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Original Research Article

Performance and ruminal parameters of fattening Moghani lambs fed recycled poultry bedding

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ABSTRACT

This study investigated the effects of recycled poultry bedding (RPB) on performance and protozoa population, microbial enzyme activity and microbial protein synthesis (MPS) in rumen contents of fattening lambs. Thirty-six male Moghani lambs (31.4 ± 3.2 kg body weight) were fed iso-energetic and iso-nitrogenous diets containing 0, 70, 140 or 210 g/kg dry matter (DM) RPB in a balanced randomized design (9 lambs per treatment). Results showed that final body weight, DM intake, average daily gain and feed conversion ratio were unchanged ($P > 0.05$) by RPB inclusion. Total protozoa population and subfamily of *Entoniniinae* and *Diplodiniiae* were linearly decreased by RPB (L, $P < 0.05$). For rumen fibrolytic enzymes including carboxymethyl-cellulase, microcrystalline-cellulase and filter paper degrading activity, the extra cellular, cellular and total (extra cellular plus cellular fraction) activity were similar ($P > 0.05$) by feeding the experimental diets. Inclusion of RPB in the diet linearly decreased extra cellular and total α-amylase activity (L, $P < 0.05$), while cellular activity was unchanged ($P > 0.05$). The extra cellular activity of proteases tended to increase (L, $P = 0.07$) and their total and cellular activity increased ($P > 0.05$) in lambs fed RPB. Incorporation of RPB into the diet had no effect (L, $P > 0.05$) on urinary purine derivative excretion and MPS. In conclusion, inclusion of RPB up to 210 g/kg DM had no negative impact on performance, ruminal fibrolytic enzyme activity and MPS, while it increased rumen protease activity and decreased protozoa population in fattening Moghani lambs.

1. Introduction

Recycled poultry bedding (RPB) is a solid waste consisting of poultry excreta (urine and feces), bedding material, feathers and spilled feed (Azizi-Shotorkhoft et al., 2013). In Iran, the production of dry RPB exceeds 1.5 million metric tons annually (Statistical Centre of Iran, 2013). The proper use of inexpensive agro-industrial by-products such as broiler litter (BL) is important to improve livestock production (Negesse et al., 2007). The fact that it is cheaper, with high crude protein (CP) content (150 to 350 g/kg DM; Obeidat et al., 2011) and some required minerals (Rankins et al., 2002), suggests the potential value of RPB as a ruminant feed. Moreover, the use of RPB in ruminant feeding has led to decreased production costs and greater total production, and is a mean of disposing of waste in an environmentally-friendly way (Elemam et al., 2009). However, owing to the presence of pathogenic bacteria it should be processed before offering to ruminants (McCaskey and Anthony, 1979). Most of the nitrogen (N) in RPB is in the form of non-protein nitrogen (NPN) which can be easily and rapidly degraded in the rumen (Animut et al., 2002). Ruminal degradability of uric acid (the main component of NPN in RPB) has been estimated at 960 g/kg (Zinn et al., 1996). Uric acid is broken down in the rumen at a slower rate compared with urea and consequently most of the ammonia is captured by the rumen microorganisms (Oltjen et al., 1968).

Studies conducted on the use of poultry litter as a feed ingredient have mainly focused on the productive performance of livestock. Different processed RPB has been successfully used in

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ruminant diets (Negesse et al., 2007; Azizi-Shotorkhoft et al., 2013; Baluch-Gharaei et al., 2015). Recycled poultry bedding contains copper (Cu) which has an inhibitory effect on the activity of ruminal protozoa (Kišidayová et al., 2000). For example, Vardyova et al. (2006) found that long-term feeding of Cu-containing pasture to sheep significantly decreased the total population of rumen ciliate protozoa. Recently, Baluch-Gharaei et al. (2015) also reported that the total population of rumen protozoa and sub-family of *Entoniniinae* were significantly reduced as the level of deep-stack RPB increased in the diet of sheep as compared with a diet free of poultry litter. Therefore, feeding high levels of RPB to ruminants may change the population of rumen microorganisms, particularly protozoa, and consequently their hydrolytic enzyme activity.

To our knowledge, no literature data is available on the effect of heat-processed RPB in pellet-form diets on rumen hydrolytic enzyme activity and microbial protein synthesis (MPS). Therefore, this experiment was conducted to evaluate the effect of feeding different levels of RPB in pellet-form on performance, ruminal protozoa population, rumen microbial activity (measured as the activities of rumen hydrolytic enzymes) and MPS in fattening Moghani lambs.

2. Materials and methods

2.1. Heat-processed recycled poultry bedding

The RPB (large-scale, commercially processed at 80 °C for 20 min) which was obtained from the manufacturer (Sabzevar, Khorasan Province, Iran), contained a mixture of bird excreta, feather, spilled feed, cardboard and buttonwood shavings. To remove pathogenic bacteria and improve poultry litter quality, the material was processed under an indirect thermal operation in a special hot tank (with a capacity of 5 tons) for 20 min. The tank was comprised of 2 walls between which a hot steam (80 °C) was directed. Finally, the produced RPB was ground to pass through a 6-mm sieve by the factory.

