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Metabolic Profile Characteristics and Treatment of Ketosis in Holstein-Friesian Cows in Egypt

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Abstract

Ketosis is a major metabolic disorder of dairy cattle especially in early lactation that can resulted in visible clinical symptoms that typically occurred within the first six to eight weeks post-calving included anorexia, hard dry faeces, rapid loss of condition and decreased milk yield. This study was conducted for evaluation the metabolic profile status and treatment of ketosis in Holstein-Friesian dairy cows in Egypt. A total number of thirty one Holstein-Friesian dairy cows were included in the present study and belonged to Giza and El-Behera governorates. Fifteen cows were apparently healthy while sixteen were suffered from anorexia, wasting, rapid loss of condition, sweet breath odor and decrease in milk yield. Results showed significant ($P \leq 0.001$) decrease in rectal temperature, metabolic profile included serum total protein, globulin and glucose in ketotic cows. Also, there was significant ($P \leq 0.01$) decrease in serum BUN while serum inorganic phosphorus showed mild significant ($P \leq 0.05$) decrease. Treatment was applied to all affected cows and metabolic profile was reassessed after treatment. Results showed significant ($P \leq 0.001$) increase in serum levels of total protein, globulin, and glucose while serum BUN and inorganic phosphorus showed significant increase ($P \leq 0.01$). These data is considered one of few records about the status of metabolic profile test in Holstein-Friesian cows suffered from ketosis in Egypt.

Key words: Ketosis, Holstein-Friesian Cows, Metabolic Profile, Treatment.

Introduction

Ketosis is a major metabolic disorder of dairy cattle especially in early lactation which developed when dairy cows fall into a condition of excessively negative energy balance that caused by insufficient dietary intake and generous lactation **(Melendez et al., 2006).** Support for the view that increase milk yield due to genetic selection in dairy herds had been proposed to enhance the gap between energy expenditure and availability as dairy cows had to fulfill this difference through increase the use of their body reserves **(Friggens et al., 2007)**. Ketosis can be clinical or subclinical according to the subjectivity of the clinical signs **(Bali et al., 2016)**. Clinical ketosis has visible clinical symptoms that typically occurred within the first six to eight weeks post-calving resulting in anorexia, hard dry faeces, rapid loss of condition and decreased milk yield **(Youssef et al., 2010)**. Rapid detection of ketosis through cow-side tests that based on detection of ketones in blood, urine, and milk play a magic role in effectiveness of treatment **(Zhang et al., 2012)**. Metabolic profile status included hemato-biochemical parameters was found to be a useful diagnostic tool for ketosis. In cattle, a number of treatments were available for ketosis but in some cases the response was only transient. Beside the rational treatment, medical one was included intravenous administration of 50% glucose solution followed by an oral drench of propylene glycol (225 gram twice daily for two days) followed by 110 gram daily for two days. Also, the use of glucocorticoids in treatment had been amply demonstrated in field cases **(Asrat et al., 2013)**. The present study was conducted to study the metabolic profile status and establishment of treatment for ketosis in Holstein-Friesian dairy cows in Egypt.

Material and Methods

A total number of thirty one Holstein-Friesian dairy cows, four to six weeks after calving were included in the present study

