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Research Article

Effect of Dry Ginger Powder Supplementation on Growth Performance, Rumen pH and Selected Blood Metabolites in Beetal Bucks Under Heat Stress Condition

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Abstract

This study was designed to evaluate the effect of dry ginger powder supplementation on production performance, rumen pH and selected blood metabolites of Beetal bucks raised under heat stress conditions. Eighteen Beetal bucks weighing 34.5 ± 2.5 kg; 12 ± 1 month of age were randomly assigned to one of the three dietary treatments in a complete randomized design, (1) 0, (2) 500 mg/kg/day, (3) 1000 mg/kg/day dry ginger powder and labelled as C, GP 0.5 and GP 1.0, respectively. All bucks were adapted to a basal based diet for 1 weeks prior to the start of the experiment. Treatment diets were fed from d 0 to 56. Blood was collected on d 0, 14, 28 and 56 days for analysis of plasma cortisol, BUN. Intakes were recorded daily and individual body weights were measured weekly. Bucks were fed their respective diets for ad libitum intake. Data regarding dry matter intake (DMI), body weight (BW) gain, feed efficiency (FE) and selected blood metabolites were collected. It was found that DMI was 7.4% higher in GP 0.5 as compare to GP 1.0 and C. Results shows that BW and FE was 21.8% and 15.1% higher respectively in GP 1.0 and rumen pH was more stable in GP 1.0 and cortisol level was lowest in GP 1.0 as compared to GP 0.5 and C. It was concluded that the GP 1.0 group showed higher performance than other treatments in weight gain, feed efficiency and blood metabolites.

Keywords: *Dry Ginger Powder; Beetal Bucks; Heat Stress*

Introduction

Pakistan has 74.1 million goats and ranked 3rd globally after china and India [1]. Even though these animals are resistant to harsh environmental conditions; however, the performance of these animals frequently decrease because of heat stress (HS) [2].

Currently, Heat Stress (HS) a major concern in the dynamic climatic context [3]. Heat stress outcomes are reduced performance, reproduction, production, milk volumes and quality, as well as natural immunity [4]. Feed intake remarkably decreased when temperature reaches up to 40ºC in dairy goats [5] due to decreased saliva production [6]. It is also documented that animals can make both physiological and behavioural adjustments in the existence of a stressful situation which can eradicate that period from being a stressor [7]. Heat stress has also been scientifically reputable to cause bad effect on the growth of animals. Different species depending upon their biological states have thermoneutral zone of temperature. Outside this limit, animal require extra energy for thermoregulation. Therefore, negative impact on growth and production [8].

As far as feed intake is concerned, it decreased when environmental temperature increased up to 40ºC in dairy goats [9]. During heat stress maintenance needs increased up to 30% [10] and due to decreased intake energy amount is not enough to meet up the everyday needs which caused reduction in body weights of animals [9]. To counter this situation of heat stress, many feed supplements and additives are used in field conditions. But recent research shows the importance of dry ginger powder as anti-oxidant and intake stimulant, anti-oxidant activity may help to decrease stress on animal. The significant increase in the daily intake in those groups which offered dry ginger powder [11]. Supplementation of 2 ml of ginger oil per day per goat significantly increased the milk yield [11]. Ginger contains chemical ingredients such as ginger diol and gingerol produced antioxidant activity [12]. The dry ginger powder contains about 88 - 91% dry material, 9 - 12% moisture, 9% crude protein, 3 - 6% ether extract, 3 - 8% fiber and about 8% ash [13]. Supplementation of ginger decreases the stress by decreasing the level of cortisol [14]. The active component of ginger stimulates digestion by increasing muscular activity of gastrointestinal tract (GIT) [13].

There was significant surge in milk yield of Holstein cow which supplemented with 50 gm ginger as compared to basal diet [15]. Ginger increases the absorption of both essential and other nutrients which improves the growth of animals [16]. Ginger essentially enhances the production and secretion of bile which helps in digestion and absorption of lipids [17]. Ginger also has gastrointestinal properties such as a potential to stimulate the reticulorumen contractions [18].

Purpose of the Study

The purpose of this study was to estimate the effects of various levels of dry ginger powder supplementation on growth performance and blood metabolites in Beetal bucks under heat stress. Keeping in view the long summer stress period and importance of dry ginger powder it was assumed that addition of dry ginger powder in feed may increase intake of animals under heat stress which ultimately affect the growth performance of bucks.

