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EFFECTS OF DIETARY REPLACEMENT OF GRADED LEVELS OF PIGEON PEA (*CAJANUS CAJAN)* SEED MEAL FOR SOYBEAN SEED MEAL ON PERFORMANCE OF COBB 500 BROILER CHICKS

MSc Thesis

BY

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EFFECTS OF DIETARY REPLACEMENT OF GRADED LEVELS OF PIGEON PEA (*CAJANUS CAJAN)* SEED MEAL FOR SOYBEAN SEED MEAL ON PERFORMANCE OF COBB 500 BROILER CHICKS

A Thesis Submitted to College of Veterinary Medicine and Agriculture of Addis Ababa University in Partial Fulfillment of the Requirement for Degree of Masters of Science in Animal Production Studies

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DEDICATION

This thesis is dedicated to my beloved father Mr. Mitiku Kassa whom I lost for his continuous love, encouragement, moral and financial support throughout my life. His love stays forever throughout my life. I never forget him until my death.

STATEMENT OF THE AUTHOR

First, I declare that this Thesis is my own work and that all sources of materials used for this Thesis have been properly acknowledged. It has been submitted in partial fulfillment of the requirements for MSc degree at Addis Ababa University and is deposited at the University Library to be made available to borrowers under rules of the Library. I seriously declare that this Thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
ATVET	Agricultural Technical Vocational Education Training
CF	Crude Fiber
CP	Crude Protein
DBWG	Daily Body Weight Gain
DM	Dry Matter
DMRT	Duncan Multiple Range Test
EE	Ether Extract
FAO	Food and Agriculture Organization of the United Nation
FCR	Feed Conversion Ratio
FNRI	Food and Nutrition Research Institute
GLM	General Linear Model
ME	Metabolize Energy
NFE	Nitrogen Free Extract
NVI	National Veterinary Institute
PP	Pigeon pea
PPSM	Pigeon Pea Seed Meal
SAS	Statistical Analysis System
SB	Soya Bean
TA	Total Ash
TEO	Total Edible Offal
TNEO	Total None Edible Offal
UGS	Users Guide Statistics

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ABSTRACT

The study was conducted to evaluate the effects of dietary replacement of graded levels of pigeon pea (cajanus cajan) seed meal for soybean seed meal on performance of Cobb 500 broiler chicks on feed intake, growth performance and carcass traits in Dilla University, southern, Ethiopia. One hundred eighty (180) unsexed Cobb500 broilers day old chicks were randomly assigned to five treatment diets with three replications in a completely randomized design. Experimental diets: were formulated in such a way that [T1, T2, T3, T4 and T5 to replace 0%, 25%, 50% ,75% and 100% of soya bean seed meal by pigeon pea seed meal respectively for both starter and Finisher diets.. Data collection of the feeding trial started after an adaptation period of the chicks to the experimental pens and diets for three days. Final body weight gain, average daily body weight gain were not significantly different (P>0.05) in all treatments. But, carcass characteristics did not vary (P>0.05) across treatments. Mortality was not recorded in all treatments. Cost of feed per body weight gain (gram) declined as the replacement level of pigeon pea seed meal increased in treatment diets but net profit increased with increasing level of pigeon pea seed meal. Thus, it was concluded that replacing soybean seed meal by pigeon pea seed meal as unconventional protein source in starter and finisher broilers diets up to 100% is economically feasible and more profitable and nutritionally adequate without adverse effects on the performance of Cobb500 broiler chicks.

Key words*: Carcass Characteristics, Cobb500 broiler chicks, Feed Intake, Growth Performance, Pigeon Pea Seed Meal, Soya bean seed meal.*

1. INTRODUCTION

Poultry is the largest livestock species accounts for more than 30% of all animal protein consumption in Ethiopia (Getu *et al*., 2014). The importance of poultry production today is primarily due to the short generation interval and relatively quick turn over on investment and high quality protein from their products. Chicken meat is a good source of animal protein but its availability in human diet is very low in tropical countries like Ethiopia (Dessie *et al*., 2017). Thus, production of poultry meat for rapid human population is an important system for supplying high quality protein and it provide an interesting source of finance (Haseik *et al*., 2012).

The poultry industry has suffered more than any other livestock industry as a result of inadequate supply and high cost of feed. Feed cost is expected to continue in the upward change. The major cost of production of egg and meat in commercial poultry production is feed (Gebeyew *et al.*, 2015). The search for alternative unconventional protein sources for livestock feeding in developing countries because of high cost and scarcity of conventional protein sources such as soya bean meal and ground nut cake is needed to reduce the high cost of conventional protein sources. One of alternative or such unconventional feed resources that could be used to reduce the problem of high cost and scarcity of conventional protein sources in livestock diet with particular references to poultry is the pigeon pea.

Pigeon pea (*Cajanus cajan*) is an important grain legume, commonly grown and consumed in both tropical and subtropical regions of the world, and also has the common name 'lobiaadassy' (Arif *et al*., 2017). Pigeon pea is a nitrogen-fixing plant used as a source of animal feed, fire wood, and fodder. The protein content in the seeds, young stems, leaves and shells may be suitable for feeding broilers. Compared with other tropical legumes, pigeon pea is well adapted to poor soils, and tolerates drought conditions (Narina *et al*., 2014; Khoury *et al*., 2015). In the tropics, it is cultivated on a large scale because of its high dry matter content, as a cover crop or as green manure.

The use of pigeon pea (PP) in poultry diets is limited by the presence of the anti-nutritional factors, trypsin inhibitors, haemagglutinin and saponin, which reduce intake, feed efficiency and nutritional value. These detrimental effects can be minimized by processing, such as fermentation, boiling, grinding, soaking and cooking, as they are easily destroyed by heat (Gemede and Ratta, 2014). Swathi *et al*. (2014) reported that the true protein digestibility of PP seeds increased significantly with cooking at 37°C for 12 hours.

Pigeon pea (*Cajanus cajan)* locally called "yergib ater" is an important multi-purpose shrub legume grown throughout the tropics and subtropics for its edible legume grain that is used as a human food. It is the preferred pulse crop in dry land areas where it is intercropped or grown in mixed cropping systems with cereals or other short duration annuals. The main products of pigeon pea are dry grain, green pods and fodder (Mergeai *et al*., 2001). Thus, the crop is used as a cheap source of protein-rich food and fodder for poor smallholder farmers.

The high nutritive value of pigeon pea is perhaps the most to be found among the very poor households in Africa. Pigeon pea is increasingly becoming an important subsistence crop in the whole of Africa with production reported in more than 33 countries. Bulk production is however concentrated in Eastern Africa and some countries have been reported to export significant amounts. The supplementation of cereals with protein rich legumes is considered as one of the best solutions to protein-calorie malnutrition in the developing world (Damaris, 2007).

In Ethiopia, due to climate variability the frequencies of extreme events have increased over recent times. In order to address these problems drought resistant, early maturing and heat tolerant crop species and varieties have been developed by the research systems in Ethiopia. Due to its drought tolerant nature and high nutrient composition pigeon pea is one of the grain legumes that has been chosen by Ethiopian Institute of Agricultural Research for the livelihood improvement to meet the current nutrient needs of human being (FAO, 2010).

In addition to human consumption, pigeon pea is grown for animal feed. It may be fed to all domestic animal species, both ruminant and non-ruminants (Damaris, 2007). Dry land legumes are believed to offer enormous opportunity for reducing food insecurity and poverty in the semi-arid tropics especially due to their adoptability to semi-arid conditions and their high likelihood to be adopted by the poor and vulnerable communities (Simtowe *et al*., 2012).

Broiler farming is increasing rapidly in Ethiopia because it takes a maximum of 6 weeks' time to harvest those results in quick return for the producers. But poultry producers face difficulties with the unavailability and high prices of the conventional feed ingredients particularly those of protein sources. There is much dependence on soybean meal and groundnut cake as the major conventional protein concentrates for feeding livestock in developing tropical countries (Ani and Okeke, 2011). This has led to increase in the prices of these feed ingredients and livestock feeds. Consequently the prices of animal products have increased thereby making them out of reach of the common man. There is a need, therefore, to search for alternative feedstuffs which are cheap and locally available. Animal proteins are also in short supply and expensive as well. Formulation of balanced diet for poultry by using a good number of feed ingredients following the nutrient allowances recommended in different feeding standards is a common practice in developed countries. But in Ethiopia and other developing countries, availability of conventional feed ingredients in the formulation of balanced diet is very much limited. Hunduma *et al*. (2010) stated that in commercial poultry production system feed expense accounts for about 60% of the total cost of production. The study by Fisseha *et al*. (2010) and Shapiro *et al*. (2015) showed that feed shortage is one of the biggest challenges to the development of the poultry sub-sector in Ethiopia. Therefore, unavailability and cost of poultry feed ingredients are the major constraints for the development of poultry production. Incorporation of some unconventional feed ingredients in the formulation of balanced diet may overcome the above-mentioned problems and this may also minimize feed cost.

Due to lack and increasing demand of protein-based feed ingredients, poultry nutritionists have been diverting their attention towards the use of unconventional, cheap and locally available feed ingredients; however, those ingredients might have reasonable level of anti-nutritional factor(s). Pigeon pea (*Cajanus cajan*) seed may be considered as an alternative feed ingredient in this respect. Pigeon pea is an important unconventional legume and an important source of protein up to 30% (Amaefule and Obioha, 2001). Pigeon pea consumption in Ethiopia is quite low possibly due to the availability of other beans and therefore remains underexploited. Thus, attention may be paid to make use of the unconventional feed ingredients for consumption for both human and animals.

Previous published reports suggest that broilers fed boiled pigeon pea seed meal diet showed improved daily weight gain (Amaefule and Onwudike, 2000). Pigeon pea has attracted attention as a crop capable of providing feed for animals because high yields of grains can be obtained under relatively adverse conditions. Amaefule and Onwudike (2000), Amaefule *et al* (2006) reported the nutritional value of pigeon pea seed meal to be adequate for poultry feeding and showed that pigeon pea seed meal possesses required qualities of nutrients to be considered as poultry feed ingredients.

In Ethiopia, practically the supply of feed is scarce and its price is high enough which limits the smallholders as well as commercial poultry farmers to run their business profitably. Recently, poultry nutritionists considered the use of pigeon pea in the poultry ration as a protein source to overcome the problem of high price of protein from other sources. Although pigeon pea seed meal has been used in poultry feeding, the effects of replacing soybean seed meal with pigeon pea seed meal in poultry ration have not been fully investigated. Keeping the above facts in mind, this study was conducted to evaluate the effects of dietary replacement of graded levels of pigeon pea (*cajanus cajan*) seed meal for soybean seed meal on performance of Cobb 500 broiler chicks using pigeon pea (*Cajanus cajan)* seed meal as unconventional protein source with the following specific objectives:

- To determine feed intake of broiler's chicken
- To evaluate growth performance of broiler's chicken
- To evaluate carcass characteristics of broiler's chicken
- To analyze the partial budget replacement of pigeon pea seed meal for soybean seed meal.