that was undertaken for seven months. All the animals were examined according to the guidelines approved by faculty of veterinary medicine, Cairo University, Egypt and belonged to Giza and El-Behera governorates. From the total number, fifteen cows were apparently healthy and fed on concentrate mixture and roughage while sixteen cows were suffered from anorexia, wasting, rapid loss of condition, sweet breath odor and decrease in milk yield. By the history, later group was kept on low quality and quantity feed. Full detailed history and clinical examination was performed on each cow **(Radostitis et al., 2007)**. Diagnosis was based on cow-side rapid detection Modified Rothera's test for positive detection of ketotic cows **(Asrat et al., 2013)** and multidiagnostic strip reaction supplied by Yercon Co., Ltd., Changchun, China according to manufacturer instruction. Two blood samples were taken from jagular vein of each cow; the first one was about 2 cm that was taken with anticoagulant (EDTA) for estimation of hemoglobin concentration, PCV, RBCs count, MCV, MCH, and MCHC **(Feldman et al., 2000)**. The other blood sample was about 7 cm without anticoagulant and serum was separated **(Kaneko et al., 2008)** and used for estimation of total protein **(Kaplan and Szalbo 1983)**, albumin **(Tietz, 1990)**, globulin, glucose **(Zilva and Pannall, 1979)**, BUN **(Tietz, 1990)**, triglycerides **(Stein, 1987)**, total cholesterol **(Roeschlau et al., 1974)**, calcium **(Young, 1990)**, inorganic phosphorus **(Daly and Ertingshausen, 1972)**, magnesium **(Thomas, 1998)**, sodium **(Henry et al., 1974)** and potassium **(Hoeflmayr, 1979)** according to specific test kits produced by Spectrum diagnostics, MDSS, GmbH, Hannover, Germany. Fecal analysis was applied to each cow for exclusion of parasitic infestation **(Solusby, 1982)**. All diseased cases were treated using the regimen of 500 ml glucose 25% (I.V.) plus 0.05 mg/kg dexamethasone 2 mg/ml (I.M.) for each cow followed by an oral drench of propylene glycol (225 gm/head/twice per day for two successive days) followed by 110 gm/head/once per day for three successive days. The obtained data were analyzed statistically by using SPSS program version 16 **(Levesque, 2007)**.

Results

The present study was applied on thirty one Holstein-Friesian dairy cows, four to six weeks post calving. Sixteen cows had a recorded signs of anorexia, wasting, rapid loss of condition, sweet breathing odor and decrease in milk yield (fig. 1) and possessed a positive result through modified Rothera's test and urine strip test. Concerning physical examination (table 1) (fig. 2). Results showed significant ($P \leq 0.001$) decrease of rectal temperature in ketotic cows (38.2±0.05 ˚C) compared to control healthy cows (38.6±0.03 ˚C). Respiration and pulse rates showed non-significant changes in comparison to control group.

Regarding metabolic profile status, results of hematological examination were showed in table (1), (fig. 3). There were non-significant changes in ketotic and apparently healthy cows. Non-significant decrease of hemoglobin concentration was recorded in ketotic cows (9.1±0.25 g/dl) in comparison to healthy cows (9.62±0.32 g/dl).

Results of serum biochemical parameters were showed in table (1) (fig. 4). A high significant ($P \leq 0.001$) decrease was recorded for total protein (g/dl), globulin (g/dl) and glucose (mg/dl) in ketotic cows (5.82±0.14), (2.6±0.15) and (31.8±1.08) respectively in comparison to control healthy cows (7.1±0.22), (3.89±0.16) and (52.8±1.57) respectively. For BUN, significant decrease ($P \leq 0.01$) was recorded in ketotic cows (33.3±2.45 mg/dl) when evaluated toward control healthy cows (43.5±1.46 mg/dl). Also, serum inorganic phosphorus (mg/dl)

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showed mild significant (P≤0.05) decrease in ketotic cows (6.16±0.12) toward healthy cows (6.8±0.26). Other biochemical parameters showed non-significant changes between ketotic cows and healthy ones.

