# Broiler litter as feed for ruminants -Potential and limitations under Nigerian conditions

M. A. BELEWU
*Department of Animal Production, University of Ilorin, Kwara State, Nigeria*

SUMMARY

In Nigeria, ruminant livestock are often underfed mostly during the dry season of the year due to high environmental temperature, poor green forage production and high cost of feed. This has resulted in the inclusion of alternative feedstuffs in animal rations. Broiler litter plays a vital role in supplying and correcting nutrient deficiencies in animal nutrition. Generally, growth rate, milk production and feed efficiency were higher in animals (sheep, goats and cattle) fed broiler litter-based diet than in animals fed control diet (without broiler litter). This paper reviews the nutritional value, health hazard, processing techniques and factors affecting the acceptability of broiler litter as feed.

Subject review article. Received 4 Sep 95; revised 10 Jan 97.

RÉSUMÉ

BELEWU, M. A.: *La litière de poulet comme alimentation pour les ruminants—les potentiels et les limitations sous les conditions nigérianes.* Au Nigéria le bétail ruminant est souvent sous-alimenté surtout pendant la saison sèche de l' année due à la température environmentale élevée la faible production de fourrage vert et le haut coût d' aliment. Ceci a abouti à l' inclusion de nourriture alternative dans les vivres d' animal. La litière de poulet joue un rôle vital dans le fournissement et la correction des déficiences nutritives dans la nutrition d' animal. En général, la proportion de croissance, la production de lait et l'efficacité d' alimentation étaient plus élevées dans les animaux (les moutons, les chèvres et les bovins) nourris avec le régime basé sur la litière de poulet, que dans l' animal nourri avec le régime de contrôle (sans la litière de poulet). Ce document discute la valeur alimentaire, les risques pour la santé, les méthodes de traitement, et les facteurs influençant l'acceptabilité de la litière de poulet en tant qu'aliment.

## Introduction

Intensive improvement in broiler production in recent years has resulted in vast quantities of litter (manure plus bedding). For example, about 1000 birds on deep litter are estimated to produce 30 tonnes of faecal matter mixed with litter of variable fibre and moisture content per week (Oluyemi & Robert, 1979). The litter was found as the most valuable animal waste due to its high protein content of which about 45-67 per cent is the true protein, 18-30 per cent uric acid and 12-17 per cent ammonia.

The ammonia can be used in the same manner as urea while the uric acid is better utilized by ruminants than urea due to its lower solubility in water. The litter is also relatively high in feed energy compared with other animal wastes.

Broiler litter has been extensively investigated for its nutrient composition, health hazard, processing methods and its economic consideration but its inclusion in ruminant livestock ration is still very scanty in Nigeria.

In the present paper, attention is focussed on the evaluation of broiler litter as a component of animal rations while the potential and limitations on its use as ruminant livestock feed under Nigerian conditions are considered.

## Nutritional value

### *Factors affecting chemical composition of broiler litter*

Literature on broiler litter shows wide variations in its chemical composition and nutritive value between individual countries. Important causes of

variation include:

(a) type of material used as bedding,
(b) density of birds,
(c) age of birds,
(d) age of litter and processing methods.

Broiler litter is vital mainly for its protein content. Field studies in Nigeria show that the mean crude protein content is between 16 and 31 per cent and 30 per cent of the protein constitute the true protein while the rest is the NPN (purines, uric acid and allantoin). The crude protein present in broiler litter can be utilized at a level comparable to the conventional protein feedstuffs and its inclusion in dairy cattle nutrition will help in reducing production cost by 20-40 per cent (FAO, 1980). The litter contains about 25 per cent crude fibre with a third of the fibre derived from excreta and two thirds from the bedding materials (Muller, Drevjany & Kozel, 1968). The litter is high in ash content (7.9 per cent) with Ca:P ratio 1.2:1 which shows that diets based on broiler litter are well balanced in these two basic elements. The calcium and phosphorus content of the litter varies with the content in the diet and also the nature of the grit given to birds. The potassium content depends on the bedding materials used while the micro-mineral in the litter is influenced by their levels in the ration.

