RESPONSE IN GROWTH PERFORMANCE AND YIELD OF BROILERS FED ON PROCESSED ACACIA TORTILIS SEED MEAL AS A REPLACEMENT OF SOYA BEAN MEAL

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DECLARATION AND RECOMMENDATION

This research is my original work and has not been presented for a degree or any other university award.

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This research has been submitted for examination with our approval as University Supervisors.

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DEDICATION

This study report is dedicated to my late Mother, Severina Ciobaithili; who encouraged and motivated me to go to school at my tender age.

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ABSTRACT

Livestock provide food to humans and income to producers. Chicken and their products provide 28 per cent of all meat globally. Chicken producers are always looking for new feed ingredients for use in feed formulations. In Arid and Semi-Arid Lands of Kenya, *Acacia tortilis* trees grow in the rangeland and produce large quantities of seeds during the dry season. The leaves and pods are eaten by ruminants and hence, presents an opportunity to fed chicken. There exists no empirical evidence on the potential of *Acacia tortilis* as an economically viable feeding option for poultry. The aim of study was to determine the response in growth performance and yield of broilers fed on processed acacia tortilis seed meal as a replacement of soya bean meal. The processed *Acacia tortilis* seeds were sent to the laboratory for proximate analysis and used to formulate the experimental diet. Ninety broiler chicks of mixed sex and uniform age were purchased from a reputable firm. The chicks were reared in a house where heat was provided using 100 watts bulbs and withdrawn when birds had grown feathers. The chicks were fed on broiler starter from day 1 to day 7, after which the experimental diet was fed for 28 days. The study employed a Completely Randomized Design (CRD). The chicks were randomly assigned to six treatments with three replicates, five birds per unit. The following were the feed replacement levels; (T0-Control 0% *acacia* + 100% Soybean, T1-20% acacia + 80% soybean, T2- 40% *acacia* + 60% soybean, T3- 60% *acacia* + 40% soybean, T4 - 80% acacia + 20% soybean and T5 - 100% *acacia* +0% soybean) in a deep litter rearing system. Feed and water were provided *adlibitum*. Weighing of chicks and leftover feed was done weekly and records kept. Data collected was summarized and organized in excel. Analysis of Variance (ANOVA) was done using SPSS software version 20. The results indicated that, the mean initial weight was not significant ($p > 0.05$). Mean daily weight gain (DWG), mean weight gain change mean and final weight gain (FWG) were statistically significant ($p < 0.05$)), whereby, 20% *Acacia* as replacement of soybean meal had the highest performance. The mean voluntary feed intake (VFI) was not significant ($p > 0.05$). on feed conversion ratio there aws statistically significant difference ($p < 0.05$). The carcass characteristics in relation to the weight of the bird, there was no significance difference ($p > 0.05$).On economic benefit there was no significance difference in feed input and cost ($p > 0.05$), but there was significant difference in biomass harvested and value of biomass ($p < 0.05$) where T1 was the highest in the two attributes. Incidence cost was significance ($p < 0.05$). The Profit index was significant ($p < 0.05$) where the T1 had the highest value of 1.5. The study recommends that *Acacia tortilis* seed meal can be incorporated in chicken diet at 40% as a substitute of Soybean meal but optimally at 20%.

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Key Words: *Acacia tortilis, Soybean, broilers, growth performance, Anti- nutritional factors*

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ACRONYMS

ADB	**:**	Africa Development Bank
ADF	**:**	Acid Detergent Fibre
ANF	**:**	Anti-Nutritional Factor
ANOVA	**:**	Analysis of Variance
ASALS	**:**	Arid and Semi-Arid Lands
ATSM	**:**	*Acacia tortilis* Seed Meal
CF	**:**	Crude Fibre
COT	**:**	Certificate of Transporting Meat
CP	**:**	Crude Protein
CRD	**:**	Completely Randomized Design
DF	**:**	Dietary Fibre
DM	**:**	Dry Matter
DMRT:		Duncan Multiple Range Test
DVO	**:**	District Veterinary Officer
DWG:		Daily weight Gain
EAA	**:**	Essential Amino Acids
EE	**:**	Ether Extract (fat)
FAO	**:**	Food and Agricultural Organization
FCR	**:**	Feed Conversion Ratio
FWG:		Final Weigh Gain
GDP	**:**	Gross Domestic Product
IC	**:**	Indigenous Chicken
IW:		Initial Weight
KALRO	**:**	Kenya Agriculture and Livestock Research Organization
KARI	**:**	Kenya Agriculture Research Institute

LSD	**:**	Least Significance Difference
ME	**:**	Metabolizable Energy
MOLD	**:**	Ministry of Livestock Development
NDF	**:**	Neutral Detergent Fibre
NSP	**:**	Non Starch Polysaccharide
SBM	**:**	Soya Bean Meal
VFI	**:**	Voluntary Feed Intake
WGC	**:**	Weight Gain Change

CHAPTER ONE

INTRODUCTON

1.1 Background to the Study and Introduction

Feeding the poor of the world is one of today's most important issues, as human populations rise, putting more strain on natural resources. Livestock play an important role in reducing poverty, as they provide customers with high-quality protein and daily income to producers (McLeod, Ahuja, & Food and Agriculture Organization (FAO), 2011). The world's metropolitan population grew quite quickly over the 20th century, from 220 million to 2.8 billion. In developing countries, demand for animal protein for human nutrition is growing rapidly, in particular for pork and poultry products (OECD and United Nations Food and Agriculture Organization, 2010). This is an incentive for smallholders of livestock, who make up almost 20 per cent of the world's population (McDermott et al., 2010), to increase household income and improve their livelihood through the supply chain of livestock.

The next few decades in the developing world will see an unprecedented scale of urban growth. This will be particularly true in Africa and Asia, where between 2000 and 2030 the urban population will double. Throughout the entire span of history, the increased urban growth of these two regions will double in one century. In 2030, developing world towns and cities will account for 80% of urban society (Population Fund, 2007).According to the The United Nations Population Fund (UNFPA) Annual Report (2009), the most important demographic changes affecting the poorest countries today and in the years ahead are: a comparatively high fertility rate with a strong population growth rate, resulting in an increasing youth population and a relatively high level of rural-to-urban migration. Such trends may present new opportunities in some countries, while in others they have contributed to the rapid growth of youth unemployment and the development of urban slums, with declining infrastructure and excess demand for essential public services such as education, health care and food production. This is a significant development that impacts food supply systems, as urban populations are predominantly food consumers, unlike those in rural areas that produce and consume food. The need to maintain low food prices for the drives of urban populations has continued to scale and intensify poultry, particularly chicken production (McLeod et al., 2011).

Agriculture is important to the economy of Kenya, contributing indirectly 26 per cent of GDP and 27 per cent of GDP together with other segments in the economy. It employs over forty per cent of the population and over seventy per cent of rural dwellers in Kenya. The population of Kenya has grown substantially from 11 million in 1970 to 39.5 million in 2015 and is predicted to double the current growth rate in the next 27 years. The growth in population, combined with the expansion of agriculture into arid land, has changed the nature of pastoralist, where increased competition for natural resources in some areas has led to increasing conflicts. The number of people falling off nomadic livelihoods has increased dramatically, moving frequently to settled communities heavily dependent on help for food. Considering the importance of agriculture in rural areas of Kenya where poverty is widespread, it is difficult to overestimate the sector’s position in poverty reduction. Accordingly, strengthening and improving the quality of the agricultural sector and encouraging the involvement of the poorest and most vulnerable in this system, is a prerequisite and a required condition for Kenya's recovery and growth following drought and slow development in recent years (Africa Development Bank (ADB), 2010).

The overall, demand for chicken products has shown a steady upward trend, with chicken now accounting for 28% of meat in the diet. Chicken meat and eggs in many cultures are suitable foods. The standard of living is growing worldwide, and in particular the developing counties, and there is a positive connection between living standards and the consumption of animal products. It is therefore estimated that 50 per cent more food will have to be produced in the coming 20 years in order to satisfy global demand. Consumption of poultry meat in Kenya is projected to rise from 54.8 thousand metric tons in 2000 to 164.6 thousand metric tons in 2030, and from 6 to 305 thousand metric tons in Nairobi (Robinson & Pozzi, 2011), owing to urbanization , population growth, economic development that makes people wealthier, and the continued viability of grill chicken production systems (FAO, 2011b).The broiler industry is increasingly expanding and should be able to satisfy demand (FAO, 2008), once again assuming that export policies stay the same, and relative input and output rates for the poultry sector remain constant (Carron et al., 2017).It is a major obstacle for the farming and food-producing industries in meeting the quantity and quality demands of animal products. To surmount the challenges, innovation and efficiency are important for the future. Poultry meat has shown the fastest growth rate when compared to consumption of meat products. The trend in international trade in poultry products, especially poultry meat, is expected to rise significantly (Poultry Research Foundation & Selle, 2008).

In Kenya families with very little land or resources can raise chicken at home, making it easily accessible even to the poor farmers. Indigenous chickens play a major role in rural Africa's household food supply. They are now raised with more productive production per bird in semi-intensive systems (Radwan, et al., 2010).The main advantages of producing meat from poultry are that they need limited areas of land, small amounts of feed and are highly efficient meat and egg converters of feed. In the coming years, broiler industry is expected to be powered by many factors including: healthy and high-quality food production, affordable prices, and chicken-friendly and environmentally sustainable manner. Such factors are not new to the industry, but their effect will become increasingly important on how chicken meat will be processed in the future.

Researchers in chicken production needs to come with ways and means to address these challenges. Chicken meat is likewise the most water-efficient animal protein production method on the planet. Pimental and Pimental (2003) have reported that 1 kg of chicken meat can be processed with approximately 2.3 kg of grain requiring approximately 3500 litters of water, while 1 kg of beef requires approximately 105400 liters of water for the production of hay and grain alone and this number may be as high as 200000 litters of water in rangeland (grass fed) production systems (Poultry Research Foundation).Poultry science has driven the substantial increases in chicken growth rate and feed conversion capacity. The advancement of genetics, nutrition, and reproduction and disease control sciences has been instrumental in allowing these changes to occur (Poultry Research Foundation & Selle, 2008). Livestock rearing is under growing pressure to reduce its environmental pollution, especially in emissions from greenhouse gases. They also placed natural resources, such as energy and water, under pressure. Through this respect, poultry farming has a significant comparative advantage over other land-based animal production systems. In fact the processing of chicken meat is the most energy-efficient of all animal proteins (Poultry Research Foundation & Selle, 2008).The most popular method of rearing chicken in Kenya is the extensive system of production. Indigenous chicken farming is leading to many Kenyan farmers livelihoods. It makes up 80% of Kenya's poultry population (Kamau, 2018). The feed products provided in this process for the local chicken include: household waste, environmental vegetation, insects and worms. The other feeds are by-products of cereal by-products from local small industrial units. Competition for feed capital in villages influences the viability and development of extensive chicken systems. Changing vegetation composition, growing crops, and recurrent droughts pose a serious threat to rangeland livestock production (Abebe, et al., 2012).This is common during the dry period, particularly in Arid and Semi-arid lands (ASALs), where there is a severe shortage of animal feed during the drought era. This leads to poor production of poultry. Chicken feed scarcity could be improved by combining complete on-farm rations with imported and local feed ingredients. Due to advances in nutrient analysis and feed assessment techniques, these incentives are becoming more frequent (UN Food and Agriculture Organization & Department of Agriculture and Consumer Protection, 2013). In Kenya's ASALs, *Acacia tortilis* trees grow abundantly in the vast rangeland and during the dry months produce high quantities of seeds. Other livestock consume the tree leaves and pods and thus, the seeds present an opportunity as alternative non convectional poultry feed by processing and incorporating them in poultry feed formulations. During the dry season, *Acacia tortilis* pods and leaves are used as a substitute in low-quality forage grazed by ruminant animals to provide food and protein feedstuffs. Grinding has been shown to increase the digestibility of seeds (Aganga, et al., 1998).

Through this research, *Acacia tortilis* seed meal was envisaged to be an ingredient in formulations of poultry feed. Among the solutions to the increasing cost of feed ingredients is exploring the potential of substitute feed as part of replacing the costly conventional feed ingredient such as soya bean meal (Yakubu, et al., 2017).In the study the bird were fed different replacement levels of soya bean with *Acacia tortilis* seed meal. The experimental diet was introduced after the bird had acclimatized.

1.2 Statement of the Problem

Control and access of chicken at household level cuts across all gender, but mainly women and children play a leading role in dietary and economic wellbeing of the household. However, livestock feeding is a real problem during the drought season, particularly in the ASALs (Abebe et al., 2012).This leads to low performance and hence the need to utilize the locally available resources as alternative feed ingredient in chicken feed formulations. The search for alternatives to soybean as sources of feed ingredients in chicken feed remains a major concern due to high cost and competition with humans for food. Despite many years of research seeking for alternative feed ingredients, solutions have not been exhausted. The study seeks to determine the growth performance of broilers fed on processed *Acacia tortilis* seed meal as a substitute for soya bean meal. *Acacia tortilis* trees are prevalent in Kenya's ASALs and produce high quantities of seeds during the dry months, and have very little feed nutritional value. Humans do not eat the *Acacia tortilis* seeds and hence there is no competition with poultry for food. In addition to the low-quality ruminant-fed forage, *Acacia tortilis* seeds and leaves have been shown to be part of the solution to protein feed shortage in the dry period (Aganga et al., 1998).

1.3 Justification of the Research

Chicken farmers continue to seek opportunities for greater adjustment in the kind and quantity of feed ingredients for use in formulations of feed. Opportunities are growing due to advances in nutrient analysis, higher production costs and innovations for feed evaluation (UN Food and Agriculture Organization & Department of Agriculture and Consumer Protection, 2013). A high percentage of households in rural Kenya keep chicken. There are about 22 million native chickens in the country and 90 per cent of rural communities mainly keep them under the free range model in small flocks of up to 30 birds. The industry is versatile, needing little forage (Kingori, et al., 2010). It is the interest of livestock nutrition researchers to come up with alternative feed ingredients for livestock. The alternative feed ingredients should be cheap, nutritious and locally available in comparison with conventional feeds. In the ASALs of Kenya, there are abundant *Acacia tortilis* trees which produce large quantities of seeds during the dry months, and these seeds have little nutritional value . It has been shown that *Acacia tortilis* pods provide protein rich feed particularly in low rainfall seasons to support low standard forage grazed by ruminant (Aganga, et al., 1998). The processed *Acacia tortilis* seed meal has not been utilized as an alternative feed ingredient in chicken feed in the region. This study was to seek for an alternative feed ingredient to be used in chicken feed rations and contribute to academic knowledge. The study was thus designed to determine the growth output of broilers fed on processed *Acacia tortilis* seed meal at different rates as a substitute for soya bean meal.

