RESPONSE OF LAYING HENS TO DIETARY LEVELS OF SHEEP MANURE.

BY

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DECLARATION

I hereby declare the originality of this piece of work which was carried out by me in the Faculty of Agriculture, Ahmadu Bello University, Zaria; under the supervision of Prof. S.O. Ogundipe.

The work of other investigators is specifically acknowledged by means of references. No part of this thesis has been previously submitted for a degree or diploma.

Signed ---------------------------
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Date - November, 1997

Ahmadu Bello University, Zaria

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CERTIFICATION

This Thesis entitled **"Response of laying hens to dietary levels of sheep manure"** by Francis O. Abeke meets the regulations governing the award of Master of Science of the Ahmadu Bello University, Zaria. It is approved for its literary presentation and contribution to scientific knowledge.

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DEDICATION

With Love and deep sense of appreciation I dedicate this work to the Almighty God who was, who is and who is to come.

and

To my beloved Cousin - Kate and my future family.

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ABSTRACT

Three hundred and thirty-six (336) laying hens of a commercial strain were used in two experiments designed to investigate the effects of dietary levels of heat treated sheep manure (H.SM) or sun-dried sheep manure(S.SM) on the performance of laying hens and on egg yolk pigmentation

In experiment 1, point of lay birds were fed diets with 0.0, 7.5, 15.0, 22.5, 30.0 or 37.5% H.SM while in experiment 2. laying hens were fed diets with 0,1,2,3,4 or 5% S.SM.

The chemical compositions of both H.SM and S.SM were determined. H.SM was found to contain 86.95% dry matter, 16.88% crude protein, 24.42% crude fibre, 2.95% ether extract, 26.3% Ash, 1.32% calcium and 0.5% Phosphorous while S.SM was found to contain 83.96% dry matter, 19.06% crude protein, 27.07% crude fibre, 3.77% ether extract, 20.81% Ash, 0.96% calcium and 0.48% phosphorus. The metabolizable energy (ME) for heat-treated sheep manure was found to be 1088 kcal/kg.

Increase in dietary levels of heat treated SM caused a significant ($P<0.05$) increase in feed intake, feed cost per ten eggs produced and Roche Yolk Colour Score (RYCF) but lowered the efficiency of feed conversion, hen-day egg production, hen-housed egg production and percent change in body weight.

The results obtained also revealed that RYCF scores were significantly, ($P< 0.05$) higher with increase in the dietary levels of S.SM but other parameters such as feed intake, feed efficiency, egg weight, feed cost and percent hen-day egg production were not significantly ($P > 0.05$) affected by dietary levels of S.SM.

It is concluded that laying hens could tolerate 7.5% dietary level of heat treated sheep manure with no adverse effect on egg production, feed efficiency and feed cost per 10 eggs. This level of H.SM also produce a satisfactory degree of egg yolk pigmentation (RYCF score of 4) for the table egg. For the S.Sm 2% dietary level was observed to be adequate for producing satisfactory degree of egg yolk pigmentation for table eggs.

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INTRODUCTION

In a world where malnutrition and starvation stare the entire human race on the face, it is amazing to note that there exists much wastage of agro-industrial by-products which could be utilized for increased food production especially the animal protein foods. In cases where such by-products are utilized, they are inappropriately or grossly under utilized.

The protein intake levels of most developing countries including Nigeria is very low due to the high cost of the product. Various efforts are being made by the animal scientists in the area of nutrition research to increase the level of animal protein intake of the populace. Despite these efforts the poultry industry is almost being crippled because of high costs of feeds. It is imperative therefore to look inwards for alternatives and cheaper sources of feed ingredients if progress is to be made in the poultry industry. It is this process that has brought into focus the need to provide more information on the nutritive value of this seemingly useless but protein-rich animal egesta for poultry feeding.

The ever increasing cost of poultry feed is threatening the survival of many poultry farms today. As much as 70% of the total cost of producing poultry meat and eggs is due to feeds (Cunha 1977). The costs of the conventional feed ingredients has continued to increase without checks. In the past, importation had helped to meet the shortfalls to keep the prices low. Today however, the present economic crises has necessitated the conservation of scarce foreign exchange. Nutritionists therefore have to explore other areas hitherto neglected if the poultry industry has to survive.

Dependence on alternative source of ingredients, especially when it encourages a shift to other ingredients for which there is no competition by humans will be of great help for the poultry industry.

Primarily, the dietary requirements of poultry parallel those of humans with a resultant competition for the already scarce conventional feed resources. Man's interest being over-riding. Fadugba (1989) opined that where the amount of food available to the human is limited, it would be morally wrong to use acceptable human foods for feeding animals. It then becomes imperative that other sources have to be assessed for rapid livestock output to meet the growing human demand for animal protein foods. These should be cheap and nutritionally adequate for feeding animals with the aim of lowering the cost of producing edible meat and eggs. (Olomu 1976; Olomu and Offiong 1983).

Fortunately, Nigeria is blessed with many livestock and the manure which are often obtained in large quantities have some potential in poultry nutrition. In recent years, the use of animal manure for the feeding of livestock has generated considerable interest due to the fact that the conventional sources of feed can no longer adequately supply the needs of the fast growing livestock and poultry industries. This study was therefore designed to determine the nutritive value of heat-treated sheep manure for laying hens and the optimal level of sun-dried sheep manure that will produce a satisfactory degree of egg yolk pigmentation.

LITERATURE REVIEW

COMPOSITION OF ANIMAL MANURE (ANIMAL WASTE)

The typical animal wastes according to Philip and Dorothy (1968) and Church (1969) is made up of the following:

(1) Food residues, that is those portions of the food which either escape or are incapable of being digested and absorbed.

(2) The remains of the intestinal and digestive secretions not destroyed or reabsorbed e.g residues of gastric juices, bile, pancreatic and enteric juices.

(3) Substances excreted into the intestinal tract, notably phosphates and other salts of calcium, iron and other metals.

(4) The bacterial flora of the intestinal tract and their metabolic end products.

(5) Cellular debris from the mucosa of the gut.

(6) Excretory products excreted into the gut.

(7) Metabolites of micro organisms that grow in the large intestine with possibly, some coming from the fore-stomach in the case of ruminants.

(8) Cellular elements to which may be added under pathological conditions, blood, pus, mucus, serum and parasites.

(9) Abnormally, enteroliths, gall stones and pancreatic calculi.

The percentage of fecal material contributed by any one of these sources has not been determined in ruminants. Church (1969) reviewed some older publications on this topic and noted that fecal materials from ruminant species is primarily a mass of bacterial cells and that practically all of the nitrogen of faeces from cows fed purified diets is microbial protein. This author based his estimate on the content of diaminopimelic acid and estimated digestibility of rumen micro-organisms. Perhaps a substantial amount of this might be derived from cellular debris sloughed from the lining of the intestine and metabolized by the micro-organisms.

Church (1969) also reported that a 350 kg dairy cow might slough about 2,500 g of cells from the gut wall daily. This quantity, the author said, represents about 500g of digestible protein. Presumably, a substantial portion of this debris would be digested and absorbed in the small intestine, but such debris from the large intestine would probably not be reabsorbed even if hydrolysed by enteric enzymes or micro organisms.

Relative complete analyses of the faeces of ruminant species are not as readily available in the literature as one might expect although there are a great deal of data on digestibility in the literature. An example of some of the available data on faeces from three ruminant species is shown in table 1.0. The data show that a substantial part of faeces from ruminants consuming forage or forage-concentrate mixtures is made up of the fibrous parts of the plants, primarily the cell wall components - lignin, cellulose, hemicellulose and nitrogen-free-extracts (which may be largely hemicellulose and lignin according to Church, (1969). The mineral elements (ash) may also make up a substantial percentage of the total.

Whether there is any real difference between species in the composition of dry matter excreted is questionable. The data shown do not allow a critical comparison because of the differences in analytical methods and in feed stuffs fed. There will usually be a difference in the water content of faeces between sheep and cattle fed comparable rations. As a general rule, faeces from sheep have 55 and 70 percent water and that from cattle from 70 to 90 percent depending upon the diet. Those species which form fecal pellets are able to remove more water from faeces so as to conserve it for other functions (Church, 1969).

Table 1.0: Percentage composition of faeces from different ruminant species (dry basis).

ANIMAL -	Sheep	Sheep	Sheep	Calves	Calves
FEED SOURCE -	pasture forage	Alfalfa hay	Alfalfa pellets	Semi-synth diet	Alfalfa hay:conc 1:1 ratio
CONSTITUENTS					
Water Content	50-69		54-64	80-82	76-79
crude Protein	10-16	11-25	9-10	37-58	13-19
Crude fat	7-10			34	3-6
Crude fibre	21-29		41-49		32-44
N F E	26-36				28-46
Ash	8-11	15-25	16-19	13-31	4-8
Water extractives		8-16			
Alcohol-Benzene extracts		7-13			
Hemicellulose		14-18			
Cellulose		12-26	30-31		
Lignin		16-20		Trace	
Soluble CHO		16-19			
Undetermined					
Energy Kcal/g	3.92-4.46		4.18-4.31		

Source: Adapted from Church, D.C. (1969)

Several other reviews have been published on the nutritive value of animal wastes and potentials for using processed wastes in livestock feeds. According to Paul (1977), livestock wastes contain many of the same classes of chemical compounds found in feeds. Chemicals analysis of sundried and heat-treated sheep manure (H.SM) carried out by Ogundipe et al (1992) reveals that sheep manure contains a lot of nutrients required by the chicken. The report reveals that chemical composition of the two types of sheep manure (S.M) were similar for most of the nutrients except for percent ash and percent calcium. These values were higher for the heated S.M than for the sun-dried S.M. The values were 26.36 and 20.81 percent ash and 0.95 and 0.66 percent calcium for heated and sun-dried S.M samples respectively. The analyses also reveal that percent crude protein and ether extract were also slightly lower for the heated sample than for the sun-dried sample. Average chemical compositions were dry matter 89.02%, crude protein 18.7%, crude fibre 26.52%, ether extract 1.78%, Ash 23.59% calcium 0.81% and total phosphorus 0.45%. The metabolisable energy value was 1076 Kcal/kg.

Although the metabolizable energy of sheep manure is low as observed by the authors, it is nevertheless characteristics of ruminant manure. The M.E. falls within the range of 1000 to 1300 ME.Kcal/kg often reported for rice offal which has received some degree of acceptance by feed millers for poultry ration formulation. This factor according to the authors together with the fairly high content of crude protein can make sheep manure a partial substitute for the more expensive oil seed cakes such as the groundnut and soya bean cakes.

