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ORIGINAL ARTICLE

CHANGES IN SERUM ENZYMES LEVELS ASSOCIATED WITH LIVER FUNCTIONS IN STRESSED *MARWARI* GOAT

Kataria[1*] N., A.K. Kataria[2], M. Chaturvedi[1] and A. Sharma[1]

[1] *Department of Veterinary Physiology, College of Veterinary and Animal Science, Rajasthan University of Veterinary and Animal Sciences, Bikaner – 334 001, India*

[2]*Apex Centre for Animal Disease Investigation, Monitoring and Surveillance, College of Veterinary and Animal Science, Rajasthan University of Veterinary and Animal Sciences, Bikaner – 334 001, India*

Phone: 0091 – 151 - 2546399

**Email-* nalinikataria@rediffmail.com

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The liver is embellished with diverse metabolic activities, and evaluation of its functional status is dependent upon its ability to perform a specific metabolic function. A number of tests have been devised for the detection of alterations in hepatic functions out of which the measurement of serum enzyme activity is very important in clinical cases (Varley, 1988). Generally enzyme levels in serum increase due to increased membrane permeability, cell necrosis or cytosol leakage in the serum

(Alemu *et al.,* 1977), therefore liver cell damage due to toxic agents, injury or diseases has been detected in domestic animals by measuring the activity of liver specific enzymes in the serum. The important enzymes related with hepatic functions are alkaline phosphatase, gamma glutamyl transferase, 5'-nucleotidase, aspartate aminotransferase, alanine aminotransferase, ornithine carbamoyl transferase, glutamate dehydrogenase, sorbitol dehydrogenase, arginase (Tennant, 1999), lactic dehydrogenase, aldolase, isocitric dehydrogenase and glucose -6-phosphatase (Wolf and Williams, 1973).

To determine the diagnostic value of the blood serum level of the enzyme it is necessary to carry out investigations in stressed animals when affected with various diseases (Goranov, 1984) and then compare them with the normal range of values given for those animals, preferably of the same breed, and in similar environmental conditions. *Marwari* is a breed of goat in arid tract playing an important role in the economy of marginal farmers and labourers. It is a melancholy that despite of immense quality characteristics of *Marwari* breed very little attention has been paid on this aspect. Studies on serum enzymes of hepatic functions have not been well documented for *Marwari* breed. Therefore, the present investigation was planned to determine variations in serum enzymes of hepatic functions in clinically affected *Marwari* goat.

Materials and methods

Serum enzyme levels were determined in adult goat of *Marwari* breed belonging to farmers' stock of arid tract of Rajasthan state, India. The animals were grouped into healthy (220) and stressed (180). In healthy animals the blood samples were collected as a part of routine health checkup during moderate ambience (maximum temperature varied between 26 and 29 ^{0}C). The stressed group comprised of gastrointestinal parasiticised (30), pneumonia affected (50) and drought affected (100) irrespective of sex.

All the samples were collected in sterile tubes without anticoagulants for serum separation. The serum enzymes included were sorbitol dehydrogenase (SDH, E.C.1.1.1.14), malate dehydrogenase (MDH,E.C.1.1.1.37), glucose-6-phosphate-dehydrogenase(G6PD, E.C.1.1.1.49), glutamate dehydrogenase (GD, E.C.1.4.1.3), ornithine carbamoyl transferase (OCT, E.C.2.1.3.3), gamma-glutamayl transferase (γGT, E.C. 2.3.2.2), 5'nucleotidase (5'NT, E.C. 3.1.3.5), glucose-6-phosphatase (G-6-Pase, E.C. 3.1.3.9), arginase (ARG, E.C. 3.5.3.1), and aldolase (ALD, E.C. 4.1.2.7). They were determined by the methods as described by King (1965) for SDH, MDH, G6PD, GD and G-6- Pase; by Brown and Grisolia (1959) for OCT; by Wolf and William (1973) for γGT; by Varley (1988) for 5'NT; by Manning and Grisolia (1957) for ARG and by Sibley and Lehninger (1949) for ALD. Serum enzyme activities were measured according to the specific reaction of each enzyme by using basic standard techniques. The required temperature maintenance was carried out according to the method for each enzyme and wherever required, necessary temperature corrections were done. All results of enzyme activities were expressed as per SI units in Units/litre written as U/l.