2. LITERATURE REVIEW

2.1. Description and Distribution of Pigeon Pea (*Cajanus Cajan*)

Pigeon pea (PP) (*Cajanus cajan*) is one of the most widely grown legume crop in the tropical and subtropical countries (Purdue, 2006; Arif *et al*., 2017) and has very low human food and industrial preference (Amaefule and Obioha, 2001). Compared with other tropical legumes, this plant is well adapted to poor soils, and tolerates drought conditions (Narina *et al*., 2014; Khoury *et al*., 2015). A wide variability exists in the chemical composition of pigeon pea seeds due to geographical location, cultivar, growth conditions and storage conditions (Amaefule and Onwudike, 2000). The crude protein content of the seed ranges from 19 - 29% which is of a good quality except that it is low in methionine (Amaefule and Nwabara, 2004). Its wide range of cultivars and the many ways of their uses in farming system have made pigeon pea popular to small scale farmers. Pigeon pea is grown widely in India and in some parts of Africa and Central America. According to Govind (2016), India is the largest producer of pigeon pea accounting for 66 percent of total production and the other major pigeon pea producing countries are Myanmar (17.09 percent), Malawi (6.15 percent), Kenya (4.36 percent), and United Republic of Tanzania (5.29 percent). Akande *et al*. (2010) also reported that, pigeon pea widely grown in about 14 countries in over 4 million ha. The major pigeon pea producer countries in the world include; India, followed by Uganda, Tanzania, Keneya, Malawi, Ethiopia and Mosambique in Africa.

Pigeon pea is relatively resistant to drought, improves soil fertility and prevents soil erosion on steep land. It is in Eastern Africa countries (Damaris, 2007). Pigeon pea is multipurpose nitrogen fixing crop that provides the seed as human food and poultry feed, the leaves and young stems as animal fodder, fuel wood and shelter material for the subsistence farmers. Introducing and familiarizing this legume crop can be used as alternative feed resources to minimize the livestock feed scarcity (Iorgyer, 2009).

Netsanet and Yonatan (2015) also reported that in Ethiopia, pigeon pea seed have not been widely disseminated in most lowland areas and thus there is limited experience and know how on its utilization. However, this multipurpose crop is becoming an important subsistence crop in the whole of Africa mainly and its' has a crude protein content of 278 g/kg and cow pea seed of 241 g/kg (Balogun, 2013). Pigeon pea seed has anti-nutritional compositions like phytate 1.81 mg/100 g, cyanide 0.65 mg/100 g), tannin (1.05 mg/1000 g, saponins 1.19 mg/100 g and oxalate 0.14 mg/100 g and it can improve nutrition and food security in Nigeria though it has low human food preference (Balogun, 2013).

2.2. Nutritive Value of Pigeon Pea Seed

Pigeon pea seeds and its by-products such as divided and dried-up seeds are used as livestock feed. Pigeon pea seed can successfully replace cow pea in the diet of man. Pigeon pea is typically used as a protein source, due to its high concentration of protein in seeds (23.0 percent, DM basis). The pigeon pea protein is highly comparable with soybean protein in its content of essential amino acids other than methionine (Onwukal, 2006).

The common pigeon pea cultivars contain between 17.9% and 24.3% protein in whole grain samples, and between 21.1% and 28.1% for split seeds (Emefiene *et al*., 2014; Bamidele and Akanbi, 2015;). Solomon *et al* (2017) reported 20–22% protein, 1.2% fat, 65% carbohydrate and 3.8% ash in pigeon pea seed. It also contains different minerals, vitamins and is a good source of amino acids. On a dry matter basis, pigeon pea seed has a CP level of 22-27%, crude fiber (CF) 7.3-10%, nitrogen free extract (NFE) 61.2%, ether extract (EE) 1.7-2.1%, ash 3.1-4.2%, and lysine of about 7.59% (9–11). It is also a good source of soluble vitamins, especially thiamin,riboflavin, niacin, and choline (Akande *et al*., 2010; Arif *et al*., 2017). Amaefule *et al.* (2003) reported that the chemical composition of pigeon pea depends on cultivar, geographical location, and growth conditions. According to Deosthale and Rao (1981) pigeon pea has protein content which ranged from 19.8 to 23.6%, methionine from 1.2 % to 1.9% and trytophan from 0.43 to 0.62%. In addition, pigeon pea contained a higher amount of nitrogen free extract (60.85%) which can be used as a source of energy (FNRI, 1980), thus reducing the cost of feeds. According to the finding of Babiker *et al*. (2006) socked pigeon pea seed has 00.08% tannin content. According to the report of Akande *et al.* (2010), roasted pigeon pea seed has DM=96.34, CP=21.07, EE= 5.96, CF=7.52, Ash=4.02 and NFE = 57.77.

Table 1: Chemical composition of pigeon pea seed studied by different authors

Item	Amount	Authors
Dry matter (%)	91.3-93.0	Arif *et al*. (2017)
Crude protein (%)	22-27	Akande *et al.* (2010); Arif *et al.* (2017)
	17.9-24.3	Emefiene *et a*l. (2014)
	19.3-26.3	Elsayed *et a*l. (2014
	21-22.5	Gemede and Ratta (2014)
	20.6-27	Santhanam and Egigu (2014); Aja *et al*. (2015)
	21.1-28.1	Bamidele and Akanbi (2015)
Nitrogen free extract (%)	61.2	Akande *et al.* (2010)
	55.8-58.7	Arif *et al*. (2017)
Crude fiber (%)	7.3-10	Akande *et al*. (2010)
	6.4-8.2	Elsayed *et al*. (2014)
	11.8-14.46	Arif *et al*. (2017)
Fat as ether extract (%)	1.7-2.1	Akande *et al*. (2010)
	0.71	Odeku (2013)
	1.3-2.0	Elsayed *et al*. (2014)
	0.6-3.2	Bamidele and Akanbi (2015)
	1.58-2.18	Arif *et a*l. (2017)
Ash (%)	3.1-4.2	Akande *et al*. (2010)
	4.56-5.0	Arif *et al*. (2017)
Lysine (%)	7.59	Akande *et al*. (2010); Arif *et al*. (2017)
Moisture (%)	8.71	Odeku (2013)
	6.1-6.2	Elsayed *et al*. (2014)
Calcium	0.38	Feed ipedia, 2016
	310-280 ppm	Arif *et al*. (2017)
Phosphorus	0.32	Feed ipedia, 2016
	32-29 ppm	Arif *et a*l. (2017)
Tannin (%)	0.32 - 0.02 , 0.08	Arif *et al.* (2017), Babiker *et al*. (2006)

Table 2: Amino acid profile of raw and roasted pigeon pea (PP) seeds (g /16g N)

Pigeon pea (PP)	**Amino acids (g /16g N)**						
	Lysine	Methionine	Histidine	Arginine	Leucine	Isoleucine	Tyrosine
Raw PP	7.79	1.19	3.66	5.86	6.78	2.43	2.63
Roasted PP	7.55	0.89	2.88	6.18	7.23	2.73	2.86

Source: Akande *et al.* (2010)

Table 3: Vitamin profile in pigeon pea seed

Vitamin	**Value (per 100 g)**
Sun-dried Seeds	
Carotene as Vitamin A	220 IU
B1	150 IU
β-Carotene	0.72 mg
Thiamine	0.14 mg
Riboflavin	2.9 mg
Immature Seeds	
B-Carotene	145 IU
Thiamine	0.40 mg
Riboflavin	0.25 mg
Niacin	2.4 mg
Ascorbic Acid	26 mg

Source: Aja *et al*. (2015

2.3. Effect of Pigeon Pea on Broiler Performance

Hassan *et al*. (2013) observed that broilers can perform well up to a 12 percent incorporation rate of pigeon pea seeds as a substitute for sesame cake. However, incorporation rates above 20 percent decreased performance (Amaefule, 2011; Ani and Okeke, 2011). In some cases, feed intake, and weight gain decreased at low incorporation rates of from 5 to 10 percent (Oso *et al*., 2012).

The effect seems to be higher in starters than in finisher broilers (Igene *et al*., 2012). In some cases, growth performances were maintained with 10 to 20 percent raw pigeon pea (Iorgyer *et al*., 2009).

Many groups tried to improve performance with technical treatments such as thermal treatments (roasting or cooking), soaking, fermentation or dehulling (Abdelati *et al*., 2009). In most cases the growth performance of broilers is improved, with no clear advantage to one particular processing except that fermented pigeon pea did not produce good animal performance (Oso *et al*., 2012). Optimization of thermal treatments showed that over-processing (autoclaving at 120 °C for 30 min.) led to decreased performance. Toasted pigeon pea could support growth up to 27 percent in finisher diets, while performance was reduced (although non-significantly) in younger birds (Ani and Okeke, 2011).

In general, the general recommendation in broilers would be to limit incorporation to 10 percent raw pigeon pea in young animals. With processed (toasted) pigeon pea and in older animals, higher incorporation rates, up to 20 percent, could be used. According to Ani and Okeke (2011), roasted pigeon pea seed meal at inclusion rate of 26% in starter feed and at 27% in the finisher diets may have beneficial effects on the productive performance of the birds.

2.4. Use of Pigeon Pea in Broiler Nutrition

Many studies have been performed to examine the effects of PP as an alternative protein source in broiler nutrition. Castillo *et al*. (2016) evaluated the effect of substitution of PP (cooked) seed meal for corn and soybean meal in the starter diet for broilers, at rates of 0%, 20%, 30%, 40%, and 50%. After cooking the seed meal, the protein content decreased very little. Crude protein in the seed meal resulted in a significant linear decrease in weight gain with increasing dietary level of PP seed meal. The experimental groups had lower feed consumption than the control diet (0% PP seed meal). Nevertheless, the poorest feed conversion ratio (FCR) was observed for the control group.

Amaefule *et al*. (2006) used 150 black Bovan Nera pullets to evaluate growth performance with diets of raw or processed PP seeds. The treatments consisted of feeding 10% PP seed meal for eight weeks. For the first treatment, the seeds were toasted for 30 minutes, for the second, boiled for 30 minutes, and for the third, soaked in water for 24 hours. They observed that there was no significant difference in the parameters analyzed between treatments with processed or raw diets of PP seeds. They concluded that the inclusion of up to 10% of PP seed meal in poultry diets could be a good source of protein. The results of this trial showed that live weight, daily weight gain, FCR, and average mortality did not statistically differ within groups fed a diet of raw or processed PP seed meal. However, feed and protein consumption decreased for chickens fed with a raw PP seed meal diet, although using this diet significantly reduced the daily feed cost.