Some form of processing of the waste for refeeding is desirable to make the nutrient more available, to control odour, insects and disease problems. Refeeding processed wastes also helps to reduce the amount of those more expensive feed ingredients required in the formulation of poultry diets

Figure 1.0 explains the potential for reducing problem of waste handling by recycling

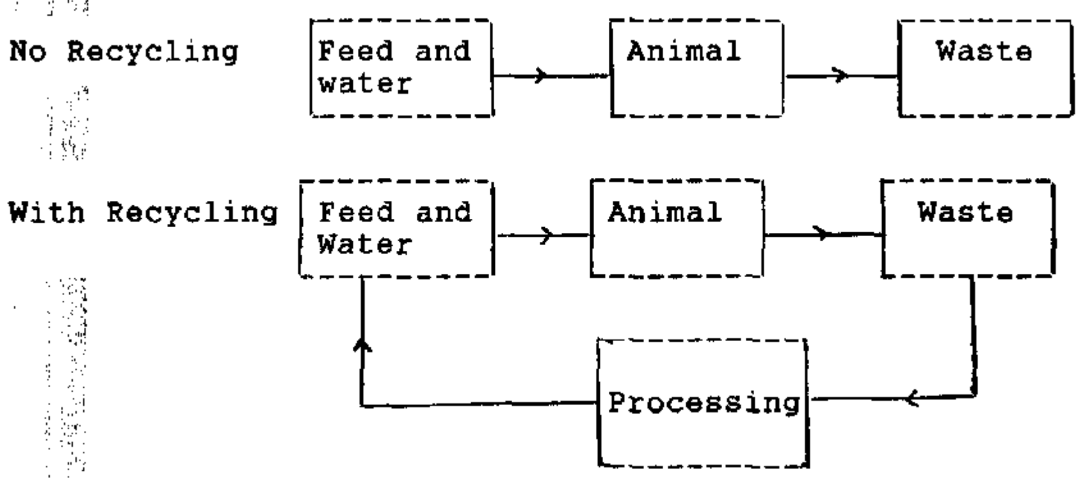

Fig. 1.0: Potential for reducing problem of waste handling by recycling

Fecal nitrogen

The amount of nitrogen in manure according to Paul (1977) is of particular interest for refeeding as it is a major component of protein. The nitrogen present in the faeces exist principally in the form of (a) bacteria (b) unabsorbed intestinal secretions and digestive juices (c) epithelial cells (d) mucous materials (e) food residue and (f) amino acids.

Philip et al (1947) reported that it was believed in the early days of nutrition study that the fecal nitrogen consisted principally of food residue. The phrase "metabolic-product nitrogen" has been used as a designation of all fecal nitrogen except that present as food residues and bacteria. Data regarding the output of metabolic nitrogen may be obtained by determining the fecal nitrogen excreted when a diet of adequate energy value but containing no nitrogen is fed. However, Church (1969) was of the opinion that to prevent tissue catabolism from exceeding its normal level, it is customary in studies of basal nitrogen metabolism to include a minimal percentage of adequate protein in the maintenance diet. Table 2 shows the nitrogen distribution between faeces and urine of different livestock species.

Table 2: Distribution of nitrogen in faeces and in urine of livestock species.

	Percentage of total nitrogen	
Species	Faeces	Urine
Beef Cattle	50	50
Dairy Cattle	60	40
Sheep	50	50
Swine	33	67
Poultry	25	75

Source: Church, D.C. (1969).

Prior (1975) estimated that in the United States of America, about 374.6 million metric tons of animal waste was produced annually by all animals in confinement and that this corresponds to 1352 metric tons of nitrogen produced. The proportion of total nitrogen excreted by sheep and cattle according to Henzel and Ross (1973) increases as dietary according to Henzel and Ross (1973) increases as dietary nitrogen increases. Mason (1969) reported that 45 to 60 percent of the total nitrogen excreted in faeces was alpha-amino nitrogen. In old cattle waste, more than half of the nitrogen may exist in slowly mineralizable organic forms.

Manure storage may also affect the form of nitrogen present. Manure storage usually takes one of these three basic forms; storage in piles, aerobic liquid treatment and anaerobic liquid treatment. There are nitrogen losses under all the system. Laboratory report by Hensler et al (1970) indicate that nitrogen loss for fermented piled steer manure was 27 percent; for anaerobic liquid treatment, 32 percent and for aerobic liquid treatment, 30 percent. During aerobic digestion, nitrogen loss occurs partly as volatilized ammonia and if organic carbon substrate is available, considerable nitrogen can be denitrified (Chang et al, 1971). Hensler et al (1970) reported that nutrient recoveries were lowest from aerobic liquid treatment. Good storage stabilized manure nitrogen forms.

Amino Acid Content of Animal Manure

Paul (1977) reported that while a greater percentage of excreted nitrogen occurs in the urine, over 90% of the amino acids is in the faeces. He pointed out that for refeeding considerations, it should be noted that nitrogen must be in the amino acid form for utilization by non-ruminants. Philip et al (1947) and Church (1969) reported that fecal amino acids are derived from protein digestion as well as from intestinal organisms and secretions and that it is more abundant in the faeces of the young animal than for the old animal. Church (1969) also reported that in an experiment on white rats, histidine, methionine, lysine and valine were higher in the faeces when potato starch or dextrin was fed as compared to when sucrose and glucose meals were fed. Table 3 shows the amino acid contents of livestock faeces.

Table 3: Amino acid contents in livestock faeces.

Amino acids	Beef cattle	Sheep	Swine	Poultry
Arginine	1.1	3.4	3.1	
Histidine	0.7	1.3	1.8	
Isoleucine	1.3	3.7	4.8	4.5
Leucine	3.8	4.4	7.2	7.3
Methionine	2.9	5.1	5.1	4.4
Phenylalanine	0.6	1.5	2.7	0.8
Threonine	0.0	3.4	4.0	4.0
Tryptophan	1.8	4.8	3.7	4.5
Valine	-	0.9	-	-
Aspartic acid	2.3	4.9	4.8	5.7
Serine	4.3	-	6.3	9.7
Glutamic acid	1.5	-	2.7	4.7
Proline	3.8	-	15.6	14.0
Glycine	1.8	-	4.2	4.9
Alanine	2.7	-	7.0	7.5
Cystine	4.0	-	5.3	9.7
Tyrosine	0.2	-	3.0	2.3
Total A.A (g)	32.5	33.4	81.9	100.0

Source: Paul, E.T. (1977)

Mineral Contents of Animal Manure

Phosphorus is usually associated with the faeces as opposed to the urine of ruminant animals. Barrow and Lambourne (1962) indicated that about 0.06g organic phosphorus is excreted per 100g of feed eaten; the remaining is excreted as inorganic phosphorus. Generally, only trace amounts of phosphorus are excreted in the urine. The higher the phosphorus content of feed, the higher the inorganic phosphorus content of the faeces. Gerritse and Zugec (1977) found that pig slurry contains 10-30 percent organic phosphates.

The inorganic phosphate in sheep faeces is probably present as calcium hydrogen phosphate. Phosphorus forms in stored manure from different animal origin probably approaches a similar equilibrium with 15-25 percent of the total phosphorus in inorganic form. Between 36 and 55 percent of the phosphorus in various samples of animal manure was water soluble (Bear, 1942). Parker et al (1959) reported that about 94% of the phosphorus in broiler manure was available as compared with 88% in hen manure.

Most of the potassium in animal manure is water soluble and readily available. Water soluble potassium contents of various manures range from 75 to 97 percent (Bear 1942). Most of the Potassium excreted by cattle is in the urine.

Sulphur excretion in faeces was reported to be about 0.1g per 100g of feed eaten, while the remaining sulphur is excreted in the urine. Other nutrients present are mainly associated with faeces except for Boron which is mostly excreted in the urine (Church, 1969).

There are relatively little information on the trace elements content of farm yard manure in literature. Philip et al (1947) found a sample of cow manure to contain 80 ppm of manganese, 50 ppm of boron and no copper. The authors also reported that Danish farm-yard cow manure contained on the average 55 ppm of manganese, 5.5 ppm of copper and 3.9 ppm of boron. Church (1969) reported that dry cow manure contained 1500 ppm of manganese, 35 ppm of boron and 18 ppm of copper. Table 4 shows the trace element contents of cow manure.

Table 4: Trace Element contents of Animal manure (As PPM Dry Matter Basis)

Elements	Minimum	Maximum	Average
Boron	4.5	52.0	20.2
Manganese	75.0	549.0	201.1
Cobalt	0.25	4.70	1.04
Copper	7.6	40.8	15.6
Molybdenum	0.84	4.18	2.06

Source: Philip et al (1947).

Fibre Contents of Animal Manure

Ruminants have more fibre in their faeces than non-ruminant.

This is because fibrous materials constitute a greater bulk of the diet of ruminants. Report by Ogundipe et al (1992) indicates that sheep manure contains about 27% crude fibre. Church (1969) reported a value of between 39 to 40 percent and 30 - 32 percent crude fibre in faeces of deer fed alfalfa hay and bitter brush respectively. Church(1969) also reported that sheep manure contain 21 to 29 percent crude fibre when fed on pasture forage. Faeces of sheep fed on alfalfa pellets had 41 to 49 percent crude fibre, and calves fed on Alfalfa hay and concentrate in the ratio of 1:1, had between 32 to 44 percent crude fibre in their faeces.

The fibre present in the faeces of these ruminants are mainly lignin, hemicellulose, waxes and cutin which are relatively less digestible by microbes in the rumen of the animals. They are also resistant to enzymes present in the abomasum of ruminants. Their function in diets may therefore be limited to providing bulk (Fadugba, 1989, Comb, 1962).

Other Nutrients in Animal Manure

According to Philip et al (1947), animal faeces contain fat, vitamins and enzymes. The amount and composition of fat excreted through the faeces is largely independent of feed fat but tends to approximate the composition of blood lipids. The authors pointed out that fecal fat is largely of endogenous origin, the secreted fat being partially reabsorbed. Only to a minor degree does fecal fat come from epithelial debris and bacterial. The authors also reported that the fat content of normal faeces may vary from 5 to 25 percent (on a dry matter basis). A variety of vitamins are also found to be present in the normal faeces.

Various enzymes have been found in the faeces. The first to be so demonstrated was pancreatic amylase. The amylase content of the faeces has been considered to be an index of pancreatic activity. The excretion of this enzyme has been found to increase when animals drink water immediately after eating. Other enzymes which have been found in the faeces under various conditions are trypsin, renin, maltase, sucrase, lactase, nuclease and lipase (Philip et al, 1947).

Those nutrients primarily excreted in faeces will likely have lower availabilities than those excreted in the urine. The nutrient content of animal manure varies with animal species. Consequently only through chemical and biological evaluation is it possible to predict accurately the nutrient input from a given animal manure (Wilkinson, 1979).

According to Church (1969), the following factors may affect the nutrient composition of animal manure: (a) animal size, (b) housing and rearing management, (c) ration fed and (d) storage, hauling and spreading methods. The author argued that even though multiplicity of factors and their possible interaction make the prediction of nutrient value of animal manure without chemical analysis very uncertain, this should not prevent us from utilizing them. Micro nutrient content of animal manures likewise may have significant nutrient value where the particular micronutrient is deficient in the diet. Salter and Schollenberger (1939), illustrated that losses of nitrogen were quite large through volatilization when manure were not immediately utilized.

Nutrient Content of ruminants' urine

Urine represents the main route of excretion of nitrogenous and sulphurous metabolites of the body tissues. In addition, it is usually the principal route for some of the mineral elements particularly chlorine, potassium, sodium and phosphorus. Consequently, urine is essentially an aqueous solution of these various components with minor amounts of pigment and sloughed off cells from the urogenital tract (Church, 1969).

There is scanty information in literature on the proximate composition of urine from ruminant species although data on many individual components are available. Urea is usually the principal nitrogen-containing compound present, with lesser amounts of other components such as ammonia, allantoin, creatine and creatinine (Philip and Dorothy, 1968).

