NUTRITIVE VALUE OF WHEAT OFFAL IN THE FEEDING OF SHEEP

By

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DECLARATION

I hereby declare that this thesis has been written by me and that it is a record of my own research work. It has not been presented in any previous application for a higher degree. All quotations are indicated and the sources of information are specifically acknowledged by means of references.

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CERTIFICATION

This thesis by Juliana Uchenna Abii meets the regulations governing the degree, Master of Science of Ahmadu Bello University and is approved for its contribution to scientific knowledge and literary presentation.

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CONTENTS

DEDICATION

To my dear parents, Hyacient and Maria Abii,

My sisters and brothers,

and my darling niece, Nkeiru;

With kind thoughts.

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ABSTRACT

Two experiments were carried out with male and female (non-pregnant and non-lac tating) Yankasa sheep to determine the nutritive value of wheat offal. The two experiments were growth experiments and lasted for 56 and 70 days respectively. The treatments consisted of the following wheat offals levels, 0, 30, 60 and 90%.

The results indicated that up to 30% wheat offal could be incorporated in the diet of sheep. The 30% wheat offal diet supported increased feed intake, weight gain and feed conversion efficiency. Increasing the level of wheat offal up to 60% resulted in reduced (P/0.05) feed intake and weight gain though the feed conversion ratio was not significantly affected. The 90% wheat offal resulted in further reduction in feed intake, weight gain and feed conversion ratio.

The production cost revealed that the 90% wheat offal diet effected the highest cost per kilogram of body weight gain even though this cost did not significantly differ from that of the 30% wheat offal diet. However, the time taken to gain this weight differed greatly (P/0.05) between the two diets (7 and 21 days for the 30 and 90% whət offal diets respectively). Time factor also made the 30 and 60% wheat offal diets significantly different (P/0.05). The time was 7 days for the 30% and 12 days for the 60% wheat offal.

Dry matter digestibility. for the wheat offal diets was not significantly (p/_0.05) different, however, the 30% wheat offal diet had the highest digestibility which was significantly (p/_0.05) higher than that of the control diet. There was no significant difference among treatments in nitrogen digestibility.

INTRODUCTION

Proteins of animal origin (meat, egg, milk and fish) have higher biological value than those of plants or cereal origin. Production and availability of animal protein is one of the most effective ways of reducing hunger in man. (Nuru, 1975). The Food and Agricultural Organisation (FAO 1968) reported that animal protein contributed only 8.6g of an estimated 51,7g daily per capital protein supply of an average Nigerian diet. He further stated that these figures decreased to 6.3 of a total of 45.1 by 1976. Oyenuga (1966) gave a comparison of the daily animal protein consumption in Nigeria with those of the following countries: USA - 65g, UK - 45g, Germany - 49g and Australia - 45g.

Usually, healthy animals would fulfil their genetic potential in the conversion of feeds which are unusuable by man for performance and production. It has been accepted that for any successful livestock production in Nigeria, the feeding of concentrate supplements is very essential during the dry season when herbage quantity and quality are at their lowest levels. Grains and protein concentrate usually for a major proportion of these concentrates which supply energy and or protein which may be deficient in all forage diets.

For a long time, maize has been the major ingredient used in the formulation of highly efficient diets for ruminants. But the availability of maize in large quantity to meet livestock requirements has been limited because maize is still a major source of food for people in this country. This has lead to the scarcity of the commodity, a situation which has aggravated in recent time. It is therefore necessary to find alternative sources of supplementary feed for livestock in order to reduce the competition between man and animal for the little available grains. Devendra and Ragharan (1978) recommended an increased efficiency in the utilisation of agro-industrial by-products as both advantageous and justified, and indentified three salient reasons for their use:

1. Inadequate feed supplies to support livestock population.
2. High cost of feeding animal
3. The need to increase producivity from the animals.

They concluded that every attempt must therefore be made to maximise their utilisation in the rations for farm animals.

As an industrial by-products, wheat offal is relatively cheap (about ₦250.00 per ton), compared to maize which sold at about ₦720.00 per ton or groundnut cake which sold at about ₦700.00 per ton. Apart from the fact that it is cheaper than maize, a comparison of the chemical composition of these ingredients show that wheat offal is comparable to maize (Table 1). Although maize has slightly higher ME value (3439 Vs 2910 Kcal/kg) than wheat offal, the protein (17.6%) is about twice that of maize (8.6%) and it is about four times richer in minerals than maize (5.4% Vs 1.67%), while the ether extract contents of the two are about the same (Nelson, 1984). Furthermore, it has been used extensively, in poultry production.

The objective of this study is therefore to exploit the possibility of using wheat offal as the major concentrate (energy and protein) source in the diet of sheep. The use of this local industrial by-product in cutting down cost and producing cheap feed of acceptable quality may stimulate the interest of farmers to increase production.

Nutritional Constraints imposed by Rumen Function.

Recent research has shown that even when the digestible energy is not limiting, productivity in ruminants is governed by the availability of essential amino acids and glucose precursors at the site of metabolism (Preston 1974). The pattern of these two requirements closely paralled each other, and both are directly related to the productive rate. The significance of this relationship lies in the fact that the rumen function processes are apparently incapable of supplying

Table 1: Percentage composition of some feedstuffs.

	Brewers' dried Grain	Yellow corn (ground)	Wheat bran	Cotton seed cake	Peanut meal & Hulls Ex Pelle
Protein	26	8.8	15.0	41	45
Fat	6	3.8	3.5	1.5	6
Fibre	15	2.5	10.5	13.0	11.5
+ME_p	1155	1550	570.0	830.0	1100.00
++ME_s	775	1550	1055.0	1070.00	1475.00
Amino acids					
Arginine	1.300	.450	1	4.50	5.00
Histidine	.500	.190	.300	1.1600	1.00
Lysine	.900	.250	.600	1.700	1.40
Tyrosine	1.200	.410	.400	.950	
Tryptophan	.400	.090	.270	.600	.50
Phenylalanine	1.300	.450	.500	2.300	2.30
Cystine	.400	.160	.300	.850	.80
Methionine	.400	.200	.180	.650	.50
Thronine	.900	.630	.400.	1.450	1.40
Leucine	2.300	1.100	.900	2.500	3.10
Isoleucine	1.500	.400	.600	1.600	2.00
Valine	1.600	.400	.720	2.100	2.20

++ME_s = Metabolisable energy for swine in Kcal/lb

+ME_p = Metabolisable energy for poultry in Kcal/lb

All other constituents in percentages.

Source: Nebraska Computer Feed Formulation Data Feed Ingredients Analysis and Ration Specifications and Restrictions (Revised 1973).

the amounts of amino acids and glucose needed to support high levels of production cycle reflecting rapid growth in young animals and high levels of milk production.

Two sets of factors are responsible for this situation. If amino acid supply is to depend only on rumen synthesis, then it will be governed by the intake of fermentable energy and efficiency of microbial synthesis. The evidence according to Orskov, (1970) indicated that even when these two factors are operating at maximum attainable levels, the amount of microbial protein synthesized approached adequacy only for late growth early and mid-pregnancy and mid and late lactation. Both fast growth in young animals and early lactation represent critical points when considerable supplementation with preformed protein is required.

