Use of milk's electrical conductivity in the detection of mastitis

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Abstract. Mastitis is a costly udder disease affecting dairy cattle. Decreased milk yield, treatment and labor costs, decreased milk quality and cow death etc. are some of the factors that make up costs. These losses are caused by subclinical mastitis without visible symptoms. Mastitis can be detected by performing one of the simple screening tests such as electrical conductivity (EC) measurement of milk. Our study evaluated the use of this method for the detection of subclinical and clinical mastitis.

1 Introduction

Milk is a complex secretion of the mammary glands. It contains all the nutritional components necessary for human nutrition. The quality of milk is a fundamental element of health and the economic future of the farmer. Mastitis is one of the most economically important and costly diseases of dairy cattle. Losses from mastitis include reduced milk production, medication, labor costs and increased risk of animal death [1].

Mastitis is an inflammation of mammary glands. It causes the physical, chemical, bacteriological alteration in milk and pathogenic alterations in glandular tissues of udder [2].

Electrical conductivity has been used for over 40 years to detect mastitis-infected milk [3]. Milk is a conductive food due to its rich composition, especially the mineral substances it contains. Other ions, especially sodium and chlorine ions, also affect the electrical conductivity of milk [4]. The electrical conductivity of normal composition cow's milk is between 4.0-5.5 mS/cm (milliSiemens/centimeter) at 25°C [5, 6].

Although there are many methods used in the detection of mastitis, one of the most reliable methods is the somatic cell count value of milk. There is a positive relationship between this value and the electrical conductivity of milk. Reasons such as the low rate of somatic cell count detection, the extra expense and labor requirement of somatic cell count and bacteriological tests have led to the option of turning to electrical conductivity measurements, which is a cheaper and easily recorded method [7]. Electrical conductivity values can be measured with the help of practical hand devices [8] or a set up on the milking line [9].

The aim of the study is to evaluate the electrical conductivity as a useful tool for the detection of mastitis, especially sub-clinical mastitis, in order to reduce the economic losses in the early stages of treatment and infection.

2 Material and method

The animal material of this study consisted of 50 Holstein cows in their second lactation in the Cukurova University Faculty of Agriculture Dairy Cattle Research and Application Farm. Milk samples were collected in the morning with the help of sampling cups in the automatic milking system, taking into account the hygiene conditions.

The electrical conductivity of milk is measured by means of conductometers. It works according to the principle of measuring the degree of conductivity by utilizing the electrical conductivity of the anions and cations contained in the liquid immersed in it with the help of electrodes. Before the measurement, the electrical conductivity of the potassium chloride solutions prepared to calibrate the device is measured. Then the probe and thermometer of the device are immersed in the sample, it is rotated for a couple of turns and the reading is taken after the value indicated by the device becomes stable. For conductivity measurements, raw milk was taken into falcon tubes and measured with a Hanna HI 9812-5 brand portable conductometer whose cell constant was accepted as k= 0.341 1/cm, and the results were given as mS/cm.

The somatic cell count of the collected milk samples was determined by a somatic cell counter (Somatic Cell Counter DCC, DeLaval Group, Sweden).

The obtained data were subjected to the homogeneity test before the analysis and it was determined that the somatic cell numbers did not show normal distribution. Regression and correlation analyzes were performed by subjecting non-normal somatic cell count data to logarithmic transformation [10].

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3 Results and discussion

Somatic cell count and electrical conductivity results of 50 lactating cows analyzed are shown in Table 1. When the results are examined, it is seen that the average electrical conductivity of the samples is 5.52±1.215 mS/cm. Similar results have been found by many researchers [11, 12, 6]. According to analyze results the milk samples has Electrical Conductivity values less than 5.5mS/cm and considered as healthy.

According to the Turkish Food Codex communiqué on raw and heat-treated drinking milk (No: 2000/6) published by the Ministry of Food, Agriculture and Livestock in Turkiye, a limitation has been imposed on the SCC required in milk, and SCC must be ≤500000 per milliliter [13].

Table 1. Somatic Cell Counts and Electrical Conductivity Values in Milk Samples.

	N	Mean	Std. Dev.	F	p
EI	50	5.523	1.215	142.239	.000
logSCC	50	5.676	0.263		
SCC	50	528519	390704		

Table 2. Correlation between somatic cell number and electrical conductivity.

	EI	logSHS
EI	1.000	0.865
logSHS	0.865	1

It has been reported that there is a relationship between daily milk yield and electrical conductivity, and it was found that a 1 mS increase in electrical conductivity caused a 0.88 kg decrease in daily milk yield [14].

In our study, it was determined that there was a statistically significant positive correlation between the number of somatic cells and electrical conductivity ($p<0.05$; $r=0.865$). Similar to our findings, found a positive and significant correlation between California mastitis test, somatic cell count and electrical conductivity.

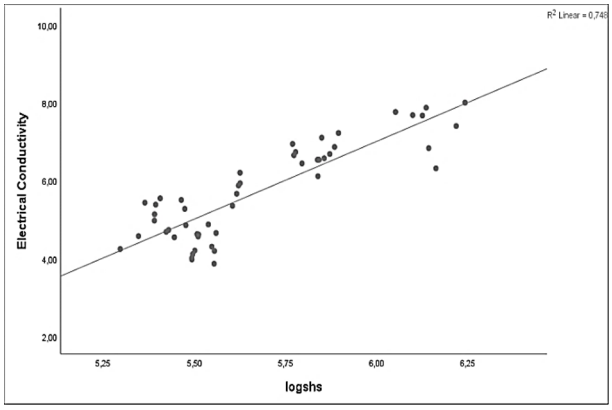

Fig. 1. Regression between somatic cell number and electrical conductivity.

It is understood from Fig. 1 that there is a statistically significant ($p<0.01$) relationship between the number of logarithmic transformed somatic cells and electrical conductivity of milk obtained from cows, and the regression coefficient is high ($R^2 = 0.748$).

The fact that there is a high regression between the somatic cell number and electrical conductivity confirms that the electrical conductivity increases as the somatic cell number increases, and in this case, it is a result of mastitis.

In determining the electrical conductivity, Na, Cl and K in milk are determinants. Because, in breast infections, secretory cell membranes throw potassium into the cell and sodium into the extracellular fluid. The released ion density increases the permeability of blood vessels and impairs the functioning of the active ion transport system [6]. Thus, EI values in milk increase due to the increase in Na and Cl ions in milk when the cow encounters intramammary infection [11].

The electrical resistance of milk samples was measured and with the California mastitis test, it was determined that electrical conductivity increased in parallel with the increase in the number of somatic cells [16].

4 Conclusion

Early diagnosis and prevention of subclinical mastitis is a priority for every dairy operator, due to obtaining quality milk and preventing economic losses. The electrical conductivity of milk is a method for diagnosing subclinical mastitis that can be used in combination with other methods. While electrical conductivity is highly correlated with CMT and SCC scores, SCC and EC are affected by parity, age, lactation stage, season, stress, milking interval and environmental factors.

It has been determined that electrical conductivity is similar to the number of somatic cells in the detection of subclinical mastitis.

As a result, it was concluded that the use of electrical conductivity for the diagnosis of subclinical mastitis may be an easier and safer diagnostic method than the detection methods with somatic cell count and California mastitis test.

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