Journal of Animal and Veterinary Advances 7 (11): 1467-1473, 2008
ISSN: 1680-5593

Performance and Carcass Characteristics of Intact Zebu Bulls Fed Different Levels of Deep Stacked Poultry Litter

Nuha Hamed Talib and Faisal Awad Ahmed
Animal Production Research Center, Hillat Kuku, P.O. Box 1355, Khartoum North, Sudan

Abstract: The objective of this research was to study the effect of feeding diets of Deep-stacked Broiler Litter (DBL) on growth, dry matter intake, feed conversion ratio and carcass composition in Baggara cattle raised for 14 weeks. Thirty six Sudan Zebu intact bulls with 166.7±9.71 kg initial body weight were assigned in a randomized complete design to 1 of 4 dietary treatment groups that differed in DBL as a percentage of concentrate diet. The percentages in concentrate diet were 0, 20, 40 and 60%. Growth in term of total gain and daily gain was not affected by inclusion of processed litter in concentrate diet up to 40%. At higher inclusion rate (60%) both total gain and daily gain dropped ($p<0.01$). Dry matter intake was not affected by feeding processed litter ($p>0.05$) and so palatability. Feed conversion ratio deteriorated with increasing inclusion rate of DBL and became significantly lower at ($p<0.05$) at 60% inclusion rate. Dressing percentage was not affected by dietary treatments. Non carcass components as a percentage of empty body weight was affected differently by dietary treatments but generally tended to be heavier in slaughtered bulls fed poultry litter and that was reflected in that carcass weight in kg in term of empty body weight either hot or cold was lighter ($p<0.001$) in those bulls. The fat reservoir in body tissues tended to be lower in animal fed DBL than others and that resulted in less insulation of carcass and higher chiller shrinkage percentages. Whole sale cuts from bulls fed different levels of DBL as a percent of cold side weight were not affected by different dietary treatments. The previously mentioned results indicate that DBL could be safely used as a feed ingredient for bulls without any effect on animal health. Inclusion of DBL in concentrate diets produced acceptable growth rates of bulls with compromisable prices. That reasonable growth rate achieved in this study suggest that fattening mature Baggara bulls do not need high energy diets and a very small amount of bypass protein produces a reasonable growth; saving high quality protein for other types of production.

Key words: Stacked poultry litter, zebu bulls, sudan

INTRODUCTION

The rapid development of poultry industry in urban areas of the Sudan, particularly around Khartoum city, has resulted in considerable amounts of poultry litter (Talib, 2007). Poultry litter, which is the bedding of poultry houses mixed with excreta and off-feeders, is very rich in crude protein (Rankins, 1995). In the Sudan, it is mainly used as a fertilizer in agriculture and its use as a protein source in animal feeds is scarce. Some limitation for this scarcity are the public perception of dislike in using poultry droppings in animal feed, the possible contamination with pathogens if collected from bedding of sick birds and the possibility of toxins from pesticides and cleaners used in poultry houses. To overcome these limitations, some methods have been developed such as deep stacking (Chaudry *et al*., 1996), ensiling (Hadjipanayiotou, 1994) and heat processing (Jacob *et al*., 1997). The study reported herein aimed at looking into the performance and carcass characteristics of intact Zebu bulls offered diets containing different levels of deep-stacked poultry litter as a protein source.

MATERIALS AND METHODS

Feeds

Deep-stacked broiler litter: Broiler litter collected from a commercial broiler house, bedded with wood shavings was used. The broiler litter is a mixture of bird excreta, wasted feed, bedding and feather. Deep stacking was prepared in an under ground silo pit (2×2.5×1.5 m). The collected litter was spread on a plastic sheet and sprayed with water to bring its moisture contents to about 30% g (Dry Matter [DM] % = 70%) using locally made garden

Corresponding Author: Faisal Awad Ahmed, Animal Production Research Center, Hillat Kuku, P.O. Box 1355, Khartoum North, Sudan

Table 1: Ingredients and chemical composition of the diets fed to cattle in feedlot performance trial

