Influence of saltwater intake on the health of dairy cattle

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A R T I C L E   I N F O

A B S T R A C T

Water is an element extremely important, essential for life, and necessary to maintain some factors such as intracellular pressure, assist digestive processes, carry nutrients, eliminate toxins through urine and allow the thermal balance of living things. However, it is a scarce element as the national water resources policy in Brazil advocates. In recent years water has become one of the biggest global problems due to lack and quality. The objective of this study was to evaluate the influence of saline intake on the health of dairy cattle. The actions consisted of periodic visits to a rural property located in the city of Pesqueira, Agreste Pernambucano - Brazil, whose main economic activity is milk production and cheese making. The herd has milk aptitude and consists of 182 animals. Samples of desalination tailings water that were supplied for quench the animals were collected. Blood samples from the cattle were collected and sent for hematological exams. The results showed alterations of some physicochemical parameters of water and high serum levels of chloride and sodium in cattle. The continuous intake of wastewater from the desalination process for the quench of dairy cattle alters the serological and physiological patterns of these animals. Further studies must be conducted on dairy products regarding their quality and health impact.
Keywords: Wastewater, desalination, milk, health.

R E S U M O

A água é um elemento de extrema importância, essencial para a vida e necessária para manter alguns fatores como, por exemplo: a pressão intracelular, auxiliar os processos digestivos, carrear nutrientes, eliminar toxinas através da urina e a permitir o equilíbrio térmico dos seres vivos. Porém, é um elemento escasso como diz a política nacional dos recursos hídricos no Brasil. Nos últimos anos, a água vem se tornando um dos maiores problemas globais, por conta da sua falta e da sua qualidade. Objetivou-se, neste estudo, avaliar a influência da ingestão de água salina na saúde de bovinos leiteiros. As ações consistiram em visitas periódicas a uma propriedade rural localizada no município de Pesqueira, Agreste Pernambucano - Brasil, cuja atividade econômica principal é a produção de leite e fabricação de queijo artesanal. O rebanho possui aptidão leiteira e constitui-se de 182 animais. Foram coletadas amostras de água, obtida de rejeito de dessalinizadores, que era fornecida para a dessedentação dos animais. Amostras de sangue dos bovinos foram colhidas e encaminhadas para a realização de exames hematológicos. Os resultados obtidos demonstraram alterações de alguns parâmetros físico-químicos da água e elevados níveis séricos de cloreto e sódio nos bovinos. Conclui-se que o uso contínuo da água residual do processo de dessalinização para a dessedentação dos bovinos leiteiros altera os padrões sorológicos e fisiológicos desses animais. Sugere-se que sejam realizados estudos nos produtos lácteos quanto à qualidade dos mesmos e seu impacto à saúde única.
Palavras-Chave: Água residual, dessalinização, leite, saúde.

Introduction

According to Schuster & Srinivasan (2004), the use of water resources in the semiarid regions of Brazilian Northeast is a very complex practice due to the climatological and geological peculiarities of the region, characterized by low rainfall with irregular spatial and temporal distribution, besides the regional geological composition unfavorable to the retention of large volumes of rainwater. Irregular distribution of rainfall and prolonged periods of drought are the main problems of the semiarid region when it comes to water potential.

Pernambuco is a State that systematically lives with scenarios of quantitative and qualitative water scarcity that negatively affects health and quality of life, and also the production and rural activities, with a reduction in the productivity of the main rainfed or irrigated crops, as well as in the livestock activities, in particular, the milk and meat production.

The drought has directly affected agriculture and livestock, which survives with reduced profit margins or losses, and without ensuring the proper permanence of families in the regions of origin, which systematically face deficient water availability in the main surface and underground water sources. Rural water supplies are often carried out by mobile units ("water trucks"), without proper quality and quantity control.

Cattle need a constant supply of abundant, good quality and clean water for healthy rumen fermentation and metabolism, maintain the flow of food in the digestive tract, favor proper digestion and nutrient absorption, maintain healthy blood volume and meet the demands of body tissues (Adams & Sharpe, 1995).

This water must be colorless, odorless and tasteless to considered good for quench the dairy cattle; the ideal pH is close to the neutrality range (pH 7.0) since values above 7.6 indicate alkalinity and may have high levels of calcium (Ca) and magnesium (Mg), making the water unfit for consumption (IEPEC, 2008).

Salinity is the main factor determining whether a water source is appropriate for the animal. Most salts, which are dissolved in water, contain inorganic compounds such as sulfates, chlorides, carbonates, calcium bicarbonates, magnesium, and sodium. In some cases, these salts may be present in excess and cause harmful effects. Usually, dairy cattle are more resistant to excess salt than beef cattle. If salinity is adequate, it can be an excellent contribution to mineral consumption (Dias, 2006).

