EFFECT OF PARTIAL SUBSTITUTION OF MAIZE WITH POTATO PEEL MEAL ON PRODUCTION PERFORMANCE AND CARCASS CHARACTERSTICS OF COBB-500 BROILER

BY

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MSc Thesis

By

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STATEMENT OF THE AUTHOR

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Place: Jimma University, Ethiopia

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BIOGRAPHICAL SKETCH

The author, Solomon Dugassa Erena was born from his mother Biritu Borja and his father Dugassa Erena on July 21, 1991 G.C in Guto Gidda, East Wollega Zone, of Oromia Regional State. He attended his elementary education in Burka Uke and Dalo Primary School. He joined Biftu Nekemte Secondary and Nekemte Preparatory School in 2006 and 2008 respectively. Solomon Dugassa, joined Madda Walabu University in the academic year of 2009/2010 and graduated with BSc. degree in Animal and Range Sciences with very great distinction in July, 2012. Soon after graduation he was employed by the Oromia Regional State, Agency of Livestock and Health and assigned as livestock expert to Limmu Kossa district where he served for two years. In 2014, Solomon was employed by Wollega University as junior researcher in Animal Nutrition. Finally he joined Jimma University, College of Agriculture and Veterinary Medicine to pursue his MSc in Animal Nutrition.

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LIST OF ABBREVIATION

ANF	Anti nutritional Factors
ANOVA	Analysis of Variance
AOAC	Association of Analytical Chemists
BWG	Body Weight Gain
CF	Crude Fiber
CP	Crude Protein
CRD	Completely Randomized Design
DDGS	Distillers Dried Grains Solubles
DMRT	Duncan Multiple Range Test
EE	Ether Extract
FAO	Food and Agriculture Organization
FBWG	Final Body Wight Gain
GLM	General Linear Model
HACCP	Hazard Analysis and Critical Control Points
IBW	Initial Body Weight
ILRI	International Livestock Research Institute
JUCAVM	Jimma University, College of Agriculture and Veterinary Medicine
Kcal	Kilo calorie
ME	Metabolizable Energy
MRR	Marginal Rate of Return
NFE	Nitrogen Free Extract
NR	Net Return
NRC	National Research Council
NSP	Non-Starch Polysaccharides
pH	power of Hydrogen
PPM	Potato Peal Meal
SAS	Statistical Analysis System
SBM	Soya Bean Meal
SE	Standard Error
SNNPR	Southern Nation, Nationality and Peoples Region of Ethiopia
TR	Total Return
TVC	Total Variable Cost

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ABSTRACT

A total of 120 day old Cobb-500 broiler chicks were used to evaluate the effect of partial substitution of maize with potato peel meal on the production performance and carcass characteristics. The experimental chicks were randomly grouped into 12groups each with 10 chicks of comparable mean group weight and housed in separate experimental pens. Finally four starters treatment rations containing 0, 5, 10 and 15% of potato peel meal as substitute of maize were randomly assigned to the experimental chicks in completely randomized design with 3-replicate. At the end of the 21 days feeding period, the experimental chicks were switched to four finishers treatment rations containing 0, 5, 10 and 15% of potato peel meal as substitute of maize. The data collected on the production performance and carcass characteristics were subjected to statistical analysis of variance. The results obtained showed that substitution of maize with 5-15% of potato peel meal negatively affected feed consumption and body weight gain of the experimental chicks during the first week of the feeding trial. However, there was improvement in feed intake and body weight gain of the treatment groups placed on 5-15% of potato peel meal as substitute for maize starting from the 2nd week of the feeding trial. Significantly higher ($P<0.05$) mean weekly feed intake was recorded for the group fed on the treatment containing 5-15% potato peel meal as substitute for maize during the last two weeks of the feeding trial. Mean body weight of 2.1 kg was attained by all the groups fed on the treatments containing 5-15% potato peel meal, the values of which was significantly higher($P<0.05$) than that of the group fed on control treatment ration at the end of 42 days of the feeding trial. Moreover, there was no significant difference ($P>0.05$) among all the groups fed on the treatments containing 5-15% potato peel meal in mean final body weight attained at the end of 42 days of the feeding trial. There was no significant difference ($P>0.05$) between all the treatment groups in mean feed conversion ratio throughout the feeding trial of 42 days. The results obtained also showed that there was no significant difference ($P>0.05$) between all the treatment groups in carcass characteristics and meat chemical composition. The partial budget analysis showed that the highest net of return was recorded for the groups fed on the treatment containing 15% potato peel meal as substitute for Maize. The results of the current study indicated that potato peel meal could be safely and economically included at 5-15% into broilers ration as substitute of Maize. Further research should be conducted on its effectiveness on layers.

Keyword: Broiler, Carcass, Potato Peel Meal, Performance, Ration, , Substitution

1. INTRODUCTION

Poultry meat and eggs are estimated to contribute 20-30% of the total animal protein supply in low income food deficient developing countries (Sonaiya and Swan, 2004). In rural Ethiopia almost every family owns chicken and practice traditional chicken production system which provide valuable sources of protein and family income (Tadelle*et al*., 2003). The Ethiopian rural poultry production contributes about 98 and 99% of the national eggs and poultry meat production, respectively (Alemu and Tadelle, 1997). Unfortunately however, poultry is omnivorous mono-gastric animals that compete with human population for the available scarce concentrate food. Energy is the most critical and expensive nutrient in poultry ration and energy content of poultry ration is important because it governs feed intake (high energy content cause low feed intake and low energy content cause high feed intake). Energy requirement of poultry could mainly be obtained from cereal grains and the largest demand for cereal grain also comes from poultry. On the other side, Ethiopia lacks self-sufficiency in cereal grains indicating that poultry production is competing with human population for the available scarce concentrate feeds Shiferaw *et al.* (2014). Thus, the use of cereal grains in poultry feeding results in prohibitive market price (Kanengoni *et al*., 2015).

In developing countries including Ethiopia, the shortages of cereal grains and high market price of other high energy concentrate feed makes poultry feed expensive (Wadhwa and Bakshi, 2013). According to Madubuike and Ekenyem (2001) and Faniyi (2002) the feed cost accounts for 70 – 80% of the total cost of poultry production, the large segment of which is attributed to high market price of maize. Maize (*Zea mays* L.) is a major staple food grain throughout the world, particularly in Africa, Latin America and Asia. The maize grain is a major feed grain and a standard component of livestock diets where it is used as a source of energy. Other grains are typically compared to maize when their nutritional value particularly energy content is estimated (Ecocrop, 2010). In Ethiopia, maize is the popular cereal grains widely used both as human food and poultry feed. Nevertheless, maize availability under the current Ethiopian condition and in the future is under question due to its higher demand for different processing industries. The continual increase in prices of conventional poultry feeds seems to be justified by the use of cereal grains particularly maize as source of starch industry (Ekeyem *et al*., 2006).

This situation warrants the evaluation of other locally available non-conventional feed resource and inclusion of the promising ones into poultry feeding. Potato peel is one of such feed resource appealing for inclusion into poultry ration under the current Ethiopian condition. Potato (*Solanum tuberosum)*, is the most widely cultivated root crop in the world, ranking 4th after rice, wheat and corn (FAO, 2008). Mean annual global potato production is estimated at 388 million metric tons (FAOSTAT, 2019). German immigrant is credited for the introduction of potato into Ethiopia in 1858. Soon after the introduction, farmers in the Ethiopian highlands started the cultivation of the new tuber as an insurance crop, against cereal crop failures. Among the African countries, Ethiopia has the greatest potential for potato production and 70% of the country's arable highlands is believed to be suitable for potato production (FAO, 2008). At present, potatoes are widely grown and the annual per capita consumption of potato is estimated at 5 kg (FAOSTAT, 2008).

