

UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
DEPARTMENT OF ANIMAL SCIENCE

THE EFFECTS OF PARTIAL REPLACEMENT OF SOYABEAN WITH ALKALI TREATED
SUNFLOWER SEED CAKE ON BROILER (FINISHER) PERFORMANCE

BY SILIKO HOPE KIBOMBWE

29012988

in partial fulfillment of the requirements for the award of the Bachelor of Science Degree in
Agriculture Sciences

UNIVERSITY OF ZAMBIA
SCHOOL OF AGRICULTURAL SCIENCES
DEPARTMENT OF ANIMAL SCIENCE

THE EFFECTS OF PARTIAL REPLACEMENT OF SOYABEAN WITH ALKALI TREATED
SUNFLOWER SEED CAKE ON BROILER (FINISHER) PERFORMANCE

BY SILIKO HOPE KIBOMBWE

In partial fulfillment of the requirements for the award of the Bachelor of Science degree in
Agriculture sciences

TABLE OF CONTENTS

CHAPTER 1	1
INTRODUCTION.....	1
PROBLEM STATEMENT.....	5
JUSTIFICATION.....	5
MAIN OBJECTIVE.....	6
SPECIFIC OBJECTIVE.....	6
HYPOTHESES.....	7
CHAPTER 2	8
LITERATURE REVIEW.....	8
CHAPTER 3	12
MATERIALS AND METHODS.....	12
CHAPTER 4	14
RESULTS.....	14
INITIAL WEIGHT OF BIRDS.....	17
TOTAL FEED INTAKE.....	17
FINAL WEIGHTS OF BIRDS.....	17
TOTAL WEIGHT GAIN.....	17
FEED CONVERSION RATIO.....	17
DISCUSSION.....	18
CONCLUSION.....	19
REFERENCES.....	20
APPENDICES.....	23

I. ABSTRACT

Soya bean meal is commonly used as major protein contributor in broiler production but with the currently high cost of producing poultry in Zambia, it has become necessary that alternative local feeds replace soya bean meal in order to reduce the cost of feeding which accounts for about 70% of production.

The study was carried out to investigate the effects of pre alkaline treatment of sunflower seed cake on its nutrient content as well as the effects of replacing soya bean meal in finisher diets with alkali treated sunflower seed cake, on the growth performance of broilers. A total of 100 day old unsexed broiler chicks (Ross) were used in the experiment. The experiment lasted 42 days and a two phase feeding program was used. 5 experimental diets were supplied ad libitum; the soya bean meal in finisher diet was replaced at the rate of 10% and 20%.

Replacement of soya bean meal with TSSC had no significant effect ($P > 0.05$) on the feed conversion ratio of the birds. It was concluded that TSSC can replace soyabean meal up to 20% in broiler finisher diets.

II. ACKNOWLEDGEMENTS

Firstly and most importantly I give thanks to my almighty God for giving me this opportunity to carry out my research project, for giving life to me and all the people around me that rendered various forms of support.

To my parents, Mr. G.H Kibombwe and Mrs. G.K Kibombwe for the moral and financial support, my siblings and my friends for giving me the encouragement especially when I needed it most.

To my supervisor, Dr.Kanyinji for being my guide throughout the process, I thank you.

To the personnel at the field station and the laboratory that offered and shared their knowledge, practical skill and experience making my research an enjoyable learning experience, one I would call a success.

I thank you all.

III. LIST OF TABLES

	PAGE
TABLE 1 ; Composition of USSC and TSS.....	18
TABLE2 ; Composition of broiler finisher diet.....	19
TABLE3 ; Summary of the initial weight (g/bird) ,final weight(g/bird),total weight gain (g/bird/3wks) daily feed intake (g/bird),total feed intake (g/3wks) and feed conversion ratio	20
TABLE4; Economic comparison of replacing soya bean with SSC in broiler finisher diets.....	28
TABLE 5; Comparison of the chemical composition of sunflower seed cake with other oilseed meals.....	29
TABLE 6. The fiber contents (% of DM) of selected feedstuffs.....	32
TABLE 7. A brief overview of the actions of soluble and insoluble non-starch polysaccharides (NSP) in the anterior digestive tract.	32

IV. LIST OF ABBREVIATIONS

AME	Apparent Metabolisable Energy
ANOVA.....	Analysis Of Variance
A.O.A.C.....	Association of Official Agricultural Chemists
FCR.....	Feed Conversion Ratio
HO.....	Null Hypothesis
H1.....	Alternative hypothesis
NSP.....	Non Starch Polysaccharides
s-NSP.....	soluble-Non Starch Polysaccharides
i-NSP.....	insoluble - Non Starch Polysaccharides
SBM.....	Soybean Meal
TSSC.....	Treated Sunflower Seed Cake
USSC.....	Untreated Sunflower Seed Cake

goes
mbia,

CHAPTER 1

INTRODUCTION

Broiler chickens (*Gallus gallus domesticus*) are a domesticated fowl, a subspecies of the red jungle fowl, bred and raised specifically for meat production. Typical broilers have white feathers, yellowish skin and most that are commercially bred reach slaughter weight at between 5-7 weeks of age. Broilers are usually grown as mixed sex flocks in large sheds under intensive conditions but some strains can be grown as free range flocks.

Broiler production is one of the growing industries in Zambia both at commercial and household level. Many people have developed interest and realized the benefits of investing in the area of production. Poultry meat is one of the most palatable of all meats; it is easily digestible and acceptable to most people (FAO, 1967). This explains part of the reason why the demand for poultry meat is on the increase.

