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Assessment of Age Effect on Serum Metabolite and Mineral Profile of Crossbred Calves

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A B S T R A C T

This study was conducted to evaluate the impact of age (from birth to three months) on serum metabolites and minerals in crossbred calves. The research was carried out on six apparently healthy crossbred calves (aged 0-3 months) of similar physiological status. Blood samples were collected from the experimental animals on 0, 3, 7, 10, 15, 30, 45, 60, 75 and up to 90 days age of calves. Five of whole blood from each animal was collected in clot activator vaccuttainer. Serum was separated and analyzed for serum metabolites and minerals. Significantly ($P < 0.05$) highest concentration of serum glucose and uric acid were observed on the day of birth, while the lowest concentration was observed on 90th day. Significantly ($P < 0.05$) lowest concentration of serum BUN, total protein, and cholesterol was observed on the day of birth whereas, the highest concentration of BUN, total protein and cholesterol was observed on 90th day after birth. Serum creatinine concentration was highest on 3rd day and decreased abruptly on 7th day. The overall level of creatinine was fluctuating from birth to 90th day of life. Among minerals, significantly ($P < 0.05$) highest concentration of calcium and magnesium were observed on the day of birth, while the lowest concentration was observed on 90th day of life. Serum concentration of inorganic phosphorus was significantly ($P < 0.05$) lowest on the day of birth, while the highest concentration was observed on 90th day. It could be concluded that the age is having significant effect over all metabolites and minerals.

Keywords

Metabolites, Minerals, Crossbred calve

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Introduction

The most vulnerable period in the life of any animal is the period after birth. In all species, the neonatal period represents a critical time during which all organ functions must adapt to the extra-uterine life. It is a transition phase from the sheltered intra-uterine to the exposed extra-uterine environment (Piccione *et al.*, 2008).

The analysis of blood biochemical indicators is a fast and reliable method for the evaluation of animal health. The blood concentrations of many constituents in calves change dramatically with age, particularly during their first week of life (Birgele and Ilgaza, 2003; Mohammad, 2009).

In all animal species, the interval from birth to 30 days of age, known as the neonatal period, represents a delicate phase during which the metabolic profile, the serum and biochemical characteristics undergo a differentiation (Mohri *et al.*, 2007; Piccione *et al.*, 2008 and Piccione *et al.*, 2010).

The metabolic responses that occur during the transition from a fetal to neonatal life represent a transition from an unstable to a more stable status. The newborn becomes engaged in a series of profound metabolic and morphological changes that are known as the adaptive period (Piccione *et al.*, 2007). In fact, it is recognized as the most vulnerable period in the life of animals because of the high mortality and morbidity, which are more relevant during the first day of life (Piccione *et al.*, 2008; Piccione *et al.*, 2009; Piccione *et al.*, 2010). In early weaning strategies, calves are fed limited amount of milk along with good quality and highly fermentable starter feed (Sweeney, 2010).

Materials and Methods

The research was approved by the Institutional Animal Ethics Committee (IAEC, No.: 227/VPY/2016). The present study was conducted in the Department of Veterinary Physiology and Biochemistry, College of Veterinary Science & A. H., Anand Agricultural University, Anand on six crossbred calves maintained at Instructional Livestock Farm Complex (ILFC) of Department of Livestock Production Management at College of Veterinary Science & A.H., Anand from birth to three months of age. The experimental animals were reared in semi-open housing system which is made up of concrete floor under asbestos roofed housing system constructed east west direction and well covered with trees. These experimental calves were separated from other animals in pakka shed house. The experimental animals were maintained on ICAR feeding standards, 1998. The serum metabolites viz. glucose, blood urea nitrogen, total protein, creatinine, uric acid, cholesterol and minerals like calcium, inorganic phosphorus and magnesium were analyzed using Diagnostic kits manufactured by Crest Biosystems, Coral Clinical Systems, Goa, by Spectrophotometer (model Visiscan 167). Blood samples were collected from the experimental animals on 0, 3, 7, 10, 15, 30, 45, 60, 75 and up to 90 days age of calves. Five ml of whole blood from each animal was collected aseptically from jugular vein from birth to three months of age in clot activator vacutainer. Serum was separated by centrifugation at 3000 rpm for 15 minutes and stored at -20 ℃ in deep freeze until analyzed for serum metabolites like glucose, blood urea nitrogen, total protein, creatinine, uric acid, cholesterol and minerals like calcium, inorganic phosphorus and magnesium. The data was analyzed using completely randomized design (CRD) and significance was tested by Duncan's New Multiple Range Test (DNMRT).

