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Determination of mastitis by measuring milk electrical conductivity

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Abstract

The current research was conducted to determine the presence of mastitis in lactating buffalos by analyzing the Electrical Conductivity (EC) change of milk. Udder health of milking buffalo is the most crucial factor of successful breading from health and economic perspective. Mastitis the inflammation of udder has become most costly disease of dairy animals during last few decades. The bacterial infection responsible for mastitis is mainly caused by *streptococcus* and *staphylococcus* bacterial species. Mastitis increases the EC of milk due to damage of tissues of udder by number of pathogens. It increased the concentration of ions mainly Na^+ and Cl^- and decreased the concentration of K^+ and lactose in milk. EC has been introduced as an indicator parameter for diagnosis of mastitis as ionic concentration has direct influence on change in EC. 50 fresh milk samples were collected randomly directly from udder, from five dairy farms of Quetta city, Pakistan. The result for EC was determined as low as 3.00mS/cm and as high as 8.5mS/cm. The fluctuation in EC might be due to difference in electrolytes concentration present in milk. The 40% milk samples showed EC values with in average range and considered negative for mastitis with mean of 4.87 mS/cm, while the 60% of milk samples were found with high EC values than average range. The mean EC value for subclinical is 5.97mS/cm and 6.7mS/cm for clinical mastitis. This proposed the presence of high concentration of ions and suggested that buffalos were suffering with mastitic infection. Hence EC is proved as direct trait for the diagnosis of mastitis mainly subclinical through milk which can't diagnosed by the visible status of udder and milk. This helps a lot to decrease the economic loss at early stage of infection to permit earlier cure before the advancement of disease.

Keywords: Buffalo milk, mastitis, electrical conductivity, Quetta.

Introduction

Milk is a complex lacteal secretion of mammary glands. It contains all the nourishing constituents require for human diet. The quality of milk is an essential constituent of health and economic prospective (Bashir *et al*., 2013).

Mastitis is one of the most economically important and costly disease of dairy animals. Loses due to mastitis are decreased in milk production, medication, labor costs, non delivered milk, veterinary fees, reduced milk quality, reduced in milk price, and increased the risk of death of animal (Nielen *et al*.,1991). It is an inflammation of mammary glands. It causes the physical, chemical, bacteriological alteration in milk and pathogenic alterations in glandular tissues of udder (Sharma *et al*., 2007).

The cause of mastitis is 20 different types of bacterial species typically *streptococcus* and *staphylococcus* varieties (Janzekovic *et al*., 2009). *Staphylococcus aureus* causes the wild spread infection in humans and animals (Ahmed *et al*., 2008).

Mastitis has two stages. Early stage of mastitis is sub clinical mastitis with no apparent changes, although it is responsible of 15 to 45% decreased in dairy milk production and also altered the milk composition (Halasa *et al*., 2007). The sever stage of mastitis is clinical mastitis with visible changes such as pain, red, warm and swelling in udder as well as pus, clots, bloody appearance of milk (Janzekovic *et al*., 2009).

Early diagnosis of infection is important as apparent changes in udder tissues are much earlier than become visible and also to overcome the economic loses and enhances the chance of recovery of dairy animal. Various methods based on physical, chemical changes of milk and cultural isolations of microorganism are used for diagnosis of sub clinical mastitis (Guha *et al*., 2010).

EC of milk has been introduced as indicator parameter for mastitis during last few decades. EC is the measured by the presence of ions (Ilie *et al*., 2010). Milk has conductive properties as it is enrich compound especially mineral salts such as sodium, chloride, potassium, calcium, magnesium and others ions (Mucchetti *et al*., 1993). The concentration of Na^+ and Cl^- ions is increased and concentration of K^+ and lactose is decreased when the cows and buffalos were suffering with mastitis due to inflammation of udder, hence increase the EC. Although EC is also affected by some other factors such as bread, lactation stage and milking interval (Kamal *et al*., 2014). Since somatic cell count is also an excellent method for determination of sub clinical mastitis, as SSC also increased during infection (Durr *et al*., 2008). EC is now employed as routine test for diagnosis of sub clinical mastitis (Milner *et al*., 1996).

Mastitis changed the chemical composition and nutritional values of host animal milk. The high SSC reduced the quality of milk and milk products, decreased the shelf life, flavor and deteriorates the physiochemical properties of milk. Mastitic milk contains both pathogens and bacterial toxins. The utilization of such milk may directly on indirectly increase the risk of food born infections (Kasikci *et al*., 2012).

The present study was conducted to determine the EC as an excellent trait for the determination of mastitis especially sub clinical mastitis to decrease the economical loses at the early stage of infection to permit earlier cure.

Materials and Methods

Sample Collection

The total of 50 fresh milk samples were collected randomly, directly from udder of milking buffaloes, from 5 different dairy farms of different areas (10 from each) in Quetta city, Pakistan.

Electrical Conductivity

Principle

Milk EC is determined by measuring the concentration of cations and anions. The most common ions of milk are Na^+, Cl^- and K^+. The active transport systems which are present in the sensory cells of mammary glands of udder pump the Na^+ and Cl^- into the extra cellular fluid and K^+ into the cells. The concentrations of Na^+ and Cl^- ions are increased while concentrations of Lactose and K^+ are decreased in milk during infection. There are three factors which change the ionic concentration in mastitic milk, the destruction of tight junctions, the destruction of active ion-pumping system and increased permeability of blood capillaries. The high concentration of Na^+ and Cl^- in extracellular fluid, pour these ions into the lumen of the alveolus, after cell damage due to infection. The concentrations of K^+ and lactose decrease to maintain osmotic pressure in milk. The leakage of lactose into the extracellular fluid and blood after the destruction of the normal lactose barrier caused the decrease in lactose concentration in milk. During mastitis alterations in concentration of Na^+, Cl^- and K^+ in milk occur which cause an increase in EC.

