RESPONSE OF BROILERS TO DIETARY LEVELS OF SUNFLOWER SEED

BY

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DECLARATION

This is to certify that this thesis has been written by me and is a record of my own research work.

The works of other investigators are duly acknowledged and referred to. No part of this thesis has been previously submitted for a degree or diploma.

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CERTIFICATION

This thesis entitled evaluation of sunflower seed in broiler diets by T.S. Olugbemi meets the regulation governing the award of the degree of Master of Science of Ahmadu Bello University, and is approved for it's contribution to knowledge and literary presentation.

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DEDICATION

This work is dedicated to the memory of my father, Late Prof. Lawrence Bayode Olugbemi who played a significant role in ensuring my success in this venture.

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ABSTRACT

Broiler chicks were fed diets containing 0, 10, 20, 30, 40 or 50% sunflower seed (SFS) during the starter and finisher phases.

Increase in dietary level of SFS above 20% caused a significant decrease in feed intake, weight gain and increase in feed conversion ratio ($P<0.05$) during the starter phase(0-4 weeks). During the finisher phase(5-8 weeks), birds fed with 50% SFS had a lower feed intake and weight gain compared to birds fed the other diets ($P<0.05$). Feedcost/kg weight gain were lower for birds fed diet with 40 or 50% SFS ($P<0.05$). However, there was no significant effect of the dietary level of SFS on mortality rate ($P>0.05$) both at the starter and finisher phases.

Over the 8 week experimental period, increase in dietary level of SFS above 20% caused a decrease in feed intake , weight gain and feed conversion ratio ($P<0.05$). Dietary levels of SFS above 30% also reduced carcass and gizzard weight ($P>0.05$) but had no significant effect on other organs ($P>0.05$). It is concluded that broilers could tolerate up to 20% SFS without detrimental effect on performance.

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CHAPTER 1

INTRODUCTION

There has been a reduction in poultry production in Nigeria in recent times. Prominent among the factors which have contributed to the decline in the industry is the high cost of feed which accounts for about 80% of the total cost of production. The profitability of the poultry industry is therefore to a large extent dependent on the cost of feed. The ever increasing cost of feed can be attributed to the fact that basic poultry feed ingredients such as maize, soyabeans and groundnuts are sometimes low in supply and are also consumed by humans.

Of the feed ingredients, the protein sources are more costly than the energy sources. Oil seed cakes have been important as protein sources for farm animals, particularly for the monogastric species. Oil seed cakes such as soyabeans and groundnut cake have long remained the major sources of plant protein in poultry feeds, accounting for about 25 - 40% of the total diet. The high demand for these seeds for human consumption has however resulted in their being expensive and sometimes unavailable (Fetuga, 1977). Reducing the cost of poultry production entails providing measures that would reduce the cost of feed. These measures amongst others include discovering alternative protein and energy sources which are readily available, cheap and nutritionally balanced. It should provide similar results to those of conventionally used protein and energy sources. In addition to these, it is desirable that the protein or energy sources in question are either not consumed by

humans or are in low demand for human consumption.

One of such alternative protein source which can be used to replace or supplement soyabeans is sunflower seed (Helianthus annuus).

Sunflower is a crop which is not only one of the best adapted high protein crops available (Noland *et.al.*, 1980), but can be grown in all climatic regions of Nigeria and other tropical countries. It grows well wherever maize can be successfully grown (Talabi, 1988).

Information covering the potential of the seed in broiler diets is scanty as most of the work on sunflower has been done using the meal in rat, rabbit, pig and calf rations while that of poultry rations have been carried out with the meal after decortication and extraction of the oil (Daghir *et.al.*, 1980). Daghir *et.al.* (1980) reported that broilers could tolerate 10% dietary inclusion of full fat sunflower seed without any adverse effect on performance. The authors observed no significant differences with respect to average body weight, feed consumption, feed efficiency, mortality or organ weights when incorporated at the 0, 10 and 20% level in semi-purified diets of birds raised in cages. However, a significant reduction was observed in body weight at the 30% level of incorporation.

Singh *et.al.* (1981) determined the effect of replacing groundnut cake with sunflower cake at three levels (0, 50 and 100%) and three levels of dietary protein (12, 14 and 16%) on matured white leghorn pullets. They reported that diets containing

sunflower cake gave the highest egg production while diets with the mixture of groundnut and sunflower cake produced lower results. The least result was recorded on diets having groundnut cake alone. Egg production from dietary protein levels of 14% and 16% did not differ significantly from each other but was lower in the 12% diets than the 14 and 16% protein diets.

Singh and Prasad (1979) examined the effect of sunflower cake and dietary protein levels (18, 22, 26%) on the performance of broilers. They reported weight gain increments as the percent protein increased from 18 to 26%. Balogun and Etukudo (1991) reported results which showed that sunflower seed is a potential alternative to the conventional, but more expensive oil seeds. The increased need to utilize other protein sources which are not in serious demand by humans coupled with it's potential usefulness has motivated this study.

The objectives of this study were:

(1) To determine the optimum level at which sunflower seed can be safely included in broiler rations without adversely affecting their performance;

(2) To determine the economics of the inclusion of raw sunflower seed in broiler rations;

(3) To determine the effect of raw sunflower seed inclusion on the organs and other broiler meat characteristics.

CHAPTER 2

LITERATURE REVIEW

2.1 Descpription of Sunflower Plant

Sunflower (Helianthus annuus) is a member of the composite family, a large family of flowering plants which are mainly herbs and shrubs. They are characterized by crowding together of individual flowers into the heads. The whole inflorescence appears flower like with the plant being coarse (Hutchinson, 1973).

Sunflowers are generally cross pollinated by insects, particularly by bees. The fruit is white, grey, black or stripped and a four sided achene lop to 1 cm long. The leaves are large ovate, petiolate and serrate. The taproot is pronounced and produces many side-roots that fully exploit the soil (Geoffrey, 1967).

The Sunflower grows quickly reaching a maximum height of 2 metres depending on the variety. The stem bears alternate leaves, large and dark green in colour. The head is terminally borne and can attain an enormous size (Hutchinson, 1973).

2.2 Origin and Distribution

Sunflower (Helianthus annuus) is a native of America. It is found in the great plains region of the United States of America from Nebraska to Northern Mexico where it is found in both cultivated and wild forms (Wolfe, 1959; Martin, 1970).

The sunflower is believed to have evolved from a subspecies, as a mutation with less extensive branching than is exhibited by the wild form. It was introduced to Europe in the 16th century by the Spanish and it's cultivation spread to many countries such as the soviet Union (Arnon, 1972).

The cultivation of sunflower as an economic crop is now being undertaken by the new world settlers as a supplementary food, garden ornament and as an ensilaged crop in the late 1800's and early 1900's (Anon, 1980).

Sunflower was brought into Africa in the early 20th century by the Portuguese traders and European missionaries. It was introduced into Nigeria in the early sixties on a large scale to supplement the shortage in edible oils and meals (Ogunremi, 1979). Field study on the cultivation of sunflower in Nigeria started in 1965 at the Institute of Agricultural Research and Training at Moor Plantation, Ibadan. Ogunremi (1979) in South Western Nigeria and Tanimu *et.al*. 1986 at Samaru, Zaria showed that sunflower can do well especially from derived savannah in the south to the Sudan savannah in the northern part of the country.

2.3 World Production

The world's production of sunflower seed is governed by the Soviet Union, U.S.A. and Argentina. These three countries account for 60% of the total world production of sunflower seeds (Anon, 1981).

Sunflower has been reported (Anon, 1981) to be extensively grown in Romania and Bulgaria and on a smaller scale in other parts of Europe. Within the tropics, sunflower is grown on smaller scales in most parts of India, Asia and African countries like Kenya and Nigeria. The United States of American is the world's largest exporter of Sunflower seed (1,550,000 tonnes in 1980-1981) and almost the leading exporter of sunflower oil. About 400,000 tonnes of seeds were processed domestically in the United States, producing 300,000 tonnes of oil of which some 200,000 tonnes were exported. Over five million tonnes of sunflower oil and six million tonnes of meal were consumed in the United States in 1981. Also, the largest consumer of oil and meal was the U.S.S.R. where about 30% of the world's production was consumed.