According to FAO (2008), the estimated potato production in Ethiopia increased from 0.28 million tones in 1993 to around 0.53 million tones in 2007. In Ethiopia potato is consumed by human indiscriminately, leaving behind a large volume of potato peels as inedible by-product. At present, potato peels are produced at household levels, hotels and restaurants and at small scale, at potato chips production installations. Potato peels are accountable for about 15- 40% of the whole tuber, depending on the peeling method (Arapoglou *et al*., 2009). In urban areas, particularly in hotels, restaurants and commercial potato chips production sites, potato peels represents an environmental problem, indicating the use of potato peels as poultry feed has environmental, nutritional and economic implications.

The by-product represents a potential source of energy and minerals for livestock feeding when properly collected and processed. According to Wafar *et al.(*2017) sun dried potato peel contains 3118.42 kcal/kg of metabolizable energy, 11.61% of crude protein, 8.01 % of crude fiber, 2.050% of ether extract, 6.21% of total ash and 72.08% of nitrogen free extract. The chemical composition of potato peels, particularly its low crude fiber content makes it a better feed resource to be included in poultry feeding system. It was reported that sun dried potato peel contains moderate amounts of feed nutrients that can sustain broilers at optimum level of performance without adverse effect on growth performance, carcass characteristics and serum biochemistry (Wafar *et al.*,2017). This being the cases, this study was aimed at studying the feasibility of partial substitution of maize with potato peel meal in broiler's ration with the following specific objectives.

- To evaluate the effect of partial substitution of maize with potato peel meal on the production performance of Cobb-500 broilers.
- To evaluate the effect of partial substitution of maize with potato peel meal on the carcass characteristics of Cobb-500 broilers.
- To evaluate the cost benefit of partial substitution of maize with potato peel meal in Cobb-500 broilers ration.

2. LITERATURE REIVEIW

2.1. Socio-Economic Role of Poultry in Ethiopia

Ethiopia has diverse agro-climatic conditions favoring production of many different kinds of crops, providing a wide range of human food and livestock and poultry feed ingredients. In Ethiopia, poultry is synonymous with chicken (Solomon, 2007). Indigenous chicken are distributed throughout the different agro-ecologies and regional states (Reta, 2009). The Ethiopian indigenous chickens make up more than 95% of the country's poultry flock. Rural family poultry are a valuable asset to local populations as they contribute significantly to food security, poverty alleviation and the promotion of gender equality, especially in disadvantaged groups and less favoured areas of rural Africa (Guèye, 2000) and Ethiopia is not exception to these conditions. The Ethiopian Growth and Transformation Plan states that livestock resources development will be practiced as part of the economic growth scaling up strategy. The focus will be on the expansion of livestock fattening and dairy resources development technology. In addition to this, honey and poultry resources development technologies will be put in place, indicating that poultry is included in the development strategy of the Ethiopian government (MoFED, 2010).

There is no reliable data indicating the annual contribution of village poultry for the national economic development in Ethiopia. Nevertheless, it is believed that rural poultry accounts for 99% of the national total production of poultry meat and eggs in Ethiopia (Tadelle *et al.,* 2000). ILRI (2000) estimate showed that poultry meat production in Ethiopia grew, on an average, only by 0.34% per annum during the period of 1985-1994 while the annual hen egg production declined by 0.39% per annum during the same period. This growth rate of poultry production is, indeed, much lower than that of the fast growing human population. In 2005, the total poultry meat and egg production were estimated at 42,560 and 36,624 tonnes, respectively. According to FAO (2008), mean annual egg and poultry meat production in Ethiopia was estimated at 68 million USD between the agricultural year of 2000 and 2005. According to Aklilu *et al*., (2007), annual income from sale of eggs and live birds is estimated to be about Birr 322/ household in the Tigray Regional State, indicating that village poultry in extremely poor areas of the country play important economic, nutritional and socio-cultural roles in the livelihoods of the rural households. Yearly income from household indigenous chickens ranges from Birr 50 to over Birr 300 and is largely under the control of women. This income is significant and represent 25% of the typical annual income of poor families in SNNP of Ethiopia (Bush 2006).There are small and large scale modern poultry production systems located outside in and in the vicinity of Addis Ababa and in big regional towns. In the small scale modern poultry production system, the modest flock sizes usually ranging from 50 to 1000 exotic breeds, kept for operating on a more of commercial basis. Most small-scale poultry farms are also located around Bishoftu town and Addis Ababa city. This production system is characterized by medium level of feed, water and veterinary service inputs and minimal to low bio-security. Reliable economic data concerning the value of small scale poultry products sold in any one year is not available. The general indications are that small scale modern poultry production system supply eggs and meat to urban and peri-urban population, particularly to supermarkets, kiosks and hotels(Solomon, 2008).

Some of the small scale modern poultry producers, along with Bureau of Agriculture, Cooperatives and DebreZeit Agricultural Research Center distribute breeding seeds and promote improved poultry and feeding technologies. There are few private large scale commercial poultry farms, all of which are located in DebreZeit. ELFORA, Alema and Genesis are the top 3 largest commercial poultry farms with modern production and processing facilities. ELFORA annually delivers (www.ethiomarket.com elfora), around 420,000 chickens and over 34 million eggs to the market of Addis Ababa. Alema poultry farms is the 2nd largest commercial poultry farms in the country delivering nearly half a million broilers to Addis Ababa market each year. The farm has its own broilers parent stock, feed processing plants, hatchery, slaughter houses, cold storage and transportation facilities. The large scale commercial poultry Provide fertile eggs, table eggs, day old chicks, broiler meat and adult breeding stocks to the small scale modern poultry farms. They are kept as full time business and highly dependent on market for inputs. The general indications are that the intensive poultry industry plays a key role in supplying poultry meat and eggs to urban markets at a competitive price. The industry also provides employment for a range of workers from poultry attendants to truck drivers to professional managers (Solomon, 2008).

2.2. Poultry Feed Resource in Ethiopia

For many decades, farmers and feed manufacturers have been facing the challenge of effectively reducing the cost of poultry production. Several factors such as diet composition, digestible nutrient content, energy to protein ratio, feed formula, feed processing, environment condition and disease affect the cost of poultry production. Feed type also affects the cost of poultry production and product quality through influencing feed intake, growth and laying performance and feed conversion efficiency. Dietary management of energy intake has been reported to decrease the cost of production and improve product quality (Ferket and Gernat, 2006). There is no planned feeding of chickens under traditional village production in Ethiopia and scavenging is almost the only source of diet. The availability of scavenging feed resource base depends on season (Yami and Dessie, 1997).

The amount of feed available for scavenging in relation to the carrying capacity of the land areas and flock dynamics across the different seasons and agro-ecologies is still not adequately quantified. Studies conducted in the highlands of Ethiopia in different seasons revealed that the materials present in the crop, as visually observed, and are seeds, plant materials, worms, insects and unidentified materials (Dessie , 2000). During the short rainy season (March to May) the percentage of seeds in the crop contents is higher, probably due to increased availability of cereal grains which had just been harvested. The nutritional status of local chickens from the chemical analysis of crop contents indicated that crude protein was below the requirements for optimum egg production (Yami and Dessie, 1997).