Ahmed *et al*. (2006) studied a total of 200 day-old broiler chicks in four treatments for six weeks, to evaluate the effect of soaked PP at various levels. Treatments consisted of four levels of supplementation in the diet (0, 50, 100, 150 g/kg). Feed intake, energy intake, live weight dressing percentage, pancreas and spleen weight, serum cholesterol, and protein efficiency ratio were not different between treatments. However, the addition of 100 g/kg of pigeon pea seed to broiler diet improved FCR, feed intake, total serum lipids, cholesterol, protein, methionine, and lysine in the birds (Tusar *et al*., 2015).

Different research projects have been developed with the objective of reducing feed cost and improving performance in poultry (Castillo *et al*., 2016). Using 30% inclusion levels in the diet of broiler chicks, Castillo *et al*. (2016) found that body weight decreased and FCR increased, likely due to high concentrations of anti-nutritional factors (Santhanam and Egigu, 2014; Aja *et al*., 2015). Other authors indicated that removal of the outer layer (decortication) may reduce anti-nutritional factor levels (Arif *et al*., 2017), for example, Arif *et al*. (2017) reported beneficial effect by feeding diets containing 7.5% of decorticated pigeon pea seeds on Lohman broiler chicks, by improving body weight and FCR.

Amaefule and Nwagehara (2004) showed that the digestion of crude protein and dry matter improved following processing of PP seeds. Research on a 10% dietary addition of PP seeds, which had either been soaked, decorticated (remove outer layer) with added enzymes, or decorticated toast, had no effect on the performance of broiler chickens (Arif *et al*., 2017). However, CP, ash, and CF from cooked and roasted PP seed meal were lower, and EE and NFE were higher, compared to crude PP seed meal, according to Ogbu *et al* (2015). Others have reported that 40% inclusion of PP meal in the starter broiler diet increased productive performance when compared to a 30% inclusion; however, this level increased the cost of the diet (Amaefule *et al*., 2011).

Optimizing inclusion is important for any ingredient in poultry diets. Inclusion levels of pigeon pea seed meal from 0% to 32.5% in the starter phase, and from 0% to 27% in the finisher diet positively affected daily feed intake, FCR, and weight gain during the starter period; however, in the finisher phase, there were no significant differences (Ani and Okeke, 2011). The authors concluded that inclusion of 26% of PP seed meal in starter feed phase may have beneficial effects on the productive performance of the birds. Muhammad *et al.* (2017) reported that raw pigeon pea at up to 15% –30% inclusion significantly increased feed conversion ratio and decreased body weight in broiler chicks.

Igene *et al*. (2012) determined the effect of boiled PP on performance, carcass characteristics, and hematological parameters in broilers. At the finishing stage, a substitution of 50% PP for soybean meal increased growth and final weight, without affecting other parameters, however, when using higher levels of inclusion, body weight declined significantly (Igene *et al*., 2012). In the starter phase, up to 80% PP was included in replacement for soybean meal, and at the finishing stage, up to 100% was replaced (Ahmed *et al.*, 2006). Likewise, in line with the increased level of PP replacing soybean meal, the weight of edible organs (liver, gizzard and heart) decreased linearly. These authors reported that, in the control diet, hemoglobin, white blood cells, packed cell volume, neutrophils, and white blood cell differential counts were greater than at increasing levels of pigeon pea seed inclusion.

2.5. Anti- Nutritive Factors in Pigeon Pea

Legumes are important sources of protein, carbohydrates, dietary fiber and minerals. Only a few of the known legume species are extensively promoted and used. Pigeon pea is a marginally known legume, having the potential of reducing protein deficiency in developing poorer nations. The young pods and unripe seeds of this plant are used as vegetables and the ripe seeds are used as pulse. It is a good source of protein, carbohydrate, dietary fiber and energy (Pele *et al*, 2016). The young pods and dried seeds of the legumes contain 4.5% protein. In spite of its good nutritional qualities, legume consumption is declining worldwide. According Pele *et al.*, (2016), the necessity of extensive preparation and cooking time, and the occurrence of gastrointestinal distress after ingestion are contributing to the nonparticipation of the use of legumes. In addition, anti-nutritional factors interfere with protein and carbohydrate digestibility by forming complexes with proteins and minerals. Untreated pigeon pea has been reported to possess high level of anti-nutritional factors such as trypsin inhibitor, tannins and phytic acid. High trypsin inhibitor activity in legumes prevent protein metabolism while phytate phosphorus compromises mineral absorption.

Using legumes as the only protein source for growing animals can lead to growth retardation and other undesirable physiological and biochemical alterations (Lüscher *et al*., 2014). Al-Saeedi and Hossain (2015) stated that plant proteins are more resistant to breakdown in the gastrointestinal tract than animal sources, due to the existence of ant nutritional factors. They claimed that there are two main classes of protein anti-nutritional factors, lectins and proteolytic enzyme inhibitors such as trypsin inhibitors. Trypsin and chymotrypsin inhibitors are considered to be the main anti-nutritional factors present in legumes (Ganzon-Naret, 2014). Wisaniyasa *et al*. (2015) reported that PP has lower levels of trypsin and chymotrypsin inhibitor activities compared with soybean.

The trypsin inhibitors, tannins, phytate, phytic acid and phosphorous in pigeon pea seed were studied by Gemede and Ratta (2014). They found a protein content of 21-22.5%, trypsin inhibitors were present at levels of 7.5-14.4 mg/g and phytate content of 8.13- 11.13 mg/g, whereas phytic acid contributed 66.75% to the phosphorous in pigeon pea seed. They reported an *in vitro* protein digestibility coefficient of 77.8%.

The growth-depressing and toxicity effect of tannin, which is present in PP, in chicks, has been studied by Uwangbaoje (2012) and Emefiene *et al*. (2014). They illustrated that growth was reduced when they were fed a ration containing as little as 0.5% tannic acid and PP has a reported level of 0.32%. Moreover, a level of 5% caused chick mortality of about 70% at 7-14 days old, and tannic acid reduced the metabolize energy (ME) and nitrogen retention in chicks.

2.6. Methods to Reduce Anti - Nutritional Factor of Pigeon Pea

Anti-nutritional factors (ANFs) are chemical compounds synthesized in natural food and/or feedstuffs by the normal metabolism of species and by different mechanisms (for example inactivation of some nutrients, diminution of the digestive process or metabolic utilization of food/feed) which exert effect contrary to optimum nutrition. These compounds are can reduce the nutrient utilization and/or food intake of plants or plant products used as human foods and play a vital role in determining the use of plants for humans. These are the substances found in most food substances which are deleterious to humans or in some ways limit the nutrient availability to the body (Hamid *et al*, 2017). According to Millamena *et al* (2002) treatment of leguminous seeds used to inactivate some of the anti-nutritional factors and increase the nutrient utilization of the seeds.

According to Nwanekezi *et al* (2017), anti-nutritional factors in food legumes are chemical substances present in products, although nontoxic but generate adverse physiological responses in animals or humans that consume them. Those factors such as proteases (trypsin and chymotrypsin) inhibitors, amylase inhibitors and polyphenols which are a known problem in most legumes are less difficult in pigeon pea than soybean, peas and field beans.

The anti-nutritional factors found in pigeon pea include trypsin inhibitors, chymotrypsin inhibitors, amylase inhibitors, hemagglutinins (lectins), (polyphenols), saponins, cyanide, phytic acid, oxalate (Nwosu, 2013). According to Arif *et al* (2017) pigeon pea seed has 0.32-0.02 % of tannins. These anti-nutritional factors can be removed by different processing methods like cooking, soaking, germination, fermentation (Adeparasi, 1994).

Gemede and Ratta (2014) stated that soaking of PP for 24 hours followed by cooking for 20 minutes was more effective in destroying the trypsin and chymotrypsin inhibitors. Tekale *et al*. (2016) monitored the effect of processing and autoclaving on total phenols and chemical composition of PP. Cooking soaked and dehulled seeds lowered total phenols by 49%; whereas sprouting legume PP seeds increased protein and reduced carbohydrate content.

Wisaniyasa *et al*. (2015) studied the effect of various types of processing on PP. They found that germination decreased phytic acid content by 50%, whereas autoclaving and roasting were more effective in reducing phytic acid. Fermentation was found to cause a major increase in protein digestibility in vitro. Arif *et al*. (2017) reported that decortication(removing of coat) of legume seeds increased the nitrogen-free extract (NFE), sulphur and dry matter (DM) levels; however, seed CP, crude fiber (CF) and fat as ether extract (EE) decreased. Tannin content also decreased to 0.02%, compared to 0.32% in corticated seeds. Wisaniyasa *et al*. (2015) noted that heat treatment reduced trypsin inhibitor, lectin, HCN, and tannin content of guar seeds. Swathi *et al*. (2014) observed that trypsin and chemotrypsin inhibitor activities were reduced by soaking in salt solution, compared to soaking in distilled water. Both these processing methods altered the composition of legumes without causing any change to the carbohydrate fraction. In comparison to other work on legumes, Abdulla *et al*. (2017) reported that digestibility of starch, lipids, and amino acids for broilers fed on a diet containing tannin- free faba bean were lower than for those fed on a control diet, and that de hull did not reduce all anti-nutritional factors, because lectin and trypsin inhibitors are concentrated in the cotyledons. According to Trugo *et al.* (1990) cooking the legume seeds (*Phaseolus vulgaris*) for 60 minutes at 100^{o}C was very efficient in inactivating over 90% of the trypsin inhibitors.

Anti-nutritional factors associated with soybean meal are due to the presence of trypsin inhibitors which decrease protein digestibility (Hertrampf and Piedad-Pascual, 2000). Thus, in order to improve the nutritional quality and effective utilization of legume grains, application of heat treatment must be employed such as cooking (boiling) and toasting to remove the anti-nutritional factors (Farran *et al.*, 2001; Ghadge *et al.*, 2008; Akande and Fabiyi , 2010).

Previous studies (Adeparasi 1994; Akubor *et al*. 2000) suggested that toasting between 80 and 120$^{0}_{C}$ could adequately reduce ant nutritional factors to tolerable limits. According to Onimawo1 and Akpojovwo (2006), toasting up to 100^{o}c has no adverse effect on the total protein and other nutrient content of pigeon pea flour. Other nutrients such as ash (minerals), fat, crude protein, fiber and carbohydrate were not significantly ($P > 0.05$) affected by the toasting temperature. It also revealed that toasting up to 100^{o}c for 1 h had positive effects on some functional properties and greatly reduced the ant nutritional factors, reducing cyanide by 66%.Toasting significantly reduced the values of five ANFs (tannin, phytate, trypsin, hemagglutinin and alkaloids) in processed *C. cajan* seed (Solomon *et al*.., 2017). The roasted seeds of *C. cajan* can adequately reduce ant nutritional factors (Aslam *et al.*, 2016).

