell with PH, electrical conductivity and microbial load.
Key words: somatic cell, raw milk, composition, mastitis, microbial load.

INTRODUCTION

Milk is one of the most important food products of animals origin which has as special significant in terms of nutrition characteristics. mastitis infection among the animals is the most significant problem that milk industries face with. The most important bacterial agents of mastitis include Staphylococcus aureus, Coliforms, Streptococcus agalactiae , Streptococcus, Environmental enterococci. Infections cause by these organisms can cause inflammatory reactions, such as increasing somatic cell count so many more than in health breast [1, 2]. Somatic cell count is one of the most important factors to evaluate the quality and health of milk. Normal milk has less than 200,000 cells per ml. Increasing somatic cells causes significant reduction in producing amount and quality of milk. This is due to the increasing changes in milk composition such as increasing blood serum proteins like albumin and Immunoglobulin levels and decreasing lactose, casein, fat and α-lactalbumin and β-lactoglobulin. Changing in natural mineral content of milk and increasing enzyme activity by protease such as Plasmin, Cathepsin types, Elastase and Lipase may cause problems in some dairy products. Increasing somatic cells, leads to reducing shelf life and flavor quality of milk, yogurt, cheese yields the probable of a foul taste, texture and high moisture content in cheese and dough [3, 4]. Due to the damaging effects of Mastitis disease and its prevalence, this study aimed to investigate the effect of increasing somatic cell on composition and chemical - microbial features of raw milk in different seasons of year.

MATERIALS AND METHODS

Sampling

According to the national standards NO.326, 240 samples of milk were randomly selected from 10 milk collection centers and industrial farms in Khorasan Razavi Province (Iran) in 4 repetition rate of 100 ml in different seasons of a year [5]. Random sampling was disciplined. During storage of raw milk samples to testing, cold chain were applied to preserve samples of raw milk and to avoid any changes in measured parameters.

Measuring parameters

1. The somatic cell count

Somatic cell of samples were counted by fluoro opto electronic counters-Fossmatic 5000 basic Denmark Foss electric company, based on the international standard Iso-13366 [6,7]. It is planned that Europe union evaluate the quality of milk by using this device in laboratory base on project FD Rus 970-4 of TACTS program.

2. The total count of aerobic microorganism

The total count of mesophilic microorganisms were measured based on 5484 national standards and according to international standard ISO 6610 [8, 9].

3. Acidity

The acidity of raw milk was measured base on per grams of lactic acid percent according to the national standards NO.2852 [10].

4. PH

PH was measured by PH meter- model 720 inolab, manufactured by Wilhelm of Germany at 20°c according to the national standard NO.2852 [10].

5. Electrical conductivity

EC was measured by EC meter - model720 inolab Cond, made in Germany Wilhelm Company at 25°c according to the method recommended by the manufacture.

6. Lactose

Polari metric assessment of raw milk lactose was done based on national standard NO.4449 [11].

7. Fat and Protein

Milk samples were evaluated in terms of protein and fat using Milko-scan Model 134 made in Foss Electric Company, Denmark, in accordance with ISO 1996: B 141IDF standards [12].

Statistical analysis

Statistical analysis of parameters was analyzed in completely randomized design using Sigma Stat version 3.5 software. Duncan test in 0.95 was used for comparison of mean of treatments. Correlation coefficient regression was performed with slide write version 2.0 software.

RESULTS AND DISCUSSION

Somatic cell changes in different seasons

Comparative study of means were showed that significant difference is in number of somatic cells between summer and other seasons. ($p<0.05$)(Fig1.). As shown in Figure 1, number of somatic cells is highest in the summer but, in autumn it is backed again to its original level. The highest number of somatic cell was reported in August (1173000 cells/ml). The changes are in the way that somatic cell count in the milk has increased till August but after that till October, showed decreasing tendency. The changes were minor From October to March.

Hogeveen (2005), Khate and et al (2010) found similar result in increasing somatic cells in summer. They believed the reasons for increasing the number of somatic cells in summer are consist of breastfeeding period, stress that occur by changing livestock diets, hurting the mammary glands, mastitis outbreaks and suitable environmental conditions for the growth of bacteria in this season and probably more contact with wet surfaces or a combination of these factors. Mastitis disease is most important among these factors. Increasing the number of somatic cells caused a significant reduction in the quality and quantity of milk, reducing maintenance and production efficiency of dairy products, therefore knowing effective factors on increasing somatic cells in summer can help to reduce problems in the dairy industry [13, 14]. Result showed that the number of somatic cells in autumn were 67/34 percent less than in summer.

