JWPR
Journal of World's Poultry Research

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J. World Poult. Res. 6(2): 73-83, June 25, 2016

Research Paper, PII: S2322455X1600011-6

Supplementation of Different Level of Deep Stacked Broiler Litter as a Source of Total Mixed Ration on Digestibility in Sheep and Their Effects on Growth Performance

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Received: 14 May, 2016
Accepted: 16 June, 2016

ABSTRACT

Poultry litter from rigorous poultry production plants has impact on environmental pollution. Feedstuffs for animal are getting with time expensive, to reduce the feed cost which could be achieved through the assimilation of relatively inexpensive and non-conventional feed ingredients, like poultry litter. The objective of this study was to explore the nutritive value of deep stacked broiler litter in ruminant's total mixed ration. Four non castrated male sheep were used into 4×4 Latin Square Design (LSD) to 1 of the 4 dietary treatment groups that different in deep stacked broiler litter (DBL) as percentage of concentrate diet to investigate the nutritive value of DBL as a ruminant feed. The effect of dry matter intake and digestibility of DBL in sheep studied. Nitrogen retention was determined in total mixed ration at each level in the diets fed to sheep. Microsoft excels was used to balance experimental rations A, B, C, and D. Ration A was containing 0% DBL and served as control. Ration B contains 15% DBL, C was containing 30% DBL while Ration D containing 45% DBL. All the diets were prepared according to requirement of critical nutrients. All the diets were prepared isocaloric, isonitrogenous with or without DBL. Dry matter intake gradually decreased ($P < 0.05$) with the levels of broiler litter increased in the four diets. Means values of DMI (g/day) in rations A, B, C and D was 1040.7, 945.3, 840.9 and 786.8. Nitrogen retention (% of the total N consumed) were decreased ($P < 0.05$) as the broiler litter level increased in the diet. Up to 30% poultry litter in the supplement diets of sheep contributes as non-conventional source of nitrogen, and could be used for replacing traditional nitrogen sources like cotton seed cake. The findings of the present study suggested that inclusion of broiler litter up to 30% has no adverse effect on the health and apparent weight.

Keywords: Deep stacked, Mixed ration, Litter, Digestibility, Sheep

INTRODUCTION

Feed resources for livestock in Pakistan is 121 million heads of animals need about 10.9 and 90.36 million tons of Crude Protein (CP) and Total Digestible Nutrients (TDN) correspondingly but to them the obtainable CP and TDN are 67 and 69 million tons. In Pakistan feed resources are green fodder, crop residues, grazing rangelands, post-harvest grazing, cereal by products, and oilseed cakes. In these the chief one which provided about 51% of the feed resource is green fodder and crop residues (Sarwar et al., 2002). The broiler litter can be used as a supplement for conventional protein sources, but at higher inclusion levels, it needs to be augmented by increased fermentable energy (Lawrence et al., 2015). Reducing the cost of gain, the inclusion of layer litter in lambs' finishing diets is potentially valuable and can be considered as cheap alternative in livestock feeding strategies reported by Obeidat et al. (2016). Using heat- processed litter (HBL) up to 210 g/kg dry matter in diet was possible without any effect on feed intake, growth performance and animal health, but reduced loin fat, internal fat and cost per unit production reported by Bello and Tsado (2014) and Ayoub et al. (2015). Recommended that, dried poultry dropping can satisfactorily supplement sorghum stover up to 80% inclusion level for good performance and without any deleterious effects (Ayoub et al., 2015). Fodder supplies the broad fraction of nutrient to

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ruminants, but lack of these nutrients occurred throughout the dry season as a consequence a quick decline in the quality of forages take placed, leading to low forage intake and digestibility reflects poor animal performance. Low quality roughages fed to ruminants without supplementation throughout the dry season caused severe weight losses and at last animal lead to death (Adegbola, 2002). The market prices of the conventional feed sources of protein in livestock ration have risen unreasonably high and this has force the search for inexpensive protein sources (Akinmutimi, 2004). Deprived nutrient supplied, both in quantity and quality and low reproductive capabilities are identified one of the main reason limiting animal production. In this aspect, poultry litter has been recognized as one of the non-conventional feeds substances for ruminant production. Broiler litter is a secondary product of poultry industry, which is high in crude protein, quickly degraded in the rumen and low to moderate in available energy concentration (Saleh et al., 2003).

Poultry litter is usually used as fertilizer, but in addition it has a probable to use as a ruminant feed and it is more valuable as feed constituents than as a fertilizer. The use of poultry litter as a dietary supplement in ruminant ration could have a sensible result on reducing costs, insufficiency of protein in diet. The germ which there in the broiler litter is efficiently eliminated during deep stacking (Elemam et al., 2010). The disposals of poultry litter from rigorous poultry production plants have its impact on environmental pollution. Furthermore, feedstuffs for animal are getting with time expensive. Therefore to reduce the feed cost which could be achieved through the assimilation of relatively inexpensive and non-conventional feed ingredients, like poultry litter. Therefore, the present study was planned to explore the nutritive value of deep stacked broiler litter in ruminants.

