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ORIGINAL ARTICLE

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Effect of beef tallow on growth performance, carcass characteristics, meat composition, and lipid profile of growing lambs

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ABSTRACT

The objective of this study was to investigate the effect of diets with inclusion of beef tallow on growth, and carcass characteristics, meat quality, and lipid profile in growing lambs. The experiment was conducted with 15 lambs for 63 days. The lambs were randomly allotted into three dietary treatments (T_0, T_1, and T_2) with five animals in each group; T_0 (control diet without beef tallow), T_1 (diet with 2% beef tallow), and T_2 (diet with 4% beef tallow). The body weight and feed conversion ratio (FCR) were significantly ($P<0.05$) increased in T_1 group as compared to other groups. Dressing percentages of warm carcass in T_0, T_1 and T_2 group were 43.93, 42.87 and 44.05%, respectively. There were no significant differences ($P>0.05$) on meat quality and chemical composition among the three dietary groups. Group T_1 showed the highest increase of cholesterol concentration (11.5%) at the end of experiment, but serum triglyceride concentration was not significantly ($P>0.05$) correlated with any of the three dietary groups. To sum up, the use of beef tallow at 2% level in lamb diet can increase their performance without having any deleterious effect on carcass, meat quality and lipid profile.

Keywords

Beef tallow, Carcass, Lamb, Lipid profile

ARTICLE HISTORY

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INTRODUCTION

The sheep of South Asian countries are renowned due to their early maturity, high prolificacy, good quality of meat, immunity and adaptability to adverse climatic condition (Nielsen et al., 2013). However, the profitable sheep production is hindered due to low energy intake, lack of improved quality feeds, and high feed cost. In Bangladesh, people mostly rear their sheep under traditional system of grazing with little or no concentrate supplementation hampering optimum weight gain and reproductive performance. Sheep production can be made more profitable by adding concentrate as a supplementary source of dietary energy. Unconventional feed such as fats of animal origin (e.g., beef tallow) can be used in sheep ration for better growth rate (Steele, 1985).

Lipid provides more energy value than carbohydrates because it contains more carbon and hydrogen atoms than carbohydrates but the dietary level of fat should not exceed 6 to 7% of dry matter (Doreau et al., 1997; Cooper, 2000). On the other hand, the serum lipid profile may be changed upon consumption of fat, and it is evidenced that serum cholesterol is directly related to lipid metabolism (Stranahan et al., 2011).

Carcass characteristics and meat quality are also essential features for consumer acceptance along with the good growth performance. The carcass characteristics are correlated with weight and thickness of subcutaneous fat (El Karin et al., 1988). Type and level of feed supplements also influence quality and composition of meat (Sanudo et al., 1998).

Animal feed have substantial effects on biochemical, structural and metabolic features of animal, and on nutritive values and acceptability of meat (Wood et al., 2003; Olfaz et al., 2005). However, in most counties including Bangladesh, a limited study has been done previously on the inoculation of beef tallow in sheep ration for improving their growth performance and meat quality. Therefore, this study was conducted to investigate the effect of supplementing beef tallow on growth, and carcass characteristics, meat quality, and lipid profile of growing lambs.

MATERIALS AND METHODS

The experiment was conducted at the Sheep and Goat Field Research Laboratory under the Department of Animal Science and Nutrition, Chittagong Veterinary and Animal Sciences University (CVASU), Chittagong, Bangladesh, during the period from April to June 2012 covering a period of 9 weeks (63 days). All the animal experimentations were conducted as per the ethical guidelines set by the CVASU.

Experimental design, animals and diets: The experimental lambs were purchased from local market at the age between three to four months and the average body weights of about 10-kg. All experimental sheep's were male. The lambs were allowed for 15 days to be adapted with local environment prior to onset of the study. Lambs were equally and randomly divided and distributed into three dietary treatment groups; control group without beef tallow (T_0), diet with 2% beef tallow (T_1), and diet with 4% beef tallow (T_2). Each dietary group consisted of five lambs. Beef tallow was incorporated with the replacement of broken corn, soybean meal and part of the mustard oil cake (**Table 1**). Same proportion of crude protein (isonitrogenous) was maintained in each diet. Animals were grazed equally 9 h every day in experimental grazing field and allowed to 300 g concentrate mixture daily.