The chemical composition and physical properties of the bedding materials affect the nutritive value of deep litter. However, the bedding materials must be easily degraded, inexpensive, easily available, highly absorbent, easy to transport, free of dust and disease and not eaten by the bird. Various bedding materials used in poultry houses in Nigeria include rice straw, wheat straw, rice hulls, maize cob, cane bagasse, coffee hulls, hay, pine, saw dust, wood shaving and peat. The most common in southern Nigeria is the wood shavings. It is most suitable due to its easy availability and it is less dusty. Coniferous wood waste contains between 20.9 and 21.5 per cent crude protein and 12.7 per cent ash (FAO, 1980) while saw dust was found to contain 1.8 per cent crude protein, 50.3 per cent crude fibre, 3.8 per cent ether extract, 5.6 per cent ash, 6.35 per cent ADF and 15.1 per cent ADL (Adegbola & Obioha, 1982).

The quantity of bedding materials used per bird also influences the protein, vitamins and monetary value of the litter (FAO, 1980). The level of vitamin B was reported higher in the litter than the quantities present in the feed partly due to enteric biosynthesis and fermentation of the litter (Table 1). Addition of cobalt and cyanides will significantly increase the level of vitamin $B_{12}$ (Muller & Herold, 1959).

TABLE 1

*Composition of Broiler Litter-based Concentrate Diets*

| *Ingredients* | *Diets* | | | |
|---|---|---|---|---|
| | *Control (A)* | *B* | *C* | *D* |
| Cassava waste* | 98.00 | 78.00 | 58.00 | 38.00 |
| Autoclaved broiler litter | - | 20.00 | 40.00 | 60.00 |
| Vitamin premix | 1.00 | 1.00 | 1.00 | 1.00 |
| Common salt | 1.00 | 1.00 | 1.00 | 1.00 |
| | 108.00 | 100.00 | 100.00 | 100.00 |

* Cassava waste consists of peels, pulp plus small and broken tubers.

As the broiler birds advanced in age (1-8 weeks), there was an increase in the dry matter, crude protein and crude fibre content while the ether extract percentage fluctuated throughout the rearing period (Henning & Poppe, 1977). The effect of storage on the litter shows that storing the litter for more than one month resulted in the reduction of the protein content (Bhattacharya & Fontenot, 1966).

*Effect of broiler litter on the performance of ruminant livestock*

Performance of ruminant animals fed broiler litter has been reported by Bhattacharya & Taylor (1975), Ojemuyiwa (1978), FAO (1980), Jakhmola *et al.* (1988), Belewu (1992) and Ehoche (1996).

Belewu (1992) reported a digestible energy intake of 12.0 *M* cal/day when the litter was incor-

porated at 60 per cent level in Bunaji heifer rations. An apparent digestibility of crude protein of 69.1 per cent was recorded when the ration contained 40 per cent litter. Similarly, Abdul-Izzeddin & Bhattacharya (1969) also observed a crude protein digestibility of 74.4 per cent when 50 per cent unprocessed broiler litter replaced an equal amount of mixed adequate ration for sheep. Increasing the broiler litter to the 60 per cent level did not depress the apparent digestibility of the litter. Numerous workers (Jeroch *et al.*, 1969; Bhattacharya *et al.*, 1971; Belewu, 1992; Belewu, 1992; Belewu & Adeneye, 1996) found that digestibility of crude protein varied from 77 to 82 per cent when the ration consisted of only litter. The usual upper limit for the incorporation of broiler litter into ruminant diet is 40 per cent but when the level of undigestible ash is low and a cheap source of readily soluble carbohydrate (molasses, cassava waste, sugar, grain and fruit waste) is included, then the litter can be used at higher levels.

