Influence of phyto additive mixture with or without palm oil on body condition and linear traits of Black Bengal goats

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Abstract

The aim of this study was to evaluate the effect of supplementation of phyto additive mixture (PAM) with or without palm oil on body condition score (BCS) and linear traits of Black Bengal goats. This experiment was conducted on 21 goats those were equally distributed into three groups including control (no supplementation), T1 (PAM containing *Curcuma longa* and *Ocimum sanctum* in 1:1) and T2 (PAM along with 0.05% body weight Palm oil) based on similar age (8-10 months), body weight ($P>0.05$) and BCS ($P>0.05$) of goats. This experiment lasted for 3 months. Results showed that BCS was significantly ($P<0.01$) highest in T2 followed by T1 than control group goats. Linear body measures including body length (BL), height at withers (HW), heart girth (HG), abdominal girth (AG) and tail head thickness (THT) were highest ($P<0.01$) in T2 followed by T1 than control group. Tail length (TL) was higher ($P<0.01$) in T1 and T2 groups than control group goats. Pearson's correlation coefficient showed highly positive ($P<0.001$) correlation between BCS and linear body measurements in experimental goats. Therefore, it can be concluded that supplementation of phyto additive mixture (containing *Curcuma longa* and *Ocimum sanctum* in 1:1 @15g/ kg DM of concentrate mixture) along with palm oil (0.05% of body weight) improves BCS and linear body measures of Black Bengal goats.

Keywords: Body condition, Body measures, *Curcuma longa*, Goats, *Ocimum sanctum*

Introduction

Recent studies have shown accelerated interest in utilization of phyto additives as alternative animal growth promoters to antibiotics (Sriranga et al., 2021; Singh, 2021; Singh. 2022; Singh et al., 2023). Ban on the use of antibiotics as animal feed supplement by European Union and consumers awareness regarding risk of antibiotic residues in products derived from animals fed with antibiotics is conceived as major reason for this accelerated interest (Casewell et al., 2003; Tilahun et al 2013). Phyto additives are the parts of plants (whole plant) containing plant secondary metabolites which have role in natural defense mechanism of plants against invading pathogens (Sriranga et al., 2021).

Black Bengal goats are considered as major goat breed of tropical lower Gangetic region (Hossain, 2021, Mandal et al., 2022). Generally, due to poor management conditions, these goats have poor body condition which reflects improper health and performance conditions in them (Das et al., 2024). Phyto additives contain plant secondary metabolites including tannins, saponins, alkaloids, flavonoids and essential oils (Singh et al., 2023). Palm oil contains tocopherols as major phyto active chemicals which may exhibit anti oxidant properties and along with this, it supplies poly unsaturated fatty acids which may further improve defense mechanism and enhance growth of supplemented animals (Dutta et al., 2008; Lognatahan et al., 2010). Phyto additives such as Curcuma longa, Ocimum sanctum and Palm oil are abundantly available in lower Gangetic region (Mathews and Mandal, 2016; Gaonkar et al., 2020). Recent study (Singh et al., 2023) has shown that supplementation of fennel seed powder as phyto additive improved body condition and linear body measures of Barbari goats.

To knowledge of authors, no study has been conducted to elucidate the effect of supplementation of phyto additive mixture along with palm oil on body condition, linear body traits and correlations among body condition and linear body traits in Black Bengal goats in lower Gangetic region. Given those points, this study was framed to understand the effect of supplementation of phyto additive mixture along with palm oil on body condition, linear body traits and correlations among body condition and linear body traits in Black Bengal goats in lower Gangetic region.

Materials and Methods

Site of experiment

This controlled field level study was conducted in two adopted villages (Muratipur Latitude and Longitude coordinates being 22.9959° N, 88.4495° E and Dakkhin Chandamari- Latitude and Longitude coordinates being 22.9951° N, 88.4564° E) of Eastern Regional Station of National Dairy Research Institute, Kalyani, West Bengal, India. All the experimental procedures were performed by Scientists/ Specialists as per the guidelines of institute's ethics committee (Registration: 19/P/LP/09). This experiment was conducted for 3 months from February to April, 2024. Kalyani receives annually about 1250 mm rain and height above the sea level is 11 meters. Kalyani experiences a tropical climatic condition where average annual temperature is around 30.2°C.