There may be deliberate supplementary grain feeding during the ripening and harvesting period (October-March). The quantities of supplementation gradually decrease until June-August, during which scavenging is the only source of their feed. Scavenging chickens are vulnerable to predation as they need to leave the family dwelling to scavenge for feed. Commercial poultry feed consisting mainly of cereal grains, cereal grain by-products and oilseed cakes are available from feed mills that are largely concentrated in and around the capital, Addis Ababa. According to Yami and Dessie (1997), ingredients and processed feeds vary in nutritive value and there is no regular quality control mechanism in the country. The lack of feed quality legislation and laboratory facilities for chemical analysis also contributes greatly to the poor quality of processed feeds. The price of raw materials varies according to source of supply, region and season. Transport costs add significantly to the cost of feed in areas located at long distance from the sources of supply. The lack of regional feed mills and dependence on supplies of some ingredients from large cities add to the overall cost of feed in many parts of the country. In many instances, the cost of mixed feed does not seem to follow reductions in ingredient cost. Prices of mixed feed remains unduly high, even at times when the price of the major component of mixed rations fall (Solomon, 2008).

2.2.1. Effect of Dietary Energy on Performance of Poultry

The energy requirements of poultry and the energy content of feedstuffs are expressed in terms of kilocalories (1 kcal equals 4.18 kilojoules). The energy content of poultry feeds and energy requirement of poultry are commonly expressed in terms of metabolizable energy (Kong *et al.*, 2014). Birds eat primarily to satisfy their energy needs, provided, the diet is adequate in all other essential nutrients. The energy level in the diet is therefore a major determinant of feed intake in poultry. Thus dietary energy level is often used as the starting point in the formulation of practical diets for poultry. Different classes of poultry need different levels of energy for metabolic purposes, and a deficiency will affect productive performance. To sustain high productivity, modern poultry strains, particularly broilers are fed relatively high-energy diets. The dietary energy levels used in a given situation are largely dictated by the availability and cost of energy-rich feedstuffs (Kong *et al.*, 2014). Poultry cannot digest and utilize some complex carbohydrates, such as fibre, and feed formulation should use a system based on available energy. Energy concentrates required by poultry are continuously becoming scarce and expensive for poultry feeding particularly in broiler production. Feeds that provide the basic nutrients which help to achieve quality broiler carcass yield accounts for over 70% of the overall cost of production, with the energy sources being accountable for about 40–70% of the total quantity and cost (Tewe and Egbunike,1992).

The importance of dietary energy in poultry feeding cannot be over-emphasized because increasing or decreasing the dietary energy has been reported to affect feed intake in addition to promoting or undermining efficient feed utilization and growth rate (Leeson and Summer,1991). The amount of feed energy consumed by an animal could be used to fulfill the maintenance and production requirement (Mbajiorgu *et al.*, 2011). Both dietary and management factors individually or collectively influence feed energy intake in poultry production (Mbajiorgu *et al*., 2011). Energy concentration of the diet has been reported to have a significant effect on feed intake and production performance in poultry (Applegaten, 2012). Feed intake in poultry has been reported to increase or decrease based on the energy concentration of the diet (Albuquerque *et al*., 2003). This increase or decrease in feed intake in relationship to dietary energy content is influenced by the amount of feed in the gut or other physiological limitations. Singh and Panda (1992) concluded that birds usually eat with the aim of satisfying their energy requirement, and once this aim is achieved, the birds will stop eating irrespective of the fact that other key nutrient requirements such as protein, minerals, and vitamins have not been met. This scenario may tends to lead to malnutrition, poor performance, increased deposition of excess abdominal fat or carcass fat in broilers (Summers *et al*.,1992) and such a fat deposition is usually considered to be undesirable. High fat deposition is regarded as an economic loss for broiler producers.

Furthermore, energy intake is considered a fundamental factor in broiler production because it not only affects growth rate and carcass characteristics but also causes some metabolic diseases such as ascites and fatty liver syndrome (Leeson *et al*.,1995; Leeson *et al*.,1996).Therefore, appropriate focus is usually placed on the inclusion levels of various dietary energy sources when formulating diets for broiler. It is reported that increase or decrease of dietary energy play a key factor in determining not just cost but also the final product quality (Leeson and Summer,1991). The energy density in the diet should be adjusted to enable appropriate nutrient intake based on requirements and the actual feed intake. Based on these facts, several poultry researchers and nutritionists have over the years directed their research toward finding various strategies aimed at managing dietary energy intake in poultry in order to cut down the cost of production and improve quality of products. Some authors concluded that dietary energy content could be managed to influence broiler performance and carcass quality (Marcu *et al*.,2013). Others reported that changing the dietary energy content has no effect on broiler performance and carcass quality (Waldroup *et al.,* 1990). Kim *et al*.(2012) reported different responses to energy concentration with different strains of broiler. Dietary energy intake has been reported also to influence growth rate and carcass quality through its effect on feed intake (Waldroup *et al.,* 1990). Generally poultry derive energy from cereal grains, cereal grain by-products, fats and oils, roots and tubers and other agro-industrial by-products.

2.2.2. Source of Energy for Poultry Feeding

2.2.2.1. Cereal Grains

Cereal grains have been the principal component of human diet for thousands of years and have played a major role in shaping human civilization. At the global level, rice, wheat, and maize, and to a lesser extent, sorghum and millets are important staples critical to daily survival of billions of people. More than 50% of world daily caloric intake is derived directly from cereal grain consumption (Awika *et al.*, 2004). Similarly, cereal grains provide 60–70% of dietary energy for poultry (Ekeyem *et al*., 2006). Corn, wheat, sorghum, barley, rye, oats, triticale and millet represent the main cereal grains used as energy sources in broiler diets at the global level (Olomu, 1995; Seshaiah, 2000; Batal *et al*., 2012). Cereal grains contribute greatly in meeting the energy requirements of poultry and their quality depends on seasonal and storage conditions.

Maize is an excellent feed ingredient for both meat and egg laying birds and is extensively used as an energy source. It is high in energy but low in protein. The available protein in maize is of poor quality because it is deficient in both tryptophan and lysine, hence the need to provide supplemental amino acids. Most hybrid varieties tend to produce grain of lower protein content than the old open-pollinated varieties. Yellow maize has higher protein content and contains yellow pigmentation that helps in producing yellow egg yolks and yellow-fleshed broilers (Kim *et al.*, 2012). The other energy source that meets most of the same criteria as maize is low-tannin sorghum. Sorghum can be grown in low-rainfall areas and is a popular crop in hot, drought-prone regions (Ravindran and Blair, 1991; Douglas *et al.,* 1993). The high tannin content of many older sorghum varieties limits their use in poultry diets, but low tannin varieties are now available and can be used in poultry diets without any limitation (Daghir, 2008). Wheat grain is another important cereal grain used in formulating poultry diet as energy source. The energy content ranges between 3230 to 3430 kcal/kg and protein content vary between 10 and 20% with average of 13% (Olomu, 1995). The tryptophan in wheat is higher than that of maize and lysine is the most limiting amino acid of wheat (Olomu, 1995). Wheat has higher nutrient value compared to Barley (Jadhav and Siddiqui, 2010). It is more palatable and contains good amount of β-complex vitamins. It is more palatable and contains good amount of β-complex vitamins. Damaged wheat and broken–wheat, byproduct of flour mill are commonly used for preparing poultry feed (Jadhav and Siddiqui, 2010).Wheat is also an energy source with a slightly lower energy content than maize but higher in protein content. Wheat is very glutinous and if fed in a ground condition, it should be limited to 30% of the diet. Barley, on the other hand, has a protein content of 10% and a fibre content of 7% in grain form, which makes it an unsuitable ingredient for inclusion in diets for highly productive laying birds and broilers, especially under hot climate conditions (Jeroch and Dänicke, 1995). Barley is low in energy, high in fibre and less palatable compared to maize, sorghum and wheat (Jadhav and Siddiqui, 2010). For all cereals, the most limiting amino acid is lysine.