Other countries consuming significant quantities of sunflower oil are Argentina, Turkey, France, Spain, Romania, China, West-Germany, South Africa, Mexico and Bulgaria.

2.4 Economic Importance

In many countries, sunflower is grown primarily for it's oil. However, numerous other uses have been found for various components of the sunflower plant.

2.4.1 Seed

Sunflower seeds are eaten as salted whole seeds and as roasted nut (Arnon, 1972).

With respect to other Oleaginous seeds such as soyabeans, sunflower seeds is characterized by the absence of anti-nutritional factors such as trypsin inhibitors and specific off-flavours. It is also characterized by proteins with a rather balanced amino acid profile and particularly a good percentage of sulphur amino acids (Anon, 1981).

The sunflower seed is a valuable feed for poultry, in particular during the cold months, because of their high oil content (Arnon, 1972).

Roasted sunflower seeds have been used as substitutes for coffee and confectionery like Halvah which is prepared from the seed (Pustovoit, 1973).

2.4.2 By-Products

Sunflower is grown as a forage crop which is made into silage rather than fed green to animals. It is also grown for green manure (Relwani, 1975). Sunflower is also important as a source of some pigments and dyes used for medicinal purposes as in India (Martin, 1970).

The dried head can be ground to provide a fair roughage feed of up to 9% crude protein and 3% oil for farm animals (Arnon, 1972). The heads after threshing are fed to livestock and can be used as fertilizer (Acland, 1971).

The stalks are processed into pulp for the paper industry. The stalks which are also relatively rich in nitrogen, calcium and

phosphorus are incorporated into the soil after shredding to increase the fertility as well as the organic matter content. The stem of sunflower contains a high amount of phosphorus and potassium, hence it is incorporated back into the soil to serve as fertilizer. The stem is an important source of commercial fibre and is also used for the production of light acoustic - ceiling tiles (Acland, 1971).

The dried leaves of sunflower have been used as a substitute for tobacco (Mitcheal, 1975).

The cake containing hulls is an excellent feed for ruminant livestock and the dehulled cake is an excellent protein source in human diets (Arnon, 1972; Singh *et.al.*, 1981). The cake contains about 35% protein. The seed hulls can be used for fuels by pressing them into logs (Acland, 1971). In the Soviet Union, the hulls are used for the manufacture of ethyl alcohol, furfural in lining plywood and in growing yeast (Petinov, 1965).

The husks are used as litter, mainly for poultry (Arnon, 1972). The husks which constitute 35-50% of the seeds are used as fillers in feed, cakes and meals, as bedding for livestock and in the preparation of polishing abrasive.

2.5 Chemical Composition of Sunflower Seed

The chemical composition of any feedstuff determines it's nutritive value when it is to form part of the ration of an animal.

The variation in the chemical composition of sunflower seed

and meal which have been well documented may be due to genetic, varietal, soil and climatic conditions as suggested by Vaughan (1970). The processing method could also account for variation in the chemical composition of the meal (Pond and Maner, 1974). The Dry Matter(D.M.), Crude Protein (C.P.), Crude Fibre (C.F.), Ether Extract (E.E.), Ash and Nitrogen Free Extract (N.F.E.) Of the seed, meal, kernel and hull as reported by various workers are seen in table 2.1.

2.5.1 Dry Matter

This refers to the absence of moisture in the feed stuff. The moisture content of crops is important in bulk purchasing and storage of feed ingredients. Crampton and Harris (1969) observed that feeds containing more than 14% moisture could not be stored in bulk since they are likely to be mouldy. The dry matter content of sunflower meal, according to Ikurior and Fetuga (1991)is 93.85%.

2.5.2 Crude Protein

The crude protein content is calculated from the nitrogen content of the feed and is obtained by multiplying the nitrogen content by 6.25. The crude protein content of the meal and kernel have been cited to be 35.80% and 24.80% by Ikurior and Fetuga (1991) and Balogun and Etukudo (1991) respectively.

2.5.3 Crude Fibre

This is the portion that remains insoluble after the sample

has been boiled with dilute acid or alkali. It consists mainly of lignin and cellulose and is an index that can be used to predict the feeding value of feed ingredients. Feed ingredients high in crude fibre are usually less digestible and are of less nutritive value to the monogastric animal. The meal has a crude fibre content of 12.95% (Ikurior and Fetuga, 1991).

The ADF, NDF and Cellulose content of the seed, kernel and hull as reported by Balogun and Etukudo (1991) are:

seed (42.71%, 25.54%, 17.10%), kernel (45.13%,8.35%,36.78%) and hull (50.61%, 32.40%,15.50%).

2.5.4 Ether Extract

This is the oil content of the seed and it's value depends largely on the extent of the oil extraction. The oil is composed mainly of glygerides of oleic, linoleic and palmitic acids. It has the highest qualities for margarine making, salad oil, cooking, drying, canning and for medicinal purposes (Arnon, 1972). Ikurior and Fetuga (1991) reported the ether extract content of the meal to be 8.50% while Balogun and Etukudo (1991) also reported that the kernel contained an ether extract value of 27.60%.

2.5.5 Ash Content

This is the organic residue from the firing of a feedstuff at about 600°C. Calcium and Phosphorus contents of 0.21 and 0.60 respectively were cited by Kepler *et.al.*,(1982) for the seed while

Daghir *et.al.*, (1980) cited 0.15 and 0.35 percent respectively. Ikurior and Fetuga (1991) in their report cited an ash content of 8.10% and mineral contents of 0.32 Mg, 0.08 Ca, 70.00 ppm Zn, 12.50 ppm Cu, 105.00 ppm I, 20.00 ppm Mn, 144.00 ppm Na, 0.86% K, 1.20% P and 340.00 ppm Cl for the meal.

2.5.6 Nitrogen Free Extract

Nitrogen free extract (NFE) is obtained by subtracting the sum of the amounts of moisture, ash, crude protein, ether extract and crude fibre from 100.

Table 2.1: Proximate Composition of Sunflower Seed

D.M.	C.P.	C.F.	E.E.	ASH	N.F.E.	SOURCE
93.50	-				32.60	Oyenuga, 1976
94.63	15.99	14.47	13.96	2.91	47.30	Daghir et. al., 1980
-	19.39	-	-	-		Noland et. al., 1980
91.19	17.30	16.15	37.89	-	-	Kepler et. al., 1982
93.50	20.00	20.30	17.80	1.70	-	Balogun and Etukudo,1991
-	-	-	35-40	-	-	Sharma et. al., 1986
-	-	-	-	1.7-3.85	-	Singh And Prasad,1979

2.5.7 Energy Content

Noland et.al. (1980) reported a gross energy content of 7.0 k

cal/g for the Kernel. Rad and Keshavarz (1976) also reported a range of 4.4-4.61 k cal/g for the meal.

A metabolizable energy content of 3651 k cal/kg was reported by Daghir *et.al.* (1980).

2.5.8 Amino Acid Profile

The amino acid profile of the seed as reported by Singh and Prased (1979) and Kepler *at.al.* (1982) are shown in table 2.2.

