THE USE OF POULTRY WASTE AS A DIETARY SUPPLEMENT FOR RUMINANTS

H.M. SALEH, K.M. ELWAN, H.A. EL-FOULY, I.I. IBRAHIM
Radioisotopes Application Division,
Atomic Energy Authority

A.M. SALAMA, M.A. ELASHRY
Faculty of Agriculture,
Ain Shams University

Cairo, Egypt

Abstract

THE USE OF POULTRY WASTE AS A DIETARY SUPPLIEMENT FOR RUMINANTS.

The use of poultry waste as a dietary supplement in ruminant ration could have a considerable effect on reducing costs, insufficiency of protein in diet, and on solving disposal problems. The chemical composition of poultry waste and its safe use in ruminant nutrition were investigated prior to its use as a dietary supplement. No appreciable differences in chemical composition were noted in poultry wastes between oven and sun dried forms. The high content of protein, energy, and minerals in poultry waste indicated its importance as a partial substitute for concentrates in the diet. The numbers of total bacteria and pathogenic microorganisms such as *Salmonella* and *E. coli* detected in poultry waste were within the acceptable limits. Farm testing of rations containing poultry wastes were carried out on sheep (ewes and lambs), Friesian cattle and buffalo heifers. In ewes fed during late pregnancy and lactation, milk yield and performance did not show any significant changes. Lambs suckled from ewes fed on poultry waste did not show any significant difference in weaning weight, average daily weight gain or feed efficiency (kg feed used/kg weaned weight). However, the poultry waste group had shorter age at weaning than the control group. In another feeding trial on growing lambs after weaning, mean daily body weight gain was higher in lambs fed on a ration containing poultry waste than the control ration. In Friesian and buffalo calves, no significant differences in average daily body weight gain were found as a result of inclusion of poultry waste in the ration. In buffalo heifers various estimated reproductive parameters indicated no appreciable differences due to the inclusion of poultry waste in the diet except that the number of ovulations and number of services/conception were both higher in the group fed with poultry waste.

1. INTRODUCTION

The productivity of livestock in terms of milk yield or the annual red meat off-take from an animal unit in Africa including Egypt is considerably low, when compared to other developed countries. Poor nutrition, both in quantity and quality and poor reproductive performance are recognized as major factors limiting animal production. In general the animal feed base in Egypt is insufficient, especially in feed ingredients of high protein content.

There are about 2.5 million heads of cattle, 3.1 million buffaloes, 3.5 million sheep, 2.8 million goats and 144 thousand heads of camels that are mainly fed on berseem during winter. However, summer feeding depends mainly on a variety of poor quality field crop residues, which are nutritionally imbalanced and do not cover the requirements of the animal either in protein or in energy. In addition cottonseed meal, which is the main source of protein in concentrate feed mixtures in the country, is in short supply. Improved feeding systems based on supplementation of locally available feed resources will enhance milk and meat production at a considerably low cost and partially fill the gap in protein and energy shortages.

The approach in the use of poultry waste as a constituent in ruminant rations was motivated by the shift of the poultry industry from extensive to intensive system of production. This lead to a significant increase in the production of poultry wastes (PW). The amount of collectable poultry waste was found to be 750 000 tons/year during the last five years. The poultry waste is rich in protein (about 25% protein equivalent), Total Digestible Nutrients (TDN) (about 50%) as well as minerals.

Although poultry waste is mainly used as a fertilizer, it has been shown to be a potential source of both nitrogen and energy for ruminants in providing low-cost feed components [1, 2]. The use of poultry waste in feeding ruminant livestock decreases the cost of feeding and also minimizes the effects of its contribution to environmental pollution in areas of intensive poultry production. More importantly, it solves partially the shortage of the animals' requirements of protein and/or energy during the dry season. Chemical composition and nutritive value of poultry waste has been studied by a number of workers [3–7], indicating its potential use as an inexpensive nitrogen, energy and mineral supplement.

The present paper reports some experiments on the utilization of poultry waste in ruminant rations and its effects on productive and reproductive traits. The paper also attempts to identify possible problems, which may be associated with its inclusion in rations.

2. MATERIALS AND METHODS

2.1. Collection of poultry waste

Poultry waste was collected from at least 10 farms in each of the following three locations: i) Cairo and Kalubeia governorates, ii) Sakha and adjacent cities and Kafr El-Shikh governorate and iii) Giza governorate.