MATERIALS AND METHODS

Processing of poultry litter

Before mixing with other feed ingredients, litter was processed to restrict the population of pathogenic microorganisms present in raw poultry litter. For this deep stacking technique was used for poultry litter processing. The collected poultry litter was dried for five hours in sun light. The phenomenon of sunlight drying was to bring the level of the moisture content in poultry litter up to 30%. When the litter was analyzed in lab the level of moisture content was less than 30%. To bring the level of moisture content of litter up to 30%, water was sprinkled on the litter. Later on, in the lab to confirm the level of moisture content in litter and the result showed that the litter contains moisture level up to 30 %. After that deep stacked at three cubic feet for 21 days. Stacked poultry litter was pressed tightly and then covered by plastic sheath. The air was totally excluded during deep stacking of poultry litter to develop an aerobic condition to kill the microorganisms. The fermentation process occurred which heated up the stacked poultry litter up to 140^{o} to 160^{o} F for four hours which killed all the potential microorganisms e.g. *E.coli* or *Salmonella*. After 21 days the processed litter was used for mixing with other feed ingredients (Ruffin and McCaskey, 1990).

Experimental design and animals

Experiment was design involving four male sheep and four diets. Each period was consisted of 10 days adaptation and 7 days data collection period. The diets were switched over to the 4 sheep in each period according to the following scheme (Table 1). Animals used in the experiment were four male sheep each was nearly the same age and weight. Animals were treated against ecto and endo parasites a week before the starting of trail and were kept in a well ventilated shed and each individual metabolic cage was used for separate feeding, watering and collection of feces and urine. Before starting the trial all the metabolic cages including feeders and water troughs was cleaned thoroughly.

Table 1. Experimental lay out for offering different feeding rations

Periods (Day)	Sheep			
	I	II	III	IV
1	A	B	D	C
2	D	C	A	B
3	C	A	B	D
4	B	D	C	A

Ration A = 0% broiler litter+100%Total mixed ration; Ration B = 15% broiler litter+85% Total mixed ration; Ration C = 30% broiler litter+70% Total mixed ration; Ration D = 45% broiler litter+55% Total mixed ration

Feeding

In diet A, B, C and D the deep stacked broiler litter was added at a level of 0, 15, 30 and 45% along with other feed ingredients. The diet A was control and contained (0%) deep stacked broiler litter. During the adaptation period of 10 days animals were adopted to their respective diets by gradual replacement of the previous diet. The physicochemical compositions of experimental diets are given in (Table 3 and 4). The diets were fed twice daily at 9:00 am and 5:00 pm. The basal diet and each of the supplements were weighed according to the ingredient composition of the experimental ration. Feed refusal of the previous day was recorded daily before offering the fresh feed. Clean water was available to the experimental animals in the drinker fixed with each cage.

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Samples collection from feed, feces and urine

After the adaptation period data collection period was started, and remained continued for seven days. Before offering fresh feed in the morning, the refusal of the previous day was weighed and representative samples of the feed offered and feed refused was collected in a labeled polythene bags and was shifted immediately to the freezer for storage with minimum loss of moisture. Similarly, the quantities of feces excreted by each animal during 24 hour were weighed. A representative sample equivalent to 20% of the total weight was collected in a labeled polythene bag to store in a freezer. Urine excreted during the last 24 hour was collected from individual animal in labeled bottles containing 100 ml of 2.5 mol/liter sulfuric acid. Urine volume was measured and representative sample equivalent to 20% of the total volume was collected.

Chemical analysis

About 50 gram, in duplicate of the pooled feces and feed samples after thawing and mixing were taken for dry matter (DM) analysis and the remaining was air dried at 60°C for 72 hour. The air-dried samples were ground in Thomas-Willey laboratory mill to a particle size of 1 mm and stored at room temperature in labeled bottles. The sample was analyzed for dry matter, organic matter, moisture, crude protein, crude fiber, ether extract and nitrogen free extract according to (AOAC, 1997).

Ether Extract (EE)

Dried sample (2-4 gram) in a clean previously dried extraction thimble (Whatman) was taken and plugged it with absorbent cotton wool. This was kept in an extractor and fixed under the condenser of the Soxhlet extraction apparatus. 150 ml of the solvent was added to the receiving flask and connected it to the apparatus. Then the water and heater was on. Extraction was continued for 10 hours at a rate of condensation at 3-4 drops/second and then the thimble was removed from the extractor. Just before the solvent drying in the flask, the extraction was stopped and the flask was be removed. The extract were transferred into clean evaporating basin with ether were hinges, dryness was evaporated on water bath, after that basin was placed in oven at 105°C for 2 hours. Further cooled in desiccator for 30 minutes and reweighed. The percentage of EE was calculated as under:

$$\% \text{ EE (DM)} = \frac{\text{Weight of ether extract}}{\text{(Sample weight)}} \times 100$$