A similar situation applies to glucose. The principal precursors of glucose are:

a) propionic acid produced by fermentation in the rumen;
b) starch arriving at the small intestine where it can be hydrolyzed directly to glucose, and
c) amino acids surplus to requirements.

This latter source is the least efficient of the three, since only certain fragments of amino acids can serve as glucose precursors. If the animal has to depend on the rumen function, the only available source of glucose will be propionic acids, and in fact, there is more likely to be a deficiency. The picture with respect to propionate as the only supply of glucose is not conclusive, but recent evidence appears to indicate that even with molar proportions of propionic acid as high as 35%, the rapidly growing ruminant will still respond to glucose precursors in the form of dietary starch arriving at the duodenum. (Silverstre et al. 1976) or to glucose that by-passes the rumen via the oesophageal groove reflex (Fernadez et al. 1976).

It appears, therefore that high rates of production in ruminants can only be ensured by dietary supplies of pre-formed protein and glucose precursors in such a form that they will arrive, in part, at the site of metabolism as amino acids and glucose respectively.

REVIEW OF LITERATURE

Management of Sheep in Nigeria

Free range is the common system of management except in research stations. Adu (1980) described free range as a situation where the animals are allowed to roam about fending for themselves, denuding overgrazed ranges with little care for housing nor veterinary services. In the rainny season (especially in the Sahel and guinea savannah zones), the grass the animals feed on comprise mainly of annual and perennial species dominated by genera like Andropogon, Pennisetum and Digitaria species. The case is quite different during the dry season. Umunna (1982) reported that the biggest management problem facing livestock owners at this period is the provision of adequate feed. In the dry season, forages decrease in quality because of increased cellulose and lignin contents and low protein levels. These result in decrease in voluntary intake and digestibility of forages by the animal. These in turn result in weight loss and reduced performance by the animals; low disease resistance, reduced fertility, slow growth rate of young animals and as reported by Osori (1976) seasonal anoestrus.

Protein metabolism in ruminants

Protein is the first limiting nutrient for ruminants grazing indigenous forages during the dry season. Proteins are expensive and in great demand for the feeding of non-ruminants. Protein requirement for growth is such that it should be adequate for repair, replacement and building of new tissues. The rate at which new tissues are being deposited and the size of the animal govern the amount of dietary protein requirement. A variety of nitrogen sources could be used by ruminants and this requires knowledge of the metabolism of these compounds by ruminants. Ruminant animals have two protein synthessing systems; rumen microbes and ruminal tissues.

Proteins fed to ruminants are broken down in the rumen to ammonia (NH_3) and volatile fatty acids (VFA). Not all plants proteins are broken down to the same extent. For instance, soyabean meal protein is [illegible] broken down to a greater extent than protein from grains or brewer's dried grains. Plant protein not broken down in the rumen is ultimately bypassed to the lower intestinal track where it is utilised more efficiently. Some of the injested protein passes and undergoes digestion in the true stomach and intestine, but a large part of it is broken down by micro-organism in the rumen to amino acids and simpler nitrogen notably ammonia which are in turn used by the micro-organism to build their own protein tissues. McDonald (1954) found that when 94% of the total nitrogen in a sheep's ration was fed as zein, 40% of it was used by rumen micro organism to synthesize their own protein.

El-Shazly (1952) reported that the volatile fatty acids formed from the microbial breakdown of amino acids and other non-protein compounds appeared to be acids with two to five carbon chains. Those with five carbon atoms were principally branched-chain acids which, though absorbed were probably not available for resynthesis of amino acids. Downess (1961) showed that the amino acids isoleucine, leucine, lysine, methionine, phenylalanine, tyrosine, threonine, valine and histidine were metabolically essential to the ruminant. Purser (1970) reported that ruminant nitrogen metabolism or amino acid utilisation, is capable of being influenced by a combination of any of the following factors and possibly more:-

1. Nitrogen metabolism within the rumen, e.g. protein solubility
2. The composition of the microbial population
3. Nutrient availability within the rumen, including relative availability and rate of availability of specific nutrients, growth factors included.
4. Timing of nutrients availability to the animals' metabolic system.
5. Digestibility of specific amino acids from proteins in the lower alimentary tract in particular from bacterial protein.
6. The possible influence of specific free amino acid

patterns in the gut upon both the rate of absorption of specific amino acids and upon the composition of amino acids being absorbed at any one time.

Pearson and Smith (1943) indicated that ammonia was the product of nitrogen metabolism in the reticulo rumen. The level of concentration of ammonia in the rumen liquid postprandial depends on:

1. The amount of food ingested per unit time
2. The solubility of the protein taken
3. The nutritional balance of the diet, all of which are related to the various stages of microbial activity in the reticulorumen. (Orskov et al. 1975;

The extensive deamination of free amino acids result in the high concentration of ammonia-nitrogen after feeding. They further enumerated the factors that govern the degree of protein hydrolysis in the rumen resulting in the production of free amino acids initially and then to ammonia as follows:

1, Protein retention time in the rumen, this is linked to the physical presentation of the food particle size, form and weight,
2, The degree of solubility and dispersion of the protein in the rumen fluid,
3, Stimulating effect of the diet on the growth of the bacteria,

4. Factors related to the physiological indiosyncrasis of the individual animals with rumen microbial population.

McDonald (1948) reported that the major portion of ammonia is absorbed through the ruminal walls into the portal blood, and carried to the liver where it is converted into urea; whereas greater part of the urea is excreted in the urine, part of it is recycled back to the rumen via the saliva and blood. Increased quantity of rapidly available carbohydrate decrease the concentration of ammonia in the rumen, thereby improving the utilisation of protein and non-protein nitrogen.

Effect of pH on protein metabolism in the rumen.

While Ranjhan (1980) remarked that proteins were degraded at a faster rate with increasing acidicity, some other researchers had different views. For instance, Hagemeister et al. (1976), and Whitelaw and Preston (1963) reported that highly soluble proteins were highly degraded. They argued that since the rumen pH is about neutral, and since protein solubility in the rumen decreases with increasing acidity, it implies therefore that decreasing the rumen pH will decrease ruminal protein degradation by way of reducing protein solubility.

Effect of concentrate to roughage ratio on feed digestibility.

Mitchel (1942) reported that there was close negative relationship between crude fibre content and the digestibility of organic matter of feeds by different species of animals. Cutchbertson (1969) explained this as due in part to physio chemical changes such as increasing crystallinity, or higher degree of polymerisation of cellulose but more importantly, due to increase in lignification. An explanation to this as stated by him is that it may reduce the extent and rate of breakdown of the structural carbohydrates by combining chemically with them to form materials that are resistant to enzymic degradation.

Since increase in crude fibre is known to reduce digestibility of feeds, increase in the proportion of concentrate will therefore be expected to improve the digestibility of the total ration. Adeleye and Ikhatua (1977) and Kwatu (1982) reported an increase in total dry matter digestibility with increase in the concentrate portion of the diets. Crude protein digestibility was also increased with increase in the concentrate portion of the diet of ruminants. The effect of concentrate supplementation on digestibility of crude fibre is however not very clear; while Adeleye and Ikhatua (1977) reported better digestion of crude fibre at high concentrate levels, and attributed this to the earlier findings of Kane et al. (1959) who reported very high build up of rumen microorganism at high concentrate levels which are responsible for the increased breakdown of crude fibre; Nelson et al. (1968) reported lower crude fibre digestibility with increase in the concentrate portion of the diet of cows and related this to the changes in the microbial population, a build up of lactate, lowering of rumen pH and reduction in cellulolytic activity of the rumen.

