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Effect of rumen alkalosis on acid–base balance, electrolytes and fecal examination in cows fed on silage (Makmora)

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Abstract

Fifty native breed cows, assigned to study designed to clear the effect of silage (Makmora) as a high-concentrate diet on acid-base status. The cows were fed on 10-20 g/kg daily of silage (Makmora) before admitted to the clinical examination because of rumen indigestion, all cows were fed a diet containing rice straw which was used as a roughage source. Based on the present study, the results revealed that silage (Makmora) could be a dangerous cause for indigestion and threating general health condition of cattle in Egypt. The protozoal, numbers and motility were lower among diseased animals may be due to rumen ecology and nutrient digestibility by enhancing ruminal pH.

The aim of this retrospective study was to evaluate the diagnostic use of the acid-base status and fecal examination as additional auxiliary means in diagnostic investigation and as a prognostic indicator in cows with rumen alkalosis.

Due to obtained results the serum concentrations of sodium and chloride were appropriate values to predict rumen fermentation efficiency in alkalosis in cows fed on silage (Makmora).

Keywords: Cows, rumen alkalosis, acid-base status, fecal examination, (Makmora) silage.

Introduction

Pastures, including temperate and tropical grasses and legumes, are, under most circumstances, the most cost-effective sources of nutrients (Peyraud and Delaby, 2001; Hills et al., 2015), with the cost of milk production declining quadratically with increased utilization of grazed pasture (Dillon et al., 2008). Concentrate supplements are used in pasture-based systems as a management tool either to manage deficits in pasture supply (Holmes and Roche, 2007) or to increase overall DMI and milk production (Stockdale, 2000; Bargo et al., 2003).

High carbohydrate suddenly fed to ruminants without prior adaptation, the decline of rumen pH from 6.8 to 5.5 or lower occurs (Franzolin and Dehority, 1996; Owens et al., 1998) lead to rumen disorder or grain-engorgement (Owens et al., 1998). However, the reduction rate of rumen pH depends on buffering capacity in the rumen fluid. Sung et al. (2007) reported that feeding system could influence rumen pH; thus, consequently affected on microbial fermentation and its end products (Dijkstra et al., 2012). Mineral salt as sodium bicarbonate was used as a rumen buffering agent to prevent acidic conditions in the rumen fed a high-concentrate diet Kawas et al., (2007), in lambs. $NaHCO_3$ as a rumen buffer has been used to prevent sudden drops of pH in lactating cows (West et al., 1987), buffaloes (Koul et al., 1998), and lambs (Santra et al., 2003).

Hypokalemia , occurs commonly in lactating dairy cows with left displaced abomasum (LDA), right displaced abomasum, abomasal volvulus, abomasal impaction (Constable et al., 2014), clinical mastitis, retained placenta, and hepatic lipidosis (Smith et al., 2001; Wittek et al., 2005; Kalaitzakis et al., 2010; Constable et al., 2013). Alkalemia due to sequestration of chloride in the gastrointestinal tract in cattle with LDA, right displaced abomasum, abomasal volvulus, or decreased abomasal emptying rate (Grünberg et al., 2006; Constable et al., 2009, 2013).

Hypokalemia is most commonly defined as serum or plasma K <3.9 mEq/L in adult cattle (Radostits et al., 2007), although some studies have used a value <3.9 mEq/L for

serum or plasma K to define hypokalemia (Constable et al., 1991, 2013). Hypokalemia have the potential to result in diarrhea, excessive salivation, muscular tremors of the legs, labored breathing, convulsions, and death (Dennis and Harbaugh, 1948; Peek et al., 2000; NRC, 2001; Constable, 2003).

Skeletal muscle K content is considered the most sensitive and specific method for assessing whole-body K status (Johnson et al., 1991).

Hypokalemia commonly occurs due to a compartmental shift of K from the extracellular to intracellular space in cattle with hyperinsulinemia due to hyperglycemia or alkalemia due to metabolic alkalosis (Svendsen, 1969; Grünberg et al., 2006; Constable et al., 2013). Banana flower had a higher mineral elements compared to other plants and could be used in buffalo and dairy steer as supplementation fed with high-concentrate diet (Ngamsaeng et al., 2006; Kang and Wanapat, 2013).