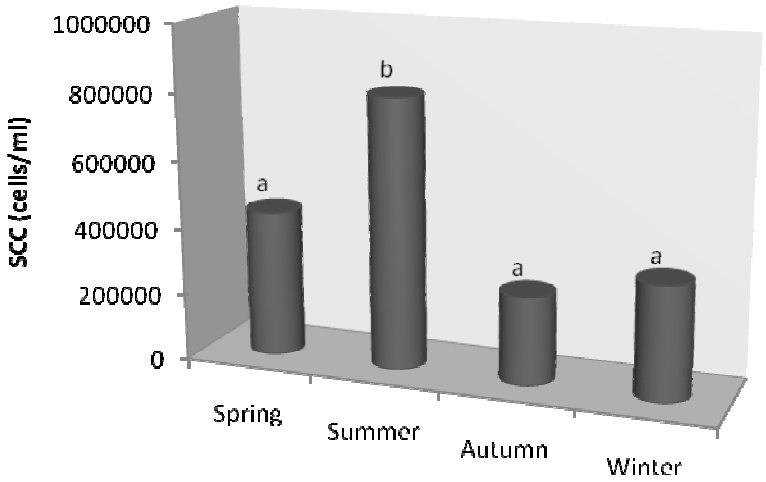


Figure 1. Changes of somatic cells in different seasons

Table 1. The mean and the standard deviation number of somatic cells in tested seasons

	Spring	Summer	Autumn	Winter
Mean SCC (cells/ml)	437806.45	805683.33	263133.33	341172.41
Std. Deviation SCC	1042471.724	123474.386	20577.453	391205.207

The effect of somatic cell composition and chemical-biological features of raw milk

The effect of somatic cell on raw milk fat

Results showed a significant relationship between somatic cell count and raw milk fat ($p<0.05$). Figure 2 shows a negative logarithmic relationship between somatic cell count and amount of fat in different seasons of a year. With increasing somatic cells count, amount of fat has been reduced. Investigation's results of Forsback et al (2009) showed a positive correlation between Lipolytic enzyme activity and somatic cell count in milk. In comparison with healthy milk, They found lower fat in the milk which has more than 100,000 cells/ml somatic cells. But among milks which somatic cell count were between 100000-1000000 cells/ml, increasing somatic cell count caused increasing amount of fat[15]. Studies indicated that the most important enzymes that somatic cells produce in response to mammary glands infection are Lipolytic enzymes. In the procedure of the above enzymes on milk fat, free fatty acids increase in milk and causes unpleasant taste, which is recognized by a rancidity taste. This flavor is felt in cattle milk with more than 400,000 cells/ml somatic cells. milk fat sensitivity to Lipase enzyme increase with increasing somatic cells and rancidity taste and soft taste in high-fat products such as butter and cheese are more obvious.

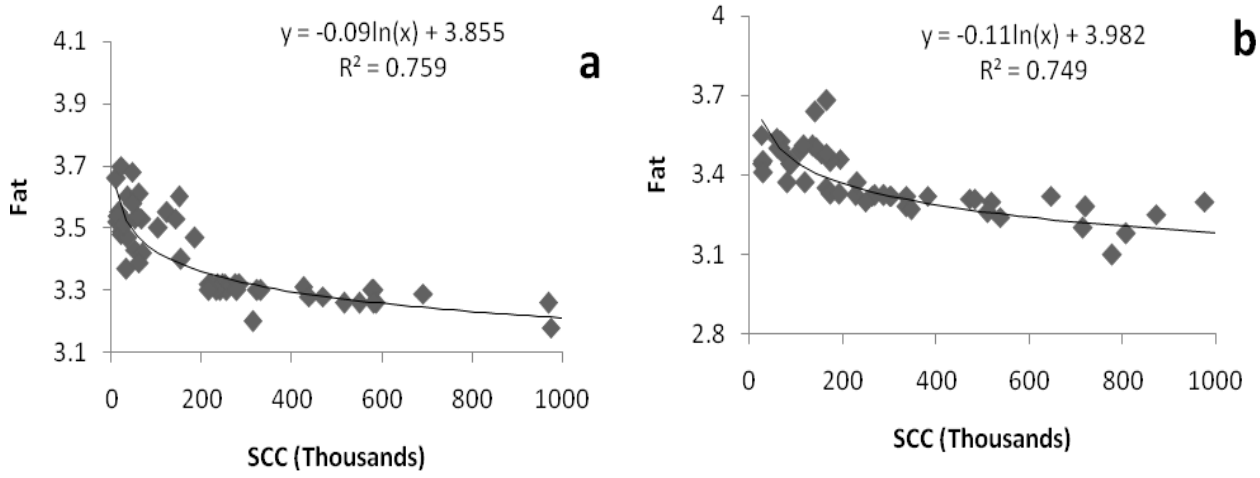
Table 2. The correlation coefficient between somatic cell count and studied parameter

