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Hemato-Biochemical Profiling in Relation to Metabolic Disorders in Transition Dairy Cows

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ABSTRACT

This study was aimed to provide a complete picture of dynamics of selected hematological and serum biochemical parameters in dairy cows from late pregnancy to early postpartum period, giving new and useful information about the guidelines for the management strategies during different physiological phases. This study was carried out on thirty clinically healthy Holstein Friesian dairy cows; in good nutritional condition. Blood samples were collected two weeks before the expected parturition, during the 1st post-partum week and during the 3rd week after parturition. Cows under investigation were clinically examined including body temperature, pulse, respiration, mucous membranes and ruminal movement. Two blood samples were collected: whole blood samples for hematological picture, while serum samples for biochemical analysis which included total proteins, albumin , globulin , AST, ALT, glucose, Creatinine, Blood urea nitrogen (BUN), Total cholesterol, Beta hydroxy butyrate (βHBA), triglycerides, Nitric Oxide (No), Malondialdehyde (MDA), total antioxidant capacity (TAC), serum calcium, magnesium, sodium, potassium, chloride and phosphorus. Significant changes between pre and post-partum period were observed in values of hemogram and biochemical parameters including RBCs, PCV%, hemoglobin, MCV, MCHC, MCH, WBCS count and differential leucocytic count, total proteins, albumin, globulin, glucose, BUN, Total cholesterol, triglycerides, calcium, phosphorus, magnesium, sodium, chloride, No, MDA and TAC, while non-significant changes were observed in AST, ALT, Potassium ,Creatinine and βHBA levels. It can be concluded that late pregnancy and the onset of lactation were accompanied by marked changes in hemato-biochemical and oxidative stress markers which have great impact on dairy cow`s health, immunity and disease susceptibility.

1- INTRODUCTION:

Peri-parturient or transition period including the change from a gestational non-lactating to a non-gestational lactating state (Morgante et al. 2012). It is characterized by alterations in both metabolic and immune functions in animals (Piccione et al. 2012). Some of these changes are related to increases in energy requirements needed by fetus and lactogenesis. Due to metabolic, behavioral and hormonal changes that occur around parturition; cows had a marked decrease in dry matter intake (Grummer et al. 2004) resulting in a negative energy balance (NEB) that further aggravated by withdrawal of nutrient to the mammary gland (Leroy et al. 2008). This energy reduction results in increased fat mobilization followed by generation of lipid peroxides and reactive oxygen species (ROS). These ROS are normally neutralized by sufficient antioxidant levels of living organisms (Trevisan et al. 2001). Peri-parturient disorders in dairy cows occur due to imbalance between increased production of lipid peroxides, ROS and antioxidant defense of the body. Reduced availability of antioxidant defenses near the time of parturition increases oxidative stress (Waller, 2000; Gitto et al.,

2002). So the health problems affect cows after birth resulted from poor nutritional management immediately after calving (Bell, 1995). These problems include milk fever, fatty liver, ketosis, retained placenta, displacement of the abomasum and severely suppressed immune function (Goff and Horest, 1997). Hemato-biochemical profiling of dairy cattle during transition period has been reported to provide a reliable method to monitor animal health during this critical period with the main purpose to predict a herd's susceptibility to production diseases (Kevin and Ellen, 2012). So, the present study was designed for monitoring of dairy cows during peri-parturient period (3 weeks pre-partum till three weeks post-partum) for evaluation clinical, hematological and biochemical changes, oxidant-antioxidant status during this critical period.

2- MATERIAL AND METHODS:

2.1. Animals:

Thirty apparently healthy highly lactating multiparous Friesian dairy cows from a private farm belong to Behira governorate, Egypt. The average age 4- 8 years, weighting 480 ± 5.86 kg, the average body condition score (BCS) of cows was 4.0, with daily milk yield 15.25± 0.22 kg per lactating animal where cows were milked automatically two times daily. Cows were fed daily on diet consisting of 30 Kg berseem (T. alexandrum), 3 Kg rice straw and were fed concentrate diet (16% protein) two times daily and their amount was differ according to her productive status where the amount for late pregnant animal was 7 kg daily while for early lactation was 10 kg daily per individual animal. Minerals and vitamin block and tap water were available all the time. All cows were kept in a free-stall barn under the same environmental condition. Cows were divided into 3 groups :(1st group was at the last 2 weeks before parturition (-14days) while, the 2nd group was at the first week of parturition (+7 days) and the 3rd group was at the third week (+21days) after calving).

