

MILK PRODUCTION PERFORMANCE AND SOME BIOCHEMICAL BLOOD COMPONENTS IN EGYPTIAN BUFFALOES AS AFFECTED BY SEASONAL VARIATION

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SUMMARY

Eighteen lactating buffaloes were used to study the effect of season on milk production performance and some blood biochemical indicators. The study included two seasons, summer and winter. Milk samples were collected at weekly intervals, while blood samples were collected after one month from calving from each animal. Plasma alanine aminotransferase (ALT), aspartate aminotransferase (AST) and alkaline phosphatase (ALP), total protein (TP), albumin, total cholesterol (TC) and triglycerides (TG) levels were determined. Results indicated that, during summer season THI values were higher than those of the thermoneutral zone, while in winter it was within the thermoneutral zone of lactating buffaloes. Milk production was significantly lower under heat stress in summer than that in winter when ambient temperature (T_a) was around the thermoneutral zone. Daily milk yield average (DMY), fat corrected milk yield (FCM) and total milk yield (TMY) in addition to milk protein % were significantly higher in winter than those in summer season. Whereas, milk lactose, fat and total solids (TS) % did not differ between winters and summer seasons. ALT was significantly higher in winter than in summer season, while AST, ALP, total protein (TP), albumin and globulin showed no significant differences. Albumin/globulin ratio (A/G ratio) was within normal values and did not also differ between seasons. A significant positive correlation was found between plasma ALT and each of DMY, FCM and TMY. Also, between plasma ALP levels and each of lactose, TS and SNF and plasma TG levels with milk fat %.

In conclusion, in winter season, buffaloes produced more milk and milk components than summer season. Plasma ALT activity could be used to predict TMY, FCM and average of DMY, meanwhile plasma ALP activity could be used to predict milk TS and SNF contents.

Keywords: Buffalo, season, milk yield and components, blood plasma component

INTRODUCTION

It is well known that, the main dairy animals in Egypt are water buffaloes and their milk is more preferable by consumers than cow's milk. Also, buffaloes are sensitive to weather changes and adverse climatic conditions, which are hazardous to buffalo's milk productivity (Marai and Habeeb, 2010). Many metabolites were estimated in animal's blood to give an indication of the physiological condition of the body (Sakowski *et al.*, 2012). Blood content profiles have been used to identify dietary defect even before productivity is impaired. Such profiles have also been used to monitor herd health, to diagnose subclinical disease, to predict risk of ketosis or abomasum displacement, as well as to investigate herd problems with metabolic disorders (Geishauser, *et al.*, 1997; Oetzel, 2004; LeBlanc *et al.*, 2005 and Macrae *et al.*, 2006). Production of milk requires close coordination between biochemical pathways, to supply synthesis intermediates and pathways for secretion (Akers, 2005).

Many authors declared that calving season affects on milk yield conversely Khan (1996)

came to conclusion that there was no significant effect of calving season on milk yield in buffaloes.

Contradictory results had been found for the correlation between daily milk yield (DMY) and plasma alanine aminotransferase (ALT) activity where Sakowski *et al.* (2012) found a significant negative correlation between DMY and plasma ALT activity, while Jozwik *et al.* (2012) found a significant positive correlation between the same variables.

The objectives of the present study were to evaluate the effect of seasonal changes on buffalo milk production and characteristics and find out the relation between these characteristics to some plasma parameters.

MATERIALS AND METHODS

Eighteen buffalo cows representing four parities were kept in open yard (30×70 m²) at Mostorod Research Farm belonging to the Animal Production Department, Faculty of Agriculture, Al-Azhar University. All animals were tested after about one month of parturition. Half of the buffaloes (n= 9)