Table 2.2: Amino Acid Content of Sunflower Seed(%)

AMINO ACID	1	2	3
Arginine	3.67	2.74	1.64
Glycine	7.10	10.12	0.89
Histidine	3.67	2.74	0.42
Leucine	6.03	8.38	1.05
Isoleucine	3.19	4.11	0.68
Lysine	2.19	0.76	0.65
Methionine	0.24	1.37	0.30
Phenylalanine	4.84	6.29	0.76
Threonine	0.28	1.65	0.62
Tyrosine	0.86	1.60	0.36
Valine	7.23	6,14	0.87
Serine	4.22	4.90	0.77
Aspartic acid	-	-	1.49
Glutamic acid	-	-	3.97
Alanine	-	-	0.48
Proline	-	-	0.85
Cysteine	-	-	0.23
Ivecine	-	-	-
Tryptophan	-	-	-

1 = Singh and Prasad (1979); Variety 1
2 = Singh and Prasad (1979); Variety 2
3 = Kepler et.al., (1982)

2.5.9 Antinutritional Factors

Although antinutritional factors abound in sunflower meal, the levels of these factors most at times are low enough for the material to be safely included in rations for animals. Ikurior and Fetuga (1991) identified phytic acid, phytin-P and tannins in sunflower seed meal. Other antinutritional factors identified include arginase and trypsin inhibitors (Rutkowski, 1971). These components being heat labile, are easily inactivated during seed processing (Roy and Bhat, 1974). Chlorogenic acid, a polyphenolic compound although not considered a toxic substance has been found to bind with proteins with molecular weight of less than 5000 (Sabir *et,al.* 1974), thus reducing the feeding values of the meal to some extent.

Daghir *et.al.* (1980) similarly reported that sunflower seed does not contain any substances toxic to chicks as levels up to 20% did not significantly depress body weight.

2.6 Utilization of Sunflower

2.6.1 Utilization of Sunflower Seed

There are several reports indicating the response of animals to dietary SFS.. These include the experiment by Daghir et.al. (1980) in which they studied the utilization of full fat sunflower seed in broiler rations. Two experiments were conducted in battery cages using semi purified diets and two in conventional floor pens with practical type diets. Whole sunflower seeds were tested as

full-fat raw (SFFR) or full-fat steamed or heated as a source of protein and energy. There was a significant reduction in body weight at the 30% level of incorporation in semipurified diets. Liver and pancreas weights tended to increase with an increase in the SFFR levels in the ration but the differences were not statistically significant. In broilers raised in floor pens and fed practical type diets, SFFR addition of SFFR at 15 or 25% inclusion level decreased body weights of hens in one of the experiments and feed intake was reduced in both. It was concluded that in practical type broiler rations, SSFR can constitute upto 10% of the ration without any adverse effect on performance.

Cuca *et.al.* (1973) fed 12% protein diets containing sunflower seed to broiler chicks supplemented with different levels of methionine, leucine and threonine. No significant response was observed when methionine was added, but there was a significant response from threonine supplementation.

Taha *et.al.* (1981) in their study on the nutritional evaluation of sunflower seed protein products used day old chicks deprived of protein for 7 days. Protein efficiency ratios were 2.81 (control diet), 1.88 (meal alone), 2.44 (meal with lysine), 1.41 (meal with methionine) and 2.85 (meal with lysine and methionine).

Adamu (1992) evaluated sunflower seed as a protein supplement in growing pig rations. Pigs were fed diets with 0, 10, 20, 30 and 40% sunflower seed. No significant differences in weight gain,

feed efficiency and feed consumption were observed. Hence it was concluded that 40% sunflower seed could be fed to growing pigs without any adverse effect.

Balogun and Etukudo (1991) evaluated undecorticated full-fat sunflower seeds (USS) in the diet of rabbits. The 49 day trial involved the feeding of 40 rabbits, four isonitrogenous diets containing 0, 10, 20 and 30% USS. Results of the experiment showed that feed intake, feed conversion efficiency and growth were slightly better with the control diet. They concluded that as little as 10% USS in the diet could not support optimum growth of rabbits.

Kepler *et.al.* (1982) examined the potential of sunflower seed as a fat source in sow gestation and lactation diets. About 55 primiparous crossed gilts and 44 multiparous crossbred sows were used for 3 different trials. Diets containing 0, 25 or 50% ground whole, sunflower seeds were individually fed at a level of 2.27kg per day until farrowing. Observations made showed a non significant increase in fat levels of colostrum with addition of sunflower seeds to the sow diets. However a significant increase in percentage milk fat with increasing level of sunflower seeds was also observed. Addition of sunflower seeds had no effect on the number of still born piglets, live piglets born or weaned, percentage survival, litter and piglet weights at birth and gain to 14th day. There was also no difference in reproductive performance. Although 50% inclusion did not seem to be

detrimental, it couldn't be recommended due to initial consumption problems.

Dinnuson *et.al.* (1980, 1981) reported that growing finishing pigs could utilize 10% ground, whole sunflower seeds but diets containing 26% sunflower seeds resulted in decreased gains.

Noland et.al. (1980) reported that substitution of unextracted sunflower seeds for either 0, 25, 50 or 100% of the soyabeans meal in pig diets produced no significant differences in digestible energy or apparent nitrogen retention. However, all diets containing unextracted sunflower seeds had significantly higher digestible nitrogen than the diets containing soyabeans meal as the protein source. Replacement of 25% of the soyabean meal with unextracted sunflower seeds produced the greatest increase in digestibility.

Ikurior and Fetuga (1991) reported that the digestibility of sunflower seed meal protein in rats was 80% while Sarwar *et.al.* (1973) cited 80.2% in mice.

Adams and Jensen (1985) reported the following digestibility for dry matter 69 + 4%, energy 77 + 5%, Ether extract 91 + 3% and protein 79 + 5% of sunflower seed in growing pigs.

The metabolizable energy of full fat sunflower seed has been reported by a number of authors to be 3984 k cal/kg for pigs (Adams and Jensen, 1985); 1760-2310 k cal/kg (National Academy of Science, 1971); 4400 k cal/kg for pigs and 3967 k cal/kg for poultry (Aduku, 1993).

2.6.2 Utilization of Sunflower Hulls

In a feeding trial, Robertiello *et.al.* (1984) obtained 24 of 28 days old male Newzealand white rabbits. These were fed for two months with pelleted diets without sunflower seed husk or with 29% sodium hydroxide treated or untreated sunflower seed husk. The mean feed intake per rabbit on these three diets were 3295, 4343 and 4645g respectively. These produced equivalent of 3.50, 2.98 and 3.76g/g gain. The carcass dressing percent was 53.95, 58.95 and 56.20% respectively. They concluded that although alkali treatment increased sunflower seed husk digestibility invitro, there was no effect on the performance of rabbits compared with those given untreated sunflower seed husk.

Singh and Prasad (1979) determined the effect of sunflower seed hull on broiler performance by replacing 20% of maize with sunflower hulls. Two additional diets with oat were prepared to have the same crude fibre and energy levels in order to compare the hull fibre with oat fibre. They found that replacement of 14 parts of maize with sunflower hull did not affect weight gain, feed efficiency, energy and protein efficiency or percentage yield of edible meat. Consumption of the diet having sunflower hulls was significantly higher than that of the control. The diet containing fibre from sunflower hull did not differ from the diets containing an equal amount of fibre from other sources with regard to weight gain, feed consumption or efficiency of feed utilization. Although not conclusive, the authors suggested that up to 14% sunflower

hulls in the diet may have no harmful effect on the performance of broilers.

2.6.3 Effect of Sunflower Hulls on Large Intestine Function in Finishing Pigs

Gargallo and Zimmerman (1981) conducted a study involving 24 crossbred pigs from eight litters with an average body weight of 70kg. Sunflower hulls were added to the basal, corn-soyabean meal diet containing 16% crude protein and fed at 3% body weight. Sunflower hulls were added at 2, 10 and 20% of the weight of the diet. All of the animals averaging 95kg were slaughtered 10 hours after feeding and caecum and colon contents were incubated for 10 hours. Results of the study showed that plasma Urea Nitrogen was lower in pigs fed the diet with 20% added sunflower hulls (SFH) and showed a negative correlation with plasma glucose. Intestinal empty weights and fill were not affected by dietary SFH level but dry matter content of caecum and colon fill increased linearly with increasing level of SFH. Increases in dietary SFH did not affect acetate but resulted in a linear decrease in propionate and butyrate concentrations in the caecum and colon. VFA produced in caecum and colon during 24 hour could represent an average of 6.2, 5.6 and 5.0% of the energy required for maintenance in 95kg pigs fed 2, 10 and 20% added SFH respectively. It was concluded that increasing amounts of SFH in the diet did not greatly affect the degree of fermentation taking place in the large intestine, as

measured by total VFA production. Hence dietary SFH was not well utilized by the pigs.

