

## Poultry litter as a feedstuff for ruminants: A South African scene

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### Introduction

In South Africa the trading with poultry manure / litter as an animal feed is illegal, except if the specific product is registered as an animal feed according to Act 36 of 1947. All suppliers have to comply to this law. Furthermore, nutritional consultants are legally not permitted to recommend the feeding of unregistered litter. However, a farmer can feed poultry litter that is available on his farm or buy litter as a fertilizer and feed it to his livestock. This practice occurs primarily because litter is usually a relatively cheap non-protein nitrogen (NPN) source, and not because it has any superior nutritional qualities. It must be accepted that there are certain risks and problems associated with the feeding of unprocessed and unsterilized poultry manure/litter to livestock, though even the registered product is not well balanced nutritionally.

Feeding consultants are confronted with the situation that farmers would like to know how to feed the product safely to their animals. It has been the author's approach that even though an advisor cannot recommend the feeding of poultry litter, he should be able to give sound advice to the farmer who wants to feed the product. The advisor must therefore have an informed knowledge of the potential and problems of poultry litter as a feedstuff. This article was prompted by a resent communication by consultants in which recommendations were made on how to supplement broiler litter that is fed to ruminants. Unfortunately statements in this communication suggested that many advisors are not well-informed about the potential and problems when poultry litter is fed to farm animals. The purpose of this publication is neither to promote, nor to condemn the feeding of litter, but to serve as a guideline on the using of litter as a feed ingredient.

### Classification and properties of poultry litter

Poultry manure refers to pure excreta from layers in batteries and poultry litter to the mixture of excreta and bedding material obtained largely from broiler houses, but also from houses where pullets and layers are kept on deep litter systems. A small amount of feed spillage may be present in the material. In this discussion both products will be referred to as poultry litter in general.

Poultry litter is classified as a bulky protein supplement. The product is of an alkaline nature with a positive cation-anion balance, resulting in a high buffering capacity in the rumen of animals. The commercial value of poultry litter is based usually on its crude protein and ash content.

**Table 1** Specifications for poultry manure as animal feed according to Act 36 of 1947

	Broiler %	Layer %	Limits %
Moisture	12	12	(max)
(CP) Crude protein	24	22	(min)
CP from uric acid	60	60	(max)
Fat	1.5	1.5	(min)
Fibre	15	15	(max)
Ash	15	25	(max)
Feathers	1	1	(max)
Calcium	3.5	8	(max)
Phosphorus	1.5	2	(min)
Sodium	0.5	0.5	(max)
Silica	0.5	0.5	(max)
Copper (ppm)	50	50	(max)
<u>Pathogen-free</u>	20000 Microorganisms per gram		

Act 36 of 1947 states that no product originating from animals can be sold as an animal feed unless it has been registered as an animal feed. This requires that the product meets certain nutritional and hygienic standards. The standards as required for poultry excreta in South Africa are presented in Table 1.

### Uses of poultry litter

As early as 1960 an article on the feeding of poultry litter to beef cattle was published in the *Landbou Weekblad*. Since then unsterilised litter has been used extensively as a ruminant feed in South Africa. Several investigations were conducted and showed that the product can be fed successfully to cattle and sheep (Bishop *et al.*, 1971; Lyle *et al.*, 1975).

1. Winter supplement for ruminants:  
Cattle: 1.5 - 2.5 kg/head/day  
Sheep: 0.2 - 0.4 kg/head/day  
Because of the bulky nature of litter and its relatively low crude protein concentration (compared to NPN winter supplements), the product tends to replace (substitute) grass. Its value as a supplement as such is probably substantially less than what is anticipated for other NPN supplements.
2. Drought feed:  
Cattle: 4.5 - 6 kg/head/day or 1% body weight  
Sheep: 1 kg/head/day or 1 % body weight
3. Production ration:  
Beef production: 15 - 25% of ration  
Since poultry litter has a lower available energy value than grain, a reduction in performance can be expected, relative to the proportion of litter in the diet.
4. Ensiled:  
Inclusion rate up to 30% based on DM content of all products.
5. Dairy rations:  
The product should not be included in the diets of lactating dairy cows.  
Any drug present in litter could be secreted in the milk.