Topps (1966) as reported by Church (1969), found that the total or relative excretion of urea is primarily a function of nitrogen intake from the feeding of low (4%) versus high (10%) protein diets to sheep. On the low protein diet, ammonia accounted for slightly more urinary nitrogen than urea while other components such as allantoin, hippuric acid and creatinine represented substantial percentages of the total. However with high protein diet that is (near optimum dietary protein) urea was by far the largest fraction present.

Differences in urinary composition between sheep and cattle were observed when the same ration was fed to both species (Church 1969). Sheep excreted less of the total nitrogen as urea and creatinine but more as ammonia and hippuric acid. Blaxter (1961) as cited by Church (1969) also indicate that ruminants probably excreted much larger amounts of purine bases than do monogastric species.

Church (1969) cited the work of White et al (1964) that creatinine excretion is related to muscle mass and less influenced by diet while Church (1969) found that young lambs maintained on nitrogen free diets for a few days had decreased creatine excretion but creatinine excretion was little affected. Church, (1969) also indicated that creatine excretion decreased markedly as crude protein intake increased, when expressed as a percentage of total nitrogen excreted through the urine. Small quantities of sulphur were present in the urine of young lambs. Sulphur excretion according to Church (1969) is often proportional to the nitrogen-sulphur ratio in body proteins.

With respect to the mineral elements, urine composition of Cl, k, Na and P are markedly affected by dietary intake although excretion is also regulated by absorption and excretion in the large gut. Phosphorus in urine occurs primarily as the mono or dibasic phosphorus salt (Church, 1969).

Manure Handling and Nutrient Availability

Manure is a by-product of livestock production. Therefore the nutritional qualities of manure are greatly influenced by many factors including handling, storage and processing methods before inclusion in poultry diets (Paul, 1977). Since nutrient content of manure vary with the ration fed, species of livestock as well as treatment methods, it would be essential to handle it well to remove the impurities such as beddings, wasted feed, extra water, soil and stones.

According to Paul (1977), the final state of the manure in terms of nutrient content when ready for utilization depends on the handling and storage method. The author also reported that proper handling ensures that the nutrients are conserved, the manure is made safe for the recipient animal and the palatability of the manure is improved. Hensler et al (1970) pointed out that there is nutrient loss in stored manure under any condition.

Also, manure may include beddings, wasted feed, extra water and soil. Thus the final state of the manure when ready for utilization depends on many aspects of its past history and it is not surprising that properties vary considerably. The need for proper handling and purification before use becomes imperative (Paul, 1977).

Numerous methods of processing livestock waste for feeding have been studied. The methods range from simply mixing raw manure with new feed to the complex waste processing schemes that yield several usable products including protein, vitamins, minerals and water.

Paul (1977) noted that drying of manure is probably the oldest method of processing waste for refeeding. Drying of manure could be done either with heated air or natural air before incorporating it into the feed. The temperature of manure drying is important. Whitson (1946) reported that cow manure dried at 45^0C possessed a considerable degree of androgen activity and also a growth promoting factor but when dried at 80^0C the former was largely destroyed, while the later was not impaired. Whitson (1946) also added manure dried at 45^0C to a practical laying ration, at a level of 8% and obtained a significant reduction in egg production but when the manure was dried at 80^0C it had no adverse effect on egg production.

Effect of Fibre in poultry diets

Monogastric animals unlike ruminants do not have the necessary enzymes for degrading cellulose, but according to Albanese (1963) microbes present in the caecum sometimes can effect little breakdown of cellulose. Albanese, (1963) also pointed out that the fibre content of a feedstuff is probably the single most important determinant of the nutritive value.

This is because it largely determines the proportion of chemically available nutrients which can be utilized by the animal.

The effect of dietary fibre on digestibility and utilisation of feed has been extensively investigated. Turner (1947) reported that inclusion dried cow manure into the ration of the chicken grower diet increased growth rate up to 10% level of inclusion. At 20% dietary inclusion level, he found that growth rate was depressed. He attributed this decrease in growth rate to the increased fibre content of the diet.

According to Dogari (1985), Crampton (1956) found that poultry can digest fibre to between 20 and 30%. The report also showed that the feed efficiency in broilers fed a ration with 6% added cellulose was significantly ($P < 0.05$) less than that of the control only during the fourth to the sixth week. By the seventh week of the experiment, the feed efficiency had improved. Favourable effects of fibre in poultry diets have been documented. Fibre provides bulk in the feed. The necessity for making up a concentrate mixture so that it will have a certain amount of bulk has been stressed. This is to avoid the formation of dough-like mass in the stomach which is not readily attacked by digestive enzymes. Amodu (1985) reported that fibre aids digestion because its bulk stimulates peristalsis and secretion. It also opens up concentrated foods so that digestive juices can come in closer contact with them.

them. The author also considered bulk to be important also from the stand point that a certain distension of the digestive tract is desirable for the tract's most effective activity. It is believed that this distension can be brought about by a large intake of any kind of food but is particularly accomplished by such indigestible materials like the crude fibre. Amodu (1985) also considered the influence of fibre in the elimination of feed residues as a laxative effect. He explained that feeds high in fibre tend to be laxative and that fibre which readily absorbs water and swells is more laxative than the one which does not.

Eastwood (1974) reported that hemicellulose and to a lesser extent cellulose can increase stool weight by absorbing water. He stated that the lignin component of the plant material can absorb organic materials and so enhance the rate at which materials are lost in the stool. The author further maintained that bulk is not the only cause of laxative effect as many feeds are laxative because of specific chemical substances in them. He further stated that fibre has a cation exchange properties. Mendeloff (1975) stated that plant fibres may play a role in counteracting the toxic effects of drugs, chemicals and food additives.

Other effects of fibre in the diet that may not be favourable have been cited. The work of Woodman and Evans (1974) showed that the fibrous feeds might decrease the digestibility of crude protein and ether extract. This according to them is so because the greatly increased bulkiness of the ration due to the inclusion of fodder cellulose may lead to a more imperfect contact between proteolytic enzymes and the basal food. There is also the possibility that the presence of the fibre may speed up the rate of passage of food through the simple stomach of monogastrics. The authors further stated that fibrous feeds may increase the output of nitrogenous materials into the faeces thus causing a depression of the apparent digestibility of the basal ration. This is supported by the work of Actan. et al (1982), who working with fibre from wheat bran obtained results which supported the hypothesis that dietary fibre constituents may reduce protein digestibility and increase nitrogenous excretion through ionic interaction, matrix restriction and modification of filtration characteristics of the fibre component.

Both copper and zinc were bound by fibre sources during invivo studies conducted by Thompson and Weber (1982). All the residues studied bound more copper than zinc. Ershoff (1974) believed that certain types of dietary fibre are partially responsible for lowering zinc, calcium, phosphorus and probably iron absorption.

Cunha (1977) stated that a high fibre intake may mean low intake of food nutrients unless the roughage is fortified with these nutrients. Experiments with growing chickens carried out by Isa'aches et al (1960) and also by Lilie and Denton

(1966) indicated that growing chickens on a high fibre diet exhibited a delay in sexual maturity and reduce body weights at maturity. Feed consumption and body weight gain especially in meat type birds were decreased when birds were fed a high fibre diet (Kondra et al, (1974). Deaton et al (1979) found no significant ($P > 0.05$) differences in feed conversion, egg production, egg weights, shell breaking strength and mortality rate between birds when they substituted a high fibre sunflower meal for soyabean meal. However, gizzard weights and intestine lengths were increased significantly. The reports of Ewing (1950) and Ewing (1963) indicated that chicks can perform well on diets with up to 9% fibre. El Abbady et al (1970) worked with balady white chicks up to the age of twenty weeks. They concluded that male chicks can perform well on 12% crude fibre, as opposed to 4% crude fibre for the females. When the females were 8 weeks old, they could tolerate up to 7% crude fibre without adverse effects. However feed consumption and mortality increased and growth rate was depressed when the male white baladi chicks were placed on a diet of 17% crude fibre.

Fibre is known to promote constant passage of materials through the alimentary tract. Dogari (1985) reported that the addition of fibre to the diets of chicks stimulated growth.

Kondra et al (1974) fed a high fibre diet (19.6%) to meat and egg type chicken during the last 6 weeks of their period and found a significant ($P < 0.05$) reduction in feed consumption. There was also a reduction in body weight gain per bird, but there was no effect on feed efficiency. The addition of fibre also resulted in an increase in weight and size of the various parts of the alimentary tract. Mortality during the growing period was not effected by the high fibre diet. It was concluded that chicken were capable of a high degree of anatomical and physiological adaptation to compensate for variation in nutrient concentration of their diet. However Nelson (1972) reported that due to reduced feed intake as a result of high crude fibre content of the diet of pullets from 9 weeks of age, sexual maturity was delayed.

As a result of earlier findings on the use of fibrous feedstuffs in layers diets, Deaton et al (1979) evaluated the effect of replacing soyabean meal with high fibre sunflower meal. They found that the increased dietary fibre resulted in a significant ($P < 0.05$) increase in gizzard weights and gut length. Feed efficiency decreased but egg production, egg weight, shell breaking strength and mortality were not affected.

Smith and Keen (1971) worked on increasing fibre level in feed of broilers and layers and found that if the level is above 30% of the total laying hen diet, performance of both types of birds were adversely affected. The carry-over effects of feeding high fibre diet to birds during growing period were increased rate of lay and body weight gain (Kondra et al (1974) The feeding of a high fibre grower diet followed by low fibre laying diet also resulted in an increased feed efficiency but this does not hold for birds fed high fibre growing and laying diets. The high fibre diets (20% wheat straw) fed during the laying period reduced rate of lay and feed efficiency but did not affect the weight, quality and fertility or hatchability of the eggs (Amodu, 1985).

Poultry like other animals are greatly affected by the level of fibre in their diets. Savoury and Gentle (1976) reported increased feed intake with increased dietary fibre in Japanese quail (Coturnix. Coturnix japonica) but found no obvious effect on rate of passage. Nelson (1972) reported an increase in the total feed intake with increase in dietary fibre in growing and laying diets. Baungardt (1969) suggested that at low densities, physical capacity and distension of the digestive organs limit nutrient intake. With these high dietary levels of fibre, the energy needs of the birds are not satisfied even though a transient satisfaction due to distended digestive tract occurs (Whitson 1946; Donaldson et al (1956).

Utilization of Animal Manure in Poultry Diets

Result from study by Tywonczuk et al (1978) indicates that pullets could tolerate up to 6% dietary cow waste without detrimental effects on performance and nutrient retention.

Result from study by Alzujay et al (1962) shows that when sheep excreta (dried and sterilized) was fed to broilers as feed substitute in broiler ration at 4,8 and 12% inclusion levels, it gave greater daily weight gain than both the commercial diets or diets not supplemented with sterilized excreta. Body weight gains were greatest in chicken given diets supplemented with 4% excreta.