3. MATERIALS AND METHODS

3.1. Description of the Study Area

The experiment was conducted at Dilla University poultry farm, placed in Dilla town 365 km South of the capital city Addis Ababa and 85 km South of the regional city Hawassa. The area located between 6°24′30″ to 6°24′30″N and 38°18′30″E to 38°18′30″E with an average altitude of 1625m above sea level. Rainfall is bi-modal (occurring from September to October and March to May) and ranges between 1200 and 1800 mm. The minimum and maximum temperature ranges between 18 ^{0}C and 25 ^{0}C (NMA, 2016).

3.2. Experimental Animals and Their Management

The experimental house was prepared and partitioned into 15 pens with enough working space allowances and the house wall, floor, door, windows and brooder were cleaned, washed and disinfected with savlon and dried before the introduction of experimental birds in the house. The floor was covered with dry *teff* straw properly. Before the arrival of the birds, the experimental house was ready with electric light, heater (cone shaped metal sheet as brooder with 250-watt lamp). The heater in the brooder was let switched- on for 24 hours before the arrival of the chicks, to warm the rooms.

A total of 180 day old Cobb 500 chicks were purchased from Alema farm plc, Bishofitu, Ethiopia and the chicks were transported with proper care and arrived at the study area. Chicks were adapted in brooding room for three days by providing prepared starter diets. Then, the chicks were equally distributed with initial BW (mean ± SD) of 85.77±1.43 g to respective experimental pen and diets. Chicks were maintained under a wire mesh partitioned deep litter housing system. Chicks were vaccinated with marex+NCD combined vaccine for Newcastle disease on the 1st day, thermostable /NCD/lasota on 7th day, gumboro on 14th day for infectious bursal disease, thermostable/NCD/lasota on 21st day and again Gumboro on 28th day. They were administered with anti-stress (sugar in first time), vitamins and antibiotics in a solution form during the first trial period. The temperature of the brooding room was controlled with thermometers. Brooding temperature was kept at 32°C at the beginning of the first week and decreased gradually in subsequent weeks until it was adjust to ambient temperature at 28°C. Fifteen 250 watt bulbs were used. The bulbs were hanged just above the bird's level at the center of each pen. Artificial light was provided in the evening. Adjustments were done by switching off or raising the bulbs according to the temperature of the house and also by observing the bird's behavior. Adequate ventilation and space was provided to make the chicks comfortable. There were continuous supplies of drinking water. The feeding and water troughs were cleaned daily.

The chicks per replicate were fed in group and were offered the pre-prepared experimental starter diet that was formulated for the experiment. After three days of the brooding period, body weight was taken by using a digital balance. Fresh clean water was *ad–libitum* available at all times. The same procedures of cleaning and disinfection in the brooder house were employed in the experimental house.

Biosecurity measures and sanitization: To prevent any outbreak of diseases, strict biosecurity was maintained during the experimental periods. Proper hygiene and sanitation programs were also followed.

3.3. Experimental Feed Ingredients and Their Proportion

Pigeon pea seed was bought from Konso Zone (Southern Ethiopia) and soya bean seed from Bishoftu town (Oromiya region) and Addis Ababa, Ethiopia. The required amount of raw pigeon pea and soya bean seed was transported and stored in the study area for further processing and preparation.

To eliminate the anti- nutritional factors, both soybean seed and pigeon pea seeds were roasted prior to inclusion in the diets as described by Jambunathan and Singh (1980); Matanmi (1980); Onimawol and Akpojovwo (2006), and as used by Ani and Okeke (2011). Roasting was employed on flat pot and set over on burning firewood at 100°C for 30 min with continuous stirring until about 75% of them were cracked to tell a slight change in colour (from brown to darker brown) and a "roasted" aroma was achieved (Solomon, 2007). This method is more effective in preventing burning and nutrient denaturing of the seeds. The temperature was measured by placing thermometer on the flat clay plate. The seeds were then spread out in the air to cool and then crushed and included in the diet. Finally feed ingredients were crushed using a hammer mill and used to formulate the experimental diets.

The trial period (49 days) was classified in to starter and finisher phases; the first 21 days as the starter and the last 28 days as finisher phases. The proportion of soybean and pigeon pea in the starter diets and maize in the finisher diets was higher to fulfill the protein and energy requirement of the birds, respectively (Table 4). Replacement levels of PPSM were uniform for both phases. The feed ingredients to be used in the formulation of the experimental rations for the study were maize, wheat meddling, soya bean, pigeon pea, nuge (*Guizoita abyssinica*) cake, wheat bran, meat and bone meal, vitamin mineral premix, salt, limestone, lysine and methionine. The broiler diet was formulated for two phases (starter and finisher) with the feed ingredients that were available in local markets. Feed ingredients used in the experiments were confirmed as fresh and of good quality. The first 21 days (1-21) were considered as the first phase and the birds were supplied starter diet. In the remaining 28 days (22-49 days), the experimental birds were supplied finisher diet. In all cases, water was offered to the chickens *ad libitum.* The nutrient requirements (ME, CP, Ca, P, Lysine and Methionine were satisfied as recommended for Cobb 500 broiler diets.

The composition of the treatment rations used in the current study was formulated as described in table 4. Accordingly, the formulated feed included protein (21.7- 22.3 % CP for starter, 19.21-19.52 % CP for finisher) and energy levels (ME 2806 -2891 kcal/kg for starter, ME 3016-3068 kcal/kg for finisher) of the five diets were found within the recommended levels for broiler chicks. The formulation was employed according to the report of Olomu and Offiong (1978) 2800-3000 kcal/kg for optimal performance of broilers; Oluyemi and Robert (1988) recommended protein requirement for broilers raised in the tropics as 23-24% for starter and 19-20% for finisher broiler chickens.; NRC (1994) 23% CP, 3000 kcal ME/kg for a 1- 21 day old chick and 20%CP, 3,200 kcal ME/kg for 22- 42 days. Pfizer (1996) also formulated the protein requirement of the starter broiler as 23% for starter and that of finisher as 21% in the tropics. However, ME level of 2900 kcal/kg for both starter and finisher rations under local conditions was also recommended (Pfizer, 1996).

Table 4: Proportion of the ingredients and replacement levels of pigeon pea for starter and finisher diets

Ingredients (%)	Starter diets					Finisher diets				
	Treatments					Treatments				
	T_1	T_2	T_3	T_4	T5	T_1	T_2	T_3	T_4	T5
Maize	32.77	30.77	31.77	31	29.77	53	53	53	52.5	52.7
Wheat Bran	10	10	9.5	10	10	4	4	3	3	2
Roasted SBSM	30.00	22.5	15.00	7.50	0.00	24.0	18.0	12.00	6.00	0.00
Roasted PPSM	0.00	7.50	15.00	22.5	30.00	0.00	6.00	12.00	18.00	24.0
Meat and Bone meal	5	7	6.5	7	7	3.77	3.77	6	7	7.5
Nuge seed cake	10	10	10	10	10	4	9	9	9.5	9
Wheat Middling	10	10	10	9.77	11	9	4	2.77	1.77	2.57
Salt	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Limestone	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09
vitamin mineral premix	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
DL-lysine	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
DL-Methionine	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

PPSM: pigeon pea seed meal, SBSM: soya bean seed meal; T1: PPSM 0%; T2: PPSM 25%; T3: PPSM 50%; T4: PPSM 75%; T5: PPSM 100%.

According to the proximate analysis result (table 6), %CP value of roasted SBSM was higher than PPSM. Due to this variation; feed formulation was considered the %CP difference and has taken other measurement and used the protein rich ingredient to balance the %CP content of SBSM and PPSM in the formulation.

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3.4. Experimental Design and Treatments

For this study, completely randomized design (CRD) was used and the study was involved with five different treatment rations with three replications. Twelve chicks were randomly assigned to each of the three replicates of the five treatment diets (T1, T2, T3, T4 and T5) as describe below. The rations contained pigeon pea seed meal at replacement rate of 0, 25%, 50%, 75%and 100% for soya bean seed meal and was represented as T1, T2, T3, T4 and T5, respectively. The layout of the experiment was shown in Table 5.

Table 5: Layout of the Experiment

Dietary treatment	**Replacement level of PPSM for SBM**	**No. of bird/ Replication**			**Total number of chicks in each treatment**
		R1	R2	R3	
T1	0% PPSM	12	12	12	36
T2	25% PPSM	12	12	12	36
T3	50% PPSM	12	12	12	36
T4	75% PPSM	12	12	12	36
T5	100% PPSM	12	12	12	36
Total		60	60	60	**180**

3.5. Chemical Analysis

Representative samples of the feed ingredients (maize, soya bean (roasted), pigeon pea (roasted) and Noug (*Guizoita abyssinica*) cake) and samples of treatment diets were taken and subjected to proximate method of AOAC (1990) to determine dry matter (DM), crude protein (CP), crude fiber (CF), and Ether extract (EE) and total ash content before the beginning of the experiment at laboratory of National Veterinary Institute (NVI) and Horticoop Ethiopia Plc., at Bishoftu town. The nitrogen was determined by using the Kjeldhal procedure and CP was computed by multiplying the nitrogen (N) content by 6.25. The metabolize energy (ME) value was determined indirectly following the method given by Wiseman (1987) as follows: ME (Kcal/kg DM) = 3951 + 54.4 EE – 88.7 CF – 40.8 Ash. The calcium and phosphorus content were determined by atomic absorption spectrophotometer. Chemical analyses were carried out in duplicate.

