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Effects of frequent oil treatment on the performance of native growing rams under intensive management system

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Abstract

The effects of oral administration of seven mL soybean oil/ kg live weight (LW) on the performance and carcass characteristics of native ram. In a 162 days feeding trial, 18 growing native rams (9.4 ± 1.2 kg BW and 176 ± 5.6 d of age) were randomly allocated to three treatments (T_0, control, T_1, monthly infusion of oil and T_2, fortnightly oil infusion group) with six replicates in each. All animals were fed roughage (*Ad lib* urea molasses straw, UMS) and concentrate (1.5% of body weight). After feeding and digestion trial, five animals in each group were slaughtered for carcass characteristics. During the trial, growth rate was significantly ($P<0.05$) influenced by the treatments (T_0, T_1 and T_2 were 69.5, 83.8 and 69.8 g/d). On average, T_1 group showed 20.7% higher growth over the control and T_1. The protozoa populations were reduced by 74% and 84% in T_1 and T_2 than that of control group. Consequently, the ammonia concentration in the rumen fluid of T_1 group was significantly ($P<0.05$) lower (177 mg/L) than that of T_2 (208.0 mg/L) and control (245.0 mg/L) group, respectively. Consequently, Feed conversion ratio (FCR) was better (8.0) belonged to T_1 than that of control (8.6) and T_2 (9.3). Interestingly, fat deposition was inclined significantly ($P<0.05$) in T_2 group than that of T_1 and control, which is unacceptable to the customers. Meanwhile, fortnightly oil treatment (T_2) is not recommended, but further study is required with different intervals. (*Bangl. vet*. 2011. Vol. 28, No. 1, 19 – 30)

Introduction

In Bangladesh ruminants rely mainly on rice straw with addition of other crop residues and grass from uncultivated land, which are rich in cell wall lignin and provide unbalanced nutrients for the growth of rumen microbes. These microbes play an important role in utilization of cellulose by fermentation in ruminants (Bird and Leng, 1984; Chaudhury *et al*., 1995). *In vivo* experiments showed that elimination of ciliated protozoa from rumen increases the intestinal protein flow (Kayouli *et al*., 1986; Veira, 1986; Ushida *et al*., 1989) thus improving body weight in young ruminants under certain feeding conditions (Ivan *et al*., 1992; Bird *et al*., 1994;). During the last decade there were many studies on the role of protozoa in rumen metabolism and performance of ruminants (Demeyer, 1988; Jouany *et al*., 1988). Mom Seng *et al*. (2001); Nguyen Thi Hong Nhan *et al*. (2001; 2003); Nguyen Xuan Trach (2004); and

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Chowdhury *et al*. (2005; 2006) have shown that vegetable oil eliminated protozoa from the rumen and as a result, ruminants fed certain diets grew faster. Eliminating the protozoa from the rumen improved growth rates, as the bacterial flow from the rumen is increased when the protozoa are absent (Leng, 1989). Ponnampalam *et al.* (2005) supplemented a roughage-based diet with canola and soya meal containing lipids, which accelerated growth and reduced feed intake/kg gain. Many authors studied different levels of vegetable oil but limited work has been done on the effect of frequent oil treatment on ruminants. The present study was conducted to investigate the effect of frequency of oil treatment on intake, growth, nutrient utilization, rumen fermentation pattern and carcass characteristics of growing rams under intensive system of feeding.

Materials and Methods

Location and agro- climate

The research station is located at 23°5/N, 90°2/E at an altitude of one metre above sea level in the Madhupur Tract (Agro Ecological Zone 28) of Bangladesh. The soil is Red Brown Terrace, acidic (pH-4.5 - 5.5) with very little (<1.5%) organic matter (Brammer *et al*., 1998). Mean annual temperature is 25.3°C. Though the average annual rainfall is about 200 mm but during July to October rainfall rises to 2000 mm.

Experimental treatments

The experiment was conducted in 18 growing rams of 176 ± 5.6 days age and 9.4 ± 1.2 kg live weight (LW). Animals were randomly allocated to three experimental treatments with six rams in each group. The experimental treatments were T_o Control; T_1 (7 g/kg BW soybean oil monthly); T_2 (7 g/kg BW soybean oil fortnightly). After 18 hours fasting, oil was infused into the rumen via the stomach tube. Rumen fluid was collected one day before and after oil infused into the rumen.