Ogundipe et al (1992) reported that up to 30% dietary sundried or heat-treated sheep manure had no signifcant effect on feed intakes and mortality rates although final weight, weight gain, feed conversion efficiency and feed cost (N per kg gain) were however significantly affected by dietary treatments. They reported that final weight and weight gain increased slightly for the two types of manures at 10% dietary level. There were however no significant difference ($P > 0.05$) between weight gains at 10% and at 20% dietary levels from the two types of manure. Feed conversion efficiency was also not adversely affected by either of the S.M. types up to 20% dietary level. Feed cost (N per bird) was reported to be decreased as the dietary level of both types of S.M. increased. The decrease in feed cost was however more rapid for the sun-dried S.M. than for the heated S.M. The decrease was significant ($P < 0.05$) at 20% dietary level for sundried S.M. and at 30% dietary level for heated S.M when compared with the control. They found that although heat treatment of SM decrease weight gain and feed conversion, the difference were not significant ($P > 0.05$). It appears that the slight reduction of the crude protein and the ether extract due to heat treatment could have been responsible for the slight reduction observed in weight gain and the significant reduction observed for feed conversion efficiency at the 30% dietary level of S.M.

In the opinion of the researchers, it can be concluded that sheep manure with its fairly high crude protein content (18.7% C.P.) although with low energy content can be utilised as a partial substitute for the more expensive oil seed cakes in poultry diets where energy density is not a critical factor. Ogundipe et al (1992) also found that sun-dried and heated S.M. can be successfully fed in chick diets up to 20% level without adverse effects on weight gain, feed intake and feed conversion efficiency. Feed cost (N per bird) could be substantially reduced in the process. The results also indicate no improvement in the nutritive value of sheep manure apart from the sterilization of the product by subjecting the manure to heat treatment. In fact the nutritional quality of the manure could be slightly reduced by the reduction in the crude protein value.

Pearcy (1950) reported that chicks could tolerate upto 6% dietary cow manure and that such inclusion level enhance appetited and growth while reducing mortality.

Turner (1947) carried out a study with white plymouth rock chicks which were fed rations containing 2.5%, 5%, 10% and 20% dried cow manure and 10% dried goat manure. At 14 weeks of age the final weights of cockerels from diets with up to 10% level of both the cow and goat manure were similar to that of the control but weight was depressed at the 20% dietary level of the cow manure. The pullets were reared up to 24 weeks of age by which time the growth on all dietary levels of manure were greater than that of the control group. Bird (1948) reported that when 5% dietary level of dried cow manure was fed to poults, a significant ($P < 0.05$) growth response was recorded. He concluded that cow manure contain an unknown factor for turkey poult growth.

Study by Rubin (1946) revealed that when crossbred pullets were fed a diet containing the cow manure factor, eggs from the hens receiving the supplement diet contained factor which was not found in the eggs of the control group. The factor was concentrated in the acetone - insoluble fraction of the yolk, and was also found to improve hatchability of eggs from hens receiving diet with the supplement.

Head (1948) reported that when two weeks old crossbred chickens were fed on an all plant-protein diet supplemented with sun-dried and oven dried cow manure, there was an increase in growth rate and comb development although in a supplementary trial sundried cow manure from pasture increased growth only.

Rubin (1946) reported that the faeces of hens were found to resemble the manure of the cow in that it contains a factor which stimulates the growth of chicks. The factor appeared to be synthesized in the gut or possibly in the voided faeces as it was not present in the hen's diet. Faeces free from urine, which were obtained from hens in which artificial anus was produced stimulated growth more than the mixture of faeces and urine normally voided. Young growing chickens did not synthesize measurable amounts of the factor.

Bruce (1943) indicated that when dried powdered manure from cows with or without access to pasture or extracts of the manure were added at 10% levels to the diets of growing chicks receiving previously a diet low in riboflavin, growth was improved. When the manure were added to a rich diet, no harmful effect was seen and the flesh of the chicks were not tainted. Among chicks receiving manure from cows which had access to pasture, precocious comb development was observed which was attributed to the presence of male hormone in the manure.

In a related study carried out by Head (1948), to determine the chick growth factor in cow manure, the author used 10 months old bird raised from hens with a low hatchability record. Neither the control nor the experimental group had received animal protein from 5 months of age but a ration containing 35% soya bean oil. The experimental group received a supplement of 0.1% of an acid insoluble fraction of an extract of cow manure. The diets were reversed after 6 weeks and after 11 weeks the supplement was discontinued. The hatchability of the eggs from the birds receiving the supplement rose from 54% to over 90% and the effect continued for another period of 15 to 16 weeks. It was concluded that hens receiving a ration containing cow manure extract stored the growth factor for a considerable time, but pullets which have no source of supply at the commencement of laying cannot store the factor.

Head (1950) also reported that cow manure dried at 45^0 when added to a chick ration, there was a depressed growth when casein was additionally fed. However, cow manure had no effect on hens given soyabean meal but slightly accelerated the growth of chicks from hens given a low protein ration.

Report by Head (1948) indicates that at 5% and 10% dietary levels of cow manure, egg production was increased. He also observed that when a group of experimental hen with seasonal variability in hatchability was fed on dried cow manure diets containing the unidentified growth factor, it eliminated the seasonal change in the low hatchability group.

The growth factor for chicks found in cow manure was investigated in comparison with all other known factors required for chicks. When 5% to 8% of maize was replaced by dried cow manure, the growth rate was better than the other diets containing all the known factors for chick growth. From this observation, Copping (1946) reasoned that the growth factor in cow manure differed from other recognised growth factors for chicks. The growth factor was extracted from dried cow manure by boiling water, or 50 or 95% ethyl alcohol but not by ether or chloroform. The factor was stable to dry heat at 100°C for one hour and to autoclaving for 15 minutes. It was not dialysed through a cellophane membrane. Concentrates were obtained which had growth stimulating properties. When included at 3.75 to 7.5mg per 100g diet, the growth stimulating effect was evident on a diet containing no animal protein. The factor was transmitted through the egg to the chick from hens receiving a diet containing cow manure. The amount thus transmitted was sufficient to promote good growth for 6 weeks from hatching.

Copping (1946) found that the growth factor in cow manure produced similar results when tested in feed against pure vitamin B_{12}. It was of special interest that both factors were active by injection so that their effect was direct and not through stimulating the intestinal flora. Turner (1947) identified the factor to be a B-complex vitamin as well as presence of male hormone present in the cow manure.

Effect of Sheep Manure on egg Yolk Pigmentation

Ogundipe et al (1992) showed that sheep manure (S.M.) have significant ($P < 0.05$) effects on egg yolk colour. Percent hen-day egg production, feed intake and Roche Yolk Colour Fan (R.Y.C.F.) scores were significantly ($P < 0.05$) improved for all S.M. diets compared with the control diet. They reported major improvement for all the sun-dried S.M. dietary levels ranging from 2.5 to 10 percent with an overall mean RYCF score of 10.52, compared with the over all mean RYCF score of only 3.86 for the heated SM diets. The difference was highly significant ($P < 0.01$). The improvement in the RYCF score for the sundried S.M. diets went up from the lowest level of 1 for 0% S.M. diet to 9.97 for the first dietary S.M. level of 2.5%. The RYCF score for the sundried S.M reached its peak of about 11 at 5% dietary level. Heated S.M. levels did not show marked improvement in yolk colour score. It resulted in only a range of RYCF score of 2.64 for 2.5% dietary level to its peak score of 5.25 for the 10% dietary level.

Using brown strain layers, Ogundipe et al (1992) also found that although all the dietary levels of heated S.M improved RYCF scores, the scores for the 2.5% heated S.M never attained the consumers preferred RYCF score of 4. Heated S.M at 7.5% and 10% dietary levels attained this score by the 12th and 6th day respectively. Yet neither of these higher levels attained the RYCF score of 7 which is the minimum for eggs suitable for the pastries industry. These researchers observed immediate and very high responses of the yolk colour score for the sundried S.M. diets. The lowest dietary level of 2.5% sundried S.M. diet went up to a RYCF score of 8 on the 6th day and reached a score of 11 by the 9th day. The score remained at this high level of between 11 and 12 from the 9th day to the end of the 28th day. Similar trends were observed for all other dietary levels of sun dried S.M. If adequate egg yolk pigmentation is the goal, then a dietary level of only 2.5% sundried S.M. is more than sufficient. Also response for the white strain layers were very similar to the observation made for the brown strain layers. The lowest dietary level of 2.5% sundried S.M. gave very high scores as from the 6th day and stabilized at between 10 and 11.8 as from the 12th day. Although the peak scores were slightly higher for the brown strain layers than for the white strains, the differences appear to be very insignificant ($P > 0.05$).

SECTION II

EXPERIMENTAL

COLLECTION AND PROCESSING OF SHEEP MANURE FOR THE EXPERIMENTS

Sheep manure for the two experiments was obtained from the sheep pens at the National Animal Production Research Institute (N.A.P.R.I), Shika, Zaria. The sheep were usually taken out for grazing during the day. At night, they were brought into the pens which had cemented floors. In the morning, their faeces were swept together, straws and other foreign particles like stones were removed and then bagged. Approximately 1.6 tons of the wet sheep manure were collected for the two experiments.

Heat-treated sheep manure was then processed by heating approximately three kilograms of the manure each time in an open pan for three minutes with constant stirring to prevent charring. The temperature of the heated material reached about $70^{0}C$ during the process as recorded by a thermocouple. The heated sheep manure was then ground for ration compounding. About 1.5 tons of sheep manure were processed this way.

The sun-dried sheep manure was obtained by spreading about 50kg of the manure outdoors on a cemented floor and left to dry in the sun for three days. The product was then ground and incorporated into the diets for the egg yolk pigmentation study.

Determination of the chemical composition of sheep manure

The aim of the chemical analysis was to determine the nutrient composition of sheep manure in order to evaluate its suitability for poultry ration formulations.

Procedure:

Representative samples of heat-treated and sun-dried sheep manure were collected and chemically analysed to determine their compositions for dry matter, crude protein, crude fibre, ether extract, ash, calcium and phosphorus according to AOAC (1975) methods. Nitrogen composition was determined using micro Kjeldahl apparatus. Three determinations were made for each item analysed for.

RESULTS AND DISCUSSION

The results of the chemical analyses of the heat-treated and the sun-dried sheep manure prepared for the experiments are presented in table 5.

Church (1969) reported only 16% crude protein for sheep manure but it was not stated whether this value was for heat-treated or for sun-dried sheep manure. The ether extract values obtained in this study were higher than the values of 1.68% and 1.8% for H.SM and S.SM respectively reported by Ogundipe et al (1992). The reasons for the differences in the values are not clear. The values were however lower than the value of 10% reported by Church (1969). The crude fibre content obtained in this analysis were found to be very close to the values of 26.47% and 26.57% for H.SM and S.SM respectively by Ogundipe et al (1992) and the range of 21 to 29 percent reported by Church (1969). The values for ash obtained in this analysis were found to be higher than the values of 26.31% and 20.81% for H.SM and S.SM reported by Ogundipe et al (1992) and the range of 8 to 10 percent reported by Church (1969).

The Calcium and Phosphorus values of 1.32 and 0.50 percent respectively for heat-treated sheep manure and 0.96 and 0.48 percent respectively for sun-dried sheep manure are slightly higher than the values of 0.95 and 0.48 percent for heat-treated sheep manure respectively and 0.66 and 0.42 percent respectively for sun-dried sheep manure reported by Ogundipe et al (1992). The analysis revealed that heat-treated and sun-dried sheep manure are rich in many of the nutrients required by chickens such as the crude protein, calcium and Phosphorus. There were slight differences in nutrient composition for the two types of sheep manure due to the method of processing.

