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Prevalence and Potential Risk Factors Associated With Ketosis in Dairy Farms in Egypt

Key words

dairy cow;
ketosis;
risk factors;
BHBA

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Abstract: Ketosis is an energy-related metabolic disease that primarily occurs during the early lactation period in dairy cattle. Ketosis adversely affects production, animal health, and reproduction. The present study determines the prevalence and risk factors associated with ketosis in dairy cattle during early lactation in Egypt. A total of 1179 dairy cows from 37 dairy farms were screened for ketosis using a semi-quantitative cow-side milk strip test. A questionnaire was constructed to include the hypothesized risk factors. Risk factors were assessed on both the cow and herd levels using logistic regression model. The findings showed that the prevalence of ketosis was 6.35% (75/1179 cases). On the cow level, the final logistic regression model revealed a significant association between ketosis and parity ≥4 (P= 0.040, OR: 1.74, CI 95%: 1.025–2.95), cows with a dry period length ≥ 65 days (P =0.02, OR: 1.88, CI 95%: 1.1–3.18), calving season (P=0.037, OR: 1.73, CI 95%: 1.03–2.89), BCS>3.5 (P= 0.010, OR: 2.03, CI 95%: 1.19–3.47), milk yield ≥25L/day (P= 0.033, OR 2.04, CI 95%: 1.06-3.92), dystocia (P< 0.001; OR: 3.18, CI 95%: 1.75–5.77), retained placenta (P= 0.006, OR: 2.85, CI 95%: 1.35-6.032), and displaced abomasum (P< 0.001, OR: 26.28; CI 95%: 7.20–95.90). On the herd level, there was an association between ketosis and insufficient prepartum feeding of a total mixed ration (P= 0. 021, OR: 6.29, CI 95%: 1.325–29.86), and in herds deficient-lactation supplementation propylene glycol (P= 0.047, OR: 4.86, CI 95%: 1.020–23.19). In conclusion, ketosis is an existing problem in dairy farms in Egypt; therefore, identification of risk factors may provide a useful approach for the prevention and control such metabolic problems.

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Introduction

Ketosis is a metabolic disease in dairy cattle defined by high concentrations of ketone bodies in body fluids. Ketosis occurs mainly near peak milk production (1), but ketosis has also been documented in late pregnancy (2). The differences in energy requirements for milk production and energy intake due to reduced feed intake during the transition period result in a negative energy balance state (3). Fat mobilization occurs in response to increased energy demands and concomitant deficiency in blood glucose, resulting in high ketones production in the liver (4). These ketone bodies, including acetone, acetoacetate, and beta-hydroxybutyrate are utilized peripherally as an energy source (5). A blood serum concentration of BHB ≥1.2 mmol/L (6) and ketosis thresholds of 100 μmol/L milk BHB using point-of-care meter indicate a positive case for ketosis (7)

In dairy cows, ketosis may appear either in clinical or subclinical form (8). Decreased milk production and increased risk for other diseases are the main economic losses due to ketosis (9), but bodyweight loss, culling, and increased mortality are additional implications (10).

The detection of ketone bodies in serum, urine, or milk is used to diagnose ketosis (11). Several techniques have been employed to measure the concentration of ketone bodies in blood, urine, or milk in order to diagnose bovine ketosis (12). As BHB is the standard indicator of ketosis in ruminants and is more stable than other ketone bodies, colorimetric detection of blood BHB using an ultraviolet spectrometer is the gold standard method for detecting ketosis (13). Fourier Transform Infrared (FTIR) Spectrometry is used also for measurement of milk ketone bodies (14). This method is fast, inexpensive, and easy to implement on a large scale (15). Fluorometric detection of BHBA levels in milk and blood was recommended by Larsen(16) because it produces results that are closely correlated with those of the standard spectrophotometric method, are not affected by blood sample hemolysis, and do not require the preparation of whole milk samples. Gas liquid chromatography can also be used for diagnostic purposes (17). Recently, metabolomics analysis using nuclear magnetic resonance (NMR) spectroscopy mass spectrometry (MS) has been introduced for diagnosis of different blood metabolite associated with ketosis (18). Cow-side tests, a field technique has been developed to provide rapid evaluation and overcome the cost of other diagnostic tests (1). PortaBHB is a semi-quantitative cow-side test that may be used for screening cows for ketosis by measuring BHBA in milk (19).

