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Effect of used rice straw of mushroom cultivation on growth performance and plasma metabolites in beef cattle

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Abstract

The present experiment was designed to know the feasibility of using rice straw used as bedding materials for mushroom cultivation as cattle feed and its effect on the growth performance and plasma metabolites in ten beef cattle (BW 73±7 kg; 1 year). The animals were divided into two groups and fed two diets using a crossover design for a period of 60 days each. Diet one was control diet (CL-diet) composed of rice straw, dhal grass, wheat bran, and mustard oil cake and in another diet 10% of rice straw of CL-diet was replaced by the rice straw used as bedding material for mushroom cultivation, which was considered as mushroom straw diet (URS-diet). In both the dietary treatments the animals were fed at 1.5 times of maintenance energy and protein requirement. The animals were weighed once a week throughout the experimental period, and the blood samples were collected on the day 60 of each experiment. The acid detergent fiber was slightly lower and neutral detergent fiber was slightly higher ($P < 0.05$) for URS-diet compared to CL-diet. The crude protein and crude ash contents were higher ($P < 0.05$) in URS-diet compared to CL-diet. Body weight gain was greater for URS-diet compared to CL-diet. Plasma concentration of glucose, and blood urea were comparable between dietary treatments. Plasma total cholesterol, triglyceride, HDL-C, and LDL-C were lower in URS-diet compared to CL-diet. It could be concluded that, the URS-diet could be fed to cattle without any adverse effect on growth and plasma lipid profile.

Key words: cattle, growth, plasma metabolites, spent mushroom substrate

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Introduction

Livestock sector plays an important role in the rural economy of Bangladesh. It is well recognized as an integral component of farming systems. But this sector contributes only 30% of the agricultural sector compare to 55% from crop (Rashid, 1995). The biggest constraint behind this is identified as poor nutrition i.e. scarcity of feeds and fodder of livestock (Begum, 1992; Rashid, 1995). Due to high pressure on land for crop production for human consumption, farmers cannot spare land for fodder production for livestock feeding (Rashid, 1995). In this regard, Begum (1992) also stated that, while limitation of feed and fodder is seriously recognized, there is also equally important concern on how available feed resources are efficiently utilized. To overcome the scarcity of animal feed and to reduce feed cost it is necessary to find out the feasibility of using agro-industrial wastes.

In recent years, agro-industrial wastes e.g. poultry litter, cow dung, sugarcane bagasse, wood pulp, slaughter house waste etc. have attracted the attention of nutritionists for their economical and nutritional potentialities in the feeding of animals (El Sabban et al., 1970; Newton et al., 1977, Kumar et al., 1983). At present, synthetic antibiotic growth promoters are taken under banning policy and encouraged unconventional feedstuffs with bioactive components for logical importance in livestock farming. Mushroom, which is a fleshy saprophyte fungus, are found growing on damp rotten log of wood trunk of trees, decaying organic matter and in damp soil rich in organic substances. Edible mushroom are highly nutritious and can be compared with eggs, milk and meat. The content of essential amino acids in mushroom is high and close to the need of the human body (Oei, 2003). Mushroom is easily digestible and it has no cholesterol content. For these reasons mushroom

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cultivation in Bangladesh gradually gaining popularity. For mushroom cultivation straw is used extensively (Oei, 2003). Spent mushroom substrate is the organic material remaining after a crop of mushrooms has been harvested (Aamlid and Landschoot, 2007). So, spent mushroom substrate is a by-product of this culture system (Yohalem et al., 1996).

According to Langer et al. (1980) and Durrantet al. (1991) fungal cultivation resulted in considerable changes in the spent straw, remaining after mushroom harvesting, leading to increased crude protein and soluble cell wall content which might be more useful than the original straw when fed to ruminants. Rice straw is being used as bedding materials for mushroom (*Agaricus bisporus*) cultivation in Bangladesh. After harvesting the straw along with small particles of mushroom is either dumped of or burned as fuel for cooking. This waste material can be rich in microorganisms and extra-cellular enzymes (Ball and Jackson, 1995) and contain relatively high levels of nitrogen, potassium, phosphorus, calcium and trace elements, notably iron and silicon, (Langar et al., 1980; Burton et al., 1994) that may be used as animal feed. It might influence the growth performance and plasma metabolites in beef cattle. Use of this URS in animal feeding could be reduce the animal feed cost and at the same time could be minimized the environmental pollution caused through decomposition of the URS. Based on the above statement, the present experiment was undertaken to identify the effect of URS on growth performance and plasma metabolites in beef cattle.