Converting to as fed basis:

$$\% \text{ EE as fed} = \frac{\text{Weight of ether extract}}{\text{(Sample weight)}} \times (100 - \% \text{ moisture})$$

Crude Fiber (CF)

It is the organic residues that remain when a moisture free sample is digested first with weak acid solution (H_2SO_4) and then with a weak alkaline solution (NaoH). The residues collected after digestion is ignited and the loss in weight on burning is registered as crude fiber. Moisture free sample (1-2 gram) was taken in a tall from beaker. Two hundred ml boiling dilute H_2SO_4 was added and was digested for 30 minutes on crude fiber extraction apparatus. Then was filtered through glass buchner funnel with an aid of suction air pump. Then was wash with hot water until it became acid free (15 ml filtrate is collected and 1 drop N/10 NaoH and 1 drop Phenolphthalein indicator was added. Pink color is an indicator of being acid free). Transferred again to tall beaker and 200 ml boiling dilute NaoH was added. Then was filtered through glass buchner funnel with an aid of suction air pump. Then was washed with 10 ml hot dilute H_2SO_4 and then with hot water until it became acid free. It was transferred to a prepared gooch crucible, and then with 10ml ethanol crucible was held. Then sample was dried in an oven at 135°C for 2 hours. Then was cooled in desiccator for 30 minutes and weighted. Samples were further ignited in muffle furnace at 600°C for 30 minutes. Ignition residues were cooled in desiccator for 1 hour and reweighed. The percentage of CF was calculated as under:

$$\% \text{ CF (sample)} = \frac{\text{(crucible weight + dried residue) - (crucible weight + ash residue)}}{\text{(Crucible weight + sample) - empty crucible weight)}} \times 100$$

$$\% \text{ EE (DM)} = \frac{\text{CF \% in sample}}{\text{DM \% in sample}} \times 100$$

Nitrogen Free Extracts (NFE)

It was found by the difference after the analyses of all other items mentioned in proximate analysis. It is as under: (%Moisture + %Crude protein + %Ether extract + %Crude fiber + %ash + %NFE) = 100

Therefore, %NFE = 100 - (Moisture + Crude protein + Ether extract + Crude fiber + Ash)

Dry matter and ash

For the estimation Dry Matter (DM) and ash, about 2 gram samples were taken in clean and pre-weighted crucibles in duplicate. The crucibles were then placed in laboratory oven for 18h at 100°C. After drying in an oven the samples was cooled in a desiccator for 30 minutes and reweighed. The DM% was determined by using the following formula.

$$\text{DM (\%)} = \frac{\text{C-A}}{\text{B-A}} \times 100$$

A = weight of empty crucible

B = weight of crucible + sample (pre drying)

C = weight of crucible + sample (post drying).

The samples were incinerated in a muffle furnace at 550°C for 6 hour to estimate its ash content. After incineration the samples were cooled again in a desiccator and were re-weighed. Ash was calculated as under:

$$\text{Ash (\%)} = \frac{\text{D-A}\times 100}{\text{C-A}}$$

A = weight of empty crucible
C = weight of crucible + sample (post drying)
D = weight of crucible + ash

Organic Matter (OM) was calculated after subtracting ash from DM

OM = (100-Ash % in DM)

Crude protein

Crude Protein in the representative sample of feed was determined with kjeldhal method (AOAC, 1997). In this method samples was digested with concentrated Sulphuric acid and was followed by distillation and titration. Samples (about 0.5 gram) in duplicate were taken in the Tecator digestion tubes and were added with 3 gram of catalyst (Potassium sulphate 93%, Copper sulphate 7%) and 5 ml concentrated sulfuric acid. Acetanilide (0.1 gm) was processed as standard for recovery of nitrogen. The digestion tubes were heated in Tecator digestion block. The tubes were then allowed to cool at room temperature. About 15 ml distill water was added with the tubes containing digested samples. After dispensing required amount of sodium hydroxide (NaOH) solution (40%) in the tubes to alkaline the sample and the contents were distilled for about seven minutes. The resulting ammonia was collected in conical flask containing 10 ml boric acid and 3-4 drops of methylene red. The titration of distillate was carried out with sulfuric acid solution of known normality. To determine the blank values duplicate tubes containing 15 ml distilled water and 5 ml sodium hydroxide was processed for distillation and titration. The percentage of nitrogen was calculated as under:

$$\text{N (\%)} = \frac{\text{(V1-V2)} \times 14.0) \times \text{mol/liter (N) of titrate}}{\text{(Sample in milligram)}} \times 100$$

V1= Titration reading of sample
V2= Titration reading of blank
14.01= Atomic weight of Nitrogen (N)

Crude protein was determined for feed sample, by multiplying the nitrogen content of the sample by 6.25. The results were corrected for dry matter as given under:

$$\text{N (\%) in DM} = \frac{\text{N\% in sample}}{\text{DM \% in sample}} \times 100$$

Feed intake

Feed intake was measured by subtracted the feed refused from total offered feed. The feed intake during experimental trials was calculated by the following manner.