Several studies have highlighted the association between ketosis and other diseases, including displacement of abomasum, which is strongly associated with ketosis (20). In addition, mastitis (21), and metritis (22) are more likely to occur in ketotic cows. Ketotic cows' reproductive performance was hindered since their conception rate was lower than that of non-ketotic cows (23). Several animal risk factors for ketosis of which a higher dairy cow body condition score (BCS) at calving (24, 25), and increased parity (26) have been identified.

Clinical and biochemical investigation on subclinical and clinical ketosis have been conducted in dairy cows (27, 28) and buffalo (29, 30). In addition, limited trials on treatment of ketosis in dairy cattle has been presented (31) However, to the best of the authors knowledge, studies on risk factors associated with ketosis in Holstein dairy cows are scarce. Therefore, the objective of this study was to determine the prevalence and the associated risk factors of ketosis at both cow and farm levels in Egypt.

Materials and methods

Study area

The present study was carried out at the middle and northeastern Delta region of River Nile, Egypt. Eight main governorates namely Qalyubia, Dakahlia, Menofia, Gharbia, Ismailia, Al Sharqia, Damietta, and Kafr Elsheikh) were included in this study. According to the Köppen-Geiger climate classification (32), the climate of these governorates is a hot desert climate (Figure 1).

Figure 1: Study area (7 governorates) for prevalence of ketosis in dairy cows in Egypt. The red dots are sampling locations

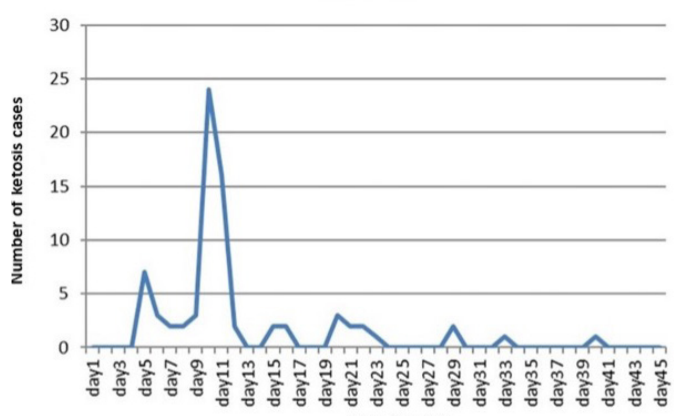

Figure 2: Frequency of ketosis cases across the first 42 days after parturition

Study Animals

The present study has been approved by Mansoura university Animal Care and use committee (MU-ACUC:VM.R.23.01.43).. Firstly, farms from the basic geographic and administrative units in the Delta region were visited. Owners were asked to participate in the study and to give consent and thirty-seven owners out of 93 (39.8%) accepted to be enrolled in the study. In farms under investigation, all parturient cows at risk of ketosis during 42 days after parturition are included in the study (1,179 cows). All the dairy farms that participated in this survey had Holstein-Friesian cows in free-stall barns. The cows were 3-9 years of age with a mean body weight of 575 ± 78 kgm. Each farm was sampled once, and all cows were screened during 42 days after parturition. A questionnaire was constructed to explore the hypothesized risk factors based on previous studies (33). The questionnaire included data concerning each cow and the farming system. Risk factors on both cow and herd level were proposed (Table 1). On the cow level, the hypothesized risk factors were parity, dry period length, BCS at parturition (34), the season of parturition, calving assistance, milk yield, and post-parturient diseases (dystocia, retained placenta, metritis, lameness, displaced abomasum, and clinical mastitis) (Table 2). However, on the herd level, the hypothesized risk factors were herd size, amount of prepartum total mixed ration, and lactation supplementation with glucose precursors.

