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Prevalence and Treatment of Ketosis in Dairy Cows in and Around Addis Ababa, Ethiopia

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Abstract: Prevalence of ketosis in dairy cows at Genesis farm, Slam farm, Akaki kality farm and Bollie private farm located in and around Addis Ababa, Ethiopia was studied from November 2008 to March 2009. The ketone bodies in urine and milk samples were semi quantified by Rothera's test and Strip test was used specifically for urine sample. The body temperature, pulse rate, respiratory rate, rumen motility, abnormalities in urine, faeces and milk was recorded. The affected cows were treated with dextrose 50%, or dextrose 25% plus dexamethasone or propylene glycol and dexamethasone. The ketosis prevalence rate was maximum in the month of January (30.77%), in higher age (8-9 years) groups (13.4%), during 1st month of lactation (18.87%) and 4th lactation number (18.8%). The decrease in milk yield from ketosis affected cow ranged from 18.18 to 40%. The cows were administered with dextrose 50% or dextrose 25% plus dexamethasone or propylene glycol and dexamethasone and effective restoration of milk-yield within 3-4 days were recorded. To prevent this metabolic disease, immediate diagnosis and proper treatment of affected cow is essential to restore the milk yield. In addition, veterinary professionals need to give great attention for diagnosis, management and control of this disease during risk stage.

Keywords: Dairy cows, ketosis, prevalence, Rothera's test, strip test

INTRODUCTION

Ketosis is a metabolic disorder in dairy cows caused by reduced intake of feeds with insufficient energy to meet the need for high milk production. As a general statement, clinical ketosis occurs in ruminants at times when they are subjected to heavier demands on their recourses of glucose and glycogen that can be met from their digestive and metabolic activities (James, 1992). Ketosis occurs world wide but ruminants are particularly vulnerable because, a direct supply of glucose is essential for milk production, particularly for the formation of lactose. The utilization of volatile fatty acids for energy purpose also depends upon available glucose. During calving and peak lactation period glucose demand is increased and cannot often be completely met (Radostists *et al*., 2000).

In most countries ketosis is prevalent where intensive farming is practiced. It occurs mainly in housed animals during the winter and spring months and rare in pasture cows. Regarding specific etiology it occurs most commonly during the first month of lactation, less commonly in the second month and only occasionally in the late stage. Cows of any age may be affected but the disease increases from a low prevalence at the first calving to a peak at the fourth. There is a greater risk for the development of ketosis in cows that have an extended dry period, those at calving and those which have retained placenta, lameness or hypomagnesaemia (Bergman, 1973; Lean *et al*., 1991). Its occurrence depends much on management, nutrition and climate. An occurrence rate of 10.5% has been recorded in one population but the estimated occurrence in the national herd in United Kingdom was only 1-5% (Smith, 1996). The prevalence of ketosis in lactation was reported to be 5-16%, but in individual herds it varies substantially (Aiello, 1998).

In cattle, a number of treatments are available but in some affected animals the response is only transient; in rare cases the disease may persist and cause death or necessitates slaughter. The rational treatment in ketosis is to relieve the need for glucose formation from tissue and allow ketone body utilization to continue normally. The effect of the administration of glucose is complex but it allows the reversal of ketogenesis and the establishments of normal patterns of energy metabolism (Herdit and Emery, 1994). The i.v. injections of 500 mL of 50% glucose solution results in transient hyperglycemia (2 to 2½ h), increased insulin and decreased glucagon secretion and reduced plasma concentration of non-esterified fatty acids. Its effect has a marked improvement in most cows but relapses occur commonly unless repeated treatment is used (Radostists *et al*., 2000). To overcome the necessity for repeated injections of glucose, propylene glycol (225 g twice daily for two days followed by 110 g daily for two days

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to cattle) can be administered as a drench (Blood *et al*., 1983). The efficacy of glucocorticoids in the treatment of bovine ketosis has been amply demonstrated in both experimental and field cases. Hyperglycemia occurs within 24 h of glucocorticoids administration and appears to result from glycolysis rather than gluconeogenesis (Herdit and Emery, 1994). Therefore, the study on prevalence of ketosis in dairy cows and their response to the administration of glucose (dextrose), dexamethasone, dextrose plus dexamethasone and propylene glycol was conducted at different dairy farms in and around Addis Ababa, Ethiopia and the results are reported.