Experimental design, animals and management practices

This trial followed completely randomized design wherein female Black Bengal goats of similar age (8-10 months), body weight and BCS were allocated in three comparable groups with 7 goats in each groups namely, T1 (supplementation of PAM containing equal proportions of *Curcuma longa* and *Ocimum sanctum* @15g/Kg DM conc.) and T2 (PAM with palm oil @ 0.05% body weight of goat). Same amount of concentrate mixture (1.5% of Body weight) of same composition was offered to each experimental goat. On basis of dry matter, Crude protein, Ether extract and Ash content in concentrate mixture were 20.54%, 11.91%, 3.12% and 3.47%, respectively. Each goat was maintained under semi extensive management practice. Similar housing and other management practices were followed in each group.

Preparation and supplementation of phyto additives to goats

Fresh and good quality Turmeric (freshly harvested rhizomes), Tulsi (middle aged leaves) and Palm oil was procured from local market of Kalyani. For the preparation of phyto additive mixture, turmeric rhizomes and Tulsi leaves were dried in hot air oven operated at 60 °C for 24 hours followed by grinding in mechanical grinder. The particle size of phyto additive mixture was obtained so that it may pass through a screen of 1mm. This mixture was stored in air tight containers until further usage. Supplementation of phyto additive mixture was done before morning feeding (T1, supplementation of PAM containing equal proportions of *Curcuma longa* and *Ocimum sanctum* @15g/Kg DM conc.; T2, PAM @15g/Kg DM conc. along with palm oil @ 0.05% BW of goat). Total phenolics and flavonoids contents (mg/100g) were 167.85 ± 0.08 and 3.78 ± 0.01 in *Curcuma longa* while total phenolics and flavonoids contents (mg/100g) in *Ocimum sanctum* were 176.24 ± 0.21 and 97.15 ± 0.26, respectively. Total phenolics and flavonoids content were estimated using spectrophotometer as per the standard process followed by Soni and Sosa (2013). All the experimental animals were kept under 2 weeks of adaptation period before taking any observation. The supplementation period lasted for 3 months. The dose rate of PAM was taken from the farm experiment conducted at the same institute and Palm oil was near to recommendations of Dutta *et al.* (2008).

Body condition score (BCS)

Every goat was observed fortnightly before morning feeding for BCS as per the recommended method by Ghosh *et al.* (2019). In this 1-5 points scaling system (difference of 0.5 between two points), BCS 1 indicates emaciated condition and BCS 5 signifies obese goats. This method was based upon visual and palpation technique for specific skeletal points on the body of goats which considers spinous process of back region, tip of transverse process, level of deposition of muscle and fat between spinous and transverse position, flank region and fat over sternum part of goats (Villaquirán, 2012).

Body measurements of goats

Estimations of linear body measurements (cm) were performed fortnightly (Singh *et al.*, 2023) before morning feeding using a calibrated measuring tape for body length (distance between shoulder and pin bone), heart girth (circumference around heart), abdominal girth (circumference around abdominal region), tail length (measured from tail head to tip of tail), tail head thickness (using vernier calliper from starting point of tail).

Statistical analysis

Univariate linear model using SPSS version 26.0 (IBM Inc.) was performed on collected data with treatment as fixed factor. Data recording and graphical representation was done using MS Excel 2007 version. Duncan's multiple range tests were performed to determine significant difference among different treatment groups. Pearson's correlation statistics tool was performed for estimating correlation coefficients among different parameters. Significant difference among the parameters were accepted when $P<0.05$.