### Problems and risk factors

#### Nutritional problems

The approximate composition of litter is given in Table 2.

#### 1. Variation in composition

The wide variation in the composition of poultry litter (Table 2) complicates ration formulation with this product. Factors which can contribute to variation are: composition of diet of birds (*viz.* layer or broiler rations), type of bedding material (sawdust, bagasse, hay, straw, newspaper, hulls); litter processing and management; number of birds and duration of birds on bedding material. It is advisable to obtain the chemical composition, especially crude protein, before the product is used.

#### 2. Moisture content

Fresh manure from layers contains a relatively high level of moisture, up to 70%. Factors affecting moisture content are climate, ventilation in houses, diet of birds and condition of storage. The hot arid climate of South Africa causes litter to dry out fairly quickly.

**Table 2** Approximate composition of broiler litter on a dry basis

Nutrient	%
Moisture	10 – 24
Crude protein	10 - 26
True protein (% of CP)	40 - 60
Crude fibre	22 - 25
Ash	10 - 17
TDN	45 - 65
ME (MJ/kg)	6 - 7.3
Calcium	1.5 – 3.0
Phosphorus	1.2 - 1.8

### 3. Crude protein

Crude protein (nitrogen X 6.25) concentrations of up to and over 30% on a dry basis (DM) are reported for poultry litter in the USA. South African samples usually contain between 18 and 22% crude protein. The reasons for the difference are a higher proportion of bedding material in South African litter and higher ammonia losses during sun-drying than in the USA.

The crude protein in litter consists of both true protein nitrogen and NPN, with uric acid the main NPN component in poultry wastes. The proportion of true protein in litter varies between 40 and 60 % of the crude protein. Mavimbela (2000) measured approximately 50% true protein (based on amino acid analyses) in South African samples. The rumen degradability of the crude protein in Mavimbela's samples was between 72 and 86%. At high litter intakes, high concentrations of ammonia are found in the rumen and consequently high blood urea nitrogen concentration. Israeli workers observed liver damage in beef cows consuming poultry manure as their sole (100 %) overwintering diet (Silanikove & Tiomkin, 1992). They stated that the liver damage was caused by high ammonia concentrations in the rumen due to uric acid catabolism. This could not be substantiated by Mavimbela *et al.* (1997). American workers also suggested that the liver damage could have been due to a high copper concentration (not measured) in the Israeli litter.

It is often claimed that poultry litter causes reduced fertility in cows, because of the high ammonia release in the rumen. This seems unlikely if litter constitutes only a proportion (e.g. 25%) of the total diet of the cows.

### 4. Available energy

It is frequently stated that poultry litter is deficient in energy. However, with a digestible energy value of between 8.0 and 10 MJ kg DM and a TDN of approximately 60% its available energy value is comparable to that of a good quality hay. However, relative to the amount of crude protein, the available energy may be insufficient for the rumen microorganisms to utilise the nitrogen. This would be a problem at high litter intakes.

Where broiler litter was used as a survival ration under drought feeding conditions, a better response was obtained in the performance of sheep when the litter was mixed with 15% molasses than on a 100% litter diet (Mavimbela *et al.*, 1997). However, this seemed to be due to a higher feed intake rather than a better utilization of the ammonia.

### 5. Fibre

South African litter seems to contain more fibre and has on average larger particle sizes (higher effective fibre) than litter in the USA. The possible reason is that, in the USA five to six batches of broilers are kept on the same litter material before the house is cleaned, while in South Africa the houses are cleaned after each batch of birds.

### 6. Ash and mineral concentration

The ash concentration in litter is relatively high and tends to dilute the concentration of other nutrients in litter. Soil often contaminates the litter, usually when handled carelessly during loading with front-end loaders.