delivered in 2008 during summer season while the rest buffaloes delivered in 2009 during winter season. Buffaloes were tested to evaluate the differences between milk characteristics in the winter and summer months of Egypt. The overall mean minimum and maximum ambient temperatures are presented in table (1). Animals were fed concentrate fed mixture and green fodder, berseem (*Trifolium alexandrinum*) in winter and corn fodder (*Zea maiz*), (Darawa) in summer according to Ghoneim (1967). Milk yield of each buffalo was weighed and samples of 20 ml were collected twice daily in the morning and evening by hand milking at weekly interval. Samples were mixed and preserved in plastic sterilized vials with two drops of potassium dichromate till assayed. Blood samples were also collected from the jugular vein in heparinized vials. Plasma samples were immediately centrifugated and plasma samples were obtained and stored at -20°C until determination of alanine aminotransferase (ALT), aspartate aminotransferase (AST) and alkaline phosphatase (ALP), total protein (TP), albumin, total cholesterol (TC) and triglycerides (TG) using a commercial kit (Biodiagnostic, Egypt).

Milk components (fat, protein, lactose, total solids, and solids not fat) were determined by Milko Scan 130 tester type: 10900 based on infrared spectroscopy (AOAC, 1990). The 7% fat corrected milk yield (FCM) values were calculated by the formula: $FCM (kg) = 0.28 \times MY (kg) + 10.34 \times \text{milk fat} (kg)$, according to Tyrrell and Reid (1965).

Meteorological data were obtained from Central Laboratory of Agricultural Climate. Temperature humidity index (THI) was calculated using the formula of Amundson *et al.* (2006) as follows:

$$THI = 0.8 \times Ta \text{ } ^\circ C + \{ (RH \%) \times (Ta \text{ } ^\circ C - 14.4) / 100 \} + 46.4.$$

Where; $Ta \text{ } ^\circ C$ is the ambient temperature ($^\circ C$), and RH is the relative humidity (RH %) / 100.

Statistical analysis was carried out using SPSS Program (SPSS, 1999). Averages during summer and winter seasons were used for performing the T Test in order to find out the effect of season. Person coefficient test was used to find out the correlations between milk characteristics and plasma biochemical parameters.

RESULTS AND DISCUSSION

Seasonal conditions:

THI was higher than 78 in summer and less than 70 in winter (Table 1). THI value of 68 is considered the upper limit of dairy cattle

comfort zone (Johnson *et al.*, 1989 and Marai and Habeeb, 2010). Temperature humidity index value of 74 to 78 is considered hazardous and represents an alert condition for animals (Abd El-Ghany *et al.*, 2010). Accordingly, animals were under severe heat stress during summer and thermoneutral zone during winter.

Daily milk yield (DMY):

Highly ($P \leq 0.01$) difference between the averages of DMY in winter and summer seasons was found (Table 2). Increased DMY in winter occurred when ambient temperature was almost around the thermoneutral zone. In summer THI was extremely high (>78) which depressed DMY. It is well established that high ambient temperature during summer reduces the animal appetite and feed intake, and impairs milk production (Marai and Habeeb, 2010). In this connection, Kamiya *et al.* (2005), Hussain *et al.* (2006) Tanaka *et al.* (2007), Javed *et al.* (2009) and Marai and Habeeb (2010) reported that milk production changes in both dairy cows and buffaloes due to the change in specific biological functions such as increasing body temperature and enzymatic reactions by climate changing.

Total milk yield and 7% fat corrected milk yield:

The average TMY showed higher ($P \leq 0.01$) values in winter than in summer season (Table 2). The corresponding averages of 7 % FCM yield showed highly significant differences ($P \leq 0.01$) between winter and summer while milk fat% was almost similar (Table 2). These remarkable differences may be due to higher milk yield in winter as compared to summer.

Milk composition:

Milk protein (%) was higher ($P \leq 0.05$) in winter than in summer, while milk lactose (%), fat (%) and TS did not differ between the two studied seasons. Thus, SNF(%) was higher ($P \leq 0.05$) in winter than in summer season. The seasonal variation in milk components which might be found in some European countries was not clear in most of the milk components of buffaloes under the Egyptian conditions. This could be attributed to differences in ambient temperature and light/darkness ratio beside differences in feed quality and feed intake (Table 1).