Samples from each location were subjected to sun drying for at least 2 weeks or oven drying at 75°C for 48 h in specialized laboratories.

2.2. Nutritive quality of poultry waste

The chemical composition [8], mineral content and pathogenic microorganisms [9] of poultry waste were determined in the following laboratories: i) Faculty of Agriculture laboratory, Ain Shams University, ii) Sakha Agriculture Experiment Station laboratory, Animal Production Institute, Ministry of Agriculture and iii) Agriculture Experiment Station laboratory, Radioisotope Applications Division, Egyptian Atomic Energy Authority, Cairo. The extraction as well as the determination of aflatoxins [10] using high performance liquid chromatography [11], were carried out at the Agriculture Experiment station, AEA.

Based on dryness and tests for pathogenic microorganisms, sun dried poultry waste was considered most suitable for use in the feeding trials.

2.3. Feeding trials

2.3.1. With sheep

An on-farm feeding trial was carried out at Sharkia province where a diet containing 14% poultry waste was compared with a control diet without poultry waste (Table I). Barki ewes, six per treatment, were fed the two diets ad libitum during the last 3 weeks of gestation and up to 12 weeks after lambing. All animals had access to drinking water at all times.

The milk yield of ewes fed on the two rations was recorded. The lambs were weighed before and after suckling at 9.0 and 16 h and milk consumption by lambs was calculated by difference. Body weight of lambs was recorded weekly from birth to weaning.

2.3.2. With male lambs

Twelve male Rahmani lambs were assigned to two groups. The treatment group was fed with a diet containing 17% poultry waste (PW) and the control group without PW (Table II). From the first day of the feeding, lambs were examined twice weekly for libido, separation of penis from the prepuce, erection and ejaculation.

TABLE I. COMPOSITION OF EXPERIMENTAL DIETS (ON DM BASIS) GIVEN TO SHEEP

Ingredient (%)	Control Diet	PW Diet
Crushed yellow corn	74	66.5
Cotton seed meal	15	11
Poultry waste (PW)	-	14
Soybean meal	5	3.5
Wheat Bran	5	4
NaCl	0.5	0.5
Mineral mixture	0.5	0.5
Total	100	100
Chemical composition (on DM basis)		
Organic matter (OM)%, on DM basis	96.5	93.8
Ash	3.5	6.2
Crude protein (CP)	14.2	14.1
Ether extract (EE)	3.9	2.9
Crude Fiber (CF)	9.9	10.2
Nitrogen free extract (NFE)	68.5	66.6

TABLE II. COMPOSITION OF DIETS (ON DM BASIS) USED IN THE FEEDING TRIAL WITH MALE LAMBS

Ingredient (%)	Control Diet	PW Diet
Yellow corn	10	24
Poultry waste (PW)	0	17
Concentrate feed mixture (CFM)	70	39
Berseem hay	20	20
Total	100	100
Calculated chemical composition (%, on DM basis)		
Ash	8.8	9.5
Crude protein (CP)	18.6	18.8
Ether extract (EE)	2.6	2.4
Crude fiber (CF)	15.3	14.4
Nitrogen free extract (NFE)	54.7	54.9

2.3.3. With Friesian calves

An on-farm trial was conducted at Kafr-El Sheikh governorate using growing Friesian calves. The average daily weight gain was determined after 240 days of feeding with a ration containing either 10 or 20% PW.

2.3.4. With buffaloes

Experiments carried out at Milk Replacer Research Center, Faculty of Agriculture, Ain Shams University focused on some reproductive traits of buffalo heifers. Radioimmunoassay of milk/plasma was used to determine the progesterone concentration for detecting non-pregnancy and ovulation, amongst other reproductive parameters.

A feeding trial on buffalo calves to determine the effect of PW as a dietary supplement on average daily gain, was carried out in a farm in Sharkia province.

2.3.5. Acceptance by end users of poultry waste in their animal feeding system

Sarkia governorate, 100 km from Cairo, was chosen for assessing the acceptance by farmers of PW as a dietary supplement in ruminant rations. The farmers were classified into three categories based on their ownership of cattle and/or buffaloes. They were requested to respond to a questionnaire.

3. RESULTS

3.1. Chemical composition and mineral content of poultry waste (PW)

The average chemical composition and the mineral content of sun dried samples of PW collected from the three locations is given in Tables III and IV. The crude protein equivalent was similar and ranged from 19–23%. However, the ash content was relatively high in samples from location 1 (Table III).