3.6. Data Collection

The following parameters were recorded for the experiment:

3.6.1. Feed intake

The measured amount of feed was offered twice a day at 08:00 AM and 05:00 PM hours with ad *libitum* water access throughout the experimental period. The feed offered and refused was recorded for each pen. Total daily feed intake was calculated by subtracting amount of daily feed refused from amount of daily feed offered. The average daily feed intake was calculated by dividing total daily intake by the number of chicks on that day. Daily feed refusals in each replicates was collected, weighed and recorded at 8:00 AM morning before the daily feed was offered.

$$\text{Average daily feed intake (g)} = \frac{\text{Daily feed offered (g)} - \text{Daily feed refused(g)}}{\text{Number of birds present} \times \text{Experimental days}}$$

3.6.2. Body weight gain

The body weights of chicks were recorded initially, on the first day after being randomly assigned to respective pens, and then finally for each replication. The average body weight gain of birds in each replication was calculated by subtracting the initial body weight from the final body weight. Body weight was recorded at the beginning of the experiment and subsequently on a weekly basis. Weighing of the chicks was carried out in the morning between 7:30 and 8:00 AM before the daily feed was offered.

$$\text{Average daily body weight gain (g)} = \frac{\text{Total body weight gain per pen (g)}}{\text{No of experimental days (49 days)}}$$

3.6.3. Feed conversion ratio (FCR)

Feed conversion expresses the individual's efficiency of feed utilization and is presented as the ratio of feed consumed to gain. FCR also expressed as the amount of feed consumed per unit of weight gain was considered as feed conversion ratio. That was calculated by using the following formula:

$$\text{Feed conversion ratio (FCR)} = \frac{\text{Average daily feed intake (g)}}{\text{Average daily body weight gain (g)}}$$

3.6.4. Carcass characteristics

At the end of the experimental period (7th weeks), two chicks (one male + one female) from each pen which were close to mean live weight of the group were randomly selected, labeled and isolated from the pen. Then they were starved for 12hrs and weighed immediately before slaughter. Chicks were slaughtered manually by severing the jugular vein, allowed to bleed completely and weighed to determine blood. After slaughtering, the birds were de-feathered by hand plucking. After de-feathering, feather was weighted and all nonedible (viscera, head and shank) were removed and weighted separately. Then the carcass was weighed and carcass percentage was determined using the following equation. The individual parts and organs were weighed using a digital balance and recorded. Data on pre-slaughter live weight, weight of back, neck, breast, drumstick, thigh, liver, wing, gizzard and total non-edible offal's including gastrointestinal and reproductive organs, head, the visceral organs including heart, kidneys, spleen, lungs, shank, feather and blood weight were recorded. Total non-edible carcass (TNE) included feathers, blood, head, shank and claw, esophagus, crop, spleen, pancreas, kidneys, heart, lungs, intestines, gonad, cloacae, and abdominal fat were recorded separately. The weight of total carcass cut parts was determined by the summation of the back, wing, neck, drumsticks, thighs, wings, breast and edible offal's (gizzard and liver). All the dissections were carried out by a single person to reduce the variation in the cutting procedure. Carcass weight on commercial bases was calculated by adding the weight of the two drumstick, thigh, back, two wings and breasts. Finally, the carcass percentage was determined using the following equation:

$$\text{Carcass percentage (\%)} = \frac{\text{Carcass weight (g)}}{\text{Slaughter weight (g)}} \times 100$$

3.6.5. Mortality

Death was not occurred in all period of experiment. Therefore data on Mortality was not recorded from the beginning until the end of the 7th weeks.

3.7. Partial Budget Analysis

The partial budget analysis was computed to determine the profitability of the replacement of different levels of PPM in the broiler diet. In the analysis chicken cost, feed and the profit after the experiment were looked into, or differences between gains and losses for the proposed change were considered. The net income (NI) was calculated by subtracting total variable cost (TVC) from the total return. The change in net income (ΔNI) was calculated as the difference between a change in total return and changes in total cost (ΔTC). The marginal rate of return (MRR) measured the increase in net income (ΔNI) associated with each additional unit of expenditure (ΔTC) and was calculated as:

$$MRR = \left(\frac{\Delta NI}{\Delta TVC}\right)$$

Source: (Upton, 1979)

3.8. Statistical Analysis

Experimental data obtained from feed intake, daily weight gain, feed conversion ratio and carcass yields were analyzed as per completely randomized designs by employing GLM ANOVA procedure using Statistical Analysis System (SAS, 2008) version 9.1.3 computer software program Subjected to the analysis of variance (ANOVA). Significance differences among the treatment means were determined by using Duncan Multiple Range Test (DMRT) as contained in the SAS package (Duncan, 1955; UGS, 2011). Differences between treatment groups were considered statistically significant at $p \leq 0.05$. The model for the data analysis was: $Y_i = \mu + T_i + +E_{ij}$.

Where: Y_i is the response variable,

μ is the overall mean,

T_i is the treatment effect

E_{ij} is error associated with the experiment

4. RESULTS

4.1. Chemical Composition Experimental Ingredients and Treatment Diets.

Chemical composition of the feed ingredients used in the experiment is presented in table 6.

Table 6 Proximate chemical composition of experimental ingredients

Ingredients	**Parameters**								
	DM (%)	CP (%)	EE (%)	CF (%)	ASH (%)	NFE (%)	Ca	P	ME (Kcal Kg^{-1})
Maize	87.44	7.46	4.07	3.21	1.51	71.7	0.4	0.3	3826
RSB	95.967	34.22	20.028	9.90	5.280	73.46	0.32	0.7	3947
RPP	89.067	20.77	2.133	5.614	4.416	43.87	0.13	0.46	3389
Nuge seed cake	85.76	31.53	8.03	22.29	5.49	81.56	0.26	0.65	2187

RSB: Roasted Soya Bean.; RPP: Roasted pigeon pea; NFE (Nitrogen free extract) = 100-(Moisture + CP + EE + CF + Ash); DM=Dry Matter; CP=Crude Protein; CF=Crude Fiber; EE=Ether Extract; Ca=Calcium; P = phosphorus; ME: Metabolize energy (Kcal/kg DM) = 3951 + 54.4 EE – 88.7 CF – 40.8 Ash.

The chemical composition and calculated metabolize energy values of the experimental diets are presented in Table 7 and 8. The levels of dry matter (DM), crude protein (CP), nitrogen free extract (NFE) and phosphorous (P) did not show variation between treatment diets.

Table 7: Chemical composition and calculated metabolize energy values of the experimental diets used in the starter (1-21 days) ration.

Treatment diets	**Nutrient (%)**								
	DM	CP	EE	CF	Ash	NFE	Ca	P	ME
T1	89.93	22	7	11.3	12.32	37.31	1.1	0.86	2826.834
T2	89.92	22.3	5.5	10.4	11.3	40.42	1.3	0.96	2866.68
T3	90.04	21.53	7	10.83	12.42	38.26	1.23	0.92	2864.443
T4	88.99	21.9	5	11.01	9.83	41.25	1.27	0.95	2845.349
T5	89.68	21.7	6	9.98	12.32	39.68	1.47	1.05	2889.518

Table 8: Chemical composition and calculated metabolize energy values of the experimental diets used in the finisher (22-49 days) ration.

Treatment diets	Nutrient (%)								
	DM	CP	EE	CF	Ash	NFE	Ca	P	ME
T1	90.93	19.46	6.49	7.3	9.9	47.78	0.94	0.7	3252.626
T2	89.86	19.5	6.5	8.1	9.6	46.16	0.93	0.68	3194.45
T3	90.84	19.52	6.2	8.03	8.9	48.19	1.15	0.76	3212.899
T4	89.92	19.32	6.7	7.55	10.1	46.25	1.25	0.8	3233.715
T5	90.22	19.21	6.63	6.96	10.3	47.12	1.23	0.8	3274.08

DM = dry matter; CP = crude protein; EE = crude fat; CF = crude fiber; NFE = nitrogen free extract; Ca = calcium; P = phosphorus; ME = metabolize energy; T1 = 0%PPSM; T2 = 25%PPSM; T3 = 50%PPSM; T4 = 75% PPSM; T5 = 100%PPSM. (NFE) = 100-(Moisture + CP + EE + CF + Ash)

4.2. Feed Intake, Body Weight Gain and Feed Conversion Ratio

The initial body weight (IBW) of chicks was not different (P>0.05) across all treatments. Daily body weight gain (DBWG) and final body weight gain (FBWG) for the starter phase were significantly different (P<0.05) between treatments where the highest DBWG and FBWG were recorded on T5 from the rest of treatments. But in finisher phase daily body weight gain (DBWG) and final body weight gain (FBWG) were not significantly difference (P>0.05) across treatment diets. In both phases of the experiment, total feed intake (TFI) was no different (P>0.05) across treatments. There was no significant difference (P>0.05) in average feed intake (AFI) in the starter phase but, it had shown a difference (P<0.05) in finisher phase, where AFI was higher in the control group.

According to the findings of the present study, there was significant difference (P<0.05) in the feed conversion ratio between birds fed experimental ration during the starter. Accordingly, FCR was lower in birds fed on T5 than the rest of treatments; this may indicated that good quality performance of chicks. FCR was showed decreased trend as increased levels of PPSM in treatments. But, there was no significant differences in FCR on finisher and entire phase as table 9.

Table 9: FBW, DBWG and FCR of broilers fed with starter and finisher diets.

Phase	Parameters	Replacement levels of pigeon pea for soya bean(mean ± SD)						
		T_1	T_2	T_3	T_4	T_5	P-value	Sig.
Starter	IBW (gm./bird)	86.33±2.92	84.38±1.47	87.00±3.6	85.66±0.44	85.47±1.6	0.70	NS
	FBW (gm./bird)	626.0 ±17.5^{c}	678.75 ±25^{b}	667.7±30^{bc}	703.8 ±7.5^{ab}	738.0 ±34^{a}	0.001	**
	DBWG(gm./bird)	29.80 ±0.83^{c}	32.32 ±1.19^{b}	31.79±1.4^{bc}	33.51±0.35^{ab}	35.14±1.6^{a}	0.001	**
	AFI (g/bird/day)	51.75± 9.00	41.98±1.84	42.21±1.3	43.00±0.55	44.62±3.4	0.107	NS
	TFI (kg/21days)	13.04±2.26	10.57 ±0.46	10.69 ±0.3	10.83 ±0.13	11.24±0.8	0.11	NS
	FCR (g feed/g gain)	1.73±0.30^{a}	1.29±0.04^{b}	1.33 ±0.09^{b}	1.28±0.02^{b}	1.27±0.16^{b}	0.0238	*
Finisher	IBWG (gm./bird)	626.0±17.5^{c}	678.75 ±25^{b}	667.7±30^{bc}	703.8 ±7.5^{ab}	738.0±34^{a}	0.00	**
	FBW (kg./bird)	1.860±0.04	1.862 ±0.09	1.876 ±0.0	1.817±0.11	1.884 ±0.1	0.77	NS
	DBWG(gm./bird)	65.25 ±1.49	64.09±3.56	63.90 ±0.7	62.27 ±4.02	64.98 ±3.8	0.77	NS
	AFI (g/bird/day)	105.4 ±9.1^{a}	96.4 ±0.66^{b}	96.9±0.21^{ab}	96.8 ±0.36^{ab}	99.79±4.2^{ab}	0.015	*
	TFI (kg/28days)	35.44 ±3.06	32.46 ±0.10	32.57±0.0	33.53 ±1.43	32.55±0.1	0.15	NS
	FCR (g feed/g gain	1.61±0.15	1.50 ±0.07	1.51 ±0.01	1.55 ±0.09	1.54 ±0.15	0.7717	NS
Entire	TFI (g/bird/7weeks)	4040.5 ±44	3581.3 ±46	3577 ±25	3615.7 ±6.0	3731±192	0.13	NS
	TBWG (g/7weeks)	1774.25±58	1778.3±107	1789.2±19	1730.69±98	1797.9±10	0.88	NS
	FCR (g feed/g gain)	2.27 ±0.24	2.01 ± 0.11	1.99±0.02	2.09 ±0.11	2.08±0.23	0.3327	NS

**: P<0.05; * = significant; ** =highly significant; $^{a-c}$ Means within a row with different superscripts differ significantly (P<0.05); IBWG: initial body weight gain; FBWG: final body weight gain; AFI: average feed intake; TFI: total feed intake; FCR: feed conversion ratio ; TBWG: total body weight gain; T1= 0% of PPSM; T2= 25% of PPSM; T3= 50% of PPSM; T4=75% of PPSM; T5= 100% of PPSM; mean± SD = mean± standard deviation; NS:Non-significant; Sig.:Significant* *levels.*

4.3. Carcass Characteristics

The carcass measurements of Cobb500 broilers fed on experimental ration is presented in table 10. The findings of the present study showed that, there was no significant difference ($P>0.05$) on the slaughter weight, carcass weight and weight of individual main carcass cuts parts of Cobb500 broilers fed experimental ration. But significant difference was shown ($P<0.05$) in abdominal fat deposition between treatments and it had a decreased trends when the level of pigeon PPSM increased in test diets. There were differences ($P<0.05$) in TEO and TNEO between treatments, where higher TEO were recorded in T1 and lower was shown in T5. Also highest TNEO was recorded in T5.