		Fat	Pro	Lactose	pH	Acidity	EC	Log SCC	Log TC
Fat	Pearson Correlation Sig. (1-tailed)	1	-.402* 000*	.036 .366	-.038 .360	-.201* .027	.012 .455	-.042* .034	.282** .003
Pro	Pearson Correlation Sig. (1-tailed)	-.402** .000	1	.129 .111	-.073 .244	.091 .194	.048 .326	.132 .105	-.071 .249
Lactose	Pearson Correlation Sig. (1-tailed)	.036 .366	.129 .111	1	.094 .185	.036 .365	.046 .331	-.412** .000	.151 .076
pH	Pearson Correlation Sig. (1-tailed)	-.038 .360	-.073 .244	.094 .185	1	-.045 .334	.036 .368	.052** .000	.026 .403
Acidity	Pearson Correlation Sig. (1-tailed)	-.201* .027	.091 .194	.036 .365	-.045 .334	1	.070 .253	-.399** .000	-.246** .009
EC	Pearson Correlation Sig. (1-tailed)	.012 .455	.048 .326	.046 .331	.036 .368	.070 .253	1	.211* .022	.133 .103
Log SCC	Pearson Correlation Sig. (1-tailed)	-.042* .034	.132 .105	-.412** .000	.052** .000	-.399** .000	.211* .022	1	.461** .000
Log TC	Pearson Correlation Sig. (1-tailed)	.282** .003	-.071 .249	.151 .076	.026 .403	-.246** .009	.133 .103	.461** .000	1

Correlation is significant at the 0.01 level (1-tailed).**

Correlation is significant at the 0.05 level (1-tailed).*

Although natural lipase during HTST milk pasteurization process will inactivate but in milk with high somatic cells count, there are some high heat resistant lipases that do not completely inactivate by pasteurization process and will cause increasing of free fatty acids and unpleasant taste and odor in milk and milk products. Bianchi et al (2004) found similar results in significant reduction of fat in mastitis goats milk than healthy goats milk [16].



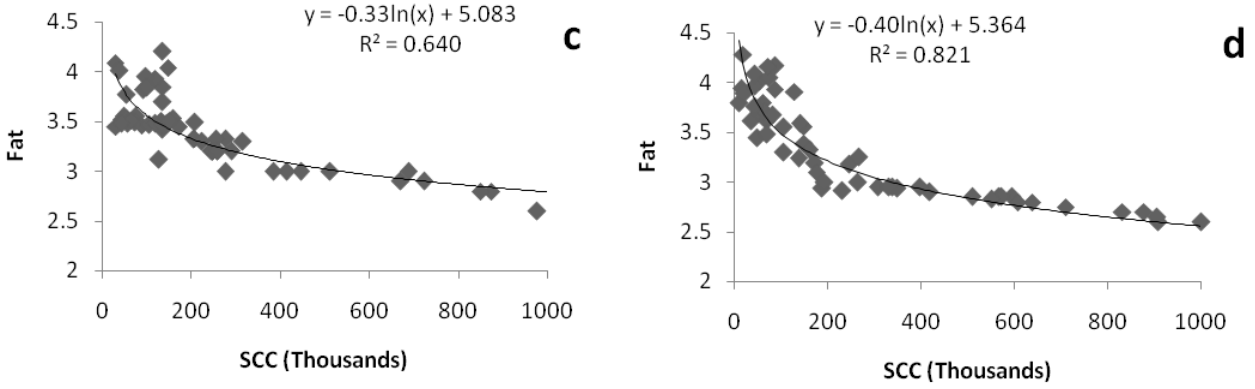


Figure 2. Relation between somatic cells with fat in a) spring b) summer c) autumn d) winter

The effect of somatic cells on raw milk protein

According to Table 2 and Figure 3 there is no significant difference between the protein amount of milk at higher or lower somatic cells count ($p>0.05$). Increasing somatic is associated with low-loss ingredients such as lactose, α_{S1} casein while some serum proteins increase, therefore the total protein almost remains unchanged. So far different results were obtained in determining of protein in samples of raw milk. Litwinczuk et al (2011) investigated changes in the protein components of raw milk with different somatic cells count. The results showed that increasing somatic cells causes little change in milk protein measure and its due to reducing of casein in milk [17]. whereas Bianchi et al(2004), Albenzio et al(2005) and Forsback et al(2009) reported that sheep's milk and cow's milk with higher somatic cells have more total protein in comparison to milk with lower somatic cells [15, 16,18]. To sum up, results that determined protein in Mastitis raw milk are different and they are related to type of microorganisms.