3.2. Pathogenic microorganisms and aflatoxin concentration

The total bacterial count (CFU/g) of sun dried PW was 174.6×10^4 while that of the oven dried PW was 508.9×10^4. Salmonella and E.coli were not detected in both sun dried and oven dried PW.

Aflatoxin G_1 was found in both sun and oven dried PW (109.5 and 132.3 ng/g, respectively) while B_1, B_2 and G_2 were not detectable.

TABLE III. CHEMICAL COMPOSITION OF POULTRY WASTE USED IN THE FEEDING TRIALS

Location	DM (%)	OM	CP	EE	CF	NFE	Ash
				(% IN DM)			
1	90.5	41.3	19.4	1.2	8.1	42.6	28.7
2	94.5	81.0	20.2	3.3	12.7	45.0	19.0
3	88.0	85.4	23.0	-	-	-	14.6

Locations: 1. Faculty of Agriculture, Ain Shams University.
2. Sakha Agriculture Experiment Station, Animal Production Institute, Ministry of Agriculture.
3. Agriculture Experiment Station, Radioisotope Application Division, Atomic Energy Authority.

TABLE IV. THE MINERAL CONTENT OF POULTRY WASTE

Location	1	2	3
Percentage			
P	na	2.11	1.93
Ca	na	3.1	6.5
Na	na	0.44	0
K	na	2.08	1.78
Mg	na	0.52	0.44
Zn ppm	na	158.2	338
Cu PPM	27.05	38.8	123
Fe PPM	na	1422	na
Mn PPM	na	158	na
Pb PPM	10.7	7.7	na
Cd PPM	0.15	0.97	na
Cr PPM	na	0.93	na
As PPM	308.2	na	na

Locations: 1. Faculty of Agriculture, Ain Shams University.
2. Sakha Agriculture Experiment Station, Animal Production Institute, Ministry of Agriculture.
3. Agriculture Experiment Station, Radioisotope Application Division, Atomic Energy Authority.
na — data not available.

3.3. Feeding Trials

3.3.1. With Sheep

Milk production in ewes and the productive performance of suckled lambs are presented in Table V. There was no significant difference between the diets in terms of milk production and feed conversion efficiency in lactating ewes, and age at weaning and average daily body weight gain in the suckled lambs.

3.3.2. With male lambs

The age and weight at puberty and mean daily gain of male lambs fed a diet containing 17% PW is given in Table VI. There was no significant difference between the two diets in relation to age at weaning and weight at weaning. The average daily body weight gain was higher in the PW supplemented group as compared to the non-supplemented group, though this difference was not statistically significant ($P < 0.05$).

3.3.3. With buffalo and Friesian calves

Both buffalo and Friesian calves supplemented with diets containing PW showed similar daily body weight gain as compared to the control ration without PW, indicating its the supplementary feeding value (Table VII). Similarly, PW supplementation had no significant influence on reproductive parameters, including the plasma progesterone profiles, of buffalo heifers as compared to the control diet (Table VIII).

3.3.3. Acceptance of poultry waste by farmers

Of the 30 smallholder farmers interviewed none used PW as a feed supplement. Only 20–30% of the medium (4–10 animals) and large-scale (over 10 animals) farmers used PW as a feed supplement. However, they all used it as a fertilizer for crop production.

TABLE V. EFFECT OF DIET CONTAINING POULTRY WASTE (PW) ON DRY MATTER INTAKE (DMI) AND MILK PRODUCTION IN EWES AND PERFORMANCE OF SUCKLED LAMBS

Parameter	Control	PW Diet
Percentage of PW	0	14
DMI		
g per head/day	1346.90	1369.77
g/kg LW/day	31.38	30.90
g/unit MBS	80.32	79.73
Milk production		
g per head/day	660.37	740.58
g/kg LW/day	15.39	16.71
g/unit MBS	39.38	43.11
Feed efficiency		
kg DMI/kg milk yield	2.04	1.85
Performance of lambs		
Birth Weight (kg)	3.84	3.80
Weaning Weight (kg)	20.58	20.18
Age at Weaning (days)	87.7	79.9
Average daily gain (g)	191	206
No. of kg weaned/kg LW of ewe	0.48	0.53
No. of kg feed/kg weaned weight	5.73	4.65
Mortality	0	0