Results and Discussion

Body condition scores of goats

There was significant effect of supplementation of PAM along with palm oil on BCS in treatment groups (Table 1). Highest ($P<0.01$) BCS was observed in T2 group followed by T1 group than control group goats. Ghosh *et al.* (2019) remarked that the BCS range between 2.5 to 4.0 indicates under healthy condition of goats. In this study, the overall BCS in control group was 2.48 (under conditioned BCS) than 2.89 and 3.24 in T1 and T2 goats (healthy conditioned BCS). The reason behind this may be attributed to enhanced fat and muscle deposition around the skeletal regions of treatment groups than control group due to positive effects of PAM and palm oil. Singh *et al.* (2023) recently found that supplementation of fennel seed powder improved BCS in goats in controlled field condition. Dutta *et al.* (2008) indicated that palm oil supplementation may enhance energy density of feed which enhances daily gain in supplemented animals. Loganathan *et al.* (2010) remarked that palm oil also contains phyto active components. Sriranga *et al.* (2021) showed that phyto active compounds have potential to enhance defence mechanism of natural immune system in animals against invading pathogens which enhances growth in supplemented animals. *Curcuma longa* and *Ocimum sanctum* and Palm oils (Dutta *et al.*, 2008; Deka, 2009; Oderinwale *et al.*, 2020) are found to possess plant secondary metabolites including tannins, saponins, alkaloids, poly phenols and essential oils which play vital role in defence mechanism of natural immune system in animals. A combination of palm oil along with phyto additive mixture showed highest positive impact on body condition in supplemented goats followed by the goats which were only supplemented with phyto additive mixture as compared to non supplemented goats.

Linear body measures of goats

Linear body measurements including body length (cm) (Table 2), height at withers (cm) (Table 3), heart girth (cm) (Table 4), abdominal girth (cm) (Table 5), tail length (Table 6) and tail head thickness (cm) (Table 7) were found to be highest ($P<0.01$) in T2 group followed by T1 than control group goats. Tail length was increased ($P<0.01$) in treatment groups than control group. However, T1 and T2 groups were similar ($P>0.05$). The reason for increased linear body measurements was due to positive effect on growth of skeletal system along with better deposition of fat and muscle around these skeletal regions as showed by higher BCS in T2 group followed by T1 group goats as compared to non-supplemented group (control group). Values of body measures are in line with findings of Sahoo *et al.* (2018). In line with findings of present study, Singh *et al.* (2023) also showed that goats supplemented with phyto additive than control group Barbari goats. Ansari *et al.* (2022) showed that supplementation of 3g/day/calve with fennel seed powder or 30g/day/calve with oregano leaf powder led to higher heart girth and height at withers whereas, body barrel, hip height and hip width were similar.

Correlation among different parameters

Pearsons' correlation coefficients showed (Table 8) a highly positive correlation among BCS & HG ($r= 0.641$; $P<0.01$), BCS & BL ($r= 0.667$; $P<0.01$), BCS & AG ($r= 0.656$; $P<0.01$), BCS & HW ($r= 0.641$; $P<0.01$), BCS & TL ($r= 0.626$; $P<0.01$) and BCS & THT ($r= 0.667$; $P<0.01$). These correlations indicated that the animals which had higher BCS showed increased linear body measurements. In addition to this, among linear body measurements, the correlation was also highly positive and significant ($r>0.9$; $P<0.001$) the findings of the present study is in agreement with earlier studies (Anusha *et al.*, 2017; Reshma *et al.*, 2022) which indicated that

Table 1: Body condition score of goats supplemented with phyto additive mixture with or without palm oil

Fortnights	Control	T1	T2
Initial	**2.36^{a} ± 0.11**	**2.21^{a} ± 0.10**	**2.29^{a} ± 0.11**
1	2.36^{a} ± 0.08	2.43^{ab} ± 0.08	2.50^{b} ± 0.07
2	2.29^{a} ± 0.13	2.57^{b} ± 0.11	2.92^{c} ± 0.10
3	2.43^{a} ± 0.08	2.79^{b} ± 0.10	3.14^{c} ± 0.09
4	2.50^{a} ± 0.10	2.93^{b} ± 0.08	3.36^{c} ± 0.07
5	2.57^{a} ± 0.21	3.21^{b} ± 0.06	3.64^{c} ± 0.17
6	**2.71^{a} ± 0.09**	**3.43^{b} ± 0.15**	**3.86^{c} ± 0.09**
Overall	**2.48^{a} ± 0.07**	**2.89^{b} ± 0.08**	**3.24^{c} ± 0.10**

Means bearing different superscripts (a, b, c) differ significantly (P<0.05)