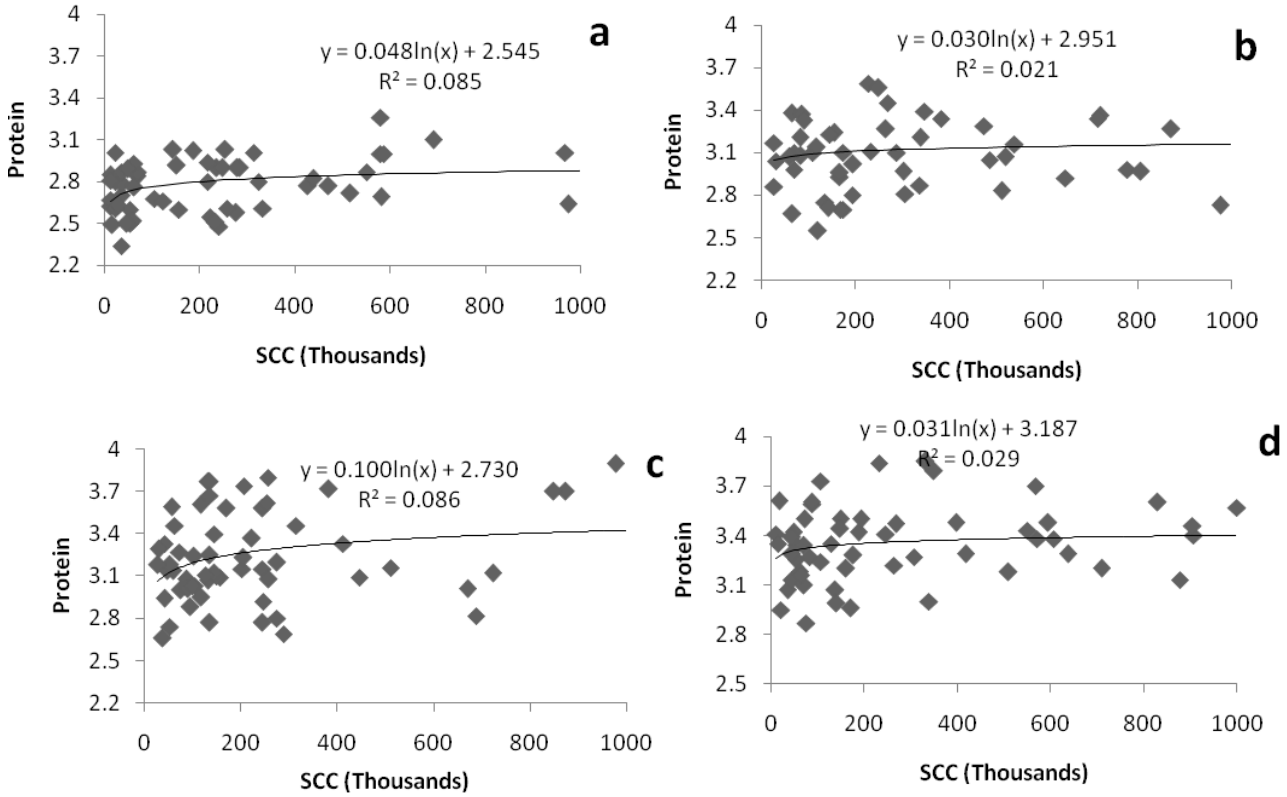


Figure 3. Relation between somatic cells with protein in a) spring b) summer c) autumn d) winter

The effect of somatic cells on lactose

Lactose in natural milk is between 4/4 and 5/2 percent (average 4.8 percent) but because of mastitis disease and increasing somatic cells it reduces into 4/4 and less. Mastitis disease causes decreasing milk lactose through damaging the secretary cell that produce milk in mammary glands. Significant difference was shown between number of somatic cells and lactose density by comparing of means ($p<0.01$). According to the experimental results of Sharma et al(2011) the amount of lactose and fat in contaminated milk with high somatic cell count is reduced, with comparison to healthy milk, and it's due to decreased synthetic activity of the breast tissue. Ogola et al (2007), Sharif et al (2007) and Forsback et al (2009) also found similar results in their tests [15,19,20,21].