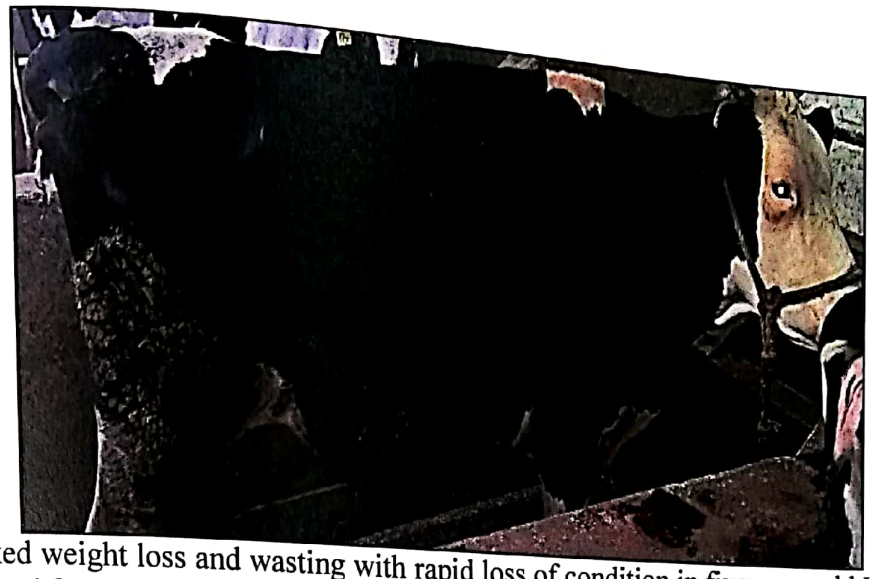

Figure 1. Marked weight loss and wasting with rapid loss of condition in five years old Holstein-Friesian dairy cow suffered from ketosis.

Table 1. Clinico-hematobiochemical alterations in Holstein-Friesian dairy cows suffered from ketosis compared with apparently healthy cows.

	Parameter	Cows suffered from ketosis	Apparently healthy cows
Clinical examination	Respiration (time/min)	22.9 ± 0.60	22 ± 0.67
	Pulse (Pulse/min)	63.8 ± 1.91	60 ± 1.47
	Rectal temperature (°C)	38.2 ± 0.05[a]	38.6 ± 0.03
Hematological parameters	Hemoglobin (g/dl)	9.1 ± 0.25	9.62 ± 0.32
	PCV (%)	29.1 ± 0.93	29 ± 1.04
	RBCs (X^6/µl)	6.26 ± 0.19	6.2 ± 0.21
	MCV (fl)	46.3 ± 0.19	46.1 ± 0.20
	MCH (pg)	15.3 ± 0.03	15.3 ± 0.04
	MCHC (%)	33 ± 0.18	33.1 ± 0.18
Biochemical parameters	Total protein (g/dl)	5.82 ± 0.14[a]	7.1 ± 0.22
	Albumin (g/dl)	3.0 ± 0.14	3.1 ± 0.12
	Globulin (g/dl)	2.6 ± 0.15[a]	3.89 ± 0.16
	Glucose (mg/dl)	31.8 ± 1.08[a]	52.8 ± 1.57
	BUN (mg/dl)	33.3 ± 2.45[b]	43.5 ± 1.46
	Triglycerides (mg/dl)	8.47 ± 0.57	9 ± 0.63
	Total cholesterol (mg/dl)	146.8 ± 2.6	147.6 ± 4.71
	Calcium (mg/dl)	10.3 ± 0.25	10.7 ± 0.43
	Inorganic phosphorus (mg/dl)	6.16 ± 0.12[c]	6.8 ± 0.26
	Magnesium (mg/dl)	2.34 ± 0.23	2.1 ± 0.12
	Sodium (mmol/l)	157.6 ± 2.14	154.6 ± 2.76
	Potassium (mmol/l)	3.9 ± 0.16	4.2 ± 0.15