An abundance of most minerals is present in poultry excreta and it is an excellent source of minerals to the

animal. A survey of the concentration of minerals in South African samples was conducted by Van Ryssen *et al.* (1993) (Table 3). The minerals in litter seem to be readily available to the animal. The calcium and phosphorus concentrations in litter are well above the requirements of beef cattle and sheep. Ruffin & McCaskey (1990) indicated that, if brood cows are fed an 80% litter and 20% grain diet, they will consume five times more calcium, phosphorus and potassium than required. The problem typically associated with high dietary calcium concentrations is milk fever (parturient paresis), and has been observed in South Africa in beef cows consuming litter.

Copper toxicity in sheep was a problem when the sheep consumed broiler litter from broilers receiving copper sulphate as a growth promoter and/or anti-fungal agent (Van Ryssen *et al.*, 1977). From our latest survey (Table 3) it became obvious that copper sulphate is apparently not used in South Africa for these purposes anymore. The copper concentrations ranged within acceptable intake levels for sheep. From USA literature it seems as if copper sulphate is still used widely in broiler diet. Caution about excessive copper concentrations is not applicable to the South African situation.

High levels of some minerals were measured in this survey, especially those of iron and aluminium. Exceptionally high concentrations of some minerals were measured in this survey in manure from poultry kept outdoors on soil, the so-called free-range chicken, e.g. pure layer manure contained 1683 mg aluminium, 2271 mg iron, 9.2 mg chromium, 1.17 mg lead and 17.9 mg vanadium/kg dry matter, while pure manure from free ranging birds contained 9885 mg aluminium, 16762 mg iron, 51.6 mg chromium, 46.4 mg lead and 50.8 mg vanadium/kg DM.

**Table 3** Mean mineral concentration of broiler litter and pure layer manure in South Africa (DM basis) (Van Ryssen *et al.*, 1993)

Element	Broiler litter	Layer manure
Calcium %	2.53	8.81
Phosphorus %	1.46	2.31
Magnesium %	0.58	0.90
Sodium %	0.56	0.47
Potassium %	1.33	2.05
Aluminium mg/kg	834	1683
Copper mg/kg	43.6	45.9
Iron mg/kg	1335	2271
Zinc mg/kg	254	372
Manganese mg/kg	317	546
Cadmium mg/kg	0.32	0.50
Cobalt mg/kg	1.08	1.39
Chromium mg/kg	11.21	9.20
Arsenic mg/kg	4.92	2.48
Lead mg/kg	0.55	1.17
Vanadium mg/kg	30.1	10.1
Molybdenum mg/kg	1.46	10.37
Mercury mg/kg	0.49	1.71
Selenium mg/kg	0.57	0.13

(Van Ryssen *et al.*, 1993).

## 7. Vitamins

Poultry litter contains very low levels of the fat-soluble vitamins, A and E.

## 8. Ruminal compaction

In the USA diets containing high levels of litter were found to cause bloat in cattle. The physical nature of the product seems to be conducive to a lack of ruminal stimulation with a low saliva flow and a low voluntary intake. A standard recommendation in the USA is that long hay must be supplied when cattle are fed diets high in broiler litter (Fontenot, 1991; Ruffin & McCaskey, 1998). Mavimbela (2000) did not find a similar problem with sheep on a complete litter diet in South Africa. The average particle size of the litter used by Mavimbela (2000) was substantially higher than that of the litter used in the USA.

#### 9. Bulkiness and transport

Poultry litter is a bulky product. This makes the transportation of the product per unit nutrients expensive.

#### Supplementation to poultry litter

The main nutritional problem with poultry litter is its high rumen degradable protein content relative to its available energy content. The addition of an energy source such as maize meal or molasses would assist in microbial utilization of the ammonia in the rumen. If required, maize or molasses could be used to stimulate the intake of litter. In a drought feeding situation the addition of 15% molasses seems to be maximum because diarrhoea may become a problem at higher inclusion rates of molasses (Mavimbela, 2000). If litter is fed for extended periods it may be necessary to supplement vitamin A and E to the animals. There seems to be little need for any other substances to supplement poultry litter, except for salt if needed to control litter intake.