Steers fed 40 per cent autoclaved broiler litter gained weight more rapidly than those fed a control diet (Drake, McClure & Fontenot, 1965). Similarly, Belewu (1992) reported an increased daily weight gain when 40 and 60 per cent litter was fed to Bunaji heifers. Conversely, Ehoche (1996) reported reduction in liveweight gains (6.3-5.2 per cent) when cotton seed cake (CSC) replaced cage layer wastes (CLW) with between 40 and 60 per cent. Noland, Ford & Ray (1955) and Bosman (1973) observed depressed growth rate in steers fed poultry litter diet at 40 per cent inclusion level. Tagari *et al.* (1976) and Adeleye (1991) reported a non-significant difference in weight gain when 0, 15, 25 and 35 per cent litter was included in steer rations. Numerous workers (Goel & Pradhan, 1978; Vijchulata *et al.*, 1980) reported increasing feed intake when 20 per cent poultry litter was fed to steers while feeding 100 per cent dried poultry excreta to male calves gave higher dry matter intake with better feed efficiency. To improve the feed intake of animals fed broiler litter rations, FAO (1980) and Belewu (1992) suggested incorporation of readily-soluble carbohydrates. Harmon *et al.* (1972) observed that inclusion of 10 per cent molasses is the optimal level for obtaining maximal feed intake in steers fed either 25 or 50 per cent litter ration. Supplementation of other readily available soluble carbohydrate sources like cassava waste, potato cannery waste, and maize or sorghum grain increased digestibility of dry matter, crude protein, crude fibre, ADF, NDF, energy and milk yield and composition (Ojemuyiwa, 1978; Daniel *et al.*, 1983; Belewu, 1992; Belewu & Adeneye, 1996) (Table 2).

TABLE 2

*Effect of Feeding Broiler Litter-based Concentrate Diets on the Performance of Bunaji (White Fulani) Bull Calves*

| *Broiler litter level (%)* | *Crude protein (%)* | *Crude fibre (%)* | *ADF (%)* | *NDF (%)* | *Mean LWG (kg/d)* | *Gain:DM* | *DMI g/d/ 0.75 wkg* |
|---|---|---|---|---|---|---|---|
| 0 | 5.14 | 12.58 | 23.75 | 35.35 | 300.11[a] | 0.07[a] | 145.52[a] |
| 20 | 6.99 | 13.26 | 50.00 | 59.78 | 413.26[b] | 0.10[b] | 154.20[b] |
| 40 | 9.76 | 13.86 | 57.87 | 59.98 | 648.12[c] | 0.16[c] | 157.97[c] |
| 60 | 12.06 | 15.46 | 60.00 | 63.67 | 732.50[d] | 0.17[d] | 134.34[d] |

Source: Belewu & Adeneye (1996)

Average daily milk production (12.8 litre/head/day) of cows fed 5 kg/head/day of diets containing dried litter was only slightly higher (3 per cent) over control (without litter) diet (Muller & Drevjany, 1967; Muftic *et al.*, 1974).

Belewu (1992), in agreement with Kristensen *et al.* (1976), reported higher fat content in the milk of cows fed 40 per cent dried poultry excreta in their ration.

### Health hazards

Livestock faecal waste may contain various types of parasitic and non-parasitic pathogens as well as toxigenic fungi capable of causing diseases in humans, livestock and poultry. Livestock faecal

waste may also contain drugs.

*Drugs*

The presence of drugs in the litter could be associated with feed spillage, if the concentrated feed contains it. Some drugs are also excreted at concentration level in the faeces and these include arsenicals, coccidiostats, antibiotics, sulfonamides, hormones, nitrofurans, nitrobenzenes, purines, organophosphates, chlorinated hydrocarbons, heavy metals and pesticides. There is, therefore, the need to investigate the presence of drugs in the litter.

*Pathogens*

Poultry are potential agent of several pathogens which are communicable to humans as well as other livestock through the litter. Animal scientists should, therefore, pay more attention to how these communicable diseases could be controlled or eradicated through the various processing techniques. Among the communicable diseases are Newcastle disease which causes conjunctivitis while chlamydia causes pneumonia in human beings (Biester & Schwarts, 1959; FAO, 1980). *Mycobacterium* and *Listeria monocytogenes* caused tuberculosis and listerosis in human respectively (Davis & Brown, 1970).