Samples and test for BHBA in Milk

A composite milk sample was collected from each cow participating in this study AM. To quantify β- hydroxyl butyric acid (BHBA) in milk, a semi-quantitative cow-side milk strip test (PortaBHBTM, PortaCheck, USA) was used. Each milk sample was tested by dipping a Porta BHBTM milk strip into it. The results were read after one minute by comparing the color of the test strip to the color chart on the test bottle. The values of the color charts indicated 0, 50, 100, 200, and 500 μmol /L based on the color density. The positive cows for ketosis were identified at a level of 200 μmol of BHBA/L.

Statistical Analysis

For statistical analysis, SPSS, commercial statistical software, was used (SPSS for Windows, version 16.0, SPSS Inc, USA). First, descriptive statistics and the distribution of risk factors for cases of ketosis were performed. At animal levels, the logistic regression analysis was conducted to test the association between ketosis and the possible risk factors. In an initial step, univariate logistic regression statistics were conducted. In such a process, the category of the cattle (ketotic or non-ketotic) was the dependent dichotomous variable, but the proposed risk factors were the independent variables. Then, independent factors with a significant association (P<0.1) were included in the multivariate backward stepwise logistic regression analysis. The goodness of the fit statistical test greater than 0.05, was used by Hosmer and Lemeshow to suggest that the results of the model match the data in the multivariate analysis were at an appropriate level. The regression coefficient (β), odds ratio (OR), confidence interval (CI: 95%), standard error, and P value were the parameters in the results for each variable. Results were considered significant at P< 0.05 in every statistical analysis.

Results

The prevalence of ketosis in cows under investigation was 6.35% (75/1179) using the PortaBHB milk ketone test at a cut-off point of 200 μmol of BHBA /L (Figure 2). The herd prevalence of ketosis varied from 0 to 11.55%. Most ketosis cases (65.3%) were observed during the second postpartum week, whereas the remaining instances (16%) and (18.7%) were observed during the first and other weeks, respectively.

Table 2 and 3 show the descriptive statistics and the results of univariate analysis of factors associated with ketosis. On cow level, univariate statistical analysis showed a significant association between ketosis and parity ≥ 4 (P =0.017, OR: 1.82, CI 95%: 1.11–2.0 97). Where cows with parity 1 was (35.96%), parity 2 (20.36%); parity 3 (19.25%), and parity≥ 4 was (24.43) %. A significant association was also recorded between ketosis and cows with a dry period length ≥ 65 days (P=0.019, OR: 1.8, CI 95%: 1.1–2. 9). Thus, 75.07 % of cows had a dry period length < 65 days, whereas 24.93% of the cows had a dry period length ≥ 65 days. Cows with BCS >3.5 are significantly associated with ketosis (P=0.001, OR: 2.25, CI 95%: 1. 37–3. 68). Where, cows with BCS of ≤ 3.5 represented 78.97% and those with a high BCS > 3.5 represented 21. 03%. Calving in winter season was significantly associated with high prevalence of ketosis (P= 0.013, OR: 1.84, CI 95%: 1.14-2.96). Thus, 28.6 % of dairy cows calved in winter, 36.64 % of cows calved in autumn, 19.92 % of cows calved in summer, and 14.84 % of cows calved in spring. Regarding the milk yield, ketosis was prevalent in cows with milk yield ≥25 kg (P= 0.012, OR: 2.24, CI 95%: 1.20–4.2). Cows with a milk yield ≥ 25 kg/day represented 71% and cows with < 25 kg/day represented 29%. Concerning postpartum events, a significant association between ketosis and the following disorders was documented: dystocia (P<0.001; OR: 2.92, CI: 1.68–5.08), retained placenta (P= 0.001; OR: 3.1, CI 95%: 1.6-6.03), displaced abomasum (P< 0.001; OR: 37.5, CI 95%: 11.25–124.97). Where calving assistance was required for (11.37%) of cows. Placenta was retained in (6.45%) of cows. Moreover, the most frequently identified postpartum disorders were clinical mastitis (21.9%), lameness (7.12%), metritis (3.81%), and left displaced abomasum (1.1%). However, metritis, mastitis, and lameness showed non-significant associations.