Parameters	Broiler litter (%) in concentrate diet 0	20	40	60	Deep stacked broiler litter	Sorghum straw
Diet composition (%)						
Molasses	45.00	43.00	39.00	36.00	-	-
Groundnut cake	8.50	8.00	4.00	1.00	-	-
Wheat bran	42.00	26.00	15.00	2.00	-	-
Urea	3.50	2.00	1.00	0.00	-	-
Processed broiler litter	0.00	20.00	40.00	60.00	-	-
Salt	1.00	1.00	1.00	1.00	-	-
Total	100.00	100.00	100.00	100.00	-	-
Chemical composition (g kg^{-1} DM)						
Dry matter	689.50	712.70	691.40	654.20	677.60	957.70
Crude protein	229.20	212.50	216.70	220.80	265.00	35.20
Ash	97.70	113.00	147.00	144.00	145.60	72.70
Crude fiber	72.00	60.00	96.00	118.00	236.60	380.00
Ether extract	18.00	14.00	10.00	18.00	34.40	12.60
Calculated ME[1] (MJ kg^{-1} DM)	11.01	10.78	9.97	9.95	9.12	6.69

Proximate analysis was performed according to AOAC (1975) methods, ME (MJ kg^{-1} DM) = 0.012 CP + 0.031 EE + 0.014 NFE + 0.005 CF (MAFF *et al.*, 1975). The ME for sorghum straw was 6.69 MJ kg^{-1} DM as reported by Sulieman and Mabrouk, (1999), The ME for deep stacked broiler litter was calculated according to the Equation TDN% = 75- Ash% (Jacob *et al.*, 1997) and then ME (MJ kg^{-1} DM) = TDN kg ×4.4×4.18×0.82 (NRC,1996)

watering can. Then, the sprayed litter was filled in plastic sacks and put in the underground pit and pressed manually. The pressed material was covered using plastic sheet. A thin layer of soil (3-5 cm) was placed over the plastic sheet. Three pits were prepared. Actually, preparation of one silo pit was made in 2 days and the pit was opened after a period of at least one month. Representative samples of broiler litter were taken after deep stacking and proximate analysis was made on dried (65°C) ground samples as outlined by AOAC (1975).

Experimental feeds: Four concentrate mixtures were used comprising deep stacked broiler litter at a rate of 0, 20, 40 and 60% of concentrate in addition to other feed ingredients of molasses, urea, groundnut cake, wheat bran and salt (Table 1). All concentrate mixtures where prepared to be isonitrogenous (230 protein g kg^{-1}) and isoenergetic (10 ME MJ kg^{-1} DM). Sorghum stover (chopped) was used as a source of fiber. Proximate analysis was performed according to AOAC (1975) methods.

Experimental animals and management: Thirty six bulls with an average initial body weight 166.7±9.71 kg were used in this study. Those animals were obtained from Animal Production Research Center (Hillat Kuku) Khartoum North. Animals were vaccinated against Rinderpest, Anthrax, Black quarter and Hemorrhagic septicemia. All animals were also injected intramuscularly with Ivomec as a protection against internal and external parasites. The feeding trial lasted for 14 weeks. The first 2 weeks were considered as an adaptation period.

Cattle feedlot performance and carcass characteristic trial: The experimental animals were assigned to randomly 4 groups according to the percentage of deep stacked broiler litter in concentrate diet into 0, 20, 40 and 60% as nine animals for each group. Each group was further sub-divided into 3 subgroup of 3 animals each. The sub group was housed separately in a pen measuring (5.0×3.4 m^2) with free access to water, feeders and mineral blocks. Concentrate mixtures were offered at early morning (8 am) for all groups. While, sorghum was provided at 2 pm in the afternoon at the same feeders. The difference between weights of the quantity offered and refusal on the next morning resembles the daily feed intake. All animals were weighed early morning at weekly intervals using a weigh bridge of 1500 kg maximum capacity load with 5 kg division. All animals were slaughter serially after an overnight fasting period. Animals were slaughtered according to Muslim procedure (Halal). All slaughter procedure and carcass data adopted in this study followed Meat and Livestock Commission M.L.C (1974).

Chemical analysis: All of the feed ingredients were analyzed to their proximate components [crude protein (CP) N × 6.25, Ether Extract (EE), Crude Fiber (CF) and ash percentages] according to standard methods of AOAC (1975).

Statistical analysis: Statistical analysis was done using computer program SAS (1990) as follows:

- Analysis of variance was conducted to examine the effect of different experimental diets on feedlot performance parameters such as daily feed intake, average daily weight gain and feed conversion ratio.