The analysis also revealed that while the percent crude protein, ether extract and crude fibre values were lower for heat-treated sheep manure than for sun-dried sheep manure, the ash, calcium and phosphorus values were higher for heat-treated sheep manure than for sun-dried sheep manure. The lower values for crude protein, crude fibre and ether extract obtained for heat-treated sheep manure could be due to nutrient destruction and volatility of fats during the process of heating and stirring. Also the burning of some fibres to ash during heating could have accounted for the low crude fibre and increased ash, calcium and phosphorus values for the heat-treated sheep manure.

Table 5: Chemical Composition for the Sun-dried and the Heat-treated Sheep Manure.

Type of sheep manure	% Dry Matter	% Crude Protein	% Crude Fibre	% Ether Extract	% Ash	% Ca	% P
Sundried	83.96	19.06	27.07	3.77	20.81	0.96	0.48
Heat-treated	86.95	16.88	24.42	2.95	26.31	1.32	0.50

DETERMINATION OF THE METABOLISABLE ENERGY VALUES OF HEAT TREATED SHEEP MANURE

PROCEDURE

Adult shavers x Hubbard cocks were used for this study because mature cocks maintain a steady state and do not become obese. Thirty cocks were housed in battery cages in pairs for five days, to get them acclimatized to the cage environment. During these five days they were fed on the control ration. The feed used in this study is a practical type corn-groundnut cake based control diet (table 6). The treatment diet was a mixture of 80% of the control diet and 20% of the ground heat-treated sheep manure. There were three groups of ten cocks each. Each group was made up of five pairs of cocks.

At the commencement of the experiment, all the cocks were fasted for twenty-four hours to empty their digestive tracts. Only water was given during this twenty-four hours. The first set of ten cocks were then fed on the treatment diet made up of 80% of the control diet and 20% of the ground heat-treated sheep manure. The second group were fed on the control diet only while the third group of ten cocks were not fed for the four days of fecal collection to determine the endogenous nitrogen losses which were later used for nitrogen correction for the calculation of nitrogen corrected apparent metabolisable energy (AMEn). As soon as feed was placed in the feeders, polythene sheets were fixed under the cages for fecal collection, for all the fed and unfed groups. Water was supplied ad libitum to the fed and unfed cocks throughout the experimental period. Each group of ten cocks made up a treatment group and each pair of cocks within each treatment group represented a replicate. Every other cage in a row was left vacant to avoid possible cross contamination of faeces between replicates. Exactly twenty-four hours after the commencement of the feeding, the accumulated faeces were collected from each pair of cocks, blown to remove scales and feathers and the faeces transferred into a polythene sheet, labelled and stored in a deep freezer. This was done daily for three days. On the third day, all the birds were starved to empty their gastro-intestinal tract and the last batch of faeces were collected up to end of the fourth day.

Faeces from each pair of cocks for the four days of collection were bulked together, allowed to thaw, weighed (wet weight) and oven dried at 70°C for 72 hours and then re-weighed after cooling to obtain the dry-weight. The fecal samples were ground separately with a grinding machine manufactured by Christy and Norris Ltd. England. Samples from each feed were also ground and assayed for nitrogen composition according to A.O.A.C (1975) methods. Gross energy values of these samples were also determined with the aid of a parr adiabatic bomb calorimeter.

Table 6: **The energy contents of the basal and the substituted rations**

Diets	GE Kcal/kg	AME Kcal/kg	AMEn Kcal/kg	Eff. of utilisation of AME (%)	Eff. of utili-sation of AMEn (%)
Basal ration	4680	2801.70	2796.77	59.87	59.76
80% basal + 20% H.SM	4280	2458.96	2456.41	57.45	57.39
Heated S.M	4640	1088		23.45	

$$\text{Efficiency of utilisation} = \frac{\text{AME or AMEn} \times 100}{\text{G.E.}}$$

$$\text{Efficiency of utilisation of TME} = \frac{\text{TME} \times 100}{\text{GE}}$$

The apparent metabolisable energy (A.M.E) of the rations were calculated using the formula of Hill and Anderson (1958).

$$\text{A.M.E/g of feed} = \frac{(F^1 \times GE^f) - (E \times GEe)}{F^1}$$

where F^1 = feed intake (g)

E = Excreta output (g)

GE^f = Gross energy of Feed (Kcal/g)

GEe = Gross energy of excreta (Kcal/g)

The M.E of the test ingredient was then calculated using a simple algebraic equation.

If M.E. of the basal diet (control diet) 'X' was 'a' Kcal/kg and that of the 20% substituted ration "Y" was 'b' Kcal, then the equation becomes:

$$1x = a \text{ Kcal}$$

$$x = \frac{a \text{ Kcal}}{1}$$

$$0.8x + 0.2y = b \text{ Kcal}$$

$$0.8 a \text{ Kcal} + 0.2y = b \text{ Kcal}$$

$$0.2y = b - 0.8a$$

$$y = \frac{b - 0.8a}{0.2}$$

A correction was made for nitrogen retained in the body. Since body nitrogen, when catabolised is excreted as energy containing products, it is therefore important to bring A.M.E data to a basis of nitrogen equilibrium (Sibald 1979). Nitrogen corrected apparent metabolisable energy (AMEn) was thus calculated from the following equation.

AMEn = AME - 8.22 (gN/g feed - gN/g faeces) according to the method of Hill and Anderson (1958). The efficiency of utilisation of AME and AMEn were calculated using the formula below:

$$\text{Efficiency of energy utilisation (\%)} = \frac{\text{ME or MEn} \times 100}{\text{GE}}$$

were GE is the gross energy of the feed sample.

The true metabolisable energy (TME) of the basal and substituted rations were also calculated using the formula below according to Sibbald (1979).

$$\text{TME (Kcal/kg)} = \frac{Ge^{f} \times X - (Yef - Yec)}{X}$$

where Gef = Gross energy of the feedstuff

Yef = Energy voided as excreta by birds

Yec = Energy voided as excreta by unfed birds

X = Weight of feedstuff fed.

RESULT AND DISCUSSION

The gross energy (GE), the apparent metabolisable energy,the true metabolisable energy and the metabolisable energy corrected for nitrogen (MEn) for basal and test diets are presented in table 6. The gross energy of heat-treated S.M was 4640 Kcal/kg. The apparent metabolisable energy values (AME) for heat-treated sheep manure was 1088 Kcal/kg and the efficiency of utilisation of metabolisable energy of the sheep manure was 23.45%.

The AME value of 1088 kcal/kg obtained in this study was consistent with 1076 Kcal/kg reported by Ogundipe et al (1992) for heat-treated sheep manure. Ogundipe et al (1992) argued that although the M.E of heat-treated sheep manure is low, it is nevertheless the characteristics of ruminant's manure and that this low value still fall within the range of 1000 to 1300 Kcal/kg ME often reported for rice offal which has received some degree of acceptance in poultry ration formulation. This factor, the authors argued further, together with the fairly high content of crude protein can make sheep manure a suitable partial substitute for the more expensive oil seed cakes such as groundnut and soya bean cakes.

EXPERIMENT I

LAYER STUDY

Procedure

216 point of lay (23 weeks old) birds of a commercial strain were used for this trial. The birds were selected and divided into eighteen groups of twelve birds each and housed in pairs in battery cages. The study lasted for five twenty-eight day periods.

There were six dietary treatments with three replicates per treatment. Ration 1 contained no sheep manure while the other five rations had heat-treated sheep manure at 7.5%, 15.0%, 22.5%, 30.0% and 37.5% levels (Table 7). All rations were isonitrogenous. The experimental diet were supplied *ad libitum* during the 20 week trial period. Records of mortality, egg production, feed consumption and initial weights of birds per replicate at the beginning of the experiment and the final weights at the end of the experiment were measured.

All eggs collected from each group for three consecutive days towards the end of every twenty-eight day period were used in estimating the average weight of the egg. After weighing, three eggs from each replicate were broken out and with the aid of a pair of vernier callipers, the albumin heights were measured for calculating Haugh unit values. Also the yolk height and yolk width were measured for the calculation of yolk index. The Roche Yolk Colour Fan (RYCF) was used to determine the Yolk colour scores.

Feed conversion efficiency and feed cost per ten eggs were calculated from the record of eggs produced and feed consumed. All data collected were subjected to the analysis of variance and significance of differences between treatment means were assessed by applying Duncan's multiple range test (Steel and Torrie, 1960).

Table 7: Ingredient Compositions of Experimental Layer rations with graded levels of H.SM

	Diets					
Ingredients	1	2	3	4	5	6
Maize	48.66	42.85	37.05	31.24	25.42	19.61
Soyabean cake	10.00	10.00	10.00	10.00	10.00	10.00
Groundnut cake	15.44	13.75	12.05	10.36	8.68	6.99
Sheep manure	0.00	7.50	15.00	22.50	30.00	37.50
Rice offal	15.00	15.00	15.00	15.00	15.00	15.00
Limestone	7.50	7.50	7.50	7.50	7.50	7.50
Bonemeal	2.75	2.75	2.75	2.75	2.75	2.75
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Methionine	0.10	0.10	0.10	0.10	0.10	0.10
Vit/Min. Premix	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100
<u>Calculated Composition</u>						
ME (Kcal/kg)	2408	2269	2130	1990	1851	1706
Protein %	16.5	16.5	16.5	16.5	16.5	16.5
Fibre %	8.27	9.95	11.62	13.30	14.98	16.65
Calcium	3.60	3.69	3.79	3.88	3.98	4.07
Total P	1.48	1.50	1.55	1.46	1.50	1.54
Available P	0.44	0.45	0.47	0.44	0.45	0.46
Lysine	0.76	0.72	0.67	0.63	0.59	0.55
Methionine	0.37	0.35	0.33	0.31	0.29	0.29
Cystine	0.26	0.24	0.22	0.20	0.18	0.16
Feed cost (N/kg feed)	6.07	5.66	5.24	4.82	4.41	3.99

Premix supplied per kg ration:- Vitamin A 10,000 I.U, Vit. D3 2500 I.U, Vit. E 12 I.U, Vit. K 0.002gm, Vit. B_1 0.001gm, Vit B_2 0.0045gm, Vit. B_6 0.003gm, Nicotinic acid 0.025gm Calcium D-Pantothenate 0.01gm, Vit. B_{12} 0.012gm, Folic acid 0.0003gm, Vit. C 0.05gm, Chlorine chloride 0.3gm, Manganese 0.1gm, Iron 0.05gm, Zinc 0.045gm, Copper 0.002gm, Iodine 0.001gm, Cobalt 0.000225gm, Selenium 0.0001gm.

RESULTS AND DISCUSSION

The performance of the laying hens used in experiment 1 are presented in tables 8a and 8b.

Table 8a: Effects of dietary levels of heat-treated sheep manure on the performance of layers.