Lovett (1972) reported the presence of *Aspergillus fumigatus* and *Samonella* spp. in the litter which causes asthma, chronic respiratory disease and enteritis in man respectively. All the diseases could be communicated to man through the handling of animal litter. Apart from those diseases that are communicable to man, some are communicable to livestock, e.g. *Clostridium perfringes* and *Corynebacterium pyogenes* cause enterotoxemia and abortion in cattle respectively. The potential value of litter to ruminants can be enhanced by various processing methods so as to eradicate or control these diseases and meet the recommended microbial standards of the Food and Drug Administration of Nigeria for most human food and animal feed.

**Processing methods**

The various processing methods can be broadly classified into mechanical, biological and chemical methods.

*Mechanical methods*

The mechanical methods include mechanical drying of the litter. This reduces the bulkness of the waste to 20-30 per cent of the original volume (Surbrook *et al.*, 1971). In-house drying which is an example of mechanical methods involves the use of high velocity air movement plus mechanical stirring of the litter in a pit.

*Chemical methods*

The aim of the chemical method is to eliminate pathogens, preserve nutrients, improve nutritive value and enhance feed intake. The chemical methods include the treatment of the litter with ethylene oxide, cobalt 60 radiation, paraformaldehyde flakes and gentian violet. Treatment with ethylene oxide was found to reduce the bacterial population without eliminating them while treatment with cobalt 60 radiation at 3-5 megarads produced bacterial-free litter without any effect on the *p*H and the moisture content. Addition of paraformaldehyde flakes to poultry litter has been accredited to impact antibacterial action on the litter; it also neutralized the ammonia gas in the litter (Seltzer, Moum & Goldhaft, 1969; El-Sabban *et al.*, 1969; Bhattacharya, Abdul-Izzeddin & Schwult (1971). The purple iodine (Gentian violet) was found to exhibit certain bactericidal effect in the feed (Wyatt & Greg, 1977). Runkle & Hatfield (1975) reported an increase in feed intake when 1.5 per cent formalin was included in the litter.

*Biological methods*

Biological methods involve the use of living things (e.g. insect culture). Miller & Shaw (1969) reported that larvae of diptera species are capable of transforming 80 per cent of the organic matter of the litter and also reducing the moisture content from 75 to 50 per cent. Calvert, Morgan & Martin (1973) reported that the fly pupae contain

63.1 and 15.5 per cent crude protein and ether extract respectively.

Biodegradation of the litter by earthworm has been reported in the literature (FAO, 1980). Fosgate & Fabb (1972) found that 1 kg of earthworm could be produced from 2 kg of dairy manure. The earthworms were collected and used as earthworm meal with 58 and 2.8 per cent crude protein and crude fat respectively. The use of fungi or mould was handicapped by the production of toxins which may affect the promising results. The litter can also be ensiled alone or with any soluble carbohydrate so as to enhance the quality of the fermentation process. It was found that the stacking method helps in eliminating pathogens present in the litter (FAO, 1980).

**Economic considerations of broiler litter**

Economic considerations are not only based on the least cost method of wastes removal and disposal but must also include the methods that discharge wastes back into the environment without diminishing environmental quality (Hart, 1970).

Morris (1966) suggested that manure removal should be debited into livestock production account and treated as an expense item. Also, the quantity of bedding materials used per bird has an effect on the protein and vitamin content as well as the monetary value of the litter. Transporting the litter to the processing plant and returning it after processing is also very expensive and may be uneconomical. Considering the cost of transportation, the farmer can destroy the litter with the least expensive methods of no economic return or can use it with some economic returns by its inclusion in livestock diets. The most economical aspect is when the litter is ensiled on the farm.