- Slaughter data and carcass data were also subjected to one way analysis of variance were the experimental diets considered as the treatment effect and slaughter weight was considered as a covariate.

RESULTS AND DISCUSSION

General appearance of the deep-stacked broiler litter showed a dark color without any odd smell. The mold growth seldom found on the outer layer, which caused a slight loss of the product because the portion covered with mold, was discarded. Also, some areas in the product showed black color and sticky indicative of overheating and so discarded also.

Ingredients and chemical composition of the diets fed to cattle in feedlot performance trial are showed in (Table 1). The crude protein content of the deep-stacked broiler litter reported in this study was a bit higher while, ash contents and crude fiber contents were lower than values (254, 268 and 244 g kg^{-1} DM, respectively) reported by Wang and Goetsh (1998). This was most likely due to the higher ratio of bedding to wasted feed, excreta and feathers. The prepared experimental rations blended well with the deep-stacked broiler litter and other feed ingredients perhaps because of molasses inclusion (>35% of molasses in concentrate rations). In line with previous studies (Fontenot, 1981; Hadjipanayiotou *et al.*, 1993; Hadjipanayiotou, 1994) no disease problems were encountered in this study. In addition, there were no indications of harmful effects on humans consuming meat from animal fed deep-stacked broiler litter.

From Table 2, it was clear that total gain of Western Baggara bulls was not affected by replacing the concentrate diet by processed poultry litter except for the highest inclusion rate. Although, the experimental rations were prepared to be isonitrogenous and isocaloric (Table 1), the lowered body performance might be attributed to lower CP digestibility values for diets containing the highest inclusion rate of poultry litter. The same conclusion was drawn by Holzer and Levy (1976) raising cattle on low and high broiler litter levels. The reason for lower CP digestibility for HLBL diet might be due to extensive CP loss in the rumen in a form of ammonia. There was also evidence that processed broiler litter is very soluble (Hadjipanayiotou, 1994). Generally, the daily live weight gain in kg and feed conversion ratio of Western Baggara bulls (Table 4) was comparable with other studies (0.85-1.01, 9.4-11.2; 1.09-1.27, 7.7-8.96 and 1.13-6.49) using molasses based diets (Mohammed, 2004; Rahama, 2005; Eltahir, 1994), respectively or using conventional diets (Mohamed, 1999) for 0.49-1.07, 9.09-10.97. The daily gain reported in this study was higher than that reported by other studies (Ahmed, 2005) for 0.58-0.73 kg day^{-1} raising the same breed on conventional diets.

The inclusion of poultry litter in ruminant's diet in this study caused a non significant decrease in growth rate. Nevertheless that decrease became only significant ($p<0.01$) and most prominent for bulls fed on the highest inclusion rate of poultry litter. In line with these results Meyreles and Preston (1980), reported lower growth rate (286 g day^{-1}) for steers fed 3 kg poultry litter supplement compared to 461 g day^{-1} growth rate for those fed 1.5 kg day^{-1} poultry litter. Further more, Mahmoud (2004)

Table 2: Performance characteristics of bulls fed different levels of deep stacked broiler litter

Parameter	Broiler litter (%) in concentrate diet 0	20	40	60	Standard error[1]	Level of significance
Period (weeks)	14	14	14	14	-	-
Number of animals	9	9	9	9	-	-
Initial live weight (kg)	170.00	168.33	167.78	160.56	6.647	ns
Final live weight (kg)	270.00^a	266.11^a	265.00^a	241.67^b	12.240	**
Average live weight (kg)	220.00^a	216.67^a	216.94^a	201.11^b	5.928	*
Total gain (kg)	100.00^a	96.33^a	98.33^a	81.11^b	5.645	**
Average daily gain (kg day^{-1})	1.19^a	1.15^a	1.17^a	0.97^b	0.067	**
Dry matter intake (kg $head^{-1}$ day^{-1})						
Concentrate	5.70	5.46	5.82	5.50	0.262	ns
Sorghum straw	2.55	2.90	2.73	2.99	0.178	ns
Total	8.26	8.36	8.54	8.49	0.298	ns
Dry matter intake percentage live weight	3.76^a	3.88^a	3.94^a	4.24^b	0.119	**
Dry matter intake (g kg $W^{0.75}$)	144.60^a	148.59^a	151.22^a	159.39^b	3.719	**
Feed conversion ratio (kg DM feed kg^{-1} live weight gain)	6.97^a	7.49^a	7.36^a	8.87^b	0.445	**