Feed intake = Total feed offered - feed refused by the animal

Nutrients digestibility

Digestibility of DM, OM, and nutrients was calculated by the difference between the nutrients consumed and voided in feaces by the sheep using following equation.

$$\text{Digestibility \%} = \frac{\text{A-B}}{\text{A}} \times 100$$

Where:

A = Quantity of nutrients i.e. DM, OM, consumed by the Animal (gram/day)

B = Quantity of the above nutrients excreted by the animal in feaces (gram/day)

Nitrogen retention

Nitrogen retention (gram/day) was calculated by subtracting the total nitrogen excreted in feaces and urine (gram/day) from the total dietary nitrogen (gram/day) consumed.

In vitro Dry matter digestibility (IVDMD)

In vitro dry matter digestibility (IVDMD) was measured by the procedure as decribed by Tilly and Terry, (1963). Samples about 0.5 gram in triplicate were incubated in 60 ml centrifuge tubes fitted with Bunsen valve. Rumen liquor was collected from a rumen fistulated cow. Rumen liquor was filtered through double layers of muslin cloth and mixed with buffer solution 1:3 ratio. An aliquot of 10 ml was dispensed in each tube with simultaneous flushing of CO2 to establish anaerobic conditions in the tubes. The tubes were closed and incubated at 37 ºC for 48 hours. Tubes containing rumen fluid without sample and tubes with standard samples were also included in each run for the determination of blank values. All possible measures were adopted to maintain microflora of rumen liquor during collection, filtration and dispensing. The contents of tubes were mixed two times by gentle swirling at twelve hours interval. On termination of the incubation (48 hours), the tubes were centrifuged at 3000 rotation per minute for 5 minutes. The supernatant was discarded. The tubes with the precipitate were dried in an oven at 70-72 ºC. Finally after cooling in a desiccator the tubes were weighed.

The IVDMD was calculated as under:

$$\text{IVDMD\%} = \frac{\text{A} - (\text{B} - \text{C})}{\text{A}} \times 100$$

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A = weight of sample (DM)

B = weight of undigested dried residues in a tube.

C = weight of undigested dried residues of rumen fluid in the blank tube.

Statistical analysis

The data obtained from digestibility study was subjected to analysis of variance (ANOVA) is according to statistical analysis system (SAS version 6.04, 2000). The mean values were compared for estimating LSD and its significance level set as $P<0.05$.

Economics

The cost of the control and experimental rations was calculated according to the prevailing market rates. Similarly increases or a decrease in digestibility was also being considered for the respective ration.

Table 2. Analysis of variance of the experimental design

Source of Variation	Sum of square	Degrees of freedom	Mean square	F= 0.05
Between diets, α_i	SSα	4 – 1 = 3 (a - 1)	$SS_\alpha/3=MS_\alpha$	$MS_\alpha/MS\varepsilon$
Between animals, β_i	SSβ	4 – 1 = 3 (b - 1)	$SS_\beta/=MS_\beta$	$MS_\beta/MS\varepsilon$
Between Periods, γ_κ	SSγ	4 – 1 = 3 (c - 1)	$SS_\gamma/3=MS_\gamma$	$MS_\gamma/MS\varepsilon$
Experimental error, $Є_{ij\kappa}$	SSε	3×3×3 = 27 (a -1) (b - 1) (c-1)	SSε/27=MSε	
Total	SST	64-1=63 abc-1		

Yijk = μ + αi + βj +γk + Єij k; where: Yijk = Combine effect of periods, animals and diets; μ = Population mean; αi= Effect of diets i.e. A, B, C and D; βj = Effect of animals i.e. i, ii, iii and vi; γk = Effect of periods i.e. 1, 2, 3 and 4; Єijk = Random error N (o, б2).

Table 3. Physical composition of experimental sheep rations during 8-10 months old

Ingredient	Ration (%)			
	A	B	C	D
DBL	0.00	15.0	30.0	45.0
CSC	20.0	13.0	6.0	0.00
Wheat Bran	24.0	20.0	16.0	7.00
Molasses	10.0	10.0	10.0	10.0
DCP	1.00	1.00	1.00	1.00
Wheat Straw	24.0	20.0	19.0	21.0
Maize fodder	20.0	20.0	17.0	15.0
Salt	1.00	1.00	1.00	1.00
Total	100	100	100	100

Ration A= 0% broiler litter+100%Total mixed ration; Ration B= 15% broiler litter+85% Total mixed ration; Ration C= 30% broiler litter + 70% Total mixed ration; Ration D= 45% broiler litter+55% Total mixed ration; DBL= Deep stacked broiler litter, CSC= Cotton seed cake, DCP= Dicalcium phosphate.