A dairy cow, depending on its production, body size, physiological stage, weather condition, salt intake, dietary protein, water dispenser availability, and especially water quality, may consume between 40 and 170 liters of water per day. From a dietary point of view, lower water consumption means lower milk production (Pires et al., 2010).

According to Almeida (2019), in recent years, water has become one of the biggest global problems, due to the lack and quality.

Water quality can directly affect animal health, and hematological profile monitoring is an essential tool that can be used to monitor the health of dairy cattle and assist in the interpretation of these parameters in the face of various pathologies (Campos et al., 2008).

The objective of this study was to evaluate the influence of saline intake on the health of dairy cattle.

Material and Methods

Periodic visits were made to a rural property located in the municipality of Pesqueira, Agreste of Pernambuco - Brazil, whose main economic activity consisted of milk production and cheese making.

The herd consisted of 182 animals, with racial patterns resulting from crosses of different breeds. The cattle were raised in the semi-extensive regime, alternating permanence in the corral and paddocks for grazing, and the cows were submitted to two milking and released between the milking and in the late afternoon, after nursing the calves. The cattle fed consisted of barley, wheat bran, and pasture in the rainy season, and in the dry season, corn silage, wheat bran, and palm; sanitary management performed navel antisepsis, foot and mouth disease, and rabies vaccination, in addition to two annual worms. Reproductive management included natural breeding and artificial insemination.

Cattle consumption was performed using hyper-concentrated wastewater (tailing water) resulting from the desalination of water from an artesian well. Reverse Osmosis Desalination was installed by the State Government to make drinking water available to the human population. The producer dispensed wastewater from the desalination process, without the consent of the health authorities, into a cistern and after provided to the animals. The producer dispensed wastewater from the desalination process into a cistern, without the consent of the health authorities, and after provided to the animals.

Samples of the desalination wastewater that were supplied for the consumption of the animals were collected, being packaged in plastic bottles and sent to the laboratory in isothermal boxes containing recyclable ice for analysis of physicochemical characteristics.

The bovine blood samples were obtained by venipuncture of the external jugular, by a vacuum system, and stored in two vials distributed in 4 mL aliquots, one containing the 10% ethylene diaminotetracetate (EDTA) anticoagulant, and another anticoagulant free, for blood count and biochemical tests, respectively.

Considering the determination of globular volume (GV), glass capillaries were filled with blood, properly sealed, and centrifuged at 15,000 rpm, for 5 minutes. After centrifugation of capillaries, the column formed by red blood cells was interpreted in an appropriate reading card, and the value determined in percent.

The determination of the blood hemoglobin value was made through the dilution of the whole blood sample was performed, at a ratio of 1: 250, in Drabkin's liquid, and the reading of the colorimetric reaction was performed in a spectrophotometer, the hemoglobin value being determined in g. dL^{-1} (Birgel, 1982).

Regarding the analysis of the total number of red blood cells, blood samples were diluted, 1: 200 ratio, in hematimetric pipette with Gower liquid and counting was performed in a modified Neubauer hematimetric chamber, according to Birgel (1982); the result was presented in a number of red blood cells / mL of blood.

Hematimetric indices Mean Corpuscular Volume (MCV), Average corpuscular hemoglobin (HCM) and Mean Corpuscular Hemoglobin Concentration (CHCM), were calculated from the results obtained for globular volume, hemoglobin and red cells using mathematical formulas (Birgel, 1982).

For the total leukocyte count, each EDTA blood sample was diluted 1:20, in hematimetric pipette with Thoma liquid, and counting was performed in a modified Neubauer hematimetric chamber, according to Birgel (1982), the result was presented in thousands of cells per mL of blood.

Blood smears shortly performed after blood sampling were stained with Rosenfeld (1947), for differential assessment of blood leukocytes. In each swab, 100 leukocytes were counted, using standard microscopy and 1000x magnification, identifying granulocyte polymorphonuclear cells (neutrophils, eosinophils, and basophils) and mononuclear agranulocytes (lymphocytes and monocytes), according to Birgel (1982).

Biochemical evidence of renal function (urea and creatinine) and serum activity of liver enzymes (Aspartate aminotransferase, Gamma glutamyl transferase, and alkaline phosphatase) were performed using a semi-automatic biochemical analyzer and its activities quantified by commercial kits (LabtestDiagnósticaS.A®). The value of total serum proteins was determined by the biuret method, serum albumin value through bromocresol green reactive, and globulin were obtained by subtracting individual values of total protein and albumin; the values were expressed in g dL^{-1} (Hoffmann & Solter, 1997).