#### Carry-over of diseases

##### 1. Bacteria / pathogens

Probably the main risk of feeding unsterilized poultry litter to livestock is the problem of pathogens. *Salmonella* can be a problem in any product from animal origin. Since this pathogen is very susceptible to heat and dehydration (Wuethrich, 1978), its occurrence in dry litter should be minimal. The problem exists if litter contains a relatively high moisture content. When a producer insists on using unregistered poultry litter, the best advice is to use very dry litter, with a moisture content of less than 12 %.

However, the toxin from *Clostridia* causes botulism is a well-known problem in ruminants consuming poultry litter. The toxin is not destroyed by heat and will be present in dry and processed litter. Vaccination (preferably twice) against botulism is essential, though not 100% effective. A main source of *Clostridium* contamination is dead birds and therefore, dead birds must be removed from the poultry houses before they become decomposed.

##### 2. Fungi and toxins

Mycotoxins produced by *Aspergillus* species are the most likely to be a problem, particularly if damp litter is fed. In an investigation in KwaZulu-Natal, Westlake & Dutton (1985) recorded a presence of aflatoxins in poultry feed, litter samples and the livers of chickens. Get the litter dry as quickly as possible and keep the litter dry! Remove lumps from the litter. Lumps are usually the result of water contamination, e.g. near watering points, and ideal spots for mycotoxins to thrive.

##### 3. Parasites

Wuethrich (1978) pointed out that internal parasites are not transmitted from poultry to ruminants. Incidences of measles in feedlot cattle consuming litter have been reported in South Africa. This was apparently due to labourers on the poultry farm using the broiler houses as toilets.

#### Drugs and residues

##### 1. Antibiotics / medicinal drugs

In a number of states in the USA a withdrawal period of at 15 days is required before beef cattle may be slaughtered if the poultry litter came from birds that have been treated with drugs.

##### 2. Coccidiostats (Ionophores)

Deaths among cattle in South Africa due to the feeding of litter were traced back to the coccidiostat, maduramicin, in broiler diets (Fourie *et al.*, 1991). Even at low intakes this drug is very toxic to ruminants. This

drug is presently not widely used in the poultry industry in South Africa. Residues of other coccidiostats used in the poultry industry, did not cause a problem in ruminants consuming the manure (Van Ryssen, 1991).

### 3. Copper

It seems as if copper sulphate is no longer included in broiler diets in South Africa. Although the copper concentration in litter is still high relative to the requirements of the ruminant, the concentration of minerals antagonistic to copper metabolism, is also high in litter (Van Ryssen & Jagoe, 1981). Copper toxicity in sheep should therefore not be a problem nowadays (Van Ryssen *et al.* 1993).

### 4. Arsenic

Arsenic containing compounds are sometimes used in diets of young broilers, though according to our survey arsenic levels in litter were low (Van Ryssen *et al.* 1993). Calvert (1974) included 14% manure which contained 42 mg/kg arsenic in a sheep ration. He observed that most of the dietary arsenic was excreted by the sheep with minimal retention in the body.

### 5. Hormones

Infertility and abortions in cows are sometimes suspected to be due to the consumption of poultry litter. This is to a large extent unsubstantiated, except where the hens received an external hormone. In the USA cases of abortions in cows were traced to oestrogenic activity in litter used as a fertilizer. The oestrogenic activity originated from the hormonal treatment of hens, a drug no longer approved in the USA or elsewhere in the world (Fontenot & Jurubescu, 1980).

### 6. Pesticides

Insecticides are sometimes included in poultry diets to combat insects in manure. These products are usually safe to animals consuming the manure. Pesticides used directly on manure to control flies, would be a problem. Manure intended as an animal feed should preferably be processed before flies become a problem.