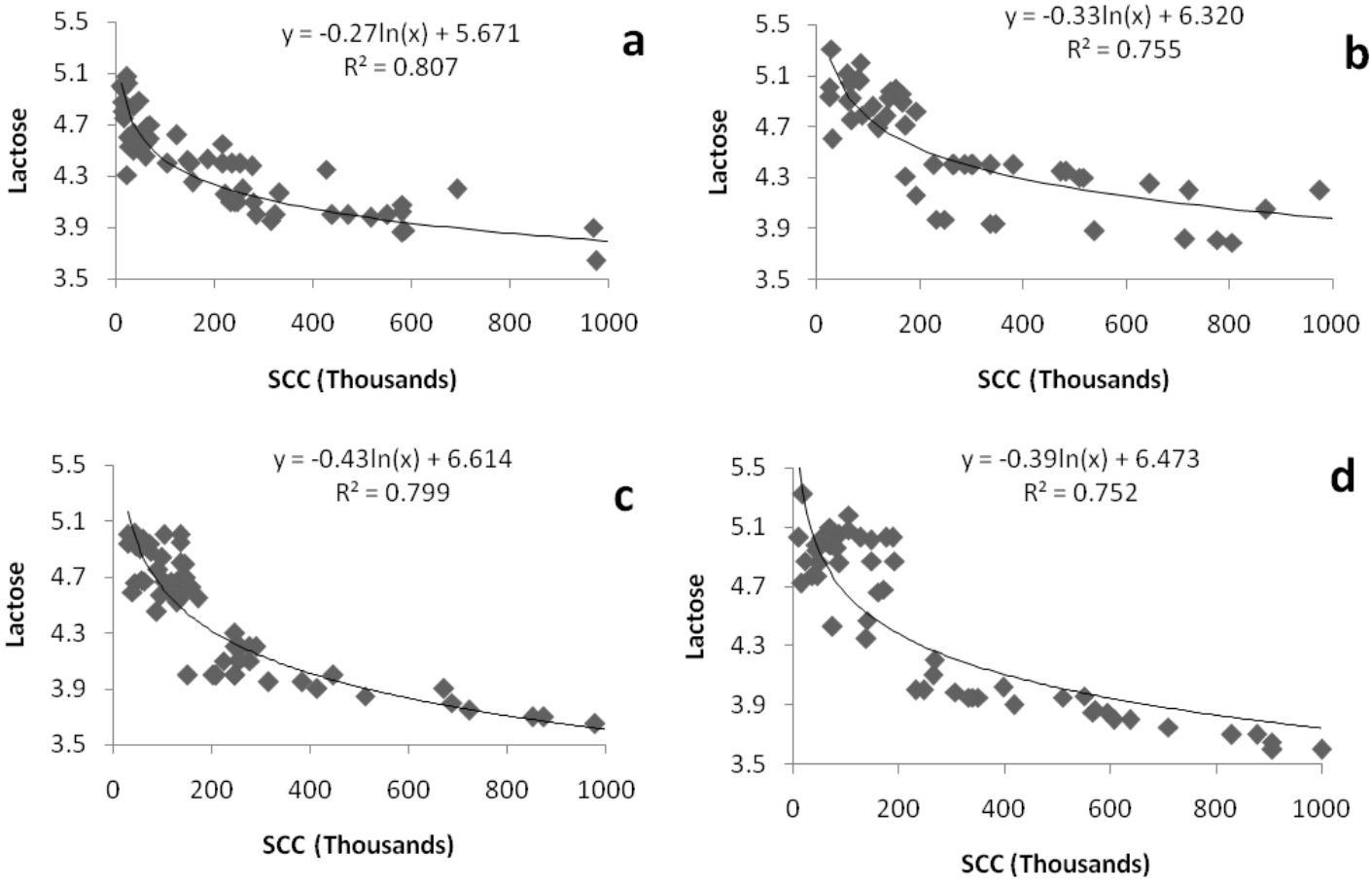


Figure 4. Relation between somatic cells with lactose in a) spring b) summer c) autumn d) winter

The effect of somatic cells on electrical conductivity

Investigation showed that the somatic cells count in raw milk has a significant effect on the electrical conductivity ($p<0.05$). As Figure 5 shows, in different seasons this effect is like a logarithmic relationship with positive slope. In increasing the number of somatic cells, electrical conductivity of milk will increase. Research result of Rasmussen et al (2003), Norberg et al (2005) and Ogola et al (2007) showed that increasing somatic cells count changes in the amount of raw milk mineral [3,19,22]. These changes will affect in type and amount of milk mineral in pH, acidity and electrical conductivity of milk. So that by increasing anions and cations such as sodium and chloride and by reducing potassium and calcium, the electrical conductivity will increase. The reason for this is that due to increasing permeability of blood vessels the amount of sodium and chloride has increased, whereas the amount of potassium phosphorus, zinc and magnesium has decreased and by reducing the absorption of calcium from blood to milk, the amount of calcium has reduced. On the other hand because of the important role of calcium in the casein micelle structure, calcium level of milk is reduced with defects in synthesis of casein. So when cattle exposed into mammary glands, milk electrical conductivity increases.