The Zambian poultry industry is growing as it moves towards being one of the major producers in the southern Africa sub region, but the high cost feed - which account for up to 60 -70% of the total cost of production - is a challenge to the industry.

A full poultry ration must include the following protein source, an energy source, minerals and vitamins in order for the bird to grow to full potential.

In Zambia, the soya bean meal is currently the most widely used protein source ingredient in broiler feeding systems. Soya beans is grown as an industrial crop and is used in oil production and in products such as soya chunks and soya meal. The by-product (cake) is fed directly to animals or processed with other ingredients into animal feed stock.

The protein and oil content of the meal is dependent on the extent to which the seed undergoes processing, with a livestock revolution underway in developing countries, including Zambia,

industrial demand for soya is likely to increase. Livestock revolution refers to increased consumption of animal products as a result of high population growth rates coupled with increased incomes and urbanization (Delgado et al. 1999)

An alternative to the use of soyabean meal in poultry diets is Sunflower seed cake (SSC), a byproduct of sunflower seed oil extraction.

SSC has the potential to be a major feed ingredient for poultry in many countries currently not suitable for extensive soyabean cultivation. SSC is a good source of protein with amino acid availabilities similar to those of SBM, and much higher than those in cottonseed or rapeseed meals. Its lysine content is relatively low but this can be resolved with supplemental lysine.

There are two types of sunflower seed cakes (Senkoylu and Dale, 1999). One type is high in oil content (40-51%) and is the one mostly used in production of sunflower oil. The seeds of these high oil sunflowers are black with a thin hull stuck tightly to the kernel that is difficult to remove. The other type of sunflower has much less oil content (about 25%) and is used primarily in the snack, confectionery, bakery and bird food markets. The seeds of these sunflowers are larger with a thick striped hull that is not held as tightly to the kernel. It is therefore much easier to remove the hull from the low- oil varieties.

The amount of hull left upon extraction for oil is what contributes largely to the fibre content of the sunflower seed cake. Fibre content should be decreased to a minimum by dehulling during processing of the sunflower seed for oil extraction; however, regulating the amount of hull left by the oil extracting companies in Zambia may not currently be possible.

Another characteristic of SSC is that it does not have anti-nutritional factors such as those found in soyabean, cottonseed and rapeseed meals. Enzyme supplementation to SFM-based diets in different types of poultry species need further study. The ingredient can successfully be included in layer, broiler and waterfowl diets at the maximum recommended level depending on the quality of the specific product being used, this will vary by variety of sunflower grown and the method of oil extraction.

The science of treating forages has been used in ruminant feeding in an effort to make roughages more digestible by the ruminant animals

Treating crop residues like corn stover and wheat straw with calcium hydroxide or calcium oxide increases their nutritional value, providing a cost-effective supplement for grain used in cattle feed rations.

Liquid calcium solutions break down the chemical bonds in crop residues that normally prevent efficient digestion of carbohydrates. Calcium oxide and calcium hydroxide raise the PH levels of crop residues, which loosen the bonds between lignin and hemicelluloses in the cell walls. Breaking these chemical bonds between lignin and hemicelluloses releases sugars that are normally inaccessible to rumen enzymes.

Calcium Oxide and Calcium Hydroxide are the most common chemicals used to treat crop residues because they are readily available and relatively inexpensive. Calcium Oxide and Calcium Hydroxide are both alkalis (high PH levels) derived from limestone and used in a wide range of applications around the world. Calcium hydroxide, for example, is used in many food applications, including corn tortillas and calcium fortified beverages.

Other alkaline treatments have been applied to crop residues, including anhydrous ammonia, sodium hydroxide, and urea, yet most recent research and commercial application has involved calcium oxide and calcium hydroxide because other alkaline treatments are more difficult to handle or produce lower quality forage than lime-based products.

The potential of treatment with 5 % ash solution in improving degradability of fibrous feeds in Ethiopia by Solomon A. Kebede et al (2012) showed results that led to the conclusion that there was a sizeable improvement in rate of degradation as a result of treatment with ash solution resulting in improvement of amount degraded in the first 24 to 48hours

As SSC tends to have high fiber content, perhaps adopting the science of treating feedstuff with chemicals to improve their value, could equally improve SSC by reducing its fiber content for better utilization in broiler diets.

This paper therefore investigated the effects of pretreating sunflower seed cake with an alkaline on the nutrient content especially fiber content as the main focus

PROBLEM STATEMENT

Soya beans meal is a major protein supplement source for poultry systems due to its excellent amino acids composition and high levels of digestibility. However the availability of soya bean meal for use in animal nutrition is limited due to its use as a human feed combined with low productivity.

Soya bean production in Zambia is however low despite the clear benefits for smallholder, this due to the limited availability of high yielding soybean seed and limited incentive for private agronomic practices, such as late planting and poor disease management as well as low usage of yield improving inputs such as inoculums. Due to low production farmers tend to have small quantities to sell and the earliest opportunity farmers have to turn their crop into cash is when the prices are the lowest of the marketing season during harvest times (Techno Serve 2011). This low production of the bean has in turn contributed to the increase in its cost and may result in the increase in stock feed prices. The increase in stock feed prices may severely affect the small-scale poultry producers resulting in a number of them dropping out if the trend of soya bean price hikes continues.

Although the protein content of soya bean meal is high it is deficient in methionine and often this must be supplemented synthetically. In addition to this, soya beans contain trypsin inhibitors which have a negative impact on protein hydrolysis.