2.2. Sampling:

Two blood samples were collected from each animal. First blood samples (coagulated blood) Were used for determination of serum total proteins , albumin , globulin (by subtracting the albumin from the total protein values) , AST, ALT, glucose, Creatinine, Blood urea nitrogen (BUN) , Total cholesterol, Beta hydroxy buterate (βHBA) ,triglycerides, Nitric Oxide (No), Malondialdehyde (MDA), total antioxidant capacity (TAC), serum calcium, magnesium , sodium , potassium, chloride and phosphorus while, second blood samples (non-coagulated blood on EDTA) were used for hematological examination.

2.3. Clinical examination:-

Complete thorough clinical examination of all cows under investigation was performed according to the method described by (Kelly, 1984). Including temperature, pulse, respiration and ruminal movement. Also, Periodical rectal examination was applied to detect the expected parturition date on all cows under investigation according to the method described by (David et al., 2001).

2.4. Hematological examination:-

Red blood Cell count (RBCs X10^6/100ml), hemoglobin concentration (Hb g/l), packed cell volume (PCV%), mean corpuscular volume (MCV fl), mean corpuscular hemoglobin (MCH pg), mean corpuscular hemoglobin concentration (MCHC g/dl), WBCs count(X10^3/100ml) and differential leucocytic count were determined by using of fully automated veterinary hematology analyzer, Exigo, Boule medical AB., Sweden in the central laboratory, Faculty of veterinary medicine, Alexandria University.

2.5. Biochemical analysis:-

Determination of serum concentrations of calcium , phosphorus , magnesium , sodium , potassium, chloride, AST, ALT, Albumin,Total protiens glucose and Creatinine were carried out by using commercial test kits supplied by (Bio-labo, France) according to the method described by Clark et al., (1975) , Daly and Ertingshausen (1972), Khayam-bashi et al., (1977) , Mathieu and Sfbc (1976) , Murray (1984) , Doumas and Biggs (1972), Curtis et al., (1975) and Young (1995) respectively. While analysis of βHBA , BUN, Total cholesterol and triglycerides were carried out by using commercial test kits supplied by (Ben-Biochemical Enterprise, Italy) and (Vitro Scient., Egypt) according to the method described by Parry et al., (1980), Rock et al., (1987) and Balistreri and Shaw (1987) respectively. Total anti-oxidant capacity (TAC), Malondialdehyde (MDA) and Nitric oxide (NO) were analyzed using test kits supplied commercially by (Bio-Diagnostic, cairo , Egypt) according to the method described by Koracevic *et al.,* (2001), Satoh (1978) and Montgomery and Dymock (1961) respectively.

The free radical defense system in these dairy cows was assessed by measuring total antioxidant capacity (TAC) which was considered the cumulative effect of all anti- oxidants present in the blood and in body fluids (Miller and Rice-Evans, 1996) not just the antioxidant capacity of a single compound .

2.6. Statistical analysis:-

Data were analyzed using the packaged SPSS program for windows version 10.01 (SPSS, 2000 Inc., Chicago, IL). Data were presented as mean ±standard Error (SE). Differences between groups were determined by the one way analysis of variance (ANOVA). Significance level was set at $P \leq 0.05$.

3- RESULTS

3.1. Clinical findings:

Clinical findings of the examined cows (Table 1) showed a non-significant increase ($P \leq 0.05$) in temperature during the period form 2 weeks pre-partum to 3 weeks postpartum. The respiratory and pulse rates showed a significant increase in late gestational period when compared to early lactation stages. Pallor m.m. was observed during pre-parturient period. The ruminal movements showed a significant decrease during 2 weeks pre-partum and 1st week of lactation compared to advanced postpartum stage.

3.2. Hematological examination:

RBCS count, PCV%, hemoglobin, MCV, MCHC, MCH, WBCS count, neutrophils and lymphocytes was significantly higher in peri-parturient cows at 2 weeks before calving than in post-parturient cows at the first and third week after calving. On the other hand the total number of MID "eosinophils, basophils and monocytes" showed non- significant changes at the three stages of the transition cycle. Tables (2, 3, 4).