Statistical significance for individual parameter between healthy and affected group was analysed as per Snedecor and Cochran (1967).

Table 1. Mean ± SEM values of serum enzymes in *Marwari* goats

Serum enzymes Ul^{-1}	Healthy Group (220)	Stressed group (180)		
		Gastrointestinal parasiticised (30)	Pneumonia affected (50)	Drought affected (100)
SDH	12.5±0.12	70.8±3.44[b]	24.2±0.57[b]	54.2±4.2[b]
MDH	39.1±1.12	127.1±3.41[b]	48.1±2.43[b]	100.3±3.4[b]
G6PD	3.8±0.01	25.4±1.2[b]	12.5±1.2[b]	23.2±0.09[b]
GD	25.2±0.9	118.2±5.22[b]	40.2±4.4[b]	110.2±4.3[b]
OCT	13.8±1.0	130.4±2.55[b]	22.0±2.20[b]	127.6±5.44[b]
γGT	24.5±1.3	119.8±2.5[b]	30.8±1.9[b]	112.5±4.3[b]
5'NT	17.5±1.78	76.5±2.3[b]	30.7±3.3[b]	70.5±4.3[b]
G-6-Pase	2.7±0.08	60.7±5.08[b]	10.7±0.08[b]	59.7±5.6[b]
ARG	9.9±0.09	65.3±3.17[b]	19.3±1.0[b]	58.3±2.6[b]
ALD	9.1±0.08	59.3±2.0[b]	17.3±0.9[b]	50.4±2.0[b]

Figures in the parenthesis indicate number of animals.

Superscript 'b' indicates a significant difference ($p \leq 0.05$) from repective healthy mean value.

SDH = Sorbitol dehydrogenase

MDH= Malate dehydrogenase

G6PD=Glucose- 6- phosphate dehydrogenase

GD= Glutamate dehydrogenase

OCT = Ornithine carbamoyl transferase

γGT= Gamma glutamyl transferase

5'NT= 5 nucleotidase

G-6-Pase=Glucose- 6- phosphatase

ARG= Arginase

ALD=Aldolase

Results and Discussion

The mean values of serum enzymes are presented in table 1. In stressed group the mean values of all the enzymes increased significantly ($p \leq 0.05$) as compared to respective healthy mean value. All the enzymes showed highest values in the gastrointestinal parasiticised animals and least values in the animals having pneumonia. In gastrointestinal parasiticised animals maximum change was observed in G-6-Pase activity. It was 22.48 times of healthy mean value. Minimum change was observed in MDH mean value which was 3.25 times.

Sorbitol dehydrogenase is a liver specific enzyme and normally its concentration remains low in plasma (Shaw,1974). Increased activity is indicative of acute hepatitis (Deritis *et al.,*1965); hepatic dysfunctions and hepatocyte damage (Asquith *et al*., 1980) and is useful in assessment of hepatocellular injury in domestic animals (Tennant, 1999). Serum SDH activity is a reliable diagnostic test for infective hepatitis (Raghavendra and Rao, 2000). Malate dehydrogenase is an enzyme of immense significance in citric acid cycle. Malate dehydrogenase is also important in gluconeogenesis. Higher activity of MDH indicated the strategies of the animal to modulate the metabolic pathways for energy generation and glucose synthesis from noncarbohydrate precursors as in ruminants the

major portion of carbohydrate available is supplied by gluconeogenesis (Abdel-Fattah *et al*., 2002).

