Livestock Science 148 (2012) 249–254

Contents lists available at SciVerse ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

The influence of the different carbohydrate sources on utilization efficiency of processed broiler litter in sheep

A. Azizi-Shotorkhoft [a], Y. Rouzbehan [a,*], H. Fazaeli [b]

[a] Animal Science Department, Faculty of Agriculture, Tarbiat Modares University, P.O. Box 14115 336, Tehran, Iran
[b] Animal Science Research Institute, P.O. Box 1483, Karaj 315, Iran

ARTICLE INFO

Article history:
Received 26 February 2012
Received in revised form
10 June 2012
Accepted 11 June 2012

Keywords:
Sheep
Processed broiler litter
Carbohydrate source
Microbial protein
Ruminal parameters
Blood metabolites

ABSTRACT

In a completely randomized design, fifteen male Moghani sheep were used to determine the influence of supplementing processed broiler litter (BL) with different carbohydrate sources (*i.e.,* corn, barley or molasses) on the nutrients digestibility, microbial protein (MP) production, ruminal parameters and blood metabolites. The three dietary treatments, which were iso-caloric and iso-nitrogenous, were corn diet (alfalfa hay, wheat straw, processed BL, corn grain), barley diet (alfalfa hay, wheat straw, processed BL, barley grain) and molasses diet (alfalfa hay, wheat straw, processed BL, molasses). The digestibility of dry matter, crude protein and neutral detergent fiber and MP in sheep fed molasses diet were higher ($P<0.05$) compared with those fed with diets containing corn or barley. However, sheep fed molasses diet had lower ($P<0.05$) ruminal pH ammonia concentration than those fed with other diets. Including various carbohydrate sources in the diets had no effect on volatile fatty acid (VFA) concentrations ($P>0.05$), except for total VFA and molar proportion of butyrate which increased ($P<0.05$) by molasses feeding. From blood metabolites only the blood urea-N concentration in sheep fed diet containing molasses was lower ($P<0.05$) than diet containing corn. In conclusion, adding molasses to processed BL-containing diet led to improved nutrient digestibility and MP production in sheep.

1. Introduction

The broiler litter (BL) is a solid waste consisting of poultry excreta (urine and feces), bedding material, feathers and spilled feed. In Iran, production of dry BL exceeds 1.3 million t/year. The proper use of inexpensive agro-industrial co-products such as BL is important to beneficial livestock production (Negesse et al., 2007). The commercial value of poultry litter as a feedstuff is based usually on its crude protein (CP) (150–350 g/kg dry matter (DM), Obeidat et al., 2011) and minerals content (Jordaan, 2004). However, Van Ryssen (2000) reported that 400–600 g/kg of the CP in BL is in the form of non-protein N (NPN) which is quickly degraded in the rumen (Animut et al., 2002). The synchronization of degradation rate of NPN and carbohydrate may lead to improve microbial protein (MP) synthesis in the rumen, decrease urinary N excretion and animal performance (Cole and Todd, 2008). Sugars are considered to have a fast degradation rate, and starch an intermediate rate (Sniffen et al., 1992). Molasses is rich in water-soluble carbohydrate (WSC) (Oba, 2011), which is cost-effective source of

Abbreviations: ADFom, ash-free acid detergent fiber; BL, broiler litter; BUN, blood urea-N; CP, crude protein; DM, dry matter; DMD, *in vivo* DM digestibility; DOMD, digestible OM in DM; Lignin(sa), lignin measured by solubilization of cellulose with sulphuric acid; ME, metabolizable energy; MP, microbial protein; NDFom, ash-free neutral detergent fiber; OM, organic matter; PD, purine derivatives; TPD, total purine derivatives; VFA, volatile fatty acids; WSC, water-soluble carbohydrate

* Corresponding author. Tel.: +98 21 48292336; fax: +98 21 48292200.
E-mail address: rozbeh_y@modares.ac.ir (Y. Rouzbehan).

1871-1413/$ - see front matter © 2012 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.livsci.2012.06.014

energy in comparison to starchy energy sources such as corn and barley. Because corn, barley or molasses differ in their rates and extents of ruminal degradation, our hypothesis was that the supply of N from processed BL to the rumen and different dietary energy source to support MP synthesis in the rumen would differ. Therefore, the objective of the study was to evaluate the effect of dietary inclusion of corn, barley or molasses as a source of energy on nutrients digestibility, ruminal parameters, blood metabolites and microbial N flow to the duodenum in sheep fed processed BL.

2. Materials and methods

2.1. Broiler litter

Broiler litter was obtained from the main factory in Sabzevar city, in which BL was humidified up to 23%, and then the material was thermally processed by indirect vapor pressure at 80 °C for 20 min.