3.3. Biochemical findings:-

Serum calcium level was significantly lower post calving than pre-parturient period, while phosphorus level showed a significant decrease in its mean value at the first week post-partum than its level before parturition and the third week after calving, level of magnesium in the third week after calving was significantly higher than those at the second week before parturition and the first week post-partum. (Table 5)

Analysis of the serum sodium showed that its mean value was significantly decreased at the first week after parturition as compared with its mean value at the last 2 weeks before parturition and the third week after calving, while the mean value of chloride showed significant increase at the last 2 weeks before parturition as compared either with its mean value at the first week after parturition or at the third week after calving. On contrary potassium level was not significantly changed either before or after calving. Table (6).

Serum total protein, albumin and globulins values were significantly lower at 1st and 2nd group when compared with the 3rd one. Table (9)

The mean value of blood urea nitrogen was significantly increased at the third week after calving as compared to the last two weeks before calving and the first week after calving. On other hand the mean value of creatinine showed non- significant changes between all groups. Table (11)

The serum glucose estimation revealed that its mean value was significantly lower in cow's serum at the first week post-partum than its level at the second week before parturition and the third week after calving, while levels of AST and ALT were not significantly changed either before or after calving. Table (10)

The mean value of total cholesterol showed a significant increase at the third week after calving, while triglycerides was significantly higher at 2 weeks before calving, on contrary BHBA showed no significant changes at the three stages of the production cycle. Table (8)

Serum level of TAC at the second week before parturition and in the first week after calving were significantly lower than those at the third week post-partum, in contrast to the mean value of No and MDA were significantly higher at the 2 weeks before parturition and in the first week after calving than those at the third week post-partum. Table (7)

Table (1): Mean values (±SE) of some clinical examination parameters of transition cows:

Groups Parameters	Group (1)	Group (2)	Group (3)
Body temperature °C	38.6 ± 0.6a	39.0 ± 0.5a	38.3 ± 0.4a
Respiratory rate / min.	23.5 ± 0.5a	21.5 ± 0.5b	19.5 ± 1.0c
Pulse rate / min.	69.5 ± 0.5a	60.5 ± 0.7b	58.0 ± 0.9c
Mucous membrane	Pale	Pale	Pale
Ruminal movement / 2 min.	2 ± 0.00	2 ± 0.00	3 ±0.00

Table (2): Mean values (±SE) of RBCS ($X10^6$/ml), Hb (mg/100ml) and HCT (%) in Transition dairy cows:

Group	RBCS (X106/ml)	Hb (mg/100ml)	PCV (%)
1	5.69±0.10a	10.94±0.27a	32.60±0.60a
2	4.82±0.10b	9.90±0.28b	28.56±0.50b
3	5.07±0.09b	9.73±0.19b	29.50±0.47b

Means bearing different letters are significantly differed at (P<0.05).

Table (3): Mean values (±SE) of MCH (Pg.), MCHC (g/dl) and MCV (FL) in transition Dairy cows:

Group	MCH (Pg.)	MCHC (g/dl)	MCV (FL)
1	16.45±0.18a	36.28±0.72a	49.72±1.26a
2	14.82±0.63b	34.90±0.26b	46.87±0.92b
3	15.08±0.45b	35.75±0.60b	48.05±0.52b

Means bearing different letters are significantly differed at (P<0.05).

Table (4): Mean values (±SE) of WBCS ($X10^3$/ml) , Lymphocytes, MID and Neutrophils ($X10^3$/µl) in transition dairy cows:

Group	WBCS (X103/ml)	Lymphocytes (X103/µl)	MID(X103/µl)	Neutrophils (X103/µl)
1	12.25±0.46a	7.07±0.33a	0.98±0.09a	5.30±0.92a
2	10.93±1.19b	3.95±0.70b	0.99±0.05a	4.01±0.46b
3	11.10±0.83b	5.52±0.94b	0.98±0.09a	4.95±1.26b

Means bearing different letters are significantly differed at (P<0.05).

Table (5): Mean values (±SE) of serum calcium (mg/dl), phosphorus (mg/dl) and Magnesium (mg/dl) in Transition dairy cows:

Group	Ca (mg/dl)	Ph (mg/dl)	Mg (mg/dl)
1	8.92±0.31a	4.78±0.34a	2.08±0.10b
2	7.11±0.22b	3.53±0.19b	1.99±0.05b
3	7.08±0.29b	5.29±0.30a	2.73±0.11a

Means bearing different letters are significantly differed at (P<0.05).