Effect of Concentrate to Roughage ratio on Liveweight Gain

Despite the obvious advantages of high concentrates to ruminants, there are however some associated problems. For example, cattle receiving all concentrate without a minimum roughage allowance are prone to developing acidosis and other digestive problems (Morris 1966). Very high concentrate feeding has been observed to "burn out" the animals resulting in sluggish appetites and low gains. (Neuman and Snapp 1969). Many studies have shown that supplementing roughages with concentrates result in improved performance by ruminant animals. Levy et al. (1975) observed that animals on low roughage diet were approximately 11% more efficient in converting metabolisable energy to gain. Ridenour et al. (1982) reported that in the growing phase, cattle fed 85% concentrate diet had higher average daily gain and better conversion efficiency than those fed 50% concentrate diet. However, in the finishing phase, they reported that steers fed 50% concentrate diet had higher (though non-significant) average daily gain than those fed 85% concentrate diet. Adu and Brinckman (1981) and Kwatu (1982) have reported better performance of sheep in terms of average daily gain, feed efficiency, dressing percentage of prime cuts with increase in the concentrate portion of the diet. Crude fibre has been defined as that portion of a feedstuffs that is insoluble, less digestible and ash free and which remains after rigorous boiling with dilute alkali and with dilute acid (Lloyds et al. 1978; Feltwell and Fox 1978; Cullison 1978). It consists primarily of cellulose, hemicellulose and lignin which are known to be almost valueless to non-ruminant. According to Mitchel (1964) cellulose is a carbohydrate, a polymer of D-glucose while lignin which has not been obtained in crystalline form consists of phenyl-propanoid building units and is not a carbohydrate as such. Very fibrous foods are normally too fluffy and carry a low proportion of nutrients per unit volume rather than per unit weight (Feltwell and Fox 1978). In compiling the digestibility of fibre from different sources, using ruminant animals, Crampton and Harris (1968) indicated that fitre from wheat short and wheat offals are presumably the same materials with digestibility ranging from 53% to 90%. Similarly, digestibility of oats, oats chippings, rolled oats and oat hulls ranged from 38-80%.

Albanese (1963) stated that although monogastric animals do not have the necessary enzymes for degrading cellulose, however, in some instances, a considerable amount of the cellulose may be utilised. He further explained that in cases like this, bacteria present in the intestines have enzymes capable of degrading cellulose. Lloyd et al. (1978) described the site and digestibility of crude fibre by various species of animals as follows:

Species	Site	% Digestibility
Ruminants	Rumen, colon	50-90%
Pigs	Caecum, colon	3-25
Rabbit	Caecum	16-18
Guinea pigs	Caecum	34-40
Poultry	Caecum	20-30
Human	Small & Large intestine	25-35

Some nutritional considerations in the choice of feed sources.

In assessing the potential use of a source of feed, and characterizing the specific suitability, due regard must be paid to the requirements in quality and quantity by ruminants and non-ruminants. For example, the later requires all their nitrogen through amino-acids while protein quality is mainly a function of digestibility and the pattern of the digested amino acids. In contrast to this, advantage should be taken when ever possible of the ruminants' ability to synthesis microbial protein from appropriate sources of non-protein nitrogen and energy. Dietary protein may constitute only a part of the amino acids required at the metabolic level, and this part should be optimised on both a physiological and on economic basis, In growing or lactating animals for instance, the contribution from rumen synthesis hardly exceeds around 60%. The difference has to be made up through the diet, the amino acid being required in the rations similar t those of monogastric (Chenost et al. 1982). The usefu ss of a dietary protein source for taking over this function depend in addition to its digestibility and amino acids composition on its solubility in the rumen. The significance of solubility seems in turn to be influenced by protein feeding levels. Thus low solubility means little degradation of the protein by rumen microbes and good availability of the amino acids for absorption in the intestine. Potential savings in dietary protein input depend largely on the combination of these three factors in a given source so that they may convinently form the basis for grading the usefulness of a protein as dietary supplement, (Chenost et al. 1982).

Agro-industrial by-products

Agro-industrial by-products for feeding livestock present a number of advantages:

1. Availability in substantial quantities
2. Relatively low or no cost
3. Low feeding value of tropical forage
4. Justification for supplementation
5. Feed shortage during periods of scarcity and uneven distribution.
6. Improved efficiency of the stall-feeding system.

The phrase "reducing feed cost" suggests the finding of cheaper feeds which immediately brings to mind the use of by-products. The most important benefit associated with the utilisation of agro-industrial by-products is the possibility of decreasing the cost of feeding without lowering the performance of livestock. The opportunity for using by-products exists only where they are already generated as one does not deliberately set out to produce a by-product. Their use often allows a reduction in feed cost because the primary product bears the major cost of the process and the by-products must be disposed of at some cost to the generator. The cost of any by-product to the livestock producer is seldom related to its nutritive value; it is more likely determined by the demand for it or the cost of alternative means of disposal. While this applies to all categories of livestock, probably the most worthy impact is with those species whose demand for nutrients is high. Since supplementation with concentrate is necessary for high production, meeting the requirement will call for skill in covering the high nutrient demand from the available feedstuff. Without exception, meeting the energy needs of the high-producing dairy and or meat animal, from maize is not only expensive but, even more importantly competes with human needs. The situation is such that in Nigeria, high energy feeds, such as maize sorghum etc. are very expensive. The justification for concentrate supplementation according to Devendra (1975c) is associated with four factors:

1. The scarcity of nutrient from both the quantitative and qualitative stand points
2. Restriction in energy uptake imposed by bulky forages
3. Relatively low prices of alternative mixed feeds from agro-industrial by-products
4. Increased milk yield of monetary value greater than the cost of the feed required to produce it. Since

concentrate supplementation is a must for especially lactating ruminants, judicious feeding and skilled manupulation of the feed ingredients is essential.

The extent of this supplementation also dictates to a very large extent the margin of profit from the enterprise.

By-products

Any excess material produced following an industrial processing of a target product is refered to as residue; and when the residue is utilised, it is refered to as by-product.

Agro-industrial by-products are usually cheap protein and energy supplements to forages; examples of which includes wheat bran, palm kernel meal, cotton seed meal, molasses, groundnut cake etc. The quantity of protein (A.R.C. 1980) and energy (Preston 1982) supplements as related to rumen function influence their values. The supply of protein to the host through microbial production alone is not sufficient to maintain high levels of production.

By-products used as energy source:

This group of agro-industrial by-products are rich in fermentable carbohydrates but low in nitrogen. The most important by-product in this category in Nigeria is molasses.

Nutritive value of Molasses:

The production of molasses in Nigeria for the 1980/81 period was among the lowest of sugar-producing countries of Africa (Barreveld, 1982). The subcommittee on Beef cattle nutrition committee on animal nutrition gave the nutrient composition of cane molasses as follow: Dry matter 74%, Crude protein 3%, DE 1080 Kcal/kg, Crude fibre 0.06%, Calcium 0.66%, Phosphorus 0.08%. It has been shown that high levels of molasses feeding in the absence of other fermentable energy sources produces low-levels of propionic acid (the chief glucose precursor) and more of butyric acid. (Clark et al. 1972 and Chenost and Mayer et al. 1977).