**Potentials for the limitations on feeding litter utilization**

The utilization of litter in animal nutrition provides a profitable means of litter disposal while livestock farmers are afforded an attractive, inexpensive feed with a value equivalent to grains. The uric acid in the litter is best utilized by ruminants since it is less soluble than urea in water. However, utilization of poultry litter as a feed component for ruminants has been satisfactory when the litter was fed between 20 and 60 per cent levels in the ration of growing cattle (Fontenot *et al.*, 1966; Belewu, 1992). The litter can be used to formulate moderate protein and energy diets which can be used as supplements to the poor roughage diets available during the dry season of the year.

The presence of unidentified growth factor in the litter is well documented (Halbrook, Winter & Surton, 1951; Oluyemi & Robert, 1979). Chicks reared on built-up poultry litter grow more rapidly on an all vegetable diet deficient in animal protein factor (Kennard, Bethke & Chamberlino 1948). A complete ration utilizing broiler litter and cassava wastes can be formulated for ruminant in Nigeria (Belewu, 1992). Broiler - dairy cattle integration would need about 500 broilers kept on wood shavings. This number of broilers would supply 25-30 per cent of the total dry matter requirement and 70-90 per cent of the protein required by the cows. Cassava wastes complement the effect of the litter by supplying soluble carbohydrates and enhancing palatability, feed intake and maximum utilization of the non-protein nitrogen (NPN) fraction of the litter.

Problems in the utilization of litter can be viewed from the social, religious and economic acceptability of the litter as animal feed. There is paucity of information on the utilization of poultry litter as ruminant feed. Furthermore, there appears to be no practical application of its use in livestock diet in Nigeria. The socio-religious factors influencing the utilization of the litter are based on the health hazard of ingestion of medicants and antibiotics as well as several disease organisms that infect man and animals. The cost of recovery, processing, distribution and transportation of fresh animal waste or litter to the processing site and its return to the farm is also very expensive.

**Conclusion**

Despite the poor energy content and the presence of disease organisms and pests in the litter, its

significance as protein source in animal nutrition should be appreciated and its desirability as a replacement for the high cost conventional protein source is noteworthy. The processing of the litter to meet the microbial standards of Food and Drug Administration of Nigeria should be encouraged. The evidence in this paper, however, calls for the need to elucidate the role of the litter in the long-term feeding of ruminants in Nigeria.

REFERENCES

**Adegbola, T. A. & Obioba, F. C.** (1982) The intake and utilization of forage and concentrate of varying energy levels by sheep. *Afr. J. agric. Sci.* (**1&2**), 1-19.

**Adeleye, O. A.** (1991) Dried poultry droppings as a source of dietary nitrogen for sheep fed corn-cob based diet. *W. Afr. J. Bio. appl. Chem.* **136** (1-4), 19-23.

**Abdul-Izzeddin, F. & Bhattacharya, A. N.** (1969) Poultry litter as a feed for cattle and sheep in Lebanon. *Proc. Leb. Ass. Adv. Sci. (1st Sci. Meet.)*, pp. 10-12.

**Belewu, M. A.** (1992) *Evaluation of broiler litter and cassava waste as feeds for White Fulani cattle.* (Ph D Thesis). University of Ibadan, Nigeria.

**Belewu, M. A. & Adeneye, J. A.** (1996) Broiler litter as protein source for Bunaji (White Fulani) bull calves. *Nig. J. Anim. Prod.* **23** (1) (in press).

**Bhattacharya, A. N., Abdul-Izzeddin, F. & Schwulst, F. J.** (1971) Poultry litter as source of protein and energy for ruminant. *Proc. 1st Asian Congr. Nutr.*, pp. 815-817.

**Bhattacharya, A. N. & Fontenot, J. P.** (1966) Protein and energy value of peanut hull and wood shaving poultry litter. *J. Anim Sci.* **25**, 367-369.

**Bhattacharya, A. N. & Taylor, J. C.** (1975) Recycling animal waste as a feedstuff. A review. *J. Anim. Sci.* **41** (5), 1438-1457.