Feeding and management

All animals received *ad libitum* (at least 10% in excess of requirement) urea molasses straw (UMS: 3% urea, 15% molasses and straw 82% on Dry matter basis) as the basal diet. They also received concentrate (wheat bran 18%; Maize crush 56%; Soybean 16.0%; Khesari [*Lathyrus sativus*] bran 8.0%; Dicalcium Phosphate [DCP] 1.0%; and Vitamin-mineral-premix 1% mixed uniformly) at 1.5% of LW. The concentrate allowance was divided into two and offered at 8 AM and 3 PM. Concentrate mixture was adjusted weekly with the changes of body weight. The animals were weighed weekly and UMS refusal was weighed daily and continued throughout the experimental period of 162 days. At the onset of the trial, animals were dewormed with required dose of Endex® (600 mg Levamisole hydrochloride and 900 mg Triclabendazole; Novartis Bangladesh Ltd. @ 20 mg/kg body weight). The animals were reared in individual pens with a wooden (wood placed half inch interval) slatted floor. The feed was offered individually in plastic pans and fresh

drinking water was supplied at all times. Feeder and waterer were cleaned and washed daily prior to the morning meal.

Digestibility trial

In a seven days digestive trial, faeces of each animal was collected, weighed and subsample was taken daily in the morning (8 AM) by using metabolic crates. Likewise, urine was collected in a bucket (which contains 100 ml 10% H_2SO_4 solution) and 10% sample was taken to determine the nitrogen content. Feed residuals were weighed and subsample was taken daily from each animal. Consequently, UMS and concentrates was taken from each batch and preserved at -20^{o}C until analysis.

Response of rumen environment to oil

Rumen samples were collected from all animals via stomach tube to measure rumen pH, ammonia and protozoa count. The pH was immediately determined using pH meter (WTW portable pH 530 meter, Germany). Immediately after collection, one ml rumen fluid was taken for protozoa cell count and rest of the fluid was acidified with concentrated sulphuric acid and kept at -20^{o}C until ammonia analysis. For protozoa cell count, fluid was diluted with nine ml of methyl green formalin-sodium chloride (MFS, contain 100 ml 35% formaldehyde solution, 900 mL distilled water, 0.6 g methyl green and 8.0 g sodium chloride) to count total and ciliated protozoa (ASC Great Northern Science Handbook *www.akscience.org/assets/handbook99/Rumen Ciliates.pdf*). After thawing the rumen liquor, ammonia concentration was measured as described by (Dimingue *et al*., 1991).

Chemical analysis

After thawing, seven samples of faeces and refusal were mixed thoroughly and a composite sample was taken for the determination of dry matter (DM), organic matter (OM) and crude protein (CP) on fresh basis and dried in an oven to determine acid detergent fibre (ADF) according to method described by AOAC (1990).

Slaughter and carcass analysis

After 162 days feeding trial and 24 hour fasting, five animals from each group were weighed and slaughtered according to Halal method. Body length (point of elbow to point of hip) and heart girth were recorded. Carcass was dressed as per Australian Carcass Portioning scheme (AUS-MEAT, 2005). Carcass was chilled at 0-4^{o}C in chilling house at Bengal meat Industries Ltd, Sathia, Pabna. Dressing percentage was calculated. Three animals from each group were taken to determine the yield of primal cuts, soft organ and offal on individual animals. Digestive tract was weighed before and after removing the contents. Data were recorded in terms of LW, warm carcass weight, dressing percentage, primal cut (left and right hind quarters up to lumbo-sacral joint, left and right hind leg bone, hind and fore quarters, rack, French rack and neck) visceral organs (liver, lung, kidney, heart and spleen),

head, gut, caul and visceral fat, total edible (carcass, viscera and visceral fat) and total saleable (edible plus skin) weight.

Statistical analysis

The data were analysed using uni-variate GLM procedure of SPSS 11.1 (SPSS Inc. 2000) statistical package. Data were included average daily intake, growth rate, food conversion ratio, digestibility, blood glucose, nitrogen balance, and carcass yield characteristics. The model used was $Yij= \mu + \mu_i + e_{ij,}$ where Yij is the observed value for a dependent variable on i_{th} oil treatment (i = monthly and fortnightly treatment), with μ is the general mean and e_{ij} as the random error. Daily LW gain of individual animal was determined as slope of line between time (weekly) and BW of the animal and the slope drain compared using the same uni-variate general linear model.

