Scientific Papers. Series D. Animal Science. Vol. LXI, Number 1, 2018
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

INFLUENCE OF DIFFERENT WATER SOURCES ON SOMATIC CELL COUNT AND COMPOSITION OF BOVINE RAW MILK

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Abstract

The objective of this study was to investigate the effects of water sources on somatic cell count (SCC) and composition of bovine raw milk. The examinations were carried out in a private Holstein farm located in Konya province of Turkey. Before and after changing water supply of the farm (BCW and ACW), all analysis results were recorded. At the BCW period, parameters were noted to be; antimony (Sb): 15.4 µg/L, arsenic (As): 40.98 µg/L, blurriness: 3.3 NTU, mercury (Hg): 2.385 µg/L and iron (Fe): 293.6 µg/L. The values of the same compounds at seven days later ATC time were measured to be <5µg/L, <10 µg/L, 0.74 NTU, 1.457 µg/L and 320.3 µg/L, respectively. According to tank milk test results during seven days before and after the process, the means for dry matter, fat, protein, lactose, density, freezing point, mineral and logarithmic SCC (logSCC) were calculated to be 11.89±0.099 and 12.02±0.111%; 3.01±0.020 and 3.47±0.034% (P<0.001); 3.30±0.044 and 3.17±0.036% (P<0,05); 4.83±0.090 and 4.64±0.063%; 1.0315±0.00099 and 1.0299±0.00071 g/ml; -0.461±0.0042 and -0.466±0.0093°C; 0.673±0.0129 and 0.686±0.0205%; 5.349±0.0453 and 5.228±0.0246, respectively. Changes in water supply caused an increase in fat percentage but, a decline in the protein percentage of tank milk. Individual milk samples of 18 cows at BCW and those collected from 16 cows at ACW shown that mineral increased (P<0.05) but logSCC decreased (P<0.01). Obtained findings here might be attributed to adverse effect of change in Sb, As and Hg on the metabolism.

Key words*: water supply, dairy cow, milk, somatic cell count, milk compound.*

INTRODUCTION

According to enhanced industry, people and different animal species may be influenced by waste materials and contaminated feed/water sources those including toxic matter and thus, animal health may adversely be affected and society may be exposed to severe health problems (Phillips et al., 2003; Crout et al., 2004; Licata et al., 2004; Ozmen and Mor, 2004; Patra et al., 2008; Sanchez de la Campa et al., 2008).

This case also causes an important environmental problem for wild animals and habitat. Such that, excessive amount of heavy metals those known as beneficial elements for human body may create drastic poisoning and toxicity (Rana, 2010; Sigrist et al., 2010).

These elements pass to the surroundings by mining, industrial activities or exhaust gases and blend to groundwater and land (Sanchez de la Campa et al., 2008).

In spite of these kind of contaminations are mostly caused by heavy metals such as arsenic (As), cadmium (Cd) and lead (Pb), no clinical symptom via drinking water or feeds has been declared in dairy cattle (Bhattacharya et al., 2009; Datta et al., 2010). Besides, it has been informed that as in taken by water or feeds substantially discarded from the cow's body during the milking process (Fangstrom et al., 2008; Datta et al., 2010) Gharibi et al. (2012) indicated that Cd, Pb, chrome (Cr) and mercury (Hg) have been accumulated in different organs and products of cattle and moreover, these elements transfer to human's body by consuming animal products.

Bilandzic et al. (2011), who investigated heavy metal residues in milk produced in Croatia, pointed out the high Pb level and suggested to dense control with sampling milk and pasture.

Really, producing raw milk in healthy conditions plays an important role for human health.

In this sense, tracking harmful effects of industrial wastes for drinking water and feeds may be seen a major issue.

In this study, changes of milk composition and revealing possible toxic effects in cows consumed water sources including different heavy metal ingredients were investigated.

MATERIALS AND METHODS

Raw milk samples collected from Holstein cows raised in a private farm in Konya region of Turkey and water samples taken from two different sources were used to be the study materials.

The farm had a semi-open barn system and lactating cows were milked twice a day in a separate unit.

The animals were fed with wheat stalk, dried alfalfa hay, corn silage and dairy cattle feeds. Water requirements of examined cows were satisfied by automatic drinking bowls.

Due to milk fat level of tank milk had dropped, water source was commented the possible reason of this case and thus, water samples were analyzed with EPA 200.7 standard using inductively coupled plasma optical emission spectrometry (ICP-OES) technique in an accredited laboratory.

Raw milk samples were collected from both tank milk and each cows individually during morning milkings for seven days.

Sample tubes with threaded were coded by the origin of the sample and the date and then, all samples were kept at -18°C in a deep-freezer until the test time.