**Biester, H. E. & Schwarte, L. H.** (1959) Disease in poultry, 4th ed. Ames, IOWA State College Press.

**Bosma, S.W.** (1973) Chicken litter in fattening rations for cattle and sheep. *S. Afr. J. Anim. Sci.* **3**, 57-61.

**Calvert, C. C., Morgan, N. O. & Martin, R. D.** (1973) Seperator for negatively phototactic housefly larvae from chicken hen excreta. US Patent Office, Patented 13 Feb 73.

**Daniel, L. B., Smith, N. J., Stallcup, O. T. & Rakes, J. M.** (1983) Nutritive value of ensiled broiler litter for cattle. *Anim. Feed. Sci. Technol.* **8**, 19-34.

**Davis, C. L. & Brown, R. E.** (1970) *Low milk fat syndrome. Physiology of digestion and metabolism in the ruminant* (ed. A.T. Phillipeon), p. 545. Newcastle-upon Tyne, England, Ories Press Ltd.

**Drake, C. L., McClure, W. H. & Fontenot, J. P.** (1965) Effect of level and kind of broiler litter for fattening steers. *J. Anim. Sci.* **24**, 879 (Abstr).

**Ehoche, O. W.** (1996) The use of non-conventional feedstuffs in the diets of growing and fattening bulls: Poultry manure. *Report presented at the Inaugural Review and Planning Workshop on Nationally Coordinated Research Programme in Livestock held from 13-15 November, 1996 at NAERL,* Ahmadu Bello University, Zaria, Nigeria.

**El-Sabban, F. F., Long, T. A., Centry, R. F. & Frear, D. E. H.** (1969) The influence of various factors on poultry litter composition. *Proc. natl Symp. Mgmt Farm Anim. Waste*, pp. 340-346.

**FAO** (1980) *Feed from animal waste. State of knowledge*, vol. **18.** Rome, Food and Agricultural Organization.

**Fosgate, O. T. & Fabb, M. R.** (1972) Biodegradation of animal waste by *Lumbricus terrestris. J. Dairy Sci.* **55**, 870-872.

**Fontenot, J. P., Bhattacharya, A. N., Drake, C. L. & McClure, W. H.** (1966) Value of broiler litter as feed for ruminants. *Proc. natl Symp. Anim. Waste Mgmt. ASAE. Pub. SP-0366*, **103**.

**Goel, S. C. & Pradhan, K.** (1978) Use of wheat straw as a major dietary component of growing crossbred calves. *Ind. J. Dairy Sci.* **31**, 350-353.

**Halbrook, E. R., Winter, A. R. & Sutton, T. S.** (1951) The microflora of poultry house litter and droppings. *Poult. Sci.* **30**, 381-387.

**Harmon, B. W., Fontenot, J. P. & Webb, K. E. Jr.** (1972) Digestibility and palatability of ensiled broiler litter and corn. *J. Anim. Sci.* **35** (i), 265-387.

**Hart, S. A.** (1970) Pollution control activity - What it means to agriculture and farmers. *Am. Soc. agric. Eng.* Paper No. **PR 70-126.**

**Henning, A. & Poppe, S.** (1977) *Animal wastes as a feed.* Praha (Inczech), St. Zem. nakl.

**Jakhmola, R. C., Kundu, S. S., Punj. M. T., Kiran Singh, Kamra, D. N. & Rameshwar Singh** (1988) Animal excreta as ruminant feed. Scope and limitations under India conditions. *Anim. Feed Sci. Technol.* **19** (1&2), 1-23.

**Jeroch, H., Henning, A., Weber, E. & Helwig, W.** (1989) Feeding value of broiler deep litter. *Jahrb*

*Tierernahrung Futterung* 7, 457-465.

**Kennard, D. C., Bethke, R. H. & Chamberlin, V. D.** (1948) Built up floor litter as a source of dietary factors essential for hatchability of chicken eggs. *Poult. Sci.* **27**, 477-481.