Materials and Methods

Animals management

The study was carried out at B-block, Small Ruminants Training and Research Centre (SRT&RC), UVAS, Ravi Campus, Pattoki. The experimental procedures were approved by Ethical Committee of University of Veterinary and Animal Sciences, Lahore. All samples were analyzed at the laboratory of Department of Animal Nutrition, Faculty of Animal Production and Technology, University of Veterinary and Animal Science (UVAS), Lahore.

Eighteen Beetal bucks (n = 18) having average body weight 34.5 ± 2.5 kg and average age 12 ± 1 months were divided into 3 groups with 6 bucks in each group and randomly assigned individual pens. The bucks were de-wormed for ecto and endoparasites during the adaptation period and vaccinated according to the farm routine practices. Diets were offered twice on the basis as 4% of live body weight at 08:00 and 16:00h. The ginger was dried and ground at 2 mm before supplementation.

Experimental design

The study duration was 63 days including 7 days of adaptation. The diets of animals group 2 (GP 0.5) and 3 (GP 1.0) were supplemented by 500 and 1000 mg/kg/d of dried ginger powder whereas group 3 served as control. Equal quantity of TMR were offered and dry ginger powder is mixed at the time of feeding according to group and weight of animal. The TMRs were formulated iso-nitrogenous containing 15 % CP and isocaloric having 2.53 Mcal ME/kg were fed 4% body weight on dry matter basis. To prepare TMR dry ingredients of concentrate were mixed. The required amount of concentrate was added with required amounts of silage into a double ribbon horizontal mixer and then mixed them properly. The concentrate was medium ground; the size of oat silage was 1 inch. Ad libitum fresh

and clean water was ensured to the calves during the entire experimental period. Nutrient composition of ration prepared and used in the study is shown in table 1.

Ingredients, %	Total mixed rations		
	C	GP 0.5	GP 1.0
Oat silage	45.0	45.0	45.0
Corn grain	18.0	18.0	18.0
Wheat bran	5.00	05.00	05.00
Sugar cane molasses	10.0	10.00	10.00
Soybean meal	10.0	10.00	10.00
Canola meal	10.0	10.00	10.00
Mineral mixture	2.00	2.00	2.00
Chemical Composition, %			
Dry matter	60.8	60.8	60.8
Crude protein	15.1	15.1	15.1
NDF	36.3	36.3	36.3
Acid detergent fiber	20.9	20.9	20.9
Ash	9.02	9.02	9.02
Metabolizable Energy (Mcal/kg DM)	2.53	2.53	2.53

S***Table 1:*** *Ingredients of the TMR on dry matter (%) basis offered to Beetal bucks in trial. 1) C. Control group. 2) GP 0.5. Dry ginger supplementation 500 mg/kg/day. 3) GP 1.0 Dry ginger supplementation 1000 mg/kg/day.*

Estimation of dry matter intake and body weight gain

The data regarding individual feed offered and refusal, if any, were collected on daily basis. Samples of feed offered and refusal were collected on weekly basis and were frozen at -20°C until further analysis during the experiment. Animals were weighed on fortnightly basis before feeding. Dry matter intake and body weight gain were calculated by using following formulae:

Dry matter intake (kg) = Dry matter offered (kg) - Dry matter refused (kg).

Body weight gain = Final body weight (kg) - Initial body weight (kg).

Sampling and analysis

The shed temperature and humidity were recorded on daily basis to calculate Temperature humidity index (THI) according to [19] by using the following formula: THI= (0.8 × temperature) + [(% (relative humidity)/100) × (temperature - 14.4)] + 46.4.

Feed samples were collected on weekly basis and oven dried at 72°C for 24 hours for dry matter and ground to 2 mm size by using Wiley mill. Finely grounded feed samples were used to determine crude protein, crude fat and ash [20].

Determination of blood metabolites

Fortnightly blood samples were collected 4h after the morning feeding from jugular vein in the EDTA vacutainer. Collected blood samples were centrifuged at 3000 rpm for 10 minutes to separate plasma. Harvested plasma samples were stored at -20°C. Plasma urea nitrogen, cortisol and glucose were analyzed by using colorimetric kits.

