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RESEARCH ARTICLE

EFFECT OF POULTRY LITTER INCLUSION IN CONCENTRATE MIXTURE ON NUTRIENT DIGESTIBILITY AND MILK PRODUCTION IN LACTATING COWS

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ABSTRACT

An experiment on 24 lactating crossbred cows assessed the possibility of utilization of poultry litter (PL) in replacement of conventional protein supplement (soybean meal) in lactating cow diets. Cows of similar age and lactation were randomly divided in four equal groups and fed for 90 days with *ad-libitum* sorghum fodder and the concentrate mixture was offered to meet energy and protein requirements as per NRC (1988) recommendation. Concentrate fed to control (concentrate I) animals contained de-oiled soybean meal (DSM) as protein supplement while DSM protein was replaced at 25, 37.5 and 50 % with PL in concentrate II, concentrate III and concentrate IV, which accounted 28, 42 and 56 % PL levels respectively, and these concentrate mixtures were fed to cows of T1, T2, T3 and T4 groups respectively. The PL contained OM 71.5, CP 18.0, NDF 55.5, ADF 41.2, Ca 5.4, P 1.7 % and energy 3.75 Mcal/kg DM. The dry matter intake (DMI), milk production and milk composition were similar among four cow group. The DMI varied from 2.54 to 2.72 % of body weight, while milk production ranged from 5.06 to 6.59 kg. Although, milk production and organic matter intake were similar among four groups, however reduction in milk production 6 (T2), 19 (T3) and 22 (T4) % compared to T1 was accompanied by reduced organic matter intake 3, 5 and 9 per cent respectively in cow groups consuming concentrate having PL 28, 42 and 56 percent. PL inclusion in concentrate mixture reduced organic matter and energy contents, while NDF, ADF, Ca and P increased. Digestibility of DM was higher in T1, whereas intake and digestibility of OM, CP, NDF and ADF were similar among four cow groups. Present study concluded that poultry litter can be included in the concentrate mixtures of lactating cows up to 56 percent in replacement of 50 % conventional protein source, without significant reduction in nutrient digestibility and milk production. However, economics of PL inclusion in relation to milk production needs further studies.

INTRODUCTION

The availability of conventional feeds in quantity and quality as well is a major constraint in ruminant livestock production. There is also a shortage of animal feeds and water resources in many countries. The National Commission on Agriculture estimated feed deficit of ruminant animal to the tune of 44 percent of roughages and 44 percent of concentrate in India. The proper use of agricultural and/or industrial by-products is often a useful means of overcoming this problem. While, feeds and feeding represents a major share of the overall production cost for livestock production worldwide. Thus, proper use of inexpensive agricultural by-products is important to have economic livestock production (Negesse *et al*., 2007). To meet the ruminant feed requirements animal feeding industries are using unconventional and/ or agro-industrial by-products. The poultry litter (PL) is one of such by-product of poultry industry produced annually in large quantities as poultry waste. The poultry litter thus available as waste consist of droppigs, sawdust or wood shavings, feed and feathers that are appropriate for use as an animal feed. Usually, poultry litter is cheap to purchase, whereas transportation and drying are the most important added cost when used in feeding of livestock. Using PL as a feedstuff for ruminant is an alternative mean to dispose the waste product. The chemical composition of poultry litter is variable and influenced by factors such as the composition of diets fed to poultry, method of processing before feeding and bedding material used (Wang and Goetsch, 1998; Al-Marsi and Zarkawi, 1999).