Similarly, new drinking water samples were analyzed after changing the source. Thus, new milk samples were collected from the tank and cows and storaged in the freezer for seven days post-two days of changing the water source. The milk samples were protected using ice-boxes and immediately transferred to the laboratory for analyses. To tests, bovine raw milk samples were incubated at 35°C in a water bath. While dry matter, fat, non-fat dry matter, protein, lactose, density, freezing point and minerals were analyzed by Funke Gerber Lactostar device, somatic cell counts (SCC) were determined by Somatic Cell Counter DCC (DeLaval Group, Sweden).

Milk analysis results were evaluated in two groups: before and after changing water source. Due to abnormal variance had been observed among the SCC values, all SCC data were converted to logarithm 10 base (log10) for statistical evaluations. Independent sample-*t test* was used to compare the results using SPSS 17.0 for Windows packet program.

RESULTS AND DISCUSSIONS

Water analysis results before (BCW) and after (ACW) the changing of water source are presented in Table 1. As seen, Sb, As, Hg and Fe levels had reached to higher than TS 266 standard that declared by Turkish Standards Institution. Such that, As, Sb and Hg were found to be four, three and two and a half times higher than those accepted as the highest threshold levels, respectively.

Also, Fe level was measured as 50% higher than its standard. During the BCW, Sb, As and Hg levels were noted to be 15.4 µg/l, 40.8 µg/l and 2.385 µg/l, respectively.

Really, the exceed levels of each mineral might be an important risk factor for of animal and human health. Many researchers (Phillips et al., 2003; Crout et al., 2004; Licata et al., 2004; Ozmen and Mor, 2004; Patra et al., 2008; Sanchez de la Campa et al., 2008; Javed et al., 2009) pointed out to this case and mentioned the problems related to human health.

For instance, Pérez-Carrera et al. (2016) determined As concentration in some regions of Argentina as >10 µg/l that informed over the admissible level.

In this study, similar analyses were repeated after changing the water source and it was observed that Sb, As and Hg levels largely dropped but Fe increased (Table 1).

Datta et al. (2010), who determined the As levels in contaminated (0.047 mg/l) and control (0.015 mg/l) water sources, emphasized the risk of consumption of raw milk produced in their investigation area.

In this study, while Sb and As levels shown to be lower than threshold according to TS 266 by ranging between <5 and <10 µg/l, Hg decreased about 1 mg/l and diminished up to 1.457 µg/l when compared to initial source.

Nevertheless, eliminating any problems via investigating contamination reasons might be suggested.

Comparatively, a rise in an increment in Fe level might not be assumed to be an adverse effect on both the animal health and milk composition when compared to other elements.

Fe levels were measured as 293.6 µg/l and 320.3 µg/l in the BCW and ACW periods, respectively. Of the findings, especially As, Hg and Sb might be regarded as the components those had potential to cause toxic effect and to damage animal's health. This case could be seen an intimated process between udder tissues of the animal and human health due to raw milk including these elements.

However, both final results might be presumed as acceptable for TS 266 standard and thus, no adverse effect for animal health or milk might be expected. But, blurriness values of BCW and ACW were obtained to be 3.3 NTU and 0.74 NTU, respectively.

In spite of these levels were observed within the suitable ranks, the severe dropping was found as attractive.

For two periods, tank milk SCC and composition levels are given in Tables 2 and 3. As seen, fat percentage was changed from 3.01% to 3.47% and this level was statistically significant (P<0.001). In contrast, protein percentages significantly (P<0.05) reduced.

These changes might be explained by high Sb, As and Hg those determined in the drinking water. Besides, relatively low fat ratio was evaluated within the acceptable thresholds for Holstein cattle due to dropping heavy metals to the normal limits.

In this study, mean of logSCC was calculated to be 5.288±0.0299, no significant effect of CWS on SCC was observed.

Change of milk fat and protein percentages are presented in Figure 1. Similarly, changing the water supply had no significant effect on the other components.

As seen in Table 3, fat and protein levels of individual milk samples had similar trends. However, mineral level significantly increased (P<0.05) in the ACW period. Also, SCC of individual samples significantly decreased after this process (P<0.01). This finding might be commented by the negative effects of consuming water with heavy metals and also, causing a physiologic stress on body resistance because of predisposition of these sources to more microbial load. Such that, elevated SCC could be assumed as a response against microbial contamination.

Distribution of mineral and logSCC levels are given in Figure 1.