Results and Discussion

Chemical compositions

The proximate composition of concentrate mixture and UMS were presented in Table 1.

Table 1. Chemical composition in feed supplied

Feed	Dry matter	Ash	OM	CP	ADF
Urea molasses straw	86.2	14.8	85.2	8.4	30.3
Concentrate mixture	91.2	5.4	94.6	13.7	16.6

DM = Dry matter; CP = crude protein; ADF = Acid detergent fibre; OM = Organic matter

Intake

The average daily DM intake of the rams during the period of study was presented in Table 2. Average daily DM intake was not affected among the treatment. Though the DM intake per unit metabolic BW was not significant but higher (90.0g/kg $W^{0.75}$) value obtained in T_0 than that of T_2 (89.0 g/kg $W^{0.75}$) and T_1 (86.8g/kg $W^{0.75}$) this may due to the disturbance of the rumen ecosystem caused by the dose of oil.

The soybean oil used for defaunation did not reduce feed intake. Same result was evident by Chaudhury and Srivastava (1995); Santra and Karim (2000). Rams consumed 4.3 to 4.6% of BW as DM. This result was supported by Gatenby (1986). Total ADF intake was significantly ($P<0.05$) higher in control group (180.2 g/day) than T_1 (172 g/day) and T_2 (170.4 g/day). Calculated ME intake (kJ/kg $W^{0.75}$) was not significantly different between groups.

Change to rumen environment

Ammonia, nitrogen, pH and protozoa population in the rumen were presented in Table 3. Apparently, there was no change due to defaunation in pH of rumen

environment, which confirms the view of Colombier (1981). The soybean oil significantly (P<0.05) reduced the protozoa population, which agrees with Naguyen Thi Hong Nhan *et al.* (2001). Newbold and Chamberlain (1988) indicated that lipid is toxic to protozoa, due to increasing acidity, resulting from the free fatty acids liberated from the oil. The protozoa populations were reduced by 74 and 84% by monthly and fortnightly treatments, respectively. This result agreed with Ikwuegbu and Sutton (1982); Seng Mom *et al.* (2001) who found 70% reduction in population of protozoa.

Table 2. Effect of oil treatment on feed intake of rams

Items	T_0	T_1	T_2	SED	Significance
Total DM intake (g/day)	673.8 ± 8.7	678.8 ± 6.0	657.8 ± 9.3	7.8	NS
DM intake (g/kg$W^{0.75}$)	90.0 ± 2.2	86.8 ± 2.5	89.0 ± 2.2	2.1	NS
DM intake (% LW)	4.6 ± 0.2	4.3 ± 0.2	4.6 ± 0.1	0.1	NS
% Concentrate of total DM intake	25.0 ^{b} ± 1.1	28.0^a ± 1.7	25.0^b ± 0.8	0.9	P<0.05
% UMS of total DM intake	75.0^a ± 2.9	73.0^b ± 0.6	75.0^a ± 0.84	0.9	P<0.05
Total CP intake (g/day)	68.2 ± 1.5	69.0 ± 0.9	66.7 ± 1.2	1.2	NS
Total ADF intake (g/day)	180.2^a ± 1.6	172.2^b ± 2.9	170.4^b ± 3.5	2.8	P<0.05
Total OM intake (g/day)	598.6 ± 8.4	608.5 ± 8.5	587.5 ± 5.7	7.6	NS
EME intake (KJ/kg $W^{0.75}$)	925.5 ± 2.1	892.6 ± 16.3	918.9 ± 3.0	21.4	NS
EMP intake (g)/kg $W^{0.75}$	7.7 ± 0.2	7.5 ± 0.2	7.6 ± 0.1	0.1	NS

UMS = Urea molasses straw; EME = Estimated Metabolisable energy; EMP = Estimated Metabolisable Protein; SE = Standard error; SED = Standard Error Difference. NS = Non-significant