The work of Umunna and Maisamari (1981) showed that average daily gain was significantly affected by molasses inclusion. They reported that rams fed 10% and 20% molasses diets gained weight significantly fast than those on the control diet but observed a non-significant difference in the average daily dry matter intake across treatments. Although Heinervan and Hanks (1977) observed a non-significant difference in the intake of dry matter among cattle fed diets with and without molasses, they observed a slight increase in dry matter intake among those with molasses in their diets. The work of Ernst et al. (1974), showed a greater roughage dry-matter intake by steers fed hay with urea-molasses supplements than steers fed hay with urea or molasses supplements alone. The least intake was observed in the control group. They observed a non-significant difference on the apparent digestibility of dry matter or organic matter among the groups. They also reported the apparent digestibility of crude protein to be significantly improved by the supplements containing urea. Furthermore, Winks et al. (1970) reported an improved liveweight performance of weaners fed a molasses-urea supplement during the dry season.

Molasses has actually received considerable attention as a urea-carrier for low quality forage supplementation. It is also known to reduce dustiness and improve palatability of feeds. Ogunfowora et al. (1975) recorded a daily weight gain of 0.8kg in fattening steers of Keteku and N'dama breeds fed 4kg molasses plus 2kg cottonseed cake daily in addition to bush grazing. But, with pigs, Baustad (1973) reported a better feed conversion efficiency in those fed a 20% molasses diet than those on 39% molasses. (3.8kg feed/kg gain Vs 4.5kg feed/kg gain).

By-products used as energy and protein sources:

This is an intermediate class between energy and protein supplements. It includes cereal grain by-products. The composition and usefulness of these products vary with the production efficiency and level of husk present. Only the more fibrous of the cereal milling by-product is more readily available to ruminants in commercial quantities. (New feed sources 1982).

Some of these commonly available agro-industrial by-products for ruminant's feeding include brewers dried grain, wheat offal, cottonseed cake, palm kernel meal, groundnut cake, Rice bran, soyabean meal etc.

Nutritive value of cottonseed cake (CSC):

Cottonseed cake is high in protein and other nutrients but the presence of gossypol which is poisonous to pigs and poultry has restricted its use in compouhd feeds. The nutrient composition of cottonseed cake (delinted and decorticated) as given by Bello (1984) for poultry is as follows: crude protein 42%, oil 3.7%, fibre 14% and metabolisable energy 1980 Kcal/kg. Table 2 shows a comparative nutrient composition of cottonseed cake and other by-products. While same researcher reported that an inclusion of as low as 5% cottonseed cake in the ration of swine caused reduction in growth; Others observed that higher levels of up to 27% led to satisfactory swine performance when iron salts were added at an iron/total gossypol ratio 1:1. Furthermore, Noland et al. (1982) reported an inclusion of up to 24% cottonseed cake without detrimental effect in pigs ration - without iron additive but with lysine added to the diet and free gossypol level of cake shown to be less than 0.01%. Furthermore, whereas Bello (1984) had stated that an inclusion of up to 5% cottonseed cake in the rations of laying chicken had caused the laying of eggs with olive green yolk if stored for more than three days.

Table 2 : Nutrient values of some by-products of Plant Origin

	% Crude Protein	% Oil	% Fibre	Total Phosphorus %	% Calcium	% Lysine	% Methionine	M.E. Kcal/kg
Groundnut cake	48-52	6.0	5.0	0.60	0.20	1.60	0.48	2640
Soyabean meal	46.0	1.0	5.2	1.0	0.21	3.0	0.63	2420
Cashew Nuts	20.0	38.0	4.0	0.45	0.05	0.90	0.30	2860
Palmkernel meal	18-20	6.0	12.0	0.48	0.21	0.64	0.39	2178
Coconut meal	20.0	6.0	12.0	0.60	0.20	0.70	0.31	1870
Cottonseed meal	42.0	3.6	14.0	0.90	0.15	1.60	0.55	1980
Wheat bran	17.0	3.50	8.5	0.90	0.10	0.90	0.25	1870
Rice bran	11.0	12.50	12.5	1.42	0.04	0.50	0.24	2860
Brewers' Yeast	35-40	1.00	3.0	1.40	0.10	3.40	0.70	2420
Dried Brewers' grains	18-20	6.00	20.0	0.05	0.20	0.9	0.40	1960

Source: Azeez O. Bello: Livestock Feeds. Nigeria Journal of Animal Production June and December 1984, Nos. 1&2 Vol. II.

Armas and Chicco (1972) fed diets containing up to 25% cottonseed cake and reported adequate weight gain. The presence of gossypol in cottonseed cake has restricted its use to ruminant feeding in Nigeria. With ruminants, it is considered an adequate protein supplement and often represents from 20% to 30% of the total ration for lactating cows and fattening steers and lamb. Even though the gossypol content in the amounts of cottonseed cake fed to cattle has generally been considered non-toxic, McNight (1968) indicated that when up to 880 ppm gossypol was in the total diet, addition of ferrous sulphate to provide an iron:gossypol ratio of 1:1 improved weight gain in cattle. Ogunfowora et al. (1975) reported a 30% inclusion in the ration of fattening cattle; while Lawrence and Mugerwa (1974) reported an inclusion of up to 26% level of cottonseed cake in a production ration for lactating animals in Ugandan. Up to 50% cottonseed cake in concentrate feeds has been fed as supplement to sheep on Digitaria hay with satisfactory results (Ehoche et al. 1983). Alhassan (1983) indicated that cottonseed cake was the most widely used oil seed cake for ruminant animal - feeding in Nigeria due to its availability and cost relative to that of its close competitor groundnut cake.

Palm Kernel Meal (PKM):

Palm kernel meal is the main by-product of the palm oil industry. It has an appreciable oil content though it is usually dry, gritty and unpalatable unless mixed with other feedstuffs such as molasses (Oyenuga, 1968). Bello (1984) gave the nutrient composition of palm kernel meal as follows: crude protein 18-20%, oil 6%, crude fibre 12% and metabolisable energy 2178 Kcal/kg. Table 2 shows the complete nutritive profile of this meal. Oyenuga (1968) reported that ruminants could utilize palm kernel meal better than monogastric animals. Generally, 20% to 30% palm kernel meal are used in swine rations but satisfactory swine fattening has been reported using a ration consisting of 62.4% palm kernel meal, 35% maize and 2.5% blood meal and produced an average daily gain of 643g. (Gohl, 1975), Chicco (1976) reported acceptable results with 30% palm kernel meal in the rations for chicks but reduced gains at 45% level. Umunna et al. (1980) reported that cattle fed palm kernel meal supplemented rations had comparable growth to those fed groundnut cake or cottonseed cake supplemented rations. Collingwood (1958) reported increased butterfat production when palm kernel meal was fed to dairy cattle. while Babatunde et al. (1975) reported poorer feed efficiency, reduced growth rate and feed intake for pigs fed palm kernel meas as the major protein source.

Brewers' dried grains (BDG)

Brewers' dried grains are the dried, extracted residue of barley malt or other grains, alone or in mixture with other cereal resulting from the production of beer.