Corn silage is widely distributed in Egypt. It is characterized by high level of rapidly fermentable carbohydrates but poor in protein so we need adding of concenterate mixture of high source of crude protein percentage addition of urea to corn silage as alternatice to reduce cost of feeding in dairy farms but I wasobserved in Egypt that excessive addition of urea to corn silage reduce the health status of dairy cows causing alkalosis in blood . Melo , 2003 and oliveira et al, 2004 stated that addition of urea in diets based on corn silage reduce performance of dairy cows.

Material and methods:

Animals, diets and experimental design

Since there is shortage of concentrate diet in most parts of world, silage (Makmora) which contains ammonia and urea treated roughage and concentrates used as an alternative target for concentrate diet in Egypt.

Data collection, sampling procedures and chemical analysis

Blood Gases, cows were equipped with a catheter in the left jugular vein and the catheters were filled with a sterile solution of 9% NaCl and 200 IU of heparin/mL. On 1st day and day 7, jugular blood was sampled. Blood pH, partial pressure of CO^2 (p^{CO2}), partial pressure of O^2, and HCO_3^- concentrations were analyzed immediately according to Khelil-Arfa, et al., (2014).

Table (1) Ingredient composition and calculated analysis of diet.

Ingredient	%
Corn silage	70
Ground yellow corn	18.2
Soya bean meal (44%CP)	6
Cotton seed meal(41% CP)	4
Salt	1.5
Premix	0.3
Calculated analysis	
CP	7
CF	16
NDF	15
ADF	10
NEF	22
NEL (MCAL/KG)	1.1

Table (2) : chemical analysis of corn silage .

Nutrient	Percentage on analysis fed basis
Dm%	29.5
CP%	2.34
CF%	17.57
EE%	0.59
NEF%	8.4
ASH%	0.7

Statistical analysis

The statistical evaluation was done with SPSS (SPSS Inc., Chicago, Illinois). A t-test was performed. In this case, the mean values between groups before and after treatment and control group.

Results

Tab. 1: Results of the analysis of the blood acid-base and electrolytes values of diseased cows

	Minimum	Maximum	Mean value	Standard deviation.	Reference number
pH-Value	7.23	7.52	7.4	0.09	7.38-7.42
Sodium	116	137	129.6	5.93	130-150
Magnesium	1.4	3.8	2.36	0.59	4.4-5.7
Chloride	42	105	88.7	14.16	98-104
Bicarbonate	2.3	78.1	30.77	15.76	25-30
BE	-12.6	27.1	4.61	9.81	1.0-6.0

Tab. 2: Results of the analysis of the blood acid-base and electrolytes values of surviving cows

	Minimum	Maximum	Mean value	Standard deviation.	Reference number
pH-Value	7.32	7,96	7,45	0,12	7,38-7,42
Sodium	122	143	133.97	4.69	130-150
Magnesium	1.6	6	3.06	0.9	4.4-5.7
Chloride	69	185	100.93	20.23	98-104
Bicarbonate	22	55.7	30.86	8.43	25-30
BE	-11	28.5	6.24	8.42	1.0-6.0

Tab. 3: Results of the analysis of the blood acid-base and electrolytes values of the control group

	Minimum	Maximum	Mean value	Standard deviation.	Reference number
pH-Value	7.19	7.53	7.37	0.08	7.38-7.42
Sodium	130	143	136.47	3.44	130-150
Magnesium	2.2	4.6	3.24	0.53	4:4-5.7
Chloride	92	113	105	5.25	98-104
Bicarbonate	15.8	34.9	24.71	5.12	25-30
BE	-11	11.6	0.09	5.49	1.0-6.0

Tab. 4: Fecal examinations of cows in the control group and diseased

Fecal examination		Diseased group Percentage	Control group Percentage
Volume	Normal	28%	70%
Volume	Scanted	34%	30%
Volume	Constipation	8%	0
Consistency	very hard	32%	33%
Consistency	Hard	2%	3%
Consistency	thick bolus	18%	20%
Consistency	small bolus	16%	3%
Consistency	Pasty	18%	3%
Consistency	Fluid	14%	10%
Consistency	Watery	0	0
Odor	Aromatic	44%	43%
Odor	Sour	2%	0
Odor	Offensive	0	3%
Odor	highly offensive	54%	53%
Color	olive-brawn	54%	77%
Color	Greenish	8%	7%
Color	dark brown	26%	17%
Color	Black	10%	0
Color	Yellow	0	0
Digestion	Yes	68%	90%
Digestion	No	32%	10%
Abnormal constituents	Mucus	38%	2%
Abnormal constituents	Blood	20%	1%
Abnormal constituents	Food particles	18%	7%