Table 2: LSQ means of body length (cm) of goats under different treatment groups

Fortnights	Control	T1	T2
Initial	40.99^{a} ± 0.17	41.25^{a} ± 0.16	41.16^{a} ± 0.14
1	41.56^{a} ± 0.14	41.83^{a} ± 0.15	41.64^{a} ± 0.15
2	42.17^{a} ± 0.11	42.61^{b} ± 0.21	42.39^{b} ± 0.19
3	42.86^{a} ± 0.17	43.39^{b} ± 0.18	43.23^{b} ± 0.21
4	43.64^{a} ± 0.15	44.24^{b} ± 0.11	44.16^{b} ± 0.16
5	44.50^{a} ± 0.18	45.21^{b} ± 0.15	45.17^{b} ± 0.13
6	45.36^{a} ± 0.12	46.19^{b} ± 0.16	46.23^{b} ± 0.17
Overall	43.35^{a} ± 0.13	43.91^{b} ± 0.15	43.80^{b} ± 0.14

Means bearing different superscripts (a, b, c) differ significantly (P<0.05)

Table 3: LSQ means of height at withers (cm) of goats under different treatment groups

Fortnights	Control	T1	T2
Initial	**41.64^{a} ± 0.18**	**41.54^{a} ± 0.17**	**41.87^{a} ± 0.18**
1	42.24^{a} ± 0.17	42.16^{a} ± 0.19	42.43^{a} ± 0.19
2	42.94^{a} ± 0.15	43.06^{a} ± 0.17	43.30^{b} ± 0.21
3	43.67^{a} ± 0.19	43.94^{b} ± 0.18	44.11^{b} ± 0.17
4	44.30^{a} ± 0.16	44.91^{b} ± 0.19	45.16^{b} ± 0.16
5	45.06^{a} ± 0.21	46.06^{b} ± 0.20	46.27^{b} ± 0.19
6	**45.90^{a} ± 0.16**	**47.19^{b} ± 0.19**	**47.54^{c} ± 0.21**
Overall	**44.02^{a} ± 0.18**	**44.55^{b} ± 0.19**	**44.80^{c} ± 0.16**

Means bearing different superscripts (a, b, c) differ significantly (P<0.05**)**

Table 4: Heart girth (cm) of goats under different treatment groups

Fortnights	Control	T1	T2
Initial	**51.74^{a} ± 0.14**	**51.19^{ab} ± 0.13**	**51.39^{b} ± 0.18**
1	52.22^{a} ± 0.11	51.61^{ab} ± 0.19	51.90^{b} ± 0.23
2	52.76^{a} ± 0.18	52.21^{b} ± 0.20	52.51^{b} ± 0.21
3	53.31^{a} ± 0.21	53.13^{a} ± 0.18	53.35^{a} ± 0.11
4	53.97^{a} ± 0.16	54.06^{a} ± 0.17	54.2^{b} ± 0.17
5	54.54^{a} ± 0.13	55.09^{b} ± 0.14	55.29^{c} ± 0.26
6	**55.17^{a} ± 0.18**	**56.19^{b} ± 0.17**	**56.41^{c} ± 0.22**
Overall	**53.66^{a} ± 0.14**	**53.71^{b} ± 0.16**	**53.95^{b} ± 0.19**

Means bearing different superscripts (a, b, c) differ significantly (P<0.05)

Table 5: LSQ means of abdominal girth (cm) of goats under different treatment groups

Fortnights	Control	T1	T2
Initial	**54.53^{a} ± 0.24**	**54.27^{a} ± 0.27**	**54.36^{a} ± 0.21**
1	55.19^{a} ± 0.22	55.17^{a} ± 0.21	55.14^{a} ± 0.22
2	55.89^{a} ± 0.19	55.93^{a} ± 0.20	56.03^{a} ± 0.19
3	56.77^{a} ± 0.27	56.87^{a} ± 0.23	56.93^{a} ± 0.27
4	57.63^{a} ± 0.20	58.03^{b} ± 0.17	58.16^{b} ± 0.21
5	58.56^{a} ± 0.16	59.17^{b} ± 0.19	59.31^{b} ± 0.19
6	**59.49^{a} ± 0.18**	**60.33^{b} ± 0.20**	**60.46^{b} ± 0.17**
Overall	**57.25^{a} ± 0.22**	**57.58^{b} ± 0.18**	**57.67^{b} ± 0.19**