2.6.4 Effect of Processing Methods and Time on the Utilization of Sunflower Seed.

The processing method used in the preparation of dietary ingredients for use in animal diets can affect their nutritive value. Pelleting (Jensen and Becker, 1965) extrusion (Hanke *et.al.* 1972; Carlisle *et.al.* 1973; Noland *et.al.* 1976), roasting (Costa *et.al.* 1976) and micronizing (Lawrence, 1973 a, b, 1978) have been shown to improve the utilization of certain feeds.

Daghir *et.al.* (1980) tested whole sunflower seed as full-fat raw (SSFR) or full-fat steamed or treated as a source of protein and energy. No significant differences were detected with respect to average body weight, feed consumption, feed efficiency, mortality or organ weights (liver and pancreas) when full-fat or heated sunflower seed was incorporated at the 0, 10 and 20% level in semipurified diets when birds were raised in cages. Neither a detrimental nor a beneficial effect of steaming or dry heating was observed on the utilization of sunflower seed by broilers.

Noland *et.al.* (1980) determined the effect of processing time on the amino acid contents of unextracted sunflower seeds. They used rats to evaluate the effects of autoclaving the seeds at 115°C with 1.05g/cm^2 pressure for 0, 5 or 10 mins. The rate and efficiency of gain in rats were used as determinants. Rats fed on

the basal maize-soyabean meal diet gained significantly faster and more efficiently than the rats fed on the diets containing the sunflower seeds. An increase in heating time of the sunflower seed produced a significant reduction in rate and efficiency of gain. The levels of essential amino acids also tended to decrease as the heating time increased. The amino acids which decreased the most by heating were aspartic acid, arginine, threonine, leucine and lysine.

Adams and Jensen (1985) evaluated the effect of roasting, grinding and extrusion on the utilization of the fat in soyabean and sunflower seeds. The digestibility coefficients of the fat in regular, roasted and dehulled sunflower seeds were compared using 12 weanling pigs in a balanced trial. Total faecal fat was corrected for endogenous faecal fat. Roasting of regular sunflower seeds tended to decrease the digestibility of fat and energy. Dehulled sunflower seeds had lower ($P < 0.05$) fat digestibility and higher ($P < 0.05$) nitrogen and dry matter digestibility. It appears from this observation that processing method could affect the availability of fats in sunflower seeds as roasting appeared to decrease fat availability in sunflower seeds.

2.6.5 Amino Acid Profile for Sunflower Seed Meal

Ikurior and Fetuga (1991) reported that sunflower meal contained relatively well balanced amino acids except lysine which was deficient. Although lysine deficiency was indicated in the

report by Rad and Keshavarz (1976), they showed that supplementation of sunflower meal with lysine improved the metabolizable energy, however the effect of supplementation was not significant. Lysine supplementation was however required to permit 100% substitution of soyabean meal protein with sunflower meal. Moser *et.al.* (1985) found that whereas a 34% sunflower seed meal could replace up to 45% of the total lysine in the diet of starter pigs with no detrimental effect on performance, higher levels of sunflower seed meal resulted in a reduction in daily gain and feed conversion ratio. Wahlstrom (1984) also observed that sunflower seed meal could be used as the only protein source for growing pigs if diets were balanced for lysine.

2.6.6 The Role of Crude Fibre in Poultry Diets

The role of crude fibre in broiler diet of chickens is very important as they are limited in the amount of crude fibre they can utilize in their diets. Their digestive juice does not contain the enzyme cellulase that is capable of breaking down fibre. Fetuga (1977) thus indicated that cellulose, hemicellulose and lignin which constitutes crude fibre are usually regarded as being unavailable to monogastric animals. Gohl (1975) stated that fibre is almost valueless nutritionally to the chicken. He advised that too much fibre should be avoided in chicken diets as it renders the feed indigestible and low in available energy.

The bulky nature of high fibre feeds affect feed intake and

the inclusion of highly fibrous feeds in diets of chickens has been reported to affect their growth rate, feed conversion efficiency and other parameters. Fibre limits feed intake. When in high concentrations, it limits the weight of feed consumed by the bird hence imposing a physical limitation upon the intake of digestible nutrients. Diets high in fibre are usually low in energy and have a relatively high increment and therefore contribute to heat stress in a warm climate. This is known to have affected the performance of broiler chickens in the tropics (Stanley and Ishizaki, 1982). Isaachs et. al. (1960) reported delayed sexual maturity and reduced body weight at maturity due to high fibre usage during the growing period. Kondia et. al. (1974) indicated significant reduction in feed consumed by both meat and egg strain birds when fed on high fibre diets. Rhajan (1980) contended that the lower utilization of high fibre diets may be partly due to increased rate of passage of feed through the gastro intestinal tract. This reduces the time of exposure of ingesta to enzymatic degradation and the time of nutrient contact with absorptive membrane. Bayer et. al. (1978) and Abdelsamie et. al. (1983) observed that growth and feed utilization decreased with increasing fibre content in chicken diet. Deaton et. al. (1979) reported reduction in feed conversion efficiency when fibre levels were increased in layer diets. Fibre contributes little, if any, digestible nutrient and also makes other nutrients less available (Ewing, 1963).

Fibre in feeds however also has it's merits. Fibre gives bulk

to the feed (King, 1967). It aids digestion because the bulky effect stimulates peristalsis and secretion of enzymes and opens up concentrated feeds so that digestive juices can come into contact with them. Din et. al. (1979) indicated that it promotes the elimination of feed residue from the gut based on the laxative property of fibre. Due to it's physical characteristics, inclusion of fibre in the diet can modify gut functions and length as well as gizzard weight. A principle property according to their report is it's ability to hold water thereby increasing the bulk of the intestinal content. Consequently, gut dimensions increase and this improves nutrient absorption.

Ewing (1963) reported that the amount of fibre in the ration can be increased to 8 or 9% with a desirable effect on chick growth, mortality, feed consumption and egg production. He further reported that the viability of chicks decreased rapidly when the fibre content was increased to about 10% of the total ration and considered levels in excess of 10% undesirable due to decreased growths and increase in mortality especially for the first twelve weeks. El-Abbady et. al. (1970) indicated that male Baladi white chicks could tolerate up to 12% fibre and females 4% although the level could be increased to 7% until the age of 8 weeks without any detrimental effect on either mortality or body weight. A 17% crude fibre diet when fed to the male chicks resulted in depressed growth rate, feed consumption and increased mortality rate.

CHAPTER 3

EVALUATION OF SUNFLOWER SEED IN BROILER DIETS

3.1 Materials and Methods

3.1.1 Source of Sunflower Seeds

Sunflower seeds used in this study were obtained from the Institute for Agricultural Research, Ahmadu Bello University, Zaria. Representative samples were obtained from each of the bags of sunflower used in the experiment and pooled together. 1000 seeds were then randomly selected from the pooled seeds in 10 batches of 100 seeds each to determine the average weight of the seed components and their relative percentages.

3.1.2 Feeding Trial

Two hundred and sixteen day old broiler chicks (mixed sex) of a commercial strain were used for this trial. They were housed in electrically heated brooding pens (3.08m x 1.25m x1.22m) and fed the experimental diets shown in Tables 3.1 and 3.2. Birds were fed a control diet or diets with 0,10, 20, 30,40 and 50% raw sunflower seed in a completely randomized design during both the starter(0-4 weeks) and finisher (5-8 weeks) phases. Both the starter and finisher diets were isocaloric and isonitrogenous. For both starter and finisher phases, there were six treatments, each with three replicates of 12 chicks. Both experimental diets and water were supplied *ad libitum* during a trial period that lasted a total of 8 weeks.

Birds were weighed at day old and weekly thereafter. Feed intake was also measured on weekly basis while mortality was recorded on a daily basis.