a: P≤0.001 b:P≤0.01 c:P≤0.05

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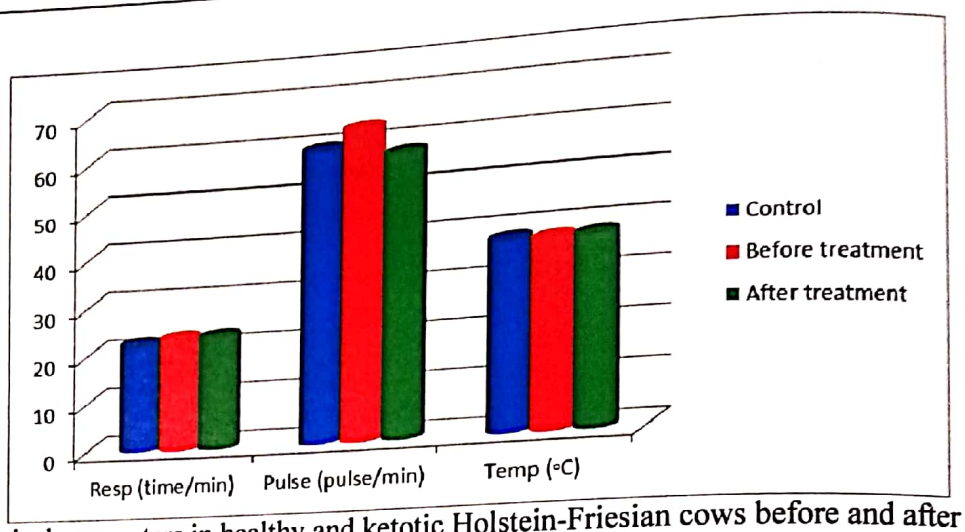

Figure 2. Physical parameters in healthy and ketotic Holstein-Friesian cows before and after treatment.

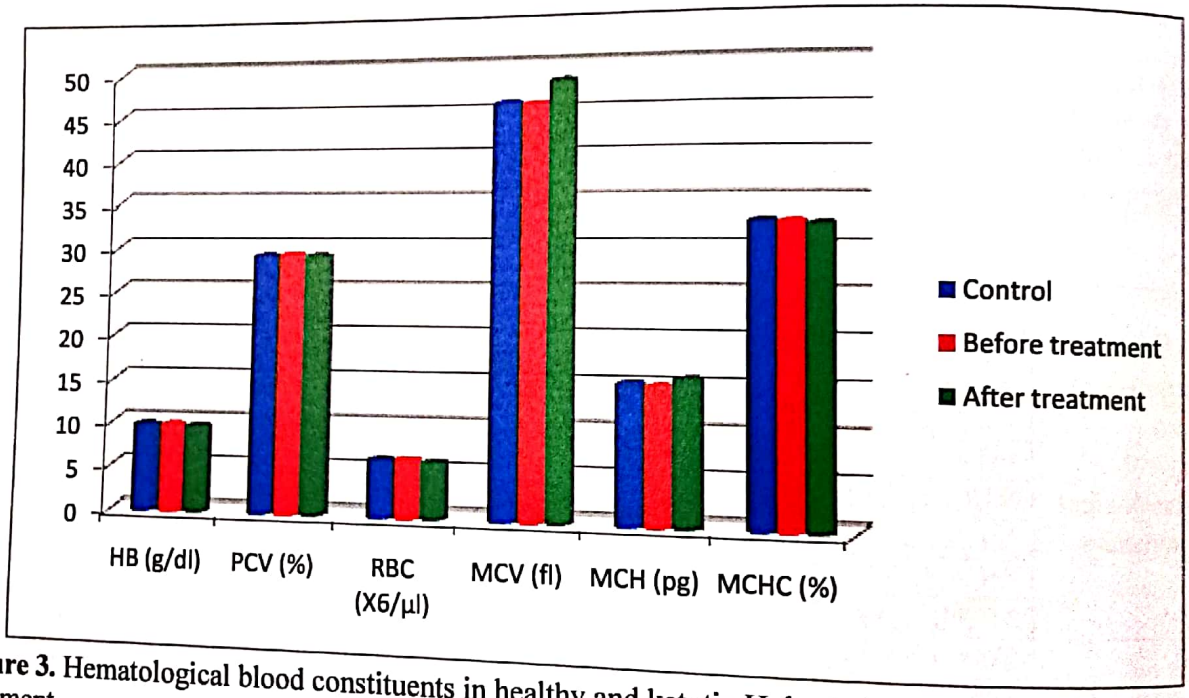

Figure 3. Hematological blood constituents in healthy and ketotic Holstein-Friesian cows before and after treatment.