Dietary treatment	Feed intake g/bird/day	Feed eff. (kg feed/ 10 eggs)	Feed cost (N/10 eggs)	% Hen-day egg prod.	% egg-prod.at peak
1. control	120.4[f]	2.59[a]	16.76[ab]	50.99[ab]	65.5[b]
2. 7.5% HSM	130.2[e]	2.53[a]	15.36[a]	56.25[a]	74.8[a]
3. 15% HSM	158.4[d]	3.33[b]	18.79[b]	51.97[ab]	73.8[a]
4. 22.5% HSM	164.6[c]	3.64[b]	19.04[b]	49.58[b]	72.6[a]
5. 30% HSM	175.2[b]	3.98[b]	19.13[b]	48.19[b]	67.87[b]
6. 37.5% HSM	185.2[a]	5.49[c]	24.12[c]	37.34[c]	51.12[c]
SEM	5.47	0.25	0.72	1.53	1.93 -

Data within the same column bearing similar superscripts are not significantly different (P > 0.05). SEM = standard error of means

Table 8b: Effects of dietary levels of heat-treated sheep manure on the performance of layers (quality measurement and body condition)

Dietary treatment	RYCF score	% change in body weight	Yolk index	Haugh unit	mean egg wt.
1. control	1.10^{f}	5.47^{a}	0.45	90.38	60.89
2. 7.5% HSM	9.13^{e}	4.08^{a}	0.44	90.59	60.99
3. 15% HSM	11.13^{d}	-1.42^{b}	0.45	90.69	61.48
4. 22.5% HSM	12.1^{c}	-2.21^{b}	0.44	89.97	61.54
5. 30% HSM	13.03^{b}	-9.88^{c}	0.44	90.25	62.41
6. 37.5% HSM	14.1^{a}	-11.81^{d}	0.45	90.48	62.09
SEM	1.02	1.55	0.002	0.20	0.43

Means in the same column bearing similar superscripts are not significantly difference ($P > 0.05$), SEM = standard of error of mean

Effect of dietary levels of H.SM on feed consumption

There was a direct relationship between feed intake and the level of inclusion of heat-treated sheep manure (H.SM) in the diet. The diet became less dense and feed consumption increased significantly ($P < 0.05$) as the level of inclusion of sheep manure increased. Average daily feed intake for the control diet was 120.43g as against 185.19g for birds fed the 37.5% hsm diet. Thus, birds fed the 37.5% H.SM diet consumed 65.03% more feed than those fed the control diet. The proximate analysis of the heat-treated sheep manure reveals that it has a high crude fibre content (24.42%). Therefore, increasing the dietary level of the H.SM consequently increased the fibre content of the diet. This resulted in lowered nutrient density particularly the energy content of the diet.

Chickens are known to consume feed in order to satisfy their energy requirement and they will eat more of a diet with low energy content than that with high energy content. This observation agrees with the report of Nelson (1972) and Savoury and Gentle (1976) that feed intake increased with increase in the fibre content of the diet. This is also supported by Fadugba (1989) who reported that feed intake increased when the energy content of a diet was decreased.

Feed consumption was regressed against sheep manure levels and the following prediction equation was obtained:

$Y = 122.437 + 1.771$ TRT $(R^2) = 0.956)$

where Y = Feed Consumption (g feed/bird/day),

TRT = treatment level and R^2 is the prediction efficiency.

Effect of dietary levels of H.SM on percent hen-day egg production

The result shows that dietary level of H.SM had a significant ($P < 0.05$) effect on percent hen-day egg production. The percent hen-day egg production for diet 2 (7.5% H.SM diet) was higher than the values for all other diets including the control. However, there were no significant ($P > 0.05$) differences between treatments for percent hen-day egg production between the control diet and diets 2 to 5. Diet 6 gave significantly ($P < 0.05$) lower percent hen-day egg production than the values obtained for all other diets. This result compares favourably with the report of Head (1948) in which 5 to 10 percent dietary level of cow manure resulted in satisfactory rate of egg production. Also 7.5% H.SM gave the best result for percent peak egg production. There was however no significant difference ($P > 0.05$) between this value and the values obtained for diets 3 and 4. There was also no significant difference ($P > 0.05$) between diet 1 and 5 but diet 6 gave a significantly ($P < 0.05$) the lowest value when compared with the results for all other diets.

The percent hen-day egg production was regressed against the dietary levels of H.SM and the prediction equation obtained is shown below $Y = 55.826 - 0.361\ TRT$ ($R^2 = 0.635$)

where Y = Percent hen-day egg production,

TRT = treatment or level of sheep manure in the diet and

R^2 = prediction efficiency.

Effect of dietary level of H.SM on feed cost per ten eggs

Based on the current market prices for the various feed ingredients, the cost per kilogramme of the layer diets were calculated. The costs were found to decrease from N6.07 for the control diet to N3.99 for the 37.5% heat-treated sheep manure diet.

Table 8a shows that the birds fed the 7.5% heat-treated sheep manure diet had the lowest feed cost per ten eggs produced (N15.36). There were however no significant differences ($P > 0.05$) for feed cost per ten eggs produced between diets 1 and 2 and between diets I and any of those diets from 3 to 5.

Diet 6 gave significantly ($P < 0.05$) higher feed cost per 10 eggs produced than the costs obtained for all other dietary treatments.

Feed cost per ten eggs produced was regressed against the dietary H.SM levels and the following prediction equation was obtained

$Y = 15.412 + 0.184\ TRT\ (R^2 = 0.752)$.

Where Y = Feed cost (N/10 eggs produced),

TRT = level of sheep manure in the diet and R^2 = prediction efficiency.

Effect of dietary levels of H.SM on egg weight

The egg weights from birds fed graded levels of dietary H.SM did not differ significantly ($P > 0.05$). between treatments The eggs became bigger as the birds grew older, regardless of their dietary treatment. The mean egg weight was 60.89g per egg at the beginning of the experiment while at the end of the experiment, it was 63.09g per egg.

Effect of dietary levels of H.SM on feed efficiency.

Table shows that treatment 2 with 7.5% heat-treated sheep manure gave the best feed/10 eggs. However, the value

Effect of dietary levels of H.SM on feed efficiency.

Table shows that treatment 2 with 7.5% heat-treated sheep manure gave the best feed/10 eggs. However, the value obtained for this diet was not significantly ($P > 0.05$) better than that of the control diet. There were also no significant ($P > 0.05$) differences for feed efficiencies between diets 3 through to diet 5. Diet 6 with 37.5% H.SM gave significantly ($p<0.05$) the least value when compared with the values for all other treatments Birds fed the control diet required 2.59kg of feed to produce 10 eggs as against 5.49kg required by those fed 37.5% heat-treated sheep manure diet.

Feed efficiency (kg feed/10 eggs produced) was regressed against dietary levels of H.SM. The prediction equation obtained is presented below

$Y = 2.225 + 0.073$ TRT ($R^2 = 0.881$)

where Y = feed efficiency,

TRT = treatment or level of heat-treated sheep manure in the diet and

R^2 = prediction efficiency.

Effect of dietary levels of H.SM on percent mortality

There was no record of mortality throughout the 5 months of the experimental period suggesting that feeding H.SM is not detrimental to the health of the birds. This may have been due to the heat treatment of the sheep manure which helped to sterilize the product before being incorporated into the indicate whether the cow manure fed in the diets were sterilized or not. However, heat treatment up to a temperature of $70^{0}C$ is believed to kill many pathogenic organisms and render others inactive.

Effect of dietary levels of H.SM on percent change in body weight

Table 8b shows the percent change in body weight of the birds at the end of the experiment. There was a progressive decrease in percent change in body weight as dietary level of H.SM increased. Percent change in body weight for the control diet was slightly higher than the value obtained for the 7.5% H.SM diet although the difference was not significant ($P > 0.05$). Birds fed diet 3 to 6 were found to have a net loss in body weight by the end of the feeding trial. This result can be compared with that of Ogundipe et al (1992) in which they reported a decline in chick growth when dietary levels of heat-treated sheep manure exceeded 10 percent.

Head (1950) reported a decline in chick growth when dietary level of cow manure was above 6 percent. Head (1948) also found that 5% to 8% dietary level of cow manure was best for chick growth. The author argued that decreased nutrient density and high fibre content of the diets were likely to be responsible for the decline in body weights.

Effect of dietary levels of H.SM on Haugh Unit Value and yolk index

Results obtained for the Haugh Unit value and the yolk index shown table 8b indicate that there were no significant ($P > 0.05$) effect of dietary treatments on these parameters.

Effect of dietary levels of H.SM, on egg yolk pigmentation.

The effects of the dietary levels of heat-treated sheep manure on egg yolk pigmentation are presented in Table 8b. The Roche Yolk Colour Fan scores show significant ($P < 0.05$) increases in yolk colour scores with increase in dietary level of H.SM. Each step increase in the dietary level of H.SM had a significant ($P < 0.05$) increase above its immediate lower level. The value of 9.13 RYCF score obtained for yolk colour at 7.5% dietary level of heat-treated sheep manure in this study is higher than the value of 5.25 RYCF score obtained at 10% dietary level of heat-treated sheep manure (H.SM) reported by Ogundipe et al (1992).The reason for the differences in values was not clear though diet composition may have been responsible.

When the RYCF scores were regressed against dietary levels of H.SM the following prediction equation was obtained. $Y = 4.550 + 0.296\ TRT$ ($R^2 = 0.772$)

where Y = RYCF score, R^2 = prediction efficiency,

TRT = treatment (level of H.SM in the diet)

EXPERIMENT II

EFFECT OF SUN-DRIED SHEEP MANURE (S.SM) ON EGG YOLK PIGMENTATION

Objective

The objective of this study is to determine the effect of sun-dried sheep manure (S.SM) on egg yolk pigmentation.

Procedure:

Six diets were formulated containing graded levels of S.SM at 0,1,2,3,4, and 5 percent levels. Diet 1 which contained no S.SM Served as the control. Each of the six diets was fed to four replicate groups of five birds which were housed singly in cages. The composition of the experimental diets are presented in Table 9

The laying hens were first maintained on the Control diet which contained very little or no yolk pigmenting factor for a depigmentation period of twenty-one days. During this period, samples of eggs were broken out and yolk colour scores were determined using the Roche Yolk Colour Fan (RYCF). By the twenty-first day, the RYCF scores had dropped to the lowest value of one. The hens were then placed on the experimental diets for the yolk pigmentation phase of the study which covered a period of three weeks.

Data were collected on daily egg production and feed intake. Three eggs from each replicate group were sampled on the first day and every other day thereafter for the twenty-one days. These were used to determine the RYCF scores. The egg weights and the albumin heights were determined for the calculation of the Haugh Unit Scores.