The supplementation of cereal-based poultry feed with small quantities of legumes or animal products improve protein intake and protein quality. The next most limiting amino acids for cereal grains are tryptophan and threonine. The nutritional profiles of ground cereal grains vary according to type, location, season, cultivation, harvesting and handling conditions. Although they contain highly digestible starch, most of the grains contain anti-nutrients, which negatively affect the digestion, absorption, and availability of nutrients (Ensminger *et al*.,1990, Jurgens,2002).

2.2.2.2. Cereal Grains By-Products

Other important energy sources that can be incorporated in poultry diets are the cereal by-products or agro-industrial by-products. By-products of cereal milling processes are appealing because they often have considerable amounts of protein, starch and fat. Various cereal by-products have been investigated to be useful for livestock feeding. Brewers dried grain (BDG), wheat offal, maize offal, rice bran, broken rice have been widely tested and incorporated into livestock diets (Farinu, 2004; Ajayi *et al*., 2005). They reported that these ingredients can be incorporated into the diet of monogastric without any detrimental effects on the performance and health of the animals. By-products of malted cereals are preferred because they often have sufficient amount of protein as well as energy (Annison *et al*., 1994).

They however, contain high concentrations of non-starch polysaccharides (NSP) and some tannins which have been shown to interfere with nutrient digestibility of chicks (Lacassagne *et al*., 1988; Longstaff and MacNab, 1991). The NSP cause a general inhibition of absorption of the macronutrients (Annison, 1993) and probably the micronutrients (Vanderkliss, 1993). Bran is the coarse outer covering of grains separated during processing. They are obtained from the milling of wheat, maize and rice. Bran normally contains 9 to 18% crude protein and 10 to 14% crude fibre (Atteh, 2002). They have laxative action in the gut and because of their high fibre content; they can be used as nutrient diluents for monogastric animals (Atteh, 2002). Rice milling waste is readily available, cheap and usually discarded as waste product by burning to reduce pollution (Akinusi, 1999). In the manufacture of starch and glucose from maize, number of by-products are obtained, which are suitable for farm animals. The de-germ grain is finely ground and separated by wet screening (McDonald *et al*., 1995). This process gives rise to three by-products, the germ, bran and gluten which are collectively referred to as maize offal (McDonald *et al*., 1995).

The offal has low energy and high fibre contents. Nsa*et al*.(2009) replaced 50% of maize with maize offal in broiler finisher diet should be encouraged. With these nutrients in wheat bran, it is a good source of energy, protein and fibre in poultry ration formulation (Nuhu*et al*., 2008). Generally, Some of the limiting factors associated with cereal by-products as animal feedstuffs include; cost of procurement, availability, poor intake, high fibre content, low digestibility of nutrient content and subsequently low animal performance. Recently, grain by-products such as distiller's dried grains with soluble (DDGS) have been used in poultry feeding. Starch constitutes the basis of energy in grains, which is highly digestible especially for poultry.

Dried grains of cereal distillers are rich in protein, exogenous amino acids-group vitamins, biotin and mineral compounds, including phosphorus (Koreleski and Świątkiewicz 2007, Thacker and Widyaratne 2007, Min *et al.* 2008). In many countries, investigations have been conducted on the possibility of applying DDGS in feed mixtures for various animal species, including broiler chickens (Nyachoti *et al.* 2005, Świątkiewicz and Koreleski, 2007, Thacker and Widyaratne , 2007, Wang *et al.* 2007, Świątkiewicz and Koreleski 2008). In poultry, Uchegbu and Udedibie (1998) found that up to 75% of maize in broiler finisher can be replaced with sorghum dried brewers' grains without reducing performance.

2.2.2.3. Fats and Oils

In human nutrition, consumption of substantial amounts of fats and oils (lipids) has been viewed in a negative light due to health concerns (Gurr, 1997; Phan and Tso, 2001); however, lipids are an important source of essential fatty acids, fat-soluble vitamins, and energy for poultry. Lipids provide concentrated sources of energy (Gurr, 1997). Typical lipids contain about 2.25 times the gross energy as carbohydrates. This can be explained by the higher ratios of carbon and hydrogen to oxygen contained in lipids than in carbohydrates (Leeson and Summers, 2001b). Stored energy is where excess nutrients are stored in the organism as adipose tissue, which acts as a safeguard against periods of energy restriction (Gurr, 1997). Lipids indirectly sustain life by providing mechanical energy when lipids and their derivatives are used to power the machinery of the modern world.

Energy supplied by lipids is indistinguishable from energy supplied by carbohydrates on a per unit energy basis (Plavnik *et al*., 1997), but the increased concentration of energy per unit weight as compared to carbohydrates is a distinct advantage in many situations. lipid as a source of nutrients such as linoleic acid and fat soluble vitamins is undeniably important, the main characteristic of lipids that is of interest in commercial poultry production is that lipids are concentrated sources of energy (Leeson and Summers, 2001b). However, Chicks and turkey are not hatched with digestive systems that are fully optimized for nutrient digestion and absorption (Jin *et al*., 1998). Thus, the ability of young poultry to utilize dietary nutrients tends to increase with age, especially over the first several weeks of life (Batal and Parsons, 2002; Thomas *et al*., 2008). Generally, according to NRC(1994) Fats and oils are normally included at a maximum level of 4–5%.

2.2.3.4. Roots and Tubers

Starchy root and tuber crops are second in importance to cereals grains as global sources of energy (Chandrasekara and Kumar, 2016). They provide a substantial part of global food supply and are also an important source of animal feed and processed products for human consumption and industrial use. the key role potato play in ensuring national food security. Most of these roots and tubers are high in metabolizable energy, but their usage as poultry feed ingredients is limited because of the presence of anti-nutritional factors. Potato food wastes are an alternative source of feed ingredients, which reduce feed and disposal cost and reduce environment pollution (Rivin *et al.*, 2012). Potato food wastes have a high nutritional value for livestock feed (Lardy and Anderson 2009). As reported by Simplot (2013), potato is a rich source of vitamin B6 and vitamin C. In developing countries, potato, fruit and vegetable processing industries generate a huge amount of wastes, which could be used as non-conventional feed resources for animal feeding (Wadhwa, Bakshi and Makkar, 2013). Bakare and Chimonyo (2017) reported that Potato Peel is one of the prominent food wastes that could be used as an alternative animal feed. Stanhope *et al*. (1980) reported that potato-processing residue could replace barley as an energy source for finishing beef cattle. Using potato by-product in growing goat ration saved 50% of yellow corn, which is used in the ration and used at 60% of the control ration without any adverse effect on goat performance (Omer and Tawila, 2008). The metabolizable energy content of Potato Peel is 3200 Kcal /kg, the value of which is comparable with that of corn, 3470 Kcal/kg(Ghazalah *et al*.,2002). However, several factors including differences in the composition of the peel (nutrient and anti-nutrient contents), processing methods, age of birds and diet composition may affect utilization of peel meals by poultry (Wafar *et al*., 2017).

2.2.3.5 . Fruit and vegetables By-Products

Banana peel meal, cassava pulp, cassava peeling and orange peels are among the examples of fruits and vegetables. A number of studies have reported the use of banana peels in poultry rations to partially replace maize as a source of energy (Duwa *et al*. 2014 and Blandon *et al*. 2015). Banana peel contains 10% crude protein and 2932 kcal/kg metabolizable energy ME (Blandon *et al*., 2015). Blandon *et al*.(2015) further showed that sweet orange peels can be included in broiler rations up to 15% without any detrimental impacts on final weight. Edache *et al*. (2012) reported that yam peels contains a reasonable high level of energy (2701 kcal/kg) and can be fed to livestock and poultry as a component of their diet.