Determination of rumen pH

Rumen fluid samples were collected from all animals. Sampling was performed 3h post morning feeding on fortnightly basis by using the stomach tube. Immediately after collection, the rumen fluid pH was recorded by using a pH meter [11].

Economic analysis

The economic analysis was calculated by the cost of feed ingredients in the local market and the price of live body weight gain of calves. At the end of trial economics of the trial was calculated to check the efficiency of ginger powder. The economic analysis was done by using the following equation:

Cost for 1 kg gain = Total cost of feed intake/total weight gain (kg).

Statistical analysis

The weekly means data was analyzed by using repeated measure ANOVA on the SAS University Edition (SAS 9.4). Model included fixed effects of treatments, weeks and treatment into week interaction. Results were declared statistically significant at $P \leq 0.05$ and super-scripts were assigned on the basis of Tukey's test.

Results

The results showed that DMI was significantly higher in GP 0.5 group ($P = 0.02$). Body weight and FE was significantly higher in GP 1.0 ($P = 0.01$) and ($P = 0.04$) respectively. Non-significant difference among the treatments was observed regarding BUN, heart girth and respiration rate ($P > 0.05$) (Table 2 and 3). The results also showed that rumen pH was significantly stable in GP 1.0 ($P < 0.01$). Plasma cortisol level was significantly ($P < 0.001$) lower in GP 1.0 (Table 3). Regarding the results for economics group GP 1.0 was more efficient ($P = 0.02$) than other groups (Table 3).

Variables	Treatments[1]				P-value		
	Control	GP 0.5	GP 1.0	SEM	Trt	Week	Trt ×week
Total DMI (kg)	75.12^{b}	80.70^{a}	78.44^{ab}	0.886	0.024	-	-
DMI (kg/d)	1.34^{b}	1.44^{a}	1.40^{ab}	0.023	0.024	0.006	0.026
Total weight gain (kg)	5.91^{c}	6.58^{b}	7.20^{a}	0.159	< 0.001	-	-
ADG (g/d)	105.65^{c}	117.55^{b}	128.57^{a}	2.847	< 0.001	-	-
Feed efficiency[2]	0.079^{a}	0.081^{ab}	0.092^{b}	0.002	0.04	-	-
Average Body length (cm)	71.58^{b}	73.79^{a}	74.75^{a}	0.544	0.003	0.000	0.587
Average heart girth (cm)	71.95	72.04	72.25	0.671	0.951	0.483	0.487
Average respiration rate (counts/min)	47.11	46.72	42.94	1.780	0.265	0.742	0.494
Cost/kg (PKR)	452.15^{a}	430.44^{ab}	382.68^{b}	12.021	0.043	-	-

Table 2: *Effects of different levels of dry ginger powder supplementation on DMI, BW and BM and economics in Beetal bucks under heat stress.*

$P \leq 0.05$ indicate significant difference among the treatments.

SEM: Standard Error of the Mean.

1) C. Control group. 2) GP 0.5. Dry ginger supplementation 500 mg/kg/day. 3) GP1.0 Dry ginger supplementation 1000 mg/kg/day

[1]Feed efficiency = total weight gain (kg)/total dry matter intake (kg).

[2]Cost/kg weight gain = (Total feed intake on as such basis (kg)/total weight gain (kg)) × cost per kg

Variables	Treatments[1]				P-value		
	Control	GP 0.5	GP 1.0	SEM	Trt	Week	Trt × Week
Rumen pH	6.21[c]	6.48[b]	6.57[a]	0.016	< 0.001	0.50	0.10
Glucose (mg/dl)	85.01[a]	80.89[ab]	76.47[b]	1.93	0.04	0.99	0.92
BUN (mg/dl)	21.74	21.16	21.13	0.90	0.85	0.95	0.73
Cortisol (ng/ml)	22.10[a]	11.52[ab]	7.64[b]	2.99	< 0.001	0.76	0.87

Table 3: Effects of different levels of dry ginger powder supplementation on rumen pH and blood metabolites in Beetal bucks under heat stress.

P ≤ 0.05 indicate significant difference among the treatments.

SEM = Standard error of the mean.