The mean metabolisable energy for swine as reported by Fetuga (1977) is 11.34 MJ/kg and ranged from 10.38 to 12.31 MJ/kg, while Deltoro-Leperz, (1981) reported a crude protein content of 28.5, ether extract of 7.5%, crude fibre of 11.7%, ash of 3.1% and non-ether extract of 49.5%. The amino acid content is superior to that of maize (Table 1) which is often used as the major source of energy in poultry rations in Nigeria. (Ademosun, 1973). Kienhilz et al. (1963)reported that a diet containing 40% brewers' dried grains supported excellent laying performance of caged birds. Furthermore, Ademosun (1974) and Jensen (1981) indicated that brewers' dried grains can be added into poultry starter and grower mash at levels of up to 10% and 15% respectively without any adverse effects on the performance of the birds. The work of Babatunde et al. (1975) showed that pigs could tolerate up to 15% of brewers' dried grains in the diet. Bhuthia et al. (1982) using 40% local brewers' dried grains reported declining feed intake values of growing finishing pigs, while Young and Ingram (1968) and Paliev et al. (1982) had reported that the inclusion of brewers' dried grains in diets for pigs at levels up to replacement of the dietary protein source did not significantly influence feed intake.

Wheat Offal:

Flour milling by-products such as wheat offals, wheat offal, wheat shorts have long been recognised and used in diets of livestock for variety of reasons. Table 3 shows the flour milling position in Nigeria and the availability of by-products.

Wheat offal comprises the husk of the grain with adhering endosperm. It is usually graded according to size as giants broads and fine bran, but in Nigeria a composite is what is sold. These grades are similar in composition though the giant bran is frequently higher in moisture (18%) content than the other grades which generally contain about 12%. It is the most fibrous of the by-products of wheat processing (Nelson, 1984). Depending on the variety of the grain, McDonald (1973) reported that the crude fibre content ranged from 8.5% to 12% and crude protein from 12.5% to 16%.

Though it has low metabolisable energy of 11.09 MJ/kg for chicks according to Fetuga (1977), Cave et al. (1970) reported that pelleting wheat bran increased it metabolisable energy by 30% for growing chicks. This is likely the effect of heat applied during pelleting which would have the effect of increasing the digestibility and consequently increasing the

Table 3: Flour Milling situation in Nigeria, showing by-product availability

Name	Installed capacity (tons)	Utilised capacity (tons)	Estimated Present Availability of wheat offal in 1975 (tons)	Projected capacity in tons (1980) Wheat offals	Estimated potentia Availability of Wh offal in 1980 (tor
Flour Mills of Nigeria Ltd. Apapa, Lagos	630,000	630,000	176,400	630,000	176,400
Port-Harcourt Flour Mills - PH	40,320	40,320	11,290	90,000	25,200
Life Flour Mills, Sapele	60,000	45,000	12,600	180,000	50,400
Northern Flour Mills, Kano	60,000	45,000	12,600	75,000	21,000
Crown Flour Mills, Lagos	-	-	-	105,000	29,400
Niger Best Flour Mills, Calabar	Na	-	-	-	72,800
Johnson Conselidated Ind. Ltd. Flour Mills Maiduguri	-	-	-	39,000	10,920
Total	790,320	760,320	212,890	1,145,000	320,600

Source: Azeez O. Bello: Livestock Feeds: Nigerian Journal of Animal Production (27) June and December 1984 Nos 1 & 2, Vol. II

NA = Not available

available energy. Morrison (1959) and Osuji (1982) reported that wheat bran is high in phosphorus, fairly high in niacin, low in riboflavin and practically has no vitamins A and D. Furthermore, Fetuga (1977) gave the nutrient composition of wheat bran as follows:- crude protein 18.2%, crude fibre 15.6%, ether extract 4.3%, ash 5.8%, non-fat extract 56% and metabolisable energy value of 11.09 MJ/kg. Wolter et al. (1980) reported that wheat bran, maize forage and sugar beet could be suitably incorporated in a balanced feed for ponies. Baker et al. (1974) worked with 200 gilts from conception to 109 days; they fed 1.9kg daily of a 12% protein diet based on maize and soyabean meal per animal; then, they fed a fully fortified maize and soya diet without or with 5% wheat bran replacing some maize and soyabean meal so that all the mixture had 16% crude protein. The diets were fed ad libitum for 28 days of lactation. From this study, they reported a no significant difference among treatments in litter size, weight changes, intake of creep feed and health of sows.

Olsen et al. (1970) observed that in a diet for pigs containing 50% maize, 20% wheat offal and 30% maize bran half of the maize could be replaced with wheat offal with no significant difference in the performance of the pigs as a result of the later diet. Babatunde et al. (1975) fed wheat offal and groundnut shells to pigs and reported that pigs on the various sources of fibre outgained pigs on the control diet though the differences among treatments were not significant.

The work of Tegbe (1984) showed that the replacement of 25 or 50% of the maize by wheat offal in a 16% crude protein diet did not affect the performance of grower pigs in terms of feed intake, gain and feed:gain ratios. Ranhjan et al. (1971) fed 10, 40, 60 and 70% wheat offal to pigs (14-15kg) and observed that growth of pigs was depressed with 60 or 70% dietary wheat offal. They however observed that feed:gain ratio was not significantly different. Whereas a non-significant difference in feed intake and feed:gain ratio of grower pigs fed 0, 23, or 43% wheat offal diets was reported by Dhudpket et al. (1971), a depressed gain in weight of pigs fed finisher diet containing 40% wheat offal was reported by Hines (1980).

Effect of wheat offal on chick performance:

Cave et al. (1965) reported that wheat offal gave poor feed intake and feed conversion efficiency in chicks when used as the sole energy source even though the diets were fortified with vitamins and minerals. Asai Netke (1971) reported that pullets grew satisfactorily on a diet composed of 60% wheat offal and and 30.9% groundnut cake meal when adequately supplemented with minerals and vitamins. Taylay and

Lerner (1939) observed that more rapid growth and early sexual maturity, were obtained when rations of chicks included 15.20% wheat offal than when an equivalent amount of whole wheat was included.

Haromoto et al. (1970) reported that wheat offal clearly reduced rumen pH and increased the volatile fatty acids and ammonia concentration within the rumen. He stated that this resulted in significantly greater digestibility of each component in straw as compared to feeding of rice straw alone. He thus suggested that wheat offal added to rice straw diet has some effect on the ruminating behaviour in relation to the changes in ruminant fermentation. It is known that wheat offal can be used as filler in animal feeds to lower protein and energy levels which had been shown to improve feed utilisation in animals. Also, due to the high fibre content of wheat offal, it can result in low digestibility of nutrients. Adu and Lakpini (1983) used up to 30% level of wheat offal in supplements for ruminants feeding and recorded no adverse effect. There are scattered evidence in literature on the replacement value of wheat offal for maize in the diets of pigs and poultry with resonable results. One of the factors militating against livestock industry in Nigeria is the problem of scarcity of cheap and nutritionaly adequate feedstuffs for livestock. The competition between man and livestock for cereal grains continues to increase with increasing population. Thus, it becomes an economic and perhaps moral issue using humanly acceptable feedstuff for animals where these feedstuffs are in short supply. The present study was designed to ascertain the nutritive value of wheat offal for maize in diets of fattening sheep.