DMI = dry matter intake; LW = live weight; MBS = Metabolic Body Size

TABLE VI. AGE, WEIGHT AT PUBERTY AND DAILY BODY WEIGHT GAIN OF MALE LAMBS FED A RATION CONTAINING POULTRY WASTE (PW)

Item	Experimental diets	
	Control diet	PW diet
Percentage of PW	0	17
Number of days on feeding trial	224	224
Age at puberty (days)	311.5	286.0
Weight at puberty (kg)	36.4	40.9
Mean daily gain (g)	129.4	164.7

TABLE VII. AVERAGE DAILY BODY WEIGHT GAIN OF FRIESIAN AND BUFFALO CALVES FED DIETS CONTAINING POULTRY WASTE (PW) FOR 240 DAYS

	Level of PW	Initial weight (kg)	Final weight (kg)	Daily weight gain (g/day)
Friesian	0	180	381.7	840
Calves	10.1	179.5	375	815
	20.5	179	379.8	837
Buffalo	0	110	215	438
Calves	15	89	182	388

TABLE VIII. REPRODUCTIVE PERFORMANCE OF BUFFALO HEIFERS ON A SUPPLEMENTARY DIET CONTAINING POULTRY WASTE (PW)

Parameter	Control Group	PW Group
No. of ovulations/conception	3.25 ± 0.9	3.25 ± 1.0
No. of 'silent' ovulations/conception	2.00 ± 0.7	1.50 ± 0.8
No. of ovulations associated with heat/conception	1.25 ± 0.2	1.75 ± 0.3
No. of services/conception	1.25 ± 0.2	1.50 ± 0.2
Age at first ovulation (months)	17.2 ± 0.3	17.7 ± 0.4
Weight at first ovulation (kg)	316.0 ± 10.8	330.3 ± 33.8
Age at fertile service (month)	18.6 ± 0.8	19.1 ± 0.5
Weight at fertile service (kg)	340.0 ± 16.0	351.0 ± 12.0
Age of heifers at 1st calving (month)	28.8 ± 0.7	29.3 ± 0.5
Weight of heifers at calving (month)	501.2 ± 16.0	484.6 ± 23.6

4. DISCUSSION

The marginal differences in the nutrient content of poultry waste between the three locations (Tables III and IV) could be attributed to the difference in the type of bedding, degree of contamination between the excreta and the bedding, the type of rations used, method of handling and method of processing and storage of excreta [12].

In relation to the safety aspects of using poultry waste in ruminant diets, the results obtained indicated that sun-dried waste was better than oven dried waste. The total bacterial count was considerably lower in sun dried poultry waste compared to the oven dried waste. This was possibly due to the action of ultra violet rays of the sun affecting the microorganisms. *Salmonella* and *E. coli* were both absent in sun and oven dried wastes. The survival of microorganisms in dietary ingredients varies widely with its moisture content. The higher the moisture content the higher would be the bacterial count. The decrease in viable bacterial cell count noted in dried PW may also be due to a reduction in the moisture content [5].

Aflatoxins were not detectable in the concentrate mixture that contained crushed yellow corn. It has been reported by Jones et al [16] that mixing with poultry waste would destroy aflatoxins in contaminated corn. Therefore, it is apparent that even if aflatoxins were present in the crushed yellow corn it would have been destroyed by the PW.

Both feed intake and milk production in ewes (Table V) was not affected by the inclusion of 14% PW as a dietary supplement. This is a clear indication that cottonseed meal and other high protein feed ingredients could be, at least partially replaced, by PW without any loss in productivity. Part replacement (up to 14%) had no effect on feed efficiency, similar to results obtained with buffaloes [17].

The weight and age at puberty of lambs fed a ration containing 17% PW was similar to those given a control ration without any PW (Table VI). Similarly, PW up to 20% in the diet had no detrimental effect on growth in cattle and buffaloes (Table VII) and on the reproductive performance in buffalo heifers (Table VIII).

The fact that none of the smallholder farmers used PW as an animal feed may be mainly due to its use as a fertilizer in crop production. It may also be due to lack of space for sun drying (over 2 weeks) and a lack of appreciation of its nutritive value as an animal feed.

5. CONCLUSIONS

The establishment of demonstration farms, organising farm visits and setting up discussion groups may be the most effective way of demonstrating to smallholder farmers the beneficial effects of poultry waste as a supplementary feed for ruminant livestock. These should be followed by training of livestock farmers and agriculture extension personnel, in the preparation and proper use of poultry waste in ration formulation. The collection of poultry wastes at different locations and subjecting them to suitable treatment also need to be accomplished.