2.2.3. Source of Protein for Poultry Feeding

2.2.3.1. Plant Proteins

When formulating broiler diets, the main emphasis is placed on the crude protein, because protein is the critical constituent of poultry diets, and together with the other main nutrients such as carbohydrates, fat, water, vitamins, and minerals, is essential for life (Cheeke, 2005).

Proteins are polymers that are composed of amino acids, which are linked together by peptide bonds. Proteins are broken down and hydrolyzed in the digestive system into amino acids. Then, after absorption, the amino acids will be assembled and metabolized to form proteins that are used in the building of different body tissues (Aviagen, 2009). They also serve vital metabolic roles as blood plasma proteins, enzymes, hormones, and antibodies, each of which has a specific role in the body (Pond *et al*., 1995).

The most widely used plant protein source in animal nutrition is soybean. However, other cereal grains such as Wheat, Maize and Sorghum as well as some plant protein meals such as canola, sunflower and peas are extensively used as well. In poultry, soybeans are used as SBM, which is made from the grinding of defatted flakes. New varieties of soybeans that have high protein and a lower oligosaccharide contents compared to conventional soybeans have lately been developed (Baker *et al*., 2011). In general, SBM is considered the best plant protein source due to its nutrient composition. Soybeans are excellent sources of protein and energy for poultry and swine. The high protein content, with its well balanced and highly digestible amino acids, makes SBM a valuable protein for human and non-ruminant animal feeding (Kocher *et al*., 2002). However, as is a common feature of plant proteins, SBM has a high concentration of ANFs, which decrease its nutritive value (Marsman *et al*., 1997; Mehri *et al*., 2010) and limit its inclusion in broiler chicken diets, especially at the starter phase. Based on the fact that old animals are more resistant to antinutritional constituents that negatively affect digestion than younger animals, only the good quality ingredients with low levels of ant nutrients should be used in starter diets to achieve good result.

2.2.3.2. Animal Protein

Animal by-product can be simply defined as a part of a slaughtered animal which is not directly contributing to human nutrition (Hazarika,1994). Protein supplements of animal origin are obtained from rendering operations, meat packing, and poultry and poultry processing, milk and dairy processing, and fish and fish processing (Denton *et al*., 2005). Meat and bone offal, blood, bones, intestines, rumen content, and the carcasses of animals rejected by a meat inspector are considered the major categories of animal byproducts used in animal nutrition.

These by-products are characterized by their high content of good quality protein and energy, reasonable EAA profile and the absence of crude fibre and other ANFs in their composition (Konwar and Barman, 2005). Thus, they are used as valuable sources of protein in animal feeding. Of these animal by-products, animal nutritionists have shown a preference for the incorporation of blood and blood-derived products in feed. Blood meal is a by-product of slaughterhouses and is used as a protein source in animal diets. Blood meal is considered one of the richest sources of lysine and a very good source of arginine, methionine, cystine, and leucine; however, it contains less glycine and very much less isoleucine than fishmeal or bone meal (NRC, 1994). Blood meal is used as a protein supplement, a lysine supplement, and vitamin stabilizer and as a source of trace minerals. Fresh blood has a high protein content of about 17% with a reasonable amino acid balance (Liu, 2002) and approximately 87% CP on a dry matter basis.

Blood meal contains 9% total lysine with a minimum biological activity of 80% (Konwar and Barman, 2005). Blood is prepared by collection after slaughtering and then heating it for protein coagulation. After this, excess water is discarded, and it is dried and powdered (Hazarika, 1994). The quality of the product obtained is greatly influenced by its purity and the method of drying. The temperature at which it is dried is important as overcooked meal is undesirable for animals and its use has a negative effect on the growth efficiency of poultry (Konwar and Barman, 2005). Porcine blood obtained by the modified spray-drying method can be treated as a potentially beneficial source of proteins, amino acids, microelements and some biologically active substances for non-ruminant animals (Jamroz *et al*., 2011). Blood meal can be included in poultry and swine diets up to a level of 25% (Hazarika, 1994). Previous reports have indicated that inclusion of 1evel 4% blood meal in diet can improve poultry performance (Anang *et al*., 2001; Nuarautelli *et al*., 1987), while others show no adverse effect of higher levels of dietary blood meal on chicken growth (Donkoh *et al*., 2002; Khawaja *et al*., 2007).

2.3. Management and Nutrition of Broiler Chickens

Broiler chickens are mainly bred for fast growth and slaughtered when they weigh about 1.8 to 2.2 kg live mass, usually between 6 and 8 weeks of age (Musa *et al.,* 2006). The overall objective for broiler chicken producers is to produce meat with leaner tissue and acceptable lipid content in order to meet modern consumer demands as per the Hazard Analysis and Critical Control Points (HACCP) approach (Weltzien, 2009). Since feed expenditures frequently comprise 80% of broiler chicken production cost (Louw *et al.*, 2011), decisions regarding ration composition have a significant impact upon profitability of any broiler production enterprise.

Therefore, to ensure fast growth rate and efficient feed conversion in broiler chickens, good management practices which involves effective disease prevention and control, flock maintenance under continuous illumination as well as provision of high quality feeds and water (fed *ad libitum*) are all necessary (Amakari and Owen, 2011). Broiler diets are formulated to provide the energy and nutrients essential for health and efficient broiler production. Amino acids, energy, water, vitamins and minerals are the basic nutrients required by broiler chickens to ensure correct skeletal growth and muscle deposition (Appleby, 2010). An economical decision on dietary nutrient levels especially for dietary protein and amino acids is required when formulating boiler diets in order to command high levels of performance (Amakari and Owen, 2011). Energy levels which will give the best economic return are mostly determined by the local conditions under which the broiler chickens are raised (Choct, 2012). However, the quality of protein in feeds is based on the presence and balance of essential amino acids in the feed ingredients but not on the dietary crude protein levels (Appleby, 2010). It is therefore, the availability of these essential amino acids that are considered when formulating broiler diets.

2.4. Cost Implications of Energy Feed

The poultry industry relies on a limited number of energy sources, mainly cereal grains and their by-products, in addition to oils and fats, which are normally included in small proportions in poultry diets (Broomhead, 2013). Currently researchers are faced with a challenge to critically evaluate grains such as pearl millet, sorghum, wheat, etc which could be used as alternative energy source in poultry industry as a result of high costs, the ever increasing competition between man and animals for maize (Tegbe *et al*., 1984; Egbunike *et al.,* 2002) and the inadequate production of farm crop to meet the needs of man and livestock (Babatunde *et al.*, 1990). Utilizing the low-cost locally available energy sources to feed poultry is a nutritionally and economically proven way to reduce the cost and product inefficiency.

Annual production, availability, cost of production, prices of other sources, productivity variations and the stiff competition with humans are the main factors affecting the prices of vital cereal grains needed for poultry feeding. Scientifically, assessing cost of feed ingredients depends on its quality evaluation, which is very important to specify ingredient suitability to meet the nutrient specification of poultry to such production type. The ingredient dry matter content and metabolizable energy concentration are crucial keys to evaluate the cereal grain quality and enable real calculation of energy cost for each source. In addition, poultry performance is highly correlated to energy intake; therefore the best energy source is that which supports the best products to maximize the returns (Scanes *et al.,* 2004).

3. MATERIALS AND METHODS

3.1. Experimental Site

This experiment was conducted at Jimma University College of Agriculture and Veterinary Medicine (JUCAVM), Poultry Farm located at 350 km South West of Addis Ababa. The experimental site is located at an elevation of 1750m above sea level and at 7^0 42’ 9’’N latitude and $36^0$47’ 6’’E longitudes. The mean annual maximum and minimum temperature are 26.8 and 11.4 ^{o}C and the mean annual maximum and minimum relative humidity are 91.4 and 39.9 respectively (Ebisa *et al.,* 2018). The average annual rainfall of the area is 1250 mm.