Table (6): Mean values (±SE) of serum sodium, potassium and chloride (mmol/l) in Transition dairy cows:

Group	Na (mmol/l)	K (mmol/l)	CL (mmol/l)
1	149.73±7.90a	3.65±0.34a	103.99±1.54a
2	123.02±2.08c	3.84±0.20a	94.92±1.45b
3	133.03±2.34b	3.77±0.17a	96.46±1.49b

Means bearing different letters are significantly differed at (P<0.05).

Table (7): Mean values (±SE) of oxidants /antioxidant profile in transition dairy cows:

Group	TAC (Mm/l)	NO (µmol/l)	MDA (nmol/ml)
1	0.54±0.10b	15.11±0.36a	14.45±0.73b
2	0.50±0.11b	16.39±1.02a	23.18±0.45a
3	0.83±0.04a	13.08±0.40b	8.02±0.24c

Means bearing different letters are significantly differed at (P<0.05).

Table (8): Mean values (±SE) of serum Cholesterol, Triglycerides and BHBA (mg/dl) in Transition dairy cows:

Group	Cholesterol (mg/dl)	Triglycerides(mg/dl)	BHBA(mg/dl)
1	150.95±4.78b	34.39±1.83a	17.79±0.59a
2	139.65±6.77b	29.04±1.05b	19.33±0.63a
3	162.05±13.49a	24.18±1.25c	17.44±0.70a

Means bearing different letters are significantly differed at (P<0.05).

Table (9): Mean values (±SE) Serum total proteins, Albumin and globulins in transition dairy cows:

Group	Total Proteins (g/dl)	Albumin (g/dl)	Globulins (g/dl)
1	6.24±0.18b	3.16±0.10b	3.08±0.22b
2	5.40±0.19c	2.99±0.20c	2.41±0.16c
3	7.60±0.19a	4.06±0.20a	3.54±0.16a

Means bearing different letters are significantly differed at (P<0.05).

Table (10): Mean values (±SE) of serum glucose (mg/dl), ALT (u/l) and AST (u/l) in Transition dairy cows:

Group	Glucose (mg/dl)	ALT (u/l)	AST (u/l)
1	55.65±1.83a	24.66±1.55a	65.93±5.70a
2	42.48±1.41c	22.40±1.35a	81.66±3.63a
3	52.27±1.49b	26.27±1.91a	49.53±4.20a

Means bearing different letters are significantly differed at (P<0.05).

Table (11): Mean values (±SE) of Blood urea and serum creatinine levels in transition dairy cows:

Group	Urea (mg/dl)	Creatinine (mg/dl)
1	35.22±1.07b	1.02±0.02a
2	36.49±0.90b	1.12±0.05a
3	39.44±1.09a	1.00±0.03a

Means bearing different letters are significantly differed at (P<0.05).

4. DISCUSSION:

Transition period is one of the most critical periods during life of dairy cows. Where cows become undergo physiological changes to prepare themselves for the onset of lactation till reach the peak of milk production. Clinical examination of cows during periparturient period showed some significant alteration in accordance with Ghanem, *et al.* (2012) including the increase in respiratory and pulse rate which may be related to stress of pregnancy and parturition Kelly (1984). The ruminal atony or decrease in ruminal movements near parturition could be attributed to increased intra-abdominal pressure by gravid uterus on rumen during advanced pregnancy and somewhat reduced calcium level during early post parturient stage Goff (2008). Transition stage not only affect clinical situation of dairy cows but also affect significantly internal hemogram including reduced RBCS count , Hb.content , MCV, PCV,MCH and MCHC values in early lactation period when compared with late pregnant one, these obtained results coincides with that observed by Găvan, *et al.* (2010) and Ghanem, *et al.* (2012), the reduction in RBCS count, MCV, and MCH returned to deficiency of iron during peri-parturient periods, that resulted in a decreased MCV (microcytosis) because cells undergo an extra division due to inadequate hemoglobin concentration (Roy *et al.*, 2010). PCV% and Hb content (gm/dl) showed a significant decrease