Materials and Methods

Animals, Diet and Management

The experiment was conducted in the village of Fulbaria and Maltipur, Muktagasafor a period of 120 days. Ten (10) beef cattle aged 1 year with average live weight of 73±7 kg were reared in similar environmental conditions in village. The cattle were housed in individual pen within farmers shed and using a crossover design with two 60 days periods having five animals in each. Two dietary treatments, one was control diet (CL-diet) composed of rice straw, dhal grass, rice polish, wheat barn, and mustard oil cake and 10% of rice straw of CL-dietwas replaced by used rice straw in mushroom cultivation (URS-diet). In both the dietary treatments the animals were fed 1.5 times of maintenance energy and protein (NRC, 1985). The animals were weighed once a week throughout the experimental period using Shaeffer's law, and the blood samples were collected on day 60 of each experimental period.

Used rice straw in mushroom cultivation was collected in polythene bag from the farmers of Fulbaria and carried to Maltipur, Muktagacha.Normal rice straw was procured from local farmers. Feed ingredients such as dhal grass, rice polish, wheat bran, mustard oil cake, and common salt were purchased from local market of Mymensingh. The selected ten (10) farmers were advised to keep the animal separate from others; ensured vaccination and deworming program; cleaned, washed and disinfected the equipment with bleaching powder solution; ensured expected ration over the experimental period; recorded the temperature; ensured proper ventilation and observed clinical symptoms..

The roughages were provided equally two times (7.00 am and 4.00 pm) everyday whereas the concentrate mixture was provided in the morning. The clean and fresh water was provided *ad libitum*. The amount of feed offered daily and refusal feed at the end of each week was recorded. Feed intake, feed conversion efficiency and feed conversion ratio were calculated. The feed samples were collected in triplicate for the determination of proximate components. Blood samples were collected and centrifuged, then preserved it until further analysis.

Proximate analysis

The proximate components of feeds, leftovers and feces were analyzed according to AOAC (1995). The Acid Detergent Fiber (ADF) and Neutral Detergent Fiber (NDF) analysis was performed according to Mertens (2002). Plasma glucose level was estimated by enzymatic Glucose oxidase method' (GOD method). Plasma cholesterol is determined by Cholesteroloxidase method (CHOD/POD method). Plasma triglycerides were estimated by the commercial available reagent kit (Atlass Co. Ltd, Japan). HDL,

LDL and VLDL were determined using crescent diagnostics cholesterol test kit, Saudi Arabia (Cat No. CS 603)

Statistical analysis

At first the raw data were organized using computer Excel program and then analyzed using SPSS Statistics (originally, Statistical Package for the Social Sciences, later modified to read Statistical Product and Service Solutions) for one-way analysis of variance (ANOVA). Mean value, Standard error, and P-values were calculated from it. P-values less than 0.05 ($P<0.05$) and less than 0.01 ($P<0.01$) were considered to be statistically significant.

Results and Discussion

Results and discussion on body weight change, nutrient digestibility and plasma parameters of cattle for URS-diet and CL-diet are presented in different subheadings.

Body weight changes

The body weight changes did not differ significantly between dietary treatments (Figure 1). But the body weight gain numerically tended to be higher (P= 0.063) in URS-diet group than CL-diet group (P=0.055).