1.4 General Objective

The general objective is to study the effects of processed *Acacia tortilis* seed meal as a replacement of soya bean meal on growth performance, carcass characteristics and economic benefits.

1.5 Specific Objectives

The objectives of the study were:-

i. To determine the growth performance of broilers, fed on processed *Acacia tortilis* seed meal as a substitute of Soya bean meal.
ii. To investigate carcass characteristics of broilers, fed on processed *Acacia tor*tilis seed meal as a substitute of Soya bean meal.
iii. To find out the economic benefit when broilers are fed on diets containing processed *Acacia tortilis* seed meal as a substitute of Soya bean meal.

1.6 Research Hypothesis

i. There is significant difference in the growth performance of broilers, fed on processed *Acacia tortilis* seed meal as a substitute of soya bean meal
ii. There is significant difference in the carcass characteristics of broilers, fed on processed *Acacia tortilis* seed meal as a substitute of soya bean meal
iii. There is significant difference in economic benefit when broilers are fed on diets containing processed *Acacia tortilis* seed meal as a substitute of soya bean meal.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of related theoretical frame work and concepts on how researchers have done work in poultry rearing as well as outline effects of dietary substitutions at different levels, and describes poultry industry in Kenya. The chapter further examines the potential and importance of *Acacia tortilis* as animal feed.

2.2 Chicken Nutrient Requirements

Leeson and Summers (2001), describes a nutrient requirement as the minimum quantity of nutrients required to achieve the maximum weight gain and feed quality, with no signs of nutritional deficiency. This is further referred to as the minimum nutrients need requirements. Intensively reared chicken needs a balanced nutrient in their diet in order to maximize growth and proper health. The nutrients provided to the birds fluctuate depending on the species, age and production source of the feeds. Recommendations on nutrient needs were based majorly on experts' and scholars literature on hand and empirical research findings respectively. Poultry requires vitamins to be able to sustain healthy conditions, physically grow and produce. They require to be furnished with oil, milk, critical amino acids, essential fatty acids, minerals, dietary vitamins, and water on daily basis. Poultry acquires the energy and vitamins needed to digest herbal feeds but regularly supplies minerals, vitamins, and some essential amino as synthetic supplements that are regularly supplied as synthetic supplements (UN Department of Food and Agriculture and Consumer Protection, 2013).

2.2.1 Energy Requirements

The most critical and highly priced feeds are the energy sources. Maize accounts for about 50-55 per cent of the poultry feeding system (Afolayan et al., 2002).The growing price of maize is complemented by its decreasing prerequisites for development and strong opposition to human and animal use (Agbede et al., 2002). This ongoing daily venture prompted the search for picks to the highly priced maize grain and protein concentrate (Adeyemi, 2005). This resulted in an animal nutritionist searching for options that could help lower the feeding price without adversely affecting the overall performance of the chicken. Replacing conventional high-priced feed components with inexpensive and convenient alternatives is an efficient way to reduce feed prices and improve efficiency. This has resulted into the need for exploring alternative feeds to replace the expensive conventional feed ingredients as part of a solution to the rising feed costs (Yakubu et al. , 2017).

Chicken that has been fed on simple carbohydrates, fats and protein may derive energy. Since poultry can't feed on digest and digest some complex carbohydrates like protein, feed components need to use an accessible energy-based feeds. According to (UN Food and Agriculture Organization & Consumer Department, 2013) metabolizable Energy (ME) is the standard indicator of accessible resistance content and chicken requirements for feed materials. Specifically, as long as the weight-decrease system is sufficient in all other basic nutrients chicken feed to satisfy their capacity needs. The amount of vitality in the eating routine is consequently a major determinant of the consumption of poultry feed. At the point when the level of dietary vitality changes, the feed utilization needs to change and the prerequisites of various nutrients should also be changed so as to keep up the important admission. For this reason, the degree of dietary strength is often used in the system of practical diets of poultry as the starting element. Different classes of poultry require distinctive level of strength and inadequate would compromise the quality of the plant. Modern-day hen strains are usually fed incredibly high-strength diets to maintain high productivity. The amount of dietary energy used in a given state of affairs is mostly determined through the availability and fee of prosperous feedstuffs for power. Due to the high price of cereals more so maize, in many developing countries like Kenya, the use of low-energy diets as chicken feed is common.

2.2.2 Protein Requirement

Protein is the second largest component in the formulation of hen feeds after the strength feeds, and focus is on the protein and feeds' energy levels. Providing dietary protein hen requirements greatly contributes to feed fees (Beski et al., 2015). The most important sources of protein are plant and animal products. The effectiveness of hen protein feed depends on its ability to provide as adequate a protein digestibility and the amount of anti-nutritional factors (ANFs) needed by hen as necessary amino acids (EAA).Using plant protein sources, the main dietary protein requirement for chicken is supplied. Worldwide, soybean meal (SBM) is the most popular source of protein and is used in chicken feed production. It has a volume of crude protein (CP) material of about 40-48%. It is based on extracting the sum of hulls and the method of extracting oil. Soybean protein is appreciated for its well-balanced amino acid profile compared to the protein meal of various oil seed grains, particularly the essential amino acids that allow it to be used to complement most cereal-based diets (FAO& Consumer Department, 2013).Owing to their lack of certain amino acids; general plant proteins require an increased supply of amino acids or certain protein sources, such as beast protein. Proteins from plants are generally more financially cheaper than creature proteins, however because of their ANF content, their utilization is troublesome. A large portion of these ANFs can be expelled through processing which further escalates the dietary plant protein expenses and lowers the protein levels because of the expulsion of ANFs and protein discharge in plant protein items (Adeyemo & Longe, 2007).

Poultry nutritionists have taken greater interest in creating a balanced diet by using animal protein sources. In EAA phrases important for skin growth and development, the animal proteins are well balanced, but they are highly priced for the production of business broilers. As a result, they are typically used as an alternative to the main protein source to improve the amino acid balance in the diets. Diseases transmission from animal products is a problem if hygienic precautions are not taken seriously. Generally, adequate sources of animal protein depending on the uncooked fabric composition utilized. Animal protein dietary supplements are obtained from numerous sources, including processing of food and eggs, meat packing and rendering, processing of pork and poultry, and processing of milk and milk products (Denton et al., 2005).

Animal proteins are really useful in chicken diets as they provide excessive amounts of amino acids, excessive on-hand phosphorus levels, responsive measures of different minerals, and worthy vitality levels. It is in this manner fundamental to comprise of at least one of these creature protein sources in poultry eats less. Other sources of animal proteins are from; egg incubation centre, blood from slaughter houses and spent hens (Moritz & Latshaw, 2001). Also, there was a penchant for improving execution to supplant some portion of the SBM in chicken weight control plans with animal items. Supplementation types of creature protein can likewise incredibly improve execution parameters over across the board eats less. This is due to the high perception of EAA and lower proportion of soybean meal indigestible carbohydrates (Firman, 2004).

Throughout the development of chicken feed, care is taken in a number of countries to cover animal protein ingredients in feed, especially for young birds requiring high levels of amino acids. As a bird's age, critical requirements for amino acids are regularly reduced to meet older birds' needs, and diets with lower protein content and comparatively higher plant protein content are reduced. The dietary protein is meant to provide amino acids for muscle repair, production, and development. Synthesis of the muscle and egg proteins involves twenty amino acids that are both physiological needs.

Many amino acids will synthesize stability; these are considered non-essential dietary amino acids and will not be included in feed formulations. Nevertheless, all 20 amino acids are physiologically necessary to synthesize a variety of proteins in the body. Lysine, methionine, threonine, tryptophan, isoleucine, leucine, histidine, valine, phenylalanine, and arginine are essential amino acids for poultry; however, some people say that glycine is essential to younger poultry. Cysteine and tyrosine are known to be semi-essential amino acids, as they can be synthesized from methionine and phenylalanine. The restricting requirement amino acids in most responsive chicken diets are lysine, methionine, and threonine. Today chicken has no protein requirement per se. Nevertheless, the synthesis of non-essential amino acids is necessary for proper protein nitrogen dietary supply. That means that the amino acids used to synthesize non-essential amino acids are no longer used for nitrogen supply. Consequently, meeting the necessary protein and integral amino acid specifications ensures that sufficient amino acids are administered to fulfil birds' physiological requirements. Chicken's amino acid requirements are determined by various variables, along with rates of development, genotype, age, physiological state, surroundings and fitness status. High egg production ranges or feather boom need obviously excessive levels of methionine. But most differences in amino acid requirements no longer result in shifts of one-of-a-kind amino acid relative proportions.

2.2.3 Fats and Fatty Acids

In comparison to carbohydrates and protein, fat and fatty acids have a greater energy density for fat. Usually chicken diets require fat to achieve the desired concentration of dietary energy. Fat contributes around 3% and no more than 5% of the most responsive diets. However, fats in feed mills and poultry houses reduce dustiness and increase the palatability of the diets. Chicken as an energy source does not have a simple definition of fat but the need for linoleic acid has been shown (Firman, 2004). Linoleic acid is the only fatty acid required for use in food and is also contained in poultry feeds.

2.2.4 Minerals

Inorganic and organic types of minerals are present both in varying quantities in animal tissues. Inorganic elements such as oxides, carbonates and sulfates are found in the left ash following live tissue combustion (Underwood, 1999). Of the 109 recognized elements, 26 are classified as integral animals (Canada, 1997). Of these, 11 are macro-elements (carbon, hydrogen, oxygen, nitrogen, phosphorus, calcium, phosphorus, potassium, sodium, chlorine, and magnesium) and 15 are micro-elements (iron, zinc, copper, manganese, nickel, cobalt, molybdenum, selenium, chromium, iodine, fluorine, mercury, silicon, vanadium, arsenic). The appearance of a mineral in animal tissue now doesn't indicate its importance. Minerals may be natural contaminants, and display a distribution similar to that seen in the world around them in this case.

The existence of important elements in animal tissues matches cell function and, thus, for each organ they have normal concentrations. As with any other nutrients, when consumed to excessive degrees or for long periods, minerals can cause toxicity. Minerals are vitamins involved in unnecessary metabolic pathways and present in a wide variety of chemical types in the feed. We are defined either as organic molecules or as separate solubility salt phases. Organic variety operation consists of differences in quality and feasible changes in their particular cell degree behaviour (Vieira, 2008).

According to Vieira (2008) electrolyte imbalance prevention requires careful consideration, particularly in warm climates. A balance of approximately 250 mEq / kg of weight loss program tend to be excellent for most efficient development under most conditions. The common stability and individual concentrations of these three minerals are significant. For their dietary stages to be successful, each must be within appropriate ranges, not bad and no longer excessive. Chicken subjected to heat stress absorbs extra water, and when the water contains electrolytes, they are more able to withstand heat.

Under these circumstances a part of the extra dietary sodium chloride was effectively substituted with sodium bicarbonate. Trace elements including copper, iodine, iron, manganese, selenium, zinc, and cobalt serve as components of bigger molecules and as co-factors of enzymes in a number of metabolic reactions. These are needed in very limited quantities within the food scheme. In addition to these most important and trace minerals, functional poultry diets should be supplemented as they are deficient in daily cereal diets (Canada, 1997; Underwood, 1999).

2.2.5 Vitamins

Vitamins (vitamins A, D, E and K) are classified as soluble and water-soluble fats (complex vitamin B and vitamin C). All vitamin C-free foods should be supplied in the diet. Usually, as the chicken synthesizes, vitamin C is no longer classified as an essential diet. In addition, dietary supplementation of diet C may also work under adverse conditions such as heat pressure (Moritz & Latshaw, 2001). The dietary vitamins have more complex metabolic functions than those of other nutrients. Vitamins are no longer merely instruments for body building or energy sources, but are mediators or contributors in the body's biochemical pathways.

2.2.6 Water

Water is now not only one of the most important animal nutritional requirements but also plays a crucial physiological role in relation to birds and specific animal thermoregulation, particularly under heat strain. Bruno, et al. (2011) claimed that broilers have a higher water intake while they are exposed to intense heat stress. Intake of water decreases to preserve thermoregulatory equilibrium (Moraes et al., 2002) while heat stress causes unnecessary loss of water via the respiratory tract as a capacity to achieve biologically efficient thermoregulation by evaporative cooling. Loss of water in critical temperature stress situations can cause major changes in thermo-regulatory stability which can also lead to dying of poultry. As a consequence, in addition to their dietary function, water quality is more essential for thermoregulation in broiler chickens compared to other animal species, especially under hot conditions (Bruno et al., 2011).

Moraes et al., (2002) opines that in chicken food, water is the most important resource and has a clear influence on each physiological process. Consistent water furnishing is important for feed digestion, nutrient absorption, waste excretion, and physical temperature regulation. Water comprises about 80 per cent of the body. The poultry eats and drinks all the time as opposed to other animals. Technology affects them irreversibly, and they increase when water hurts them for just a short period. Therefore, water must always be kept on hand. The intake of feed and the boom price correspond remarkably with the intake of liquid.

Equally important is the water quality. Water is a perfect medium for contaminant distribution, such as chemical substances and minerals, and hazardous pathogens proliferation. Poultry rearing can be challenging in arid and semi-arid lands (ASALs) due to scarcity of water. Underground water which is common in the ASALs may have excessive levels of salt. Chicken tolerates salty water that contains much less than 0.25% salt (FAO, 2013).

2.3 Poultry Industry in Kenya

Agriculture in Kenya accounts for 25-26% of GDP, with chicken playing an essential role, accounting for 30% of the agricultural addition to GDP (Zootecnica, 2016). Kenya has an estimated 31 million birds of poultry. 75% consists of native chicken, 22% broilers and chickens, and 1% breeding stock. Certain species of poultry such as ducks, geese, turkeys, pigeons, oysters, guinea chicken and quails make up 2% of the development of chicken (MOLFD, 2012). Although indigenous poultry is predominantly decided in rural areas, urban areas are stored in broilers and layers. The commercial area for poultry produces more than one million chicks a week. Indigenous chicken (IC) agriculture contributes to the livelihoods of many Kenyan smallholder farmers. It constitutes 80 per cent of Kenya's poultry population (Kamau et al., 2018). Consumers in Kenya's urban centres are increasingly demanding IC. The increased demand for IC products is linked to various socio-economic factors. Second, the population of health conscious customers is increasingly growing (Mengesha, 2012). In addition, urbanization and increased disposable per capita income among these consumers are projected to increase consumption by the year 2020 (USAID, 2010).On the other hand, more smallholder farmers have a preference for IC over exotic chicken based on their different attributes, such as being hardy and ability to scavenge (Kamau et al., 2018). Business market features are an increasing urban population and retail sector growth, such as fast food branches, supermarket branches, and restaurants. Excessive and rapidly growing demand for commercial chicken (full, half, pieces, grilled and fried chicken) and eggs (Zootecnica, 2016). Commercial poultry rearing is based in Nairobi, Mombasa among other towns. This has resulted in the explosion of industrial hatcheries in peril-urban areas, encouraging commercial farmers with hybrid broiler and layer chicks. Nevertheless, the high-return indigenous birds provided low inputs (Nyaga, 2007).