Table 1. Analyse results before and after changing water supply

		Before			After		
Parameters	Unit	Result	TS 266	Method	Result	TS 266	Method
Al	µg/L	<45	200	EPA 200.7	<45	200	EPA 200.7
NH_4	mg/L	0.064	0.5	SM 4500-NH3 B.F	0.016	0.5	SM 4500-NH3 B.F
Sb	µg/L	**15.4**	5	EPA 200.7	**<5**	5	EPA 200.7
As	µg/L	**40.8**	10	EPA 200.7	**<10**	10	EPA 200.7
Cu	µg/L	<5.4	2000	EPA 200.7	<5.4	2000	EPA 200.7
Blurriness	NTU	**3.3**	5	SM 2130 B	**0.74**	5	SM 2130 B
Hg	µg/L	**2.385**	1	EPA 200.7	**1.457**	1	EPA 200.7
Fe	µg/L	**293.6**	200	EPA 200.7	**320.3**	200	EPA 200.7
EC (cond.)	µs/cm	627	2500	SM 2510 B	605	2500	SM 2510 B
Cd	µg/L	<3.4	5	EPA 200.7	<3.4	5	EPA 200.7
Ag	mg/L	<7		EPA 200.7	0.007		EPA 200.7
Cr	µg/L	<6.1	50	EPA 200.7	<6.1	50	EPA 200.7
Pb	µg/L	<10	10	EPA 200.7	<10	10	EPA 200.7
Mn	µg/L	<1.4	50	EPA 200.7	<1.4	50	EPA 200.7
Ni	µg/L	<15	20	EPA 200.7	<15	20	EPA 200.7
ph		7.65	6.5-9.5	SM 4500 B	7.69	6.5-9.5	SM 4500 B
Flavour		Accept			Accept		
Smell		Accept		SM 2150 B	Accept		SM 2150 B
Mg	meq/L	1.17			0.52		

Table 2. Components of tank milk

Supply	N	TDM (%)	Fat (%)***	NFDM (%)	Protein (%)*	Lactose (%)	Density (g/ml)	FP (°C)	Mineral (%)	LogSCC
Before	7	11.899	3.01	8.88	3.30	4.83	1.0315	-0.461	0.673	5.349
After	7	12.02	3.47	8.55	3.17	4.64	1.0299	-0.466	0.686	5.228
Mean	14	11.95	3.24	8.72	3.23	4.74	1.0307	-0.463	0.679	5.288

*P<0.05; ***P<0.001

Table 3. Components of individual milk samples

Supply	N	TDM (%)	Fat (%)	NFDM (%)	Protein (%)	Lactose (%)	Density (g/ml)	FP (°C)	Mineral (%)*	LogSCC**
Before	18	12.11	3.11	9.00	3.35	4.954	1.0327	-0.468	0.687	5.356
After	18	12.11	3.24	8.88	3.29	4.872	1.0321	-0.475	0.731	5.045
Mean	36	12.11	3.17	8.94	3.32	4.912	1.0324	-0.471	0.709	5.201

*P<0.05; **P<0.01

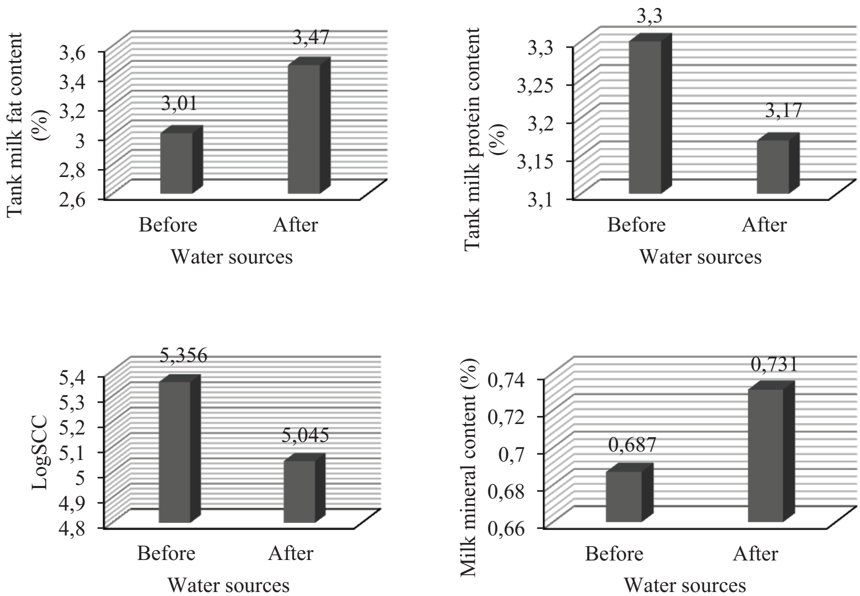

Figure 1. Distribution of investigated components before and after changing water supply

CONCLUSIONS

Finally, it was revealed that Sb, As and Hg levels of drinking water source had higher than those declared by the standards and this case was regarded as the potential reason of decreased fat percentage of tank milk.

In this sense, changing the drinking water source removed the adverse impacts and fat ratio turned to above for Holstein cattle.

While mineral levels of individual milk samples increased after this process, SCC also positively affected.

Actually, these findings indicate to involving the possibility of industrial wastes and heavy metals to the underground waters in the region where this investigation had been conducted.

However, further field studies in that location are advised to confirm revealed findings here.

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