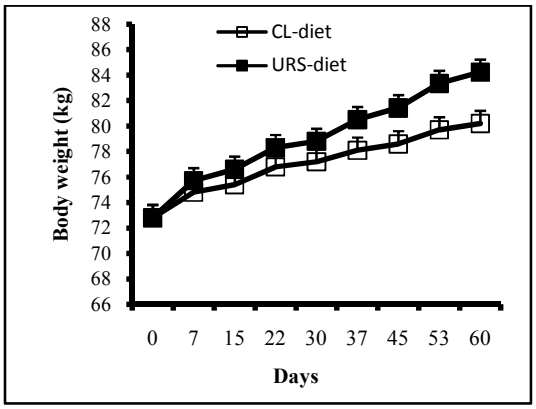

Figure 1. Graphically shown weekly body weight changes (kg/animal) of beef cattle under two dietary treatments; Solid Square indicates CL-diet and open square indicates URS-diet.

Huck et al. (2000) reported that the weight gain of feedlot beef cattle with added direct-fed microbes (DFM) increased by 2.5 to 3.0%. (Galyeanet al., 2000) also reported that dietary addition of DFM increased the body weight of feedlot cattle. It is believed that feeding mushroom-straw rich diet favorably affected the growth of Hanwoo steers because it functions as sources of roughage as well as DFM.

Table 1: Effect of used rice straw (URS) in mushroom cultivation (URS-diet) on nutrient digestibility of beef cattle

Parameters	Treatments*		SEM	P-value
	CL- diet	URS- diet		
DM digestibility (%)	46.91±0.77	41.81±0.67	0.61	0.19
CP digestibility (%)	61.11±2.33	65.47±2.31	1.59	0.001
ADF digestibility (%)	47.24±3.16	45.66±2.19	0.78	0.91
NDF digestibility (%)	49.37±1.37	52.05±4.60	2.43	0.33
EE digestibility (%)	30.45±1.40	34.92±1.59	2.73	0.001

*CL-diet, rice straw, dhal grass, rice polish, wheat barn, and mustard oil cake; URS-diet, 10% of rice straw of CL-dietwas replaced by used rice straw in mushroom cultivation;Values indicate Mean± SE; standard error; SEM, standard errors of mean; DM, dry matter; CP, crude protein; ADF, acid detergent fiber; NDF, neutral detergent fiber; EE, ether extract.

Nutrient digestibility

Table 1 shows the nutrient digestibility of URS-diet group and CL-diet group. Dry matter (DM) digestibility was slightly lower and ether extract (EE) digestibility was significantly higher (P= 0.17 and P=0.001, respectively) for URS-diet than CL-diet. Crude protein (CP) digestibility tended to be higher (P=0.001) in URS-diet. Similarly ADF was slightly lower and NDF digestibility tended to be higher (P= 0.91 and P= 0.33, respectively) for URS-diet than CL-diet. The ash digestibility remained unchanged (P= 0.23) between URS-diet and CL-diet.

In current study, the feed consumption rate of growing beef cattle was higher in URS-diet group than CL-diet group. It was observed that, URS-diet was highly palatable for beef cattle. Silvana et al. (2006) and Adamovic et al., (1998) reported that bio-degradation of straw with *Pleurotusostreatus* increased its nutritional value and digestibility in ruminant diets. Kumar (1991) observed that, herbal formulations as growth promoters have shown encouraging results on feed intake in poultry birds. In the present study, dry matter (DM %) digestibility was slightly lower and ether extract (EE %) digestibility was significantly higher in URS-diet group than CL-diet group. According to Fazaeli et al (2006), inclusion of mushroom-straw diet up to 20% of the diet did not affect the digestibility of nutrients, which may reflect the absence of a negative effect of dietary inclusion of mushroom-straw diet. On the other hand 40% mushroom-straw does not decrease rumen microbial fermentative activity and affect digestibility in a positive manner (Choi et al. 2010). Probably, the use of higher spent mushroom straw in ration will be given better output in term of productivity of animal.

Numerous studies have shown that the bioactive components of mushroom have various beneficial effects including immunomodulatory, hypocholesterolemic, and anti-tumor influences on animals and humans (Yoshioka et al., 1985; Fukushima et al., 2000; Lull et al., 2005). In this current study, crude protein (CP) and neutral detergent fiber (NDF) digestibility were numerically higher, but acid detergent fiber (ADF) digestibility found slightly lower in URS-diet group than CL-diet. Crude ash content was also numerically higher in URS-diet than CL-diet in this current study.