2.3.1 Breeding Stocks and Hatching Eggs

Kenchic, Kenbrid, Sigma and Muguku are the major industrial chick hatcheries in Kenya. There are several hatcheries of small capacity generating small numbers of day-old chicks. The firms are hatching and marketing chicks for day-old layer and broiler ready buyers. Farmers put orders for the day-old layer and broiler chicks with their respective hatcheries, and then buy the birds on due dates. There could also be a two to four month waiting period prior to submitting orders (Nyaga, 2007).

2.3.2 Source of Broiler Chicks and Feeds

Farmers have their choice of day-old chicks from their hatcheries. We buy food from the Agro vets regular feed and medicines. There are different feed millers, however, where farmers get to each other their supply of feed from one source. Every now and then farmers can upload various ingredients to the economic feeds to accelerate the increase, including maize, wheat bran, or fish meal. The impact on broiler efficiency of these changes has not yet been established (Nyaga, 2007). Most of these farmers are free of any organized activities and since there is no association to sell either eggs or poultry food, the very last product is sold individually. State meat inspectors look at carcasses and issues with a Transporting Meat (COT) certificate to facilitate urban and peri-urban farmers' market transportation.

As a result, they will be packed and shipped directly to the market as soon as the broilers are handled. Nevertheless, many farmers may have deep freezers where they store the processed birds before sending orders to the target market. Many farmers with freezers will also be able to buy broilers from their associates to store them in their freezers and then sell them to a profit if the demand is high. Whether by small-scale farmers or economic producers, broilers are always dressed. Maybe that's because they are going to lose weight quickly if they don't sell anything inside or get to market for 3 days, in which case the vendor will lose a lot (Nyaga, 2007).

2.3.3 Indigenous Chicken

It has been observed that where there are human settlements, there are indigenous chickens (ICs), and their monetary power is in their low production value, an attribute of their resource terrible rural households. Kenya's IC has a high genetic variety and is popular with consumers. There is a chance of improving IC profitability in Kenya, and there is a need for wide-ranging initiatives on the part of people and countries to tackle the entire IC fee chain. Indigenous hen production systems are classified as industrial or subsistence in accordance with production goals (Mapiye et al., 2008).

Kenya has defined and classified IC model mechanisms focused on husbandry operations and input and output levels into Free Range (FRS), Semi-intensive (SIS) and Intense (IS) schemes (Menge et al., 2005). While all manufacturing systems are employed in both rural and urban residential areas, the preference of a household for a particular gadget depends on the availability of land and business purpose. Priorities for IC rearing include: living (home usage only), living and cultivation (home usage and cultural use only), household consumption and function, and benefits only.

Menge et al. (2005) found, in keeping with the competitiveness of the three development systems, that elevating IC under FRS is more competitive than in SIS and IS. Nonetheless, due to the fact that land availability to work against FRS is declining due to the ever-increasing human population, the use of IS is considered and therefore the production systems may also turn to IS. The emergence of genetic ICs will therefore contribute to the need for better management and, thus, marketing of IC output. For existing and semi-intensive production processes, the age is between 180 and 240 days when the first egg is laid.

Nonetheless, under intense supervision, this has been shown to be reduced to 166 days. A measure of genotype and environmental interplay may also be the obvious change under intense management (Ali & Brenøe, 2002).Males grow faster and are heavier than females, with an average adult body weight of 2.2 and 1.6 kg. The rate of increase for ICs is comparable to that for company egg hybrids. Hens lay about forty-five eggs per year, ranging from 30 to 75 eggs below the free range and semi-free range systems.

But, when combined with focus, some lay-up to 120 eggs. The suggested egg weight was once measured at 47.4 g in all production processes, ranging from 36 to 52 g (Kingori et al., 2010). Approximately three clutches are laid each year later than incubation, each hold having an average of 15 eggs. The use of broody hens in all production systems is provided by chicks through natural incubation. Fertility and hatchability are often greater than 70 per cent, but hatching weights are often small, ranging from 25 g to 43 g.

In Kenya, the IC has excessive genetic diversity and, unlike distinct poultry products, is popular among customers. Their productivity, however, is low. There's room for growth in performance. Their production needs to be genetically enhanced to support their use against evolving climatic and economic conditions, with no need for alternative inputs. Other management strategies such as food, accommodation, disorder and control of parasites need to be investigated (Nyaga, 2007).

2.3.4 Exotic Chickens

In the 1960s modern varieties of chickens were developed, only maintained in limited numbers in the United States. These were Black Australorps, White Leghorns, New Hampshire Blue, Rhode Island Red, Dark Sussex. Later the Plymouth Rock, the barred rock and the buff-rock were added. With the introduction of hybrid layer and broiler flocks hatched from imported eggs, the prevalence of pure breeds was observed in the 1970s, and later imported breeding shares grown in the region.

A cockerel and pullet trading system was implemented in 26 of the then 54 districts of Kenya for the use of Rhode Island Red and Black Shaver birds, and this also affected the local village genetic pool. Shaver Star cross, ISA gray, Arbor Acres, Hybro, Cobb (United Kingdom), Hypeco (Holland) are popular breeds for egg production. We are currently developing Kienyeji, layer and kenbro for handy meat from KALRO, Naivasha (Nyaga, 2007).

2.3.5 Chicken Feeds and Feed Industry in Kenya

Two feed rations are a limitation in intensive chicken farming, contributing 60-80 % of total production costs, 70% of which are due to fish and soy meal used as a protein source (Ssepuuya et al., 2017).Chicken feed contributes 60-70% of the total fees for output, so the majority of farmers now pay close interest not only on value but also on the broad and acceptable use of feed. Any waste contributes to income loss. Poor friendly feed results in a gradual increase in broiler levels and poor production of eggs in layers each key resulting in marked income loss. There are many feed millers processing poultry feed in Kenya and it is not always possible to guarantee the best compared to when millers were few (Nyaga, 2007).

2.4 Protein Sources and Availability

Many dietary protein requirements for hen are provided with the aid of plant sources, with soybean being the most widely used protein sources. Many plant and animal protein meals are the various sources. SBM is the required supply of protein used in the processing of poultry feed. The content of crude protein (CP) is around 40-48 percent. Compared with the protein meal of different oilseed grains, soybean protein is preferred because of its well-balanced amino acid profile, especially critical amino acids (EAA), which helps it to complement most cereal-based diets (Ravindran, 2013). Due to a scarcity of other amino acids, plant proteins usually require extra supplies of amino acids or certain protein sources such as animal protein.

Plant proteins are typically more cost-effective than animal proteins; but, due to their presence of anti-nutritional elements ANFs, their use is difficult. Some of such ANFs can be eliminated by thermal processing, which also leads to an rise in dietary plant protein fees and protein levels (Adeyemo & Longe, 2007) due to decreased ANFs and protein releases in plants. Typically, plant protein sources in some EAA are nutritionally unbalanced and low and this increases their biological costs because they do not have the amino acid limitation needed by using birds to produce meat and eggs. Chicken nutritionists have taken greater account of the use of animal protein sources to create a balanced diet (Beski et al., 2015).

Animal proteins are sufficiently balanced in terms of EAA, which are important for body growth and development but high prices for the production of commercial broilers. These are therefore commonly used to supplement the nutritional stability of amino acids rather than as the primary source of proteins. There is, however, a question about the spread of disease from animal products, which is why measures to prevent disorder need to be implemented. The importance of the animal protein sources generally depends on the composition of the raw material used (Moritz & Latshaw, 2001).

There was also some interest in replacing the soybean meal SBM cycle with animal products to increase efficiency in poultry diets. Sources for the supplementation of animal proteins can also greatly improve performance parameters over widespread diets. However, it may also be attributed to a good understanding of essential amino acids or a lower percentage of indigestible carbohydrates in SBM (Firman, 2004). For a number of countries, precaution is taken to insure that animal protein ingredients are used in feeds for processing chicken feed, particularly for young birds needing a higher production cost.

The requirements for essential amino acids are also reduced as bird's age, and diets that include a reduction in animal protein content and higher plant protein levels are feasible to meet the needs of older birds (Ravindran, 2013).The availability of plant-based feed fluctuates with seasonal variations, particularly in tropics where extreme scarcity can occur throughout the year. Animal foundation feed ingredients are steeply priced, thereby restricting their right of entry and use (Beski et al., 2015).

2.5 Alternative Protein Sources

Alternative sources of proteins include tropical forages. The ideal forage has the following attributes: high biomass production in environments where different plants are unable to compete, minimal competition with human food requirements , high protein levels with an adequate amino acid profile, especially lysine, methionine and other amino acids of sulfur, excessive nutritional vitamins and minerals compared to ordinary power-based feed Tufarelli, 2018). Additional advantages involve the incorporation of forages, such as human food, timber, fabric, gum, tannery, soil improvement and soil security, into the farming method.

Crude protein quality for plant life in tropical forage ranges greatly with soybean grain values of up to 360 g / kg DM (36 percent CP).The amount of sulfur in the studied plants that contains methionine and cystine is small for chickens compared to the profiles of amino acids, the ideal protein for poultry.

The proportion of threonine appears to be fairly well distributed and the amount of tryptophan in half of the population is within the preferred range. In general, in the green part of the flora, tryptophan is rather large and the seeds decrease. While the amino acid pattern is not now ideally adapted to any particular plant species, poultry diets are usually blends of a number of compatible ingredients when mixed to fulfil the nutritional needs of the organism. It is difficult to generalize the response of poultry to dietary supplements made from forage species because it depends on the ratio of different components in the traditional diet (National Research Council, 1989).Thus, in order to formulate top of the line diets for chicken, the ultimate level of inclusion for the on-hand forage species must be perceived as nicely as being the exceptional structure of administration in combined amount. Besides nutrition, forage legumes do produce higher amounts of vitamins and minerals compared with other cereals, fodder grasses and certain agro-industrial by-products, which may therefore reduce the need for commercial premixed nutrients. The dietary fee for a feed is not only based on the quintessential nutrients but also on their digestibility and, also, on their actual consistency.

A major impact on digestibility will be the use of material containing dietary fibre and the use of plant secondary compounds with ANFs. They are pectin, cellulose, hemicellulose, β-glucans, fructans, oligosaccharides, lignins, and starch resistant (Bindelle, et al., 2008).

ANFs are defined as elements generated in herbal feed substances using the usual metabolism of plant species and interfering using distinct mechanisms such as inactivation of certain nutrients, interaction with the digestive process or metabolic usage of feed may have consequences contrary to optimal nutrition. ANFs are typically not lethal now, but can also cause toxicity when animals eat large portions of ANF-rich feed at intervals of scarcity or containment. Tannins bind protein, for example, by H-bonds and hydrophobic interactions. It reduces the digestibility of proteins and carbohydrates which includes starch and fibres. A bitter and astringent flavour is another property that is required, which in many cases decreases palatability, which is why feed intake has been limited. Tannins in chicken are correlated with less effective feed conversion (FAO, 1996b).

Insects could be used as protein sources in fowl diets because at any stage of the year they are conveniently on hand. The inclusion of insect meals in diets is likely to reduce feed costs, thus contributing to hen production's extra profitability. Insects as poultry feed are natural food sources for many outside chickens. Grasshoppers, crickets, cockroaches, termites, lice, stink bugs, cicadas, aphids, scale insects, psyllides, beetles, caterpillars, flies, fleas, bees, wasps, silk worm, ants and black soldier fly.

Prosperous sources of animal protein are the nutritional composition of insects in all lifestyle ranges (Marono et al., 2015). The numerous alternative sources of protein are artificial EAA. Feeds are developed with commercially accessible artificial EAA to satisfy broiler specifications to enhance natural stability and raw amino acid protein while also improving the quality of accepted broiler birds (Zarate et al., 2003).

2.6 Acacia Tortilis

Acacia tortilis has several therapeutic qualities as well as those of industry. *Acacia* is the largest genus in the Leguminosae-Mimosoideae has spread about 1200 species more commonly than in tropical and subtropical regions. *Acacia* species are capable of flourishing under harmful conditions. We can tolerate salinity and seasonal water logging and are suited to poor and intermittent rainfall conditions. In fact, they are sensitive to anthropogenic stresses. The plant is a crop that is immune to drought. The generic name '*Acacia'* comes from the Greek word 'akis,' which means a factor or a barb. Twisted the ability to identify' tortilis' and applies to the structure of the pipe. It is also known as umbrella thorn because of its shape as an umbrella and is often recognized as an Israeli babool in India (Orwa, 2009).

Ecologically, the tree can survive in the tropical desert tract, tropical forests to very dry forest areas. The umbrella tree can thrive with rainfall range from 10mm to 100 mm per annum, temperature of 18-28 ^{o}C and 6.5-8.5 pH. This species bears temperatures as high as 50 ^{o}C in warm, arid climates. *Acacia tortilis* tree has a flat pinnacle canopy can also reach a peak of 20 metres. Stem and branches in the mature are reddish brown with grey lenticels and in the young are dark brown. It has 2-14 pinnae each with 6-22 pairs of leaflets; the leaves are simple to densely pubescent, 1-7 cm long. Flowers are white or light yellowish-white, fragrant, solitary or fasciculus in round eyes.

Barks are black and grey-brown, rough and broken. The spines are paired, some strong and hooked up to 5 mm in length, mixed with long straight narrow spines up to 10 cm in length. It has contorted or spirally twisted pod, brown white, and 5-15 cm long, with longitudinal veins and scarcely constricted between the seed. In the Semi-dehiscent pod there are 5-18 seeds. The mature pods often tend to be on the tree in addition to releasing the seed (Verma, 2016). *Acacia tortilis* is found mainly in Africa, Arabia and Asia, in arid and semi-arid lands. The products from *Acacia tortilis* plant are; leaves, seeds, gum exudates and bark are very helpful and medicinal for commercial purposes. The bark has tannins which are used as colorants, pods and gum are used as foods, and leaves are useful for soil fertility and nutrients for ruminants. It is used for herbal treatment of various diseases such as pores and allergies to the body, asthma, diuretic and hypertension, and other disorders. In the arid lands the rainfall is scanty and unevenly distribution, this lend to vast stretches of dry and barren land. The *Acacia tortilis* survives in this environment due to its ability to withstand the harsh conditions in this part of the land and conserve the soil. Their precise advantage in arid zones is due to their severe heat, drought, salinity and alkalinity tolerance. Some of the species of *Acacia* are of good for reuse and recycling of waste land (Yadav et al, 2013).