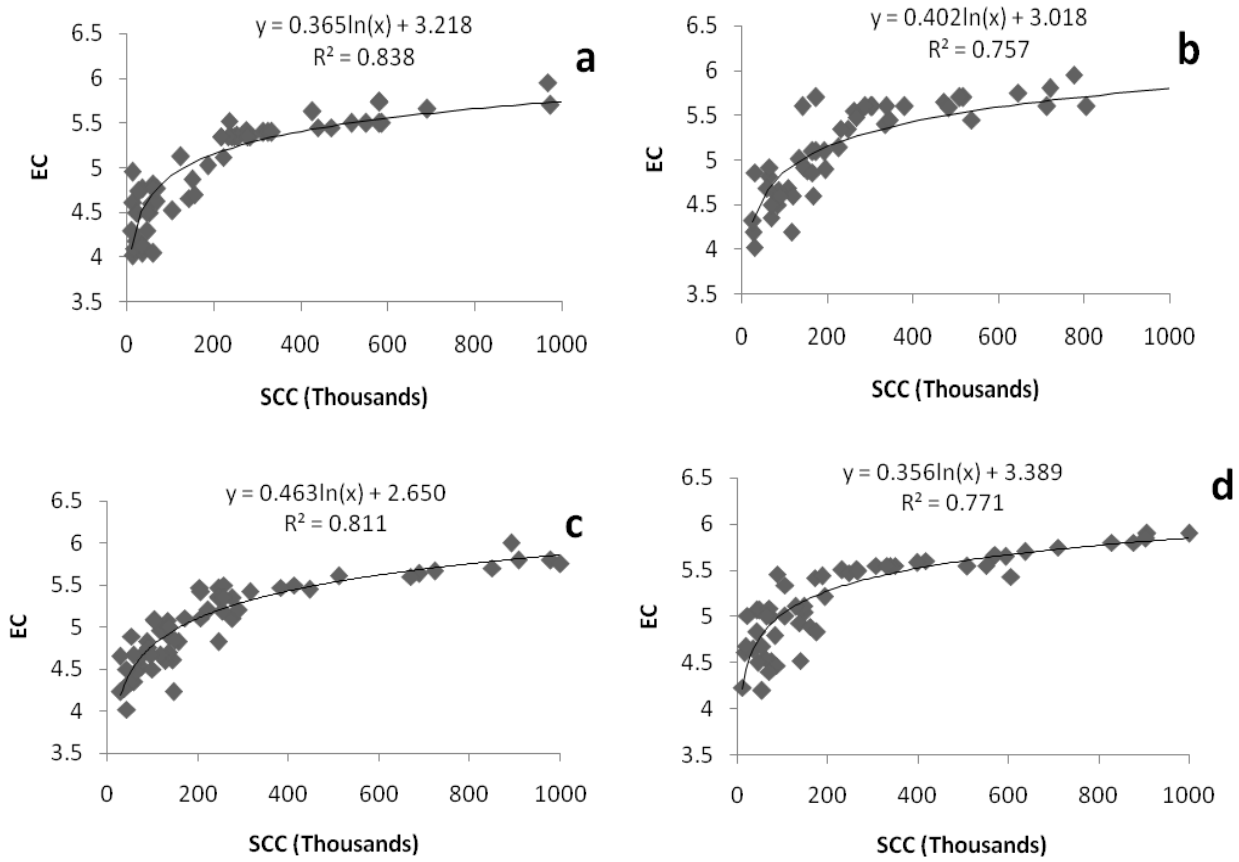
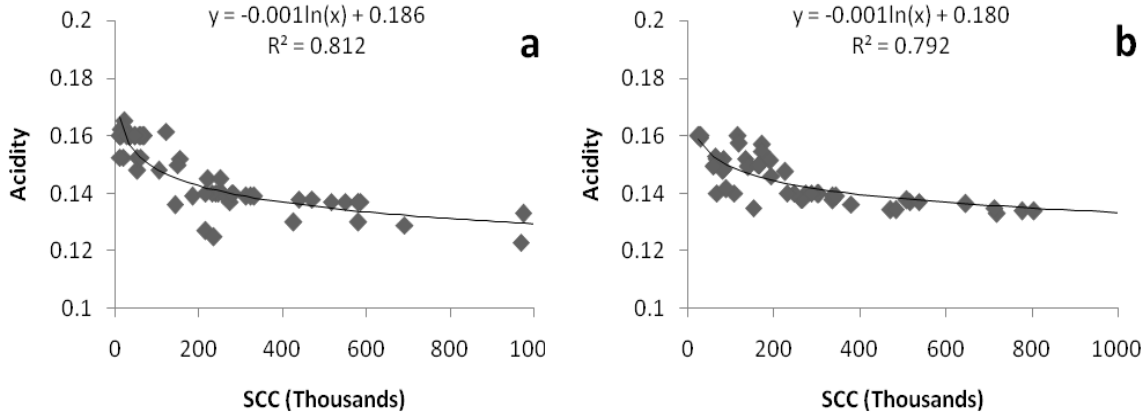


Figure 5. Relation between somatic cells with electrical conductivity in a) spring b) summer c) autumn d) winter

The effect of Somatic cells on Acidity

According to table 2, the number of somatic cells in raw milk has significant effect on acidity ($p<0.01$). Acidity of healthy milk is about 0.14 to 0.16 percent in terms of lactic acid but by increasing somatic cells in mastitis disease, acidity reduces to less than 0.14. According to Figure 6 the acidity of raw milk in different seasons in is relevant to somatic cells in the form of logarithmic equation with negative slope. Most studies that have been done on milk, indicate increasing the somatic cells count of milk lead to decreasing acidity.



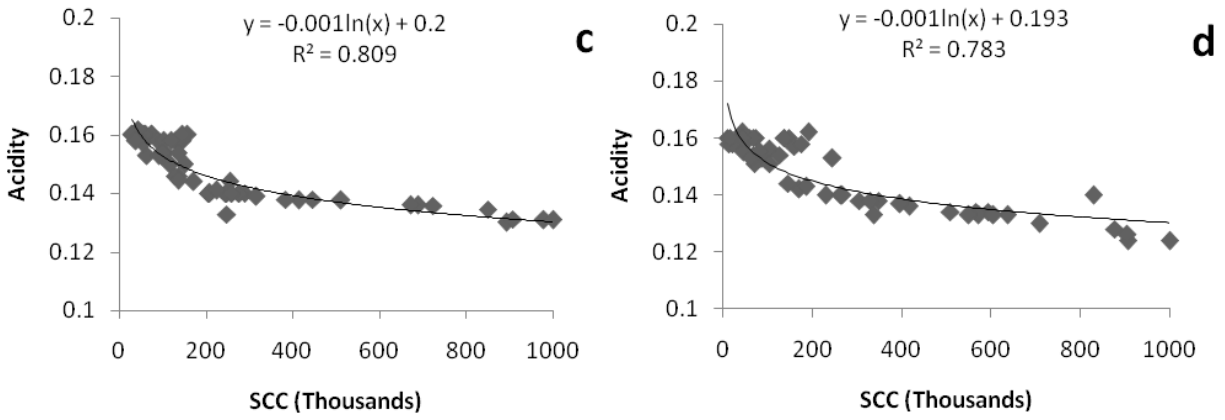


Figure 6. Relation between somatic cells with acidity in a) spring b) summer c) autumn d) winter