Means bearing different superscripts (a, b, c) differ significantly (P<0.05)

Table 6: LSQ means of tail length (cm) of goats under different treatment groups

Fortnights	Control	T1	T2
Initial	**8.19^{a} ± 0.09**	**8.30^{a} ± 0.11**	**8.24^{a} ± 0.16**
1	8.67^{a} ± 0.10	8.71^{a} ± 0.16	8.79^{a} ± 0.17
2	9.21^{a} ± 0.14	9.30^{a} ± 0.09	9.33^{a} ± 0.07
3	9.69^{a} ± 0.08	9.84^{a} ± 0.13	9.90^{a} ± 0.11
4	10.19^{a} ± 0.16	10.40^{b} ± 0.18	10.46^{b} ± 0.10
5	10.66^{a} ± 0.14	10.91^{b} ± 0.15	10.99^{b} ± 0.18
6	**11.10^{a} ±0.18**	**11.33^{b} ± 0.07**	**11.39^{b} ± 0.11**
Overall	**9.92^{a} ± 0.14**	**10.08^{b} ± 0.15**	**10.14^{b} ± 0.17**

Means bearing different superscripts (a, b, c) differ significantly (P<0.05)

Table 7: LSQ means of tail head thickness (cm) of goats under different treatment groups

Fortnights	Control	T1	T2
Initial	**2.57^{a} ± 0.05**	**2.50^{a} ± 0.04**	**2.47^{a} ± 0.04**
1	2.96^{a} ± 0.03	2.99^{a} ± 0.05	3.03^{a} ± 0.03
2	3.37^{a} ± 0.06	3.43^{a} ± 0.07	3.50^{a} ± 0.05
3	3.80^{a} ± 0.02	3.90^{b} ± 0.04	3.93^{b} ± 0.06
4	4.24^{a} ± 0.07	4.31^{a} ± 0.04	4.41^{b} ± 0.04
5	4.63^{a} ± 0.05	4.71^{a} ± 0.07	4.83^{b} ± 0.04
6	**4.97^{a} ± 0.04**	**5.06^{a} ± 0.05**	**5.19^{b} ± 0.05**
Overall	**4.00^{a} ± 0.05**	**4.07^{b} ± 0.06**	**4.15^{c} ± 0.04**

Means bearing different superscripts (a, b, c) differ significantly (P<0.05)

Table 8: Pearson's correlation coefficients (below diagonal) among body condition and linear body measurements of Black Bengal goats

	BCS	HG	BL	AG	HW	TL	THT
BCS	1						
HG	0.641**	1					
BL	0.667**	0.914**	1				
AG	0.656**	0.941**	0.966**	1			
HW	0.641**	0.897**	0.907**	0.919**	1		
TL	0.626**	0.934**	0.956**	0.960**	0.927**	1	
THT	0.637**	0.927**	0.955**	0.961**	0.897**	0.961**	1

Note: BCS- body condition score; HG- heart girth; BL- body length; AG- abdominal girth; HW- Height at withers; Tail length; THT- tail head thickness; '*'- significant at P<0.05; '**'- significant at P<0.001

BCS is positively correlated with linear body measurements showing that the animals which have higher BCS shows higher body measures. Moreover, Reshma *et al.* (2022) showed that BCS estimations could be very useful in farm management of goats under field condition. Similarly, Singh *et al.* (2023) also reported that supplementation of phyto additive (fennel seed powder) showed positive correlation among body condition and linear body traits in Barbari goats.

Conclusions

It can be concluded that supplementation of phyto additive mixture containing equal amounts of *Curcuma longa* & *Ocimum sanctum* (15g/kg dry matter of concentrate mixture) along with palm oil (0.05% body weight) may enhance BCS and linear body measurements of Black Bengal goats under field condition. This newer feeding approach may be utilized in other species for improvement in their body condition and linear body traits.

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Conflict of interest

Authors report no conflict of interest.

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