2.2. Animal study

Animal care and use were conducted in accordance with practices outlined in the Guide for the Care and Use of Agriculture Animals in Agriculture Research and Teaching. Thirty-six male fat-tailed Moghani lambs (135 ± 15 days of age and initial body weight of 31.4 ± 3.2 kg) were randomly assigned to 4 groups of 9 lambs each in a balanced randomized design. Animals were housed in concrete floor pens (1.2 m × 1.1 m) in a closed shed building. The feeding trial lasted 84 days preceded by a 14-day adaptation period to the pens, diets and experimental conditions (totally 98 days). At the beginning of the adaptation period, all animals were treated for external (1 mL of Azantole 10% per 7 L of water, as spraying method; Bayer, Germany) and internal (Triclabendazole + levamisole, 12 mL per lamb; Darou-Pakhsh Co., Iran) parasites and vaccinated against enterotoxaemia (3 mL per lamb; Razi Vaccine and Serum Research Institute, Iran). Additionally, over the adaptation period, the amount of dietary RPB was gradually elevated for each lamb to reach levels considered as the experimental levels in the dietary treatments.

Four iso-energetic and iso-nitrogenous diets (Table 1) with different levels of RPB (0, 70, 140 or 210 g/kg DM) were formulated to meet the nutrient requirements of growing lambs (NRC, 1985). Experimental diets were pelletized under heat (50 to 60 °C) and pressure (between rollers and flat die) in pellet-form and of cylindrical shape (diameter 15 mm; length 25 mm) using a pelleting machine (Pishgam Industrial Company, Iran). Pelleted complete diets were individually offered *ad libitum* 3 times a day (at 08:00, 14:00 and 20:00) to ensure a level of approximately 5% feed refusal.

Table 1
Ingredients and chemical composition (g/kg DM) of the experimental diets.

Item	Experimental diets[1]			
	RPB0	RPB70	RPB140	RPB210
Ingredients				
Alfalfa hay	150	140	140	120
Wheat straw	72.5	72.5	64.2	65.0
Wheat bran	157	110	75	35
Barley grain, ground, dry	260	280	285	270
Maize grain, ground, dry	70.0	75.0	75.0	100
Wheat grain, ground, dry	135	135	145	150
Sugar beet pulp, dry	100	80.0	50.0	40.0
Soybean meal	40.0	22.5	15.0	0.0
Processed recycled poultry bedding	0.0	70.0	140	210
Urea	2.9	2.5	0.30	0.0
Sodium bicarbonate	2.95	3.0	3.0	3.0
Limestone	4.9	4.5	2.5	2.0
Minerals and vitamins[2]	2.5	2.5	2.5	2.5
NaCl	2.5	2.5	2.5	2.5
Chemical composition				
Dry matter, g/kg fresh weight	907	910	914	915
Crude protein	136	136	136	136
Metabolizable protein	90.5	89.6	89.4	88.7
Ash-free neutral detergent fiber	336	339	340	339
Ash-free acid detergent fiber	163	159	154	147
Non fiber carbohydrates	451	448	441	439
Starch	370	364	360	355
Ether extract	20.9	19.1	18.6	18.1
Ash	52	59	67	74
Ca	5.40	5.55	5.20	5.30
P	4.10	4.15	4.30	4.40
Cu, mg/kg DM	6.85	9.60	12.5	15.3
Metabolizable energy, MJ/kg DM	10.63	10.63	10.63	10.63

[1] Diets were: recycled poultry bedding (RPB) included in the diets at 0 (RPB0), 70 (RPB70), 140 (RPB140) or 210 (RPB210) g/kg dietary dry matter.
[2] Contained (per kg): 99.2 mg Mn, 50.0 mg Fe, 84.7 mg Zn, 1.0 mg Cu, 1.0 mg I, 0.2 mg Se, 9,000 IU vitamin A, 2,000 IU vitamin D, and 18.0 IU vitamin E (Roshd Daneh Co., Iran).

Animals had free access to fresh water. Samples of feed and orts were collected daily and bulked for further analyses. Representative samples were pooled to obtain a composite per lamb within the treatment. All animals were individually weighed every 21 day at 08:00 after a 16-h feed deprival. For each lamb, average daily gain (ADG) was calculated by linear regression analysis of body weight vs. time. Feed conversion ratio (FCR) was calculated as g daily dry matter intake (DMI) per g ADG.

2.3. Rumen liquor sampling

On day 75 of the trial, rumen liquor (RL) samples (70 to 80 mL) were taken from 5 lambs in each treatment at 3 h after feeding using a flexible polyvinyl chloride stomach tube. The first 10 to 20 mL portion of collected samples was discarded to avoid saliva contamination (Jasmin et al., 2011).

2.4. Protozoa population

Total numbers and generic composition of rumen ciliate protozoa were determined according to the methods described by Dehority (2003). For this purpose, a sub-sample of RL (2 mL) was pipetted into screw-capped test tubes containing 5 mL of formalinized physiological saline solution (20 mL formaldehyde in 100 mL saline containing 0.85 g sodium chloride in 100 mL distilled water). Then, 2 drops of brilliant green dye (2 g brilliant green and 2 mL glacial acetic diluted to 100 mL with distilled water) were added to the test tube, mixed thoroughly and allowed to stand overnight at room temperature. Total and differential counts of protozoa were made in 30 microscopic fields at a magnification of × 20 in a haemocytometer (Neubauer improved, Marienfeld, Germany).

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