during peri-parturient periods, that was attributed to anemia due to stress of pregnancy and parturation (Daramola *et al.,* 2004). Elevation of serum cortisol around parturition (Preisler et al., (2000) and Kim et al., (2005), resulting in a significant decrease in total leucocytic count, lymphocyte % and neutrophils % in the early lactating group compared with late pregnant one. The significant decrease of serum calcium level after birth was coincides with that observed by Zeinab (2007) and Hagawane et al (2009) whose suggested that deficiency may be returned to improper food metabolite absorption from gastrointestinal tract, insufficient mobilization of Ca from the skeleton, excessive Ca loss in urine and draining of high percent of Ca and phosphorus Hassan(1988) in colostrum during excessive milking soon after birth. The significant changes of magnesium was in agreement with Crnkic(2010) who concluded that these changes may be due to insufficient food intake or poor bioavailability of Mg in the digestive tract but, these results disagreed with Bajora et al(1994) who found no significant changes in serum magnesium level in pre- and post-parturient cows. Na and Cl in pre-partum were significantly higher than those at calving and post-partum due to their secretion in colostrum and milk Daramola et al., (2004) and Ghanem et al., (2012). On other hand potassium level not changed in three groups, Serum total proteins as parturition approach usually decreased may be due to the fetus synthesizes all its proteins from the amino acids derived from the dam and fetal muscle growth reaching its maximum size at late pregnancy (Jainudee, and Hafez, 1994). Serum globulins showed a significant decrease during transition period, which associated mainly with the production of colostrum that rich in antibodies that derived from γ-globulins and other immunological changes occurred around parturition (Janku et al., 2011). Serum total protein, albumin and urea are indicators of diet protein intake (Toharmat et al., 1999). Urea is a good indicator of long term intake of dietary protein (Toharmat et al., 1999 and Kida, 2003). On contrary to albumin which is not a long indicator of protein intake due to its short half-life in blood. The significant increase of serum urea level at 3rd week after calving might be returned to excess dietary protein intake that enhance the hepatic microsomal activity which favors the transformation of alimentary ammonia into urea (Giuseppe et al., 2006). On the other hand the non-significant changes in creatinine level disagree with Ghanem et al., (2012) who reported elevated creatinine level near calving. Creatinine level rises around parturition due to fetal maternal circulation and the load of organic waste of the newborn Ferrell (1991). During transition period there is no liver cell injury (Castaneda-Gutierrez et al., 2009), so the levels of ALT and AST not-significantly changed in periparturient period. Our data findings concerning glucose are compatible with those obtained by Herdt (2000) who reported that, the prepartum increase of some hormones as cortisol and estrogen resulting in raising of glucose value. While the transient fall in glucose levels in the early lactation can be returned to withdrawal of large amount of blood glucose by the mammary gland for the synthesis of milk lactose Chandra et al., (2013) and Neama, 2015). Serum total cholesterol concentration was minimum following calving and got build up as the lactation progresses Grummer (1993) and Zeinab (2007). The higher level of cholesterol with advancement of lactation was a physiological adjustment to meet the lactation requirements as those reported by Neama (2015). The hormonal level of estrogen along with thyroxin play a vital role in reducing the cholesterol levels during pregnancy (Hagawane et al., 2009). Triglycerides mean values revealed significant decrease in the early lactating group compared with late pregnancy group. As reported previously by Ghada et al., (2015), Triglycerides concentration significantly decreased at calving and remained at the lowest concentration until the 8th week of lactation. The reasons for such disturbances are probably due to triglycerides accumulation in the liver (Bremmer et al., 2000 and Turk et al., 2004); and triglycerides taking up by the mammary gland for milk fat synthesis and secretion (Bernard et al., 2008 and Mantovani et al., 2010). TAC concentration was significantly lower before calving (Castillo et al., 2003; Bozukluhan et al., 2013 and Mousa and Galal 2013) and the highest concentration of TAC was observed 8 weeks post-partum (Castillo et al., 2006). The lowest mean value of TAC (2 weeks before calving and at parturition) was coincident with the absence of vitamins and mineral supplementation, absorption along with the stress of heavy pregnancy and onset of parturition and lactation. Increased MDA and NO concentration just before and after calving were due to initiation of lactation and colostrum secretion. But these changes did not last long as animal adapted itself, therefore the postpartum fatty liver and ketosis did not occur and this reflected in the level of BHBA, this explain the

non-significant changes that noticed in BHBA during transition periods in cows under investigation El-Maghraby and Mahmoud (2016).