**Kristensen, V. F., Andersen, P. E., Jensen, G. K., Pisker, A. N.** and **Birkkjaer, H. E.** (1976). Feeding value of dried poultry waste for dairy cows. *Faeliesud Valget for statens najeriog Husdyr. Brugsforsog.* **2** *Beretning Hillerod, Denmark.*

**Lovett, J.** (1972) Toxigenic fungi from poultry feed and litter. *Poult. Sci.* **51**, 308-313.

**Malik, S. & Bhattacharya, A. N.** (1971) Nitrogen and energy utilization from different kinds of poultry litter in sheep. *Proc. 10th inter Congr. Anim. Prod.* p. 250.

**Miller, B. F. & Shaw, J. H.** (1969) Digestion of poultry manure by diptera. *Poult. Sci.* **48**, 1844-1845 (Abstr.).

**Morris, W. H. M.** (1966) Economics of liquid manure disposal from confined livestock. *Proc. natl Symp. Anim. Waste Mgmt. Am. Soc. agric. Eng.* Pub. No. SP- 0366, p.126.

**Muftic, R., Bugarski, D., Varadin, M. & Dzinic, M.** (1974) The effect of broiler litter as the chief constituent of ration on the production and reproductional qualities of cows. *Veterinaria* **25**, 397-406 (In Serbo-Croatian).

**Muller, Z. & Drevjany, L.** (1967) Feeding and processing of deep litter for feeding purposes. *Res. Rep. Res. Inst. Biofactor Anim. Nutr.* **1967**, Prague (In Czech).

**Muller, Z., Drevjany, C. & Kozel, V.** (1968) Influences of different materials used for poultry deep litter upon gains and feed conversion and upon final deep litter value as feed for cattle. *3rd Eur. Poult. Confr. Jerusalem-Israel 8-13, Sep 69.*

**Muller, A. & Herold, M.** (1959) Biosynthetic activity of poultry litter with particular respect to protein and vitamins. *Res. Rep. Antibiotic Res.* Roztoky near Prague - Lab. of Antibiotics in Anim. Hom. Procernice (In Czech).

**Noland, P. R., Ford, B. F. & Ray, M. L.** (1955) The use of ground chicken litter as a source of nitrogen for gestating-lactating ewes and fattening steers. *J. Anim. Sci.* **14**, 860-865.

**Ojemuyiwa, G. T.** (1978) Dried poultry dropping in dairy cattle production rations (BSc Project). Department of Animal Science, University of Ibadan, Nigeria.

**Okorie, A. U., Obioha, F. C., Anyaehie, A. A. & Ahamefule, H. C.** (1981) Dried poultry waste versus groundnut cake as protein supplement for grazing West African dwarf goats and sheep. *Nig. J. Anim. Prod.* **8** (2), 148.

**Oluyemi, J. A. & Robert, F. A.** (1979) *Poultry production in warm wet, climate*, p. 113. London, Macmillan Press.

**Runkle, D. S. & Hatfield, E. E.** (1975) Chemically treated waste in steer rations. *J. Anim. Sci.* **41** (1), 416-420.

**Seltzer, W., Moum, S. G. & Goldhaft, T. M.** (1969) A method for the treatment of animal waste to control ammonia and other odour. *Poult. Sci.* **48**, 1912.

**Subrook, T. C., Sheppard, C. C., Boyd, J. S., Zindel, H. C. & Flegal, C. J.** (1971) *Drying poultry waste. Livestock waste.* ASAE, Michigan. **Apr. 19-22**, 192-194.

**Tagari, H., Levy, D., Holzer, Z. & Ilan, D.** (1976) Poultry litter for intensive beef production. *Anim. Prod.* **23**, 317-320.

**Vijchulata, P., Henry, P. R., Ammerman, C. P., Becker, H. N. & Palmer, A. Z.** (1980) Performance and tissue mineral composition of ruminants fed cage layer manure in combination with monensin. *J. Anim. Sci.* **50**, 48-56.

**Wyatt, R. D. & Greg, S.** (1977) New chemicals for feed mixes. In *Mould problems in poultry feed.* Cited by Ytzhak Degani (1980). *Poultry international*. March, 1980.