In Kenya, after harvesting the seed, the Turkana make porridge from the pods and the Maasai consume the immature seeds. In India, West Africa, Somalia and Ethiopia, it is used as cattle fodder. A ten year old *Acacia tortilis* yields approximately 4-6 kg of dry leaf and 10-12 kg of pods annually. The pods are fed to animals with no grazing. Grinding pods would make them nutritious and increase the voluntary feed intake. More than 90% of the flora abort and drop to the ground and thus supplying additional forage to the livestock. These flowers are good feed especially for the small ruminants during the dry season. The species is considered to be more beneficial than many indigenous species growing in the arid region of India because of its hardiness drought and rapid growth. For afforesting moving sand dunes, refractory areas, hill slopes, ravines and laterite soils, it is a promising species. *Acacia tortilis* bushes have nodule in their roots and are therefore a fixing plant for nitrogen (Orwa, 2009).

2.6.1 Nutritional Composition of *Acacia tortilis*

Acacia species hold a high content of crude protein (up to 218 g / kg dry count (DM)), rendering it one of the most suitable forage for animal feeding (Hlatini et al., 2016). Neutral detergent fibre (NDF) and acid detergent fibre (ADF) content ranged from 154 to 308 and from 114 to 251 g / kg DM, low in phosphorus, fair in calcium, magnesium and sulphur, and rich in most microelements. Iron and selenium ranged from 132 mg / g to 459 mg / g and 13 mg / g (Yadav et al., 2013)

Plate 2.1

Researcher standing near a mature Acacia tortilis tree

Plate 2.1: The plate shows the researcher standing near an *Acacia tortilis* tree at the compound of the catholic mission in Isiolo Town. There are very many *Acacia tortilis*

Plate 2.2

Acacia tortilis Pods and Seeds

Plate 2.2: Shows the harvested seeds and the pods of an *Acacia tortilis* tree

2.6.2 *Acacia tortilis* Feeding Value

Pastoralists in Africa have long acknowledged the importance of dry season Acacia trees and shrubs as a supply of forage (browse and pod). They also developed amazing methods to collect the fodder over the years including pollarding (e.g., Acacia Nilotic), lopping (Acacia seal) and manually shaking the pods of species like *Acacia tortilis* using long hooked poles. For domestic and wild herbivores, fallen leaves, flora and pods are a necessary source of forage. *Acacia tortili*s blooms abundantly, producing massive amounts of extraordinarily nutritious seed pods that can be saved as a dry season supplement (Araya et al., 2003).

Chemical research reveals that seed pods of *Acacia tortilis* are achievable sources of protein, minerals and average carbohydrate ranges for livestock. *Acacia tortilis* pods are very useful for goats, so when grass is reduced on the range, the pods may be an acceptable replacement to grass in goat diets. *Acacia* pods were used by pastoralists and agro-pastoralists, especially in Africa, as a strategic dry season supplementary feed to increase the nutritional fee for the relatively low quality dry season natural forests. Not accessible to livestock producers in arid and semi-arid regions, feeding alternatives such as oil-seed cakes that are hardly ever used because they are too expensive and not readily available. Farmers periodically harvest the pods, dry them and retain them for use in fundamental periods at some stage. However research need to be carried out to determine the duration that the feed should be kept before it becomes unfit for the consumption by the animals (Araya et al. , 2003b). It has been shown that inclusion of *Acacia tortilis* leaf meal in pig diet improved their performance. There was good consumption up to a point in incremental stages, but there was a threshold level after which growth output was suppressed. Thus, incorporation of moderate levels of *A. tortilis* leaf improves growth performance of pigs (Khanyile & Hlatini, 2015).

2.7 Chickens Rearing in the Arid and Semi- Arid Lands

In the Kenyan ASALs (Arid and Semi-Arid Lands) the main livelihood is keeping of livestock; cattle, sheep, goats and camels. A study performed on indigenous chicken rearing in Makueni found the business to be competitive in ASALs. Kenya's Makueni County is located in the low and irregular rainfall ASALs (Kingori et al., 2010). This trend results in crop failure, livestock deaths and exposes the population to food insecurity (Ayieko et al., 2014). There is a need for an alternative livelihood to cope with this condition which undermines Food and Nutritional security which is one of the pillars of the Presidents Big 4 Agenda. The indigenous chicken (IC) has been found to be adaptable to the harsh climatic conditions with little input requirements. The other advantages of the IC include; little space requirements, quick income returns and low disease incidence. Furthermore, the chicken can easily be sold off for money during emergencies and especially during the drought season which is a common phenomenon in the ASALs. The chicken is a rich source of protein, which addresses food and nutrition security. Therefore ,poultry enterprise could provide an exit strategy from poverty and leads to improved livelihoods (Nduthu, 2013). A study on the factors influencing indigenous poultry production in Katina sub-county, Machos County, Kenya by Nduthu (2013) found that managing livestock in Africa is likely to be more profitable than growing crops under these harsh climatic conditions. The major challenges facing livestock production in the ASALs is the availability of adequate, good quality feeds all year-round due scarcity of rainfall (MOLD, 2007). Poultry need feeds that give the fundamental elements for body functions, which include maintenance, growth, and egg production. This is a requirement that the free-range manufacturing gadget does no longer meet adequately. To acquire a balanced diet, it is endorsed that in addition to scavenging, a farmer have to consist of protein supplements which are less costly and locally handy (KARI, 2006). The dimension and productivity of the village flock relies upon on family waste and crop residues, and on the availability of different scavengable feed resources. The main reasons for elevating IC are to furnish meals and cash income. The key constraint faced by farmers is; high disease mortality, inadequate nutrition, accommodation and lack of advertisement outlets. The solution to these disorders is: combined education, nutrition, housing and rural access to the street network needs to be established to promote market access. IC's supremacy in medium to extreme agricultural areas is attributed to its need for small households and the grain supply. Massive quantities of land are dedicated to grain processing in these areas, and therefore there is much little or no space available for large animal species. Furthermore, the stringent environmental stipulations in ASALs that provide a reason for low profitability, limited flock size and therefore low IC ranking as a supply of farm animal profits. Limited flock sizes, low productivity and reproductive success, and high mortality from IC were found in marginal tropical agro-ecological areas (Okeno et al., 2012).

In order to increase productivity of IC, they should be supplemented with food that has energy, proteins and vitamins. These feeds should be locally found like blood from slaughter houses and white ants for proteins. For people living around the lake they can use Omena fish. The common feed supplement for IC are sorghum and maize (Nduthu, 2013). *Acacia* *tortilis* grows abundantly in the ASALs, and the research study seeks explore the possibility of using *Acacia Tortilis* seeds in feed ingredients for chicken.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter explains how the study was carried out. It covers research design, location of study, treatments, data collection procedure, analysis and experimental animal's management. The aim of the study was to compare growth performance of broilers fed on processed *Acacia tortilis* seed meal as a replacement of SBM.

3.2 Study Area

The experiment was conducted at Mwangaza estate which is located in Isiolo Municipality, Wabera ward Isiolo North Sub County, Isiolo County in Kenya. Mwangaza estate is located on western side of Isiolo International Air Port about 1km from Isiolo town centre. At an altitude of 1085 meters above sea level and 341547 Northing, and 36561Easting arc 1960 utm 37n (Isiolo land department,). The rainfall is bimodal and the average annual precipitation range from 500 mm to 670 mm per annum, the average annual temperature is 29^{o}C which is typical of Arid and semi-Arid lands of Kenya (Isiolo County CIDP,2018-2022). The low rainfall and high temperatures in this county hampers crop production. In this environment livestock production is the main livelihood. The *Acacia tortilis* pods were collected from area surrounding Maili Saba town which is in Buuri sub county, Meru County in Kenya. Maili Saba is located along the Isiolo Nanyuki town, 7km from Isiolo town.

3.3 Materials Preparation

The feed diet was composed of the following ingredients; Maize germ, Maize grain, processed *A. tortilis* seed meal, Soybean meal, Fish meal, Cotton seed cake, Wheat pollard, Sunflower, Broiler premix, Stock salt, Limestone, Bone meal, Salinomycin, Methionine, Lysine and Mycotoxin binder. The diet ingredients were sourced from the main markets in

Meru town and the other ingredients were purchased from well-known feed manufacturer and Supermarkets. The *Acacia tortilis* pods were obtained from the trees in the vicinity of Maili Saba town in Buuri Sub County, Meru County- Kenya. The pods collected were dried and thrashed to release the seeds. Winnowing was done to remove the chaff. The seeds were cooked in boiling water for 1 hour to reduce the anti-nutritional aspects, increase digestibility and palatability. In the experiment the Acacia tortilis seeds were boiled for one hour and ground, this was a form of processing. The processing was done to improve nutritional value of Acacia tortilis seed meal to enhance palatability, voluntary feed intake, digestibility and concentration of nutrients. The water was decanted and the seeds were dried and taken to the mill to be ground into flour. The flour was sent to laboratory for proximate analysis. The resultant *Acacia tortilis* pods meal was used to formulate the diets at various substitution levels.

Further, Proximate analysis was done for the other seven feed ingredients used in the feed formulation. The total main food ingredients were eight. The additive ingredients which were eight were added in all the formulated diets in equal amounts. The crude protein and energy levels of the diets were made similar using standard feed formulae for broiler starter. Table 3.1; diet composition of Broilers; below shows the composition of the feed ingredients by weight per treatment. The ingredient were weighed and put in the automatic feed mixer and the machine was operated for 30 minutes after which the feed was thoroughly mixed. The feed was then stored in a six bags separately and labelled per treatment numeral 0-5.Where T0 was the control.

Table 3.1

Diet Composition of Broilers in Kg

Ingredients	T0	T1	T2	T3	T4	T5
Maize germ	3.85	3.85	3.85	3.85	3.85	3.85
Wheat pollard	10	10	10	10	10	10
Fish meal(Omena)	4	4	4	4	4	4
Cotton seed cake	8.05	8.05	8.05	8.05	8.05	8.05
Acacia seed meal	0	3	6	9	12	15
Maize grain	27	27	27	27	27	27
sunflower cake	2.1	2.1	2.1	2.1	2.1	2.1
Soybean meal	15	12	9	6	3	0
Stock salt	0.175	0.175	0.175	0.175	0.175	0.175
Limestone	0.98	0.98	0.98	0.98	0.98	0.98
Bone meal	0.91	0.91	0.91	0.91	0.91	0.91
Salinomycin	0.035	0.035	0.035	0.035	0.035	0.035
Mycotoxin binder	0.105	0.105	0.105	0.105	0.105	0.105
Methionine	0.035	0.035	0.035	0.035	0.035	0.035
Lysine	0.28	0.28	0.28	0.28	0.28	0.28
Broiler premix	0.14	0.14	0.14	0.14	0.14	0.14
Total(kg)	**72.66**	**72.66**	**72.66**	**72.66**	**72.66**	**72.66**
ME	**2930.8**	**2906.58**	**2888.31**	**2858.07**	**2833.83**	**2809.59**
CP	**22.0**	**21.8**	**21.6**	**21.4**	**21.2**	**21.0**

T=treatment, kg=kilogram, ME=metablizable energy (Kca/kg), Kca= kilocalories, CP=crude protein

3.4 Experimental Design and Layout

The study employed Completely Randomized Design (CRD) where ninety (90) broiler chicks were randomly assigned to six (6) treatments with three (3) replications. Five birds were housed in a cubicle in deep litter system rearing method. The six (6) treatment groups, each with three (3) replicates of five (5) birds per replicate were fed different levels compositions of experimental diets. Table 3.2: Feed substitution level shows the percentage of *Acacia tortilis* seed meal which was replacing the soya bean meal and vice-versa.

Table 3.2

Feed Substitution Level

TREATMENT	FEED SUB STITUTION LEVEL
T0 Control	0% *Acacia tortilis* seed meal + 100% of Soya bean in the diet.
T1	20%*Acacia tortilis* seed meal + 80% of Soya bean meal in the diet
T2	40% *Acacia tortilis* seed meal + 60% of Soya bean meal in the diet
T 3	60% *Acacia tortilis* seed meal + 40% of Soya bean meal in the diet
T4	80% *Acacia tortilis* seed meal + 20% of Soya bean meal in the diet
T5	100 *Acacia tortilis* seed meal + 0% of Soya bean meal in the diet

The chicks were brood in a round brooder and were homogenous and they were removed from the brooder and randomly placed in the experimental units. The unit (cages) were assigned the treatments randomly per replica. Each cage had five birds. The cages were randomized as follows: Six pieces of papers of equal sizes were labelled T0 to T5 and were randomly picked for each experimental unit. The units were then labelled according to the piece of paper picked. The results as shown in table 3.3.

Table 3.3

Experimental Design

T0	T3	T1	T5	T2	T4
T1	T4	T0	T3	T5	T2
T3	T0	T2	T1	T4	T5

The cubicles (units) were partitioned 90cmX 90cm and 65cm high. The partitioning was done using shade net nylon nets. The structure was made of timber frames of 2''x 2''. The bulbs for providing heat at the units were 100 watts hanged at 55 cm from the ground in the middle of each cage unit. There was fluorescent tube on the roof to provide extra lighting.

3.5 Chemical Analysis of the Feed.

Each sample of feed ingredients (maize germ, maize whole grain, processed *Acacia tortilis* seed meal, soybean meal, omena, wheat pollard, cotton seed cake and sunflower cake) were sent to laboratory at the University of Nairobi for proximate analysis and used to make the experimental diets. The other ingredients included in the diets were bone meal, stock salt, limestone, lysine, methionine, broiler premix, and Salinomycin and Mycotoxin binder. The feed ingredients were mixed using an automatic electric fed mixture at Gakurine farm in Meru town for homogeneity.