Multivariate logistic regression model revealed a significant association between ketosis and parity≥4 (P= 0.040; OR: 1.74; CI 95%: 1.025–2.95), calving in winter season (P=0.037;OR: 1.73, CI 95%: 1.033–2.89), BCS>3.5 (P= 0.010, OR: 2.03; CI 95%: 1.19–3.47), milk yield ≥25L/day (P= 0.033, OR: 2.04, CI 95%: 1.06-3.92), dystocia (P< 0.001; OR: 3.18, CI 95%: 1.75-5.77), retained placenta (P= 0.006; OR: 2.85, CI 95%: 1.35-6.032), and displaced abomasum (P< 0.000, OR: 26.28, CI 95%: 7.20-95.90) (Table 4).

On herd level risk factors, risks of ketosis increased in herds fed a prepartum total mixed ration <12 kg/day (P= 0. 021;

Table 1: Description and levels of hypothesized risk factors associated with ketosis in dairy cows

	Risk factors	Level and description
1	Calving Season	According to calving season, categories were winter calving =1, spring calving =2, summer calving =3, and autumn calving =4
2	Cow Parity	cows with parity 1 =1, parity 2 =2, parity 3=3, parity≥4=4
3	Body Condition Score	According to the body condition at calving, dairy cows were categorized into cows with low and moderate BCS ≤3.5 =1, and cows with high BCS > 3.5 =2.
4	Milk Production	According to average daily milk production, cows were categorized into: cows with low milk production<25Kg =1, and cows with high milk production≥ 25kg =2
5	Dry Period Length	According to length of dry period, cows were categorized into: cows with short dry period< 65 days =1, and cows with long dry period ≥65 days =2
6	Dystocia	Cows had dystocia=1, and cows with normal birth =2
7	Retained Placenta	cows with retained placenta=1, and cows without placental retention=2
8	Metritis	Cows were categorized into cows with metritis=1, and cows without metritis=2
9	Left Displaced Abomasum (LDA):	Cows with LDA=1, and cows without LDA=2
10	Mastitis	Cows with clinical mastitis =1, and cows without clinical mastitis=2
11	Lameness	Cows with lameness =1, and cows without lameness=2
1	Herd Size	Small dairy herds with lactating cows <100 =1, and large dairy herds with lactating cows ≥ 100
2	Amount of Prepartum Total Mixed Ration	According to the amount of prepartum, TMR, dairy herds were categorized into: herds receive a sufficient TMR (≥12kg)=1 , and herds did not receive adequate TMR (<12)=2
3	Lactation supplementation with propylene glycol	Herds were supplemented with propylene glycol=1, and herds were not supplemented with propylene glycol=2

OR: 6.29; CI 1.325-29.858), and in the herds with a lack of lactation supplementation with glucose precursors (P= 0.047; OR: 4.86; CI 1.020-23.19) (Table 5-6).

Discussion

Dairy cows are at risk of a period of negative energy balance (NEB) during the transition from late gestation to early lactation, caused by insufficient nutritional intake to fulfill the animal's maintenance and milk production requirements (35). To meet energy demand, dairy cows' body fat is being used for energy and protein for gluconeogenesis, leading to an increase in non-esterified fatty acids (NEFA) and BHBA (36). It has been concluded that the time in which early-lactation dairy cows are at risk for hyperketonemia lasts at least until 42 day in milk (37). The design of the present study fulfills the objectives to determine the prevalence and risk factors of ketosis in dairy cows. It has been stated that the cross-sectional studies are the best choice when the aim of the research is to estimate the prevalence of a characteristic in a specific population, they may also be useful if the aim is to evaluate factors associated with a disease or condition (38). In the present study, the prevalence of ketosis was 6.35% with peak prevalence during the first two weeks of lactation. A higher prevalence was reported in North America (18.8%) (39), Europe 29.3-39% (22, 40), Asia 9.6%-17.9% (41, 42), and Africa 16.9 (22). This finding may be attributed to differences between geographic regions which affect dairy cows' husbandry and farm management. It has been stated that country differences, cultural backgrounds, climate, dairy farming structures, increased milk production and herd size seem to have been considerably associated with dairy farm development (22, 43). Moreover, feeding strategies, genetic variation, and other diseases may also affect the prevalence (44). McArt et al. (45) stated that using the incidence of hyperketonemia has benefits over using its prevalence for the recognition of optimal testing and treatment policies at the herd level.