Regarding the treated cases, results of modified Rothera's test and urine strip test showed very mild reaction in five cases while both tests showed negative results in eleven cases after five successive days of treatment. Concerning physical examination and hematological parameters, results showed non-significant changes before and after treatment (table 2) (fig. 2&3). General improvement of biochemical status in ketotic cows after treatment was recorded included high-significant ($P \leq 0.001$) increase of total protein (g/dl), globulin (g/dl) and glucose (mg/dl) after treatment (6.8±0.13), (3.52±0.08) and (45±1.06) respectively in comparison to the status before treatment (5.82±0.14), (2.6±0.15) and (31.8±1.08) respectively. Significant ($P \leq 0.01$) increase of serum BUN (mg/dl) and inorganic phosphorus (mg/dl) was recorded in treated cows (table 2) (fig. 4). The recorded results were (40.04±1.80) and (6.61±0.08)

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respectively in comparison to status before treatment (33.3±2.45) and (6.1±0.12) respectively. Other parameters showed non-significant changes before and after treatment.

Table 2. Clinico-hematobiochemical parameters in Holstein-Friesian dairy cows suffered from ketosis and after five days of treatment.

	Parameter	Before treatment	After five days of treatment
Clinical examination	Respiration (time/min)	22.9 ± 0.60	23 ± 0.54
	Pulse (Pulse/min)	63.8 ± 1.91	58.3 ± 1.56
	Rectal temperature (°C)	38.2 ± 0.05	38.5 ± 0.03
Hematological parameters	Hemoglobin (g/dl)	9.1 ± 0.25	9.53 ± 0.2
	PCV (%)	29.1 ± 0.93	29 ± 0.41
	RBCs (X^6/µl)	6.26 ± 0.19	6 ± 0.10
	MCV (fl)	46.3 ± 0.19	48.6 ± 1.16
	MCH (pg)	15.3 ± 0.03	15.9 ± 2.06
	MCHC (%)	33 ± 0.18	32.8 ± 0.82
Biochemical parameters	Total protein (g/dl)	5.82 ± 0.14	6.8 ± 0.13[a]
	Albumin (g/dl)	3.0 ± 0.14	3.27 ± 0.06
	Globulin (g/dl)	2.6 ± 0.15	3.52 ± 0.08[a]
	Glucose (mg/dl)	31.8 ± 1.08	45 ± 1.06[a]
	BUN (mg/dl)	33.3 ± 2.45	40.04 ± 1.80[b]
	Triglycerides (mg/dl)	8.47 ± 0.57	8.59 ± 0.44
	Total cholesterol (mg/dl)	146.8 ± 2.6	149.5 ± 2.05
	Calcium (mg/dl)	10.3 ± 0.25	10.57 ± 0.19
	Inorganic phosphorus (mg/dl)	6.16 ± 0.12	6.61 ± 0.08[b]
	Magnesium (mg/dl)	2.34 ± 0.23	2.14 ± 0.03
	Sodium (mmol/l)	157.6 ± 2.14	156 ± 1.50
	Potassium (mmol/l)	3.9 ± 0.16	4.33 ± 0.06