Even though, there was no significance difference between treatments in dressing percentage of carcass, the study showed higher and lower dressing percentage was observed on T4 and T5 respectively. On the other side most of carcass cut parts (Wing, back, thigh, drumstick, and breast) were showed, numerically higher than other treatment diets on T4 than other treatment diets.

Table 10: Carcass characteristics of cobb500 broiler chicks fed with different levels of PPSM.

Carcass parameters	**Treatments(mean± SD)**						
	T1	**T2**	**T3**	**T4**	**T5**	**p-value**	**sig**
Slaughter wt. (kg)	1.81±0.18	1.82 ±0.18	1.78 ±0.10	1.73 ±0.16	1.77 ±0.1	0.8886	NS
Carcass weight (kg)	1.28 ±0.13	1.31 ±0.12	1.28 ±0.11	1.31 ±0.38	1.21±0.14	0.9113	NS
Dressing %	70.8 ±3.8	72.1 ±2.1	71.8 ±4.9	74.9 ±14.1	68.1 ±6.0	0.6486	NS
Carcass parts (gm.)							
Skin	114.6 ±16	113.3±23	106.0 ±8.3	103.0±34.6	92.3 ±28	0.5181	NS
Neck	57.16 ±7.67	59.00 ±11.3	57.33 ±7.89	54.66 ±14.7	55.33 ±6.4	0.9490	NS
Wing	65.5 ±9.0	65.0 ±6.2	64.8 ±6.7	69.0 ±16.8	64.5 ±6.8	0.9332	NS
Back	138.8±22	155.5 ±27.8	131.5 ±17.7	134.8±34.4	124.5 ±13	0.2732	NS
BREAST	431.3±48.6	438.6±39.4	448.5±42	471.3±140	432.5±45	0.8763	NS
Drumstick	165.3 ±16.7	163.5 ±22.8	164.3 ±23.9	175.0 ±58.5	158.8 ±31	0.9456	NS
Thigh	185.0 ±27.1	194.0 ±29	190.8 ±19	202.0±79.4	181.0 ±23	0.9221	NS
Edible offal (gm.)							
Gizzard	39.1 ±6.61	39.8 ±5.5	40.0 ±6.4	41.6 ±6.8	40.8±4.9	0.9611	NS
Liver	45.6 ±8.1	42.6 ±4.8	45.0 ±4.8	43.8 ±5.8	40.0±3.8	0.4686	NS
Fat	40.6 ±17.2^{a}	40.0 ±13.6^{a}	32.1 ±12^{ab}	22.0 ±10.6^{b}	21.0 ±8^{b}	0.0269	*
Other parts							
TEO (gm.)	125.5±16^{a}	122.5 ±17^{ab}	117±18.5^{ab}	107.5±19^{ab}	101.8±12.5^{b}	0.0141	**
TNEO (gm.)	497.0 ±49^{ab}	442.6 ±33^{b}	471.6 ±63^{ab}	451.6 ±86^{b}	549.6 ±89^{a}	0.0267	**

**: P<0.05; * = significant; ** =highly significant; a-c Means within a row with different superscripts differ significantly (P<0.05); TEO= total edible offal= (skin, gizzard and liver); TNEO = total non-edible offal; T1= 0% of PPSM; T2= 25% of PPSM; T3= 50% of PPSM; T4=75% of PPSM; T5= 100% of PPSM; mean± SD = mean± standard deviation; Carcass weight = (commercial carcass + edible offal), Dressing percentage = (Weight of carcass/slaughter weight)*100; NS: Non-significant; Sig.: significant level.*

4.4. Mortality

There was no death of chicks in all the treatment diets throughout the experimental period.

4.5. Partial Budget Analysis

The partial budget analyses of Cobb500 broiler fed experimental rations are presented in Table 11. The result showed that there was significant difference (P<0.05) in total feed cost (TFC) per treatment and feed cost per bird across treatments. The partial budget analysis indicated that the feed costs in Cobb500 broiler chickens fed on experimental ration was decreased as increase the replacement levels of pigeon pea increase. Thus, the cheapest cost (birr /Treatment) was recorded in birds fed on T5 (2578.08 birr per treatment and 85.94±4 per bird) as compared to the other treatments and mainly to the control diet (3090.09 birr per treatment and 103.00±4 per bird). Total cost of feed per treatment and feed cost per bird were became decreased as increased the level of PPSM in the diets. As a result, the highest net income was obtained from birds fed on T5 as compared to those birds fed on other treatments.

Table 11: The economics of Cobb500 broiler chickens fed with different levels of PPSM

Parameters	Treatments *(mean± SD)*					
	T1	**T2**	**T3**	**T4**	**T5**	**Sig.**
No. of birds	30.00±0	30.00±0	30.00±0	30.00±0	30.00±0	NS
Chick cost(birr/bird)	26.00±0	26.00±0	26.00±0	26.00±0	26.00±0	NS
TFC (birr)	3090.09±6.5^{a}	2973.94±3.3^{b}	2849.63±0^{c}	2716.33±0^{d}	2578.08±3.2^{e}	**
FC (birr/bird)	103.00±4^{a}	99.13±0^{b}	94.99±4^{c}	90.54±0^{d}	85.94±4^{e}	**
Av. FBW (kg/bird)	1.860±0.04	1.862 ±0.09	1.876 ±0.0	1.817±0.11	1.884 ±0.1	NS
Broiler sale (birr/kg)	85.00±0	85.00±0	85.00±0	85.00±0	85.00±0	NS
BWG (gm.)	1687.92±55	1694±109	1702.25±21	1645.03±99	1712.47±106	NS
GI (birr/kg)	4524.34±50	4534.89±92	4562.59±17	4413.3±84	4584.7±89	NS
TI (birr/bird)	150.81±4.98	151.16±9.17	152.09±1.66	147.11±8.40	152.83±8.92	NS
NI (birr/bird)	47.81±4.99^{b}	52.03±9.18^{b}	57.1±1.66^{ab}	56.56±8.4^{ab}	66.89±8.92^{a}	**
ΔFC (birr/bird)	-	-3.87	-8.02	-12.46	-17.07	NS
ΔTI (birr/bird)	-	0.35	1.28	-3.70	2.01	NS
ΔNI (birr/bird)	-	4.22	9.29	8.76	19.08	NS
MRR (Δ NI/ ΔFC*100)	-	-109.09	-115.91	-70.28	-111.80	NS
BWG per FC (gm./birr)	16.39±0.54^{b}	17.09±1.1^{b}	17.92±0.23^{b}	18.17±1.1^{b}	19.93±1.23^{a}	*

Summary

Total feed cost of research	14208.08(Birr)
Total income of research	22619.85(Birr)
Net income of research	8411.77(Birr)

**: P<0.05; * = significant; ** =highly significant; [a-c] Means within a row with different superscripts differ significantly (P<0.05); PPSM = pigeon pea seed meal; T1= 0% of PPSM; T2= 25% of PPSM; T3= 50% of PPSM; T4=75% of PPSM; T5= 100% of PPSM; mean ±SD= mean ± standard deviation; NS: Non-significant; Sig.: significant level; mean± SD = mean± standard deviation ; BWG = body weight gain; GI= gross income; TI = total income; NI= net income; FC= feed cost; ΔTI=change in total income; ΔNI = change in net income; ΔFC = change in feed cost ; Av. FBW = average final body weight; MRR=Marginal rate of return.*

5. DISCUSSION

5.1. Chemical Composition of Treatment Ingredients

The proximate result of for nuge seed cake (%DM= 85.76, %CP=31.53, %EE=8.03, %CF=22.29, %ash= 5.49, %NFE= 81.56, Ca=0.26, P=0.65 and ME=2187) was agreed with the finding of Wubu (2011), in CP (31.6%), but inconsistence in % DM (92.9), % CF (14.7), % Ash (10.2), % Ca (6.7), % P (0.83) and[ME kcal/kg]=(2596).

The chemical composition of roasted soya bean (DM= 95.967, Ash= 5.280, CP= 34.22, EE= 20.028, CF= 9.90, NFE= 73.46 and ME (kcal/kg DM) = 3947) in the current study showed a comparable value of DM= 97.2, CP= 33.1 and CF= 7.6, but higher value in Ash= 3.1, EE= 12.8, NFE= 40.6 and ME (kcal/kg DM) = 3846 as reported by Lidetewold *et al*. (2016).

The chemical composition for roasted PP in the current study showed that, CP = 20.77, CF= 5.614 and DM = 89.069. The DM% (89.067) of pigeon pea showed the lower value as compared to the finding of ARIF *et al.* (2017). The result of roasted pigeon pea in the current study showed lower in %CP (20.77), %CF (5.614), %CF (5.614), %Ash (4.416) and %DM (89.069) of pigeon pea seed and higher in EE and NFE was as compared to the result of Onu and Okongwu (2006).

The current study indicated that, which was lower as compared to the finding of Onu and Okongwu (2006). However, %Ash (4.416) of the roasted PP was comparable with the value reported by (Akande *et al.*, 2010; Arif *et al.*, 2017). Whereas EE (2.133) was found in the range which was reported by Akande *et al*.,2010; Elsayed *et al*., 2014; Bamidele and Akanbi, 2015; Arif *et a*l. (2017) but higher than the result reported by (Odeku., 2013; Onu and Okongwu., 2006) . NFE (43.87) value of pigeon pea was lower as compared to the result of reported by FNRI 1980; Onu and Okongwu, 2006; Akande *et al*., 2010; Arif *et al*., 2017). The result was agreed with the report of Ogbu *et al*. (2015) who reported lower ash and CF from cooked and roasted PP seed meal, but EE and NFE were higher compared to crude pigeon pea seed meal.

The result of the current study showed that, the % CP (20.77) of roasted PP was lower than the finding of Gemede and Ratta (2014). But it is found in the range studied by (Akande *et al.*, 2010; Elsayed *et a*l., 2014; Emefiene *et a*l., 2014; Santhanam and Egigu, 2014; Aja *et al*., 2015; Arif *et al.*, 2017). The variations in CP content could be due to factors such as soil, season of harvest, and agro-ecology. But, result was in line with the results of Tiamiyu *et al*. (2015), who stated that heat treatment of protein supplements may result in denaturation or destruction of the protein. The level of crude fiber in poultry feed must be kept below 7%. A crude fiber level above 7% has negative effect on the production performance of chicken (Varastegani and Dahlan, 2014).