Many techniques have been used to quantify or semi-quantify ketone bodies in blood, milk, and urine have been used to diagnose bovine ketosis (12), of which the detection of BHBA in serum and plasma is the gold standard test for ketosis since BHBA is the primary ketone body in ruminants and is more stable than other ketones, although this test is costly and time-consuming (46). A variety of cow-side tests are used to screen herds for ketosis in body fluids (blood, milk, and urine). In the present study, PortaBHB milk ketone test, is a simple, non-invasive, and quick field test

Table 2: Categorization of cows as ketotic or non-ketotic with relation to different risk factors

Variable	Ketotic cows		Non- ketotic cows	
	Number (75)	%	Number (1104)	%
Seasons				
Winter:	31	41.3	306	27.72
Autumn:	24	32	408	36.95
Summer:	12	16	223	20.20
Spring:	8	10.7	167	15.13
Parity:				
1:	25	33.33	399	36.1
2:	12	16.00	228	20.7
3:	11	14.67	216	19.6
≥4:	27	36.00	261	23.6
Body condition score:				
≤ 3.5	48	64.00	883	80.00
>3.5	27	36.00	221	20.00
Milk production:				
<25kg	12	16.00	330	29.00
≥25 kg	63	84.00	774	71.00
Long dry period:				
Short < 65	48	64.00	841	76.20
Long ≥ 65	27	36.00	263	23.80
Dystocia:				
Present	19	25.30	115	10.40
Absent	56	74.70	989	89.60
Retained placenta:				
Present	12	16	64	5.80
Absent	63	84	1040	94.20
Metritis:				
Present	02	2.70	43	3.90
Absent	73	97.30	1061	99.80
Lef displaced abomasum:				
Present	09	12	04	.40
Absent	66	88	1100	99.60
Mastitis :				
Present	18	24	240	21.7
Absent	57	76	864	78.3
Lameness:				
Present	8	10.7	76	6.9
Absent	67	89.3	1028	93.1

Table 3: Univariate logistic regression model for animal level risk factors associated with ketosis

Variable	β	S.E.	OR	95.0% C.I. Lower-Upper	*P*
Parity	.59	.251	1.82	1.11-2.097	.017
Dry Period Length	.58	.251	1.8	1.1-2.9	.019
BCS: >3.5	.81	.252	2.25	1.37-3.68	.001
Calving season	.61	.244	1.84	1.14-2.96	.013
Milk Yield ≥25kg/day	.81	.32	2.24	1. 2-4.2	.012
Dystocia	1.07	.28	2.92	1.68 - 5.08	0.001
Retained placenta	1.10	.34	3.1	1.6–6.03	.001
Metritis	-.392	.733	.68	0.16-2.9	.59
Abomasal displacement (LDA)	3.62	.614	37.5	11.25–124.97	0.000
Mastitis	.128	.28	1.14	0.66-1.97	0. 647
Lameness	.479	.392	1.62	0.75–3.5	0.222

β: Regression coefficient; SE: Standard error; OR: Odds ratio; 95% CI: Confidence interval; P: P value

Table 4: Multivariate logistic regression model for animal level risk factors associated with ketosis

Variable	β	S.E.	OR	95.0% C.I. Lower-Upper	*P*
Parity≥4	.553	.269	1.74	1.025–2.95	.040
Calving in the winter season	.546	.262	1.73	1.033-2.89	.037
Dry period length >65 days	.629	.27	1.88	1.1-3.18	.020
BCS>3.5	.707	.274	2.03	1.19-3.47	.010
Milk Yield≥25L/day	.712	.334	2.04	1.06-3.92	.033
Dystocia	1.16	.304	3.18	1.75-5.77	.000
Retained Placenta	1.05	.382	2.85	1.35-6.03	.006
LDA	3.27	.661	26.28	7.20-95.90	.000
Constant	-4.241	.866	-	-	.000