Table 4. Chemical composition of experimental sheep rations during 8-10 months old

Ingredient	DM	TDN	DE	ME	CP	Ca	P
	%		M cal/Kg		%		
DBL	87	50	0.00	0.00	20.0	2.30	1.60
CSC	91.40	69	3.04	2.49	26.50	1.00	1.40
Wheat Bran	89	70	1.40	0.73	17.00	0.12	1.38
Molasses	76	75	3.30	2.70	5.00	1.19	0.11
DCP	99	0	0.00	0.00	0.00	3.75	2.00
Maize fodder	70	67	2.82	2.31	9.00	0.50	2.50
Salt	96	0	0.00	0.00	0.00	0.00	0.00
Wheat Straw	91	42	1.94	1.58	3.00	0.16	0.05

*Feed composition of the ingredients used for formulating experimental rations (NRC, 1989). DM= Dry matter, TDN= Total digestable nutrients, DE= Digestable ether extract, ME= Metabolizable energy, CP= Crude protein, Ca= Calcium, P= Phosphorus, DBL= Deep stacked broiler litter, CSC= Cotton seed cake, DCP= Dicalcium phosphate.

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RESULTS

The present experiment was conducted to incorporate broiler litter in total mixed ration for sheep. Four non castrated male sheep were used into 4×4 latin square design to 1of the 4 dietary treatment groups that different in deep stacked broiler litter as percentage of concentrate diet to investigate the nutritive value of deep stacked broiler litter as a ruminant feed. The effect of dry matter intake and digestibility of deep stacked broiler litter in sheep studied. Nitrogen retention was determined in total mixed ration at each level in the diets fed to sheep.

A computer program Microsoft Excels was used to balance Experimental Rations A, B, C, and D. Ration A was containing 0% dry stacked broiler litter and served as control. Ration B contains 15% DBL, C was containing 30% DBL while Ration D containing 45% DBL. All the diets were prepared according to requirement of critical nutrients. All the diets were prepared isocaloric, isonitrogenous with or without DBL. The data of analysis of variance subjected to experimental design were shown in table 2.

Feed intake

In table 5 mean values of dry matter intake (DMI) for sheep are presented. These measures were found not significantly different ($P<0.05$) among the four rations. The mean value of dry matter intake g/d for ration A, B, C and D were 1011.7, 995.3, 940.9 and 886.8 respectively. Dry matter intake as gram/kilogram metabolic body weight were not found to be different from the 15 and 30% inclusion rate of deep stack broiler litter except for higher inclusion rate which increased ($P<0.05$). However dry matter intakes were lower for the 45% DBL than ration A, B, C during the study. Similarly intake of organic matter (OM), ether extract (EE), ash (A) and nitrogen free extract (NFE) and nitrogen (N) significantly different ($P<0.05$) among the four diets. These were high in ration A than that in ration D. whereas intake of the crude fiber (CF) and ash (A) content significantly different ($P<0.05$) among the all diets these were larger in case of high inclusions of DBL.

In vivo digestibility of nutrients

The mean value of *in vivo* digestibility of (DMD), organic matter (OMD), nitrogen (ND), crude fiber (DCF), ether extract (DEE) and nitrogen free extract (DNFE) for sheep are presented in table 6. These measured were found significantly different ($P<0.05$) among the four rations. Sheep receiving ration A was the highest DM digestibility (75.37%) and low for ration D that (67.19%). Similarly Organic Matter (OM), Ether Extract (EE) and Nitrogen Free Extract (NFE) digestibility were also decreased for those feed which have larger amount of deep stacked broiler litter as compared to the ration which have zero DBL. The mean digestibility of crude fiber and nitrogen significantly different ($P<0.05$) among the four ration. The crude fiber digestibility was high in ration C 69.54% and lowest for ration A 32.14%, in case of nitrogen the digestibility increased as the inclusion of the DBL increased among the ration

Nitrogen retention

Nitrogen consumed and retained by the sheep on the four diets is shown in the table 7. Diet composition significantly influenced ($P<0.05$) the quantity of nitrogen consumed and excreted in the feaces and urine by the experimental animals. The mean results were compared it was found that sheep receiving high level of broiler litter supplements in total mixed ration excreted greater quantity of nitrogen in feaces and urine ($P<0.01$) as compared to control diet. These differences reflected in Nitrogen Retention (NR, % of the total nitrogen) in the body of sheep. The nitrogen retention(NR) were expressed as percent of total N consumed of the rations A, B, C, and D. were 67.49, 53.36, 47.57 and 41.94 % respectively. The NR was appreciably greater in the rations containing low level of deep stacked broiler litter as compared to that rations containing highest inclusion of broiler litter.

In vitro Dry Matter Digestibility (IVDMD)

The *in vitro* dry matter digestibility (IVDMD %) of four experimental diets A, B, C, and D are shown in the (Table 8). The percent digestibility decreased as the inclusion of deep stacked broiler litter increased in the diets. The higher digestibility were recorded in control ration A (0%DBL) while the lowest digestibility in the ration contained high proportion of deep stacked broiler. The *in vitro* digestibility for diet A, B, C and D were 67.22, 60.91, 57.58 and 54.72%.Which were gradually decreased among the ration

Economics

The cost of the control and experimental rations were calculated according to the prevailing market rates. Similarly up and down in digestibility were also being considered for the respective ration. The result of present study given in the Table 9 shows that as the broiler litter inclusion increased in the diet cost of the diet reduced. Best result obtained for ration C on which the nitrogen and crude fiber digestibility is high compared to other three diets.