Table 3. Influence of oil treatment on rumen environment of rams

Parameter	T_0	T_1	T_2	SED	Significance
Ammonia (mg/L)	245^a ± 15.5	177^c ± 10.5	208^b ± 12.7	13.1	P<0.05
pH	6.3 ± 0.9	6.3 ± 0.1	6.4 ± 0.1	0.1	NS
Protozoa cell count (-×10^5 cells/ml rumen liquor)	2.3^a ± 0.1	0.6^b±0.1	0.4^b ± 0.1	0.1	P<0.05

P<0.05 = Significant at 5% level; NS = Not significant; $^{a,b\ c}$ = Mean value with different superscripts within rows differ significantly at P<0.05

The ammonia concentration in the rumen fluid of sheep given monthly oil was significantly (P<0.05) lower (177.0 mg/L) than in those treated fortnightly (208 mg/L) and control (245.0 mg/L) animals. The present findings are similar to results of other authors (Ikwuegbu and Sutton 1982; Kayouli *et al.,* 1983; 1984; Soetanto, 1985; Nguyen Thi Hong Nhan *et al.,* 2001). The rumen outflow of protein from bacteria and fungi increases in the absence of protozoa (Newbold and Hillman, 1990). There are several reports that defaunation leads to an increase in the bacterial population, which uses ammonia as the source of nitrogen for cell synthesis (Hungate, 1966; Koyouli *et al.,*

1983; 1984; Newbold and Hillman, 1990). The reduction in ammonia concentration could be due to high rate of ammonia assimilation by bacteria.

Nutrient utilization

DM and CP digestibility were not significantly different (P<0.05) among the groups (Table 4). ADF digestibility was significantly (P<0.05) higher (72%) in T_0 compare to T_1 (62.0%) and T_2 (61.0%). Reduced digestibility of fibre in defaunated rams could be attributed to elimination of specific cellulolytic activity by protozoa. Better digestibility of cell wall constituents in control than in treated animals probably due to increased retention time of feed particle in the rumen (Kayouli *et al.,* 1983; 1984; Ushida and Jouany, 1989), stabilization of rumen environment favouring development of cellulolytic flora (Hegarty *et al.,* 1991) and stimulation of bacteria by protozoa (Onodera *et al.,* 1988). Organic matter digestibility was significantly (P<0.05) lower in T_1 than that of T_0 and T_2. This finding partially supports to Rowe *et al.* (1985) but contrasts with Chaudhury and Srivastava (1995); Veira and Ivan (1983). The data on nitrogen intake, excretion through faeces and urine and its balance were presented in Table 4. The daily nitrogen intake and excretion through faeces and urine was not significantly different among the treatments, while nitrogen balance was significantly (P<0.05) higher in defaunated rams than control groups. Higher nitrogen balance in defaunated rams was possibly due to greater microbial protein synthesis in the rumen (Bird *et al.,* 1994). It is generally accepted that in absence of rumen ciliates, the efficiency of rumen microbial growth is enhanced and more microbial and dietary protein flows from rumen to duodenum (Bird and Leng, 1985)

Table 4. Influence of oil treatment on nutrient utilization of rams

Parameter	T_0	T_1	T_2	SED	Significance
Digestibility (%)					
DM	76.0 ± 1.7	77.0 ± 1.4	77.0 ± 1.7	1.65	NS
CP	59.0 ± 4.2	62.0 ± 2.0	66.0 ± 2.9	3.20	NS
ADF	72.0^{a} ±2.3	62.0^{b} ± 1.6	61.0^{b} ± 5.5	2.24	P<0.05
OM	81.4^{a} ± 1.0	77.73^{b} ± 0.5	83.6^{a} ± 1.2	1.62	P<0.05
N-balance (mg/kg $W^{0.75}$)					
Total N- intake	1410 ± 33.2	1456.0 ± 27.5	1449.0 ± 19.9	27.50	NS
Faecal N-excretion	574.0 ± 42.5	554.0 ± 51.0	507.0 ± 59.2	46.68	NS
Urinary excretion	145.0 ± 6.5	120.0 ± 2.2	165.0 ± 7.8	47.37	NS
Total excretion	710.0 ± 44.9	674.0 ± 53.5	672.0 ± 61.0	47.37	NS
Nitrogen balance	691.0^{b} ± 40.8	782.0^{a} ± 21.1	777.0^{a} ± 45.5	27.34	P<0.05

P<0.05 = Significant at 5% level; N = Nitrogen; NS = Not significant; ^{a,bc} = Mean value with different superscripts within rows differ significantly at P<0.05