Higher levels of G6PD are important for glucose oxidation through the hexose mono phosphate (HMP) shunt. This pathways is essential for synthesis of fat and is the major source of NADPH, which maintains the reductive environment for all biosynthetic processes using NADPH as a cofactor (Kaneko *et al.,* 1999). Glutamate dehydrogenase, a complex allosteric enzyme, plays a central role in amino group metabolism. Whenever a hepatocyte needs fuel for citric acid cycle, GD activity increases, making alpha-ketoglutarate available and releasing NH_4^+ for excretion. This enzyme is highly concentrated in liver of goat (Keller, 1971). It is associated with microsomal function of hepatocytes and is released following acute liver damage (El Samani, 1985). The estimation of GD as a liver function test is being emphasized in goat (Tennant, 1999).

Ornithine carbamoyl transferase is an important enzyme of urea cycle taking place inside the hepatocytes. Liver disease can produce increase in the OCT activity (Tsuchiya, *et al.,* 1994). Determination of its serum level is important for detection of liver diseases and is used as an indicator of extent of hepatocellular damage. It is important in all phases of hepatic necrosis. Serum levels of OCT are also elevated even in chronic diseases when there is an active liver necrosis (Blood *et al*., 1979).

Serum γGT is commonly used indicator of hepatobiliary disease in cattle, sheep, goat and horse (Saeed and Hussain, 2006). γGT is considered as a serum marker for diseases of hepatobiliary system and is now in general use for the diagnosis of liver diseases in animals. Liver is the primary source of the enzyme 5'-nucleotidase (5'-NT) in goats. The determination has been most used in the cases where rise in serum ALP activity is there. Serum 5'NT increases in diseases of liver and biliary tract in a roughly parallel manner. Serum levels of 5'NT rises in obstructive jaundice (Kowlessar, *et al*., 1961); Inflammatory hepatic disease (Bardauill and Chang, 1962) and damage in the liver tissues (El Samani, 1985).

Glucose-6-phosphatase enzyme is normally present in the microsomes of the liver cells. Glucose-6-phosphatase can increase markedly in acute viral hepatitis or toxic necrosis of liver (Koide and Oda, 1959). Glucose-6-phosphate is dephosphorylated by G-6-Pase to yield free glucose which is exported to replenish blood glucose (Lehninger *et al.,* 1993). Measurement of G-6-Pase is important in assessing gluconeogenic activity (Weber *et al*.,1965). Serum arginase elevations have been demonstrated in progressive hepatic necrosis with unfavorable prognosis (Tennant, 1999); in naturally occurring liver diseases of goats (Adam *et al*., 1974); hepatocellular damage in goats (Braun *et al*.,1986), making it a useful tool for diagnosis of liver diseases. Elevated levels of serum ALD are useful predictors of liver damage (Alemu *et al.,*1977); acute viral hepatitis or hepatic necrosis due to chemicals or drugs (Sibley and Fleisher, 1954); acute and chronic hepatic damage (Katz and Ducci, 1958); and myocardial infarction in animals (Chazov and Savina, 1958). As per the available literature it can be stated that the present investigation may be the first to provide values of certain serum enzymes *viz*. SDH, MDH, GD, G-6-PD, OCT, GGT, 5'NT, G-6-P, ARG, ALD etc. in healthy and clinically affected *Marwari* breed of goat which is indigenous to arid tract in India. The variations observed in the present study could help in realistic evaluation of the management practice, nutrition and diagnosis of disease conditions as all

the enzymes investigated in this study belonged to the class whose level in the blood can be used diagnostically to determine the level of damage or dysfunction of liver.

Conclusion

Increased activity of all the serum enzymes determined in the present study showed the modulation of liver functions directly or indirectly as these enzymes are either formed by hepatocytes or participate in metabolic processes. It was concluded that any stress to the body can affect the liver functions as a part of stress alleviation response. The present study provided the normal values of these enzymes in the goats at one platform which could be helpful in the evaluation of hepatic functions in clinical cases.

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