Evaluation of overall production performance: Feed intake and body weights were recorded on 7 days interval. Growth performance was evaluated by live weight gain, feed intake and feed conversion ratio (FCR). Experimental animals were sacrificed after 63 days of feeding trial to determine yield and quality of meat. Carcass characteristics was evaluated by means of dressing percentage, yield of primal cuts, hot carcass weight, visceral organs (liver, lung, kidney, heart and spleen), head, gut, caul and visceral fat, total edible fat (carcass, viscera and visceral fat), total saleable (edible plus skin) weight, fat thickness at 12th rib (mm) and color of meat. The composition of meat in three dietary groups was compared by estimating moisture, ash, crude protein, ether extract and crude fiber, as per the methods described by Association of Analytical Communities (AOAC, 2012).

Lipid profiling: Blood sample was collected from experimental animal at beginning and at the end of the study. Any change in plasma lipid concentration was investigated by estimating total cholesterol (Tch), Triglycerides (TG), High Density Lipoprotein (HDL) and Low Density Lipoprotein (LDL). Enzymatic colorimetric test kits were used to assay the blood plasma concentration of Tch, TG and HDL following the method of Gordon et al. (1977).

Statistical analysis: The collected data were tabulated and edited in Microsoft Excel. The data were analyzed using SPSS (Ver. 11.5). The parametric ANOVA through Completely Randomized Design (CRD) were used to obtain the least square means with standard error of all parameters. The value was converted to percentage of live weights prior to statistical analysis. The mean differences were compared using least significant difference test at 5% and 1% level of significance.

RESULTS AND DISCUSSION

Effect of beef tallow on live weight gain of lamb: The highest total weight gain (4.68±0.09 kg) was found in T_1 group of animal, which was significantly higher than other groups. Final body weight, FCR, dressing percentage and other growth parameters are mentioned in **Table 2**. A significant variation was observed in average daily live weight (LW) gain (**Table 2**). Addition of beef tallow at 2% level in the ration in T_1 group showed significantly higher growth and superior FCR over the control group (T_0), and 4% level tallow group (T_2). Similar results on growing rams and calves were described by previous investigators (Bird et al., 1979; Bird and Leng, 1985; Santra and Karim, 2000). Higher average LW gain and superior FCR of lamb treated with 2% beef tallow was probably due to reduced methanogenesis (Kreuzer et al., 1986; Santra et

Table 1. Percentage of feed ingredients of concentrate feed mixture and chemical composition of the supplied feed.

Name of the ingredients	Feed mixture (%)		
	T_0 (0% beef tallow)	T_1 (2 % beef tallow)	T_2 (4% beef tallow)
Broken corn	50	48	46
Soybean meal	10	12	14
Wheat bran	16	16	16
Mustard oil cake	21	19	17
Di Calcium Phosphate	1	1	1
Salt	1	1	1
Vitamin mineral premix	1	1	1
Beef tallow	0	2	4
Total	100	100	100
Chemical Composition (% Dry mater)			
Dry matter	89.093	87.231	85.47
Crude protein	18.66	18.674	18.69
Crude fiber	6.27	6.104	5.936
Nitrogen free extract	60.884	59.05	57.238
Crude fat	3.588	5.588	7.23
Crude ash	5.16	5.028	5.4
Lysine	0.912	0.927	0.942
Methionine	0.298	0.2962	0.294
Calcium	1.25	1.232	1.231
Phosphorus	1.41	1.426	1.406
Metabolisable energy (Kcal/kg)	2514.1	2629.12	2744.14

Table 2. Effect of beef tallow on Daily body weight gain, feed conversion ratio and other production traits of three dietary groups