Table 5. Means dry matter, organic matter, crude fiber, ash, ether extract, nitrogen and nitrogen free extract intake of the experimental rations fed to sheep aged 8-10 months

Intake [b] (g/d)	Rations [a]			
	A	B	C	D
DMI	1011.7[a]	995.3 [a]	940.9 [a]	886.8[b]
OMI	842.46[a]	627.57[b]	590.07[c]	585.23[bc]
CFI	198.72[c]	212.13b[c]	226.41[b]	294.79[a]
AI	81.57b[c]	86.61[c]	94.59[b]	104.43[a]
EEI	67.11[a]	51.18[b]	46.25[bc]	38.97[c]
NI	22.92[a]	20.98[ab]	18.58[bc]	16.52[c]
NFE	523.24[a]	455.18[b]	404.87[bc]	378.87[c]

Mean in the same row with different superscripts are significantly different (P<0.05); Ration A = control (0 % broiler litter); Ration B = 15% broiler litter; Ration C = 30% broiler litter; Ration D = 40% broiler litter; bDMI= Dry Matter Intake; OMI= Organic Matter Intake; NDI = Nitrogen Intake; EEI= Ether Extract Intake; AD= Ash Intake; CFI=Crude Fiber Intake and NFEI= Nitrogen Free Extract Intake.

Table 6. Means dry matter, organic matter, crude fiber, ash, ether extract, nitrogen and nitrogen free extract digestibility (%) of the experimental rations fed to sheep aged 8-10 months

Digestibility (%)	Ration			
	A	B	C	D
DMD	75.37[a]	71.46[ab]	68.07[bc]	67.19[c]
OMD	73.11[a]	70.25[a]	60.62[b]	53.30[c]
CFD	32.14[c]	51.12[b]	69.54[a]	51.42[b]
AD	62.54[a]	57.03[b]	39.10[c]	37.07[c]
EED	68.80[a]	58.73[b]	48.71[bc]	43.27[b]
ND	64.29[a]	66.50[a]	70.44[a]	53.49[b]
NFED	69.88[a]	41.49[b]	41.38[b]	34.97[c]

Mean in the same row with different superscripts are significantly different (P<0.05); Ration A = control (0% broiler litter); Ration B = 15% broiler litter; Ration C = 30% broiler litter; Ration D = 40% broiler litter; bDMD= Dry Matter Digestibility; OMD= Organic Matter Digestibility; ND = Nitrogen Digestibility; EED= Ether Extract Digestibility; AD= Ash Digestibility; CFD=Crude Fiber Digestibility and NFED= Nitrogen Free Extract Digestibility.

Table 7. Mean nitrogen retention (%) in experimental diet fed to sheep aged 8-10 months

Ration	Broiler litter/Total mix ration (%)	Nitrogen Retention (%)
A	0/100	67.69[a]
B	15/85	53.36[b]
C	30/70	47.57[bc]
D	45/55	41.94[c]

Mean in the same column with different superscripts are significantly different (P<0.05); Ration A = 0% broiler litter+100%Total mixed ration; RationB = 15% broiler litter+85% Total mixed ration; Ration C = 30% broiler litter+70% Total mixed ration; Ration D = 45% broiler litter+55% Total mixed ration.

Table 8. In vitro dry matter digestibility of the experimental rations used in sheep aged 8-10 months old

Ration	Broiler litter/Total mix ration (%)	In vitro dry matter digestibility (%)
A	0/100	67.22[a]
B	15/85	60.91[b]
C	30/70	57.58[c]
D	45/55	54.72[d]

Mean in the same column with different superscripts are significantly different (P<0.05); Ration A = 0% broiler litter+100%Total mixed ration; Ration B = 15% broiler litter+85% Total mixed ration; Ration C = 30% broiler litter+70% Total mixed ration; Ration D = 45% broiler litter+55% Total mixed ration.

Table 9. Market price of experimental ration fed to sheep aged 8-10 months in Pakistan

Ration	Broiler litter/ Total mix ration (%)	Cost/Kg
A	0/100	Rs=17.95
B	15/85	Rs=15.87
C	30/70	Rs=13.80
D	45/55	Rs= 11.44

Ration A = 0% broiler litter+100%Total mixed ration; Ration B = 15% broiler litter+85% Total mixed ration; Ration C = 30% broiler litter+70% Total mixed ration; Ration D = 45% broiler litter+55% Total mixed ration.