a: P≤0.001 b:P≤0.01 c:P≤0.05

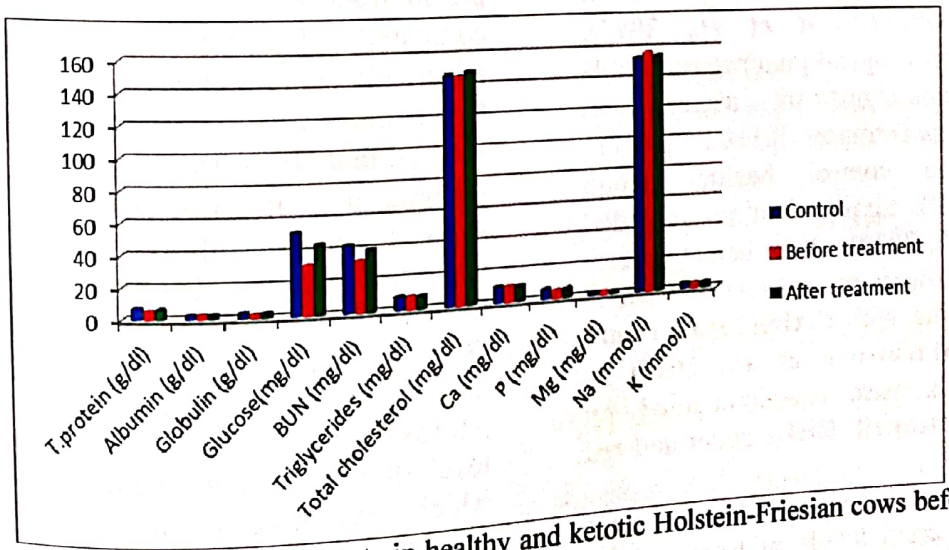

Figure 4. Serum biochemical constituents in healthy and ketotic Holstein-Friesian cows before and after treatment.

Discussion

Bovine ketosis is a major metabolic disorder that may appear as primary disorder or in association with other disease conditions. The aim of the present study is to evaluate

the alterations of metabolic profile of Holstein-Friesian dairy cows suffered from ketosis and changes of this profile after treatment. Transition dairy cows experience the highest risk for production of such disorder **(Mulligan and Doherty, 2008)**. Rapid detection of ketone bodies in urine and milk is an effective diagnostic tool for ketosis that potentiates the effectiveness of treatment. Modified Rothera's test in the present study showed the development of purple color as a result of the reaction of ketone bodies in urine and sodium nitroprusside. These findings were similar that of **(Henery, 1975)**. The urine strip test showed pink to maroon color indicating positive reaction for ketosis matching the records of **(Radostitis et al., 2000)**. Physical findings revealed that respiration and pulse rates of the affected cows were within the normal ranges while rectal temperature revealed significant ($P\leq0.001$) decrease. This may be due to severe hypoglycemia, weakness, and anorexia. Also, wasting, scanty faeces, depression with smell of acetone in the breath and urine were the most recorded signs. These findings were in consistence with **(Asrat et al., 2013)**. Regarding hematological parameters, results showed a non-significant decrease in hemoglobin concentration (9.1±0.25 g/dl) in comparison to control healthy group (9.62±0.32 g/dl). Similar findings recorded by **(Belić et al., 2010)**. Other hematological parameters showed no differences which come in the line with **(Sahinduran et al., 2010)** and **(Marutsova et al., 2015)** as clinical ketosis wasn't accompanied by changes in hematocrit, RBCs count and red cell indices.

In the present study, a significant decrease ($P\leq0.001$) in serum levels of total protein, globulin and glucose was recorded in comparison with apparently healthy group (table 1). Reduction of total protein and globulin beside the non-significant decrease of serum albumin was an indicator for hepatic overload as the liver was directed the protein pool of the body for production of energy in case of ketosis. Similar records were recorded by **(Youssef et al., 2010)**. Severe hypoglycemia can be explained by the response to low energy diet and generous utilization of glucose in mammary gland **(Nazifi et al., 2008)** and **(Youssef et al., 2010)**. The present work also revealed a significant ($P\leq0.01$) decrease in the serum level of BUN when compared with apparently healthy group (table 1). Support the view that hepatic injury and decrease the ability of liver to excrete urea, breakdown of tissue proteins beside low dietary protein played a magic role for such decrease. Significantly ($P\leq0.05$) lower level of serum inorganic phosphorus was observed in ketotic Holstein-Friesian dairy cows (table 1). The decrease was agreed with the findings of **(Ziogas et al., 2007)** and **(Youssef et al., 2010)** as urinary excretion of phosphorus due to hyperparathyroidism resulted as a response to lower calcium level and anorexia. Other members of metabolic profile tests showed non-significant changes compared with the metabolic profile of apparently healthy cows.