Parameters	T_0 (0% BT[a]) (Mean±SE[b])	T_1 (2% BT[a]) (Mean±SE[b])	T_2 (4% BT[a]) (Mean±SE[b])	Significance
Initial body weight (kg)	12.2±0.76	10.7±1.07	10.1±0.85	NS[c]
Final body weight (kg)	15.52±1.19	15.34±1.13	13.68±1.09	NS
Total weight gain (kg)	3.32±0.44	4.68±0.09	3.58±0.27	S[d]
Average daily gain (gm/day)	52.70±7.02	74.29±1.37	56.83±4.36	S
FCR[d]	6.18±0.91	4.04±0.08	5.41±0.42	NS
Pre-slaughter weight (kg)	15.23±1.52	15.3 ±1.76	13.77 ±2	NS
Hot carcass weight with Viscera (%Live weight)	77.81±1.11	72.29±1.1	72.30±1.43	S
Dressing percentage	43.93±1.26	42.87±0.59	44.05±0.73	NS
Feed cost (BDT[e]/kg feed)	27.59	28.5	30.5	NS
Total feed cost (BDT[e]/sheep)	521.45	538.65	576.45	NS
Feed cost (Tk/kg live weight gain)	170.5±25.2	115.3±2.2	165±12.9	S

[a]Beef tallow, [b]Standard Error, [c]Not significant, [d]Feed Conversion Ratio, [e]Bangladeshi Taka (currency), [d] Significant

al., 1996), and increased microbial and dietary protein flow from rumen to duodenum (Bird and Leng, 1985). The lower growth rate and poor FCR in T_2 group might be due to poor digestibility and/or imbalance between fat in the diet and hydrogenation of fats in the rumen. However, certain benefit can be ascribed to the effect of beef tallow on treatment T_1, considering that lambs from this group had the best final weight gain. The average daily gain was also found to be similar to the results obtained by Osman et al. (1988). The cost of per kg feed formulation was higher in group T_2 (Bangladeshi Taka, BDT 30.5) and lower in group T_0 (BDT 27.59). However, higher feed cost for gaining one kg mutton was found in group T_0 (BDT 170.5) and lower in group T_1 (BDT 115.3), and it indicated the higher profit might be secured when sheep ration were supplemented with 2% beef tallow.

Effect of beef tallow on carcass characteristics of lamb: Results of average values for mass and carcass characteristics of slaughtered lambs are presented in **Table 2**. The highest dressing percentage of carcass was found in T_2 group (44.05%) which is somewhat lower than previous study (Gabrilides et al., 1993; Papadopoulos et al., 1993; Tzalis et al., 1994; Cifuni et al., 2000). According to the former study, a varying level of dressing percentage might be observed based on the age and body weight of animal. The beef tallow treatments did not affect the proportion of lung, kidney, heart, spleen and other non-carcass components (**Table 3**). No significant differences of

Table 3. Effect of beef tallow on carcass characteristics (% live weight) of lamb

Parameters	T_0 (0% BT[a]) (Mean±SE[b])	T_1 (2% BT[a]) (Mean±SE[b])	T_2 (4% BT[a]) (Mean±SE[b])	Significance
Yield of edible by products				
Kidney	0.27±0.03	0.29±0.03	0.24±0.03	NS[c]
Lungs	0.98±0.03	0.99±0.05	1.52±0.28	NS
Heart	0.39±0.01	0.45±0.03	0.50±0.05	NS
Spleen	0.23±0.04	0.21±0.02	0.26 ±0.02	NS
Liver	2.28±0.10	2.53±0.25	2.61±0.4	NS
Non-carcass component				
Skin	9.94±0.3	8.58±0.65	9.49±0.89	NS
Head	6.33±0.09	6.87±0.05	7.28±0.55	NS
Feet	2.83±0.07	2.51±0.23	2.66±0.32	NS
Stomach and intestine	27.24±1.72	22.67±0.53	21.9±1.71	NS
Yield of primal cut				
Neck	5.5±0.71	5.29±0.43	5.35±0.4	NS
Left Hind leg	4.92±0.08	4.63±0.31	5±0.15	NS
Right Hind leg	4.83±0.14	4.49±0.32	5.08±0.17	NS
Left foreleg	4.11±0.14	4.08±0.17	4.16±0.08	NS
Right foreleg	3.91±0.11	4.19±0.07	4.17±0.18	NS
Fat deposition				
Fat thickness at 12th rib (mm)	1.4±0.17	1.8±0.23	2.7±0.12	S[d]
Caul Fat	1.22±0.05	1.12±0.16	1.41±0.22	NS
Visceral Fat	0.71±0.06	1.52±0.18	2.25±1.08	NS