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Poultry litter is a rich source of nitrogen, calcium and phosphorus besides other minerals and vitamins. This is relatively low in fiber but high in ash content, and therefore, a poor source of energy. High crude protein (CP) 15 to 35 % in dry matter (DM) (Azizi-Shotorkhoft *et al.*, 2012) and DM digestibility (65 to 68% in DM; Mavimbela *et al*., 2000) suggest that PL has a potential value as a ruminant feedstuff. According to Van Ryssen (2001), non-protein nitrogen (NPN) usually accounts a great part of the CP content in BL (40-60%) which is quickly degraded in the rumen (Animut *et al*., 2002). Ruminal degradability of uric acid, the main part of NPN content in BL, has been 96% (Zinn *et al*., 1996). Uric acid is broken down in the rumen at a slower rate compared to urea and consequently most of the ammonia is captured by the rumen microbes (Oltjen *et al.*, 1968). However, PL has a high ash content (24.7 % in DM; Stephenson *et al*., 1990) which may reduce available energy (Fontenot, 1991). According to Egna *et al*. (1991) and, Goetsch and Aiken (2000), the content of crude protein (CP) in poultry litter is ranged between 15 and 35% of dry matter. Mekasha *et al*. (2004) reported that CP (on DM basis) content in poultry litter was 298 g/kg. Inclusion of poultry litter in ruminant diets did not affect nutrient intakes, digestibility, average daily gain (ADG), or feed efficiency (Murthy *et al*., 1995; Animut *et al*., 2002; Jackson *et al*., 2006; Negesse *et al*., 2007). However, Elemam *et al*. (2009) reported improved final live weight, ADG, and total gain for lambs fed diet containing 45% PL. Therefore, the present investigation was planned to study the feeding value of rations with concentrates containing various levels of poultry litter with green sorghum forage in the diet of lactating cows on their performance.

MATERIALS AND METHODS

A feeding trials was conducted at the Livestock Research Center of G.B. Pant University of Agriculture and Technology, Pantnagar from September to November for 90 days. The poultry litter based on paddy husk, used in the feeding trial was collected from layer house of the poultry Research Center of the University. This litter was about a year old. The litter was collected from the pens and dried in sun by spreading in an 8cm thick layer on a pucca floor for 4 days with frequent stirrings. Dried litter was mixed thoroughly and placed into gunny bags for the preparation of concentrate mixture and four representative samples were drawn, which were analyzed for chemical constituents. Four types of iso-nitrogenous concentrate mixtures were prepared (Table 2), reference concentrate mixture I contained wheat and de-oiled soybean meal (DSM) as conventional energy and protein sources, while other three concentrate mixtures contained poultry litter at 27.78, 41.67 and 55.65 % respectively in concentrate mixture II, II and IV, which replaced wheat and DSM at varying level in concentrate mixture. Twenty four lactating crossbred cows of similar lactation were randomly divided into four equal groups of six each, and were fed one of the concentrate mixtures to meet energy and protein requirements accordance to National Research Council (1988). Animals received green sorghum *ad libitum* during the experiment. Water was available free choice three times in a day. Daily records of feed intake and refusals were maintained during the entire feeding experiment.

A digestion trial of 7 days of sample collection was conducted at the end of experimental feeding, during which daily feed intake, output of faeces were recorded and collected. Samples of feed, orts and faeces were collected every morning. For N estimation, faeces samples (0.001%) from individual animals were place every morning in a 500-ml Kjeldahl flask containing 25 ml concentrated sulfuric acid. The DM of feed, faeces and refusal was determined by drying to a constant weight in a hot air oven at 70^{o}C. Dried samples for each day of the 7 days collection were pool, ground to pass a 1-mm screen and preserved for chemical analysis. Organic matter (OM) was determined by ashing at 550°C for 4 h and crude protein (CP) by a Kjeldahl technique (AOAC, 2000). Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined by the procedure of Van Soest *et al*. (1991) without sodium sulphite or α-amylase. Total fat was determined using Soxhlet extraction procedure and expressed as ether extract (EE), while gross energy (GE) was estimated by ballistic bomb calorimeter following the procedure (Sastry *et al.*, 1999). The Ca content was determined by the precipitation method (Talpatra *et al*., 1940), while, P content was determined spectrophotometrically following the metavandate method (AOAC, 2000). The results of nutrient intake, digestibility, milk production and composition were subjected to analysis of variance for statistical significance test using general linear mathematical model as: $Y_{ijk} = \mu + T_i + e_{ij;}$ where: Y_{ijk}= Observation mean; μ = General mean, T_i = Effect of i^{th} treatment (i = 1, 4), e_{ij}= Random error. The Significant levels were determined among diets by least significant difference tests using SPSS Base 14.0 (2005).