Procedure

0.1M KCl solution is used for the calibration of electrical conductivity meter. The EC of each fresh buffalo milk sample was measured one by one, by washing the electrochemical sensor with distilled water after each measurement.

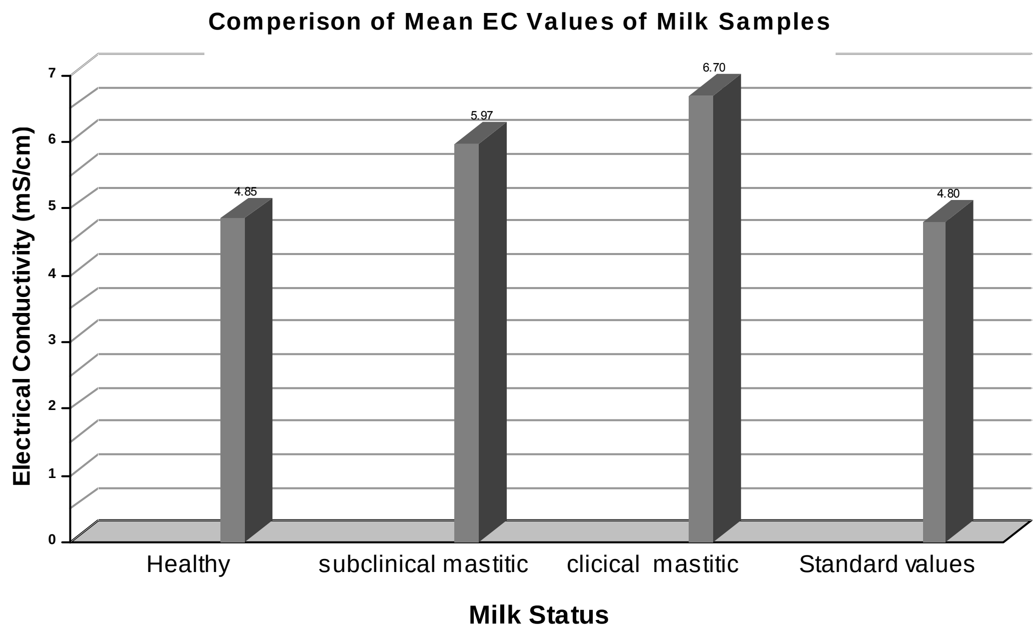
Results and Discussion

The results for the analyzed 50 raw milk samples of lactating buffalos were shown in Table 1, showed the ranges of EC values of milk. According to results the milk samples were classified as healthy, subclinical mastitic and clinical mastitic milk. The standard range for EC of normal milk is between 4.0-5.5mS/cm (Spakauskas *et al*., 2006). The mean values of EC for healthy, subclinical and clinical mastitic milk were

4.87mS/cm, 5.37mS/cm and 6.44mS/cm respectively suggested by Norberg *et al*. (2004). According to analyzed results the 40% milk samples (20 in number) had EC values less than 5.5mS/cm and considered as healthy whereas, 60% of milk samples (30 in numbers) had EC values greater than 5.5mS/cm and considered as mastitic. The minimum value of EC for healthy milk was 3.0mS/cm and maximum value was 5.48mS/cm with mean value of 4.87mS/cm. The mastitic milk had minimum EC value 5.61mS/cm and maximum of 8.5mS/cm.

Table No. 1: Electrical Conductivity Values (range) for Healthy, Subclinical, and Clinical Mastitis

No. of samples	%age of samples	EC (mS/cm) Ranges	Status of milk
2	4	3.00-4.00	Healthy
8	16	4.00-5.00	Healthy
10	20	5.00-5.50	Healthy
25	40	5.50-6.50	Sub clinical Mastitis
3	6	6.50-7.50	Clinical Mastitis
2	4	7.50-8.50	Clinical Mastitis



Almost similar result was investigated by Norberg *et al*., (2004). Their mean EC value for healthy milk was 4.87mS/cm. While for mastitic milk, EC value agreed with Spakauskas *et al*., (2006) had maximum E.C 8.5mS/cm. Within 60% mastitic milk samples 66.7% had EC values less than 6.5mS/cm with mean of 5.97mS/cm and suggested that buffalo were suffering from subclinical mastitis, whereas 33.33% samples had EC greater than 6.5mS/cm with mean of 6.7mS/cm and suggested the clinical mastitis in buffalos.

Mastitis had caused change in physicochemical, bacteriological characteristics of milk. The E.C of milk increased as the concentration of Na^+ and Cl^- ion increased during infection. E.C test had been introduced as excellent trait for the detection of mastitis through milk as E.C is very sensitive to charge compounds. It was also proved as an indicator trait for diagnosis of subclinical mastitis to reduce the economic losses at early lap of infection.

Conclusion

It was concluded that EC of milk samples had high correlation with mastitis. This parameter had found very affective to diagnose the health status of udder. The analyzed results separated the healthy, subclinical and clinical mastitic milk status. The high EC for healthy, subclinical and clinical mastitis milk was 5.48mS/cm, 6.3mS/cm and 8.5mS/cm respectively. All above factors proved EC as excellent trait for diagnosis of mastitis status.

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