Changes of plasma parameters

There were no significant effects on the plasma parameters, which are shown in Table- 2. Plasma glucose concentrations (P=0.85) did not differ significantly. It was found that numerical value of plasma glucose was higher for URS-diet than CL-diet. Total cholesterol, triglycerides, LDL-C and HDL-C did not differ significantly but numerically lower (P= 0.098, P=0.36, P= 0.12 and P=0.20, respectively) for URS-diet than CL-diet. Blood urea nitrogen were numerically lower (P=0.61) for URS-diet than CL-diet.

Table 2. Effect of used rice straw (URS) of mushroom cultivation (URS-diet) on plasma parameters of beef cattle

Parameters	Treatments*		SEM	P-value
	CL-diet	URS-diet		
Glucose (mmol/L)	5.6	5.7	0.2	0.85
T Cholesterol (mg/dL)	176.3	133.8	13.5	0.098
Triglyceride (mg/dL)	41.6	36.5	2.8	0.36
HDL-C (mg/dL)	7.2	4.8	0.9	0.20
LDL-C (mg/dL)	160.8	121.7	13.1	0.12
BUN (mg/dL)	2.2	2.0	0.2	0.61

*CL-diet, rice straw, dhal grass, rice polish, wheat barn, and mustard oil cake; URS-diet, 10% of rice straw of CL-dietwas replaced by used rice straw in mushroom cultivation,Values indicates; # SEM, Standard Errors of mean; HDL-C, High density lipoprotein; LDL-C, Low density lipoprotein; BUN, Blood urea nitrogen.

Glucose metabolism is influenced by nutritional and physiological conditions of animals (Buckley et al., 1982) and reduced during heat exposure (Sano et al., 1983). Blood glucose is one of the most common metabolites used to assess the energy status of cattle (Ndlovu et al., 2007). Park et al. (2012) studied that spent mushroom substrate (SMS) had higher BUN and glucose concentrations, and these results may be attributed to higher nitrogen (N) and energy consumption due to increased feed intake of 10% (15% SMS group) and 17% (20% SMS group), as compared to the control group. In the current study, plasma glucose concentrations did not differ significantly. It was found that numerical value of plasma glucose was higher for URS-diet than CL-diet. Cholesterol contains triglycerides and low-density lipoprotein (LDL-C), very low-density lipoprotein (VLDL-C) and high-density lipoprotein (HDL-C).

In this experiment, cholesterol, triglycerides, HDL-C and LDL-C were numerically lower for URS-diet than CL-diet in every case. HDL-C is tested to determine risk of developing heart disease (Thomas et al. 1997). HDL-C is helpful for recovery of cardiovascular diseases also. The addition of mushrooms affected serum triglyceride and cholesterol concentrations and effectively prevented the progress of hypercholesterolemia and cholesterol accumulation in liver induced by a high cholesterol diet in rats (Bobek et al., 1995; Fukushima et al., 2001). The percentage of URS replacement was not sufficient for altering significant variation between CL-diet and URS-diet groups at all cases. Probably, higher percentage of URS-diet supplement will get positive output in URS-diet group. In ruminants, urea can be influenced by quantity of dietary protein, level of feed intake, and protein degradability in the rumen (Karnezos et al., 1994). Blood urea nitrogen level was found statistically non-significant in the current study. The BUN test is used to evaluate kidney function and to monitor the effectiveness of dialysis and other treatments related to kidney disease or damage. Though Urea level of blood showed no significant difference, numerically lower value in case of URS-diet found during the study period.

Conclusion

The used rice straw diet (URS-diet) showed variation for body weight change, nutrient digestibility and plasma parameters. It is revealed that under present experimental conditions, the URS-diet could be fed to cattle without any adverse effect on growth performance and plasma lipid profiles. It can also be concluded that used rice straw of mushroom cultivation is a good choice for cattle feed establishment.

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