The data on Haugh Unit Scores and other parameters were subjected to the analysis of variance and differences between treatment means were determined using Duncan's multiple range test. The RYCF mean scores and the standard errors were determined. Also the graph of RYCF scores against time in days were plotted to determine the rate of response to the feeding of the sheep manure diets. (fig.2)

GRAPH OF RYCF SCORES AGAINST TIME IN DAYS

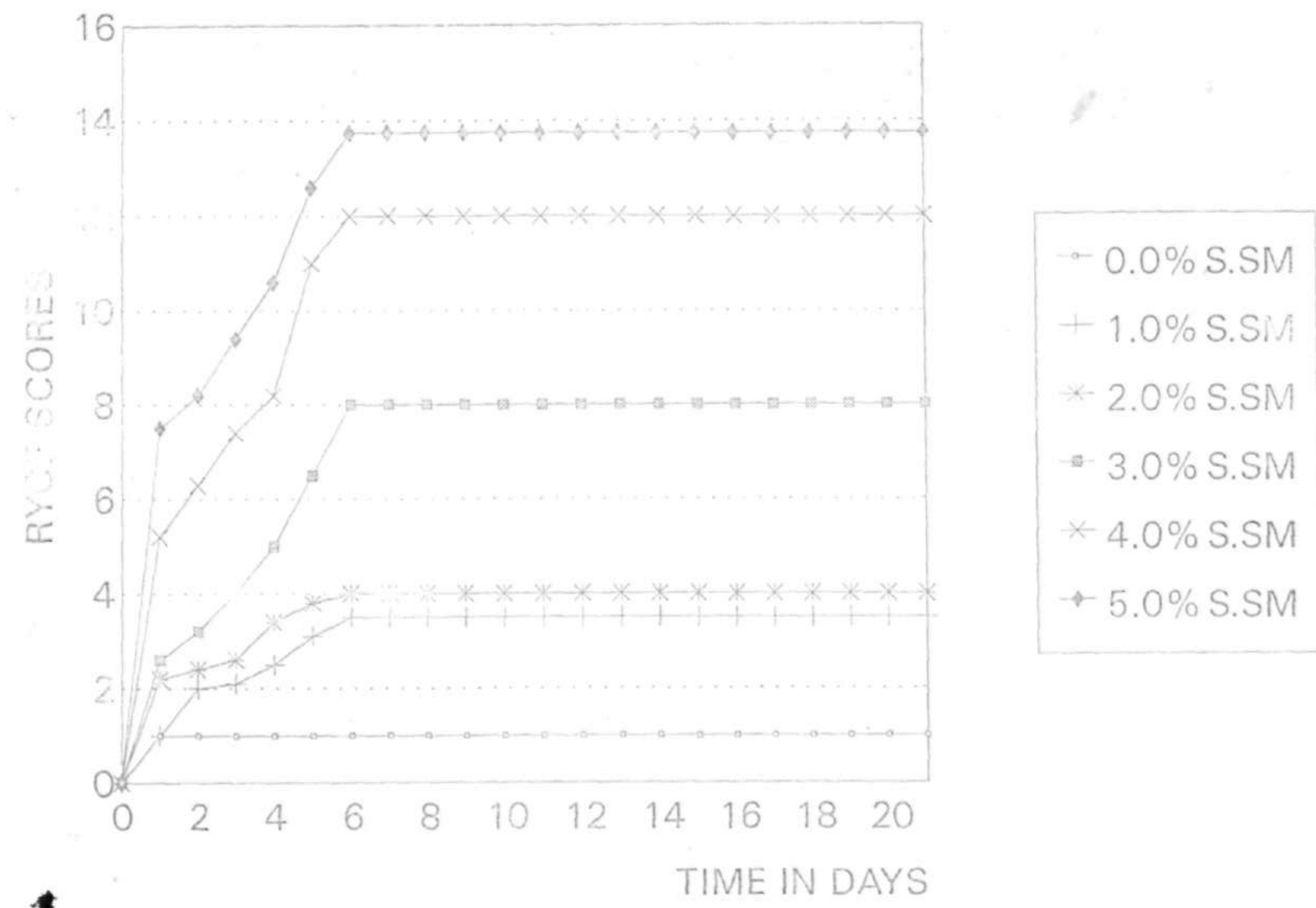

Table 9 Composition of sun-dried sheep manure rations for Egg Yolk Pigmentation experiment

Ingredients	Control	Sun-dried	S.M	diets		
	1	2	3	4	5	6
Maize	48.39	47.58	46.76	45.93	45.11	44.30
Groundnut cake	25.81	25.62	25.44	25.27	25.09	24.90
Sheep manure	0.00	1.00	2.00	3.00	4.0	5.0
Rice offal	15.00	15.00	15.00	15.00	15.00	15.00
Limestone	7.50	7.50	7.50	7.50	7.50	7.50
Bone meal	2.75	2.75	2.75	2.75	2.75	2.75
Salt	0.30	0.30	0.30	0.30	0.30	0.30
*Vit. Premix	0.25	0.25	0.25	0.25	0.25	0.25
Total	100.	100.	100	100	100	100
Calculated composition						
ME (Kcal/kg)	2464	2446	2427	2408	2390	2371
Protein %	16.5	16.5	16.5	16.5	16.5	16.5
Fibre %	8.18	8.40	8.63	8.85	9.08	9.30
Calcium %	3.40	3.42	3.42	3.44	3.44	3.45
Available P %	0.45	0.45	0.45	0.46	0.46	0.46
Lysine	0.74	0.73	0.71	0.69	0.68	0.66
Methionine	0.40	0.39	0.37	0.36	0.35	0.35
Cystine	0.31	0.29	0.27	0.25	0.24	0.23
Feed cost (N/Kg feed)	5.63	5.59	5.55	5.52	5.48	5.43

*Composition of premix is as in table 7.

RESULTS AND DISCUSSION

The results for the egg yolk pigmentation study are shown in Table 10

The results show that sun-dried sheep manure (S.SM) had a significant ($P < 0.05$) effect on egg yolk colour. The RYCF scores increased with increase in dietary level of sun-dried sheep manure The RYCF scores shot up from the lowest value of 1 recorded for the control diet which had no S.SM to 4 which is the consumers minimum acceptable RYCF score at only 2% dietary level of sun-dried sheep manure, and finally reaching 13.75 RYC at 5% dietary level of S.SM. This observation agrees with the report of Ogundipe et al (1992) that sun-dried sheep manure significantly ($P < 0.05$) increased egg yolk colour when included in layers diet. In fact, there was a significant ($P < 0.05$) increase in RYCF score for every increase in dietary level of sun-dried sheep manure.

Also, the maximum RYCF score for each dietary treatment was obtained between the 6th and 8th day and stabilised from this point onwards. This result is similar to the result obtained by Ogundipe et al (1992) who reported from a similar study with S.SM that maximum RYCF score was obtained from the 6th day of feeding S.SM in the diet.

There was no record of mortality for the twenty-one days the experiment lasted. Also there was no significant ($P > 0.05$) difference between diet 1 and any of the other diets with respect to change in body weight, Haugh Unit Scores, Yolk index, feed consumption, feed efficiency, feed cost per ten eggs, and percent hen-day egg production.

When the RYCF score for this experiment was regressed against dietary treatment, the following prediction equation was fitted

$Y = 0.786 + 0.344\ TRT\ (R^2 = 0.989)$

where Y = RYCF scores

TRT = treatment and R^2 = prediction efficiency

Table 10: Effects of graded levels of sundried sheep manure on egg quality and other production parameters

Dietary treatment	RYCF scores	Mean Egg weight	Haugh Unit score	Yolk index	Feed consumption (g feed/ day)	Feed eff. (Kg feed /10 eggs	Feed cost N/10 eggs	% hen day egg prod.
1.Control	1.00^{f}	58.25	96.89	0.48	129.2	3.27	18.41	40.28
1% S.M	3.53^{e}	59.50	94.96	0.49	130.4	3.13	17.48	42.26
2% S.M	5.75^{d}	60.25	94.70	0.49	133.3	3.06	17.00	43.85
3% S.M	7.63^{c}	58.75	96.98	0.48	137.7	3.36	18.52	41.67
4% S.M	11.75^{b}	59.50	96.01	0.50	143.8	3.48	19.07	42.26
5% S.M	13.75^{a}	60.00	96.65	0.49	150.1	3.41	18.53	44.05
SEM	0.9048	0.5887	0.3385	0.0062	3.0497	0.0813	0.4417	1.3075

Means followed by different letter superscripts are significantly ($P < 0.05$) difference from each other.

S.M = sheep manure SEM = Standard error of mean.

Table 11: Table of Correlations between productive traits

	HD	FC	FE	Fcost	RYCF
HD	1.000				
FC	-0.744	1.000			
FE	-0.948*	0.906	1.000		
Fcost	-0.962*	0.858	0.988**	1.000	
RYCF	-0.464	0.896	0.722	0.631	1.000

* (P < 0.05) HD = Hen-day, Fc = Feed consumption, FE = Feed efficiency

** (P < 0.01) Fcost = Feed cost, RYCF = Roche Yolk Colour fan for layers experiment.

Table 11 shows the correlation between productive traits measured, for the layers study. The table reveals that hen-day has a negative correlation with other productive traits. Increase in hen-day egg production therefore will lead to a decrease in other productive traits. Feed efficiency and feed cost had a significant (P < 0.05) negative correlation with hen-day egg production

Feed consumption had a positive but insignificant (P > 0.05) correlation with other parameters. Also feed efficiency had a positive and significant correlation with feed cost. Both feed efficiency and fed cost had positive but insignificant (P > 0.05) correlation with Roche Yolk colour fan score.

As the level of egg production increased, there was a corresponding decrease in egg yolk colour intensity as the pig menting factor is spread over more number of eggs. Oluyemi and Roberts (1979) has reported that high producing birds have lower egg yolk colour intensity than low producing birds.

SUMMARY AND CONCLUSION

The search for alternative cheap and easily available feed ingredients for poultry ration formulation necessitated this study, which was designed to determine the nutritive value of heat-treated sheep manure (H.SM) for laying hens and the optimal level of sun-dried sheep manure (S.SM) that will produce the minimum preference degree of egg yolk pigmentation.

The first experiment was on the determination of the effect of graded levels of H.SM diets on the performance of laying hens. Six dietary treatments were formulated and each treatment was replicated three times. Diet 1 which served as the control contained no H.SM while diets 2 to 6 contained heat-treated sheep manure at 7.5%, 15.0%, 22.5%, 30.0% and 37.5% respectively. The second study was designed to determine the optimal level of sun-dried sheep manure (S.SM) that will produce the minimum preference degree of egg yolk pigmentation. There were also six diets formulated for this experiment. Diet 1 without S.SM served as control while diets 2 to 6 contained sun-dried sheep manure at 1.0%, 2.0%, 3.0%, 4.0% and 5.0% respectively. Chemical analysis of H.SM and S.SM samples were carried out and metabolisable energy of the H.SM samples were determine before the commencement of the feeding trials. Results obtained show that:

1. Sheep manure is fairly rich in crude protein, and other nutrients needed by laying hens but it is low in

metabolisable energy.

2. Inclusion of sheep manure in layers ration reduced feed cost but increased feed cost/10 eggs
3. Dietary level of 7.5% heat-treated sheep manure gave the best result in terms for percent hen-day egg production, feed efficiency (kg feed/10 eggs produced) and feed cost (#/10 eggs)
4. Feed intake increased as the level of sheep manure in the diets increased
5. Weight gain decreased as dietary level of sheep manure increased.
6. The Roche Yolk Colour Fan score increased as dietary level of sun-dried sheep manure increased. The dietary level of sun-dried sheep manure that will produce the minimum preferred degree of egg yolk pigmentation was found to be 2.0%
7. Sheep manure inclusion in the diets had no effect on parameters such as egg weight, Haugh Unit Score, egg yolk index and mortality rate.
8. Sheep manure is high in fibre content.