3.6 Experimental Animals and Management

Ninety (90) day old mixed sex broiler chicks were bought from a reliable company (KENCHIC) and were of uniform in age at Meru depot. The chicks were vaccinated on Day 7 against Newcastle disease, and on Day 10 against Gumboro. Prior to introduction of the chicks, the house was disinfected 4 days before introduction of the chicks, the doors and windows opened for aeration. Heating was done using electric bulbs of 100 watts until when the chicks had grown adequate feather for insulation against the cold weather. The starter commercial diet was purchased from a reliable company and was fed to chicks' *ad libitum* up to day7. Clean water was provided (*ad libitum)* at all the times. The waterers were cleaned daily while the feeders were cleaned weekly. The experimental diet (broiler starter) was fed from day 8 to the end of the experiment on day 35. The chicks were randomly placed in the experimental unit 5 birds per unit. The chicks continued to be provided with the heat at the unit with the 100 watts bulb. The waterers and feeders were placed in each unit. The birds were weighed on weekly basis to access the weight gain. The leftovers feed were collected each morning and the same was stored in receptacles and weighing was done at the end of the week at the same time with the chicks. The chicks were fed adlibitum and provided with clean water all the time. The birds were weighed in groups of fives and the records were kept.

3.7 Data Collection

The feed was offered to the chicken at *ad libitum* to each group during the day starting at 6.30 am morning up to evening. In the morning before placing more feed at 6.30 am, the remaining feed was collected and put in appropriate receptacles and weighed weekly. The difference between feed offered and feed balance (refuse) was used to compute the voluntary feed intake per group. The birds were weighed on weekly basis to access the growth rate. The weighing was done using electric balance. The feed conversion efficiency was calculated by dividing average daily feed intake per bird by average weight gain per bird

$$\text{FCR} = \frac{\text{Average feed intake}}{\text{Average weight gain}}$$

3.8 Laboratory Analysis

Analysis of feed ingredient was done at University of Nairobi for proximate analysis to know the amount of Dry Matter (DM) Crude Protein (CP) Ash, EE (fat), crude fibre, Energy and carbohydrate.

3.9 Carcass Parameters and Dressing Percentage

Determination of broiler carcass parameters was done after birds starved for 12 hours before slaughtering procedures. For each operation a total of three birds are slaughtered. The live weight of the birds was taken before slaughtering. The birds were killed by dislocation of the neck and the pancreas, breast fat, spleen and the intestine of each bird were removed and weighed. The percentage weight of the organs was determined by dividing the organ weight by the live weight of the bird and multiplied by 100 to get the percentage.

3.10 Data Analysis

Data collected was summarized and organized using excel. Analysis of Variance (ANOVA) was done using SPSS software version 20. Where there was significant difference post- hoc test was conducted and the means separated using Dancun Multiple Range Test (DMRT) at 0.05 significance level.

Plate 3.1

Day Old Broiler Chick in a Brooder

Plate 3.1 Shows day old chick in brooder after they had been placed. In the plate the waterers and feeders were conveniently placed so that all the chiks could access them easily.

Plate 3.2

Acacia Pods being thrashed

Plate 3.2 Shows thrushing of the pods to release the seeds. The activity is labor intensive.

Plate 3.3

Acacia tortilis Seeds Being Dried after Boiling

Plate 3.3 Shows people spreading Acacia *tortilis* seeds after boiling them to dry. It took two days to dry them. After the drying they were taken to the mill harmer and ground into to flour to be used in the feed formulation as part of the ingredients.

Plate 3.4

The Broiler Chicks in Cages

Plate 3.4 Shows the experiment design and cages with chicks inside**.** The waterers and feeders were put in each unit. Bulbs were placed in the middle of the cages to provide heat when the birds had not grown feathers.

Plate 3.5

Weighing the Chicks

Plate 3.5 Shows weighing of chicks in groups of five per unit**.** The birds were put in a carton box and placed on top of the weighing scale ,the weight taken was recorded in a ledger and later used to carry out data analysis.

Plate 3.6

Weighing of the Bird When They had Grown

Plate 3.6 Shows weighing of the birds at week three. At this time the birds had grown such that I could not weigh all of them at same time, I could weigh three and then the other two later. Thereafter their weight were combined to get the mean.

Plate 3.7

Slaughtering the Chicks

Plate 3.7 Shows the researcher and a colleague carrying out slaughtering of the birds after taking the live weight. The critical organs were removed and weighed whereby the data was used to evaluate the carcass characteristics.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

The chapter contains the results and discussion of the study findings. This study sought to determine the growth performance and yield of broilers fed on different levels of processed *Acacia tortilis* seed meal as a replacement of soybean meal. All the experimental birds survived during the experiment. The parameters evaluated were; proximate analysis of the feed ingredients used in formulation of the Diets for Broilers. The other parameters evaluated were; mean initial weight of the chicks, mean daily weight gain, mean weight gain, mean final weight gain, mean voluntary feed intake, mean feed conversion ratio, mean carcass characteristics, mean feed input, mean cost of feed input, mean biomass harvested, mean cost of harvested biomass, mean incidence cost and mean profit index. The results are summarized from Tables 4.1 to Table 4.19.

4.2 Proximate Analysis of the Experimental Diet

Table 4.1 shows the DMRT outcomes of proximate analysis which was done in the laboratory at University of Nairobi and results were received in triplicates. ANOVA was done and the results indicated there was significance difference, see Appendix 1

Table 4.1

Proximate Composition of Feed Ingredients (%) used to Formulate Diets for Broiler Chicks

Feed	**CP %**	**DM %**	**Ash %**	**EE %**	**Fibre %**	**NFE**	**ME KCAL/Kg**
Fish meal	64.01a	92.67c	18.14a	12.94c	0.20h	4.22h	3437.49a
Wheat pollard	15.86e	92.76c	3.97e	5.14f	9.87e	65.45b	2825.72f
Sunflower cake	26.29d	94.62a	4.76d	15.18b	33.84a	19.91f	2961.83d
Maize meal	8.15g	89.97d	13.5g	3.66h	3.90g	83.45a	2670.79h
Maize germ	12.93f	87.71e	3.46f	12.51d	6.14f	65.41b	3096.80c
Cotton seed cake	31.67c	93.40b	5.52c	7.67e	23.63b	31.01d	2891.84e
Acacia tortilis seed meal	31.37c	92.94c	4.75d	4.13g	20.43c	38.88c	2743.21g
Soya bean meal	36.37b	92.87c	6.01b	19.41a	14.27d	23.71e	3310.68b

Means having the same letters are statistically not significant

The chemical composition of ground *Acacia tortilis* seeds were having comparable results with ground *Prosopis juliflora* in nearly all attributes except in CP which was low at 12.6% compared to 31.7 where ATSM which was higher and fat (Manhique et al.,2017). In the ingredients used to formulate the ratio, crude protein was highest in fish meal at 64.01% and the lowest was maize meal at 8.15%, while soya bean meal had a CP of 36.37%.,while *Acacia tortilis* was 31.73%.

Lovell (1988) found out that the nutrient composition of feedstuffs depends on the origin and processing methods used. According to the National Research Council (1993), soybean has 48 per cent crude protein without hulls and oil solvent extraction in soybean meal (SBM) has 44 percent crude protein. The low CP in soybean content may be due to adulteration of soybean meals by marketing agents using low quality products, such as sawdust. This was expressed in the high SBM crude fire content (14.27%); double the recorded (Agbo, 2008;

Noreen &Salim, 2008). It is necessary to notice that although the amount of crude soybean protein was below the expected standard, this had the same impact over the six diets that were created. This reveals that farmers could buy adulterated feed ingredients from fraudulent merchants, resulting in substandard feed formulation, which in effect is expressed in poor output by the broilers. Sunflower cake at 33.84 per cent recorded the higher crude fiber of all products, which is considered a limiting factor in its usage as chicken feed. The crude protein content of fish meal (64.01 per cent) was lower than that obtained from (Otubusin, 2009), which recorded 70 per cent CP. This number along with the ash content (18.4 percent) was within the normal range which, according to Drew et al. (2007), may differ from 50 to 70 percent and 10 to 21 percent, respectively, based on fish types, source and method of processing. High dietary fiber content decreases total dry matter and dietary nutrient digestibility, contributing to poor performance (De Silva & Anderson, 1995). .*Acacia tortilis* seed meal had CP of 31.74 which is high compared to 26.3 (Araya et al., 2003). The CP in *Acacia tortilis* is same as that of cotton seed cake 31.67. Sunflower meal had a protein content of (26.29%) which is lower than 28% CP reported by Maina et al., (2007). This may be attributed to the high fibre content (33.84%) which according to (Maina et al., 2007), protein concentration in sunflower cake is inversely proportional to the fibre content. Sunflower seed chemical composition depends on temperature, soil quality, variety, and cultivation methods (Karunajeewa et al., 1989; Senkoylu & Dale, 1999). The amount of fat was (15.18 per cent). The discrepancy in crude fat values may be due to the type of processing method used before extraction of the ether (Akande, 2011).The crude fibre reported in sunflower was (33.84%) and varies between 14% and 39% (Villamide & San, 1998). Crude protein content of maize meal was (8.15%). Maize protein's nutritional value varies by cultivar, grain type and growing conditions (Korniewicz et al., 2000), grain drying temperature (Kaczmarek et al., 2007), starch structure (Svihus et al., 2005), and anti-nutritional factors, primarily phytate, enzyme inhibitors, and resistant starch (Cowieson, 2005).The crude protein content of the six diets in the study was made nearly isoprotein (Table 3.1). This was attributed to initial analysis of ingredients prior to formulation of diets in order to balance for the CP and energy. Dietary protein plays a major role in supplying amino acids for body protein biosynthesis that are necessary for body maintenance, development, production, and reproduction (Alam et al . , 2016).Though the protein content in the six diets was isoproteinous, the concentration of protein ingredients per ingredient was significant ($p < 0.05$).In the present analysis, the crude fibre content differed significantly across diets ($p < 0.05$). This variation in crude fiber was caused by different ingredients to balance the crude protein. Fish meal had low fibre content (0.02%) had high protein content. Crude fiber in the feed offers physical bulkiness, increases binding and reduces feed passage through the digestive system (Ayuba & Iorkohol, 2012; Obeng et al., 2015). In non- ruminant animals, chicken included, are generally unable to digest fibre because they do not secrete cellulose enzyme which enables ruminant animals to digest fibre (Bureau et al., 1999).Cell wall carbohydrates can be quantified by determination of Nitrogen Free Extracts (NFE), which includes cellulose, hemicellulose and lignin as the major components (Van Soest et al., 1991). The sample with the highest NFE was maize meal at 83.45% and the lowest was fish meal at 4.22%. The ash content in this study was significance ($p < 0.05$), the samples with highest figure was fish meal (18.14%) while maize meal was the lowest (1.35%).

4.3 Results of Growth Performance

Growth performance is determined by the weight gain, voluntary feed intake and the feed conversion ratio. The following are the results on growth performance indicators;

4.3.1 Mean Initial Body Weight

The chicks were weighed at the beginning of the experiment on day seven after acclimatization and before feeding on the experimental diets were started. The treatment means of the initial body weight were not statistically significant ($p > 0.05$), see table 4.2. This indicates that the changes which were experienced later were as a result of the different treatments.

Table 4.2

Mean Initial Weight (g) ANOVA

Initial weight (gms)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	158.764	5	31.753	.242	.936
Within groups	1574.667	12	13.222		
Total	1733.431	17			

4.3.2 Mean Daily Weight Gain (DWG)

Mean weight gain was accomplished by subtracting the original mean weight (g) from the final mean weight (g), divided by the number days of the trial which were 28 days. ANOVA for daily weigh gain was significant ($p < 0.05$) see Appendix 4: Daily Body Weight Gain ANOVA.Post hoc test was conducted using DMRT, see Table 4.3: Post hoc test for daily weight gain and figure 4.1. The highest DWG was observed in T1 (53.93g), T2 (47.42g) and T0 (46.97g) in descending order. However there was no statistically significance difference between the following treatments means; T1, T2, T3 and between, T2, T0, T3 and between, T3, T4. Treatment (T5) was the least at DWG of (28.50g). T1 and T2 performed better than T0 which was the control.

Table 4.3

Post Hoc Test for Mean Daily Weight Gain

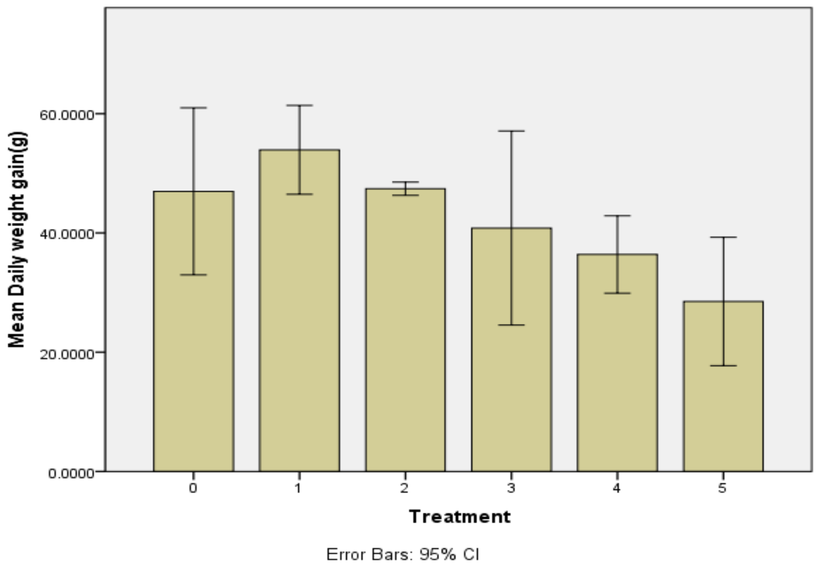
Treatment	Means
T1	53.936a
T2	47.423ab
T0	46.976ab
T3	40.823bc
T4	36.390c
T5	28.500d

Means having the same letters are statistically not significant

Key: T0- 100% Soya bean meal +0% *Acacia tortilis* seed meal
T1- 80% Soya bean meal + 20% *Acacia tor*tilis seed meal
T2- 60% Soya bean meal + 40% *Acacia tortilis* seed meal
T3- 40% Soya bean meal + 60% *Acacia tortilis* seed meal
T4- 20% Soya bean meal + 80% *Acacia tortilis* seed meal
T5- 0% Soya bean meal + 100% *Acacia tortilis* seed meal

Figure 4.1

Mean Daily Weight Gain



4.3.3 Mean Weight Gain (body weight change)

The broiler's mean weight gain was calculated by subtracting the original mean weight from the overall average weight. (Mean final weight – Mean initial weight = weight Gain. ANOVA was done and the differences was significant ($p < 0.05$).see Appendix 2: Mean Weight Gain (g) ANOVA. Post hoc test was conducted using DMRT; see Table 4.4; Mean Weight Gain change (g) and figure 4 .2.