Results and Discussion

The physicochemical analysis of the hyper-concentrated wastewater (tailing water) presented: salinity - 7,310 µS cm^{-1}; ionic composition: cations - calcium (394.8 mg L^{-1}), magnesium (227.6 mg L^{-1}), sodium (713.0 mg L^{-1}) and potassium (1.6 mg L^{-1}); anions - chloride (2100.0 mg L^{-1}), sulfate (5.3 mg L^{-1}), nitrate (40.9 mg L^{-1}), bicarbonate (552.0 mg L^{-1}) (Table 1). These high mineral concentrations observed in water offered to cattle are in line with the claims of Leprun (1983), noting that surface water quality in the Northeast of Brazil is directly related to the nature of the local substrate (nature of the rock and soil type) and the laying mode so that the waters of the sheets are noticeably more concentrated than the surface ones (rivers, streams, and dams).

Table 1. Predominant ionic composition in hyper-concentrated wastewater (tailing water) from the desalination of water from an artesian well.

Cations	mg L^{-1}	mmol (+) L^{-1}	LD (mg L^{-1})	Method	MPV (mg L^{-1})	Anions	mg L^{-1}	mmol (+) L^{-1}	LD (mg L^{-1})	Method	MPV (mg L^{-1})
Ca^{2+}	394.8	19.70	0.25	3500 Ca B	-	Cl^-	2100.0	59.22	0.25	4500 Cl B	250.0
Mg^{2+}	227.6	18.72	0.15	3500 Mg B	-	SO_4^{2-}	5.3	0.11	0.1	4500 SO_4^{2-}B	250.0
Na^+	713.0	31.02	0.05	3500 Na B	200,0	$NO3^-$	40.9	0.66	0.1	4500 $NO3^-$B	-
K^+	1.6	0.04	0.08	3500 K B	-	$HCO3^-$	552.0	9.05	0.06	2320 B	-

MPV = Maximum Permitted Values for human consumption (Portaria de Consolidação nº 05, de 28/09/2017, Anexo XX MS); LD = Method detection limits; (-): reference values (MPV) are not in the legislation (Portaria de Consolidação nº 05 de 28/09/2017, Anexo XX MS); Method = Standard Methods for the Examination of Water and Wastwater, 22th ed. (2012).

Regarding the effects on the organism of cattle ingesting it, Pereira (2009) highlighted that the performance of these animals might be affected by water quality, especially the concentration of minerals presented and ingested by the animals. In fact, the salinity contents (7,310 µS

cm^{-1}; VR = 4,700 to 7,800 µS cm^{-1}), chloride (2100,0 mg L^{-1}; VR = < 500 mg L^{-1}) and sodium (713.0 mg L^{-1}; VR = < 500 mg L^{-1}), obtained above the tolerable limits for cattle, even those already used to consumption (4,700 to 7,800 µS cm^{-1} and < 500 mg L^{-1}, respectively), they certainly caused serious deleterious effects on the organism, characterized mainly by diarrhea.

According Waldner & Looper (2005), on the importance of water as a vehicle for diarrhea-causing pathogens, gastrointestinal syndrome in calves were due to high alkalinity, hyper-concentrated water with chloride and sodium. It was since it was supplied to the bovine animals examined without any previous treatment, it is causing damage in production.

Among the serum mineral levels determined in cattle, the osmotically active ones stood out: sodium - 180 ± 25 mmol L^{-1}, potassium - 3 ± 0 mmol L^{-1}, urea - 34 ± 3 mg dL^{-1} and glucose - 32 ± 0 mg dL^{-1}; in addition to chloride - 106 ± 2 mmol L^{-1} and total proteins - 9 ± 0 g dL^{-1} (Table 2). The serum osmolality of the examined cattle varied above the reference values (300 mmol kg^{-1}) in the animals (333 ± 41.1 mOsm kg^{-1}), probably due to the ingestion of hyper-concentrated water in salinity, chloride and sodium.

Table 2. Bovine serum biochemistry. Font: Silva et al. (2019).