Discussion

The results of the T-tests showed that the pH-value, the concentration of bicarbonate and the base-excess were significantly ($p=0.01$) higher in diseased cows. Additionally. the concentrations of sodium, potassium and chloride in the serum of the affected cows were significantly ($p=0.01$) lower than in cows of the control group. affected cows had a characteristic hypochloremic and hypokalemic metabolic alkalosis. Control group had reduced levels of potassium only. Comparing cows of the study group which survived to affected cows, concentrations of sodium, potassium ($a = 0.01$) and chloride ($a = 0.05$) were significantly lower in affected cows.

Tripathi et al., (2004) reported that feed intake was reduced by buffering agent supplementation ($NaHCO_3$). The acid–base balance of animals depends on the intricate association between anions and cations in

the blood. Extracellular H^+ is one of the most vigorously regulated variables of the body. The vital limits of pH variation for mammals are between pH 7.36 and 7.44 Houpt, (1989).

Under normal conditions, acids and bases are added continuously to the body fluids as a result of either ingestion or production during cellular metabolism. The body combats any changes in the normal acid–base balance, by using three fundamental mechanisms: chemical buffering, respiratory adjustment of blood carbonic acid and excretion of H^+ or HCO_3^- by the kidneys Houpt, (1989).

Indrova, et al., (2016) physiological parameters for pH, partial pressure of carbon dioxide (p^{CO2}), and concentrations of base excess ([BE]) and standard bicarbonate ([HCO_3^-]) are 7.38-7.43; 5.2-6.4 kPa; -0.5-4.5 and 23.5-27 mmol/l, respectively, in the blood of dairy cattle Pechova et al., 2009.

Alkalemia and metabolic alkalosis are frequently present in dairy cattle with clinical signs of severe hypokalemia (Sielman et al., 1997; Sattler et al., 1998; Peek et al., 2000). Marked abnormalities in serum [K], both hypokalemia and hyperkalemia, are frequently associated with cardiac arrhythmias (Fosha-Dolezal and Fedde, 1988).

Atrial fibrillation was diagnosed in cows with naturally acquired hypokalemia (Sielman et al., 1997; Sattler et al., 1998; Peek et al., 2000), and in 1 of 7 lactating dairy cows with experimentally induced hypokalemia following I.M. administration of two 20- mg doses of isoflupredone acetate at a 48-h interval (Coffer et al., 2006). Taken together, these findings suggest that hypokalemia plays a role in the development of atrial fibrillation in adult cattle.

Experimental induction of metabolic alkalosis by oral administration of sodium bicarbonate in 3 Jersey cows caused marked metabolic (strong ion) alkalosis, hypokalemia, and an increase in muscle K concentration of 6 to 10%, indicating an intracellular shift of K from the extracellular space to the intracellular space (Svendsen, 1969).

As a cause of alkalosis must be considered Michelle, et al., (2011) in ruminants animals the more moldy and potentially highly contaminated feeds at a feedlot and, in poor crop years, beef cows can be fed contaminated screenings, straw, and cereal by-products, poorly preserved silages. Kiessling, et al., (1984); Westlake, et al., (1989); Upadhaya, et al., (2009) Aflatoxin B1 can bind reversibly to albumin, with unbound aflatoxin B1 passing from the circulation into tissues.

Aflatoxins may cross the placenta and damage fetal tissue; however, little work has focused on reproductive effects. Aflatoxin elimination is through the bile, feces, urine, and into milk and eggs. Most species eliminate the toxin within 24 hours after exposure. Helferich, et al., (1986).

Chronic aflatoxicosis in cattle is associated with clinical signs of reduced appetite, feed efficiency, milk production, and icterus.

Corn and grass silages are often contaminated with molds, including Aspergillus, Penicillium, Mucor, Geotrichium, and Monascus. Fink-Gremmels, (2005); O'Brien, et al., (2006) Sumarah, et al., (2005) Geotrichum candidum occurs in silages and gives off a rancid odor that tends to repel animals, reducing feed consumption. Scudamor, and Livesey, (1998). Dalefield, (2004) cholestatic liver disease and dermal photosensitization, edema and erythema of the ears, eye lids, face, and lips are visible in sheep. Dairy cows may develop a sudden decrease in milk production and ill thrift followed by dermal photosensitization.