These factors encourage the need for poultry producers to diversify into the use of other protein sources in their feeding systems.

JUSTIFICATION

Sunflower seed cake contains high levels of protein that enable it to be used as a substitute for soya bean meal in poultry and piggery rations. Lower levels of lysine and threonine may cause some restrictions on non ruminant use of sunflower meal, however sunflower meal contains an excellent level of methionine which provides potential advantages of mixing with other meals.

Sunflower meal is also considered to be a safe feed for all species owing to the fact that it contains no anti nutritional factors present as opposed to other potential protein sources for example; cotton contains gossypol, soya beans contain trypsin inhibitor

In comparison to an equivalent amount of soya bean cake, the price of sunflower is up to 50% lower. This is partly because there is no competition for the meal with man; this is not the case for the soya bean meal.

MAIN OBJECTIVE

- I. To determine the effect of pre-alkali treatment of sunflower seed cake on the nutrient content of sunflower seed cake
- II. To determine the effect of pre alkali treatment of sunflower seed cake on broiler growth performance.

SPECIFIC OBJECTIVE

- I. To determine the effect of pre- alkali treatment of sunflower seed cake on moisture, ether extract ,crude fiber and crude protein content.
- II. To determine feed intake , weekly body weight , body weight gain and feed conversion ratio (FCR) of birds fed on the different rations.

HYPOTHESES

- I. H_0 : feed containing alkali treated sunflower seed cake has no effect on its nutrient content
- II. H_1 : feed containing alkali treated sunflower seed cake has an effect on its nutrient content

- III. H_0 : feed containing alkali treated sunflower seed cake has no effect on broiler body weight.
- IV. H_1 : feed containing alkali treated sunflower seed cake has an effect on broiler body weight.

- V. H_0 : feed containing alkali treated sunflower seed cake has no effect on broiler feed intake
- VI. H_1 : feed containing alkali treated sunflower seed cake has an effect on broiler feed intake

- VII. H_0 : feed containing alkali treated sunflower seed cake has no effect on broiler body weight gain
- VIII. H_1 : feed containing alkali treated sunflower seed cake has an effect on broiler body weight gain

- IX. H_0 : feed containing alkali treated sunflower seed cake has no effect on broiler feed conversion ratio
- X. H_1 : feed containing alkali treated sunflower seed cake has an effect on broiler feed conversion ratio

CHAPTER 2

LITERATURE REVIEW

Typical high oil content sunflower seeds (*Helianthus annuus*) contain about 40 to 50% oil. The oil, once dewaxed, is a light yellow color. The greatest use for this oil is as an edible product for human consumption due primarily to the high ratio of polyunsaturated fatty acids to saturated fatty acids (Trotter et al., 1970), and its low linolenic acid content

The primary unsaturated fatty acids are linoleic and oleic acid. The saturated fatty acids consist of low levels of palmitic and stearic acids and small amounts of palmitoleic, linolenic, arachidic, behenic, and lignoceric acids. Uses for sunflower oil are many and varied and are broken down into edible and inedible products, inedible products include animal feeds and paint bases (Anderson, 1970).

Processing of high oil type sunflower seed is predominantly carried out by three methods. These are 1) direct solvent extraction, 2) prepress solvent extraction, and 3) expeller or screw extraction. As a result of processing, sunflower meal composition may vary greatly. This is due to the amount of heat used in processing and extracting the meal (Pineiro et al, 2002).

Protein quality and quantity are two of the primary considerations in animal nutrition for the use of a particular feedstuff. When amino acids are considered, sunflower meal is considered to be rich in tryptophan, arginine, and especially methionine, but low in lysine (Delic et al., 1971) and it generally contains a crude protein range from 26 -40%

Sunflower seed cake has been found to provide lower metabolisable energy of 7.9MJ/Kg to poultry in relation to soya bean meal, 9.2MJ/Kg. These values for gross energy will vary due to the amount of residual oil and hulls after processing (Silva 1990).

Poultry do not produce the enzymes required to digest fibres present in the feed. This fact is reflected in the high degree of nutrient concentration and refinement of commercial feed compositions. Even if fibres cannot be digested by broiler chickens and laying hens they are not inert. In fact, the study of the digestive physiology of poultry may lead to the suggestion that fibres do have an important role to play.

A brief look at some characteristic segments of the alimentary canal of poultry may justify such an assumption.

Nutrients are digested and absorbed along the small intestine; but as previously indicated, poultry cannot degrade the fibre fraction of the feed. Instead, completely or partly undigested fractions of water soluble digesta particles, including fibres, are moved by means of anti-peristalsis into the pair of caeca. Coarser fractions of digesta are prevented from entering the caeca by a filter-like meshwork of villi stretching into the lumen (Björnhag, 1989). The caeca harbour large numbers of bacteria with the capacity to use the energy present in the fibres. Some metabolic end products from this fermentation, such as short chain fatty acids, can finally be absorbed and utilized by the bird.

It has been assumed that fibres exert a range of effects in the digestive tract of the fowl as will be shown.

The term 'dietary fibre' was first used by Hipsley (1953) and later defined by Trowell (1976) as "the residue of plant food resistant to hydrolysis by human alimentary enzymes". What is often meant by 'fibre' may chemically be described as chains of sugar units. These chains can be identified following the removal of another sugar polymer, starch, in the feed sample. The fractions obtained may then be denoted non-starch polysaccharides (NSP) and they are commonly further characterized with respect to their solubility in water.