The effect of somatic cells on PH

Results showed that the number of somatic cells in milk has a significant effect on pH ($p<0.01$). According to Figure 7 this effect showed as a positive slope of curve in an equation, it means increasing somatic cells count causes increasing pH. Natural pH of raw milk is about 6.6 in this case reach to 6.9 or higher than it and usually reaching PH more than 6.7 is known as symptoms of mastitis disease. Sudarwant et al (2011) found that increasing PH to 7.5-6.7 is due to increasing somatic cells count [23].

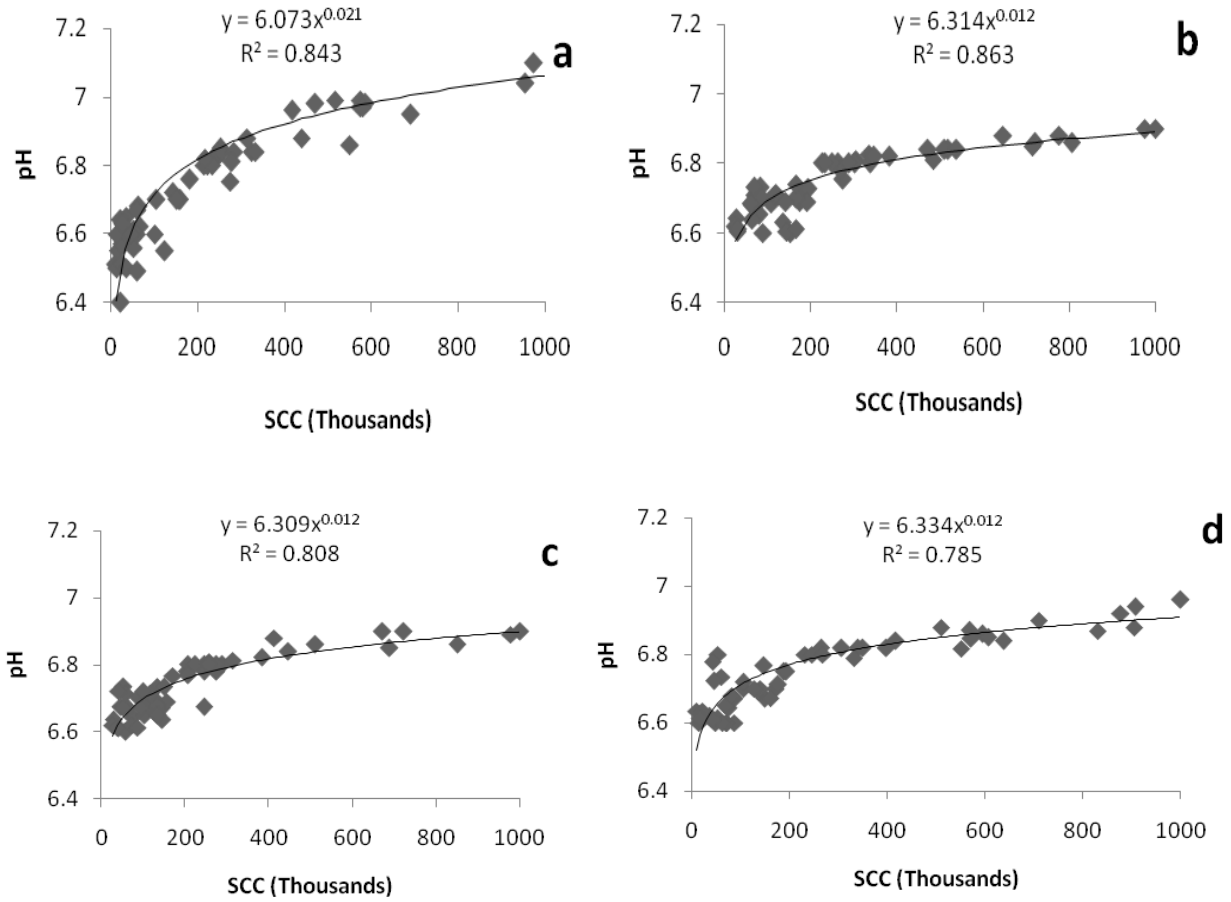


Figure 7. Relation between somatic cells with PH in a) spring b) summer c) autumn d) winter

The effect of somatic cells on amount of aerobic microorganisms

According to results, there is significant relationship between the number of somatic cells count and aerobic microorganisms ($p<0.01$). Figure 8 indicates a positive linear relationship between somatic cell count and total count of aerobic microorganisms in different seasons. Numbers of aerobic microorganisms were increased by increasing somatic cells count. In the milk of healthy animals there is a little microorganisms may be lower than 1000 cfu whereas in mastitis milk number of microorganisms is higher than 5×10^5 ml. Effect of this disease on total count of microorganisms depends on microbial infection and steps of infection. Microorganisms that affect the microbial amount are included streptococcus agalactiae and Streptococcus uberis. However other pathogenic bacteria such as staphylococcus aureus can effect on microbial load. However milk with low somatic cells count, have better quality. Also Murphy et al (2000), Barbano et al (2004), Malinowski et al (2006) investigated the relationship between the number of somatic cells and the causative agent bacteria of mastitis disease and reported similar result in this respect [24,25,26].