β: Regression coefficient; SE: Standard error; OR: Odds ratio; 95% CI: Confidence interval; P: P value

with good specificity for the detection of ketones in milk is used, but it has a low sensitivity (50.7%) at a cut-off point of 200 μmol/L (47). A Study on accuracy of PortaBHB milk strip cow-side test for diagnosis of hyperketonemia suggested that this cow-side test has good accuracy (28). The prevalence of subclinical ketosis has been found to be relatively high using different diagnostic techniques to assess BHB concentrations. However, this may be due to the accuracy of various diagnostic thresholds for SCK detection (48). Commercial automatic devices have become widely available for practical measurements of blood BHB concentrations and SCK diagnosis in dairy cows to predict outcomes with reasonable accuracy (49). Likewise, according to a recent meta-analytical study, the handheld glucometer has the greatest sensitivity and specificity (94.8 and 97.5%, respectively), and milk BHB TSs have low Se (39.7%) (48). Some BHB-detecting devices also had low sensitivity and specificity, which could be responsible for false negative or

Table 5: Classification of cattle herds as ketotic or non-ketotic in respect to different exposure factors

Risk Factor	Category	+ve (n =16)	-ve (n =21)	OR	95.0% C.I. Lower-Upper	*P
Herd size (lactating cows)	Small<100	6	13	2.7	0.70-10.3	0.146
	Large≥100	10	8			
Amount of prepartum total mixed ration /day (TMR)	Sufficient (≥ 12 kg TMR)	5	15	5.5	1.33-22.73	0.019
	Insufficient (< 12 kg TMR)	11	6			
Supplementation of propylene glycol (200 gm/cow daily	Yes	6	15	4.1	1.042-16.66	0.044
	No	10	6			

*P-values are for comparisons of data for each factor evaluated

Table 6: Final logistic regression model for positive risk factors associated with ketosis in cattle on herd level

Variable	β	S.E.	OR	95.0% C.I. Lower-Upper	P
Insufficient prepartum TMR	1.84	0.795	6.291	1.32-29.85	.021
Lactation supplementation with glucose precursors	1.582	0.797	4.864	1.02 -23.19	.047
Constant	-1.88	0.720	0.153	-	. 009

β: Regression coefficient; SE: Standard error; OR: Odds ratio; 95% CI: Confidence interval; P: P value

false positive rates in subclinical ketosis diagnosis (50, 51) FTIR spectroscopy for routine milk BHB analysis measuring in early lactation has been used (52). Though, FTIR threshold differences can affect various sensitivity and specificity and influencing the diagnostic accuracy (53).

On the cow level, the final logistic regression model revealed a significant association between ketosis and cows of parity ≥4. This finding is consistent with that reported by Vanholder et al. (26), who concluded that cows of parity ≥ 3 were at a higher risk of ketosis (2.8 times) than heifers. The increased likelihood of ketosis with increased parity has been attributed to a significant depletion of energy reserves in multiparous cows compared with primiparous ones (21).

Regarding the dry period, the significant association between ketosis and cows with a long dry period in the present study may be attributed a greater BCS during parturition and higher lipid mobilization at the start of lactation in cows at risk (54). It has been concluded that A 4-wk DP improved metabolic status, as reflected by lower plasma NEFA concentration in early lactation compared with an 8-wk dry period (55). However, the increased risk of ketosis in high milk-yielding cows described in this study may be explained by greater energy requirements and inadequate dry matter intake (DMI) to meet metabolic lactation demands, resulting in NEB and hyperketonemia (56). In addition, Roche (57) stated that inadequate nutritional management of the cow in the dry period and after calving has a significant negative impact on subsequent conception rate, services per conception and interval from calving to conception.