MATERIALS AND METHODS

Study area: The study was carried out in and around Addis Ababa (Genesis farm, Slam farm, Akaki kality farm and Bollie private farm) which is located at 9º2' N, 38º42' E with an elevation of about 2,400 m above mean sea level. Addis Ababa receives a mean annual rain fall of 1,800 mm^3 in bimodal pattern. The short rainy season lasts from March to May and long rainy season extends from June to September. The average minimum and maximum temperature is 10.7°C and 23.6°C, respectively (NMSA, 2005).

Study design: A cross-sectional observation in a multi stage sampling technique was adopted. For estimation of ketosis prevalence and standard error of the estimated prevalence (SE, expected prevalence and precision level), a sample size of 151 milking cows were screened for ketosis from November 2008 to March 2009.

Study animals: The exotic and local breeds of cows were used in this study. The history of the animals like age, stage of lactation, lactation number, milk yield, nutritional condition, symptoms observed by the owner, past and present history regarding other illness were recorded. The clinical examination including general and physical examination such as body temperature, pulse rate, respiratory rate, rumen motility, faeces and urine and milk examination for ketone bodies were also recorded. Irrespective of lactation stage, lactation number and age groups, 6 cows were treated with 500 mL of 50% dextrose through i.v.ly, 3 cows with 500 mL of dextrose 25% i.v.ly+0.02 mg/kg of dexamthasone through i.m.ly., 3 cows with 0.02 mg/kg of dexamethasone i.m.ly and 5 cows treated with propylene glycol 225 gm/head twice a day for two days followed by 110 gm/head two days as a drench.

Rothera's test and Strip test: Rothera's test and strip test were used for the detection of ketone bodies. Fresh urine and milk samples were collected and analyzed for the presence of ketone bodies using Rothera's reagent and strip test. The Rotheras's reagent consists of a powdered mixture of one part of sodium nitroprusside and 100 parts of ammonium sulfate. About 5 g of the powdered reagent was placed in a dry test tube, 5 mL of urine was added and the mixture was agitated. One to 2 mL of concentrated ammonium hydroxide was added to form a layer above the mixture and allowed to stand for 15 min. The test was read on the basis of color development i.e., no colour (-), slightly purple (+), moderately purple (++), black-purple (+++) and dark - purple (++++). Rothera's reagent reacts with acetone and acetoacetate but does not react with beta-hydroxybutyric acid. The procedure and development of color for the milk sample was also the same (Coles, 1986). The dipstick was routinely used in urinalysis to measure the amount of ketone bodies present as they react with nitroprusside. The strip test was most sensitive to acetoacetic acid and reacts weakly with acetone and not at all with beta-hydroxybutyric acid. The test showed buff pink, pink and maroon color showing the acetoacetate level of 5-10, 10-50 and 50-100 mg/dL, respectively (Radostists *et al*., 2000).

Data analysis: The data collected from various parameters was subjected to Chi-square statistical analysis using statistical discovery soft ware (JMP5) computer program. The level of significant difference in disease prevalence among the month, age, lactation stage and lactation number was determined with 95% confidence interval.

RESULTS

A total of 151 recently calved cows were examined for this study in which 17 (11.26%) showed positive results for ketosis. The highest prevalence of ketosis was recorded in the month of January (30.77%) followed by November (18.18%), February (7.55%), March (5%) and December (4.76%). The ketosis prevalence among the months was statistically significant (X^2 = 13.62; df = 4; P = 0.0086; $p<0.05$) (Table 1).