Nonstarch polysaccharides (NSPs) are polymeric carbohydrates differing in composition and structure from amylose and amylopectin. These complex carbohydrates are present in high quantity in certain feedstuffs. Chemically, NSP consists of macromolecular polymers of monosaccharides joined by a specific type of linkage called glycosidic bond formed between hemiacetal group of one sugar and the hydroxyl group of another, whereas in starch the glucose molecules are joined mainly by α (1-4) bond with a small number of α (1-6) bonds (Smits and Annison, 1996). The nature of the bonds determines their susceptibility to digestion by avian enzymes.

Fibre contents of some raw materials used in poultry feeds are listed in table 6. For comparative purposes, the crude fibre content of each feedstuff is listed next to the contents of the soluble NSP (s-NSP) and insoluble NSP (i-NSP).

NSPs have a large number of adverse effects on the performance and well-being of poultry.

NSPs are not available directly to the system. Most NSP are part of cell wall and closely associated with other polysaccharides or non-carbohydrates like protein and lignin. NSPs are not available to the system as they are resistant to endogenous enzymatic digestion and monogastric animals do not secrete the enzymes to degrade the complex bonding of NSPs.

NSPs induce physico-chemical changes hindering nutrient utilization. The association of NSPs with other fractions in feed stuffs determines the antinutritive activity. Solubility is an important property, which increases the viscosity of ingesta in birds (Choct et al, 1991). Higher viscosity of ingesta would lead to reduced digestion and absorption of feed nutrients and hence poor performance.

Water holding capacity (WHC) Soluble NSPs have property of adsorbing or imbibing water molecules to give viscous solutions. The viscosity is dependent on size of molecule, branching character, presence of charged groups, surrounding structure and concentration. As the concentration increases, the molecules interact and become entangled in a network and increases the viscosity (Choct et al, 1991). The primary important negative effect of increased gut viscosity is reduction in contact intensity between potential substrates and digestive secretions resulting in depressed digestibilities of fat, protein and carbohydrates and overall reduction in AME of diet. In addition, high viscous digesta increase the amount of sticky droppings. Sometimes NSPs complex with intestinal enzymes leading to lesser enzyme availability for digestion and also causing reduced fat digestibility by entrapping the bile salts. In addition, viscosity forming agents increase the thickness of unstirred water layer resulting in increased resistance for absorption of fatty acids and monoglycerides. Further, viscosity increases the proliferation rate of enterocytes and change in morphology of villi and microvilli resulting in poor absorption (Smits and Annison, 1996).

NSPs have an effect on intestinal viscosity; highly viscous properties of soluble NSPs reduce the digesta passage rate and impair the diffusion of digestive enzymes to their substrates and mixing with gut contents.

NSPs have an effect on endogenous enzyme activity. Viscous polysaccharides may complex with digestive enzymes and reduce their activity. Knarreborg et al (2002) reported decreased activity of pancreatic enzymes viz., amylase, lipase, trypsin and chymotrypsin in vitro upon incubation with cellulose, pectin and xylan.

An overview of the different roles of s-NSP and i-NSP in the anterior digestive tract is given in Table 7.

In general, it seems reasonable to suggest that s-NSP tend to act detrimentally on digestion whereas the negative effect of i-NSP are less pronounced, and in some cases, even beneficial to the bird.

Various treatment methods have been used to improve feeding value of fibrous feeds. One of these methods is chemical treatment and have reportedly improved the utilization of fibrous feeds to such an extent as to make their utilization as feed ingredients feasible and profitable (Jackson, 1977).

For chemical treatment alkali chemicals are usually employed (Jackson, 1977; Chaudhry, 1998). Alkali treatment dissolves lignin providing greater access to cellulose by bacterial cellulases, it also promotes greater degradation of fibrous feeds to reduce the particles during mastication, increasing their retention in the cecum.

It has been known for nearly a century that alkali treatment of straw can increase its digestibility, the earliest methods were developed in Germany where straw was pressure cooked in dilute sodium hydroxide solution followed by washing with clean water to remove the untreated alkali. The sodium hydroxide dissolved the lignin and silica, hydrolyzed ester linkages among cell wall constituents and caused the cellulose to swell, all of which enhanced digestibility. Later, Beckmann replaced pressure cooking by simple cold water soaking to reduce costs.

In a simple method, a 4-5% aqueous solution of sodium hydroxide is sprayed on the straw and fed directly to animals after a 24 hour curing period. The use of calcium hydroxide is almost as effective as sodium hydroxide.

Sunflower seed cake contains a considerable amount of s-NSP (as shown in table 6), which have been described as being detrimental on digestion in poultry, perhaps alkali treatment of SSC could help poultry utilize it better.

CHAPTER 3

MATERIALS AND METHODS

The experiment was conducted at the field station, School Of Agricultural Sciences at The University of Zambia.

The sunflower seed cake used for the study was purchased a local feed supply company in 50kg packed bags. The treatment required that the moisture content of the cake be raised to 50%. A proximate analysis of the untreated cake prior to treatment was therefore important.

The moisture content, ether extract (EE), crude fiber (CF) and crude protein (CP) were determined, AOAC (1990) results tabulated in table 1. To raise moisture content of the cake from 7.85 % to 50% Therefore having determined the moisture content of 7.85 %, the remaining 42.15 % moisture had to be added. The amount of sunflower required for the entire feeding period was weighed and soaked in a CaOH solution at the rate of 5%(w/w) in a drum and left covered at room temperature. The processed meal was sun dried and milled for further use.

5 basal diets were formulated table 2, with TSSC at different inclusion rates as shown below.