No feed sample submitted for mycotoxin analysis can ever be labeled as safe to feed to animals because laboratories do not have the analytical capability or mycotoxin

standards to test for all possible mycotoxins produced by molds and there is lack of toxicity data in ruminants for many mycotoxins Michelle, et al., (2011).

Fluid therapy and treatments

Affected cows were treated with 10 liter of dextrose saline 5% daily and changing the diet. Fluid therapy in mature cattle Roussel, (2014) unlike calves, most mature cattle with dehydration are not acidotic. When significant alkalosis is present, one should choose an acidifying solution that contains K and Cl in excess of physiologic concentrations. The acidifying properties of a high K and Cl solution can be explained using the principles of strong ion difference theory. In brief, increasing the relative amount of strong anions, in this case Cl, in the plasma reduces strong ion difference and acidifies the extracellular fluid.

Baraka (2006) stated that to administer magnesium sulfate solution 20-50% injection in the line of treatment, per-os administration of acetic acid (vinegar) at the dose of 2 ml/kg body weight; intramuscular injection of Terramycin long acting preparation; fresh rumen fluid transfaunation (for up to 7 days) was highly efficient in treatment of rumen alkalosis in dromedaries.

Constable and colleagues, (1998) showed that the time required for cervical skin to return to its normal position after tenting and the degree of eyeball recession in dehydrated pre-ruminant calves are reasonably accurate methods to determine the state of hydration for calves. For example, when skin pinched on the neck takes 6 seconds to return to normal, this indicates 8% dehydration. There have not been similar studies of the relationship between clinical signs and degree of dehydration for mature ruminants. For nonlactating cattle at moderate ambient temperature, approximately 3.5% to 5% of body weight in water is required daily. Therefore, for a 500-kg animal, it will be necessary to provide 17.5% to 20% of body weight, or 88 to 100 L, over 48 hours.

Conclusions And Recommendations

The significant gaps in our understanding of the consequences of individualized feeding on silage (Makmora) highlight the current need to develop an integrated research program that analyzes the potential disadvantage and or benefits of feeding assessment of the cost of feeding Makmora, under more controlled research conditions.

Changes in the acid-base balance ABB parameters in the blood during metabolic alkalosis were mirrored. The results suggest that ruminal alkalosis, impacts on characteristics of the blood and consequently lead to metabolic alkalosis,

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تأثير قلوية الكرش على اتزان الحمضية و القلوية والكهارل وفحص الروث في الابقار المغذاة على السيلاج(المكموره)

ناجي السيد المشد ، سامح عرابي ، محمد محيي الحنفي

خلفية خمسون الأبقار سلالة الأم، المكلفة بدراسة تهدف إلى إبعاد تأثير السيلاج (Makmora) كما اتباع نظام غذائي عالي التركيز على الوضع الحمضي القاعدي. تم تغذية الأبقار على 10-20 غرام / كغ يوميا من الأعلاف (Makmora) قبل ادخاله الى الفحص السريري بسبب عسر الهضم الكرش، تم تغذية جميع الأبقار اتباع نظام غذائي يحتوي على قش الأرز الذي تم استخدامه كمصدر نخالة. وبناء على هذه الدراسة، أظهرت النتائج أن السيلاج (Makmora) يمكن أن يكون سبب خطير لعسر الهضم وthreating الحالة الصحية العامة للماشية في مصر. والأوالي، وكانت أرقام والحركة السفلية بين الحيوانات المريضة قد يكون راجعا إلى الكرش البيئة والمغذيات الهضم من خلال تعزيز pH.Objective الكرش والهدف من هذه الدراسة بأثر رجعي كان لتحليل استخدام التشخيص للحالة الحمضي القاعدي كما تعني مساعدة إضافية في التحقيق التشخيص وكمؤشر النذير في الأبقار مع cows.Conclusion الكرش القلاء نظرا لهذه النتائج كانت تركيزات مصل من الصوديوم وكلوريد القيم المناسبة للتنبؤ كفاءة التخمير الكرش في القلاء في الأبقار المغذاة على سيلاج (Makmora).