Seasonal effects was observed in milk protein and in milk fat contents. This might ascribe that the expansion of light-to-dark ratio leading to a reduction in fat and protein contents of milk, probably as a consequence of a greater secretion of prolactin which is reported to be higher in summer than in winter

(Sevi *et al.*, 2004). Hence Ozrenk and Inci (2008) found that milk fat, protein and total solids percentages were the highest during the winter and the lowest during the summer season.

Blood parameters:

Alanine aminotransferase (ALT) was higher ($P \leq 0.05$) in winter than in summer, while AST and ALP showed non significant differences between the two seasons (Table 3). Koubkova *et al.* (2002) and Rasooli *et al.* (2004) found that the increase in ambient temperature enhanced ALT activities in cattle. On the other hand, Abo El-Nor *et al.* (2007) and Sobiech *et al.* (2008) reported that ALT activity may increase with the high metabolism which accompany to high milk production in winter seasons.

Plasma proteins:

Plasma total protein as well as albumin and globulin concentrations showed non-significant differences in the two studied seasons. Moreover, A/G ratio was within the normal range and did not differ significantly between seasons (Table 3). These results are in agreement with those previously reported by Kumar and Puri (2009) who stated that no significant differences between summer and winter were detected in serum protein levels in buffaloes. On the other, hand Gudev *et al.* (2007) found significant differences between plasma proteins in both summer and winter seasons. They demonstrated that heat exposure causes initial hemoconcentration followed by hemodilution in buffaloes. This variability may cause high fluctuations in plasma protein values in this study.

Lipid profile:

Plasma TC in summer season was significantly lower than in winter (Table 3). Triglycerides (TG) did not show significant differences between seasons. The significantly higher plasma TC concentration in winter than in summer may be due to the increase in thyroxin secretion in winter. Rasooli *et al.* (2004) demonstrated that cold environment stimulated thyroid hormone secretion to increase basal metabolic rate in order to maintain body temperature, which accompanies high levels of blood metabolites such as cholesterol.

These results are in agreement with those reported by Verma *et al.* (2000) who found lower levels of serum TC during summer than during winter season, in lactating Murrah buffaloes. In this hence, Shafferi *et al.* (1981), Abdel-Samee (1987) Marai *et al.* (1995), and Habeeb *et al.* (1996) reported that cholesterol

concentration in plasma TC decreases with the increase in ambient temperature. The decrease in TC levels may be due to dilution as a result of the increase in total body water or to the decrease in acetate concentration, which is the initial precursor for the synthesis of cholesterol. The marked increase in glucocorticoid hormone level may be another factor causing the decline in blood cholesterol during heat stress (Marai and Habeeb, 2010).

Correlations between milk and blood parameters:

Plasma ALT showed significant positive correlation with each of DMY, FCM and TMY (Table 4), while plasma AST activities were not significantly correlated with any milk characteristics. These results agree with the results of Jozwik *et al.* (2012) who found positive correlation between DMY and plasma ALT activities. This is not in harmony with Sakowski *et al.* (2012) who found negative correlation between ALT and TMY. The significant positive correlation between ALT and milk characteristics indicates that milk production is in direct relation with the activity of transaminase enzymes, which is related to metabolism and lactation process (Abo El-Nor *et al.*, 2007 and Sobiech *et al.*, 2008).

Lactose levels were significantly and positively correlated with plasma ALP, which may be due to dephosphorylation process connected with carbohydrate metabolism or even with the capture of blood sugar molecules by the mammary gland cells (Folley and Greenbaum, 1947; and Kuhn and Lowenstein; 1967). Akers (2005) stated that lactose production, may require 85% of the available glucose. Also, ALP is a mediator enzyme in lactose synthesis via activation of lactose synthetase enzyme (Leung *et al.*, 1989), which serves to combine glucose and galactose and thereby form lactose. Hence, TS, SNF and lactose were positively and significantly correlated with ALP (Table 4).