. Control 0% sunflower seed cake inclusion rate

USSC (Untreated sun flower seed cake) at 10% inclusion rate

USSC (Untreated sun flower seed cake) at 20% inclusion rate

TSSC (Treated sunflower seed cake) at 10% inclusion rate

TSSC (Treated sunflower seed cake) at 20 % inclusion rate

The brooder house was cleaned out and disinfected 1week prior to the arrival of the chicks, windows were covered with black polythene plastic to regulate ventilation and heat distribution a day before the arrival of the birds, litter, feed and water were put in place with heaters left on overnight.

100 day old (Ross) chicks were kept in one compartment for brooding up to 21 days of age, during this period, the birds were routinely managed. Drinkers were cleaned and water replaced

every day, ensuring that litter was kept dry. A 2-phase feeding programme was used and starter feed was provided ad libitum.

Gumboro and Newcastle vaccinations were administered to the birds through drinking water in the 2nd and 3rd week.

10, 1m x 1m compartments were constructed within the poultry house, light and heat were provided. On day 22, the birds were randomly separated into 5 treatment groups with 2 replications and 10 birds per replication. The experimental design used was the Completely Randomized Design (CRD).

Drinking water was changed every day; 2kg of feed/day per unit was given.

Data based on the following variables was collected; initial weight at day 21, final weight at day 42, feed intake per treatment per day, live weight gain for 3weeks, and at the end of the experiment feed conversion ratios were calculated. The data was subjected to MINITAB 16 statistical software and analyzed by one way ANOVA at α 0.05

CHAPTER 4

RESULTS

Results of proximate analysis of untreated sunflower seed cake show a decrease in crude fiber content and an increase in the moisture, ether extract and crude protein contents as shown in table.

Table 1; Moisture content(g/kg DM) , ether extract(EE)(g/kg DM) crude fiber(CF)(g/kg DM) and crude protein(CP)(g/l g DM) constituents of untreated sunflower seed cake(USSC) and treated sunflower seed cake TSSC)

VARIABLE	USSC	TSSC
Moisture	7.85	7.92
Ether extract	11.13	11.95
Crude fiber	31.04	25.48
Crude protein	21.12	22.05

Table 2 Composition (%) of formulated broiler finisher diets.

	CONTROL	TSSC		USSC	
	0%	10%	20%	10%	20%
White maize	41.32	41.32	41.32	41.32	41.32
ME(Mechanically extracted soya	16.76	15.08	13.41	15.08	13.41
Sunflower	0.00	1.68	3.35	1.68	3.35
No. 3 maize meal	21	21	21	21	21
Soya full fat	16	16	16	16	16
Limestone	0.84	0.84	0.84	0.84	0.84
Di-calcium phosphate	1.702	1.702	1.702	1.702	1.702
Lysine	0.2	0.2	0.2	0.2	0.2
methionine	0.2	0.2	0.2	0.2	0.2
Salt	0.40	0.40	0.40	0.40	0.40
Base mix	1.08	1.08	1.08	1.08	1.08
	100	100	100	100	100

Table 3 Summary of the initial weight (g/bird), final weight(g/bird),total weight gain (g/bird/3wks) daily feed intake (g/bird),total feed intake (g/3wks) and feed conversion ratio .(Mean and standard error)

VARIABLE	CONTROL	USSC		TSSC	
	0%	10%	20%	10%	20%
Initial weight(g/bird)	707.70± 9.05 ^a	713.30 ±8.06 ^a	728.40 ±20.22 ^a	716.45 ±9.69 ^a	715.55 ±3.61 ^a
Final weight(g/bird)	2541.9 ±19.5 ^l	2615.10 ±12.7 ^a	2549.6 ±30.5 ^b	2584.0 ±5.2 ^{ab}	2569.0 ±8.1 ^b
Total weight gain, (g/bird/3wks)	1834.20 ±28.5 ^{ab}	1903.97 ±17.7 ^a	1821.15 ±50.7 ^b	1867.55 ±4.5 ^{ab}	1853.45 ±11.7 ^{ab}
Daily feed intake (g/bird)	168.21 ±14.9 ^b	178.06±13.03 ^a	165.98 ±12.73 ^b	164.74 ±15.66 ^b	168.28± 10.72 ^b
Total feed intake (g/3wks)	3532.41 ±33.5 ^a	3739.26 ±71.5 ^a	3485.58 ±30.2 ^a	3459.54 ±91.3 ^a	3533.88 ±12.8 ^a
Feed conversion ratio (FCR)	1.92 ± 0.25 ^a	1.96 ±0.03 ^a	1.91±0.01 ^a	1.85±0.14 ^a	1.90±0.01 ^a

Values are means ± SD (n=20), Levels not connected by the same letter within the same row are significantly different

INITIAL WEIGHT OF BIRDS

There were no significant differences in initial weights among all treatments, this may have been because all birds at this time had received uniform management and all were fed on starter feed for up to 21 days.

TOTAL FEED INTAKE

There were no significant differences among all groups

FINAL WEIGHTS OF BIRDS

There were no significant differences among the control, USSC 20% and TSSC 10% and 20%. The differences in the birds final weight may have been different due to variations in the physiological abilities of individual birds and due to possible poultry managerial differences per unit.

TOTAL WEIGHT GAIN

Despite the differences in the final weights of the birds, upon statistical analysis there were no significant differences among the Control, TSSC 10% and 20%

FEED CONVERSION RATIO

There were no significant differences in feed conversion ratio among all groups.