2.2. Animal study

Fifteen mature-male Moghani sheeps with average live weight of 62 ± 2.3 kg were allocated individually in metabolic cages to allow total collection of feces and urine. The animals were assigned to a balanced completely randomized design with 5 animals in each diet. The three experimental diets which are shown in Table 2 consisted of 260 g alfalfa hay, 260 g wheat straw and 240 g processed BL per kg of DM, and were supplemented with either 240 g corn (corn diet), barley (barley diet) or sugar beet molasses (molasses diet) per kg DM. The ingredients and nutrient composition for the experimental diets, which were formulated according to NRC (2007), are shown in Table 2. The diets were provided in two equal meals each day at 08:00 and 17:00 h with free access to clean water and mineral–vitamin block. All sheeps were fed with equal amounts of the diets, which had no differences in type and proportion of ingredients except for main carbohydrate source (*i.e.*, corn, barley or molasses) in order to avoid the influences of ingredient characteristics and intake level on the rumen parameters (Seo et al., 2010).

Table 1
Mean chemical composition and metabolizable energy (ME) of processed BL (g/kg DM or as stated) ($n=4$).

Item	Processed BL
DM (g/kg fresh weight)	930
CP	238
NPN (g/kg CP)	451
TP (g/kg CP)	549
EE	22.3
NDFom	353
ADFom	185
Lignin(sa)	75
Ash	184
ME[a] (MJ/kg DM)	9.3

DM, dry matter; CP, crude protein; NPN, non-protein nitrogen; TP, true protein; EE, ether extract; NDFom, ash-free neutral detergent fiber; ADFom, ash-free acid detergent fiber.
[a] The metabolizable energy calculated by the following equation (Deshck et al., 1998); ME (MJ/kg DM) = digestible OM (g/g DM) × 18.5 (MJ/kg DOM) × 0.80.

Table 2
Ingredients and nutrient composition and metabolizable energy (g/kg DM or as stated) for the experimental diets given to sheep.

	Source of carbohydrate				
	Corn	Barley	Molasses	SEM	*P*-value
Ingredients					
Alfalfa hay	260	260	260		
Wheat straw	260	260	260		
Processed BL	240	240	240		
Ground corn	240	0	0		
Barley	0	240	0		
Molasses	0	0	240		
Nutrient composition					
DM (g/kg fresh weight)	928	933	923	6.1	0.16
CP	123	125	121	2.4	0.44
NDFom	422[b]	452[a]	377[c]	3.5	0.011
ADFom	269[a]	271[a]	252[b]	2.9	0.017
Lignin(sa)	62.9[ab]	65.2[a]	60.4[b]	1.5	0.032
Ash	99[b]	103[b]	122[a]	3.05	< 0.01
Ca	6.6	6.7	6.9	0.45	0.90
P	3.4	3.5	2.6	0.34	0.63
ME (MJ/kg DM)	9.04	8.91	8.70	0.24	0.54

DM, dry matter; CP, crude protein; NDFom, ash-free neural detergent fiber; ADFom, ash-free acid detergent fiber; ME, metabolizable energy. Means in the same row with different superscripts differ ($P<0.05$).

The apparent nutrients digestibility period lasted for 28 days with 21 days for adaptation period to metabolic cages and diets and 7 days for samples collection (Givens et al., 2000). During the last week, samples of feeds and feces from each sheep on each treatment were weighed and 10% sample was frozen for later analysis. At the same time, urine sample was collected in a bucket containing 100 ml of sulfuric acid solution (containing 10 ml of concentrated sulfuric acid in 100 ml of distilled water), to keep the final pH below 3, which was placed below the urine outlet in the metabolic cages. The collected urine from an individual animal was measured and a subsample of 20 ml was stored at −20 °C for the estimation of purine derivatives (PD) (Chen and Gomes, 1995). The DOMD (digestible organic matter (OM) in the DM) was calculated using the following equation:

$$\text{DOMD (g/kg DM)} = [\text{OM intake (g)} - \text{faecal OM (g)} / \text{DM intake (kg)}]$$

The metabolizable energy (ME) values of the experimental diets were calculated using the following equation (Agricultural and Food Research Council 1993):

$$\text{ME (MJ/kg DM)} = 0.0157 \times \text{DOMD}$$

2.3. Rumen liquor samples

Samples of rumen liquor were withdrawn 0, 3 and 6 h after morning feeding on the day 6 of last week of experiment by stomach tube, strained through two layers of muslin and pH was measured immediately. Samples