RESULTS AND DISCUSSION

The present investigation envisaged to study the effect of partial replacement of the dietary concentrate mixture by poultry litter on the milk production, nutrient utilization of lactating cow fed green sorghum forage. The chemical composition of the poultry litter (Table 1) used was with the reported range of variations (Egna *et al*., 1991; Goetsch and Aiken, 2000; Azizi-Shotorkhoft *et al*., 2013). Poultry litter inclusion reduced OM and NDF contents, while ADF, calcium and phosphorus contents increased (Table 2), was due to higher ash and less water soluble contents, and higher acid resistant fiber, calcium and phosphorus contents. These results corroborates favorably with earlier reports (Murthy *et al*., 1995; Animut *et al*., 2002; Jackson *et al*., 2006; Negesse *et al.*, 2007; Elemam *et al*., 2009; Obeidat *et al*., 2011) of various level of poultry/ broiler litter inclusion in ruminant diets. The mean daily dry matter intake of the cows fed sorghum forage with various levels of poultry litter (0 to 56%) in the concentrate mixture varied between 9.3 to 8.7 kg per cow per day (Table 3). Ration of cows containing 565 percent poultry litter consumed less dry matter and ration containing zero percent poultry litter in concentrate mixture had consumed maximum dry matter (Table 4). Ration containing other levels of poultry litter had similar dry matter intake. The small and non significant reduction in DM intake on ration with concentrates mixture containing 42 and 56 percent poultry litter would have been due to the their lower palatability caused by the increased dustiness, high ash contents, bulky and less utilizable form of the rations. Intake of OM, CP. NDF and ADF followed the trend of DM intake. Ration containing 28, 42 and 56% PL had decreasing trend of energy intake was due to low energetic value of the poultry litter because of higher ash and low organic matter contents. Most of the cows refused the concentrate mixture containing 42 and 56 percent poultry litter on the first day of the feeding trials. Gradually cows adapted to these diets over a week periods. During the adoption periods animals were fed higher levels of poultry litter in the concentrate mixture ate more forages than the animals fed concentrate mixture containing zero and 28 percent poultry litter. During the periods [0 to 90 days], the milk production and its constituents were statistically similar among four animal groups. Although, milk production and organic intake were similar among four groups, however reduction in milk production 6, 19 and 22 % was accompanied by reduced organic matter intake 3, 5 and 9 per cent respectively with groups consuming concentrate having poultry litter 27, 42 and 55 percent.

The differences in the dry matter intake kg/ day, kg/per100 kg body weight and gram per kg metabolic body weight were similar among dietary treatment. These results confirmed findings of Rajgopal *et al*. (1990) and Ragghunandan *et al*. (1993), reporting similar dry matter intakes on ration containing up to 40 percent dried poultry dropping/ litters. Reddy *et al*. (1990) reported DMI of cows 2.58, 2.49 and 2.43 kg/100kg body weight on rations containing 0, 15 and 30% poultry litter respectably. Consistent with our results, Rossi *et al.* (1999) reported no differences in DM intake of Simmental×Angus cows when soybean meal-based protein supplement was replaced by caged layer litter. Conversely, Elemam *et al*. (2009) observed that DM intake increased for lambs fed 45% broiler litter compared with lambs fed 0, 15, 30% broiler litter. Abebe *et al*. (2004) reported that OM intake increased when BL fed to Spanish goats wethers fed wheat-straw based diet. In another study, when broiler litter was included at different levels (0, 200, 400, or 600 g/kg of DM concentrate) in diets for Spanish and Boar×Spanish doelings goats, Negesse *et al*. (2007) observed no major difference between the experimental and control diets in term of nutrient intakes and concluded that intake would not be impacted negatively when the including rate of BL is less than 400 g/kg. Concurrent with the previous research studies, results of the current study indicated the possibility of inclusion of poultry litter in concentrate mixture of Cows at levels up to 56 % of the DM.

Digestibility of dry matter ranged from 61.72 percent to 63.20 percent in respective rations containing 0 to 56 percent poultry litter in the concentrate mixture. The low dry matter digestibility on poultry litter included ration is due to relative higher silica and lignin, low organic matter and thus reduced energy contents of the ration. These results agree favorably with the findings of Venkateshwar *et al*. (1992), who fed the concentrate mixture containing 0, 20, 30 and 40% dried poultry dropping and observed poor dry matter digestibility with 30 and 40 % poultry dropping included diets. The intake and digestibility of CP, OM, NDF and ADF were similar among four dietary treatments, showing the possibility of inclusion of poultry litter up to 56 percent in concentrate of lactating crossbred cows. It is concluded that inclusion of poultry litter up to 56% in the concentrate mixture of lactating dairy cows did not adverse effect on the milk production, milk composition, feed intake and digestibility of the nutrients. Therefore, was not significant effect on the feeding value of the concentrate containing various levels of poultry litter poultry can be incorporated 56% in the concentrate mixture of cows in replacement of replace 50 % soybean meal protein.