DISCUSSION

Mandal et al (2003) reported that inclusion of sunflower meal at 0, 5 and 10% level replacing part of soybean meal in broiler chick diet had no significant ($P>0.05$) effect on body weight gain and feed intake during starter and finisher periods. This is in agreement with the results obtained from this experiment with reference to total feed intake mean values of both treated and untreated rations. However, the significant differences observed between USSC 10, 20% and Control -with reference to body weight gain do not correspond with the findings of Mandal et al(2003). The contrary results may be due to the different methods of oil extraction that exist and affect the nutritional quality as reported by Mandarino (1997)

Also, Zafari and Sell (1990) investigated the effects of replacing soya bean meal with sunflower seed cake and found that inclusion of 10% or 20% sunflower meal (32.6 % protein and 18.4% crude fibre) had no significant ($P>0.05$) effect on body weight gain of broiler chicks.

Mandal et al (2003) also found that inclusion of 10% sunflower meal replacing part of soya meal significantly ($P\leq 0.05$) decreased feed efficiency of broiler chicks during a whole period of 0-7weeks, similar results were obtained in this experiment. According to Cobb-vantress, Broiler Performance and Nutrition Supplement guide, the average feed conversion ratio (FCR) at the end of the period of 6weeks should be at about 1.705, however, all groups gave very high FCR's.

The factors that affect FCR are feed intake and body weight gain. A low body weight gain observed could have been as a result of high feed wastage levels that could have occurred. There were regular cases of water spillages which meant birds feed intake was affected negatively.

Monogastric animals lack appropriate enzymes to degrade fiber (Richard et al 2003) and according to Klein (2013) dietary fiber dilute broiler diets hence leading to reduced feed intake resulting in growth depression and that dietary fiber has no direct nutritive benefit in poultry and is therefore regarded as unuseful roughage.

Therefore we can conclude that even though treating SSC may have resulted in a decrease in its fiber content, the decrease was not sufficient enough to cause any significant changes or improvements to the growth of broilers in their finishing diets.

CONCLUSION

This study showed that alkaline treatment of sunflower seed cake decreases the fiber content but replacing soya bean meal in broiler finisher diet with alkali treated sunflower seed cake has no significant overall effect on broiler performance. Therefore TSSC can replace soya bean meal up to 20% in broiler finisher diets.

REFERENCES

- I. Anderson, L. R. 1971. Potential Utilization of Sunflower Oil in the United States. Proc. 4th Int. Sunflower Conf. p. 23.
- II. A.O.A.C. 1990. Official Methods of Analysis (11th Ed.). Association of Official Agricultural Chemists. Washington, D.C.
- III. Björnhag, G. (1989) Transport of water and food particles through the avian ceca and colon. *Journal of Experimental Zoology* 252(S3), 32-37.
- IV. Choct, M., Hughes, R.J. & Bedford, M.R. (1991). Effects of a xylanase on individual bird variation, starch digestion throughout the intestine, and ileal and caecal volatile fatty acid production in chickens fed wheat. *British Poultry Science* 40(3), 419-422.
- V. Cortamira, O., A. Gallego and S.W. Kim, 2000. Evaluation of twice decorticated sunflower meal as a protein source compared with soybean meal in pig diets. *Asian-Aust. J. Anim. Sci.*, 13: 1296-1303.
- VI. Delgado, C., R. Marco, S. Henning, S. Ehui, and C. Courbois. 1999, *Livestock to 2020; The next Food Revolution. Food, Agriculture, and the Environment. IFPRI Discussion Paper No. 28.* Washington, D.C.; International Food Research Institute, Food and Agriculture Organization of the United Nations, and the International Livestock Research Institute.
- VII. Delic, I., T. Bokorovic, A. Sreckovic and M. Bioloska Nikolic. 1964. Biological Value of Sunflower Oil meal as a Protein Feed for Fattening Pigs. *Nutr. Abstrs and Rev.* 34:596.
- VIII. FAO (1967) poultry feeding in tropical and subtropical countries, 2nd edition, FAO.
- IX. Klein R, 2013, Chicken nutrition. A guide for nutrition and poultry professionals' pp 152, 236, 238.
- X. Hipsley, E.H. (1951). Dietary "fibre" and pregnancy toxemia. *The British Medical Journal* 2(4833), 420-422.
- XI. Hetland, H. & Svihus, B. (2001). Effect of oat hulls on performance, gut capacity and feed passage time in broiler chickens. *British Poultry Science* 42(5), 354-361.
- XII. Ibrahim, M. A., and E. A El Zubeir. 1991. Higher fiber sunflower seed meal in broiler chick diets. *Animal Feed Science and Technology*, 33; 343-347.
[http://DX.DOI.ORG/10.1016/0377-8401\(91\)90072-Z](http://DX.DOI.ORG/10.1016/0377-8401(91)90072-Z) (verified Jan 6, 2014)