3.2. Source , Preparation of Potato Peel Meal and Experimental Feeds

Adequate quantities of potato peel used in the current study was collected from JUCAVM student cafeteria. The peel was mechanically removed from the raw potato tuber with the use of knife. The fresh peels, as it is removed from the tuber were collected, washed and spread on plastic sheet and sun dried. Hand was passed through the peel to ensure uniformity in drying with removal of any foreign material encountered. The sun dried peels was milled in hammer mill to pass through 3mm sieve size and stored in moisture and rodent free places until required for laboratory chemical analysis and treatment ration formulation. Some of the other feed ingredients used in the current experiments such as maize, sorghum and limestone were purchased from Jimma local market and separately grounded to pass through 3mmsieve size and stored in safe place until required for feeding. Wheat bran, soya bean meal, bone and meat meal, lysine, methionine, salt and vitamin and mineral premixes were purchased from Addis Ababa and transported to the experimental site.

3.3. Laboratory Chemical Analysis

Representative samples of the potato peel meal and the other feed ingredients (maize, sorghum, soya bean, wheat bran and bone and meat meal) were taken for proximate analysis. All the sample feeds were oven dried and grounded to pass through 1mm sieve size. The grounded sample feeds were separately stored in air-tight plastic bags until required for laboratory chemical analysis. Dry matter (DM), crude fiber (CF) and total ash were determined at animal nutrition laboratory of JUCAVM, according to AOAC (1990).

Nitrogen was determined at Food Science and Post-Harvest Technology laboratory using Kjeldhal procedure and crude protein (CP) was calculated by multiplying N content by 6.25. The metabolizable energy content of the feed ingredients were calculated using the following formula suggested by Pauzenga (1985). ME (kcal/kg) = 37*% CP +81.8*%EE+35.5*NFE. Where; ME = Metabolizable Energy; CP= Crude protein; EE= Ether Extract, NFE=Nitrogen Free Extract.

3.4. Experimental Ration Formulation

Total of four starter and finisher broilers' treatment rations shown in Tables 1 and 2, were formulated based on the laboratory analytical data. Soon after the treatment ration formulation, representative samples were taken from each of the experimental treatment and subjected to laboratory chemical analysis for the purpose of adjustment of energy and protein contents of the treatments in accordance to the nutrient requirement of the experimental birds. The starter's treatment rations were formulated to contain 3025-3161 Kcal of Metabolizable energy/kg of dry matter and 21-22% of crude protein. The finisher's treatment rations were formulated to contain 3106-3217 Kcal of Metabolizable energy/kg of dry matter and 19-19.5% of crude protein. Both the starters and finishers treatment rations were formulated in accordance of requirement (NRC,1994). Maize and sorghum were included in the control starters and finishers treatment rations (T1) as the major source of energy. Potato peel meal was included to replace 5, 10 and 15% of the energy value of maize in T2, T3 and T4 respectively. Soya bean meal was included as the major source of proteins. All the treatment diets were equally fortified with vitamin and mineral premix and synthetic amino acids (lysine and methionine) in accordance with the National Research Council recommendation (NRC, 1994).

Table 1.Proportion of Feed Ingredients and Composition of Broilers Starters Treatment Rations

	Treatments			
Feed Ingredients	T1	T2	T3	T4
Maize	55	52.25	49.5	46.75
Potato Peel Meal	0	2.75	5.25	8.25
Sorghum	10	10	10	10
Soya bean Meal	25	25	25	25
Wheat bran	1.2	1.2	1.2	1.2
Bone and Meat Meal	6	6	6	6
Limestone	1	1	1	1
Lysine	0.25	0.25	0.25	0.25
Methionine	0.3	0.3	0.3	0.3
Salt	0.25	0.25	0.25	0.25
Vitamin premix	1	1	1	1
Total	100	100	100	100
Calculated analysis				
DM	91	90	89.9	89.9
Crude Protein (%)	21	21.5	22	22
CF(%)	4	4.5	4.8	5.5
EE(%)	3.79	3.39	3.52	3.38
Ash(%)	3.78	3.88	4.43	4.49
NFE(%)	58.43	56.43	55.15	54.53
Energy (ME/kg DM)	3161	3087.2	3059	3025
Calcium	1.02	1.02	1.01	1.01
Phosphorus	0.66	0.64	0.63	0.61

T1= Ration containing 0% Potato Peel Meal, T2= Ration containing 5%Potato Peel Meal,
T3= Ration containing10% Potato Peel Meal, T4= Ration containing 15% Potato Peel Meal

Table 2. Proportion of Feed Ingredients and Composition of Broilers Finisher Treatment Rations

	Treatments			
Feed Ingredients	T1	T2	T3	T4
Maize	55	52.25	49.5	46.75
Potato Peel Meal	0	2.75	5.25	8.25
Sorghum	13	13	13	13
Soya bean Meal	17	17	17	17
Wheat bran	6.2	6.2	6.2	6.2
Bone and Meat Meal	6	6	6	6
Limestone	1	1	1	1
Lysine	0.25	0.25	0.25	0.25
Methionine	0.3	0.3	0.3	0.3
Salt	0.25	0.25	0.25	0.25
Vitamin premix	1	1	1	1
Total	100	100	100	100
Calculated analysis				
DM	91	90	89.9	89.9
Crude Protein (%)	19	19.5	19.5	19.45
CF(%)	6.5	6.9	7.5	7.7
EE(%)	7	6.5	6.8	6.9
Ash(%)	3.4	3.38	3.43	3.49
NFE(%)	54.7	53	51.67	51.35
Energy (ME/kg DM)	3217	3134.7	3112	3106.5
Calcium	1.01	1.01	1.02	1.03
Phosphorus	0.67	0.71	0.75	0.78

T1= Ration containing 0% Potato Peel Meal, T2= Ration containing 5%Potato Peel Meal, T3= Ration containing10% Potato Peel Meal, T4= Ration containing 15% Potato Peel Meal

3.5. Management of Experimental Chicks

A total of 120 unsexed day old Cobb-500 broiler chicks were purchased from Alema commercial poultry farms, located in Bishoftu. The chicks were transported to JUCAVM Poultry Farm, individually weighed and randomly divided into 4 groups each with 30 chicks. Each group was further sub-divided in to three groups each with 10 chicks of comparable group weight. Experimental pen was thoroughly cleaned, disinfected, well ventilated and provided with all the necessary poultry house equipment's before the arrival of the chicks. Each group was housed in with dimension of 2.5x1m, which was designed to accommodate 10 chickens along with manual round feeders and drinkers. Finally the chicks were randomly allotted to the four dietary treatments of starters ration (Table 1) in completely randomized design with three replications for a period of 21 days as shown in Table 3. At the end of the 21 days feeding period, the experimental chicks were switched over to dietary treatment of finisher ration (Table 2) for further feeding period of 21 days. The chicks were vaccinated against Marek's disease, Newcastle disease and Gomboro on the 1st, 14th and 21st day respectively. The experimental diets were offered twice a day at 8:00PM and 16:00AM hours throughout the experimental period. Water was made available at all times.