The economical aspects in the use of poultry waste as a dietary supplement in ruminant rations in Egypt may be viewed as follows. The inclusion of 15% poultry waste would cost 24 Egyptian ponds. It would save the cost of 15% of concentrate in the feed mixture, amounting to 75 Egyptian pounds. The difference per ton will be about 51 Egyptian pounds. In other words, poultry waste mixed concentrate feed will cost about 10% less than the cost of a ton of concentrate feed presently available in the market.

REFERENCES

[1] KHATTAB, H.M., EL-ASHRY, M.A., EL-SERAFY, A.M., SOLIMAN, H.S., Wood shaving duck litter in ration for growing lambs, Agric. Wastes, **4** (1982) 25.

[2] SPOELSTRA, S.F., TJOONK, L., STEG, A., Ensiling and feeding mixtures of cage layers manure and whole crop maize to beef bulls, CEC Seminar on Feeding Value of By-products and their Use by Beef Cattle, Melle-Gontrode, Institute for Livestock Feeding and Nutrition Research (IVVO), The Netherlands (1983).

[3] POLIN, D., VARGBESE, S., NEFF, M., GOMEZ, M., FLEGAL, C.J., ZINDEL, H., The metabolize energy value of dried poultry waste, Res. Rep. No. 152, Michigan Agric. Expt. Sta., East Lansing 32 (1971).

[4] TINNIMIT, P.Y., MCGUFFY, K., THOMAS, J.W., Dried animal waste as a protein supplement for sheep, J. Anim. Sci. **35** (1972) 431.

[5] ABOU-ARAB, A.A.K., ABO EL-NOR, S.A., Evaluation of milk produced from lactating buffaloes fed diet containing dried broiler letter, J. Agric. Sci. Mansoura Univ., **18** (7) (1993) 2030.

[6] EL-ASHRY, M.A., KHATTAB, H.M., EL-SERAFY, A., SOLIMAN, H., ELMOULA, S.M., Nutritive value of Poultry Wastes for Sheep. Biological Wastes, **19** (1987) 287.

[7] EL-ASHRY, M.A., SALEH, H.M., EL-FOULY, H.A., AMIN, S.O., The effect of different levels of caged layer droppings in male lamb diets on growth performance and semen characteristics, Egypt. J. Nutri. and Feeds, **3** (1) (2000) 1.

[8] A.O.A.C. Official Methods of Analysis (13th Ed.). Association of Official Analytical Chemists, Washington DC (1980).

[9] Oxoid Manual. The oxoid of culture media, ingredients and other laboratory services, England. 4th Ed (1979).

[10] A.O.A.C. Official Methods of analysis (16th Ed). Association of official analytical chemists. Washington DC MSA (1996).

[11] GUYON, F., CAUDE, M., ROSSET, R., Determination of aflatoxins by liquid column chromatography, spectrophotometer and spectrofluorometric detection, Rev. Fr. Corps gras. **26** (1979) 217.

[12] ADRIANO, D.C. PRATT, P.E., BISHOP, S.E., Fate of inorganic forms of N and salt from land disposed manure from dairies, ASAE Proc., 271 (1971) 243.

[13] FONTENOT, J.P., JURUBESCU, V., "Processing of animal waste by feeding to ruminants", Digestive Physiology And Metabolism In Ruminants, (Y. RUCHEBUSCH, B. P. THIVEND, Ed.), Avl Publishing Co., USA (1980).
[14] CHAUBAN, T.R., Comparative feeding value of urea/dried poultry excreta supplemented sugarcane tops silage to Buffaloes, Indian J. Dairy Sci. **47** (1994) 11.
[15] ABDELMOWLA, S.M., FOUAD, A., SALEM, D.A., WLAT, M., EL-KERDA, W. Y., SABRY H.H., Yucca shidigera Extract and Yeast in sheep rations, Egypt. J. Appl. Sci. **12** (11)(1997) 1997.
[16] JONES, F.T., WINELAND, M.J., PRASONS. J.T., HANGLER, J.R., Degradation of aflotoxin by poultry litter, Poultry Sci. **75** (1996) 52.
[17] EL-ASHRY, M.A. EL-BASIONY, A.Z. HAMDY, S.M., FOUAD, F.A., Sun dried broiler litter in lactating dairy buffalo rations, Egypt. J. Anim. Prod. **31** (2) (1994) 189.