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Effect of dietary *Phyllanthus emblica* supplementation on biochemical stability of heat stressed Salem Black Goats

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Abstract

The present study was conducted to evaluate the influence of heat stress and *Phyllanthus emblica* powder supplementation on the blood biochemical responses of Salem Black goats under tropical environmental conditions. Adult Salem Black does of uniform age and body weight were randomly divided into different experimental groups comprising control, heat-stressed and supplemented animals. The experimental animals were maintained under varying environmental conditions, including exposure to natural sunlight, while the supplemented group received *Phyllanthus emblica* powder regularly throughout the study period. Meteorological observations recorded during the experimental period indicated exposure of animals to severe heat stress conditions. The biochemical parameters assessed included plasma total protein, albumin and globulin concentrations at different intervals during the experimental period. Heat stress produced noticeable alterations in the biochemical profile of goats, particularly in the non-supplemented heat-stressed group. A progressive decline in plasma total protein, albumin and globulin concentrations was observed under heat stress conditions, indicating adverse effects on metabolic and physiological status. In contrast, goats supplemented with *Phyllanthus emblica* powder maintained comparatively better biochemical stability and showed values closer to the control group throughout the study period. The findings of the study suggest that heat stress exerts detrimental effects on the blood biochemical constituents of Salem Black goats, whereas supplementation with *Phyllanthus emblica* powder helps in alleviating these adverse effects and improves the adaptive capacity of goats under thermal stress conditions.

Keywords: Heat stress, *Phyllanthus emblica*, Salem Black goats, Blood biochemical parameters.

1. Introduction

Indigenous goat breeds are naturally adapted to harsh agro-climatic environments and are capable of surviving under poor feeding and stressful conditions more efficiently than exotic and crossbred animals (Akinyi, 2008) ^[1]. Their smaller body size and adaptive genetic potential enable them to maintain stable productivity even under limited nutritional and environmental resources (Nyamushamba *et al.*, 2017) ^[7]. Among the different climatic stressors, heat stress is considered one of the major factors affecting livestock production, welfare and physiological stability, especially in tropical and subtropical regions (Banerjee *et al.*, 2014) ^[3]. Prolonged exposure to elevated environmental temperatures adversely affects metabolic activities, growth and reproductive efficiency in goats. Salem Black goats, an important indigenous meat breed of Tamil Nadu, are well suited to hot and humid climatic conditions and are commonly reared in Salem, Dharmapuri, Krishnagiri, Erode and Namakkal districts (Aleena *et al.*, 2018) ^[2]. However, continuous heat load can still induce physiological and biochemical disturbances. Nutritional supplementation using antioxidants has been suggested as a practical strategy to alleviate heat stress where conventional cooling systems are difficult to adopt (Kumar, 2009) ^[6]. *Phyllanthus emblica* (amla), a rich natural source of vitamin C, flavonoids and polyphenols, possesses strong antioxidant properties that help reduce oxidative stress and improve thermotolerance in goats (Randhawa *et al.*, 2013) ^[9].

Materials and Methods

The experiment was carried out at Livestock Farm Complex, Veterinary College and Research Institute, Namakkal, located between approximately 11°00'–12°55' N latitude and 77°28'–78°50' E longitude, at an elevation of approximately 192 m above mean sea level. The experiment was conducted during the summer season (March – May). The trial was carried out using eighteen adult, non-pregnant Salem Black does (3–5 years), randomly allotted into three groups (n = 6): T₁ (pen-housed control), T₂ (sunlight exposure from 10:00 a.m. to 4:00 p.m. without supplementation) and T₃ (sunlight exposure with *Phyllanthus emblica* supplementation at 15 g/day/goat), following one week of acclimatization. The average meteorological data for the entire study period both inside the shed as well as outside are given in Table 1. Temperature-humidity index (THI) was calculated using the formula (Marai *et al.*, 2007): $THI = [(0.8 \times T_{db}) + \{(RH/100) \times (T_{db} - 14.4)\} + 46.4]$; where T_{db} is dry bulb temperature (°C) and RH is relative humidity in per cent.

Blood samples were collected aseptically from the external jugular vein of experimental goats at fortnightly intervals using heparinized tubes. Plasma was separated by centrifugation and stored at –20°C until further biochemical and endocrine analyses. Parameters including total protein, albumin, globulin were estimated periodically throughout the study.

Results

Plasma biochemical parameters were markedly influenced by heat stress during the experimental period. Plasma total protein, albumin and globulin concentrations showed a progressive decline in heat-stressed goats without supplementation (T₂), with significantly lower (P < 0.05) values observed on the 30th and 45th day compared to control (T₁) and supplemented goats (T₃). The reduction was more pronounced on the 45th day, where T₂ recorded the lowest

total protein (4.61 ± 0.11 g/dL), albumin (3.91 ± 2.68 g/dL) and globulin (1.91 ± 2.45 g/dL) levels. In contrast, *Phyllanthus emblica* supplemented goats (T₃) maintained biochemical values closer to control animals, indicating the ameliorative effect of supplementation against heat stress-induced alterations in protein metabolism.