Table 3: Experimental design of feeding trial

Treatments	Replication per treatment	Number of birds per replication	Total
T1(ration containing 0%PPM)	3	10	30
T2(rationcontaining5%PPM as substitute of Maize)	3	10	30
T3(ration containing 10%PPM as substitute of Maize)	3	10	30
T4(ration containing 15%PPM as substitute of Maize)	3	10	30
Total			120

PPM= Potato Peel Meal

3.6. Data Collection

3.6.1. Production Performance

The initial body weight of the chicks was taken as the group weight for each replicate prior to the distribution of the birds to their respective treatment groups. Weekly weight was monitored and recorded to determine growth trend that may be attributed to the dietary treatments. Weekly weighing was done before feeding in the morning. Final body weight was taken at the termination of the feeding trial. Feed intake was determined by difference between the feed offered and the left-over on a weekly basis. Weekly feed intake per group and per head was calculated as: FI= (Feed offered-feed leftover) per week (Amao *et al*. ,2015). Feed conversion ratio was determined by dividing the average feed consumed by the average body weight gain. Feed conversion ratio was calculated for periods between 1-21 and 22-42 days of age on the basis of feed intake and weight gain.

FCR = $\frac{Amount\ of\ feed\ consumed\ (g)}{Body\ weight\ gain} perweek$ (Amao *et al*., 2015).

Mortality and disease conditions were recorded as occurred and expressed in percent at the end of experimental period.

3.6.2. Determination of Carcass Characteristics

At the end of the 42 days of the feeding trial, 2 birds (one male and one female) with comparable body weight were randomly selected per replicate for carcass and organ weight evaluation. The selected birds were starved for 12 hours prior to slaughter while water was provided. The birds were weighed to compare live and slaughter weights. Slaughtering was done by severing the jugular vein with a sharp knife. After evisceration, the data on hot carcass and organ weights were recorded and expressed in gram. The eviscerated carcass was chilled at 4 ^{o}C for 24 hours. Cold carcass weight was determined. Dressing percentage was calculated as percentage of live weight excluding edible offal (skin, gizzard and liver). Finally, the carcass was partitioned in to breast, wing, drumsticks with thigh, neck and back yields and weighed and expressed in gram based.

3.6.3. Determination Meat pH

The pH meter electrode was introduced directly into the breast (*Pectoralis major*) muscle at a depth of 2.0 cm below the surface (Anca *et al*.,2017).

3.6.4. Proximate Analysis

Moisture content was measured based on weight loss from a definite quantity of meat, after 24 hours oven drying at 105°C. The dried sample was cooled in desiccators and weighed. The moisture content was calculated as a percentage of fresh sample weight as follows.

Moisture %= $\frac{\text{weight of fresh sample} - \text{weight of dry sample}}{\text{weight of fresh sample}} x100$ (AOAC, 1990)

Crude protein content was determined by using Kjeldahl method following the procedure described by (AOAC, 1990). Fat content was determined by extracting meat sample with diethyl ether using the procedure described by (AOAC, 1990). Ash content was determined according to AOAC, (1990).

3.6.5. Partial Budget Analysis

Upton (1979) was used to estimate the partial budget analysis of each treatment ration. Market price of formulated ration (concentrate) was registered at the time of experiment. Total feed cost was calculated by multiplying feed consumed by the birds with the cost of the ration/kg. Cost of maize was calculated as percent from total cost of ration. Total Cost of feed for each treatment was calculated as maize substituted by potato peel meal as percent of inclusion level. Total return (TR) was calculated as a total dressed carcass or meat (kg) multiplied by price of meat at Jimma Town during the termination of experiment period. Fixed cost such as medication, light, labor etc. are not included (Fixed cost =0). Net return (NR) =Total return (TR) -Total variable costs(TVC). Change in total variable cost (ΔTVC) was calculated as total feed cost of treatments containing potato peel meal (termed as experimental ration) minus total feed cost of treatments without potato peel meal *(*control). The change in TR was calculated as the difference between total incomes from the respective experimental treatments minus total income of the control. Change in NR was calculated as NR of the respective experimental treatments minus NR of the control experiment. The marginal rate of return (MRR) measures ΔNR associated with each additional units of expenditure (ΔTVC). It is calculated as: MRR = ΔNR/ΔTVC.

3.7. Data Analysis

All the data collected were subjected to analysis of variance (ANOVA) for completely randomized designs consisting of four treatments with 3 replications using the General Linear Models (GLM) Procedure of Statistical Analysis System (SAS, version 9.3). Treatment means were compared with Duncan's Multiple Range Test (DMRT). All means of statistical differences were based on $P<0.05$. The following model was employed for the data analysis.

$Y_{ij} = \mu + T_i + e_{ij}$ Where,

Y_{ij} = individual measurement on each bird ,

μ = overall mean, T_i = effect due to the i^{th} dietary treatment,

e_{ij} = random error.

4. RESULT AND DISCUSSION

4.1. Chemical Composition of Potato Peel Meal

The result of the laboratory chemical analysis of potato peel meal is shown in Table 4. The current metabolizable energy content of potato peel meal was 2826 kcal/kg compared to that of maize (3350 kcal/kg) used in the current study. Cereal grains provide 60–70% of dietary energy for poultry (Ekeyem *et al* ., 2006) and maize is an excellent feed ingredient extensively used as an energy source in poultry feeding. According to Simplot (2013), the energy content of potato tubers is about one-third of that of an equivalent weight of maize grains due to high moisture content of potato tubers. However, high yields of potato give more energy per land unit compared to maize indicating the feasibility of inclusion of potato tuber into poultry feeding system. The ME content of the rations used in the current study was contradicted with that of Ghazalah *et al* .(2002), who reported that potato peel meal contains 3200kcal /kg of metabolizable energy. The protein content of potato peel meal recorded from the current study was 13%, the value of which was higher than that of Wafar *et al.(*2017), who reported that sun dried potato peel contains 11.61% of CP.

The crude protein of potato peel meal recorded from the current study (13%) was also higher than that of most of the cereal grains (8-12%). According to Simplot (2013), the crude protein content of potato is slightly higher than that of the other roots and tubers. According to the result of the current study crude protein content of 13% was recorded from potato peel meal, the value of which was significantly higher than that of potato tuber. Fat content, measured as percent ether extract, of 0.7% was recorded from potato peel meal. According to the result of this study, the crude fibre content of potato peel meal was 5.71 %. This indicate that potato peel meal can be included in poultry feed. This value is lower than that of Hassan (2017) and Wafar *et al*. (2017), who reported crude fiber content of 10.17% and 8.01%, respectively, for potato peel meal. The differences in chemical composition of the peel might be due to peeling method, variety of potato and drying time.

Table 4: Proximate Analysis and Calculated ME of maize and potato peel meal

Constituents	Ingredients	
	maize	potato peel meal
Moisture (%)	7.50	8
DM (%)	92.50	92
Crude protein (%)	7.00	13
Crude Fiber (%)	2.10	5.71
Ether Extract (%)	4.00	0.7
Ash (%)	1.80	7.63
*Nitrogen Free Extract (%)	77.9	64.96
**Calculated Metabolizable Energy (kcal/kg)	3350	2826

ME= Metabolizable Energy, * Nitrogen Free Extract = DM% - (Crude protein + Crude fiber + Ether extract + Ash)

**ME (kcal/kg)= 37*% Crude protein+81.8*Ether Extract %+35.5*Nitrogen Free Extract(Pauzenga,1985).

4.2. Performance of the Experimental Chicks

4.2.1. Feed intake

The results of feed intake of the experimental chicks placed on starter treatment rations are shown in Table 5. The results obtained showed that the mean weekly feed intake of the treatment groups placed on maize based ration (0% potato peel meal) was significantly higher ($P<0.05$) than the others, during the 1st week of experimental period, On the contrary there was no significant difference ($P>0.05$) between the treatment groups placed on the treatment rations in which 5-15% of maize was substituted by potato peel meal in weekly feed intake. This result indicate that inclusion of 5-15% of potato peel meal at the expense of Maize depressed feed intake during the first week of feeding compared to maize based broilers starters ration. However, there was improvement in the mean feed intake of the groups placed on broilers starters ration containing 5-15% potato peel meal as substitute of maize with advancement in age and feeding period. This is might be attributed to the adaptability of the experimental chicks to potato peel meal feeding gradually with time. The mean weekly feed intake of the groups placed on maize based starters, treatment ration was 113.33 g/head, whereas; the mean weekly feed intake of the groups fed on the starters treatment ration, containing potato peel meal as substitute for 5, 10 and 15% of maize were 110.66, 110.33 and 110.66g /head respectively.