Concerning treatment, the present study showed that cows treated with glucose 25% restored their condition within 24 hours and showed clinical improvement. This result was near that of **(Banerjee, 1992)** and **(Asrat et al., 2013)**. Single injection of dexamethasone (0.05 mg/kg) beside an oral drench of propylene glycol has a significant improvement ($P\leq0.001$) of serum glucose level after five successive days of treatment which come in consistence with **(Radostitis et al., 2000)**. Adjustment of ration composition beside the medical treatment shared in correction of the serum levels of total protein and globulins which showed significant increase ($P\leq0.001$) compared with non-treated group. Serum levels of

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BUN and inorganic phosphorus showed significant ($P \leq 0.01$) increase in treated cows (table 2) reflecting the general improvement of liver to produce urea and subside down of the effect of hyperparathyroidism.

Conclusion

In conclusion, metabolic profile test of ketotic Holstein-Friesian cows showed marked decrease in serum total protein, globulin, glucose, BUN, and inorganic phosphorus while there were no changes in hematological parameters. treatment using the regimen of 500 ml glucose 25% (I.V.) plus 0.05 mg/kg dexamethasone 2 mg/ml (I.M.) for each cow followed by an oral drench of propylene glycol (225 gm/head/twice per day for two successive days) followed by 110 gm/head/once per day for three successive days was effective and metabolic profile evaluation after treatment showed marked improvement of serum level of total protein, globulin, glucose, BUN, and inorganic phosphorus. The veterinary practitioners must give attention for all diagnosis steps of ketosis and alterations occurred in metabolic profile members before and after treatment.

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الملخص العربى

"خصائص اختبار الأيض وعلاج التخلون في الأبقار الهولشتاين فريزيان في مصر"

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يعتبر التخلون واحدا من الاضطرابات الرئيسية للتمثيل الغذائي لماشية انتاج الألبان وخاصة في أول فترة الرضاعة والذي يمكن أن يحدث في غضون ستة إلى ثمانية أسابيع الأولى ما بعد الولادة. يسبب التخلون أيضا أعراض سريرية واضحة مثل فقدان الشهية وامساك وفقدان سريع للحالة العامة وانخفاض إنتاج الحليب. أجريت هذه الدراسة لتقييم وضع اختبار الأيض وعلاج التخلون في الأبقار الحلوب الهولشتاين فريزيان في مصر وقد شملت الدراسة عدد واحد وثلاثين بقرة حلوب هولشتاين فريزيان والتي تنتمي إلى محافظتي الجيزة والبحيرة واشتمل العدد على خمسة عشر بقرة سليمة ظاهريا بينما عانت ستة عشر منها من فقدان الشهية والهزال وفقدان سريع للحالة العامة ورائحة عطرية للفم وانخفاض في إنتاج الحليب. وأظهرت النتائج انخفاض معنوي ملحوظ ($P\leq0.001$) في درجة حرارة الجسم ومحتويات اختبار الأيض والتي شملت كل من البروتين الكلي والجلوبيولين والجلوكوز في مصل دم الأبقار المصابة مقارنة بالأبقار السليمة. أيضا كان هناك نقص معنوي ($P\leq0.01$) في مستوى اليوريا في حين أظهر الفسفور الغيرعضوي في مصل الدم انخفاض معنوي طفيف ($P\leq0.05$). تم تطبيق برنامج العلاج لجميع الأبقار المصابة وإعادة تقييم اختبار الأيض بعد خمسة أيام من العلاج وأظهرت النتائج زيادة معنوية ملحوظة ($P\leq0.001$) في مستويات البروتين الكلي والجلوبيولين، والجلوكوز في مصل دم الأبقار المعالجة في حين أظهرمستوى اليوريا والفوسفور الغيرعضوي زيادة معنوية ($P\leq0.01$). وتعتبر هذه الدراسة واحدة من الدراسات القليلة التي تناولت حالة اختبار الأيض في الأبقار هولشتاين فريزيان والتي تعاني من التخلون في مصر.

الكلمات الدالة: التخلون ، الأبقار الهولشتاين فريزيان ، اختبار الأيض ، العلاج.