The current study (table 6) showed that the % NFE for soya bean and pigeon pea was 73.46and 43.87respectively, the value of %NFE op Pigeon pea (43.87) was lower than the study 60.85, 61.2 and 55.8-58.7 shown by (FNRI, 1980; Akande *et al*., 2010; ARIF *et al.,* 2017). The level of crude fiber in poultry-feed must be kept below 7%. A crude fiber level above 7% has negative effect on the production performance of chicken (Varastegani and Dahlan, 2014).

The CP value of maize (7.46%) obtained in this study is within the range (4.5-9.7%) reported by other researchers (Mandefro *et al*., 2002; Adugna, 2008; Enyisi *et al*., 2014). According to the current study maize had 87.44% DM, 8.9% CP, 1.6% CF, 1.8% Ash, 4.07% EE, 0.05% Ca and 0.33% P and 4024.2% kcal/kg which is consistent with the finding of Wubu (2011) who reported 86.4% DM, 7.6% CP, 3.1% CF, 1.51% Ash, 5.4% EE, 0.05% Ca and 0.33% P and 3826% kcal/kg DM.

In the present study, the metabolize energy content for all treatment diets were ranged from 2826.834 to 2889.518 for starter and from 3194.45 to 3274.08 kcal ME/kg DM for finisher diets but lower than the recommended energy level 3000 kcal ME/kg for a 1- 21 day old chick and consistent with 3,200 kcal ME/kg for 22-42 days for broilers by NCR (1994). However, the metabolize energy content of the treatment diets was comparable with the recommended range of 2800-3000 kcal/kg for optimal performance of broilers (Olomu and Offiong, 1978).

5.2. Feed Intake, Body Weight Gain and Feed Conversion Ratio

In the present study, the average as well as total feed intake of chicks was not significantly different (P>0.05) in all treatments in starter phases. The result obtained in the present study showed an improvement over the observation of Ani and Okeke (2000) that broiler starters fed 27% roasted PSM had significantly (p<0.05) lower feed intake than birds fed 5.5-21.5% roasted PSM diets. But Average daily feed intake had shown significant difference between treatments in finisher phase and it was increased with the increase of age of chicks. This was line with the finding of Mukhtar *et al.* (2013) who studied the effect of feeding broiler chicks on diets containing graded levels of raw pigeon pea seeds (PPS) and who stated that the feed intake of chicks increased with the increase of age of chicks. In the present study, there were no significant difference (P>0.05) in feed intake among treatments in starter and finisher phase. The result agreed with the finding of Igene *et al*. (2012).

According to the current study, there were significant differences (p<0.05) among treatments in daily weight gain (DWG) and feed conversion ratio (FCR). The result is in agreement with the finding of Ani and Okeke (2000). Feed intake and weight gain were increased as increased the replacement of PP as compared to control diet. But it was in line with the finding of Ani and Okeke (2000). The results of the current study shown that weight gain was increased as increase levels of roasted pigeon pea seed meal replacement in the diet. This finding is not consistent with that of Amaefule and Onwudike (2000) and Amaefule and Nwaokoro (2002) who reported that, the pigeon pea based diet became less palatable as the level of inclusion increased beyond 26% of roasted pigeon pea seed meal.

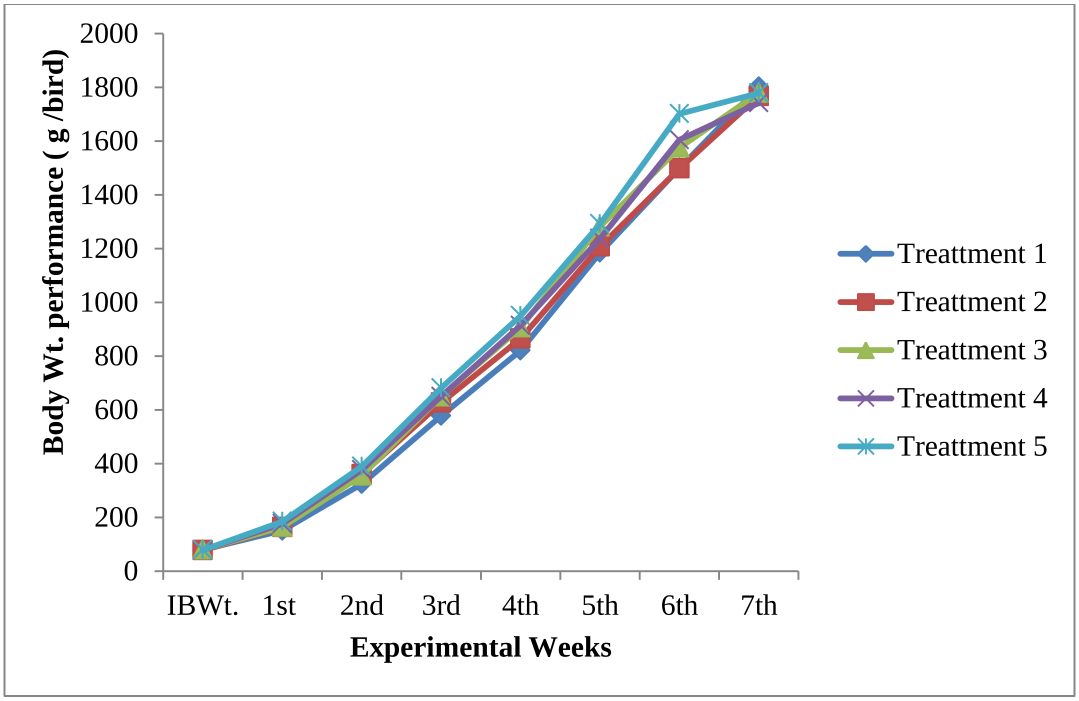

Figure 1 Weekly Growth performance of broiler (gm. /bird)

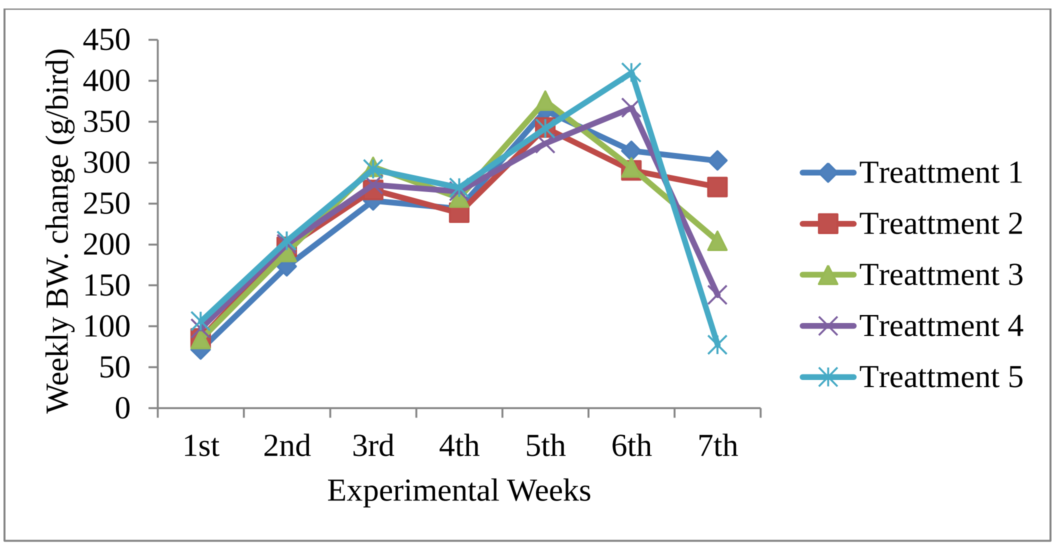

Figure 2 Weekly body weight change of broiler (gm. /bird)

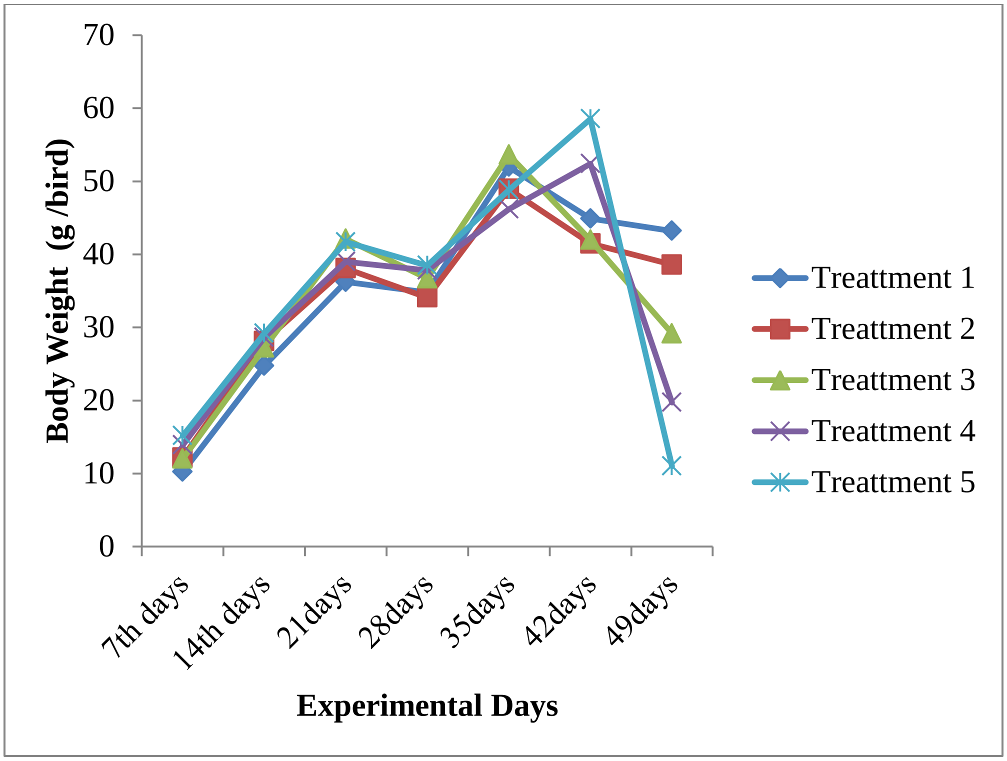

Figure 3 Daily body weight gain of broiler (gm. /bird)

During the 1st, 2nd and 3rd weeks of age (starter phase), high significant (P<0.05) differences in the body weight gain were found in all dietary treatment groups. The result was not agree with the finding of Tusar *et al* (2015) who showed no significant (P>0.05) differences in the body weight gain of broiler. In contrast, the daily as well as final body weight of broilers were not significantly different (P>0.05) with the increase in the age of broilers (finisher phase). The study showed that, body weight gain was increased with the increase in the replacement level of pigeon pea seed meal (from 0% to 100%) with higher trend in starter phase and lower trends in finisher phase of the experiment. The chicks fed on T5 showed a higher daily body weight gain (35.14±1.6g) as compared to those broilers fed on T1 (29.80 ±0.83g) in first phase of study period (21th days). But it gradually declined as age of broilers increased in the next 28 days (finisher phase). The current study showed that, daily body weight gain (DBWG) of the birds in finisher phase was higher (63.90±0.7gm/day/bird to 65.25±1.49 gm/day/bird) as compared to the finding of Igene *et al*. (2012) that ranged from 50.97-53.69gm/day/bird. The weight gain obtained from the current experiment is higher than the value (20.5 - 29.4 g/day/bird) reported by Befikadu et al. (2008) in

Cobb 500 broiler chickens fed Azolla (Azolla filiculoide) and (36.6 – 38.2 g/day/bird) reported by Lidetwold *et al*. (2016).