Plasma TG were positively correlated to milk fat % (Table, 4). This relation could be explained by the previous finding that fat levels are influenced by plasma lipid concentrations (Mc Namara *et al.*, 1995 and Tekelioglu *et al.*, 2010). In addition, Likewise Hammon *et al.* (2009) reported that high intensive fat metabolism occurs to provide milk fat. Furthermore, the positive correlation between plasma TG and milk fat % may be attributed to that milk fat is composed primarily of fatty acids esterified as triacyl glycerols (97 to 99% by weight) and are packaged in fat globules enveloped in cell membrane (Ofteidal, 2005).

TC was significantly and positively correlated with FCM. These results may be ascribed to the fat secreted droplets, which have cholesterol engulfed by plasma membrane and secreted from the cell to the lumen (Akers, 2005).

CONCLUSION

Based on the obtained results, season showed a significant effect on milk production and components where in winter season, buffaloes produced higher milk and milk components than those in summer season. Positive and significant correlations were observed between plasma ALT with each of TMY, DMY and FCM. Also, plasma ALP showed highly significant positive correlation with lactose %, TS and SNF in milk. In addition, plasma TG was positively correlated with milk fat %. Consequently, plasma ALT activity could be used to predict total milk yield, fat corrected milk yield and average daily milk yield, meanwhile plasma ALP activity could be used to predict milk total solids and solids not fat contents.

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Table 1. Means of ambient temperature (°C), relative humidity (%) and temperature humidity index (THI) during the whole experimental period from July 2008 to August 2009.

Season		Ambient Temperature (°C)			Relative Humidity (%)			THI
		Max.	Min.	Average	Max.	Min.	Average	Average
Summer	Jul-2008	37	22	29.1	100	18	58.2	78.2
	Aug-2008	37	21	30.0	94	22	59.4	79.6
Winter	Jan-2009	25	7	15.7	100	4	53.4	59.7
	Feb-2009	28	10	16.6	88	12	46.3	60.8
Summer	Jul-2009	40	20	29.8	100	4	45.6	77.2
	Aug-2009	38	22	30.0	100	21	57.3	79.3

Table 2. Means±SE of milk as affected by season of Egyptian buffaloes during the experiment period (8 weeks) (n= 18)

Parameters	Winter	Summer	P
DMY (kg)	4.5 ± 0.52	2.8 ± 0.20	**
FCM (kg)	212.8±23.81	132.7±10.18	**
TMY (kg)	269.3±31.23	169.0±12.46	**
Protein (%)	3.40±0.09	3.20±0.07	*
Lactose (%)	4.77±0.07	4.74±0.09	ns
Fat (%)	5.02±0.15	4.90±0.21	ns
TS (%)	13.38±0.16	13.08±0.31	ns
SNF (%)	8.20±0.11	7.90±0.10	*

DMY = daily milk yield, FCM = fat corrected milk, TMY = total milk yield, TS = total solids, SNF = solids not fat, *= $P \leq 0.05$, **= $P \leq 0.01$, ns = non-significant.

Table 3. Means±SE of some biochemical parameters as affected by season of Egyptian buffaloes (n= 18)

Parameter	Winter	Summer	P
ALT (U/I)	49±2.2	42±1.6	*
AST (U/I)	121±5.6	119±4.4	ns
ALP (U/I)	124±9.1	113±8.5	ns
Total Protein (g/dl)	7.52±0.23	7.48±0.23	ns
Albumin (g/dl)	3.46±0.13	3.56±0.11	ns
Globulin (g/dl)	4.06±0.13	3.92±0.16	ns
A/G ratio	0.85±0.03	0.93±0.06	ns
TC (mg/dl)	86.2±4.35	67.2±3.43	**
TG (mg/dl)	42.6±5.71	45.0±7.58	ns

ALT = alanine aminotransferase, AST = aspartate aminotransferase, ALP = alkaline phosphatase, AG ratio = albumin / globulin, TC = total cholesterol, TG = triglycerides, *= $P \leq 0.05$, **= $P \leq 0.01$, ns = non-significant.