Parameter	Average value
Magnesium	2 ± 0 mg dL^{-1}
Phosphor	8 ± 2 mg dL^{-1}
Calcium	9 ± 1 mg dL^{-1}
Alanine Amino Transferase	22 ± 11 U L^{-1}
Aspatate Amino Transferase	76 ± 2 U L^{-1}
Glutamyl Transferase Range	23 ± 9 U L^{-1}
Alacanine Phosphatase	49 ± 17 U L^{-1}
Urea	34 ± 3 mg dL^{-1}
Albumin	3 ± 0 g dL^{-1}
Creatinine	1 ± 0 mg dL^{-1}
Fructosamine	208 ± 4 umol L^{-1}
Total Creatinine Kinase	219 ± 43 U L^{-1}
Creatinine Kinase MB	300 ± 15 U L^{-1}
Total Proteins	9 ± 0 g dL^{-1}
Lactate	33 ± 1.5 mg dL^{-1}
Chloride	106 ± 2 mEq L^{-1} or mmol L^{-1}
Sodium	180 ± 25 mEq L^{-1} or mmol L^{-1}
Potassium	3 ± 0 mEq L^{-1} or mmol L^{-1}
Total cholesterol	157 ± 108 mg dL^{-1}
Glucose	32 ± 0 mg dL^{-1}
Triglycerides	5 ± 3 mg dL^{-1}
Uric acid	1 ± 0.5 mg dL^{-1}

Regarding the hematological profile, the cattle examined presented average leukocyte values of 8 ± 2.3 x 103. Mm^3, neutrophils - 2.8 ± 947 x 103.mm^3, lymphocytes - 4.7 ± 1473.mm^3, eosinophils - 576 ± 300 mm^3 and monocytes – 11 ± / 27 mm^3 (Table 3). The number of red cells of

4.7 ± 1.3 x 106 shows apparent normality but tending to value below the standards for the Northeast Region, mainly when analyzed in connection with plasma protein (9.3 ± 0 g dL^{-1}). This observation may be related to the salinity levels found in the wastewater supplied to the animals, characterizing possible dehydration.

Table 3. Cattle hematology analyze. Font: Silva et al. (2019).

Component	Average	Standard deviation
Red blood cells (x 10^6 mm^3)	7,9	1,2
Hemoglobin (g dL^{-1})	10,8	1,2
Hematocrit (%)	33,4	3,7
VCM (fL)	43,5	17,0
CHCM (%)	32,3	0,5
Total Proteins (g dL^{-1})	8,7	0,3
Fibrinogen (mg dL^{-1})	453,3	199,2
Total leukocytes (mm³)	15909	2363,8
No. Of rods	0	0
No. Of Targeted	5088,8	947,3
No. Of eosinophils	1549,4	300,2
No. Of basophils	172,8	0
No. Of lymphocytes	8560,0	1473,2
No. Of monocytes	537,7	27,1

Campos et al. (2008) evaluated that the mean values of hematological parameters in summer and winter demonstrated that summer conditions influenced blood dynamics in most of the studied parameters.

The importance of the hematological and serological profile is to assist the establishment of diagnoses and consequently constitute prognoses for this, monitor the treatments of various diseases that affect animals. However, for these objectives to be achieved and to be safely used, it is of fundamental importance to know the reference values of the blood count of healthy animals, besides the factors that may cause variations in these parameters, giving characteristic to a different hematological profile in each category of dairy cattle (Meirelles et al., 2009).

Clinical problems were also recorded in several animals, the essential being:1) Infectious keratoconjunctivitis (five animals); 2) Mastitis (seven to ten lactating cows); 3) Papillomatosis; 4) Omphalophlebitis and presence of ticks. Calves in the first days of birth had profuse diarrhea, associated in some animals with a neurological syndrome characterized by apparent blindness, motor incoordination, and death (morbidity rates - 21% - 15/80, and lethality rates - 100%).

Water supplies from wells, lakes, streams, or "water holes" are occasionally rich in salt and can cause physiological disruption to livestock or even death. The main effect reported by Ayers & Westcot (1994) is the loss of appetite, which is usually caused by a water imbalance and not related to any specific ion. The most common exception is water that contains a high level of magnesium, which is known

to cause diarrhea in animals.

According to Palhares (2005), poor quality water poses risks to human health as well as to animals and agricultural production, causing reductions in weight gain to the death of animals. Symptoms are observed in animals that the excess of some elements can cause: total dissolved solids: diarrhea; reduction of water consumption and productivity; and death; chlorine: reduced food intake and increased water consumption; iron: alters the palatability of water, showing effects on its consumption and animal productivity.

Inadequate water supply decreases food consumption and impairs animal performance (Marino, 2006).

Conclusion

The continuous use of wastewater from the desalination process for the dairy cattle consumption alters the physiological patterns and impacts on the health of these animals. It is suggested that studies must be expanded and deepened, with emphasis on the quality of dairy products and health impact.

Acknowledgment

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