Table 1.4

Post Hoc Test for Mean Weight Gain Change (g)

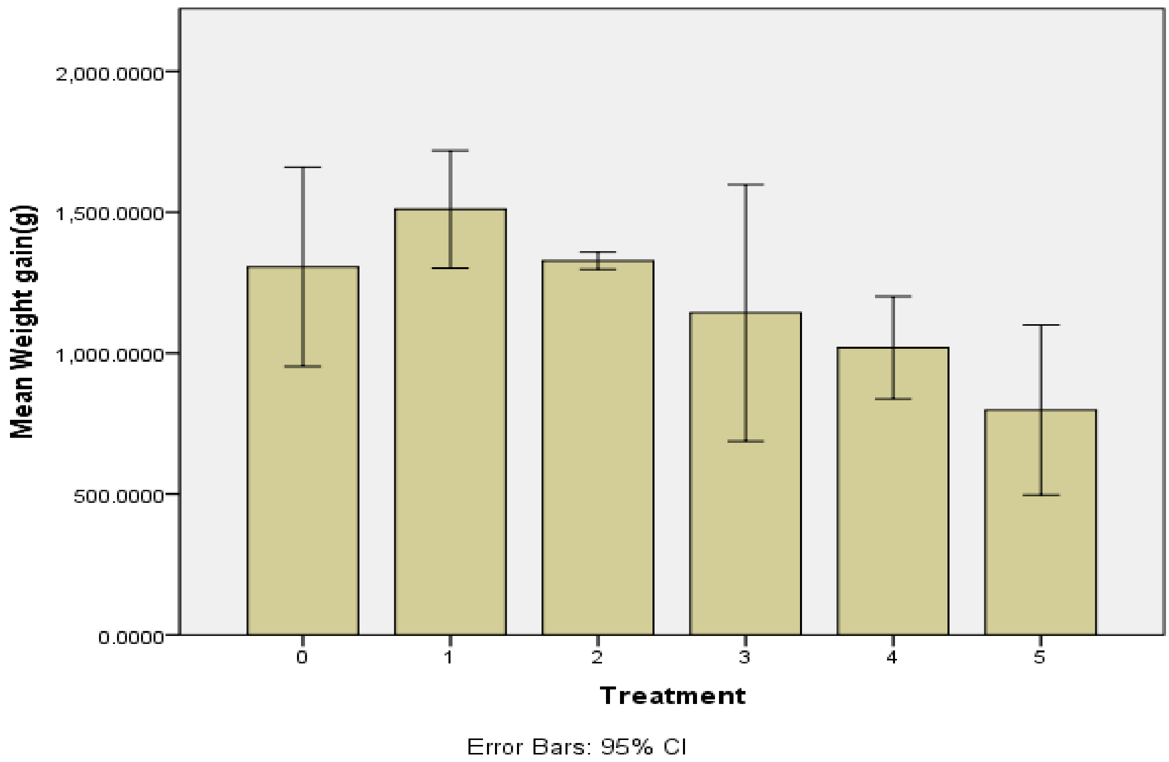
Treatment	**Means**
T1	1510.266a
T2	1327.800ab
T0	1306.000ab
T3	1142.933bc
T4	1018.933c
T5	797.933d

Means having the same letters are statistically not significant

T1 had the highest average weight gain at 1510.26 g while T5 had the lowest mean weight gain at 797.9g. Treatments T1 had a higher average than the control T0, which had mean weight gain of 1306.0g. Mean weight gain indicated that there was no significant difference between the flowing treatments; T1,T2, TO and T2, T0, T3 and T3 and T4 while T5 was statistically significant compared to all the other treatments. The study indicates that T1 had the highest weight gain although this was not significant when compared to T2 and TO (control). However T5 (treatment which had 100% ATSMS) had the least weight gain indicating that feeding ATSM as complete replacement of soya bean meal resulted in poor performance and hence it should replace soy bean optimally at 20%.

Figure 4.2

Mean Weight Gain



4.3.4 Mean Final Weight

The final body weight ANOVA indicated that there was significant difference ($p < 0.05$).See Appendix 5: Final body weight ANOVA. Post hoc test was done using Dancun Multiple Range Test (DMRT) to show where the differences were; See Table 4.5, Final mean Weight of the treatments (g) .The final weight gain indicated that there was no significant difference between the flowing treatments means; T1, T2, TO and between T2, T0, T3 and between T3 and T4 while T5 was statistically significant compared to all the other treatments. The treatment means with the same letters are not statistically different.

Table 4. 2

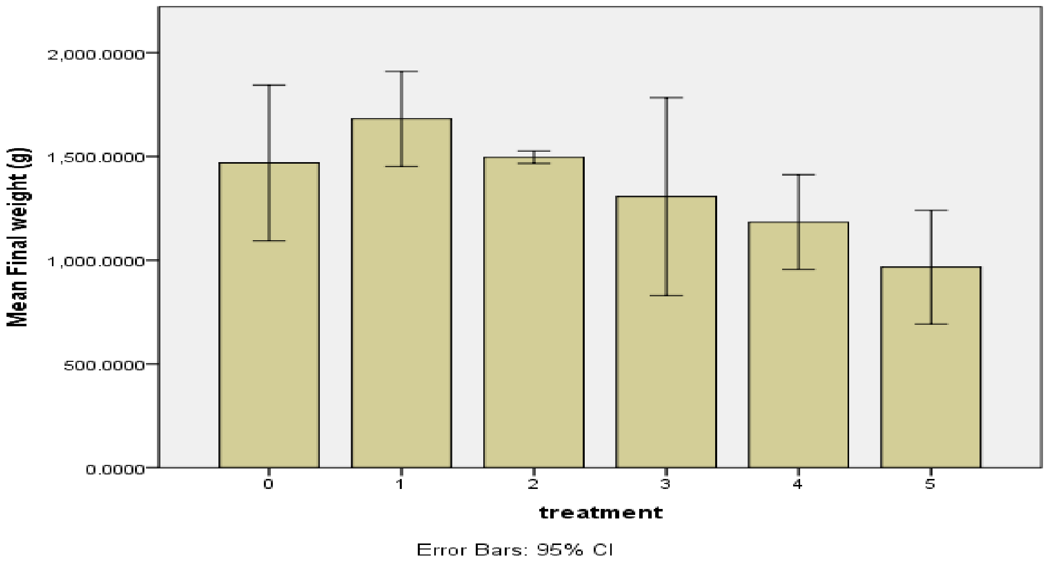
Post Hoc Test for Final Mean Weight (g)

Treatment	Means
T1	1681.133a
T2	1496.266ab
T0	1468.800ab
T3	1306.333bc
T4	1183.600c
T5	966.266d

Means having the same letters are statistically not significant

Figure 4.3

Mean Final Weight



4.3.5 Mean Voluntary Feed Intake (VFI)

The voluntary feed intake was calculated by subtracting the mean weight of feed remaining from the mean weight of the feed offered during the period. The ANOVA done for VFI indicated no significant difference ($p > 0.05$). See table 4.6. This shows that the feed was palatable and acceptable by the birds.

Table 4. 3

ANOVA on Voluntary Feed Intake

ANOVA

VFI

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	468526.071	5	93705.214	2.847	.064
Within Groups	394997.787	12	32916.482		
Total	863523.858	17			

4.3.6 Mean Feed Conversion Ratio (FCR)

The conversion ratio for feed (FCR) is the amount of feed that an animal eats that can transform into one kilo of live weight. This was determined by dividing the Mean amount of feed eaten (g) by the mean increase in weight (g) of broilers during the same duration over the 28 day trial period using the following method;

$$FCR = \frac{\text{Feed intake (g)/bird/28 days}}{\text{Weight gain (g)/bird/28 days}}$$

The mean feed conversion ratio was significant ($p < 0.05$). See Appendix 3: Mean feed conversion ratio ANOVA. Post hoc test was conducted using DMRT to show where the differences were, see Table 4.7 and figure 4.4. The highest FCR was observed in T5 which was 3.23 while the lowest FCR was T1 at 1.96. There was no significance difference between the following treatments; T1, T0, T2 and between T2, T3 and between T3, T4.The lower the FCR means the feed is more efficient in conversion into meat. The FCR displays the amount of feed used to make 1 kg of meat.

Table 4.4

Post hoc test for Feed Conversion Ratio (FCR)

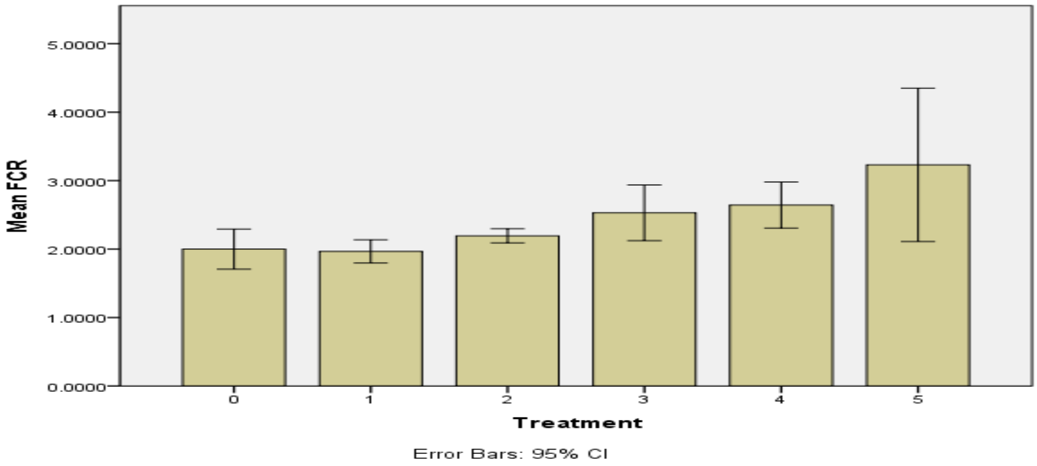
Treatment	**Mean**
T5	3.230a
T4	2.643b
T3	2.530bc
T2	2.193cd
T0	2.000cd
T1	1.966cd

Means having the same letters are statistically not significant

Treatment means having the same letter are not statistically different

Figure 4.4

Mean feed conversion ratio



4.4 Results of the Carcass Characteristics

The Carcass characteristics were evaluated to find out if there were adverse effects on the critical organs of the bird. The carcass data were arrived at by dividing the weight of the organ by the live weight of the bird and multiplied by 100 to get the percentage ratio. The carcass characteristics was analysed for liver, pancreas, spleen, breast fat and intestine. The results indicated that there was no statistical significance difference ($p > 0.05$) see Tables 4.8, 4.9, 4.10, 4.11 and 4.12 for: mean Liver Weight Ration ANOVA, mean Pancreas Weight ratio ANOVA, mean Spleen Weight Ratio ANOVA, mean Breast Fat weight Ratio ANOVA and mean intestine Ratio ANOVA.

Table 4.5

Liver Weight Ratio ANOVA

ANOVA

liver wt %LWT

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.217	5	.043	.541	.742
Within Groups	.964	12	.080		
Total	1.182	17			

Table 4.6

Pancreas Weight Ratio ANOVA

ANOVA

Pacease Wt

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.011	5	.002	2.878	.062
Within Groups	.009	12	.001		
Total	.020	17			

Table 4.7

Spleen Weight Ratio ANOVA

speen Wt

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.004	5	.001	1.141	.391
Within Groups	.009	12	.001		
Total	.014	17			

Table 4.8

Breast Fat Weight Ratio ANOVA

ANOVA

Breast fat WT

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.125	5	.025	.650	.667
Within Groups	.460	12	.038		
Total	.585	17			

Table 4.9

Intestine Weight Ratio ANOVA

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	3.287	5	.657	2.145	.129
Within Groups	3.678	12	.306		
Total	6.965	17			

There was no significant difference on the chicken's carcass characteristics implying that *Acacia tortilis* seed meal can be used as broiler feed without adverse effect on broiler carcass quality. This study is in agreement with the finding of (Mehari and Alemayehu, 2016) on study of *Acacia saligna* seed meal as alternative feed ingredients in poultry rations.

4.5 Results on Economic Benefit

A simple analysis of economic benefits was performed to check the price effectiveness of the diets used in the feed trial. Only the feed price was used in the calculation, assuming all different running fees remained unchanged. Cost of the feed was once calculated with the use of market expenditures of substances in Kenya as per March, 2019. see Table 4.13. Cost of ingredients (kshs) used in formulating diets containing processed *Acacia tortilis* seed meal as a replacement of Soya bean meal.

Table 4.10

Cost of Ingredients (kshs) Used in Formatting Diets Containing Acacia Seed Meal as a Replacement of Soya Bean Meal

Ingredient	**Price (Kshs*) per Kg**
Maize germ	30
Wheat pollard	25
Fish meal	300
Cotton seed cake	60
Acacia seed meal	150
Maize grain	30
Sunflower	50
Soybean meal	100
Stock salt	20
Limestone	10
Bone meal	60
Salinomycin	700
Mycotoxin binder	600
Methionine	1000
Lysine	600
Broiler premix	300

Note. *: 1 US Dollar = 104 Kshs.

4.5.1 Mean Feed Input and Mean Cost of Feed.

The mean feed intake in kg and the mean cost of Cost of the feed consumed in the experiment ware not significant; ANOVA was done on the cost of the feed and there was no significance difference ($p > 0.05$) see Table 4.14: mean Cost of feed ksh ANOVA and Table 4.15*:* mean Feed input in kg ANOVA.