1) C. Control group. 2) GP 0.5. Dry ginger supplementation 500 mg/kg/day. 3) GP1.0 Dry ginger supplementation 1000 mg/kg/day.

Discussion and Conclusion

In the current study, the average temperature humidity index was 76.9 ± 2.6 throughout the experiment. It is reported that heat stress changes basic physiological status of the animals. Heat stress disturbs the hormonal profile of animals and changes post-absorptive energy, protein and lipid metabolism. Heat stress also impair the liver function due to oxidative stress [21]. Ginger supplementation to the animals improves their digestive system muscular activity and increase the digestion and absorption of feed and nutrients [13]. In this study, ginger supplementation increased the dry matter intake in the GP 0.5 as compared to control and GP 1.0 treatment. Due to increase muscular activity of digestive system by ginger supplementation, GP 1.0 treatment animals showed higher body weight gain as compared to GP 0.5 animals. Increased average daily gain was observed in the GP 1.0 as compared to GP 0.5 and the control group indicated that ginger affected the digestion and absorption mechanism of feed and the nutrients. Therefore, higher body weight gain and the average daily gain was observed in the GP 1.0 as compared to GP 0.5 by comparatively lesser dry matter intake by the animals of GP 1.0 as compared to the GP 0.5. The documented results showed similarity with the previous studies in which ginger supplementation increased the digestion and absorption of the feed and also helped to relieve the constipation and flatulence in animals due to enhanced muscular activity [13]. The reported results shows similarity with documented results in the previous study that ginger supplementation increased the bile production and secretion which helped to increase the digestion and absorption of lipids [17].

Feed efficiency of the GP 1.0 animals were increased as compared to GP 0.5 and the control group which suggested that ginger supplementation improved the digestibility of feed and therefore, improved feed efficiency was observed for the GP 1.0 animals as compared to GP 0.5 and the control group. Increase in digestibility of feed is obvious from the reported results of previous studies which described the effect of ginger supplementation on the digestive tract also the increased in production of bile, which help to digest the lipids and increased muscular activity enhanced the availability of enzymes for digestion and improved absorption by increased blood flow in the digestive tract [11]. Increase in body length of the GP 1.0 animals as compared to GP 0.5 and the control group also indicated the enhancement of digestive role of feed by ginger supplementation. Due to increased absorption of nutrients, body weight of animals was increased in the GP 1.0 and GP 0.5 as compared to control group. The increased body length of the animals of GP 1.0 was obvious from the increased weight gain of this group which also indicated that higher average daily gain of the GP 1.0 and GP 0.5 improved the body length as compared to the control group. The cost per kg weight gain was reduced in the GP 1.0 and GP 0.5 as compared to the control group which indicated that the increased feed efficiency of GP 1.0 as compared to GP 0.5 effectively reduced the cost as compared to the control group. Ginger supplementation maintained the rumen pH of the GP 1.0 and GP 0.5 animals as compared to the control group in which comparatively lesser rumen pH was observed. In recent study by [22] no effect on the rumen pH was observed and it was maintained within normal range. In the current study, blood glucose concentration was lowered in the GP 1.0 and GP 0.5 as compared to the control group which is obvious from the reported results ofprevious study in which; hypoglycaemic effect of ginger

supplementation was observed due to increased pancreatic activity increased the insulin production [23]. In terms of animal production, higher cortisol levels have negative effects on growth rate and feed efficiency and increase the fat/lean ratio of carcasses.

The plasma cortisol concentration of the GP 1.0 animals was lesser as compared to the GP 0.5 and the higher level was observed in the control group animals. Increase in cortisol concentration resulted due to effect of heat stress on the control group animals whereas, in the GP 1.0 and GP 0.5, ginger supplementation reduced the negative impacts of heat stress on the animals by improving the production of antioxidants such as: glutathione peroxidase and superoxide dismutase activity [24]. It is documented that ginger has antioxidant activity which help to reduce the heat stress and more than 40 antioxidant combinations are found in the ginger [25]. Blood urea nitrogen concentration remained unaffected which was also similarly reported in the previous study [26]. Therefore, it can be concluded that dried ginger powder supplementation improves the production performance of Beetal bucks by minimizing the adverse effects of heat stress.

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Conflict of Interest

The authors declare no conflict of interest.

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