At the end of the 8 week feeding trial, two birds per replicate were randomly selected and slaughtered for carcass analysis. Birds to be slaughtered were weighed , then slaughtered by placing the head downwards in slaughtering cones in a rack and severing the head from the neck with a sharp knife for bleeding. They were then defeathered and eviscerated. Hot carcass weight was taken while the gizzard, liver, heart, abdominal fat, spleen, gut, head and legs were expressed as percentage of carcass weight. The lengths of the intestine and caeca were also measured.

3.1.3 Chemical Analysis

The sunflower seed was subjected to chemical analysis using AOAC (1984) method. Protein was determined by the Kjedahl procedure. Ether extract was determined by subjecting the samples to petroleum ether (bp 60-80°c) extraction using the Soxhlet apparatus. Dry matter was determined by oven drying of the samples at 100°c over a 12 hour period. The ash content was determined by incinerating the samples at 600°c for 4 hours. The ash samples were further subjected to mineral analysis to determine the calcium, phosphorus, magnesium, nickel, iron and magnesium contents.

3.1.4 Economic Analysis

An economic analysis of the merits or otherwise of using sunflower seed at the expense of soyabean meal and maize in broiler diet was carried out.The cost in Naira of the feed required for

one kilogramme of weight gain was calculated.

3.1.5. Statistical Analysis

Data collected above were subjected to analysis of variance using the model for completely randomized design(Snedecor and Cochran, 1967). Duncan's multiple range test was applied when treatment effects were found to be significant. Orthogonal polynomials were used to examine trends across treatments.

Table 3.1: Composition of Broiler Starter Diet (23% CP)

Ingredients	Sunflower seed levels, % 0	10	20	30	40	50
Maize	44.84	35.91	26.51	17.42	8.29	0.65
Sunflower	0.00	10.00	20.00	30.00	40.00	50.00
Wheat Offal	2.00	4.50	7.00	9.50	12.00	12.55
Soyabeans	49.21	45.84	42.48	39.13	35.76	32.85
Bonemeal	3.00	3.00	3.00	3.00	3.00	3.00
Salt	0.50	0.50	0.50	0.50	0.50	0.50
Vit/min/premix[1]	0.25	0.25	0.25	0.25	0.25	0.25
Methonine	0.20	0.20	0.20	0.20	0.20	0.20
	100.00	100.00	100.00	100.00	100.00	100.00
Cost per kg (₦)[2]	9.87	9.41	8.92	8.45	7.98	7.55
Calculated Analysis:						
Crude Protein (%)	23.00	23.00	23.00	23.00	23.00	23.00
Crude fibre (%)	3.87	6.08	8.29	10.51	12.72	16.54
Ether extract (%)	10.75	13.24	15.72	18.20	20.68	23.20
Lysine (%)	1.31	1.30	1.28	1.26	1.25	1.23
Meth + cys (%)	0.91	0.94	0.96	0.99	1.02	1.05
Calcium (%)	1.21	1.22	1.24	1.25	1.26	1.27
Total Phosphorus (%)	0.95	0.99	1.03	1.07	1.11	1.13
M.E kcal/kg	3197.00	3199.00	3201.00	3203.00	3205.00	3197.00

1. Vitamin mineral premix provide/kg of diet: vitamin A; 13,340 iu, Vitamin D_3, 2680 I.U.; Vitamin E, 10 I.U.; Vitamin K, 2.68mg.; Calcium d - pantothenate, 10.68mg; Vitamin B_{12} 0.02mg; folic acid, 0.668mg; Choline chloride, 400mg; Chlortetracycline,, 26.68mg; 3, 5-dinitro-orthotoluamide, 166.68mg; Manganese, 133.34mg; Iron, 66.68mg; Zinc, 53.34mg; Copper 3.2mg; Iodine, 1.868mg; Cobalt, 0.268mg; Selenium, 0.108mg.

2. ₦ = Nigerian currency.

Table 3.2: Composition of Broiler Finisher diet (20% CP)

Ingredients	Sunflower seed levels, % 0	10	20	30	40	50
Maize	55.16	46.02	36.87	27.74	18.59	10.96
Sunflower	0.00	10.00	20.00	30.00	40.00	50.00
Wheat Offal	2.00	4.50	7.00	9.50	12.00	12.55
Soyabeans	38.89	35.53	32.18	28.81	25.46	22.55
Bonemeal	3.00	3.00	3.00	3.00	3.00	3.00
Salt	0.50	0.50	0.50	0.50	0.50	0.50
Vit/min premix[1]	0.25	0.25	0.25	0.25	0.25	0.25
Methonine	0.10	0.10	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10	0.10	0.10
	100.00	100.00	100.00	100.00	100.00	100.00
Cost per kg (₦)	9.46	8.98	8.51	8.03	7.56	7.14
Calculated Analysis:						
Crude Protein (%)	20.00	20.00	20.00	20.00	20.00	20.00
Crude fibre (%)	3.63	5.85	8.06	10.27	12.48	14.72
Ether extract (%)	9.31	11.79	14.27	16.76	19.23	21.76
Lysine (%)	1.19	1.18	1.10	1.15	1.13	1.11
Meth + cys (%)	0.74	0.76	0.79	0.81	0.85	0.88
Calcium (%)	1.19	1.20	1.21	1.22	1.24	1.25
Total Phosphorus (%)	0.92	0.96	1.99	1.04	1.08	1.10
M.E. kcal/kg	3205.00	3205.00	3208.00	3212.00	3215.00	3216.00

1. Vitamin mineral premix for broiler as in table 3.1.

Table 3.3: Composition of Sunflower seed (% Air dry basis)

Composition	Percentage
Hull	28.79
Meat (kernel)	71.21
Dry matter	94.79
Crude protein	17.01
Crude fibre	23.78
Ash	0.48
Ether extract	33.23
*ME (KCal/kg)	3967
Calcium	0.13
Phosphorus	0.18
Manganese (PPM)	25.87
Nickel (PPM)	68.99
Iron (PPM)	146.60
Magnesium	0.34

* Aduku, 1993

3.2 Results and Discussion

3.2.1 Composition of Sunflower Seed

The proximate , mineral and physical composition of sunflower seed (SFS) are presented in table 3.3.

The weight of 100 whole seeds, hull and meat were 5.87g, 1.69g and 4.18g, respectively thereby giving averages of 58.7mg, 16.9mg and 41.8mg per seed. The hull and meat represented 28.79% and 71.21% of the whole seed while the hull: meat ratio was 1:2.48.

The analyzed crude protein content of SFS was 17.01% which is similar to 17.30% and 17-20% reported by Kepler *et.al.* (1982) and Sharma *et.al.* (1986) respectively, but higher than the value of 15.99% reported by Daghir *et.al.* (1980). On the

other hand, the values in this trial were lower than values of 20.00%, 24.00% and 19.39% reported by Balogun and Etukudo (1991), Oyenuga (1976) and Noland *et.al.* (1980)respectively. The dry matter value of 94.79% is closer to 93.63% reported by Daghir *et.al.* (1980) but higher than values of 93.50% and 91.19% contained in the reports of Balogun and Etukudo (1991) and Kepler *et.al.* (1982). Ash value of 0.48% obtained in this study is remarkedly lower than the values of 1.7%, 2.91% and 3.85% indicated by Balogun and Etukudo (1991), Daghir *et.al.* (1980) and Kepler *et.al.* (1982). Ether extract values of 17.80% and 13.96% reported by Balogun and Etukudo (1991) and Daghir et.al. (1980) are much lower than the value of 33.23% obtained in this study which is similar to 33.96% reported by Noland *et.al.* (1980). Higher values of 37.89% and 37-40% have been reported by Kepler *et.al.* (1982) and Sharma *et.al.* (1985). Crude fibre content of 23.78% obtained in this study is higher than values of 14.47%, 16.15% and 20.30% reported by Daghir *et.al.* (1980), Kepler *et.al.* (1982) and Balogun and Etukudo (1991). The Calcium content value of 0.13% is similar to 0.15% reported by Daghir *et.al.* (1980) but lower than that of 0.21% reported by Kepler *et.al.* (1982). The phosphorus content of 0.18% is lower than values of 0.35% and 0.60% reported by Daghir *et.al.* (1980) and Kepler *et.al.* (1982) respectively. The metabolizable energy content of SFS has been reported by Aduku (1993) to be 3967 ME kcal/kg while the manganese, nickel,

iron and magnesium contents were found to be 25.87ppm, 68.99ppm, 146.60ppm and 0.34% respectively.