CONCLUSION

Results of our study indicate the occurrence of significant changes of hematological, serum biochemical and indicators of oxidant-antioxidant status of dairy cows during the per-partum and post-partum periods. Dairy cows seemed to have more oxidative stress and low antioxidant defense capacity during early lactation stage, which may contribute to the incidence of many metabolic diseases. Therefore, further studies are needed to clarify correlation between increased oxidative stress and incidence of postpartum production diseases of transition dairy cows.

REFERENCES:

Bajora,V.S., Pachavri, S.P. 1994. "Blood profiles in periparturient and postparturient cows and in milk fever cases ." Indian J. Animal Sci. 64(1): 31-34.

Balistreri, W.F., Shaw, LM. 1987. Liver function.In Tietz NW, ed. Fundamentals of clinical chemistry. 3rd ed. Philadelphia: WBSaunders: 729-761.

Bell, A.W. 1995. Regulation of organic nutrient metabolism during transition from late pregnancy to early lactation. J. Animal. Sci. 73: 2804-2819.

Bernard, L., Leroux, C., Chilliard, Y. 2008. Expression and nutritional regulation of lipogenic genes in the ruminant lactating mammary gland. Adv. Exp. Med. Biol. 606: 67–108.

Bozukluhan, K., Atakisi, E., Atakisi, O. 2013. Nitric oxide levels, total antioxidant and oxidant capacity in cattle with foot-and-mouth-disease kafkas. Univ. Vet Fak. Derg., 19(1): 179-181.

Bremmer, D.R., Bertics, S.J., Besong, A., Grummer, R.R. 2000.Changes in hepatic microsomal triglyceride transfer protein and Triglyceride in periparturient dairy cattle. J. Dairy Sci. 83: 2252–2260.

Castaneda-Gutierrez, E.; Pelton, S.H.; Gilbert, R.O. and Butler, W.R. 2009. Effect of peripartum dietary energy supplementation of dairy cows on metabolites, liver function and reproductive variables. Animal Reprod. Sci. 112:301–315.

Castillo, C., Hernandez, J., Lopez-Alonso, M.; Miranda, and M., Benedito, J.L. 2003. Values of plasma lipid hydroperoxides and total antioxidant status in healthy dairy cows: preliminary observations. Archives of Animal Breeding 46, 227–233.

Castillo, C., Hernandez, J., Valverde, I., Pereira, V., Sotillo, J., Lopez Alonso, M., Benedito, J.L. 2006. Plasma malonaldehyde (MDA) and total antioxidant status (TAS) during lactation in dairy cows. Res.

Chandra, G., Aggarwal, A., Singh, A.K., Kumar, M., Upadhyay, R.C. 2013. Effect of Vitamin E and Zinc Supplementation on Energy Metabolites, Lipid Peroxidation, and Milk Production in Peripartum Sahiwal Cows. Asian-Australasian J.Animal Sci. 26: 11: 1569-1576.

Clark,W. L. E L Baginski, S S Marie, Et B. Zak1975. Spec trometric studyof a direct determination of Serum Calcim, Microchem. J.,20, p.22-32.

Crnkic, C., Muratovic, S., Piplica, S., Kavazovic, A. and Kutlaca, S. 2010. Blood plasma mineral profile and health status in postpartum cows fed an anionic diet before parturition. Turk. J. Vet. Anim. Sci. 34: 255-260.

Curtis, E.R., Silverman L . M., Christensen R. H. 1975. Tietz N. W. Text book of clinical chemistry, 3d Ed. C.A. p. 523-524.

Daly J. A. ,Ertingshausen G.,1972. Clinical. Chemistry., Direct method for inorganic phosphate determination, 18, p.263-265

Daramola, J.O., Adeloye, A.A., Soladoye, O. 2004. Changes in some hematological and biochemical parameters during pre-partum and postpartum periods in female West African dwarf goats. J. Agric. Sci. 10: 53-60.

David, E. N, Timothy G. B., Gary, C. E., 2001. Arthur's Veterinary Reproduction and Obstetrics. 8th ed. W.B. Saunders London, U.K.

Doumas B.T.,Biggs H.G.1972. Determination of serum alb umin,Standard methods of clinical chemistry. Acad. Press . N.Y. Vol 7 p.175-188.

El-maghraby, M.M. and Mahmoud, A.E. 2016. Metabolic Profile of the Transition Period in Egyptian Buffaloes (Bulbalusbulbalis). Assiut Vet. Med. J. 150: 75-81.