In this and subsequent tables,[1]Standard error of the difference between any two means, ns = not significant, * = p <0.05, ** = p <0.01, *** = p <0.001

recorded a non significant decrease in growth rate of sheep fed increasing level of poultry litter. Generally, the growth rate reported in this study (0.97-1.15 kg day^{-1}) is very high compared with other authors (0.378-0.780; 0.772; 0.51-0.59 kg day^{-1}) using poultry litter as a cattle feed ingredient (Meyreles and Preston, 1980; Hadjipanayiotou *et al*., 1993; Nouel and Combellas, 1999), respectively. Those results might be attributed to the low energy density and protein quality of other ingredients included with poultry litter.

Feed conversion ratio is the quantity of feed required to produce one unit gain of live animal. The lower the feed conversion ratio, the most efficient feed value. Feed conversion ratio reported in this study (Table 2) ranged between 6.97-8.87 kg DM feed kg^{-1} live weight gain, which deteriorated gradually, as the poultry litter inclusion rate increased. That deterioration could be due to low energy density of poultry litter compared to other ration ingredients. In accord Mahmoud (2004), reported higher feed conversion ratio (10.33) for sheep fed high level of poultry litter (30%) compared to others fed no (0%)or low levels (10-20%)of poultry litter (7.36, 9.21 and 9.42, respectively). In contrast, Meyreles and Preston (1980), reported an elevated feed conversion ratio (23.0-17.9) for bulls fed low level poultry litter compared to others fed high level poultry litter (1.5 and 3 kg poultry litter animal/day, respectively). The latter result was explained by the fact that animals on low level poultry litter consumed more feed (32.6% more feed intake), hence the nutritive value increased by duplicating the daily amount of poultry litter supplement. However, the feed conversion ratio reported in this study was in agreement (Eltahir, 1994) 6.49 or lower (9.09-10.97 and 9.4-11.82) than that reported by others (Salim, 2003; Mohammed, 2004), respectively raising the same breed to the same target weight. Other researchers recorded a high feed conversion ratio (12.7) for rations containing poultry litter (Mapoon *et al*., 1979). Their results might be attributed to lower energy value of poultry litter. Moreover, poultry litter was used as an emergency feed for stockers and so high growth rate was not the prime goal.

It was clear also that inclusion of deep-stacked broiler litter imposed no negative effect ($p>0.05$) on feed intake of the tested diets or affecting palatability (feed intake as percent body weight range 3.8-4.2 in (Table 2). Further more, there was a trend of increased feed intake (kg day^{-1}) as the inclusion rate of processed poultry litter in concentrate diets increased. That increase was often, accompanied by the decrease in energy value of the tested rations (Table 1). In other words, animal compensated for lower energy concentration in diet by increasing feed intake (Ahmed, 2003, 2005). That was true to some extent, but at severe shortage of energy the animal could not compensate and there was a drop in feed intake (Mohamed, 1999). The same was true for intake as percentage of live weight or as g kg^{-1} metabolic body weight. Generally, the data on dry matter intake reported in this study is higher than that proposed by NRC (1996) for cattle of the same body weights and this could be due to higher energy density of rations adopted by NRC (1996) and more likely, efficient breeds used for setting up these data.