[a]Beef tallow, [b]Standard Error, [c]Not significant, [d] Significant

Table 4. Chemical composition of meat of lamb that were fed on different levels of beef tallow

Parameter (%)	T_0 (0%BT[a]) (mean±SE[b])	T_1 (2%BT[a]) (mean±SE[b])	T_2 (4%BT[a]) (mean±SE[b])	Signifi-cance
Moisture	72.1±0.97	72.3±0.06	72.37±1.81	NS[c]
Crude protein	19.35± 0.78	20±0.7	19.34± 0.88	NS
Crude Fiber	0.24±0.01	0.41±0.08	0.23±0.03	NS
Ether Extract	5.76±0.03	5.58±0.68	5.79±0.65	NS
Ash	0.88±0.02	0.88±0.03	1±o.10	NS

[a] Beef tallow, [b] Standard Error, [c] Not significant

carcass and non-carcass components were found among the treatments. Fat thickness of 12th ribs, proportion of caul fat and proportion of visceral fat were presented in **Table 3**. Fat thickness of 12th rib was significantly (P<0.05) higher (2.7±0.12 mm) in T_2 group than others. This finding was similar to the results of Sultana et al. (2011). There was no significant (P>0.05) difference in deposition of caul fat and visceral fat deposition but apparently more fat deposition was measured in T_2 than other groups. The results substantiated the findings of Lough et al. (1993). Proportion of different primal cuts was also similar in three groups (**Table 3**). The higher proportion of neck cut was found in T_0 group of animal (5.5±0.71% LW), and lower was found in T_1 (5.29±0.43% LW).

Effect of beef tallow on chemical composition of meat: Results obtained from proximate analysis of meat from three groups for chemical composition are shown in **Table 4**. The result of chemical analysis of meat showing the similar chemical composition in all dietary groups, and there was no significant variation (P<0.05) among the treatments. Findings of this study concerning the chemical composition of meat was similar to Ono et al. (1984), who also stated that lamb lion chop contain 73.29% moisture, 20.30% protein, 5.03% fat, and 1.08% ash. Similar result was stated by Hoke et al. (1999) and Martnez-cerezo et al. (2005). Physical appearance of meat from three groups revealed no apparent variation. The appearance of meat was much lighter for all groups but a redness and yellowness were also found in some extent. Lanza et al. (2006) stated that Intramuscular fat content is one of the factors of meat color, as reported by Santos-Silva et al. (2003).

Effect of beef tallow on Lipid profile of sheep: The concentration of cholesterol, TG, HDL-cholesterol and LDL-cholesterol in plasma of lamb at initial period of trial and final level are presented in **Figure 1**. A remarkable pattern of increasing rate of TG concentration (68.8±1.8 to 89±6.6 mg/dL) in blood in control group of animal was observed and 2nd highest increasing rate (76.8±2.2 to 79±5.9 mg/dL) in 2% tallow group and somewhat static concentration (92.6±8.5 to 92.6±13.7 mg/dL) was found in T_2 group with 4% beef tallow. At the end of the experiment the level of LDL-c was decreased in 4% beef tallow group (48.28±9.2 to 42.12±2.86mg/dL) and the increasing trend was observed in control group and T_1 group (**Figure 1**).