EXPERIMENTAL PROCEDURE

General management and feeding of animals:

Yankasa sheep otherwise refered to as "Hausa" sheep were used in this study as they are the most nu... numerous and mostly widely distributed breed found in the savannah zone of Nigeria. They were purchased from the local market and then quarantined for a period of four weeks. During this period, they were fed native hay (Andropogon and Hyparrhenia species; predominating) and supplemented with vitamin A fortified supplement comprising cottonseed cake, bone meal, wheat offal, maize and molasses.

Both feed and water were made available ad libitum Blood and faecal samples were collected from the animals and analysed for worms. Since they were found to be heavily infested with helminths (Strongyles species), they were treated for both internal and external parasites. For the internal parasites, they were dewormed with Thiabenzole (Merck, Sharp and Dohme) and sprayed with lindane for external parasites.

All animals were individually fed ad libitum their experimental diets once daily in the morning (08.00hrs). They were housed in concrete floored and roofed barn. Feed refusals were weighed every two days on the basis of which adjustments were made in the quantity of feed fed to each animal. The animals were weighed every fortnight to monitor their progress. The initial and final weights were shrunk (that is without feed and water for about 18hrs).

Experiment 1: Growth study 1

Sixteen Yankasa sheep (male and non-pregnant dry ewes) of average initial weight 19kg and about 12 months old were used in this study which lasted 56 days. They were randomly assigned to four treatment diets and balanced for sex and initial weight. Treatment one which was the control (zero wheat offal comprised native hay and supplement fed at a ratio of 70% supplement to 30% hay. Wheat offal was added at graded levels of 30%, 60% and 90% in treatments 2, 3 and 4 respectively as shown in table 4.

Experiment 2: Growth study 2

In this study, experimental treatments were similar to those used in experiment 1 except that animals on treatments 2, 3 and 4 received in addition 50g of native hay. The hay was fed in order to determine if the incidence of diarrhoea that occured during growth study 1 could be controlled. Sixteen Yankasa sheep comprising 12 males and 4 females of average initial weight 18.5kg and under 20 months of age were used. They were randomly assigned to the four dietary treatments and balanced for sex and initial weight. The feeding and weighing of animals were as previously described for experiment 1. The study lasted 70 days.

Table 4: Percentage composition (DM basis) of supplement (1) and diets (2,3, & 4) fed in fexperiment 1

	Treatments			
	1	2	3	4
Trace mineral Premix	0.3	0.2	0.2	0.2
Salt	0.6	0.4	0.4	0.4
Vitamin A & D	+	+	+	+
Bone meal	2.4	1.2	1.0	1.0
Molasses	12.6	8.6	8.6	8.6
Corn	10.1	30.4	16.2	-
Cottonseed cake	73.5	29.1	13.7	-
Wheat offal	-	29.8	59.7	89.5
Analysed Chemical Composition:				
Crude protein %	20.6	15.4	15.1	16.7
Dry matter, %	91.8	90.3	88.5	88.6
ME Kcal/kg (calculated)	2480.3	2711.9	2594,1	2369.6
Hay crude protein, %	2.95			
Hay Dry matter, %	92.15			
Hay; ME/Kcal/kg	4.12			

Digestibility study

The digestibility study involved twenty adult rams which were used in the previous experiments (Table 4). They were randomised to the four dietary treatments, used in experiment 2 for a preliminary period of fourteen days prior to a seven day total faecal collection. The animals were fitted with the harnesses two days prior to the start of the collection. This was done to get the animals accustomed to the harness bags. The daily faecal output from each animal was collected,weighed in a labelled polythene bag and stored at $-10^{\circ}C$.

The daily feed intake for each animal was recorded and feed refusal from each animal was weighed and stored separately. At the end of the collection period, the total faecal collection and orts from each animal was bulked, thoroughly mixed and then subsampled for analysis. Samples of the faeces, the feed refusals and feed were analysed for dry matter and crude protein using standard procedures (A.O.A.C. 1975).

Statistical Calculations

At the end of the experiments, all data were subjected to analysis of variance and Duncan's Multiple range test (Steel and Torrie, 1960) was used to compare differences between means.

RESULTS

Experiment 1: Growth Study

The summary of the results is given in Table 5. In this presentation, treatments 1, 2, 3 and 4 correspond to the 0 (control), 30, 60 and 90% wheat offal diets respectively. There were significant ($P \angle 0.05$) differences in the mean daily gains among the treatments. Animals on the 30% wheat offal diet (trt 2) had significantly ($P \angle 0.05$) higher mean daily weight gain than those on the 60 and the 90% wheat offal diets (trts 3 and 4). However, there were nos significant differences in mean daily weight gains between animals on the 0 and 30% wheat offal diets (trt 1 and 2) or on the 60 and 90% wheat offal (trt 3 and 4) diets. Animals on the control diet had significantly ($P \angle 0.05$) better gain than those on the 90% wheat offal diet.

Feed intake followed a similar pattern as mean daily weight gain. Animals on treatments 1 and 2 recorded significantly ($P \angle 0.05$) improved daily feed intake than those on treatments 3 and 4. Although there were no significant differences in feed intake between animals on treatment 1 and 2, nor between those on treatments 3 and 4, there was a steady decline in intake as dietary wheat offal level increase in the diets.

Feed conversion efficiency did not show any significant differences among treatments, but treatment 4 animals showed the greatest inefficiency.

RESULTS

Table 5: Liveweight gain, feed intake, feed conversion ratio, digestibility of dry matter and nitrogen - Experiment 1

	Treatments 1	2	3	4	SE
Mean initial weight	19.0	18.6	18.8	18.4	±2
Mean final liveweight gain (g)	27.2	27.0	24.3	21.5	±2.6
Mean daily liveweight gain (g)	146.2[ab]	148.2[a]	98.7[bc]	53.4[b]	±22.9
Mean daily feed intake (g)	1014.8[a]	897.1[a]	658.4[b]	534.3[b]	±80.3
Feed conversion ratio	6.9	6.2	7.3	10.5	±1.5
Digestibility of dry matter (%)	62.9[b]	70.8[a]	64[b]	66[b]	±1.4
Digestibility of nitrogen (%)	70.2	72.3	69.3	72.7	±1.9
Cost of feed intake per kg weight gain	₦1.94	₦2.42	₦2.19	₦2.32	

a,b,c Means on the same row with different superscripts are significantly different (P∠0.05)

Experiment 2: Growth Study 2

For easy reference, treatment 1, 2, 3 and 4 (as in experiment 1) correspond to wheat offal levels 0, 30, 60 and 90% respectively. The results of the mean daily weight gain, mean daily feed intake and feed conversion ratio are shown in table 6. There were significant (P∠0.05) differences in the mean daily weight gains among the treatments. Treatments 1 and 2 animals were significantly (P∠0.05) higher in their mean daily gain than treatments 3 and 4 animals. The mean daily feed intake revealed significant (P∠0.05) differences among the treatments. Treatments 1 and 2 had significantly (P∠0.05) higher intake thank treatments 3 and 4 animals. The mean feed conversion ratio ranged from 6.82 for treatment 2 to 15.8 for treatment 4. Treatment 2 animals showed the highest efficiency though not significantly better than that of treatment 1 animals. Treatment 4 recorded the greatest inefficiency which was also not significantly different from treatment 3 animals.