Commonly, carcass quality is evaluated on a specific intended market, for the carcass and its products. The most important and most common carcass traits are quality grade (meat quality attributes) and yield grade (carcass weight, fat thickness, percentage kidney, pelvic and heart fat and ribeye area). All data on non carcass components of bulls reported in this study (Table 3) were within the normal range reported by other workers finishing Baggara cattle on conventional diets (Ahmed, 2003; Mohamed, 1999) or molasses based diet (Mohammed, 2004; Turke, 2002; Rahama, 2005; Eltahir, 1994). From (Table 3) it was clear that non carcass components as a percentage of empty body weight tended to be heavier in those fed litter containing diets. The empty body weights were higher in bulls fed control diet than bulls fed litter containing diets especially at higher inclusion rate (60%) of poultry litter ($p<0.001$). That result was not unexpected since bulls fed control diet had already heavier slaughter weights than others. The body fat stored in slaughtered bulls as a percent of empty body weight reported in this study (Table 4) was not influenced by experimental rations. But still, there was a trend of decreasing fat percent in carcasses of bulls fed poultry litter containing rations. However, other non-carcass components responded differently to inclusion of broiler litter in concentrate diets. The present results given in (Table 4) indicated that inclusion of different levels of poultry litter in concentrate ration impose no negative action on the percent of hot or cold carcass weight related to slaughter or empty body weight of bulls. Dressing percentage on hot basis or cold basis was not significantly different ($p>0.05$) between bulls fed different experimental diets. The yield of the wholesale cuts from bulls raised in this study was not influenced by diet except the left side cold weight (Table 5). All data on carcass composition are in consistence with data reported by Ahmed (2003), Mohamed (1999), Mohammed (2004), Turke (2002), Rahama (2005) and Eltahir (1994). Minor differences may occur due to different slaughter weights.

Table 3: Non carcass components of zebu bulls fed different levels of deep stacked broiler litter (Percent of empty body weight in kg)

	Broiler litter (%) in concentrate diet					
Parameter	0	20	40	60	Standard error[1]	Level of significance
Number of animals	9	9	9	9	-	-
Empty body weight (kg)	250.330[a]	233.880[b]	233.390[b]	206.7100[c]	3.156	***
Blood	4.110[a]	3.570[b]	3.910[ab]	4.0400[a]	0.182	*
Head	6.500[a]	6.460[a]	6.510[a]	6.9800[b]	0.164	***
Hide	8.320	8.150	8.160	8.3900	0.093	ns
Four feet	2.410[b]	2.500[ab]	2.520[ab]	2.6300[a]	0.097	*
Heart	0.390	0.390	0.380	0.4100	0.018	ns
Lung and trachea	1.430[b]	1.390[b]	1.530[ab]	1.5900[b]	0.066	*
Omental fat	1.510	1.490	1.380	1.3200	0.118	ns
Reticulorumen full	9.380	10.710	10.540	10.9200	1.318	ns
Omentum full	0.770[b]	0.770[b]	1.020[a]	1.2600[a]	0.117	***
Abomasum full	0.830	0.930	0.920	0.9500	0.055	ns
Intestine full	5.130	4.950	5.170	5.7600	0.291	ns
Alimentary tract full	17.030	18.480	18.770	19.8200	1.600	ns
Reticulorumen empty	2.370	2.490	2.550	2.6100	0.120	ns
Omentum empty	0.800	0.860	0.870	0.9300	0.074	ns
Abomasum empty	0.550[b]	0.560[b]	0.610[ab]	0.6200[a]	0.026	*
Intestine empty	2.500	2.250	2.540	2.6000	0.135	ns
Alimentary tract empty	6.230[b]	6.180[b]	6.570[ab]	6.7600[a]	0.221	**
Gut fill	10.830	12.300	12.200	13.0600	1.485	ns
Liver	1.590[b]	1.570[b]	1.590[b]	1.7800[a]	0.071	*
Pancreas	0.120	0.120	0.120	0.1200	0.013	ns
Spleen	0.440	0.410	0.400	0.4100	0.036	ns
Mesenteric fat	0.590	0.540	0.510	0.4800	0.054	ns
Reproductive organs	1.060	1.100	1.110	1.0700	0.048	ns
Diaphragm	0.630	0.680	0.610	0.6500	0.029	ns
Kidney	0.490	0.450	0.660	0.4200	0.129	ns
Kidney fat	1.520[a]	1.570[a]	1.360[ab]	1.0900[b]	0.152	***
Pelvic fat	0.300	0.360	0.350	0.2300	0.174	ns
Tail	0.376	0.383	0.384	0.0.362	0.021	ns

Table 4: Carcass yield and characteristics of Zebu bulls fed different levels of deep stacked broiler litter