- XIII. Irish, G. & Balnave, D. (1993). Non-starch polysaccharides and broiler performance on diets containing soybean meal as the sole protein concentrate. *Australian Journal of Agricultural Research* 44(7), 1483-1499.
- XIV. Jackson NG (1977). Review Article: The alkali treatment of straws. *Animal Feed Science and Technology* 2:105-130.
- XV. Chaudhry AS (1998). Chemical and biological procedures to upgrade cereal straws for ruminants. *Nutritional Abstracts and Reviews* 68: 319-331.
- XVI. Knarreborg, A., Engberg, R.M., Jensen, S.K. & Jensen, B.B. (2002a). Quantitative determination of bile salt hydrolase activity in bacteria isolated from the small intestine of chickens. *Applied and Environmental Microbiology* 68(12), 6425-6428.
- XVII. Knudsen, K.E.B. (1997). Carbohydrate and lignin contents of plant materials used in animal feeding. *Animal Feed Science and Technology* 67(4), 319-338.
- XVIII. Mandal, A.B., P.K. Tyagi, A.V. Elangovan, S. Kaur and A. Johri, 2003. Utilizing sunflower seed meal along with maize or maize and pearl millet in the diets of broilers. *Ind. J. Poult. Sci.*, 34: 243-248.
- XIX. Mandarino, J.M.G. 1997. 2005. Evaluation of sunflower meal on growth and carcass traits of finishing pigs. 29: 208-215
- XX. NRC (1994). Nutrient requirements of poultry. 9th revised. ed. Washington, D. C.: National Academy Press.
- XXI. Pinheiro W. fonsesa, N.A.M, Silva, C.A(2002) Evaluation of the nutritional value of sunflower meal and the possibility of substitution of sunflower meal for soyabean meal in poultry diets. *Poultry science* v.55,n 5,p 1757-1764
- XXII. Rama Rao, S. V., M.V. L. N Raju, A. K. Panda, and M.R Reddy. 2006. Sunflower seed meal as a substitute for soybean meal in commercial broiler chicken diets. *British Poultry Science* 5: 592-598 <http://dx.doi.org/10.1080/0071660600963511> (Verified Jan 6, 2014)
- XXIII. Ravindran and Blaxter, 1992
- XXIV. Richard, C.R., and R.N. Beville, R.K. Ratcliffe, and R.C. Albin. (2003). Sunflower meal as a protein supplement for growing ruminants. *J. Anim. Sci.* 53:557.

- XXV. Senkoylu, N., and Dale. 2006 Nutritional evaluation of a high sunflower meal in broiler starter diets. *Journal of applied poultry research* 15; 40- 47
<http://japr.fass.org/content/15/1/40.full.pdf+html>
- XXVI. Silva, M.N., 1990.. Evaluation of sunflower meal on growth and carcass traits of finishing pigs. *Ciênc Agrotec. Lavras*, 29: 208-215.
- XXVII. Smits, C.H.M. & Arnison, G. (1996). Non-starch plant polysaccharides in broiler nutrition - towards a physiologically valid approach to their determination. *World's Poultry Science Journal* 52(2), 203-221.
- XXVIII. Solomon A. Kebede Ulfina G. Girgo, Gameda D. Jalleta, The potential of treatment with ash solution in improving degradability of fibrous feeds in Ethiopia, *Agricultural Science Research Journal*. Vol. 2(3), pp. 100-105, March 2012
- XXIX. Techno Serve 2011
- XXX. Trowell, H. (1976). Definition of dietary fiber and hypotheses that it is a protective factor in certain diseases. *The American Journal of Clinical Nutrition* 29(4), 417-427.
- XXXI. Trotter, W. and W. Jivan. 1970. Economics of Producing Sunflowers for Oil in the United States. *Proc. 4th Int Sunflower Conf.* p. 23.
- XXXII. Zadari, I.M. and J.L Sell, 1990. Sunflower meal as a component of fat-supplemented diet for broiler chickens *Poult. Sci.*, 69: 1503-1507.