To cite this paper: Tahir Khan M, Bhutto ZA , Abbas Raza SH, Saeed M, Arain MA, Arif M, Fazlani SA, Ishfaq M, Siyal FA, Jalili M and Moshaveri A. 2016. Supplementation of Different Level of Deep Stacked Broiler Litter as a Source of Total Mixed Ration on Digestibility in Sheep and Their Effects on Growth Performance. *J. World Poult. Res.* 6(2): 73-83. Journal homepage: www.jwpr.science-line.com

DISCUSSION

The experiment was conducted to add deep stacked broiler litter for sheep in the total mixed ration to ascertain its effect on the intake and digestibility of dry matter, organic matter, crude fiber, nitrogen and nitrogen free extract. Nitrogen retention was determined for DBL at each level it was increased in the diets which have 0 level of broiler litter. The results obtained from the present study that presented in the preceding chapter were opened here for further discussion.

Dry matter intake

The results of the present study showed Dry matter intake as g/kg metabolic body weight were not found non-significant among the treatments except for higher inclusion rate which increased ($P<0.05$). When inclusion rate of deep stack broiler litter is increased the lambs tend to consume more water therefore, gradually reduction ($P<0.05$) in dry matter intake (DMI) in diet by rising broiler litter level. Ensminger and Olentine, (1978) reported almost same results as our study; he demonstrated that, low intake of dry matter having broiler litter may be due to low acceptability of broiler litter and its high mineral contents decreased the desire of food. Whereas, NRC (1984) described that, the ash content of broiler litter is 6% more as compared to other diets which decreased the appetite of animal and ultimately feed intake decreased. Nadeem et al. (1993) reported that, reduction was observed in dry matter intake when barbari goat kids were fed diet contain high level of broiler litter compared to those fed broiler litter free diet. He explained the variation in the feed intake is due to the component of basal diet and of the metabolized energy level of the diet. Obeidet et al. (2012) reported that, dry matter intake decreased in the diet which containing BL compared to those which have 0BL due to the digesta passage rate for basal dietary component with broiler litter has been slower with relative to diet which has no broiler litter so this limited the feed intake. Goatsch and Aiken (2000) discussed that, the reason for low intake might be due the presence of rocks, muds, and other debris; Beside this increased level of ash could be due to soil contamination which caused low dry matter intake. Rossi et al. (1998) reported that, the most important factor which reduced dry matter intake and digestibility might be the particle sized and source of broiler litter. They further explained that broiler litter into fraction have greater intake compared to as a whole.

In vivo digestibility of nutrients

The results of our study on In vivo digestibility of nutrients showed that there was gradual decreased ($P<0.05$) dry matter (DM), organic matter (OM), ether extract (EE) and nitrogen free extract (NFE) digestibility as the level of the deep stacked broiler litter increased in the diets. Whereas, crude fiber and nitrogen digestibility increased among the ration A to D; The low digestibility of dry matter having broiler litter may be due to low acceptability of broiler litter and its high mineral content. Bello and Tsado, (2014) reported that, rams fed diets supplemented with dried poultry dropping had significantly better feed intake; body weight gain and feed conversion ratio. The nutrient digestibility was significantly improved with DPD supplementation. It is recommended that dried poultry dropping can provide sorghum Stover up to 80% inclusion level for good performance and without having any deleterious effects in growing Yankasa rams. Lawrence et al. (2015) reported DBL as potential protein supplement in growing/finishing ruminants. However, it has been noted that optimum levels of inclusion can lead to production efficiencies that are comparable with standard feeds. There is potential to further increase the inclusion levels of DBL in fattening diets if the availability of fermentable energy can be matched to ammonia produced from uric acid degradation. Similarly, NRC (2001) agreed with these results and reported that the ash content of broiler litter was 6% more as compared to other diets which decreased digestibility. Obeidet et al. (2012) reported that dry matter digestibility decreased in the diet which containing DBL compared to those which have zero DBL because the digesta passage rate slow for those diets which contain DBL compared to diet not contains broiler litter. Animals supplemented with dried poultry droppings based diet had the best intake and apparent digestibility coefficient Bello and Tsado (2013). Nadeem et al. (1993) supported the present results that reduction occurred in the digestibility of diet which contained deep stacked broiler litter (DBL) compared to 0 DBL. the reason of low digestibility was due high minerals content present in deep stacked broiler litter which declined the digestibility of dry matter. Abebe et al. (2004) founded that organic matter digestibility decreased as broiler litter increased in the diet. The reason for it could be low level of water soluble carbohydrates which are not properly fermented in the rumen and the low pH decreased the organic matter digestibility. Another authors Nasr Sayed and Fathy (2010) reported that nitrogen digestibility increased in the diet contained broiler litter due to increased microbial protein synthesis in the rumen caused by more degradable protein in the form of ammonia nitrogen being available to rumen microbes.