Discussion

Total protein, albumin and globulin are considered important indicators of nutritional and physiological status in livestock exposed to environmental stress conditions (Attia *et al* 2016). In the present study, plasma total protein, albumin and globulin concentrations showed a progressive decline in heat-stressed goats without supplementation (T₂), particularly on the 30th and 45th day of the experiment. The reduction in these parameters may be attributed to decreased feed intake, altered protein metabolism and enhanced protein catabolism during heat stress conditions. Similar reductions in plasma protein fractions under heat stress were previously reported in goats and sheep by Singh *et al* (2016) [11] and Pandey *et al* (2012) [8], who attributed these changes to impaired hepatic synthetic activity and increased maintenance energy requirements during thermal stress.

In contrast, goats supplemented with *Phyllanthus emblica* (T₃) maintained plasma total protein, albumin and globulin values closer to control animals throughout the study period, indicating the protective effect of supplementation against heat stress-induced metabolic alterations. Similar ameliorative effects of herbal antioxidant supplementation on plasma protein profile under heat stress conditions were also reported by Banerjee *et al* (2015) [4] and Sejian *et al* (2013) [10]. However, Helal *et al* (2010) [5] observed increased plasma protein and albumin concentrations during short-term heat exposure in goats, which could be due to differences in duration and intensity of heat stress as well as breed adaptability.

Table 1: Average weather parameters both inside and outside the shed for entire study period

	Time of recording	DBT (°C)	WBT (°C)	Max T (°C)	Min T (°C)	RH (%)	AT (°C)	PST (°C)
Inside	Morning (8.00 h)	24.1±0.09	17.9±0.15	39.8±1.35	21.8±0.82	55.1±1.39	26.1±0.29	24.7±0.15
	Afternoon (14.00 h)	26.3±0.11	22.1±0.21	40.6±0.83	23.8±1.15	34.5±1.19	33.8±0.25	31.1±0.32
Outside	Morning (8.00 h)	25.1±0.45	22.8±0.29	40.3±1.18	23.5±0.89	57.2±2.17	28.1±0.59	28.6±0.44
	Afternoon (14.00 h)	33.9±0.39	28.5±0.38	41.5±1.21	24.7±1.05	28.8±1.25	38.1±0.42	45.9±0.38

DBT- Dry Bulb Temperature; WBT- Wet Bulb Temperature; Min T- Minimum Temperature; RH- Relative Humidity; AT- Ambient Temperature; PEN – Pen Surface Temperature

Table 2: Effect of heat stress on blood biochemical responses in Salem Black goats

Attributes	Days	Control - Pen(T ₁)	Direct sunlight exposure (T ₂)	Sunlight exposure with amla Supplement (T ₃)	P value
Plasma Total Protein (g/dL)	0	5.83±0.29	5.42±0.12	5.54±0.05	0.764
	15	6.15±0.23	5.28±0.28	5.61±0.11	0.621
	30	6.48 ^b ±0.16	4.92 ^a ±0.81	6.14 ^b ±0.25	0.031
	45	6.89 ^c ±0.26	4.61 ^a ±0.11	6.28 ^b ±0.11	<0.001
Plasma Albumin (g/dL)	0	4.93±1.15	4.99±0.92	4.95±0.28	0.982
	15	5.08±2.05	4.82±2.41	4.97±2.87	0.963
	30	5.11±2.65	4.32±2.35	5.01±2.38	0.058
	45	5.09 ^b ±3.02	3.91 ^a ±2.68	5.07 ^b ±2.58	<0.001
Plasma Globulin (g/dL)	0	2.66±2.11	2.63±0.58	2.65±4.33	0.552
	15	2.69±1.54	2.58±1.35	2.64±2.11	0.443
	30	2.71 ^{ab} ±2.56	2.10 ^a ±1.92	2.71 ^{ab} ±1.35	0.015
	45	2.74 ^b ±1.48	1.91 ^a ±2.45	2.78 ^b ±0.78	<0.001

Means with atleast one common superscript within same row do not differ significantly (p > 0.05)

Number of observations (n) = 6

Conclusion

The study revealed that heat stress significantly affected the biochemical profile of Salem Black goats by reducing plasma

total protein, albumin and globulin concentrations in non-supplemented animals. These changes indicate impaired metabolic and physiological stability under thermal stress

conditions. Supplementation with *Phyllanthus emblica* powder effectively alleviated the adverse effects of heat stress and maintained biochemical parameters closer to normal values. The findings suggest that *Phyllanthus emblica* supplementation improves thermotolerance and adaptive capacity in Salem Black goats under tropical heat stress conditions. Therefore, it can be recommended as a beneficial nutritional strategy for maintaining goat health and productivity during summer stress.

Conflict of Interest

Not available

Financial Support

Not available

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