## **Processing of poultry waste**

Processing destroys pathogens, improves storage characteristics and maintains or improves palatability of poultry litter. A substantial amount of research is currently being conducted in the USA on the use of poultry litter as an animal feed, mainly on the processing of the product.

### 1. Sifting

The product must be sifted before feeding to remove foreign material, lumps and bird carcasses.

### 2. Dehydration

Mild heat treatment will destroy pathogens. Heat drying has been used, resulting in a product with good keeping qualities and low pathogen levels. However, it is expensive, the product is dusty and nitrogen losses occur (Fontenot, 1991). In South Africa, sun-drying of the product to contain less than 12 % moisture will ensure that most pathogens are destroyed.

### 3. Ensiling with other component or alone

Ensiling of poultry manure is reported by many as the most economical method of processing and utilizing the product. Because litter supplies mainly NPN, it is most valuable as an additive to cereal (high energy, low protein) silage, i.e. increasing its protein content. The inclusion rate is up to 30%, on a DM basis.

**Advantages:** The fermentation process in silage destroys pathogens within three weeks, improves palatability, removes smells and minimises nutritive losses.

**Problems:** Silage making is seasonal while the supply of manure is usually continuous. Silage making with the adding of broiler litter may be labour intensive. Fermentation characteristics of litter are the low level of fermentable sugars and a high buffering capacity due to ash and ammonia from uric acid. This can buffer the fermentation process in the formation of silage and delays the development of the required low pH.

It seems advisable to vaccinate livestock against botulism, even when the litter was used as an additive in the making of silage.

Ensiling alone:

This is successful if the product contains 35 to 40 % moisture, though the reaching a low pH is a problem.

#### 4. Deep stacking

Stacking broiler litter to a depth of 1.2 m proved to be an effective method of destroying all pathogens, mycotoxins and other harmful substances without a deterioration of nutritive value of the product. This process allows the product to go through a heating process for a period of two weeks or more. The temperature raises up to about 60 °C, depending on moisture content. This process is used in South Africa in the preparation of poultry litter for the use as a fertilizer.

#### 5. Composting

This process involves initial stacking and mixing to enhance aerobic fermentation. Loss of nitrogen may occur.

### **Ethical objections**

Public perception of the feeding of animal waste is usually negative. Even though their objections may be mostly subjective and emotional, they should not be ignored.

### **Conclusion**

It should be emphasized that THE FEEDING OF UNSTERILISED POULTRY EXCRETA TO FARM ANIMALS IS POTENTIALLY DANGEROUS. If farmers want to use the product it should be stressed that they should take precautions and must pay attention to the following:

- \* In general, it must be accepted that poultry litter is a fairly low quality feed which will reduce production at high inclusion rates in the diet.
- \* The source of the product - it is advisable not to feed just any litter available or on offer. Practices on the poultry farm such as the hygienic and general management must be evaluated.
- \* The drugs included in the feeds must be known, e.g. antibiotics and coccidiostats;
- \* Animals must always be vaccinated against botulism, even if the litter was processed.
- \* The degree of processing must be ascertained. The product should at least be sifted, e.g. to remove dead birds and lumps due to moisture.
- \* Proper storage of the product must be attended to, especially to avoid an increase in moisture content and the loss of nitrogen as ammonia.
- \* Special attention should be paid to the moisture level in the litter - the drier the better. The feeding of wet and damp litter must be avoided. This is especially important because of the risks of contamination with *Salmonella* and aflatoxins.
- \* Feeding should be done at recommended levels.
- \* It is advisable to obtain the services of a competent advisor to assist in the planning of the feeding of the product.
- \* It is advisable to have at least a crude protein analysis done on the litter.
- \* If nothing is known about the product, it is recommended that a withdrawal period of 14 days be observed before animals are slaughtered (Wuethrich, 1978; Cronjé, 1983).

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