Table 4.11

Cost of Feed Input ksh ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2754.866	5	550.973	3.027	.054
Within Groups	2184.506	12	182.042		
Total	4939.373	17			

Table 4.12

Feed Input kg ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.507	5	.101	2.854	.063
Within Groups	.426	12	.036		
Total	.934	17			

4.5.2 Mean Biomass Harvested

At the end of the experiment, the extracted biomass was determined from the mean weights in Kilograms for each test. ANOVA was performed and substantial difference was noted ($p < 0.05$) see Appendix 8: Biomass harvested in kg ANOVA. Post hoc test was conducted using DMRT to show where the differences were, see Table 4.16. The output indicated the highest biomass was T1 (1.6 Kg) while T5 (0.97 Kg) was the lowest. However were no significant difference between; T1, T2, T0 and between T2, TO, T3 and between T3, T4. Treatment (T5) had the lowest mean biomass harvested which was statistically different from all the other treatments. See Figure 4.5

Table 4.13

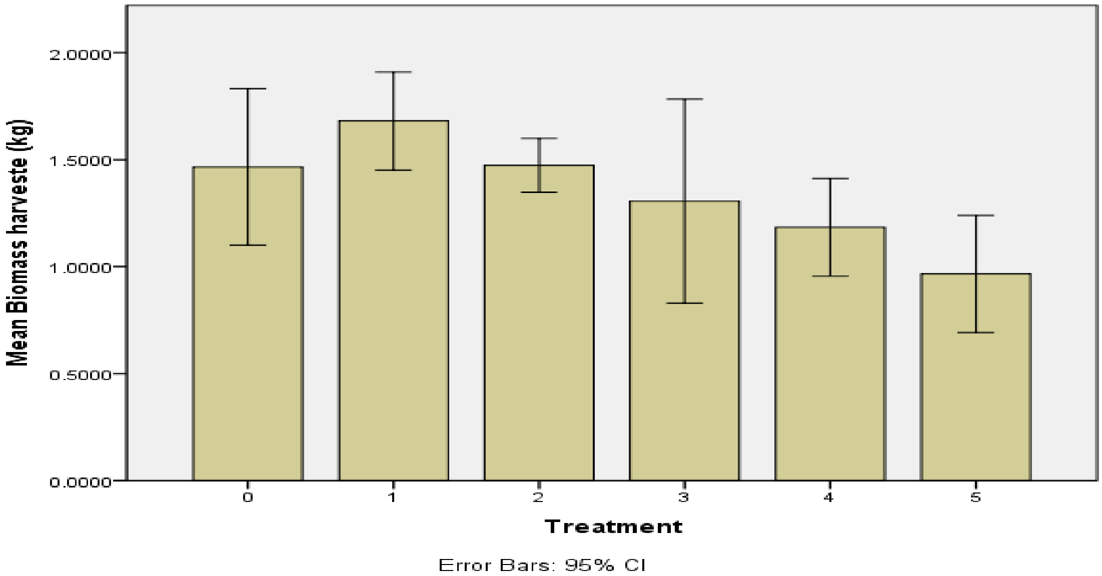
Post Hoc Test for Harvested Biomass (Kg)

Treatments	Means
T1	1.681a
T2	1.473ab
T0	1.466ab
T3	1.306bc
T4	1.183cd
T5	0.966d

Means having the same letters are statistically not significant

Figure 4.5

Mean Biomass Harvested



4.5.3 Mean Incidence Cost

The incidence cost (IC) was the cost of feed used to generate a Kg of broiler (relative cost per unit weight gain), and the lower the value, the more efficient the feed was used (Nwant to, 2003; Abuet al., 2010). IC = The cost of the feed / weight broiler. ANOVA was done for IC and it was significance ($p < 0.05$) see Appendix 6: Incident cost ANOVA. Post hoc test was conducted using DMRT to show where the differences were, see Table 4.17 The output indicated the lowest incidence cost was T0 at 118.5 which was the control followed by T1 (121.7), while T5 was highest at 203.9. However, the following clusters of treatments IC means were not significant; between T0, T1 and T1, T2 and between T2, T3 and between T3, T4. Treatment (T5) which was having 100% ATSM as replacement of SBM had the lowest IC. This shows that this feed was the least desirable. The control T0 and T1 (20% ATSM) were not statistically significance. This shows that ATSM can be used in poultry feed at 20%. See Figure 4.6.

Table 14

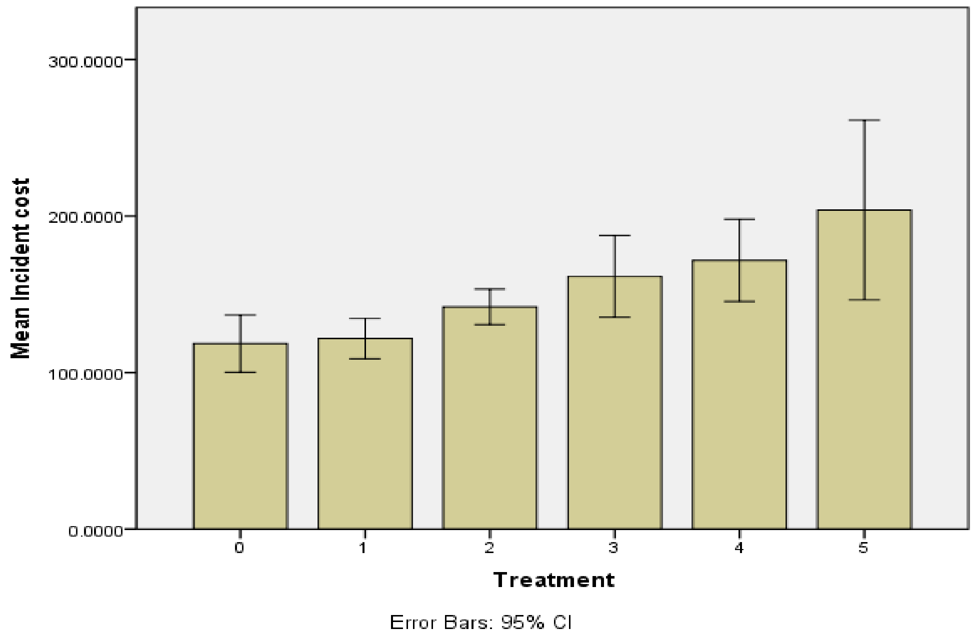
Post Hoc Test for Incident Cost

Treatments	**Mean**
T5	203.922a
T4	171.717b
T3	161.443bc
T2	141.997cd
T1	121.767de
T0	118.543e

Means having the same letters are statistically not significant

Figure 4.6

Mean Incidence Cost



4.5.4 Mean Estimated Value of Harvested Biomass

The calculated biomass value was obtained by multiplying the mean weight of the birds by the current market price (Ksh.300.00) of a broiler kg at the end of the experiment. ANOVA was done for value of biomass and it was significance ($p < 0.05$) see Appendix 7: Estimated value of biomass harvested Ksh ANOVA. Post hoc test was conducted using DMRT to show where the differences were, see Table 4.18. The mean estimated value of biomass was T1 (Ksh.504.34) followed by T2 (Ksh. 442.13) while control T0- control (Ksh.439.94) was the third and the lowest was T5 (Ksh 289.88). However there was no significant difference between the following treatment; T1, T2, T0 andT2, T0, T3 and T3, T4 and T4, T5. The study results on the estimated value of biomass for treatment T0 to treatment T3 are within the current value of the broilers of the same age in the Market. This indicated that the feed ration was within the recommended standard. The growth rate of the broilers was comparable to chicken fed on a standard broiler starter ration. Treatment T1 and T2 performed better than the control, see Figure 4.7.

Table 4.15

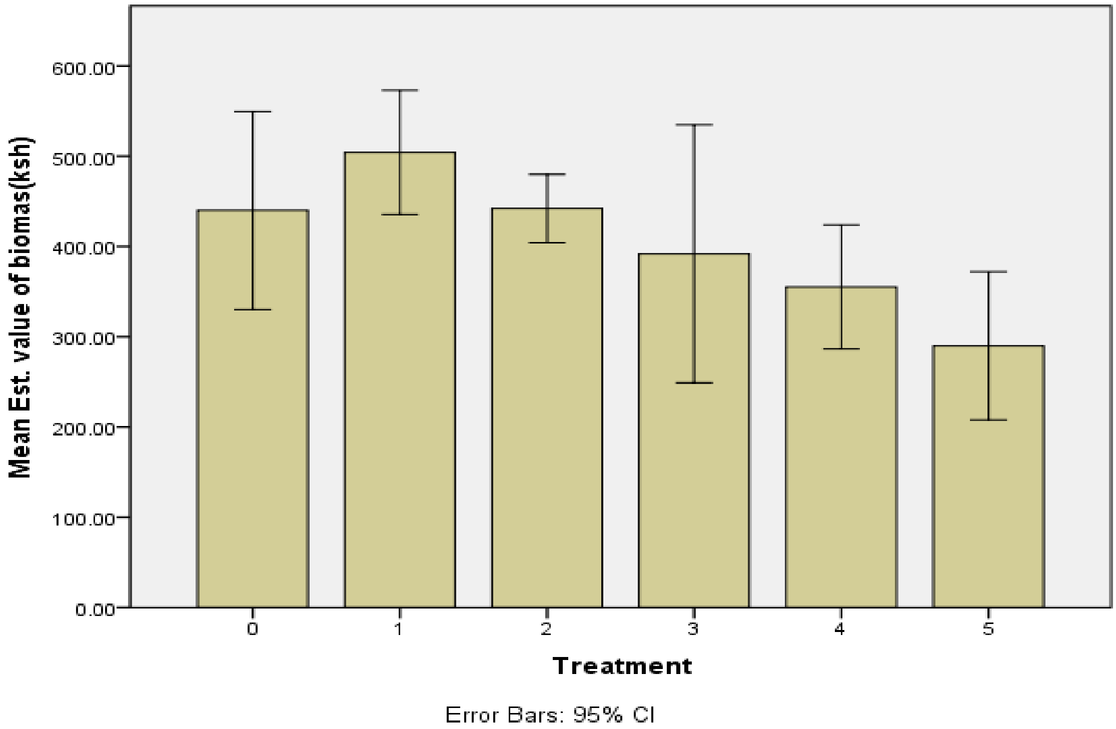
Post Hoc Test for Estimated Value of Harvested Biomass (ksh)

Treatment	Mean
T1	504.34a
T2	442.13ab
T0	439.94ab
T3	391.9bc
T4	355.08cd
T5	289.88d

Means having the same letters are statistically not significant

Figure 4.7

Mean Estimated Value of Biomass



4.5.5 Mean Profit Index

Profit index= Cost of grill / feed made (Abarike, Attipoe & Alhassan, 2012).ANOVA was done for profit index and it was significance ($p < 0.05$) seeAppendix 9: Profit index. Post hoc test was conducted using DMRT to show where the differences were, see Table 4.19 The highest value was T1 with PI (1.5) followed by T0(control)with PI(1.4) and the two were not statistically significant. The higher the PI, the better is the feed. The lowest Profit index was T5 at PI (0.48). The following means for PI was not statistically different; T1 and T0, and T0 and T2, and T3 and T4.see Figure 4.8.