APPENDICES

Figure 1; GRAPHICAL REPRESENTATION OF INTITIAL WEIGHTS, FINAL WEIGHTS, BODY WEIGHT GAIN AND TOTAL FEED INTAKE

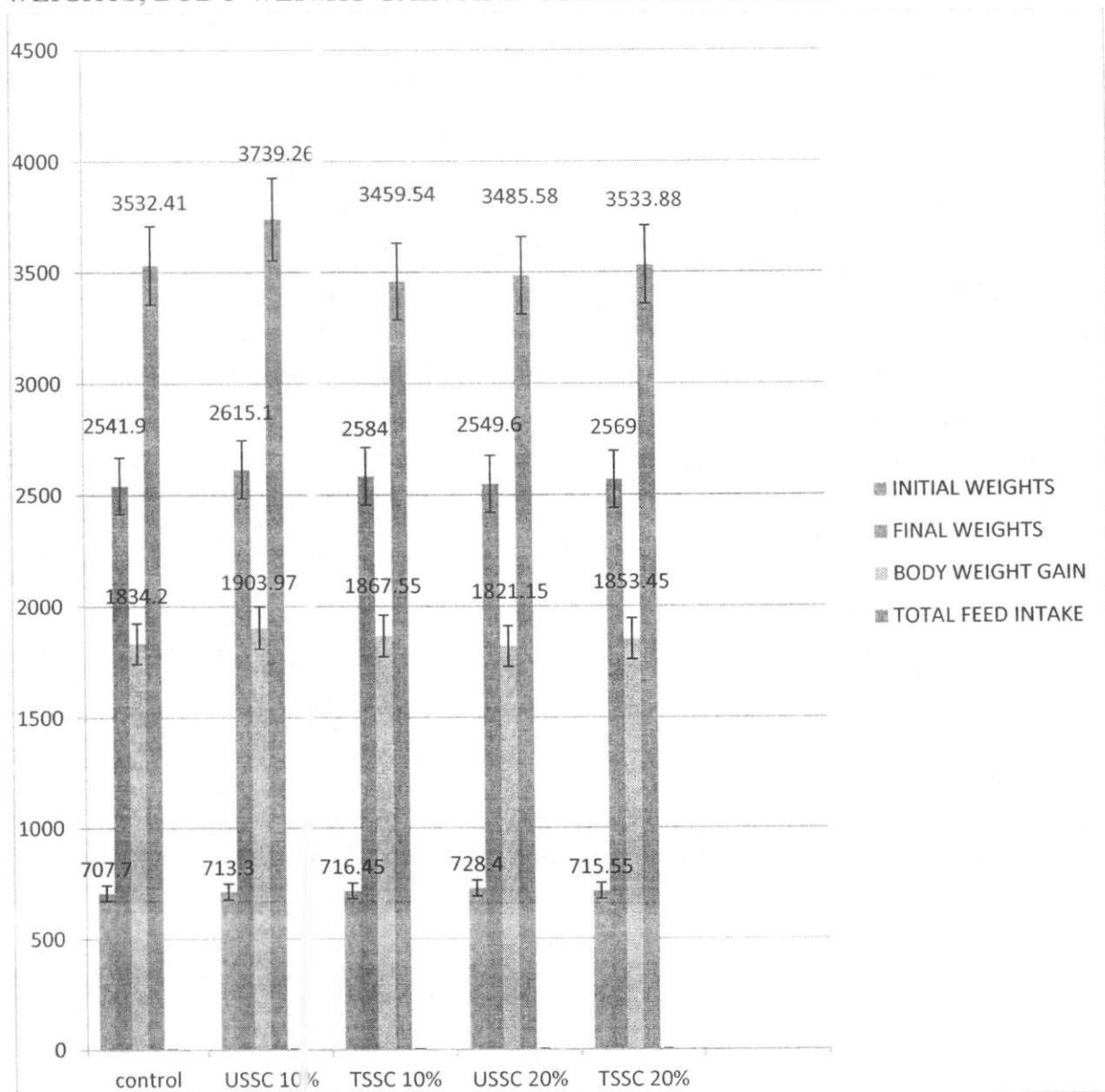


Table 4; ECONOMIC COMPARISON OF REPLACING SOYA BEAN WITH SSC IN BROILER FINISHER DIETS.

ITEM	EST.PRICE PER UNIT	QTY	FARMER USING SOYA BEAN MEAL	FARMER USING SUNFLOWER SEED CAKE (SSC)
COST			KR	KR
Day Old Chicks	4.50/bird	100	450.00	450.00
Vaccinations	21.00/bottle	4	84.00	84.00
Litter	10/50kg bag	15	150.00	150.00
No. 3 Meal	60/50 kg bag	5	300.00	300.00
White maize	60/50kg bag	3	180.00	180.00
Mechanically Extracted Soya Bean Meal	170/50 bag	2	340.00	0.00
Soya full fat	165	2	330.00	330.00
Limestone	13/9kg bag	1	13.00	13.00
Di-calcium phosphate	30/10kg bag	1	30.00	30.00
Lysine methionine	100	1	100.00	100.00
Salt	25/5kg bag		25.00	25.00
Base mix	134/7kg bag	1	134.00	134.00
Sunflower Seed Cake	40/50 kg bag	2	0.00	80.00
Starter Diet	160/50kg bag	2	320.00	320.00
TOTAL COST			2456.00	2196.00
REVENUE				
Sales of birds(5% mortality rate)	30	95	2850.00	2850.00
PROFIT			394.00	654.00

*prices used were as of jan -m rch 2014 *using TSSC is equally affordable because quicklime is a readily available material.*Costs such as water bills, electricity and labor are not included

Table 5 ; comparison of the chemical composition of sunflower seed cake with other oilseed meals.

Item	Sunflower	Soybean	Canola	Cottonseed
Crude Protein	32%	47%	36%	41%
Fat	1%	1.5%	3.5%	1.50%
Fiber	21%	3.1%	12%	11.0%
Ash	6%	6.4%	6.8%	6.30%
Lysine	1.14 %	2.99%	1.93%	1.72%
Arginine	2.40 %	3.4%	2.21%	4.55%
Cystine	0.5: %	0.73%	0.89%	0.70%
Valine	1.7: %	2.26%	1.91%	1.78%
Isoleucine	1.3: %	2.10%	1.41%	1.23%
Methionine	0.6 %	0.68%	0.73%	0.67%
Threonine	1.1 %	1.85%	1.54%	1.36%
Tryptophan	0.6 %	0.65%	0.48%	0.48%

*Source; National sunflower association © 2014

Table 6. The fibre contents (% of DM) of some feedstuffs

	Crude fibre1	Soluble NSP2	Insoluble NSP2
Maize	2.5	0.9	6.6
Wheat	3.4	2.5	7.4
Peas	6.1	5.2	7.6
Barley	6.2	5.6	8.8
Soybean meal (44%CP)	7.9	6.3	9.2
Oats	12.1	4.0	11.0
Wheat bran	12.4	2.9	27.3
Rape seed meal	12.9	5.5	12.3
Lucerne meal	26.2	7.7	11.3
Sunflower seed meal	26.7	4.5	23.1
Oat hulls	31.2	<0.5	84.7

*Adapted from (NRC, 1994) *From Knudsen (1997) except values of oat hulls which derive from Hietland and Svihus (2001) and sunflower seed meal which derive from Irish and Bainave (1993).

Table 7. A brief overview of the actions of soluble and insoluble non-starch polysaccharides (NSP) in the anterior digestive tract. Signs represent increases (+) or decreases (-).

	Soluble NSP	Insoluble NSP
Water-holding capacity / viscosity	++	+
Gastrointestinal motility	+	-
Digesta transit time		
Nutrient digestion	-	+
Bacterial growth substrate	++	+