The differences observed in the chemical and mineral compositions of the SFS used in this study and those reported by other authors could possibly be as a result of the varied methods of seed cleaning. This factor might be more pronounced for crude fibre content as the degree of seed cleaning and removal of foreign matter in the laboratory before seed processing could account for differences. Other factors responsible for compositional differences may include genetic, soil types and climatic factors.

3.2.2 Bird Performance During 0 - 4 Weeks

Table 3.4 shows the performance response of starter broilers to dietary levels of sunflower seed. The result showed that treatment had a significant effect on the birds with respect to weight gain, feed intake, feed conversion efficiency and weight at 4 weeks.

Results of the feed intake showed a linear trend with birds on the control diet consuming the most feed while those fed 50% SFS diet consumed the least. Feed intake values of 1.23kg, 1.19kg, 1.22kg, 1.10kg, 1.14kg corresponding to birds fed on 0%, 10%, 20%, 30% and 40% SFS diets did not differ significantly ($P > 0.05$). However, the feed intake of the 50% SFS group (1.01kg) differed significantly from the rest.

The low feed intake observed for the 50% SFS group could be attributed to high fiber content and bulkiness of the feed resulting in incomplete satisfaction of their protein and energy requirements. Fibre is known to give bulk to the feeds.

It has been documented that crude fibre when in high concentrations in the diet limits the weight of feed consumed by the birds hence imposing a physical limitation upon the intake of digestible nutrients (Stanley and Ishizaki, 1982). As the level of SFS increased, the level of dietary crude fibre rose from 3.87% to 16.54%. Ewing (1963) reported that crude fibre levels in excess of 10% were considered undesirable as it resulted in decreased growth of chicks. There was a significant ($P < 0.05$) linear decrease in weight gain as the level of SFS in the diet increased form 0 to 50%. The highest weight gain of 754gm was obtained from birds fed the control diet (0% SFS) followed by 10%, 20%, 30%, 40% and 50% SFS diets with 721gm, 716gm, 624gm, 612gm and 533gm respectively. Weight gains of birds fed 10% and 20% SFS diets although lower than that of the control diet did not differ significantly ($P > 0.05$). Inclusion of SFS beyond 20% depressed growth significantly($P<0.05$). The weight gain and feed intake results are in agreement with the findings of Daghir *et.al.* (1980) and Kondia *at.al.* (1974). Daghir *et.al.* (1980) reported non significant ($P > 0.05$) differences in weight gain, feed intake and feed conversion ratio (FCR) of chicks when fed SFS diets

up to 20%. Kondia *at.al.* (1974) indicated that significant reduction in body weight gain per bird and feed consumption occur when meat type birds are fed high fibre diets.

Feed Conversion Ratio (FCR) was significantly ($P < 0.05$) affected by SFS levels in the diet. FCR results showed that birds fed the 0% SFS diet were most efficient with a linear trend towards poorer feed conversion as the level of SFS increased. The control diet gave a FCR of 1.63 which was not significantly ($P > 0.05$) different from 1.64 and 1.71 obtained in the 10 and 20% SFS diets. Inclusion of SFS beyond 20% resulted in feed conversion ratios of 1.76, 1.86 and 1.90 which were significantly poorer than the control. This is in conformity with the weight gain results. Fibre in fibrous feeds which are normally low in nutrient concentration per unit volume rather than per unit weight contribute little digestible nutrients and also makes other nutrients less available (Fadugba, 1989).

There were no significant effect of the dietary treatments on mortality rate ($P>0.05$). This shows that there is no pathological effect of high dietary SFS on broiler chicks.

The results for feed cost per kilogram weight gain indicated a slight but progressive decrease as the level of SFS increased. The costs for the 0%,10%,20%,30%,40% and 50% SFS diets were ₦9.87, ₦9.41, ₦8.92, ₦8.45, ₦7.98 and ₦7.55 respectively. Although the cost of producing a unit gain in

body weight for the various treatments were not significantly different
(P > 0.05). This little cost reduction may be significant for a large scale operation.

3.2.3 Bird Performance During 5 - 8 Weeks

Table 3.5 shows the results of weight gain, feed intake, feed conversion ratio, mortality, feed cost per kilogram weight gain and weight at eight weeks.

The amount of feed consumed was similar for the 0%, 10%, 20% and 40% SFS groups with corresponding feed intakes of 3590gms, 3530gms, 3590gms and 3460gms. Feed intakes of 3320 for the 30% SFS birds and 3100gm for the 50% SFS group were significantly lower (P < 0.05) than the value for the control. Regression analysis revealed linear trends.

Weight gain results obtained from the period under consideration revealed linear decreases with increasing level of SFS. The highest weight gain of 1606gm was observed in the birds fed the control diet (0% SFS). They grew faster than birds on the 10%, 20% and 40% SFS diets (1565gm, 1505gm, 1496gm) although these growth difference were not statistically significant (P > 0.05). Birds on the 30% and 50% SFS diets on the other hand had weight gains (1315gms and 1216gms) which were lower significantly than the control. The birds with the best feed conversion ratio (2.24) were those on the 0% SFS diet

while the worst (2.55) was observed in the 50% SFS group. There was a linear depreciation in feed conversion ratio as the level of SFS in the diet increased. A non significant ($P>0.05$) difference was seen in the FCR of birds fed 0%, 10%, 20% and 40% SFS diets (2.24, 2.25, 2.39, 2.32) whereas, those on the 30% and 50% SFS diets had poor FCR ($P < 0.05$). (2.54 and 2.55 respectively).

It is however worthy of note that majority of the mortalities that occurred in the 40% SFS group were the smaller birds leaving the bigger birds. No mortality was recorded in the 0% SFS group however, the following mortalities occurred in the 10%, 20%, 30%, 40% and 50% SFS groups: 1, 2, 2, 2 and 1. Newcastle disease was diagnosed to be responsible for most of deaths which occurred during this period. The results for weight gain were probably due to reduced feed intake. Rhajan (1980) and Dvorak and Bray (1978) contended that the lower utilization of high fibre diets may be due partly to increased rate of passage of the feed through the gastrointestinal tracts hence reducing the time of exposure of ingesta to enzymatic degradation and time of nutrient contact with absorptive membrane.

Linear, trends were established for weight gain, feed intake and FCR.

The cost of producing a unit gain in body weight of the birds decreased with increasing levels of SFS in the diet, but

only at the 40% and 50% SFS inclusion level was the decrease significant
($P < 0.05$).

Average weights of the birds in the 0% to 50% SFS groups were 2410gms, 2337gms, 2270gms, 1990gms, 2157gms, 1800 gms respectively. There was no significant difference ($P > 0.05$) amongst the 0%, 10% and 20% SFS groups but other groups had weights which were significantly lower ($P < 0.05$) than that of the control group.

3.2.4 Bird Performance During 0 - 8 Weeks

The weight gain, feed intake, feed conversion ratio, feed cost per kilogram weight gain and mortality results obtained during weeks 0 - 8 are presented in table 3.6.

The highest feed intake occurred in the control group (0% SFS) while the lowest was recorded in the 50% SFS group. The feed intake of birds fed the 0%, 10% and 20% SFS group diets corresponding to 4.82kg, 4.71kg and 4.81kg did not differ significantly ($P > 0.05$). There was, however, a significant difference ($P < 0.05$) between the 30% (4.42kg), 40% (4.60kg), 50% (4.11kg) SFS diets and the control. A linear relationship was established between the feed intake and the SFS treatments. High fibre content and bulk were probable causes of this result. Monogastric animals are less efficient in digesting fibre than ruminants and when present in high levels impairs

feed intake and consequently the growth rate. High crude fibre contents of diets lowers performance of the chicken due to the fact that the higher level of crude fibre is associated with a depression in the feeding value (Nelson, 1984).