Results and Discussion

In the present experiment, significantly ($P < 0.05$) highest concentration of serum glucose and uric acid were observed on the day of birth (117.31 ± 1.01 mg/dl and 7.40 ± 0.62 mg/dl, respectively), while the lowest concentration was observed on 90th day (81.25 ± 0.72 mg/dl and 2.62 ± 0.13 mg/dl, respectively). The trend was that both glucose and uric acid decreased significantly ($P < 0.05$) from the day of birth to 90th day of life with the mean value of 98.46 ± 1.08 mg/dl and 7.40 ± 0.62 mg/dl, respectively. Significantly

(P < 0.05) lowest concentration of serum BUN, total protein, and cholesterol were observed on the day of birth (22.11 ± 2.91 mg/dl, 4.82 ± 0.46 g/dl and 56.72 ± 8.04, respectively) whereas, the highest concentration of BUN, total protein and cholesterol was observed on 90th day (37.36 ± 1.32 mg/dl, 6.77 ± 012 g/dl and 116.28 ± 7.05 mg/dl, respectively) after birth.

Significantly (P < 0.05) increasing trend for BUN, total protein and cholesterol from the day of birth to 90th day of life with the mean value of 22.11 ± 2.91 mg/dl, 4.82 ± 0.46 g/dl and 56.72 ± 8.04 mg/dl, respectively was observed. Serum creatinine concentration was highest on 3rd day (1.33 ± 0.30 mg/dl) and decreased abruptly on 7th day (0.92 ± 0.23 mg/dl). The overall level of creatinine was fluctuating from birth to 90th day of life with the mean value of 0.96 ± 0.07 mg/dl in crossbred calf in the present study. The data is depicted in Table 1.

Among minerals, significantly (P < 0.05) highest concentration of calcium and magnesium were observed on the day of birth (11.81 ± 0.04 mg/dl and 2.52 ± 0.01 mg/dl, respectively), while the lowest concentration was observed on 90th day (9.31 ± 0.04 mg/dl and 1.76 ± 0.01 mg/dl, respectively) of life. Both calcium and magnesium values were decreasing from the day of birth to 90th day of life with the mean value of 10.48 ± 0.05 mg/dl and 2.01 ± 0.01, respectively.

Serum concentration of inorganic phosphorus was significantly (P < 0.05) lowest on the day of birth (4.45 ± 0.01 mg/dl), while the highest concentration was observed on 90th day (5.22 ± 0.03 mg/dl). The trend of phosphorus showed increasing level of phosphorus from the day of birth to 90th day of life with the mean value of 4.85 ± 0.02 mg/dl in crossbred calf was observed. The data is depicted in Table 2.

Glucose is a primary source of energy, playing a vital role in metabolism of animal body. Contrary to monogastric animals, ruminants fulfill majority of their glucose requirements through the process of gluconeogenesis. However, young calves during their pre-ruminant stage rely heavily on milk as major source of energy.

The decrease in concentration was more prominent at week 8 of age as well as at the end of experiment (week 12). The decrease in blood glucose concentration at week 4 and 12 may be attributed reduced milk intake and higher starter intake (Rashid *et al.,* 2013). The decreased glucose concentration in calf probably due to of higher thyroid status which mobilizes its resources to derive more energy and due to peak basal metabolic rate at birth (Ingole *et al.,* 2012).

A dynamic increase in BUN concentration in blood plasma of calf from birth till the 3rd day of life probably reflects enhanced protein degradation and deamination of amino acids after protein-rich food ingestion and may also indicate a high rate of tissue remodelling (Nussbaum *et al.,* 2002). According to Takagi *et al.,* (2008), the increase in hepatic urea synthesis is a consequence of increased activity of urea cycle enzymes and also enhanced ammonium production.

The increase in blood plasma protein level during the first 24 hours of life probably reflects an enhanced period of intestinal permeability for immunoglobulins (Hammon *et al.,* 2002).

Kurz and Willet (1991) claimed that a radical decrease in blood plasma creatinine concentration reflects the increase in glomerular filtration rate (GFR). Creatinine is not reabsorbed in renal tubules and 10-20% of its total amount which is excreted with urea originates from tubular secretion.