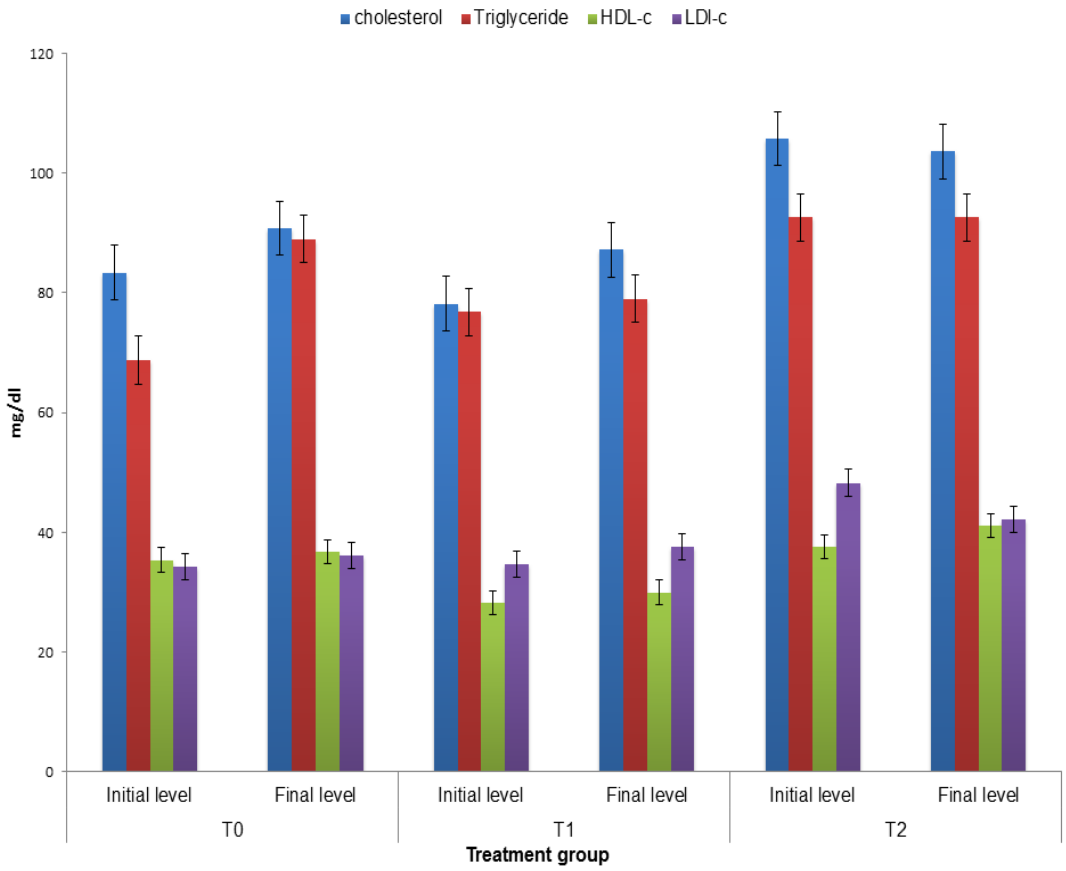

Figure 1. Effect of beef tallow on plasma lipid profile of growing lamb. (T_0) 0% beef tallow group; (T_1) 2% beef tallow; (T_2) 4% beef tallow; HDL-c, High Density Lipoprotein-cholesterol; LDL-c, Low Density Lipoprotein-cholesterol.

These results might be due to the beneficial effects of Conjugated Linoleic Acid (CLA) content of animal fat (Bhattacharya et al., 2006). The results showed that animals with a high total cholesterol level have higher levels of HDL-c, LDL-c and triglycerides (**Figure 1**). Animals with high levels of HDL-c also have higher levels of LDL-c and triglycerides. In human a significant relationship is also present between the levels of triglycerides and HDL-c (Fredenrich and Bayer, 2003; Olswold and De Andrade 2003). In agreement with our results, in human, Ping et al. (2000) observed a significant correlation between total cholesterol and LDL-c levels.

CONCLUSION

It can be concluded that the use of beef tallow at 2% level in sheep diet improves growth performances. The beef tallow has no deleterious effect on the palatability of sheep diet. The best production results concerning gain and feed conversion ratio is obtained in T_1 dietary group. Therefore, it is suggested that 2% beef tallow in a diet supplemented with concentrate can improve growth rate of growing lamb, and it can be included in sheep fattening ration. However, more detailed investigation is required considering large number of animals and longer time experimentation before making a final recommendation.

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