The age prevalence was recorded highest in 8-9 years (13.4%) followed by 7-8 years (10%), 6-7 years (9.6%) and 5-6 years (7.6%). The age prevalence was statistically not significant (X^2 = 3.805; df = 3; P = 0.4330; $p>0.05$) among the age groups for the level of ketosis (Table 2). As there are only two cows which were less than 5 years old, for the purpose of statistical analysis and interpretation they were not included.

Among the lactation stage, maximum number of ketosis cases was recorded during 1^{st} month (18.87%) post partum followed by 2^{nd} (7.69%), 3^{rd} (7.14%), 5^{th} (5.88%) and 4^{th} (5%). There was no statistically significant association (X^2 = 4.879; df = 4; P = 0.300; $p>0.05$) with the lactation stages (Table 3).

Table 1: Prevalence and association of ketosis in cows with regard to month

Month	No. of cases examined	No. of positive cases
November	11	2 (18.18%)
December	21	1 (4.76%)
January	26	8 (30.77%)
February	53	4 (7.55%)
March	40	2 (5%)
Total	151	17(11.26%)

Table 2: Prevalence and association of ketosis in cows with regard to age

Age	No. of cases examined	No. of positive cases
< 5 Years	2	1 (50%)
5–6 years	26	2 (7.6%)
6–7 years	31	3 (9.6%)
7–8 years	40	4 (10%)
8–9 years	52	7 (13.4%)

Table 3: Prevalence and association of ketosis in cows with regard to stage of lactation

Lactation stage	No. of cases examined	No. of positive cases
1st	53	10 (18.87%)
2nd	39	3 (7.69%)
3rd	28	2 (7.14%)
4th	20	1(5%)
5th	11	1 (5.88%)

Table 4: Prevalence and association of ketosis in cows with regard to lactation number

Lactation number	No. of cases examined	No. of positive cases
1st	14	1 (7.1%)
2nd	29	2 (6.89%)
3rd	43	4 (9.3%)
4th	53	10 (18.8%)
5th	12	0

When compared to lactation number, most of the animals were observed with positive results in their 4th lactation (18.8%) followed by 3rd (9.3 %), 1st (7.1 %) and 2nd (6.89%). The ketosis in association with lactation number was statistically significant (X^2 = 10.273; df = 4; P = 0.0164; p<0.05) (Table 4).

Among the 151 cases studied 17 were positive for ketosis. Among the 17 affected cows, age group

Table 5: Clinical observations for ketosis affected cows and the impact of drugs on milk yield

No.	Age (years)	Lactation stage(month)	Lactation No.	Milk yield (L/day) Before illness	Milk yield (L/day) During illness	Decrease in milk yield (%)	Drug used	Milk yield 3days after treatment
1	8	2	4	17	13	23.53	Dextrose 50%	16 (94%)
2	9	3	3	14	10	28.57		12 (85%)
3	8	1	4	12	9	25.00		11(91%)
4	7	4	2	18	13	27.77		18 (100%)
5	6	2	2	16	12	25.00		14 (87%)
6	5	1	1	14	9	35.7		12(85%)
7	9	1	4	12	8	33.33	Dextrose 25% plus	12(100%)
8	7	2	3	18	14	22.22	Dexamethasone	17(94%)
9	9	1	4	20	15	25.00		20 (100%)
10	9	5	3	15	11	26.66	Dexamethasone	15 (100%)
11	6	1	4	13	9	30.76		12(92%)
12	7	1	3	17	12	29.41		16(86%)
13	9	1	4	15	9	40.00	Propylene glycol	9 (60%)
14	9	1	4	12	8	33.33		10 (83%)
15	8	3	3	15	11	26.67		12(80%)
16	9	1	4	11	9	18.18		11(100%)
17	9	1	4	16	11	31.25		15(93%)