Throughout the experimental period, higher value of FCR was recorded on the control diet; in starter phase (1.61±0.15), in finisher phase (1.73±0.3) and in entire phase (2.27 ±0.2) than other treatments. The results contradicted with the findings of Igene *et al*. (2012) who reported that FCR value was lower in the control group than other dietary groups. The result agreed with the findings of Tusar *et al*. (2015) who stated that, the FCR value was significantly (*P*<0.01) higher in the control and it was lowest in the 10% pigeon pea. However, it was significantly different P<0.05 in starter phase of experiment and had no significant difference (P>0.05) in finisher phase. The result showed that, there were no significance difference (P>0.05) in FCR only in finisher phase. But it contrasted the finding of Igene *et al*. (2012) who showed that there was significant difference (P<0.05) in FCR only in finisher phase. The FCR obtained in this experiment ranged from 1.61±0.15 (control diet) to 1.54 ±0.15 (for control diet over the 49 days feeding trial. The result not agreed with reported by Lidetwold *et al*. (2016) who reported between 3.19 and 3.40 at 42 days of age.

5.3.Carcass Characteristics of Broilers Fed with Different Levels of PPSM

The evaluation of carcass in broiler chickens is a very important segment in production and marketing of poultry products (Nikolova *et al*., 2007). Carcass characteristics are the main tool to evaluate the quality of carcass. The results of this study showed that Broilers fed on different levels of PP seed meal had higher in carcass evaluation measurements, in terms of, thigh, drumstick and breast muscle. Most of the commercial carcass in the current experiment had no significant difference (P>0.05) among all the treatments groups, which was consistent with the study of Lidetewold *et al*. (2016) who found similar result in finisher broiler chickens fed African yam bean. In this study, dressing percentage ranged from 68.1 ±6.0 to 74.9 ±14.1 (T5 toT4), and no significant difference (P>0.05) was detected between treatment diets.

Isikwenu and Udomah (2015) reported general reduction in abdominal fat content of broilers fed on treatment diets with different levels of pigeon pea. In the current experiment, abdominal fat was significantly different (P<0.05) for all the treatment groups and it was lower in T5 than others. High body fat deposition in broiler represents economic loss to the producers. Nikolova *et al*. (2007) stated that abdominal fat is affected by genotype, sex, age and nutrition of the broiler chicken.

The dressing percentage of the current study showed that ranged from 68% to 74.9% which is comparable with the finding of Scanes *et al*. (2004) and Maigualema and Gernat (2003) who observed 70% dressing percentage for broiler chickens. Similarly, Tegene and Asrat (2010) reported comparable dressing percentage of 67% to the present study for Rhode Island Red unsexed chickens fed on fishmeal up to 12 weeks of age. On the other hand, dressing percentage of the current study is higher than the finding of Negussie (1999) observed dressing percentage of 63% for Rhode Island Red chickens kept on choice feeding of energy or protein feeds under intensive and semi intensive management conditions in the central highlands of Ethiopia.

5.4. Mortality

In the current study, there was no death of chicks in all the treatment diets throughout the experimental period this might be due to effective management and routine husbandry practice starting from the feed preparation, enough biosecurity and sanitation, and other critical technical aspects happened in the house. This might also due to timed vaccination and effective feed and water provided. The other reason might also be due to the pigeon pea and soybean seed that has no any deleterious health effects on the chicks and this also proves that there was an effective processing to properly remove its anti-nutritional factors

5.5. Partial Budget Analysis of Broilers Fed with Different Level of PPSM

Feed cost (Birr) per kg of feed was reduced with increasing replacement levels of pigeon pea seed meal (PPSM) in the treatment diets. Consequently, T5 had the lowest feed cost than the control diet. Similarly, highest revenue or net income was generated from sell of broilers fed on T5 than T1 (table 11). The result of the cost-benefit analysis showed that feed costs decreased while the inclusion level of PPSM increased across treatment groups. This is an indication of economic benefit of PPSM. This agreed with earlier researchers who stated that poultry production may not be rewarding if costly conventional feeds cannot be replaced by cheaper unconventional feeds in the diets (Hossain *et al.*, 2003).

Feeding broilers on T5 could be profitable as it gave the highest net return compared to that of the control diet with the highest body weight gain. The study is in agreement with the finding of Ayman *et al*. (2018) who stated that pigeon pea may increase growth and meat yield and could be used to reduce the cost of feeding, without having a negative effect on performance. But, the current study did not agree with Solomon *et al*. (2017) who stated that cost of producing each experimental diet with inclusion of toasted *C. cajan* was similar to the control diet. The result was also did not agree with Amaefule *et al*.(2011) who stated that inclusion of 40% of PPSM in starter diet increased productive performance when compared to a 30% inclusion; however, this level increased the cost of the diet. The results of present study showed that high income was generated as replacement levels of PPSM for soya bean seed meal (SBSM) was increased with increasing weight gain and with no adverse effects on chicks' performance. The greatest economic benefit was obtained when in broilers diet replaced higher levels of PPSM for SBSM.

Vieira *et al*. (2012) stated that economic returns will depend primarily on ingredient costs, the product mix being produced, and the price of products being sold. In the present study, soybean is expensive as compared to pigeon pea (*Cajuns Cajun*). The result indicated that the price of 1 kg pigeon pea (PP) (22 birr) is the cheapest as compared to SB (35 birr). The change in feed cost (ΔFC) (birr/bird) was reduced by -3.87 (birr),-8.01(birr),-17.06(birr) and -12.45(birr) for T2, T3, T4 and T5 respectively, as increased replacement levels of PPSM for SBSM.

6. CONCLUSSION AND RECOMMENDATIONS

6.1. Conclusion

The overall result of this study showed that graded levels of pigeon pea seed meal can replace up to 100% of soya bean seed in broiler ration with proper seed treatment without any negative effect. The graded levels replacement of soya bean by pigeon pea improved average daily body weight gain, feed intake, feed conversion ratio and most common carcass parameters such as thigh, back, breast, wing and drumstick weight. According to the partial budget analysis the net income obtained in broilers increased as increasing replacement levels of PP for SB. Thus better income was recorded in T5 than T1. The use of soya bean seed in poultry feeding in developing countries is limited by high market price, high competition with other livestock feeding and production limitation of SB due to climate impacts than pigeon pea. Pigeon pea seed meal could safely and economically be used to replace up to 100% of soya bean seed meal for broilers diet in broiler production. Therefore, it can be concluded that pigeon pea seed meal can replace soya bean seed meal up to 100% and improve the net income without much impact on the body weight and carcass characteristics at the final day.

6.2. Recommendations

1. Most of the protein source feeds like soybean are very expensive and the value of them not profitable for commercial and/or small scale poultry producers Thus, the use of locally available and easily usable protein sources are alternative choices. In this case pigeon pea can grow in all tropical area, farmers who live in tropical area should adopt to expand its production
2. Therefore, the chicken producers and poultry feed processors should use pigeon pea as ingredients in place of soybean in order to minimize feed cost. Awareness creation should be made for feed processors and poultry producers that pigeon pea should be used as a source of protein for poultry ration for improved net income and marginal rate of return without negative

impact on feed intake, body weight, and feed conversion ratio and carcass characteristics at the finisher phase.

3. Further research is needed on the effect of pigeon pea as non-conventional feed ingredients on different aspect of broiler production by considering multiple breed effects as well as layer chickens performance and partial budget analysis.

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8. APPENDIX

8.1. List of ANOVA Tables

Appendix 1 Analysis of Variance of initial body weight for starter phase (gm)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	11.51111111	2.87777778	0.54	0.7090
Error	10	53.12037037	5.31203704		
Corrected Total	14	64.63148148			

CV= 2.687100

Appendix 2 Analysis of Variance of final body weight for finisher phase (kg)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	0.01291757	0.00322939	0.44	0.7741
Error	10	0.07263156	0.00726316		
Corrected Total	14	0.08554913			

CV= 4.748128

Appendix 3 Analysis of Variance of slaughter Weight (kg) on treatments

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	0.02778187	0.00694547	0.28	0.8886
Error	10	0.62187733	0.02487509		
Corrected Total	14	0.64965920			

CV= 8.838736

Appendix 4 Analysis of Variance of carcass Weight (kg) on treatments

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	0.04307380	0.01076845	0.24	0.9113
Error	10	1.10856450	0.04434258		
Corrected Total	14	1.15163830			

CV= 16.44232

Appendix 5 Analysis of Variance of carcass dressing % on treatments

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	141.160339	35.290085	0.63	0.6486
Error	10	1410.185190	56.407408		
Corrected Total	14	1551.345529			

CV= 10.48939

8.2. List of Photos Taken While Conducting the Research

1. Feed Preparation, Formulation and Feeding of The Birds.

A

B

Figure 4 Roasting of SB and PP seed (A) and Grinding of Feed Ingredients (B and C)

C

D

Figure 5 Measuring of Ingredients (D)

E

F

Figure 6 Formulation of Ingredients (E) and mixing (F)

G H

Figure 7 Formulated feed (G) and stored feed (H)

I II

Figure 8 Initial BW Measurement for Chicks (i) and Entering of chicks to their Pen (ii)

III IV

Figure 9 Chicks at 1st Week (iii) and Wt. Measurement for Chicks at 1st Week (IV)

V VI

Figure 10 Growth performance of chicks at 2nd week (V) and Feeding of broilers (VI)

Figure 11 Growth performance of birds at 7th weeks

2. **Carcass Evaluation**

1. 2

Figure 12 Bird read to slaughter (1) and slaughtering (2)

3 4

Figure 13 Bleeding (3) and de- feathering (4)

5 6

Figure 14 De-feathered (5) and skin remove (6)


7 8

Figure 15 Cutting (7) and separating each parts (8)


9 10

Figure 16 Over all view of cut parts (9) and recording of each parts (10)