In respect to the BCS, there was a significant association between ketosis and BCS >3.5. Similar finding has been presented by Garzón-Audor et al. (58), who reported that the relative risk of ketosis in cows with BCS more than 3.5 was 3.3 times greater than in cows with BCS less than 3. The association between increased BCS and ketosis has been attributed to the reduction in DMI that occurs around calving in obese cows and increased insulin resistance (59, 60). Several studies highlighted the association between BCS and milk yield, metabolic disorders, and reproductive performance in dairy cows (61-63).

The significant association between ketosis and calving in the winter season reported in this study is consistent with the results of Asrat et al. (64), who observed an increase in the prevalence of ketosis in winter in Ethiopia. In addition, it has been reported that cows with parturition during the hottest seasons had a lower risk of ketosis (8). Whereas, Ha, Seungmin et al 2023 (65) found that cows who calved in the summer had a greater risk of ketosis, which might be related to the increased warmth and humidity in Korea. The seasonality of ketosis may be related to several factors, including ambient temperature, forage quality, and pasture availability (66)

Regarding calving related-events, the identification of dystocia as a risk factor for ketosis in this study is in contrast to Berge and Vertenten (21), who did not find an increased risk of ketosis after dystocia and is similar to Duffield et al. (67), who linked ketosis to loss of appetite caused by dystocia-related traumatic pain. The association between ketosis and retained placenta identified in this study contradicts Vanholder et al. (26), who did not record an association between ketosis and retained placenta, and agrees with Garzón-Audor and Oliver-Espinosa (58) who attributed that to the reduction in DMI. This is also consistent with (68), who reported that daily feed intake in the cows with the RP decreased on average by 0.8 kg/day on average.

Several postpartum conditions have been identified as potential risk factors for ketosis (8, 69). The significant association between displaced abomasum and ketosis reported in this study is consistent with the findings of Suthar et. al. (70). Cows with a displaced abomasum developed ketosis as a result of a negative energy balance due to their decreased appetite (71). In this study, metritis, clinical mastitis, and lameness were not identified as risk factors for ketosis. These findings contrast with those reported by Vince et al. (72), Steeneveld et al. (56), and Berge and Vertenten (21) who reported an association between ketosis and endometritis, mastitis, and lameness, respectively, and agree with (58) where they reported no association between ketosis and clinical mastitis, and (73) who concluded that there was no clear association between lameness and the development of severe NEB, even though lameness has previously been shown to affect feeding behavior with diminished feeding time and lower DMI (74).

On the herd level, fed on an insufficient prepartum total mixed ration and insufficient supplementation with glucose precursors were the main risk factors. This association could be explained by enhanced lipolysis of deposited fat and the release of NEFA into the circulation (75). An increased NEFA concentration in the blood results in the accumulation of triglycerides in the liver and a considerable rise in ketonic compound synthesis (76).

In the present study, supplementation with propylene glycol has been found to reduce the prevalence of ketosis. It has been postulated that glucose precursors promote glucose metabolism and reduce lipolysis during the periparturient period (77). McArt et al. (78) find positive effects of bolus administrations of propylene glycol on resolution and further outcomes of hyperketonemia. Similarly, the incidence of subclinical ketosis was reduced with improvement of reproductive performance has been recorded after long period supplementation with propylene glycol and glycerol (27). In a study carried out by Lomander et al. (79), it has been found that feeding of dairy cows on concentrates supplemented with 450 gm of glycerol did not affect on BHBA concentration in early-lactation. On the contrary, Hoedemaker et al. (80)stated that despite improvement of metabolic indicators after peripartal supplementation with concentrate enriched at 10% propylene glycol to cows, milk production, animal health, and fertility were not influenced.