Weight gains across the treatments differed significantly ($P < 0.05$) with the highest and lowest gains occurring in the birds fed the 0% and 50% SFS diets respectively. The weight gains obtained were 2360gm, 2286gm, 221gm, 1939gm, 2108gm and 1750gm for the 0% - 50% SFS dietary groups. These values showed a linear decrease with increasing levels of SFS. Weights of birds on the 0%, 10% and 20 SFS did not differ significantly ($P > 0.05$). Birds on 30%, 40% and 50% SFS diets produced lower weights differing significantly ($P < 0.05$) from the control. This result is most likely due to reduced feed intake.

Feed conversion ratio was significantly ($P < 0.05$) affected by SFS level in the diets. The efficiency of feed utilization decreased linearly as the level of SFS in the diet increased. FCR of the six graded levels were 2.05, 2.06, 2.17, 2.29, 2.18 and 2.35. The FCR of birds fed the 0%, 10%, 20% and 40% SFS diets did not differ significantly ($P > 0.05$). There is however significant ($P < 0.05$) differences between the 30% and 50% SFS groups and the control. The results observed in 40% SFS group might be due to the relatively higher mortalities that occurred in the group.

The cost of producing a unit gain in body weight decreased as the level of SFS in the diet increased. Although a progressive decline of ₦39.63, ₦37.88, ₦37.82, ₦37.74, ₦33.88 and ₦34.52 was observed, non significant ($P > 0.05$) differences existed in the 0% - 30% SFS groups. The 40% and 50% SFS groups differed significantly ($P < 0.05$) from the control. Although the 30% SFS group did not differ from the control as per the parameter under consideration, it might not be advisable to adopt this level as it does not favour the weight gains and final weight at 8 weeks of age.

There was no significant effect of the dietary treatments on mortality rate ($P>0.05$).

3.2.5 Meat Characteristics

The carcass weight, liver, heart, gizzard, abdominal fat, head, leg, blood, feather, lung and spleen percent, gut length, caecum length and dressing parentage results are presented in table 3.7. The results showed that birds sampled from the 10% and 20% SFS diets had significantly ($P < 0.05$) similar carcass weights with those on the control diet even though the largest weight (1.71kg) was recorded in the 10% SFS group. The 0% and 20% diets produced weights of 1.69kg and 1.58kg respectively. The lowest carcass weight of 1.38kg came from the 50% SFS group. Carcass weights of 1.46kg and 1.45kg were recorded from the 30% and 40% SFS diets. All these weights were

significantly different (P > 0.05) from the control.

Gizzard percentages showed irregular but significant (P < 0.05) differences across treatment means. The highest (1.86%) was recorded in the 50% SFS group. Gizzard weights for the 0% to 40% SFS dietary groups were 1.37%, 1.35%, 1.70%, 1.33% and 1.72%. The 0% to 30% SFS dietary groups had non significantly (P > 0.05) different percentages; the 40% and 50% also had non significantly (P > 0.05) percentages while the 40 and 50% SFS dietary groups differed significantly (P < 0.05) from the control. This observation is most likely due to the fibre content in the feeds. Deaton *et.al.* (1979) had reported that gizzard weight significantly increased when crude fibre is introduced in chicken feeds.

No significant differences were observed across treatments for liver, heart, abdominal fat, head, leg, blood, feather, lung and spleen percentages, gut length, caecum length and dressing percentage.

Table 3.4: Performance of Broilers fed graded levels of SFS (0 - 4 weeks)

Parameter	Sunflower seed level, % 0	10	20	30	40	50	SEM	Sig.Effects
Feed intake,g	1230^{a}	1190^{a}	1220^{a}	1100^{ab}	1140^{ab}	1010^{b}	36.68	L*
Weight gain, g	754^{a}	721^{a}	716^{a}	624^{b}	612^{b}	533^{c}	20.96	L*
FCR	1.63^{c}	1.64^{c}	1.71^{bc}	1.76^{b}	1.86^{a}	1.90^{a}	0.022	L*
Feed Cost /kg wt.gain(₦)	16.09	15.43	15.25	14.87	14.84	14.35	0.245	-
Mortality, %	0	0	0	2.8	5.6	0	-	-
Weight at WK 4,g	804^{a}	772^{a}	765^{a}	675^{b}	660^{b}	584^{b}	22.76	-

^{abc} Means on the same row with different superscripts differ significantly ($P < 0.05$)
L - Linear

FCR = Feed Conversion Ratio

Table 3.5: Performance of Broilers fed graded levels of SFS (5 - 8 weeks)

Parameter	Sunflower seed level, % 0	10	20	30	40	50	SEM	Sig.Effect
Feed intake,g	3590^{a}	3530^{ab}	3590^{a}	3320^{b}	3460^{ab}	3100^{c}	63.74	L*
Weight gain, g	1606^{a}	1565^{a}	1505^{a}	1315^{b}	1496^{b}	1216^{c}	54.79	L*
FCR	2.24^{b}	2.25^{b}	2.39^{ab}	2.54^{a}	2.32^{ab}	2.55^{a}	0.079	L*
Feed Cost /kg wt.gain(₦)	21.19^{a}	20.65^{a}	20.39^{a}	20.34^{a}	17.54^{b}	18.21^{b}	0.640	-
Mortality, %	0	2.8	5.6	5.7	5.9	2.8	-	-
Weight at WK 8,g	2410^{a}	2337^{a}	2270^{ab}	1990^{c}	2157^{bc}	1800^{d}	53.78	-

^{abc} Means on the same row with different superscripts differ significantly ($P<0.05$)
L - Linear

FCR = Feed Conversion Ratio

Table 3.6: Performance of Broilers fed graded levels of SFS (0 - 8 weeks)

Parameter	Sunflower seed level, % 0	10	20	30	40	50	SEM	Sig. Effects
Feed intake,g	4820^{a}	4710^{ab}	4810^{a}	4420^{c}	4600^{bc}	4110^{d}	61.65	L*
Weight gain, g	2360^{a}	2286^{a}	2221^{ab}	1939^{c}	2108^{b}	1750^{d}	51.64	L*
Dressing %	76.12	76.87	76.61	75.97	73.74	75.08	1.090	
FCR	2.05^{cb}	2.06^{c}	2.17^{cb}	2.29^{ba}	2.18^{cb}	2.35^{a}	0.079	L*
Feed Cost /kg wt.gain(N)	39.63^{a}	37.88^{a}	37.82^{a}	37.74^{a}	33.88^{b}	34.52^{b}	0.822	-
Mortality, %	0	2.8	5.6	8.3	11.1	2.8	-	-

^{abc} Means on the same row with different superscripts differ significantly (P<0.05)
L - Linear

FCR = Feed Conversion Ratio

Table 3.7: Effect of graded levels of SFS on broiler meat characteristics

Parameter	Sunflower seed level, % 0	10	20	30	40	50	SEM
Carcass weight, kg	1.69^{a}	1.71^{a}	1.58^{ab}	1.46^{bc}	1.38^{bc}	1.38^{c}	0.110
Liver %	1.86	1.90	2.01	2.04	2.17	2.57	0.106
Heart %	0.63	0.61	0.61	0.69	0.88	0.72	0.067
Gizzard %	1.37^{bc}	1.35^{c}	1.70^{abc}	1.33^{c}	1.72^{ab}	1.86^{a}	0.111
Abdominal fat %	2.28	3.03	2.42	2.55	2.40	2.35	0.111
Head %	1.97	1.96	2.19	2.03	2.07	2.24	0.109
Leg %	2.49	3.12	3.54	2.97	3.29	3.53	0.370
Blood %	4.49	4.09	4.03	4.82	5.35	5.73	0.431
Feather %	7.16	6.93	7.09	7.49	7.20	5.21	0.0006
Lung %	0.25	0.51	0.44	0.44	0.43	0.35	0.057
Spleen %	0.12	0.12	0.15	0.11	0.12	0.12	0.017
Gut length, cm	227	228	222	227	241	220	3.000
Caecum length, cm	18.63	20.38	18.63	19.00	19.78	18.88	0.290

^{abc} Means along the same row with different letter superscripts are significantly different (P<0.05)

CHAPTER 4

GENERAL SUMMARY AND CONCLUSION

The results obtained from this study suggest that inclusion of sunflower seed in broiler diets is beneficial. In the starter diets, 10 and 20% SFS inclusion rate had no detrimental effect on weight gain and feed conversion ratio. With respect to feed intake, there was no significant ($P > 0.05$) difference except at the 50% dietary level of SFS. Non significant ($P > 0.05$) difference existed in the feed cost per kilogram weight gain.