Ferrell, C.L. 1991. Maternal and fetal influences on uterine and conceptus development in the cow: II. Blood Flow and nutrient flux. J. Anim. Sci. 69: 1954-1965.

Găvan, C., Retea, C., Motorga, V. 2010. Changes in the hematological profile of Holstein primiparous in peri-parturient period and in early to mid-lactation. Anim. Sci. Biotech. 43: 244-246

Ghada A.E. Mohamed, Eman M. Abd-E.naser, Hanan K. Elsayed 2015. Preliminary study on lipid profile with relation to total antioxidant capacity and some hematological and biochemical changes of pre-post-partum buffalo heifers at Assiut city. Assiut Vet. Med. J. 61: 144: 159-165.

Ghanem, M.M.A., Mahmoud, M.E.A., Abd El-Raof, Y.M.A., El-Attar, H.M.A. 2012. Metabolic profiles test for monitoring the clinical, haematological and biochemical alterations in cattle during periparturient period. Benha Vet. Med. J. 23 (2): 13-23.

Gitto, E., R. J. Reiter, M. Karbownik, D. X. Tan, P. Gitto, S. Barberi, I. Barberi. 2002. Causes of oxidative stress in the pre- and perinatal period. Biol. Neonate 81:146-157.

Giuseppe Campanlie; Gianluca Neglia; Rossella Dipalo; Bianca Gasparrini; Corrado Pacelli; Michael J. D'Occhio and Luigi Zicarelli 2006. Relationship of body condition score and blood urea and ammonia to pregnancy in Italian Mediterranean buffaloes. Reprod. Nutr. Devel. J. 46: 57–62.

Goff, J.P, Horst, R.L. 1997. Physiological changes at parturition and their relationship to metabolic disorders. J. Dairy Sci. 80: 1260-1268.

Goff, J.P. 2008. Transition Period Management and Nutrition Problems - A Few Solutions. High Plains Dairy Conference 123: 137.

Grummer, R.R. 1993. Etiology of lipid-related metabolic disorders in periparturient dairy cows. J.Dairy Sci. 76: 3882–3896.

Grummer RR, Mashek DG, Hayirli A 2004. Dry matter intake and energy balance in the transition period. Vet. Clin. North. Am. Food Anim. Pract. 20: 447-470.

Hagawane, S.D., Shinde, S.B. and Rajguru, D.N. 2009.Veterinary Biochemical alterations in buffaloes with metabolic disorders before and after treatment. Practitioner 10: p15 -17.

Hassan,Y.H. 1988."Profile tests as diagnostic aid in detection of subclinical disorders in cattle." M.D.Thesis presented to the Fac. Vet. Med. Benha Univ, Depatment of animal medicine.

Herdt, T.H. 2000. Variability characteristics and test selection in herd- nutritional and metabolic profile testing. Vet. Clin. N. Am. Food Anim. Pract. 16: 387-403.

Jainudee, M.R., Hafez, E.S.E. 1994. Gestation Prenatal Physiology and Parturition. In, Hafez ESE (Ed): Reproduction in Farm Animals. Lea and Febiger, Philadelphia. Pp. 247-283

Janku, L., Pavlata, L., Mišurová, L., Filípek, J., Pechová, A., Dvořák, R. 2011. Levels of protein fractions in blood serum of peri-parturient goats. ActaVet. Brno 80: 185–190.

Kelly, W.R. 1984. "Veterinary Clinical Diagnosis". 3rd Ed., William Clows Ltd., London.

Kevin L., Ellen J. 2012. The Metabolic Profile for the Modern Transition Dairy Cow. Mid-South Ruminant Nutrition Conference, Grapevine, Texas.

Khayam-Bashi H., Tsan Z. , Vern W. 1977. Clinical Chem. , 23/2, p.289-291.

Kida, K. 2003. Relationships of metabolic profiles to milk production and feeding in dairy cow. J. Vet. Med. Sci. 65:671-677.

Kim, I.H., Na, K.J., Yang, M.P. 2005. Immune responses during the peripartum period in dairy cows with postpartum endometritis. J. Reprod Dev. 51: 757-764.

Koracevic, D., G. Koracevic, V. Djordjevic, S. Andrejevic, V. Cosic, 2001. Method for the measurement of antioxidant activity in human fluids. J. Clinical Pathol., 54: 356-361.