From the above, it can be observed that heat treated sheep manure can be used up to 7.5% dietary level to replace some of the more expensive feed ingredients in the diets of laying hens with no adverse effect and S.SM fed at 2.0% dietary level will produce a satisfactory level of egg yolk pigmentation

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Appendix 1.0: Ingredient Prices as at August, 1993

Ingredients	Prices N/tonne
Maize	4,200
Groundnut cake	12,000
Soyabean cake	15,000
Rice offal	300
Bone meal	1,800
Limestone	800
Common salt	7,600
DL-methionine	180,000
Vitamin/Mineral Premix for layers	128,000

APPENDIX (LAYERS STUDY)

Appendix 2 ANOVA FOR FEED CONSUMPTION (g feed/bird/day)

Source	df	ss	ms	F
Rep (r-1)	2	0.0421	0.0210	0.07[N.S.]
Treatment (t-1)	5	9691.7490	1938.3499	6696.47**
Residual (t-1) (r-1)	10	2.846	0.2895	

SEM : 5.4701

** Indicates significant difference due to treatment.

Appendix 3: ANOVA FOR EFFICIENCY OF FEED CONVERSION (KG FEED/ 10 EGGS PRODUCED)

Source	df	ss	ms	F
Rep. (r-1)	2	0.2929	0.1465	1.17[N.S]
Treatment (t-1)	5	17.9031	3.5806	28.61**
Residual (t-1) (r-1)	10	1.2512	0.1251	

SEM = 0.2450

** Indicates significant difference due to treatment.

+Appendix 4: ANOVA FOR PERCENT HEN-DAY EGG PRODUCTION

Source	df	ss	ms	F
Rep (r-1)	2	45.95	22.97	2.07NS
Treatment (t-1)	5	606.52	121.30	10.96**
Residual (t-1) (r-1)	10	110.64	11.06	

SEM = 1.5347.

** Indicates significant difference due to treatment
+Indicates that ANOVA for percent hen-day is the same for percent hen housed egg production.

Appendix 5: ANOVA FOR FEED COST PER TEN EGGS

Source	df	ss	ms	F
Rep. (r-1)	2	7.084	3.542	1.34[NS]
Treatment (t-1)	5	133.281	26.656	10.10**
Residual (t-1) (r-1)	10	26.390	2.639	

SEM = 0.7170

** Indicates significant difference due to treatment.

Appendix 6: ANOVA FOR EGG YOLK PIGMENTATION.

Source	df	ss	ms	F
Rep. (r-1)	2	0.0400	0.0200	1.66
Treatment (t-1)	5	334.8200	66.9640	5580.33
Residual (t-1) (r-1)	10	0.1200	0.01200	

SEM = 1.0168

** Indicates significant difference due to treatment.

Appendix 7: ANOVA FOR YOLK INDEX

Source	df	ss	ms	F
Rep. (r-1)	2	0.0010	0.0005	16.67**
Treatment (t-1)	5	0.0001	0.00002	0.67
Residual (t-1) (r-1)	10	0.0003	0.00003	

SEM 0.0021

** Indicates significant difference due to replicate

Appendix 8: ANOVA FOR HAUGH UNIT SCORE

Source	df	ss	ms	F
Rep. (r-1)	2	2.2972	1.1486	1.12^{NS}
Treatment (t-1)	5	1.00	0.200	0.195^{NS}
Residual (t-1) (r-1)	10	10.2529	1.0253	

SEM = 0.2045

NS Indicates no significant difference due to rep. and trt.

Appendix 9: ANOVA FOR MEAN EGG WEIGHTS

Source	df	ss	ms	F
Rep (r-1)	2	2.3025	1.1513	0.25^{NS}
Treatment(t-1)	5	9.73	1.946	0.42^{NS}
Residual (t-1) (r-1)	10	46.6975	4.6697	

SEM = 0.4269

N.S Indicates no significant difference due to Rep and [illegible]

Appendix 10: ANOVA FOR PERCENTAGE CHANGE IN BODY WEIGHT

Source	df	ss	ms	F
Rep (r-1)	2	6.4355	3.2178	1.20
Treatment (t-1)	5	747.49	149.50	55.86^{*}
Residual (t-1) (r-1)	10	26.764	2.6764	

SEM = 1.5523

** Indicates significant difference due to treatment.

EGG YOLK PIGMENTATION STUDY

Appendix 11 ANOVA FOR EGG YOLK PIGMENTATION (RYCF Scores)

Source	df	ss	ms	F
Rep (r-1)	3	0.03333	0.01111	
Treatment (t-1)	5	471.305	94.261	6103.28**
Residual (t-1) (r-1)	15	0.23167	0.101544	

SEM 0.9048

** Indicates significant difference due to treatment.

Appendix 12: ANOVA FOR EGG WEIGHT

Source	df	ss	ms	F
Rep (r-1)	3	22.45	7.4833	0.68^{NS}
Treatment (t-1)	5	11.37	2.27	0.21^{NS}
Residual (t-1) (r-1)	15	165.7967	11.05	

SEM = 0.5887

N.S. Indicate no significant difference due to Rep and treatment.

Appendix 13 ANOVA FOR HAUGH UNIT SCORE

Source	df	ss	ms	F
Rep (r-1)	3	16.53	5.51	3.01^{NS}
Treatment (t-1)	5	19.75	3.95	2.16^{NS}
Residual (t-1) (r-1)	15	27.52	1.83	

SEM = 0.3385

N.S Indicates no significant difference due to Rep and treatment

Appendix 14 ANOVA FOR FEED CONSUMPTION (g feed/bird/day)

Source	df	ss	ms	F
Rep (r-1)	3	1171.73	390.58	2.06^{NS}
Treatment(t-1)	5	1336.89	267.38	1.41^{NS}
Residual (t-1) (r-1)	15	2848.61	189.91	

SEM = 3.0497
N.S Indicates no significant difference due to Rep and treatment

+ Appendix 15: ANOVA FOR PERCENT HEN-DAY EGG PRODUCTION.

Source	df	ss	ms	F
Rep (r-1)	3	50.55	6.85	0.28^{NS}
Treatment (t-1)	5	39.55	7.91	0.13^{NS}
Residual (t-1) (r-1)	15	894.68	59.65	

SEM = 1.3075
N.S Indicates no significant difference due to Rep and treatment

+ Indicates that ANOVA for percent hen-day egg production is the same for percent hen housed egg production

Appendix 16: ANOVA FOR FEED EFFICIENCY (Kg feed/10 eggs)

Source	df	ss	ms	F
Rep (r-1)	3	0.092	0.03	0.15^{NS}
Treatment (t-1)	5	0.54	0.108	0.51^{NS}
Residual (t-1) (r-1)	15	3.178	0.21	

SEM 0.0813.
N.S. Indicates no significant difference due to Rep and treatment

Appendix 17: ANOVA FOR FEED COST/10 EGGS (N/10 eggs)

Source	df	ss	ms	F
Rep (r-1)	3	2.62	0.87	0.13^{NS}
Treatment (t-1)	5	11.88	2.38	0.36^{NS}
Residual (t-1) (r-1)	15	97.90	6.53	

SEM = 0.4417
N.S Indicates no significant difference due to Rep and treatment

Appendix 18: Calculation of AME and AMEn of basal and substituted ration and their efficiency of utilisation

(i) Substituted ration:

Feed intake (gm) = 971

Dry weight of faeces (gm) = 499.5

Gross energy of feed (Kcal/kg) = 4280

Gross energy of faeces of fed birds (Kcal/kg) = 3540

Gross energy of faeces of unfed birds (kcal/kg) = 3027

Nitrogen in feed (g/g feed) = 3.36

Nitrogen in faeces (g/g faeces) = 3.67

$$AME = \frac{(\text{Feed intake x Gross feed energy}) - (\text{Faeces weight x G.E of faeces})}{\text{Feed intake}}$$

$$= \frac{(971 \times 4280) - (499.5 \times 3540)}{971} = \frac{4155880 - 1773540}{971} = 2458.96 \text{ kcal/kg}$$

AMEn = AME - 8.22 (gN/g feed - gN/g faeces)

= 2458.96 - 8.22 (3.36 - 3.67)

2458.96 - 8.22 (-0.31)

2458.96 - 2.5482 = 2456.41 kcal/kg

Efficiency of utilisation of AME

$$= \frac{AME \times 100}{GE} = \frac{2458.96 \times 100}{4280} = 57.45\%$$

Efficiency of utilisation of AMEn

$$= \frac{AMEn \times 100}{GE} = \frac{2456.41 \times 100}{4280} = 57.39\%$$

TME of substituted ration (80% basal + 20% S.M diet)

$$\text{TME (Kcal/kg)} = \frac{4280 \times 971 - (3540 - 3027)}{971} = 2018.78 \text{ Kcal/kg.}$$

(ii) Basal ration:

Feed intake (gm) = 864

Dry weight of faeces (gm) = 465

Gross energy of feed (Kcal/kg) = 4680

Gross energy of faeces of fed birds (Kcal/kg) = 3490

Gross energy of faeces of unfed birds (Kcal/kg) = 3027

Nitrogen in feed (g/g feed) = 2.75

Nitrogen in faeces (g/g faeces) = 3.35

$$\text{AME} = \frac{(\text{Feed intake} \times \text{Gross energy of feed} - (\text{Faeces weight} \times \text{G.E of faeces})}{\text{Feed intake}}$$

$$= \frac{(864 \times 4680) - (465 \times 3490)}{864} = \frac{4043520 - 1622850}{864} = 2801.7$$

AMEn = AME - 8.22 (gN/g feed - gN/g faeces)

2801.7 - 8.22 (2.75 - 3.38)

2801.7 - 8.22 (-0.6)

2801.7 - 4.932 = 2796.77

$$\text{Efficiency of utilisation of AME} = \frac{\text{AME} \times 100}{\text{GE}}$$

$$= \frac{2801.7 \times 100}{4680} = 59.87\%$$

Efficiency of utilisation of AMEn

$$= \frac{AMEn \times 100}{GE} = \frac{2796.77 \times 100}{4680} = 59.76\%$$

TME of basal ration

$$= TME\ (Kcal/kg) = \frac{4680 \times 864 - (3490 - 3027)}{864}$$

$$= 2172.08\ kcal/kg$$

The ME of the test ingredient was then calculated using a simple algebraic equation.

If AME of the basal diet "X" was "a" Kcal/kg and that of 20% substituted heat treated S.M diet "Y" is b Kcal/kg, then the equation becomes:

$$1x = a\ Kcal \quad \text{so that} \quad x = \frac{a\ Kcal}{1}$$

$$0.8x + 0.2y = b\ kcal$$

$$0.8\ a\ kcal + 0.2y = b\ kcal$$

$$0.2y = b - 0.8\ a$$

$$y = \frac{b - 0.8\ a}{0.2}$$

Therefore

$$1x = 2801.70 \quad \text{and} \quad x = \frac{2801.70}{1}$$

$$0.8x + 0.2y = 2458.96$$

$$0.8 \times 2801.70 + 0.2y = 2458.96$$

$$Y = \frac{2458.96 - 0.8 \times 2801.70}{0.2} = 1088.00 \text{Kcal/kg}$$

Efficiency of utilisation of ME of heat-treated sheep

$$\text{manure} = \frac{1088.00 \times 100}{4640} = 23.45\%$$