The limitations of the present study should be recognized. First, this study included farms related to governorates of Delta region of River Nile (Lower Egypt). Because most of well-constructed dairy farms are found in such localities, the study was performed here. However, further studies need to be done to include other localities of Upper Egypt. Second, the present study was conducted on large scale farms, which doesn't provide concrete conclusion about smallholder farms in Egypt. But, because it is difficult to count and to have owners' consent in small-holder farms, we conducted our study in large dairy farms. Moreover, PortaBHB milk strip cow-side test may be more suitable for large scale farms than smallholders. Third, the use of PortaBHB, a semi-quantitative cow side milk strip test only, without use of BHBA test kits, standard test for diagnosis of ketosis. However, PortaBHB milk ketone test, has been reported to be a simple, non-invasive, and quick field test with good specificity for the detection of ketosis in milk (47). Interestingly, a Study on accuracy of PortaBHB milk strip cow-side test for diagnosis of hyperketonemia suggested that this cow-side test has good accuracy, and that there is no benefit of collecting a composite milk sample compared to sampling a single quarter (28). Consequently, the on farm application of this milk strip may be helpful to distinguish cows with hyperketonemia, or to measure herd-level incidence of hyperketonemia (81). Fourth, there was a variation in the management strategies and feeding programs for transition cows organized and performed by the farms' personnel, veterinarians, and nutrition consultants. Therefore, concrete conclusions about the prevalence of hyperketonemia may be influenced. Fifth, we mentioned only the frequency of cows with hyperketonemia during the first 42 post calving only. Definite association between DIM and incidence of hyperketonemia has been presented (37, 82). But in our study, we obtained snapshot about the hyperketonemia lactating cows.

Conclusions

The results of the present investigation indicate considerable variation in the prevalence of ketosis in dairy herds in Egypt. Factors associated with ketosis could help to identify cows at risk and to improve management strategies to limit their effects.

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Razširjenost in potencialni dejavniki tveganja, povezani s ketozo na mlečnih kmetijah v Egiptu

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Izvleček: Ketoza je z energijo povezana presnovna bolezen, ki se pojavlja predvsem v zgodnjem obdobju laktacije pri kravah molznicah. Ketoza negativno vpliva na proizvodnjo, zdravje živali in reprodukcijo. V tej študiji smo določali razširjenost in dejavnike tveganja, povezane s ketozo pri mlečnem govedu v zgodnji laktaciji v Egiptu. Na ketozo je bilo pregledanih 1179 krav molznic iz 37 mlečnih farm z uporabo semikvantitativnega testa na mlečnem traku. Sestavili smo vprašalnik, ki je vključeval domnevne dejavnike tveganja. Dejavnike tveganja smo ocenili na ravni krave in črede z uporabo logističnega regresijskega modela. Ugotovitve so pokazale, da je bila razširjenost ketoze 6,35 % (75/1179 primerov). Na ravni krave je končni logistični regresijski model pokazal pomembno povezavo med ketozo in pariteto ≥ 4 (P= 0,040, OR: 1,74, CI 95 %: 1,025-2,95), kravami z dolžino sušnega obdobja ≥ 65 dni (P=0,02, OR: 1,88, CI 95 %: 1,1-3,18), sezono telitve (P=0,037, OR: 1,73, CI 95 %: 1,03-2. 89), BCS>3,5 (P= 0,010, OR: 2,03, CI 95 %: 1,19-3,47), mlečnostjo ≥25L/dan (P= 0,033, OR 2,04, CI 95 %: 1,06-3,92), distociji (P< 0,001; OR: 3. 18, CI 95 %: 1,75-5,77), zadržani posteljici (P= 0,006, OR: 2,85, CI 95 %: 1,35-6,032) in dislokacijo siriščnika (P< 0,001, OR: 26,28; CI 95 %: 7,20-95,90). Na ravni črede smo ugotovili povezavo med ketozo in nezadostnim krmljenjem s skupnim mešanim obrokom pred porodom (P= 0. 021, OR: 6,29, CI 95 %: 1,325-29,86), v čredah s pomanjkljivo laktacijo pa z dodatkom propilenglikola (P= 0,047, OR: 4,86, CI 95 %: 1,020-23,19). Zaključimo lahko, da je ketoza obstoječa težava na mlečnih kmetijah v Egiptu, zato lahko opredelitev dejavnikov tveganja predstavlja uporaben pristop za preprečevanje in nadzor teh presnovnih težav.

Ključne besede: krava molznica; ketoza; dejavniki tveganja; BHBA