Combined Results

Table 7 shows the summary of the combined results of experiments 1 and 2. Treatments 1, 2, 3 and 4 correspond to the (0 (control) 30, 60 and 90% wheat offal diets respectively.

Table 6: Liveweight gain, feed intake and feed conversion ratio - Experiment 2.

	Treatments				
	1	2	3	4	SE
Mean initial liveweight (kg)	18.2	19.8	18.6	17.6	±2.1
Mean final liveweight (kg)	26.1	28.4	23.9	20.81	±2.0
Mean daily weight gain (g)	115.3[a]	121.4[a]	77.2[b]	49.2[b]	±16.4
Mean daily feed intake (g)	795.4[a]	814.9[a]	554[b]	535.0[b]	±56.7
Feed conversion ratio	7.3	6.8	8.4	15.8	±3.3
Cost of feed intake per kg gain	1.93	2.68	2.23	3.0	

a,b,c Means on the same row with different superscripts are significantly different ($P < 0.05$)

Combined Results (Experiments 1 & 2)

Table 7: Liveweight gains, feed intake, feed conversion ratios.

	Treatments				
	1	2	3	4	SE
No of animals	8	8	8	8	
Mean initial weight (kg)	18.98	18.44	18.4	17.70	±1.72
Mean final weight (kg)	26.9	26.9	23.9	20.7	±1.94
Mean daily weight gain (g)	129.48[a]	134.99[a]	86.73[b]	48.31[c]	±13.59
Mean daily feed intake (g)	900.82[a]	848.90[b]	585.47[c]	576.98[c]	±60.2
Feed conversion ratio	7.259[ab]	6.456[a]	8.12[b]	14.0[c]	±2.13
Fibre in diet	17.5	7.8	8.8	10.8	
Cost of feed intake per kg gain	1.94	2.55	2.21	2.66	

a,b,c Means on the same row with different superscripts are significantly different ($P<0.05$)

The mean daily feed intake was significantly ($P<0.05$) influenced by the dietary treatment. Animals on treatment 1 recorded significantly ($P<0.05$) higher mean daily feed intake than those on the other treatments. (Table 7). Treatment 2 animals recorded significantly ($P<0.05$) higher mean feed intake than those on treatments 3 and 4 (Table 7). Even though there was no significant difference in mean daily feed intake between animals on treatments 3 and 4, there was a steady decline in feed intake with each increase in dietary wheat offal level.

The mean daily weight gain for animals on the wheat offal diets followed the same pattern as the mean daily feed intake. Though there was no significant difference between the animals on treatment 1 and 2, both groups were significantly ($P<0.05$) higher than those on treatments 3 and 4 (Table 7). Treatment 3 animals recorded significantly ($P<0.05$) higher mean daily gain than treatment 4 animal (Table 7).

The feed conversion ratio ranged from 6.5 for treatment 2 to 14.0 for treatment 4. Animals on treatment 2 recorded significantly ($P<0.05$) better efficiency than animals on treatments 3 and 4 (Table 9). Though these animals on treatment 2 had a better efficiency value than those on treatment 1, it was not significant. Similarly, animals on treatment 1 recorded a better (but non-significant) efficiency of feed conversion than those on treatment 3. Animals of treatment 4 showed the greatest inefficiency.

Whereas dry matter digestibility revealed significant ($P < 0.05$) treatment differences, nitrogen digestibility did not. Animals on treatment 2 had a significantly ($P < 0.05$) improved dry matter digestibility than animals on treatment 1. However, animals on treatments 3 and 4 did not show any significant differences.

DISCUSSION

The two experiments carried out in this study were similar, The interest were the same and included feed intake, liveweight gain, feed conversion efficiency, digestibility of dry matter and nitrogen and economic evaluation of the performance of the animals. Since the coefficient of variability showed that the two experiments were not significantly different, the data were pooled and analysed combined (See table 7). This discussion is therefore based on the combined results on Table 7.

The steady decrease in feed intake with increase in the percentage of wheat offal in the diet could be attributed to a number of factors. Wheat offal in iteself, is not palatable or easily acceptable; furthermore, it is known to be dusty. To improve the acceptability and decrease the dustiness, molasses was added to the diets at 8.6% of dry matter. Given that at the 30% wheat offal diet, the wheat offal component was relatively small, the molasses in the diet physically improved the dustiness, and furthermore influenced intake as can be seen from the feed intake figures (Table 7). For the treatments with 60 and 90% wheat offal, the volume of wheat offal was simply too large compared to the level of molasses used and as such physical reduction of dustiness was not achieved neither did it improve palatability or acceptance of the diets. Thus, the animals on these treatments were observed shorting or coughing during feeding and intermittently, would leave the feed bunk to snot and or cough in an apparent attempt to get their nostril cleared. It was therefore not surprising that animals on the 60 and 90% wheat offal diets recorded reduced feed intake relative to those on the 0% and 30% wheat offal diets. Furthermore, wheat offal is bulky (i.e. volume per given weight) and therefore, the volume per unit weight of feed was large for the 60 and 90% wheat offal diets. Thus, given the limited size of the rumen, it was a physical impossibility to except the animals to eat enough of such a high volume feed to meet their energy needs - even though it is known that animals would endeavour to consume enough feed to meet their physiological energy requirements (Conrad et al. 1964). The total effect was that the feed intake of the animals on treatments 3 and 4 (60 and 90% wheat offal diets) was reduced by 31 and 32% respectively relative to those on treatments 2 with 30% wheat offal.

It would be easy to suggest that the level of molasses in the diet could have been further increased to probably about 15% to better reduce the dustiness and effect increase in acceptability of the diet. However it must be recalled that both molasses and wheat offal are feeds with laxative properties. Thus an appreciable level of molasses in the diet could have led to a higher degree of laxation than was observed presently.

There was a steady decrease in mean daily liveweight gain with increase in dietary wheat offal. Thus, mean daily liveweight gain had a similar pattern with the mean feed intake. This should infact not be surprising. Even though the diets were balanced to be isocaloric, the final energy levels were similar but not equi-caloric viz. 2.48, 2.71, 2.59 and 2.37 Kcal/kg of feed (ME) for treatments 1, 2, 3 and 4 respectively. Given the mean feed intake levels of 0.90, 0.85, 0.59 and 0.58kg per head per day (for treatments 1, 2, 3 and 4 respectively), it stands that the daily intakes of metabolisable energy for the treatments were 2.23, 2.30, 1.52 and 1.37 Kcal/ per day. This vividly illustrates the differences in mean liveweight gain and are in agreement with the reports of Crabtree and William (1971) and Marsh (1975). These workers demonstrated that there is positive relationship between liveweight gain and voluntary feed intake. Furthermore, the trend in weight gain recorded in this study is in general agreement with the report of Ranjhan _et al_. (1971). These workers fed pigs with diets, with graded (40, 60 and 70%) levels of wheat offal and reported reduced weight gain with the 60 and 70% wheat offal diets. The large decline in mean liveweight gain recorded by animals on treatment 4 (90% wheat offal) in which wheat offal supplied almost all the energy is similar to the results obtained by Cave et al. (1965). These workers fed wheat offals the sole energy source in the diet of chicks and reported reduced feed intake and decline in weight gain.