For the finisher phase, no significant differences ($P > 0.05$) was observed between the 0%, 10%, 20% and 40% SFS dietary groups for weight gain, feed intake and feed conversion ratio. Beyond 30% SFS dietary inclusion, feed cost per kilogram weight gain differed significantly ($P< 0.05$). Mortality was highest among the 40% SFS group during both the starter and finisher phases.

Except for carcass weight and gizzard percentage, non significant ($P > 0.05$) results were obtained with respect to liver, heart, abdominal fat, head, leg, blood, feather, lung weights, gut length, caecum length and dressing percentage when compared to those of the control.

Inclusion of up to 20% SFS in diets of broilers had no adverse effect on performance. The inclusion of SFS in broiler diets would prove to be very economical especially if practiced

on a large scale and the aggressive competition between man and birds for soyabeans and groundnut cake would be considerably reduced thereby increasing the availability of these ingredients for human consumption.

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APPENDICES

Appendix 1: Ingredient Prices as at October, 1994

Ingredients	Price ₦/kg
Maize	6.00
Soyabeans	10.00
Sunflower	3.00
Wheat Offal	4.40
Bonemeal	4.83
Salt	28.33
Vit/min Premix	353.60
Methionine	500.00
Lysine	500.00

Appendix 2: Analysis of variance for Weight gain (0-4 Weeks)

Source of Variation	DF	SS	MS	F
Treatment	5	105731.23	21146.25	16.05*
Error	12	15810.12	1317.51	
Total	17	121541.35		

Appendix 3: Analysis of variance for feed intake (0-4 Weeks)

Source of Variation	DF	SS	MS	F
Treatment	5	105729.60	21145.72	5.24*
Error	12	48447.24	4037.27	
Total	17	154175.84		

Appendix 4: Analysis of variance for feed conversion ratio (0-4 Weeks)

Source of Variation	DF	SS	MS	F
Treatment	5	0.1810	0.036	24.00*
Error	12	0.0181	0.002	
Total	17	0.1991		

Appendix 5: Analysis of variance for feed cost/kg Weight gain (0-4 Weeks)

Source of Variation	DF	SS	MS	F
Treatment	5	0.84912	0.1213	0.54^{NS}
Error	12	2.22985	0.22298	
Total	17			

Appendix 6: Analysis of variance for Weight at 4 weeks

Source of Variation	DF	SS	MS	F
Treatment	5	105777.95	21155.59	13.61*
Error	12	15823.67	1318.64	
Total	17	121601.62		

Appendix 7: Analysis of variance for Weight gain (5-8 Weeks)

Source of Variation	DF	SS	MS	F
Treatment	5	346326.45	69265.29	7.69*
Error	12	108064.76	9005.40	
Total	17	454391.21		

Appendix 8: Analysis of variance for feed intake (5-8 Weeks)

Source of Variation	DF	SS	MS	F
Treatment	5	563282.43	112656.49	9.24*
Error	12	146245.22	12187.10	
Total	17	709527.66		

Appendix 9: Analysis of variance for feed conversion ratio (5-8 Weeks)

Source of Variation	DF	SS	MS	F
Treatment	5	0.2154	0.0431	6.77*
Error	12	0.0886	0.0074	
Total	17	0.3040		

Appendix 10: Analysis of variance for feed cost/kg weight gain (5-8 Weeks)

Source of Variation	DF	SS	MS	F
Treatment	5	31.7443	6.34886	5.16*
Error	12	14.76313	1.23026	
Total	17	46.50745		

Appendix 11: Analysis of variance for Weight at 8 Weeks)

Source of Variation	DF	SS	MS	F
Treatment	5	792961.11	158592.22	18.28*
Error	12	96133.33	8011.11	
Total	17	889094.44		

Appendix 12: Analysis of variance for Weight gain (0-8 Weeks)

Source of Variation	DF	SS	MS	F
Treatment	5	793987.54	158797.51	19.85*
Error	12	95995.68	7999.64	
Total	17	889983.22		

Appendix 13: Analysis of variance for feed intake (0-8 Weeks)

Source of Variation	DF	SS	MS	F
Treatment	5	1152939.03	230587.81	20.22*
Error	12	136836.51	11403.04	
Total	17	1289775.55		

Appendix 14: Analysis of variance for feed conversion ratio (0-8 Weeks)

Source of Variation	DF	SS	MS	F
Treatment	5	0.2127	0.0425	5.66*
Error	12	0.0902	0.0075	
Total	17	0.3029		

Appendix 15: Analysis of variance for feed cost/kg Weight gain (0-8 Weeks)

Source of Variation	DF	SS	MS	F
Treatment	5	73.10969	14.6219	7.22*
Error	12	24.31706	2.0264	
Total	17			

Appendix 16: Analysis of variance for Carcass Weight

Source of Variation	DF	SS	MS	F
Treatment	5	0.83634	0.16727	19.64*
Error	35	0.25555	0.0085	
Total	17	1.091897		

Appendix 17: Analysis of variance for Liver percentage

Source of Variation	DF	SS	MS	F
Treatment	5	20.1856	4.037	0.21^{NS}
Error	30	565.091	18.836	
Total	35	585.2769		

Appendix 18: Analysis of variance for Heart Percentage

Source of Variation	DF	SS	MS	F
Treatment	5	4.74165	0.94833	1.13^{NS}
Error	30	25.27738	0.84257	
Total	35	30.01907		

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Appendix 19: Analysis of variance for Gizzard Percentage

Source of Variation	DF	SS	MS	F
Treatment	5	1.4713	0.2943	3.57*
Error	30	2.4707	0.0824	
Total	35	3.9420		

Appendix 20: Analysis of variance for Abdominal Fat

Source of Variation	DF	SS	MS	F
Treatment	5	2.2388	0.4477	0.37NS
Error	30	36.5600	1.21866	
Total	35	38.7988		

Appendix 21: Analysis of variance for Head Percentage

Source of Variation	DF	SS	MS	F
Treatment	5	54.4722	10.8944	1.34NS
Error	30	243.1667	8.1055	
Total	35	297.6388		

Appendix 22: Analysis of variance for Leg Percentage

Source of Variation	DF	SS	MS	F
Treatment	5	0.6243	0.12486	1.74^{NS}
Error	30	2.15145	0.07171	
Total	35	2.77575		

Appendix 23: Analysis of variance for Blood Percentage

Source of Variation	DF	SS	MS	F
Treatment	5	14.0944	2.8188	2.44^{NS}
Error	30	34.5896	1.1529	
Total	35	48.6840		

Appendix 24: Analysis of variance for Feather Percentage

Source of Variation	DF	SS	MS	F
Treatment	5	0.00002069	0.00000414	1.67^{NS}
Error	30	0.00007414	0.00000247	
Total	35	0.00009483		

Appendix 25: Analysis of variance for Lung Percentage

Source of Variation	DF	SS	MS	F
Treatment	5	0.008955	0.00279	0.81^{NS}
Error	30	0.06600	0.00220	
Total	35	0.074955		

Appendix 26: Analysis of variance for Spleen Percentage

Source of Variation	DF	SS	MS	F
Treatment	5	0.3231	0.06462	2.29^{NS}
Error	30	0.8459	0.02819	
Total	35	1.1690		

Appendix 27: Analysis of variance for Gut Length

Source of Variation	DF	SS	MS	F
Treatment	5	1527.2292	305.4458	0.57^{NS}
Error	30	16421.4583	547.3819	
Total	17	17948.6875		