Table 4.16

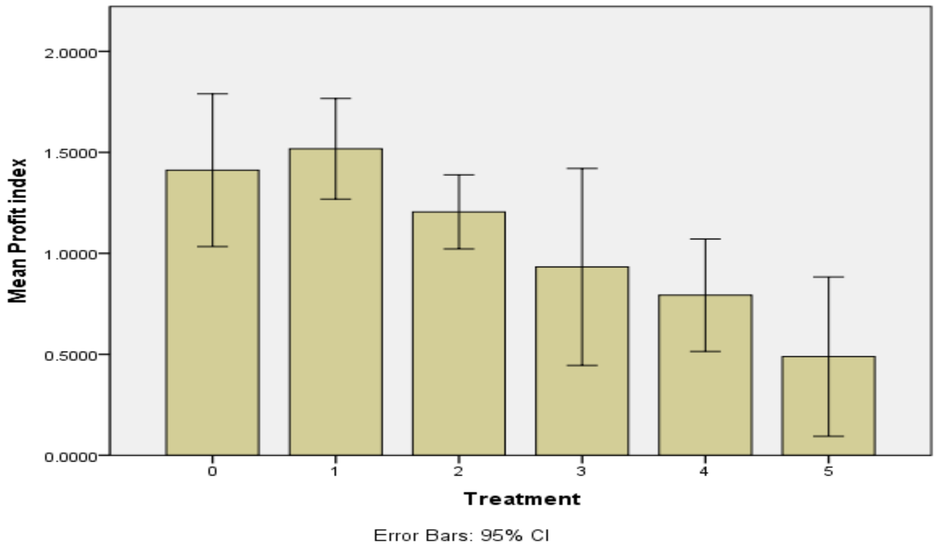
Post Hoc Test for Profit Index

Treatment	**Mean**
T1	1.517a
T0	1.411ab
T2	1.205b
T3	0.932c
T4	0.792c
T5	0.488d

Means having the same letters are statistically not significant

Figure 4.8

Mean Profit Index



4.6 Discussion

Due to the importance of protein as a major constituent of the biologically active compounds in the body, most attention is paid to the protein portion of the fed for poultry feeding. It is used in body tissue synthesis, repair, and development, and reproduction. Broilers have strong demands for dietary protein due to their fast growth rate (Beseki et al., 2015). Additionally; protein is the most expensive ingredient in the poultry fed formulation. To optimize broiler efficiency and benefit, it is important to define the optimum protein concentration in broiler diets. Knowledge is required on protein sources which are locally available that can be used in poultry diet formulations, in substitution to the costly convention feed. The main goal of this research was to establish the value of processed *Acacia tortilis* seeds as an alternative plant-based protein that can be used for feeding poultry. The proximate analysis revealed that processed *Acacaia tortilis* seeds has a crude protein of31.74%, which is higher than *Acacia angustissima* leaf meal which is 23.13% (Ncube et al., 2012).The anti-nutritional factors (ANFs) were minimized by processing through boiling for one hour. The commonly found anti nutrients in plant protein sources include: tannins, phytic acid, gossypol, oxalates, goitrogens, lectins, protease inhibitors, and amylase inhibitors (Akande et al., 2010). *Acacia tortilis* is the most abundant browse in the ASALs of Kenya, and thus forms part of readily available and accessible browse to grazing ruminants .In the study, the research was designed to explore means of incorporating *Acacia tortilis* seeds as alternative feed for poultry. It has been demonstrated that fine grinding/ milling improved the digestibility for whole seeds, from 12.0% to 53.7 % (Aganga et al., 1998). Most of the time, these seeds are consumed entirely by the grazing animals on the range, ensuring the seeds go into the poorly digested food channel and the animal receives little benefit from the seed. This may be because all seeds have a hard outer kernel, and therefore microbial activities in the rumen do not fully exploit the material of the inner seeds as in crushed seed. According to Close (1993) and Akande et al. (2010), processing also facilitates reduction or detoxification of the ant nutritional factors. Each of this was done while the nutritional value of the feed was preserved. Heat treatment includes the drying, roasting, autoclaving, and boiling of sun and oven, usually the nutritional non-labile ant factors (Martens et al., 2012). Grinding / friction of dry Acacia tortilis seeds greatly decreased the volume and were an economical way to minimize the selectivity of broilers. Poultry allows optimal use of nutrients from ground to small particle sized feeds (Jezierny et al., 2011).The results of this study are consistent with findings from Teixeira et al. (1993) which demonstrated that reduction in particle size increased digestibility of dry matter in cotton seeds. In the experiment the feed intake was not statistically significant ($p > 0.05$) and hence all the diets were well accepted by the birds. The feed consumption by animals reflects the palatability and acceptability of the formulated ration. The initial body weight was not statistically significant ($p > 0.05$). The FWG, DWG and WGC were significant ($p < 0.05$). The weight gain was highest in T1 followed by T2 and T0 while T3, T4 and T5 declined serially. The feed conversion efficiency was significant ($p < 0.05$). The FCR reflects the amount of feed consumed to produce a kilo of gain in weight gain. Broilers fed20% ATSM (T1) had the lowest mean FCR while 100% (T5) Acacia had the highest mean FCR. The birds with the lower FCR had the highest weight gain and Daily weight gain. The results obtained for FCR in the control, 20 %, 40 %, 60% 80%and 100% replacement level of SBM with ATMS in diets compares favourably to the results obtained on the research to establish the outcome of Kenbro chicks when soya meal is replaced with different cowpea meal levels (Katumo et al., 2017).On carcass characteristics there was no significant difference (p>0.05). The organs weight as a percentage of the live carcass weight (liver, pancreas, breast fat, intestines and spleen) showed that there was no significance difference (p> 0.05).This suggests that refined ATSM can be used as a replacement for SBM as a broiler feed with no negative impact on the consistency of the carcass (Mehari & Alemayehu, 2016). The study compares with the diet based on Acacia angustissima, which was successfully incorporated into the broiler starter at 10 percent inclusion level, but A.tortilis could be optimally incorporated as a replacement for SBM at 20 percent in this study (Ncube et al., 2012). There was no difference in importance (p > 0.05) with respect to consumed feed expenses. The cost of incidence (IC) is defined as the cost of feed used to generate one kilo of broiler (relative cost per unit weight gain), and the lower the value, the greater the benefit of using a particular ration (Nwaana, 2000).In the experiment IC was significance (P< 0.05). T0 (control) was the lowest at 118.54 followed byT1, at 121.76; however T0 and T1 were statistically not significant. The Profit index (PI) was significant (p<0.05) where the T1 had the highest of value of 1.5while T0 (control) had 1.4. The price of ATSM could have lower if the people were sensitized on the use of the seed and could collect the same in large quantities creating competition which could lower the price based on the law of demand and supply. The *Acacia tortilis* seeds are not used for any economic purpose as of now. The seeds are not digested by livestock due to their hard kernel. Hence the need for grinding them and use in a mash form with other feed ingredients become useful. Animals make greater use of soil nutrients for small particle sized feeds. Mash is a type of a complete feed that is finely ground and mixed so birds can easily distinguish the ingredients from each other. Mendes et al. (1995) found that broilers receiving mash diets had a better conversion ratio than those receiving the pellet or underground food. This study has demonstrated that processed ATSM could be used in feed formulation as new alternative and locally available feed for the poultry. As a result there will be promotion and increased conservation of *Acacia tortilis* trees as source of poultry feed and hence significantly contribute positively to climate change.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter presents conclusions and recommendations from the study aimed at evaluating the growth efficiency of broilers fed on refined *Acacia tortilis* seed meal as a replacement for soybean meal. The general objective was to study the effect of feeding broilers on processed *Acacia tortilis* seed meal as an alternative to soya bean meal on; Growth performance, carcass characteristics and economic benefits.

5.2 Conclusion

The General objective was to study the effects on; growth performance, carcass characteristic and economic benefits of broilers fed on processed Acacia tortilis seed meal as a replacement of soya bean meal. The study employed a completely randomized design (CRD), in a controlled experiment to test the hypothesis.

The following are the conclusions from the experiment:-

I. There was a noteworthy variation in broilers growth efficiency, fed on processed Acacia tortilis seed meal as a substitute of soya bean meal at different levels. Treatment T1 (20% Acacia as replacement of soybean meal) had the highest mean weight gain, mean daily weight gain and mean final weight gain, the difference was significant ($p < 0.05$).The voluntary feed intake was not significance ($p > 0.05$), which shows that the ration was palatable and acceptable by the birds. The conversion ratio for feed was substantial ($p < 0.05$).T1 (1.96) was the lowest which was lower than the control T0 (2.01) while T5 (2.64) was the highest.

II. There was no significant difference in carcass features of broilers, fed on processed Acacia tortilis seed meal as a substitute of soya bean meal, on Analysis of variance the difference was not significance ($p > 0.05$). This means that refined ATSM can be used as a substitute for SBM as broiler feed formulations without any detrimental impact on the consistency of the carcass.

III. There is significant difference ($p < 0.05$) in economic benefit when broilers are fed on diets containing processed Acacia tortilis seed meal as a substitute of soya bean meal. There was no significance difference in feed input and feed cost. There was significant difference in biomass harvested and value of biomass ($p < 0.05$) where T1 was the highest in the two attributes. In the experiment incidence cost was significance ($P < 0.05$). T0 was the lowest at 118.54 followed by T1, at 121.76, but this was statistically not significant. The Profit index was significant ($p < 0.05$) where T1 had the highest a value of 1.52 while the control T0 had a value of 1.42.

The price of ATSM could have been lower if the people were sensitized on the use of the seeds and could collect the same pods in large quantities creating competition which could depress the price based on the law of demand and supply. The Acacia tortilis seeds are not used for any purpose as of now; they are not even digested by livestock due to their hard kernel. The processing and using ATSM in feed formulation will provide a new alternative and locally available feed for the poultry. As a result the *Acacia tortilis* trees will be conserved and this will mitigate against the climate change.

5.3 Recommendations

Processed Acacia tortilis Seed Meal (ATSM) can be included in chicken diet up to 40% as a substitute of Soya bean meal (SBM) but optimally at 20%.There was no substantial difference in the chicken's carcass characteristics suggesting that it can be used as broiler feed without any negative impact on the consistency of the carcass. The study further, recommends that, future research could be carried out to investigate the factors which lead to T5 (100% ATSM as substitute for SBM) to be poor in all the attributes which were evaluated despite the fact that attempt was made to reduce the anti-nutritional factors by processing.

The community and manufacturer of poultry feed should be sensitized on the potential of *Acacia tortilis* seeds as poultry feed and produce it commercially.

Acacia tortilis trees should be promoted for production of animal feeds and environmental conservation.

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APPENDICES

APPENDIX 1 Proximate Analysis ANOVA

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
CP %	Between Groups	6492.464	7	927.495	14730.909	.000
	Within Groups	1.007	16	.063		
	Total	6493.471	23			
DM %	Between Groups	101.910	7	14.559	601.490	.000
	Within Groups	.387	16	.024		
	Total	102.297	23			
Ash %	Between Groups	548.697	7	78.385	3334.953	.000
	Within Groups	.376	16	.024		
	Total	549.073	23			
EE %	Between Groups	702.013	7	100.288	1982.459	.000
	Within Groups	.809	16	.051		
	Total	702.823	23			
Fibre %	Between Groups	2697.085	7	385.298	8388.197	.000
	Within Groups	.735	16	.046		
	Total	2697.820	23			
ME KCAL/Kg	Between Groups	1543985.894	7	220569.413	1150.761	.000
	Within Groups	3066.762	16	191.673		
	Total	1547052.656	23			
NFE	Between Groups	15580.903	7	2225.843	9020.642	.000
	Within Groups	3.948	16	.247		
	Total	15584.851	23			

APPENDIX 2 Weight Gain ANOVA

WT gain

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	959979.964	5	191995.993	14.190	.000
Within Groups	162359.067	12	13529.922		
Total	1122339.031	17			

APPENDIX 3 Feed Conversion Ratio ANOVA

FCR

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.453	5	.691	15.422	.000
Within Groups	.537	12	.045		
Total	3.991	17			

APPENDIX 4 Daily Body Weight Gain ANOVA

DWG

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1233.210	5	246.642	13.511	.000
Within Groups	219.057	12	18.255		
Total	1452.267	17			

APPPENDIX 5 Final Body Weight ANOVA

final weight

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	966008.133	5	193201.627	13.027	.000
Within Groups	177968.907	12	14830.742		
Total	1143977.040	17			

APPENDIX 6 Incident Cost ANOVA

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	15894.438	5	3178.888	22.194	.000
Within Groups	1718.768	12	143.231		
Total	17613.206	17			

APPENDIX 7 Estimated Value of Biomass Harvested Ksh. ANOVA

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	85129.674	5	17025.935	12.580	.000
Within Groups	16240.507	12	1353.376		
Total	101370.181	17			

APPENDIX 8 Biomass harvested (Kg) ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.946	5	.189	12.580	.000
Within Groups	.180	12	.015		
Total	1.126	17			

APPENDIX 9 Profit Index ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.305	5	.461	24.020	.000
Within Groups	.230	12	.019		
Total	2.535	17			

APPENDIX 10 Work Plan

S/NO	ACTIVITY	TIME FRAME	
1	Collection of Acacia tortilis pods	July 2018	October 2018
2	Processing of the seeds	November 2018	December 2018
3	Purchase of other feed ingredients	January 2019	February 2019
4	Sending of feed sample to laboratory for proximate analysis	February 2019	
5	Cleaning the house and making the cubicle (experimental units)	February 2019	
6	Purchase of electric weighing machine and receptacles for storing left over feeds and waterers	February 2019	
7	Purchas of feeder and waterers	February 2019	
8	Machine Mixing of the feed ingredient per treatment (6 NO.)	February 2019	

9	Heating of the house and putting wood shavings on the floor	February 2019	
10	Purchase and transportation of the chicks to the experiment site and placement	February 2019	
11	Purchase of commercial (broiler starter mash) for feeding first 21 days for chicks to acclimatize while they were at the brooder.		
11	Randomly assigning the chicks to the experimental units and feeding the chicks every day at adlibitum.	February 2019	April 2019
12	Collection of data	February 2019	April 2019
13	Slaughtering the birds 3per treatment	April 2019	
14	Analysis of collected data	May 2019	December, 2019
15	Presentation of data to the supervisor	February 2020	

APPENDIX 11 Budget for the Experiment

S/NO	ITEM/ACTIVITY	QUANTITY	UNIT COST	TOTAL COST
1.	*Acacia tortilis* pods	20 bags	500	10,000
2.	Processing of *acacia* seeds	-	0	5,000
3.	Full fat Soya beans	60kg	100	6,000
4.	Whole grain maize	162 kg	25	4050
5.	Cotton seed cake	48kg	45	2160
6.	Sunflower	12kg	40	480
7.	Omena (fish meal)	24kg	300	7,200
8.	Maize germ	26kg	25	650
9.	Wheat pollard	60kg	25	1500
10.	Proximate analysis of feeds	8	2000	16,000
11.	Limestone	1kg	500	500
12.	Bone meal	1kg	400	400
13.	Toxin binder	1kg	500	500
14.	Methionine	500 gms	200	200
15.	Lysine	500gms	300	300
16.	Stock salt	500gms	100	100
17.	Broiler starter premix	200gms	300	300
18.	Feeder	18	500	9,000
19.	Waterers	18	250	4,500
20.	Broiler starter mash	70 kg	1800	1,800
21.	Making the experimental units	18	10,000	10,000
22.	Receptacle for storage of feed left overs	18	50	90
23.	Day old broiler chicks	90	100	9,000
24.	Bulbs	9	100	9,000
25.	Weighing balance	1	3500	3,500

26.	Labour of rearing the chicken(casual)	35 days x1	584	20,440
27.	Transport	-	5000	5,000
28.	Slaughter and analysis of carcass characteristics	-	2000	2,000
29.	Compilation of the data	-	3000	3,000
	Total expenditure			**132,670**

APPENDIX 12 Certificate of Conference Participation and Paper Presentation

KeMU
Kenya Methodist University

Certificate of Participation

This is to certify that

Lawrence Mwongela Ikiamba

Presented a paper on

Growth performance of broilers fed on processed acacia tortilis seed meal as a replacement of soya bean

at the 6th Annual International Scientific Research Conference held on 20th November 2019 at Kenya Methodist University, Main Campus.

Deputy Vice Chancellor (Academic & Students Affairs)

Vice Chancellor

THEME : LEVERAGING ON RESEARCH AND INNOVATION FOR LOCAL SOLUTIONS

APPENDIX 13 Certificate of Attendance

Activity registration No. REG/CPD-A/0279/202

THE KENYA VETERINARY ASSOCIATION

Certificate of Attendance

This certificate is awarded to

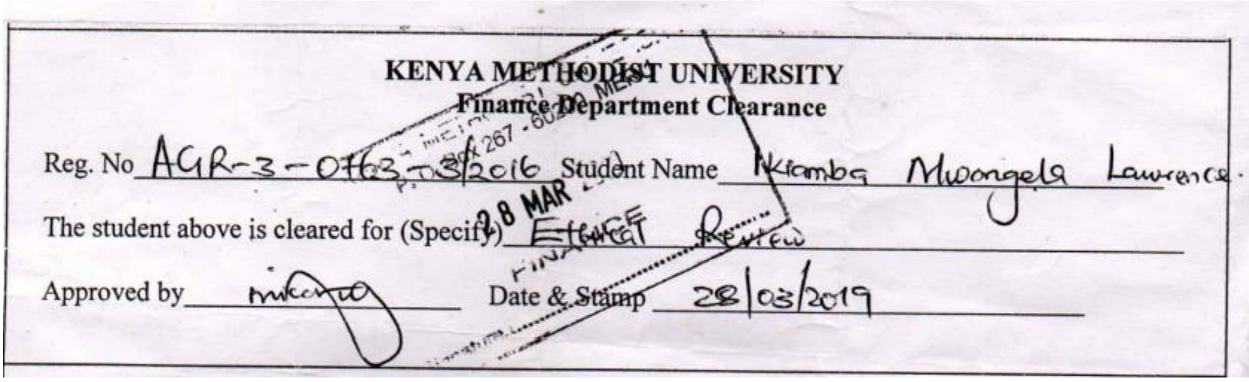
LAWRENCE MWONGELA IKIAMBA

For attending an online veterinary continuous professional development (**CPD)** scientific conference on 29th August 2020, and presented a paper on **Growth performance of broilers fed on processed acacia tortilis seed meal as a replacement of soya bean meal**

Chairman, Kenya Veterinary Association

Hon. Secretary, Kenya Veterinary Association

APPENDIX 14 Ethical review clearance



KENYA METHODIST UNIVERSITY

Finance Department Clearance

Reg. No AGR-3-0763-3/2016 Student Name Nkamba Mwongela Lawrence.

The student above is cleared for (Specify) Ethical Review

Approved by ______ Date & Stamp 28/03/2019