The feed conversion ratio showed a negative relationship with increase in the level of dietary wheat offal. Since animals on the 30% wheat offal diet recorded a better feed conversion efficiency than those on the control (0% wheat offal) diet, it could then mean that the feed conversion followed the same pattern as the mean daily weight gain though there was no significant ($P \angle 0.05$) difference among treatments. The dry matter digestibility of the treatments followed a trend that is in agreement with the report of Mitchel (1942) as cited by Phillips and Loughlin (1959). Mitchel reported that there was a close negative relationship between u crude fibre content and digestibility of organic matter of feeds by different species of animals and the results in this study showed that the higher the crude fibre content of the diet the lower the digestibility of dry matter. Head (1953) and El-Shazly (1961) in their respective studies, reported that concentrate diets have faster rate of digestion than roughage diet and this is capable of altering the ruminal pH in such a way that it could reduce the celluloytic microbial population or cause a decline in their activity. Either action cause a reduction in the digestibility of the roughage portion with a consequent total reduction in apparent digestibility. Since the roughage portion of treatment 1 constitute 30% of the diet it is possible that the principles discussed above were in operation. Nitrogen digestibility revealed no significant differences among the treatments.

An economic evaluation of the results based on the prevailing prizes of feedstuff during the period of this experiment is given in table 8 calculating the relative cost of production, cost of labour was excluded because the experimental conditions demanded high level of labour which cannot be justified under farm condition and it was a constant factor for all the treatments. The cost of production per kilogram liveweight gain increased from ₦1.94 for animals on treatment 1 to ₦2.67 for animals on treatment 2. While animals on treatment 2 would take seven days to gain a kilogram of liveweight, animals on treatment 1 would take eight days to reach same weight, whereas those on treatments 3 and 4 would take twelve and twenty-one days respestively (table 8).

A study of the economic evaluation table 8 would reveal that amongst the wheat offal treatments, treatment 2 (30% wheat offal) had a better production alternative. One could argue that treatment 3 had a better production

Table 8 Economic evaluation table

	1	2	3	4
No of animals	8	8	8	8
Mean daily feed intake	900.82	648.92	585.47	576.98
Mean daily weight gain	129.50	134.9	86.7	48
Cost of feed per kg of body weight gain	₦1.93	₦2.55	₦2.21	₦2.66
Number of days taken by animal to gain 1kg	8.0	7.0	12	21
Cost of feed per 50kg of body weight gain	96.5	133	114	125
Ratios	1	1.38	1.18	1.3
Number of days taken by animal to gain 50kg	385	370	575	1040
Cost of feed ratio	1	1.4	1.2	1.3
Time taken to gain 50kg ratio	1.1	1	1.6	3

cost per unit gain of body weight; but the faster rate of growth in treatment 2 would also reduce the cost of labour and cost of maintenance of equipments. While the cost ratio for treatments 2:3 is 1.4: 1.2, the time ration (to gain 50kg) is 1:16, a difference of 60% in time for production negative to a difference of just 14.3% in cost. Using the same argument, the cost and time ratio comparismss for treatments 2 and 4 would be 1.07 : 1 and 1:3 respectively. In other words, whereas the cost of producing 50kg sheep is very similar using diets 2 and 4, there is however, a 200% increase in time if diet 4 is used.

The experimental findings indicated that increasing levels of wheat offal in the diets of sheep resulted in reduced feed intake, weight gain and poor feed conversion efficiency of the animals. The depression in performance might be due in part to the increasing crude fibre values of the diets which might have influenced the utilisation of other nutrients through changes in gut transmissions time, digestion and absorption. A similar finding had earlier been made by Boenker et al. (1969). He reported that high fibre values in the diets led to unpairement of utilisation of essential nutrients. By increasing the percentage of this low energy feedstuffs in the ration, the fibre content of the entire rations are increased and their energy values lowered. Ewing

(1951) had explained that fibre has low value in itself, decreases apparent dry matter digestibility,contributes little if any, digestible nutrients and makes other nutrients less available. Given the experimental findings and cost considerations, it would seem that the 30% wheat offal diet is attractive for sheep feeding. Also, the 60 wheat offal diet could be used though there would be reduced rate of growth and feed intake.

CONCLUSION:

From this study, 30 to 60% wheat offal in the diets of sheep could be suggested as capable of supporting adequate performance of the animals. Nevertheless, at the current market prises of animals, feed ingredients and labour, there is need to study in greater detail the economic of using wheat offal in sheep fattening or growth operation.

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Appendix 1

Combined analysis of variance for mean daily weight gain.

	1	2	3	4	SE
Block means	91.1	112.4	108.3	80.8	
Treatment means	129.5	134.9	86.7	48.3	±13.6
Experimental means:	Expt(1):	112.1	Exp(2):	87.6	
Trt x Exp. means	146.2	148.2	98.7	55.4	±19.2
	112.8	121.8	74.8	41.3	±19.2

Analysis of Variance

Source of variation	Sum of squares	Degree of freedom	Mean squares	F
Expt.	4786.3	1	4786.3	3.6NS
Rep: Expt (error A)	7935.458	6	1322.576	
Treatment	39531.7	3	13177.2	17.005XX
Expt. x Treatment	385.634	3	128.55	0.166
Residual error (Er B)	13947.65	18	774.87	

Appendix 2

Combined analysis of variance for feed intake

	1	2	3	4	SE
Block means	686.70	779.9	740.4	705.2	
Treatment means	900.82	848.9	585.5	576.98	±60
	Expt (1)		Expt (2)		
Exptal means	774.89		681.19		
Expt: Treatment interaction	1014.78	897.06	653.44	534.30	
	786.86	800.75	517.49	619.66	

Source of variation	Sum of squares	Degree of freedom	Mean squares	F
Expt	70244	1	70244	4.5NS
Rep: Expt interaction (error)	93297.6	6	15549.6	
Treatment	700844	3	233615	23.36^{xx}
Exp :Treatment interaction	103735	3	34578.3	3.457^{x}
Residual	180009	18	10000.5	

Appendix 3

Combined analysis of variance for feed conversion ratio.

	1	2	3	4	SE
Block means	9.85	8.49	7.4	10.1	2.1
Treatment means	7.26	6.46	8.12	14.00	2.13
	Expt (1)		Expt (2)		
Expt means	7.74		10.18		
Treatment/Expt interaction	6.96 7.56	6.19 6.72	7.33 8.92	10.48 17.53	

Source of variation	Sum of squares	Degree of freedom	Mean squares	F
Expt	47.483	1	47.483	4.36
Rep/Expt interaction	65.32	6	10.886	
Treatment	282.33	3	94.109	4.786^{x}
Expt/Treatment interaction	58.08	3	19.359	0.985
Residual	353.98	18	19.663	

Appendix 4

Analysed Chemical Composition of Wheat offal

Dry matter	94.20%
Crude protein	16.05%
Ether extract	3.50%

Appendix 5

Prevailing (Prices) Market prizes of ingredients

Trace mineral Premix	₦4262/ton
Bone meal	₦150/ton
Salt	₦833/ton
Molasses	₦143/ton
Wheat offal	₦240/ton
Cottonseed meal	₦315/ton
Corn	₦700/ton