Table 6: Major clinical signs in cows affected with ketosis

No	Temp (°F)	Pulse rate	Respiratory rate	Ruminal movement/2min	Breath smell	Rothera's test Urine	Rothera's test Milk	Strip test Urine
1	103	66	22	2	_	++++	++	++
2	98	70	18	1	_	+++	+	++
3	101.5	72	20	1	+	++	+	++
4	104	66	19	2	_	++	+	+
5	103	60	21	2	_	++	++	+++
6	102	62	24	2	_	+++	+	++
7	103	56	20	1	_	+++	++	++
8	102	62	21	1	_	++	+	+
9	100	64	18	2	_	++++	++	++
10	99	50	21	2	_	++	+	++
11	102	56	24	1	_	++	+	+
12	101	60	19	3	+	+++	++	+++
13	101	74	22	1	_	++	+	+
14	98	66	19	1	_	++	+	++
15	103	74	20	2	+	++++	++	+
16	101.5	56	19	1	_	+	+	++
17	102	60	21	2	_	+++	+	+

No colour +slightly purple ++moderately purple +++ black purple ++++ dark purple

varied from 5 to 9 years old. The lactation stage of the cow also varied from 1-5 months. Lactation number of the cow varied from 1-4 (Table 5). The reduction in milk yield among the affected cows varied from 18.18 to 40%. The percentage of milk yield could restoration 4 days post treatment was calculated. The percentage of milk restored in Dextrose administered cows ranged from 85 to 100%; dextrose plus dexametasone group it was 94-100%; in dexametasone group it was 86-100% and propylene glycol group it was 60 -100%. However, dextrose treated cows responded well within 12 h of administration.

Physical findings such as body temperature, respiration and pulse rates of affected cows were within the normal range. However, rumen motility was decreased; faeces were scanty, dry and mucus coated in most of the cases. The cows appeared dull and depressed with a smell of acetone in the breath, urine and fresh milk (Table 6). Rothera's test results of urine and milk samples showed a color reaction varied from no colour (-), slightly purple (+), moderately purple (++), black-purple (+++) and dark -purple (++++) in the cases of ketosis. Strip test results for the quantitative estimation of urine showed buff pink, pink and maroon color which indicated acetoacetate levels of 5-10, 10-50 and 50-100 mg/dL, respectively.

DISCUSSION

Ketosis (Acetonemia) of dairy cattle is a metabolic disorder which may appear as a primary disease or in association with other pathological conditions. It is not unreasonable to view the disease as an extreme degree of a metabolic state which at lower levels is a constant or at least common occurrence in high milk producing cows in the post calving period. This is because of all high yielding cows in early lactation are in a negative energy balance and some may be sub clinically ketotic. In late pregnancy and early lactation it is common for negative energy balance to occur, which results in ketosis. The excessive body weight condition at calving is another predisposing factor. The excess body weight depresses appetite, increases mobilization of body fat, fat accumulation in the liver and the rate of ketone body production. Inadequate feed intake after calving contributes to ketosis. If sufficient energy intake was possible for high producing cows, they would have minimized mobilization of body fat and would have met the glucose requirements from normal feed intake (Bendixen *et al*., 1987).

In Ethiopia the study of epidemiology, pathogenesis, clinical pathology, diagnosis and treatment of ketosis in cows have not been well documented and the literature on ketosis is still insufficient. In the present study the over all prevalence was recorded from four different dairy farms from November 2008 to March 2009. The highest prevalence of ketosis was recorded in the month of January. This indicates that ketosis occurred mostly during the winter season as the animals are usually housed and there is scarce of pasture. Blood *et al*. (1983) also reported that ketosis occurs mainly in animals housed during the winter months although it is seen occasionally in animals at pasture.

The occurrence of ketosis was found to be highest in 8-9 years old cows. As the age increases with relation to lactation number, ketosis is reported to be more prevalent in the fourth lactation. This could be contributed due to progressive negative energy balance expected in higher age groups. The present observation with regard to lactation stage higher number of cows in 1^{st} month post partum was followed by 2^{nd} 3^{rd} 4^{th} and 5^{th} month. Many researchers have noted that immediate post parturient period was a greater risk and most cases ketosis occured in the first 6 weeks following calving (Kauppinen, 1983; Anderson and Emanuelson, 1985; Dahoo and Martin, 1984). Similarly it was reported that ketosis occured in immediate post parturient period with 90% of cases occurring in the first 60 days of lactation (Kelly and Whitaker, 1984). In another study highest prevalence was recorded during the third and fourth weeks of lactation in closely confined stabled dairy cows that are improperly fed and conditioned during the dry period and early lactation (Aiello, 1998).