	Broiler litter (%) in concentrate diet					
Parameter	0	20	40	60	Standard error[1]	Level of significance
Number of animals	9	9	9	9	-	-
Slaughter weight (kg)	277.22[a]	262.22[a]	261.67[a]	233.78[b]	8.465	***
Empty body weight	250.33[a]	233.88[b]	233.39[b]	206.71[c]	3.156	***
Gut fill percentage (live weight base)	10.83	12.30	12.20	13.06	1.485	ns
Hot carcass weight (kg)	144.74[a]	136.04[b]	134.34[b]	119.45[c]	1.870	***
Cold carcass weight (kg)	142.03[a]	133.70[b]	131.28[b]	116.45[c]	1.919	***
Chiller shrinkage (%)	1.90[cb]	1.77[c]	2.36[ab]	2.58[a]	0.265	*
Hot dressing percentage (live weight base)	52.21	51.87	51.35	51.17	0.740	ns
Hot dressing percentage (empty body weight base)	51.24	50.97	50.16	49.88	0.757	ns
Cold dressing percentage (live weight base)	57.87	58.26	57.56	57.83	0.982	ns
Cold dressing percentage (empty body weight base)	56.79	57.25	56.24	56.39	0.986	ns

Table 5: Yield of whole sale cuts from zebu bulls fed different levels of deep stacked broiler litter (Percent of cold side weight)

	Deep stacked broiler litter (%) in concentrate diet					
Parameter	0	20	40	60	Standard error[1]	Level of significance
Number of carcasses	9	9	9	9	-	-
Left side cold weight (kg)	71.05[a]	68.12[b]	66.12[b]	59.35[c]	1.122	***
Shin	2.27	2.07	2.52	1.94	0.210	ns
Neck	6.53	6.62	6.61	6.57	0.307	ns
Clod	6.30	5.91	6.01	6.02	0.205	ns
Chuck and blade	11.12	10.67	10.85	9.69	0.805	ns
Extended roasting ribs	6.78	6.69	6.35	6.71	0.472	ns
Thick ribs	5.71	5.44	5.85	5.55	0.351	ns
Thin ribs	3.49	3.00	3.49	3.31	0.308	ns
Brisket	7.91	8.23	8.40	8.42	0.281	ns
Hind quarter flank	6.98	6.94	8.09	6.42	0.848	ns
Thick flank	4.60	4.86	5.19	5.02	0.191	ns
Leg	5.02	5.08	6.14	5.36	0.574	ns
Sirloin	6.46	6.12	6.58	6.55	0.287	ns
Rump	6.56	6.34	6.69	6.51	0.264	ns
Top and silverside	17.69	17.38	17.45	17.30	0.369	ns

CONCLUSION

From the results of this study it could be concluded, that feeding deep-stacked broiler litter up to 60% concentrate inclusion rate to cattle imposed neither harmful effect on their health nor caused a severe reduction in their body performance or meat quality. Moreover, it was a cheap feed and produced a reasonable growth rate (0.97-1.15 Kg day^{-1}).

Extension research should be done to elucidate the benefits of using poultry litter as ruminant feed rather than a fertilizer and so that possible contamination of underground water is minimized. Farmers should also be encouraged to explore deep stacked broiler litter as a feasible method of waste management and develop their own complementary system of animal production i.e., recycling processed litter as ruminant feed.

REFERENCES

Ahmed, B.A., 2003. The effect of different levels and protein on growth and carcass composition of Western Baggara bulls. Ph.D Thesis, Faculty of Animal Production, University of Khartoum.

Ahmed, H.A., 2005. Effect of dietary energy level on finishing Baggara heifers. Ph. D Thesis, Faculty of Animal Production, University of Khartoum.

AOAC, 1975. Association of Official Analytical Chemists of the Official Methods of Analysis. 12th Edn. AOAC, Washington, DC.

Chaudhry, S.M., J.P. Fontenot, Z. Naseer and C.S. Ali, 1996. Nutritive value of deep stacked and ensiled broiler litter for sheep. Anim. Feed Sci. Technol., 57: 165-173.

Eltahir, I.E., 1994. Beef production potential of western Baggara and Friesian crossed cattle. M.Sc. Thesis, University of Khartoum.

Fontenot, J.P., 1981. Recycling of Animal wastes by Feeding. In: New Protein Foods. Academic Press, Inc., 4: 277-304.

Hadjipanayiotou, M., 1994. Laboratory evaluation of ensiled olive cake, tomato pulp and poultry litter. Livestock Research for Rural Dev., 6 (2). http://www.cipav.org.co/lrrd/lrrd6/2/cyprusl.htm.