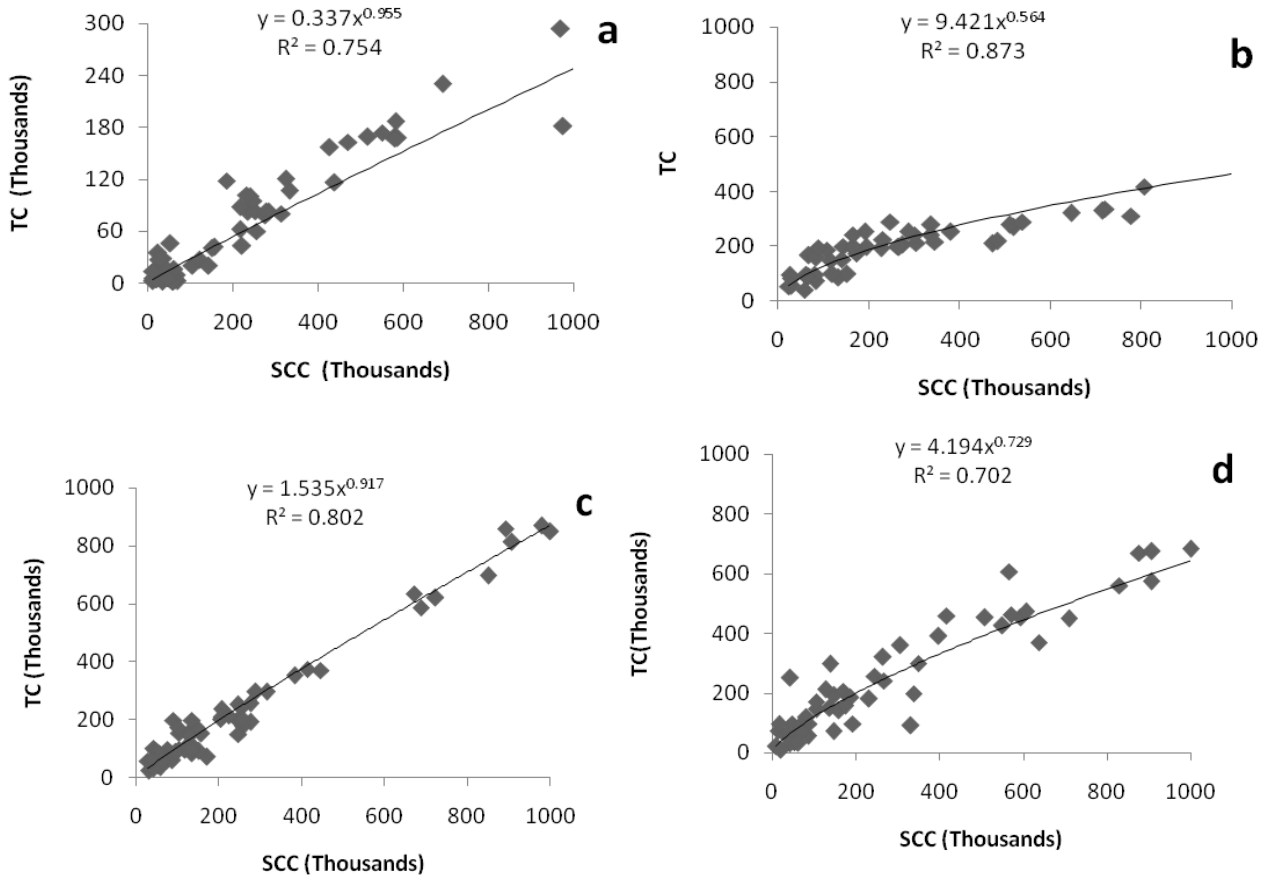


Figure 8. Relation between somatic cells with number of aerobic microorganisms in a) spring b) summer c) autumn d) winter

CONCLUSIONS

The highest number of somatic cells was observed in August. a suitable environment for growth of bacteria in summer, causing mastitis in this season. Increasing the number of somatic cells causes loss production and decreasing of shelf life, quality, production of raw milk and dairy products. To sum up, it can be said that increasing somatic cells counts through decreasing some mineral such as potassium, calcium and valuable protein such as α-lactalbumin reduce nutritional value of milk and dairy. On the other hand by reducing the amount of Casein. Lactose and milk fat, the production of some dairy products will be more limited. The result of this study indicate that somatic cell count significantly affect on amount of fat, lactose, the amount of aerobic microorganisms, PH, acidity, electrical conductivity. So that the amount of fat, lactose and acidity decreased by increasing somatic cells counts. Positive significant relation was observed between the number of somatic cells with PH, electrical conductivity and microbial load.

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