Cows of any age may be affected but the disease appeared commonly in later lactation. Radostists *et al*. (2000) stated that cows of any age may be affected but the disease increases from a low prevalence at the first calving and peak at the fourth as observed in the present study. Ketosis is most commonly seen as a gradual loss of appetite and decrease in milk production over several days. Loss of appetite first characterized by concentrate refusal, followed by silage and then by refusal of hay. As feed intake decreases, weight is lost rapidly and milk production drops. During early lactation, reduction in milk production lags behind the reduction in energy intake. Physical findings include normal vital signs, firm and dry feces, moderate depression and some times reluctance to move (Radostists *et al*., 2000).

The temperature, pulse and respiratory rates are normal and although the ruminal movements may be decreased in amplitude and number they are with normal range unless the course is long duration when they may virtually disappear. A characteristic odour of ketone is detectable in breath and often in the milk (Blood *et al*., 1983). Milk production of ketotic cow was decreased. This may be due to heavy drainage of lactose through milk to meet the demand of heavy lactation and depends on endogenous nutrients store and so the milk yield becomes decreased. Anderson and Lundstrom (1985) suggested that the increase of ketone bodies in blood may cause a decrease in milk yield. Similar clinical observations was recorded in this study.

Rothera's test in the present study showed the development of very slightly purple, slightly purple, moderate purple, dark-purple and black purple color with increasing ketone bodies in the urine. These findings corroborates with the earlier reports (Fox, 1971; Henery, 1975). The strip test results showed

various colors ranging from buff-pink, moderate pink, pink and maroon color corresponding to quantities of 1-5, 5-10, 10-50 and 50 above mg/dL of acetoacetic acid present in the urine respectively. According to Radostists *et al*. (2000) clinical ketosis always showed a pink to maroon color which was a strong reaction.

Even though, effective treatments are available for cattle, only rational treatment is to relieve the need for glucose formation from tissue, allow ketone bodies utilization to continue normally and maintain adequate dietary energy levels to prevent relapse. The cows administered with dextrose 50%, dextrose 25% plus dexamethasone, propylene glycol and dexamethasone responded well after 4 day post treatment. It may be due disappearance of ketone bodies and also the improvement of sequential clinical signs. Among the different treatment dextrose 50% administered cows restore their original milk yield within 12 h. Banerjee (1992) stated that intravenous injection of 100-500 mL of 50% dextrose gave a marked clinical improvement. A single treatment of dexamethasone (10 mg/kg) for 3 ketotic cows significantly increased blood glucose for 6-9 days and increased milk production for 1-7 days (Foster, 1988). In the present study five cases of ketosis were treated by propylene glycol at the rate of 225 g twice day for 2 days, followed by 110 g/day for 2 days proved to be effective. Radostists *et al*. (2000) also reported that similar doses of propylene glycol can be effective when administered as a drench. Propylene glycol is absorbed directly from the rumen and acts to reduce ketogenesis by increasing mitochondrial citrate concentrations, its metabolism to glucose occur via conversion to pyruvate with subsequent production of oxaloacetate via pyruvate (Herdit and Emery, 1994).

CONCLUSION

In conclusion, ketosis resulted in reduction of milk production in dairy cows in the study area. The treatment of affected cows with 500 mL of 50% dextrose or 500 mL of 25% dextrose i.v.ly, plus 0.02 mg/kg of dexamethosone through i.m.ly or dexamethosone 0.02 mg/kg either i.m.ly or propylene glycol 225 gm/head twice a day for two days followed by 110 gm/head for two days as a drench restored milk production effectively on day 4 post treatment. The veterinary professionals should give great attention for diagnosis, management and control of this metabolic disease during risk stage.

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