Hadjipanayiotou, M., L. Verhaeghe, L.M. Labban, A. Shurbaji, Abd El-Rahman Kronfoleh, M. Al Wadi, T. Naigm, H. El-Said and Abdul Kader Al-Haress, 1993. Feeding ensiled poultry excreta to ruminant animals in Syria. Livestock Res. Rural Dev., 5 (1). http://www.cipav.org.co/lrrd/lrrd5/1/syrial.htm.

Holzer, Z. and D. Levy, 1976. Poultry litter as a protein supplement for beef cattle fed fibrous diets. World Rev. Anim. Prod., 12 (1): 91-96.

Jacob, J.P., W.E. Kunkle, R.S. Tervola, R.D. Miles and F.B. Mather, 1997. Broiler litter: Part 1. A feed ingredient for ruminants Acrobat version). Factsheet PS-13 of the Department of Animal Sciences, University of Florida.

MAFF, DANS and DANI, 1975. Ministry of Agriculture, Foods and Fisheries (MAFF), Department of Agriculture of Scotland (DANS) and Department of Agriculture for Northern Ireland (DANI). Energy Allowances and Feeding Systems for Ruminants; Technical Bulletin 33. HMSO-London, ISBN: 011240894X.

Mahmoud, Z/El. N., 2004. The use of sun-dried poultry litter in diets for fattening desert sheep. M.Sc. Thesis, University of Khartoum.

Mapoon, L.K., A.A. Booboo and B. Hulman, 1979. Use of poultry litter in a diet of molasses and bagasse fattening bulls. Trop. Anim. Prod., 4 (2): 145-147.

Meyreles, L. and T.R. Preston, 1980. Performance of cattle given molasses and poultry litter mixed or as separate feeds. Trop. Anim. Prod., 5 (3): 236-238.

MLC, 1974. Meat and Livestock Commission. Cutting and preparing beef. Technical bulletin No: 17, Wueens way House, Queen's way Bletchlly Milton Keynes, U.K.

Mohamed, H.K., 1999. The effect of different dietary energy levels on performance, carcass characteristics and meat quality of the Sudan Baggara cattle. PhD. Thesis, Faculty of Animal Production, University of Khartoum.

Mohammed, A.M., 2004. Effect of slaughter weight on meat production potential of Western Sudan Baggara cattle. Ph.D. Thesis, Faculty of Animal Production, University of Khartoum.

Nouel, G. and J. Combellas, 1999. Live weight gain of growing cattle offered maize meal or citrus pulp as supplements to diets based on poultry litter and restricted grazing of low quality pastures. Livest. Res. Rural Dev., 11 (1). http://www.cipav.org.co/lrrd/lrrd11/ 1/nou111.htm.

NRC (National Research Council) 1996. Nutrient Requirements of Beef Cattle. 6th Rev. Edn. National Academy Press. Washington. D.C.

Rahama, B.M., 2005. Seasonal effects of ambient temperature on feedlot performance and carcass characteristics of Western Baggara Zebu cattle. Ph.D. Thesis, Faculty of Animal Production, Alzaiem Alazhari University.

Rankins, D.L., 1995. Processing options for broiler litter. Feed Mix, 3 (1): 8-11.

Salim, M.B., 2003. The use of Guar for fattening Western Baggara cattle. M.Sc. Thesis, University of Khartoum.

SAS, 1990. Statistical Analysis System User'guide. 4th Edn. SAS Institute, Inc., Cary, USA. 1 and 2 (6).

Sulieman, Y.R. and A. Mabrouk, Abd/Ra, 1999. The nutrient composition of Sudanese Animal Feeds (Bulletin III). Animal Production Research Centre Publications. Khartoum North, Sudan.

Talib, N.H., 2007. The potential use of deep-stacked broiler litter as a ruminant feed. Ph.D. Thesis, Faculty of Animal Production, University of Khartoum.

Turke, I.Y., 2002. The effect of different dietary protein sources on fattening performance and carcass characteristics of Western Baggara cattle. Ph.D. Thesis, Faculty of Animal Production, University of Khartoum.

Wang, Z.S. and A.L. Goetsch, 1998. Intake and digestion by Holstein steers consuming diets based on litter harvested after different numbers of broiler growing periods or with molasses addition before deep-stacking. J. Anim. Sci., 76: 880-887.