Live weight gain and carcass characteristics

Daily LW gain, FCR and carcass characteristics were in Table 5. Initial LW was not influenced among the groups, but final weight was significantly (P<0.05) higher in T_1 than those of T_0 and T_2. Consequently, average daily gain was significantly (P<0.05) higher (83.8 g/day) in T_1 compared to T_0 (69.5 g/day) and T_2 (69.8 g/day). Monthly drenching of oil into the ram (T_1) showed 20.7% higher growth over the control (T_0) and fortnightly oil drenching group (T_2). Similar studies on growing rams (Bird and Leng, 1985; Santra and Karim, 2000;) and calves (Bird *et al.,* 1979) indicated 15-20% improvement in growth of defaunated animals. FCR was lower (8.0) in T_1 than T_0 (8.6) and T_2 (9.3). Higher average LW gain and FCR of rams treated monthly was probably due to reduced methanogenesis (Kreuzer *et al.,* 1986; Santra *et al.,* 1996) and increased microbial and dietary protein flow from rumen to duodenum (Bird and Leng, 1985). On the other hand, lower average live weight gain and FCR in rams treated fortnightly may be caused by an imbalance between fat in the diet and hydrogenation of fats in the rumen. Slaughter weight, chilled carcass weight and dressing percentage were not different among the treatments.

Table 5. Influence of oil treatment on daily gain, feed conversion ratio and carcass quality of rams

Parameter	T_0	T_1	T_2	SED	Significant
Initial BW (kg)	9.2 ± 0.4	9.1 ± 0.5	9.1 ± 0.6	0.51	NS
Final BW (kg)	21.5^b ± 1.2	22.7^a ± 1.1	20.8^b ± 1.0	0.48	P<0.05
ADG (g/d)	69.5^a ± 4.9	83.8^b ± 5.4	69.8^a ± 5.7	5.30	P<0.05
FCR	8.6± 0.5	8.0 ± 0.5	9.3 ± 0.7	0.57	NS
Slaughter weight (kg)	19.2± 0.8	21.4 ± 1.0	18.7 ± 0.8	1.34	NS
Chilling weight	9.0 ± 0.3	9.9 ± 0.6	8.9 ± 0.5	0.48	NS
Dressing (%)	47.7 ± 0.8	49.2 ± 0.8	48.4 ± 0.7	0.79	NS

P<0.05 = Significant at 5% level; NS = Not significant; ^{a,bc} = Mean value with different superscripts within rows differ significantly at P<0.05. BW = Body weight; ADG = Average daily gain; FCR = Feed conversion ratio

Edible by-product and non-carcass component

Yield of edible by-product and non-carcass component as percent of LW is shown in Table 6. The oil treatment did not affect the proportion of lung, kidney, heart and spleen. Non-carcass components skin, head, feet, stomach and intestine were not significantly different among the treatments.

The effect of oil treatment on fat deposition was shown in Table 7. Fat thickness of twelfth rib was significantly (P<0.05) higher (3.0 mm) in T_2. Fat thickness increased linearly (r = 0.93) with frequency of oil treatment. There was significantly (P<0.05) higher caul fat and visceral fat concentration in T_2 (Table 7) compared to T_0 and T_1.

Table 6. Influence of oil treatment on yield of edible by-product and non-carcass omponents (% LW) of rams

Parameter	T_0	T_1	T_2	SED	Significant
Edible by-product					
Kidney	0.2 ± 0.0	0.3 ± 0.0	0.3 ± 0.0	0.01	NS
Lung	1.2 ± 0.1	1.3 ± 0.1	1.3 ± 0.1	0.07	NS
Heart	0.1 ± 0.0	0.1 ± 0.0	0.1 ± 0.0	0.00	NS
Spleen	0.2 ± 0.0	0.3 ± 0.0	0.2 ± 0.0	0.04	NS
Non-carcass component (as% live weight)					
Skin	10.4 ± 0.3	10.4 ± 0.8	10.0 ± 0.2	0.49	NS
Head	7.2 ± 0.3	7.1 ± 0.3	7.0 ± 0.3	0.30	NS
Feet	2.2 ± 0.9	2.32 ± 0.1	2.2 ± 0.2	0.24	NS
Stomach	3.9 ± 0.2	3.7 ± 0.2	3.9 ± 0.1	0.17	NS
Intestine	2.6 ± 0.1	2.4 ± 0.3	2.3 ± 0.2	0.22	NS