Table.1 Mean (±SEM) values of metabolic profiles in crossbred calves (n=6) from birth to 90 days

Days	Glucose (mg/dl)	BUN (mg/dl)	Total Protein (g/dl)	Creatinine (mg/dl)	Uric acid (mg/dl)	Cholesterol (mg/dl)
0	117.31^{a}±1.01	22.11^{c}±2.91	4.82^{c}±0.46	1.17^{a}±0.27	7.40^{a}±0.62	56.72^{c}±8.04
3	112.36^{b}±1.26	22.67^{c}±2.62	5.12^{c}±0.44	1.33^{a}±0.30	6.54^{ab}±0.60	64.79^{c}±14.82
7	108.33^{c}±1.15	26.42^{bc}±1.96	5.53^{bc}±0.29	0.92^{a}±0.23	5.82^{bc}±0.55	91.47^{ab}±9.90
10	103.77^{d}±1.31	27.38^{bc}±2.16	6.12^{ab}±0.20	1.00^{a}±0.22	5.10^{cd}±0.37	89.67^{b}±4.38
15	99.47^{e}±1.49	30.49^{ab}±2.06	6.25^{ab}±0.19	1.25^{a}±0.25	4.30^{de}±0.19	97.53^{ab}±5.02
30	95.44^{f}±1.20	31.61^{ab}±2.05	6.34^{ab}±0.19	1.08^{a}±0.39	3.91^{def}±0.19	100.85^{ab}±4.71
45	92.83^{f}±0.84	34.40^{a}±2.68	6.45^{a}±0.15	0.92^{a}±0.23	3.56^{efg}±0.20	103.69^{ab}±4.86
60	88.93^{g}±0.93	35.36^{a}±1.60	6.54^{a}±0.14	0.67^{a}±0.10	3.20^{efg}±0.17	107.29^{ab}±4.77
75	84.89^{h}±0.48	37.12^{a}±1.68	6.64^{a}±0.12	0.75^{a}±0.11	2.91^{fg}±0.16	113.63^{ab}±7.61
90	81.25^{i}±0.72	37.36^{a}±1.32	6.77^{a}±0.12	0.58^{a}±0.08	2.62^{g}±0.13	116.28^{a}±7.05
GM	**98.46±1.08**	**30.49±2.16**	**6.06±0.26**	**0.96±0.07**	**4.54±0.37**	**94.19±7.76**
CV%	**2.69**	**17.37**	**10.70**	**61.34**	**20.24**	**20.20**
$CD_{0.05}$	**3.074**	**6.148**	**0.753**		**1.067**	**22.080**

Values having different superscripts differed significantly (P < 0.05) within column

Table.2 Mean (±SEM) values of minerals in crossbred calves (n=6) from birth to 90 days

Days	Calcium (mg/dl)	Inorganic Phosphorus (mg/dl)	Magnesium (mg/dl)
0	11.81^{a}±0.04	4.45^{h}±0.01	2.52^{a}±0.01
3	11.52^{b}±0.07	4.53^{g}±0.02	2.32^{b}±0.02
7	11.15^{c}±0.06	4.64^{f}±0.01	2.08^{c}±0.01
10	10.83^{d}±0.04	4.74^{e}±0.02	2.02^{d}±0.01
15	10.56^{e}±0.06	4.81^{e}±0.03	1.97^{e}±0.01
30	10.28^{f}±0.06	4.90^{d}±0.02	1.91^{f}±0.01
45	10.05^{g}±0.06	4.98^{cd}±0.03	1.88^{fg}±0.01
60	9.81^{h}±0.03	5.06^{bc}±0.02	1.84^{gh}±0.01
75	9.49^{i}±0.06	5.13^{ab}±0.02	1.80^{hi}±0.01
90	9.31^{j}±0.04	5.22^{a}±0.03	1.76^{i}±0.01
GM	**10.48±0.05**	**4.85±0.02**	**2.01±0.01**
CV%	**1.37**	**1.37**	**1.96**
$CD_{0.05}$	**0.167**	**0.077**	**0.046**

Values having different superscripts differed significantly (P < 0.05) within column

The increase in total cholesterol level in the present study is because at birth and before having received colostrum, serum from calves contains cholesterol only in the free form and that in very small quantities. Soon after nursing for the first time cholesterol ester appears in the blood serum and the total cholesterol content of the blood serum begins to increase (Shope, 1928). In the present study, higher level of calcium during early days of life is due to the colostrum intake. Colostrum is a rich source of calcium. During early days of life the requirement of calcium is the result of growing calves, since calcium is responsible for stimulation of osteoblast growth and thus whole skeletal development. Increase in the phosphorus level with age is involved in energy utilization and transfer, acid-base and osmotic balance and for ruminal microbes for growth and cellular metabolism in calf. The higher level of serum magnesium during early days of life is a consequence of enhanced magnesium utilisation (along with calcium and phosphorus) for bone mineralization and also decreased Mg availability from ingested food (Mohammad, 2009). The main mechanism of Mg homeostasis takes place at the renal level (Quamme, 1993). During Mg deprivation, the kidney avidly conserves the body Mg.

Based on these findings, it could be concluded that, biochemical metabolites viz. glucose, blood urea nitrogen, total protein, creatinine, uric acid and cholesterol and minerals like calcium, inorganic phosphorus and magnesium having significant variation during pre-weaning period of crossbred calf.

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