Table 4. Pearson's correlations between biochemical indicators in blood plasma and milk parameters (n=36)

	DMY (kg)	FCM (kg)	TMY (kg)	Fat (%)	Protein (%)	Lactose (%)	TS (%)	SNF (%)
ALT (U/I)	0.361*	0.406*	0.361*	ns	ns	ns	ns	ns
AST (U/I)	ns	ns	ns	ns	ns	ns	ns	ns
ALP (U/I)	ns	ns	ns	ns	ns	0.456**	0.356*	0.440*
TG (mg/dl)	ns	ns	ns	0.330*	ns	ns	ns	ns
TC (mg/dl)	ns	0.375*	ns	ns	ns	ns	ns	ns
Albumin (g/dl)	ns	ns	ns	ns	ns	ns	ns	ns
Globulin (g/dl)	ns	ns	ns	ns	ns	ns	ns	ns
A/G ratio	-0.30*	ns	ns	ns	ns	ns	ns	ns

DMY = daily milk yield, FCM = fat corrected milk, TMY = total milk yield, TS = total solids, SNF = solids not fat, AST = aspartate aminotransferase, ALT = alanine aminotransferase, ALP = alkaline phosphatase, TG = Triglycerides, Glob = globulin, AG ratio = albumin / globulin, ns = non-significant.

أداء إنتاج اللبن وبعض المكونات البيوكيميائية في الدم للجاموس المصري وتأثرها بالتغير الموسمي

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تم استخدام عدد 18 جاموسة حلابة لدراسة أثر المواسم (الصيف والشتاء) على إنتاج اللبن وبعض المؤشرات البيوكيميائية في الدم. تم دراسة شهرين في كل موسم، حيث تم أخذ عينات اللبن أسبوعياً من كل حيوان وعينات الدم تم أخذها شهرياً من كل حيوان بعد الولادة بشهر وتم فصل بلازما الدم وتخزينها حتى تم تحليل إنزيمات ALT و AST و ALP وكذلك البروتين الكلي والألبومين والكوليسترول والدهون الثلاثية.

وأشارت النتائج إلى أن دليل الحرارة والرطوبة (THI) خلال فصل الصيف كان أعلى من المدى الحراري الملائم لحيوانات اللبن بينما في موسم الشتاء كان دليل الحرارة والرطوبة يقع في المدى الحراري الملائم لتلك الحيوانات. وبملاحظة خصائص اللبن والتي تحتوي على متوسط إنتاج اللبن اليومي وكمية اللبن المعدل لنسبة دهن 7% وإنتاج اللبن الكلي بالإضافة إلى النسبة المئوية لبروتين اللبن كلها كانت عالية المعنوية في الشتاء عن الصيف بينما كانت النسبة المئوية لكل من اللاكتوز والدهون والجوامد الكلية غير معنوية بين موسمي الشتاء والصيف. أثر الموسم أيضاً على نسبة مقاييس بلازما الدم حيث كانت إنزيمات ALT عالية المعنوية في الشتاء عن فصل الصيف بينما لم تظهر فروق معنوية لإنزيمات AST و ALP وكذلك مستويات البروتين الكلي والألبومين والجلوبولين. وكانت نسبة الألبومين إلى الجلوبولين في النطاق الطبيعي لها ولم تظهر فروق معنوية بين الفصول المختلفة. عموماً فإن موسم الشتاء تعطي كمية أكبر من اللبن وفي بعض محتوياته أكثر من فصل الصيف.

كما وجد ارتباط معنوي إيجابي بين مستوى إنزيم ALT في بلازما الدم مع كل من متوسط إنتاج اللبن اليومي وكمية اللبن المعدل لنسبة دهن 7% وإنتاج اللبن الكلي. كما وجد ارتباط إيجابي عالي المعنوية بين إنزيم ALP في بلازما الدم مع نسبة اللاكتوز والجوامد الصلبة الكلية والجوامد اللادھنية في اللبن. كما وجد ارتباط معنوي موجب بين الدهون الثلاثية في بلازما الدم مع النسبة المئوية لدهن اللبن.