NS = Not significant

Table 7. Influence of oil treatment on fat deposition (% of live weight) of rams (Mean ± SE)

Parameters		T_0	T_1	T_2	SED	Significant
Fat thickness at 12^{th} rib (mm)		1.4^b ± 0.2	1.7^b ± 0.3	3.0^a ± 0	0.22	P<0.05
Caul fat	(kg)	0.33^b ± 0.0	0.3^b ± 0.0	0.4^a ± 0.0	0.02	p<0.01
	(%)	1.7 ± 0.1	1.5 ± 0.3	2.2 ± 0.60	0.40	NS
Visceral fat	Kg	0.1^b ± 0.0	0.13^b ± 0.0	0.3^a ± 0.4	0.02	P<0.05
	(%)	0.6^b ± 0.1	0.7^b ± 0.1	1.6^a ± 0.2	0.13	P<0.05
Gut fat	Kg	0.3 ± 0.0	0.4 ± 0.0	0.4 ± 0.0	0.02	NS
	(%)	1.6^b ± 0.1	1.9^b ± 0.2	2.3^a ± 0.2	0.02	P<0.05

P<0.01 = Significant at 1% level; P<0.05 = Significant at 5% level; NS = Not significant; $^{a,b\ c}$ = Mean value with different superscripts within rows differ significantly at P<0.05

Both caul and visceral fat increased linearly (r = 0.99 and 0.94 respectively) with the increasing frequency of oil treatment. The gut fat as percent of LW was significantly (P<0.05) higher in T_2 compared to other groups. Caul, visceral and gut fat content did not differ significantly between T_0 and T_1. Fat deposition was significantly (P<0.05) higher in T_2. The results corroborated the findings of Lough *et al.* (1993).

Proportion of different primal cuts was shown in Table 8 but no significant (P>0.05) differences were observed among the cuts.

Table 8. Influence of oil treatment on yield of primal cut (expressed as a % of warm carcass weight) of rams

Parameter	T_0	T_1	T_2	SED	Significant
Hind quarter					
Hind quarter	33.0±1.3	33.8 ± 0.8	32.6 ± 1.0	1.05	NS
Left hind quarter	16.3 ± 0.7	16.8 ± 0.4	16.3 ± 0.3	0.52	NS
Left boneless back leg	12.5 ± 0.8	12.7 ± 0.3	11.8 ± 0.8	0.64	NS
Left back leg bone	2.0 ± 0.1	2.0 ± 0.8	3.5 ± 0.1	0.47	NS
Right hind quarter	16.6 ± 0.6	15.3 ± 1.8	16.2 ± 0.7	1.17	NS
Right boneless back leg	12.3 ± 0.5	12.8 ± 0.3	12.2 ± 0.3	0.32	NS
Right back leg bone	2.2 ± 0.2	2.0 ± 0.1	3.5 ± 0.8	0.46	NS
Fore quarter					
Fore quarter	66.4 ± 1.0	65.9 ± 1.1	66.4 ± 0.9	0.99	NS
Rack	13.7 ± 1.8	12.3 ± 0.8	12.5 ± 0.6	1.16	NS
French rack	10.5 ± 1.2	10.5 ± 0.7	10.4 ± 0.5	0.87	NS
Fore shank	3.4 ± 0.3	3.1 ± 0.1	3.5 ± 0.2	0.20	NS
Neck	11.5 ± 0.3	12.8 ± 1.2	11.0 ± 0.2	0.71	NS

NS = Not significant

Conclusions

Both monthly and fortnightly infusion of soybean oils (7 mg/kg LW) reduced the concentration of rumen protozoa and ammonia level. Average daily gain was higher in rams treated monthly in compared to control and fortnightly oil treated rams. On average the rams treated monthly showed 20.7% growth improvement over control animals (faunated) and those treated fortnightly. Fortnightly treatment increased fat deposition in animal body, which is unacceptable to the customers. It is suggested that soybean oil @ 7 mg/kg BW monthly to Bengal growing rams fed a diet supplemented with concentrate improves growth rate. To support these findings there is a need for experiments with oil given at 45, 60 or 90 days intervals.

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