Table 1. Chemical composition of feeds (% in DM)

Ingredients	Concentrate mixture			
	Wheat	Deoiled soybean meal	Poultry litter	Green sorghum
Dry matter	89.50	92.50	89.25	35.00
Organic matter	98.30	93.70	71.50	89.40
Total fat	1.60	5.20	1.00	1.50
Crude protein	11.00	43.50	18.00	7.00
Neutral detergent fiber	18.60	24.90	55.50	70.01
Acid detergent fiber	5.00	15.50	41.20	48.75
Ash	1.70	6.30	28.50	10.60
Calcium	0.15	0.27	5.40	0.42
Phosphorus	0.10	0.63	1.70	0.20
GE(Mcal/kg)	4.31	4.65	3.75	3.80

Table 2. Composition of the concentrate mixture (g/100 g)

	Concentrate mixture			
	I	II	II	II
Ingredients				
Wheat	66.25	46.49	35.60	24.70
Deoiled soybean meal	30.72	22.73	19.73	16.74
Poultry litter	0.00	27.78	41.67	55.65
Mineral mixture	2.00	2.00	2.00	2.00
Common salt	1.00	1.00	1.00	1.00
Chemical composition				
Dry matter	90.70	90.45	90.30	90.10
Organic matter	96.50	88.50	85.00	80.85
Total fat	2.65	2.20	2.01	1.80
Crude protein	20.00	20.00	20.00	20.00
Neutral detergent fiber	19.98	29.75	34.65	39.85
Acid detergent fiber	8.09	17.28	22.01	26.33
Calcium	0.18	1.63	2.35	3.09
Phosphorus	0.26	0.61	0.85	1.08
GE (Mcal/kg)	4.28	4.10	4.01	3.93

Table 3. Dry matter intake, milk production and composition in lactating cows fed concentrate containing poultry litter

	Treatment groups				SEM	Significance
	T_1	T_2	T_3	T_4		
Dry matter intake (DMI)						
DMI (kg/day)	9.31	9.17	8.91	8.71	0.378	NS
DMI (kg/100 kg BW)	2.72	2.66	2.58	2.54	0.073	NS
DMI (g/kg$W^{0.75}$)	116.9	114.4	111.2	109.3	3.486	NS
Milk production (kg/day)	6.59	6.20	5.35	5.06	0.474	NS
Milk composition (%)						
Total solid	13.06	13.14	13.24	13.38	1.000	NS
Fat	4.087	4.210	4.390	4.422	0.065	NS
protein	3.552	3.565	3.578	3.607	0.029	NS

NS means not significant ($P > 0.05$)

Table 4. Nutrients intake (kg/day) and digestibility in lactating crossbred cows fed concentrates containing poultry litter during digestion trial

Items	Treatment groups				SEM	Significance
	T_1	T_2	T_3	T_4		
Dry matter						
Intake (kg/day)	9.267	9.127	8.885	8.692	0.376	NS
Digestibility (%)	63.20^{a}	62.01^{ab}	60.47^{b}	61.72^{ab}	0.550	*
Organic matter						
Intake (kg/day)	8.41	8.18	7.99	7.69	0.323	NS
Digestibility (%)	65.30	64.21	63.06	63.80	0.640	NS
Crude protein						
Intake (kg/day)	0.88	0.85	0.83	0.83	0.041	NS
Digestibility (%)	64.01	63.64	64.82	65.29	1.427	NS
Gross energy						
Intake (kg/day)	35.82	35.11	34.15	33.32	1.321	NS
Digestibility (%)	64.04	62.50	64.29	64.68	0.656	NS
Neutral detergent fibre						
Intake (kg/day)	5.67	5.73	5.65	5.62	0.207	NS
Digestibility (%)	64.18	65.00	63.63	62.56	1.076	NS
Acid detergent fibre						
Intake (kg/day)	3.81	3.89	3.86	3.89	0.145	NS
Digestibility (%)	57.18	58.02	56.93	55.85	1.347	NS

NS; means not significant, * indicates significant ($P > 0.05$)

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