Elemam et al. (2009) observed low DM digestibility in lambs during 9 to 12 month of age when fed a diet containing 300 gram/kilogram DBL

compared to those were fed control diet due to ash content. The nitrogen digestibility increased as the incorporation of poultry litter increased in the ration compared to the controlled diet. The improvement in crude protein digestibility in broiler litter ration due to increased microbial protein synthesis in the rumen caused by more degradable protein in the form of NH3–nitrogen being available to rumen microbes Nasr Sayed and Fathy (2010); Goatsch and Aiken (2000) also reported that the crude fiber of poultry litter is relatively high digestibility in ruminants. This may be due to the exposure of poultry litter fiber to the enzymes and organisms in the digestive tract of the poultry making it more available and efficiently utilized by the microorganisms in the rumen. Alrukyan et al. (1998) is in line with our results that nitrogen digestibility increased as the level of poultry waste increased in the diet. Due to more digestible nitrogen which quickly converted in to ammonia and efficiently utilized by rumen microbe for synthesis structural protein and finally microbes digested in the small intestine. Similarly Evans et al. (1993) reported that 33% increase in ash content in the diet containing poultry waste result 14% decreased in the dry matter digestibility.

Nitrogen retention

The result of present study shown that nitrogen retention was significantly ($P<0.05$) different among the four diet; A highest, nitrogen retention recorded for the diet A and lowest for diet D in the body of sheep as the inclusion level of broiler litter increased nitrogen retention was reduced Goatsch and Aiken (2000) are agreed with our results and reported that that nitrogen retention decreased as the level of inclusion of poultry litter increased. Reason for low nitrogen retention for increased level broiler litter could be due to low available energy in poultry litter and when energy amount is less than the required rumen microbe, unable to convert ammonia into structural protein and the ammonia entered into urea cycle excreted in urine. Feeding layer litter at 150 g/kg improves feed intake, N retention, and growth performance of finishing Awassi lambs thus reducing the cost of gain. Alternatively, the inclusion of layer litter at 300 g/kg of the diet resulted in similar intake and growth performance to the control group while low- erring the cost of production a little further. Thus, due to reducing the cost of gain, the inclusion of layer litter in Awassi lambs' finishing diets is potentially valuable and can be considered as cheap alternative in livestock feeding strategies (Obeidat et al., 2016). Whereas, Awawdeh et al. (2011) reported that some alternative feedstuffs (AF) can be safely included in diets for Awassi sheep at different production stages to lower the feed and production cost without deteriorating the animal performance. With appropriate inclusion, AF can be safely included in diets for Awassi sheep without negatively affecting the quantity or quality of products such as meat or milk. McDonald et al. (2002) observed that high excretion of Nitrogen (N) in urine supplemented with diet containing poultry litter may have contributed to the high rumen degradability of N whereas high excretion of N in urine is associated with high rumen N degradability.

In vitro dry matter digestibility

The results of present study shown that, in vitro dry matter digestibility of diet (A, B, C and D) containing (0, 15, 30 and 45%) broiler litter linearly decreased ($P<0.05$) as the inclusion of broiler litter increased in vitro digestibility of a diet decrease as the broiler litter increased in the diet. The reason might be due to high mineral content. Usually 8% lime stone was added to broiler ration as source of calcium most of them excreted in the faeces. In vitro dry matter digestibility decreased as the inclusion of broiler increased in the diets. The reason could be due to decrease the water soluble carbohydrate and pH by increasing broiler litter in feed reported by Hadjipanayiotou (1994) and Park et al. (1995).

Economics

The results in our study showed that, the cost of feed linearly decreased ($P<0.05$) as the level of broiler litter in total mixed ration increased that among the four diet the ration C has best result in term of the digestibility of nitrogen and crude fiber. Anakalo et al. (2009) reported that low crude protein content diets based on cane forage require a large quantity of nitrogen. Therefore economics of feeding sugar cane could be improved by using chicken manure as an alternative and inexpensive source of nitrogen. Ayoub et al. (2015) reported that, using the heat processed broiler litter in the diet of Moghani fattening lambs up to 210 g/kg of dietary DM had no effect on growth performance, feed intake and animal health however, back-fat thickness, internal fat, dissected loin fat and cost per unit production reduced. HBL can be a cheap and safe feedstuff for use as a nitrogen source in sheep diet. Moreover, the use of HBL as a feedstuff can reduce environmental pollution. Using poultry litter as feed is significance about $100 per ton as compared to conventional feeds prices. Usually, the price of poultry litter is $10 per ton. Even after transporting the litter 200 miles, the total price of the litter, including transportation, is about $30 per ton. Another advantage of feeding poultry litter is a good alternative of hay, especially during the lean periods due to drought (Fontenot and Joseph, 2000).

CONCLUSION

Based on the results of this study, it is concluded that poultry litter can be included up to 30% as a supplementation of sheep diet, to full fill the nitrogen requirement. It can be used as a substitute of traditional nitrogen sources like cotton seed cake without having any adverse effect on the health and performance of animal. Further study is needed to investigate the toxins and metal content before use as a feeding source.

Recommendations

Laboratory analyses should be carried out of biding material particularly total ash, crude fiber and crude protein these providing useful estimates of available energy, as metabolized energy. Further, suggested that before using as feed ingredient toxin level and silver content should be determined. The harvesting period of broiler litter should be determining before use, properly deep stacked before use it to ruminants.

Competing interests

The authors have declared that there are no competing interests.

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