Leroy, J.L.M.R., Vanholder, T., Van Knegsel ATM, Garcia-Ispierto I, Bols PEJ 2008. Nutrient Prioritization in Dairy Cows Early Postpartum: Mismatch Between Metabolism and Fertility? Reprod Domest Anim 43 (Suppl.), 96-103.

Mantovani, R., Sgorlon, S., Marinelli, L., Bailoni, L., Bittante, G., Gabai, G. 2010. Oxidative stress indicators and metabolic adaptations in response to the omission of the dry period in dairy cow.

Mathieu M., SFBC col. 1976. Comité de Standardisation. Recommandationspour la mesure de l'activité catalytique de l'Aspartateaminotransférase dans le serum à 30°C. Ann. Biol. Clin. 34. 291-297.

Miller, N. J., Rice-Evans, C. A. 1996. Spectrophotometric determination of antioxidant activity. Redox Report 2: 161–17

Montgomery, H. A. C., Dymock, J. F. 1961. Analyst, 86, 414.

Morgante M, Gianesella M, Casella S, Stelletta C, Cannizzo C, Giudice E, Piccione G 2012. Response to glucose infusion in pregnant and nonpregnant ewes: changes in plasma glucose and insulin concentrations. Comp. Clin. Pathol. 21, 961-965

Mousa, S.A., Galal, M.KH. 2013.Alteration in Clinical, Hemobiochemical and Oxidative Stress Parameters in Egyptian Cattle Infected with Foot and Mouth Disease (FMD). J. Anim. Sci. Adv. 2013, 3(9): 485-491.

Murray RL.,1984. « Alanine aminotransironase » in clinical chemistry. Theory,analysis, and correlation.Kapan LA, P esce AJ, (Eds), CV Mosby St Louis 1090.

Neama A. Ashmawy 2015. Blood metabolic profile and certain hormones concentrations in Egyptian Buffalo during different physiological states. Asian J.Animal and Vet. Adv. 10 (6): 271-280.

Parry A.E.J. et al., 1980. Journal Sci. Food Agriculture. 31, 905.

Piccione G, Messina V, Marafioti S, Casella S, Giannetto C, Fazio F 2012. Changes of some haematochemical parameters in dairy cows during late gestation, postpartum, lactation and dry periods. Vet. Med. Zoot. 58:59-64.

Preisler, M.T., Weber, P.S., Tempelman, R.J., Erskine, R.J., Hunt, H., Burton, J.L. 2000. Glucocorticoid receptor down-regulation in neutrophils of peri-parturient cows. Am. J. Vet Res. 61: 14-19.

Rock, R.C, Walker, W.G. Jennings, CD 1987. Nitrogen metabolites and renal function. In: Tietz NW, ed. Fundamentals of clinical chemistry. 3rd ed. Philadellphia: WB Saunders; 669-704.

Roy, S.; Roy, M. and Mishra, S. 2010. Hematological and biochemical profile during gestation period in sahiwal cows. Vet. World 3: 26-28.

Satoh K., 1978. Clinical Chimica Acta, 90, 37.

SPSS 2000. Sample Power statistics, SPSS 11.5, Syntax reference guide for SPSS Base. SPSS Inc., 233 South Wacker Drive, Chicago.

Toharmat, T.. Nonaka, I.. Shimizu, M., Kume, S. 1999. Changes of blood composition of periparturient cows in

relation to time of day Asian-Aus J. Anim. Sci. 12 (7) :1111-1115.

Trevisan M., Browne R., Ram et al., 2001."Correlates of markers of oxidative status in the general population," American Journal of Epidemiology. 154 (4):348–356.

Turk, R., Juretic, D., Geres, D., Turk, N., Rekic, B., Simeon-Rudolf, V., Svetina, A. 2004. Serum paraoxonase activity and lipid parameters in the early postpartum period of dairy cows. Res.Vet. Sci.76:57-61.

Waller, K. P. 2000. Mammary gland immunology around parturition. Influence of stress, nutrition and genetics. Adv. Exp. Med. Biol. 480: 231-245.

Young D.S.1995. Effect of Drugs on Clinical laboratory Te sts, 4th Ed.p.3-190 to 3-211.

Zeinab Kh. E. 2007. blood profile test in dairy cow with a particular reference to downer cow syndrome. M.V.Sc. Thesis, Fac. Vet. Med. Alex. University.