There was no significant difference (P>0.05) between all the groups placed on starters treatment ration in mean weekly feed intake during weeks 2-5, indicating that potato peel meal could safely be used to replace 5-15% of maize in broiler starters ration during 2nd and 3rd week of the feeding trial. The result of weekly feed intake, during finisher phase was presented in Table 5. The results obtained indicated that there was no significant difference (P>0.05) between all the groups fed on finishers treatment ration in mean weekly feed intake during the 4th and 5thweek of the feeding trial. On the contrary the mean weekly feed intake of the groups receiving finishers broilers ration containing 5-15% of potato peel meal as substitute of maize was significantly (P<0.05) higher than that of the group assigned to the maize based control treatment ration, during the 6thweek of the feeding trial.

The results of the current study showed that potato peel meal could safely be used to replace 5-15% of maize in finishers ration as measured by mean weekly feed intake. The results obtained showed that there was increase in feed intake with increasing level of inclusion of potato peel meal. Hence, experimental broilers fed on the treatment containing 0 and 15% potato peel meal showed the lowest and highest feed intake .respectively. This might be due to the higher metabolizable energy contained in maize relative to potato peal meal. It has been suggested that feed intake of broilers is linked to metabolizable energy of the ration, in that, broilers will tend to consume less of high energy feeds than high energy feeds to satisfy their energy requirement. The current result was in line with that of Dela (2016), who reported that feed intake of broilers increased with increased level of inclusion of Cocoyam meal in the broiler chicks ration. The result of the current study was also in agreement with that of Badr *et al*., (2019) who reported that inclusion of prickly pear peel resulted in increase in feed intake of the experimental broiler. Ekenyem *et al*. (2006) also reported that inclusion of yam peel meal in broiler diet significantly increased (P<0.05) feed intake. Similarly, Blandon *et al*.(2015), reported that the feed intake of the experimental broiler increased due to increased level of inclusion of banana peel meal.

Table 5: Effect of Partial Substitution of Potato Peel Meal with Maize on Weekly Feed intake of the Experimental Chicks (Mean±SE)

Week	Dietary treatments				
	T1	T2	T3	T4	PV
Week 1	113.33±0.33^{a}	110.66±1.73^{b}	110.33±0.33^{b}	110.66±0.66^{b}	0.004
Week2	314.66±0.33	314.66±0.33	313.66±0.88	315.66±0.66	0.21
Week 3	510±5.77	511.66±1.66	516.66±1.66	511.66±5.69	0.72
Week 4	730±30	773.33±3.33	758.33±18.33	770±10.00	0.38
Week5	913.3±20.27	926.66±40.55	983.30±20.27	960.33±15.27	0.28
Week 6	1066.67±6.67^{b}	1086.67±13.3^{ab}	1101.6±14.81^{ab}	1108.3±10.33^{a}	0.01
Overall	3638.00±26.45	3713.67±47.34	3754.67±15.43	3751.33±33.21	0.11

In each row, means with different superscript letters are significantly different (P<0.05).
T1= Control , T2= 5% PPM, T3= 10%PPM, T4= 15% PPM, PV= Probability Value

4.2.2. Live Body Weight Gain

The results of the growth performance of the experimental chicks are presented in Table 6. The mean initial body weights of all groups of the experimental chicks were comparable. The results obtained revealed that the experimental chicks fed on the maize based control treatment ration attained mean live body weight of 152.79 g/head and mean weekly body weight gain of 97 g/head the values of which were significantly (P<0.05) higher than the others at the end of the first week of the feeding trial. Significantly lower (P<0.05) live body weight ranging between 149 and 150 g/head were recorded for the groups fed on the treatment rations containing 5-15% of potato peel meal as substitute for maize which might be due to significantly (P<0.05) lower feed intake. Feed intake is the major factor that influences body weight gain of broiler (Ferket and Gernat 2006). The result of the this study was in line with that of Diarra *et al.*(2012), who reported that replacing 15% maize with yam peal meal in broilers diets significantly depressed performance during the starter phase. There was no significant difference (P>0.05) between the groups fed on the treatment rations containing different levels of potato peel meal in mean live weight and weekly body weight gain.

However, the groups fed on T1, T2, T3 and T4 attained mean live body weight of 663, 667, 668 and 667g/head and brought mean weekly body weight gain of 314, 316, 318 and 317g/head respectively at the end of 21 days of the feeding trial, without showing significant difference (P>0.05) between each other. Similarly there was no significant difference (P>0.05) between all the groups fed on broilers finishers treatment ration during the 4th week of the feeding trial, indicating that maize could safely be replaced with potato peel meal at 5-15% both in broilers starters and finishers ration without affecting growth rate as measured by mean weekly body weight gain. Statistically significant difference (P<0.05) between the treatment groups in mean live body weight and mean weekly body weight gain appeared during the last 14 days of feeding finishers treatment ration.

As showed in Table 6, final live body weight of 2113, 2177, 2184 and 2171g/head was attained by the group fed on the finishers treatment ration containing 0, 5, 10 and 15% of potato peel meal respectively at the end of the 6th week of the feeding trial. The groups placed on maize based finishers control treatment ration (T1), attained live body weight of 2113g/head at the end of the 6th week of the feeding trial, the value of which was significantly (P<0.05) lower than all the others. According to the result of this study, numerically higher final mean live body weight of 2184g/head was recorded for the groups fed on the broilers finishers ration containing 10% potato peel meal as substitute of maize, followed by the groups assigned to the finishers treatment ration containing 5% potato peel meal. The higher body weight attained might be reflected from the higher feed intake of potato peel meal substituted groups hence feed intake is the most determining factor for body weight gain. Body weight has been reported to increase in proportion to feed intake (Bogart and Taylor, 1983). The result of the current study was in agreement with that of Kpanja *et al*.(2019), who reported that inclusion of potato peel meal up to 15% into broilers ration positively affected growth performance. Diarra *et al*.(2012), reported that during finishing period a significant increase of body weight and body weight gains in broiler chickens fed yam peel meal up to 15% then declined. The result of the current study was also in agreement with that of Ekenyem *et al*.(2006), who reported that inclusion of yam peel meal resulted in increase in live weight of the experimental broiler. Badr *et al* .(2019) also reported that inclusion of up to 15% of prickly pear peel fruit in ration resulted in increased growth performance of Cobb-broiler.

Table 6: Effect of Partial Substitution of Potato Peel Meal with Maize on Weekly Body Weight of Experimental Chicks (Mean±SE)

Week	Parameter	Dietary treatments				
		T1	T2	T3	T4	PV
Initial	IBW(g)/chick	55.80±0.11	55.7±0.11	55.90±0.55	55.93±0.31	0.95
Week 1	BW(g)/chick	152.79±0.70^{a}	150.86±0.153^{b}	150.05±0.27^{b}	149.74±0.3^{b}	0.003
	BWG(g)/chick	96.99±0.81^{a}	95.166±0.093^{b}	94.15±0.27^{b}	93.80±0.62^{b}	0.01
Week 2	BW(g)/chick	348.47±2.59	350.52±1.53	349.86±0.91	349.860±0.91	0.84
	BWG(g)/chick	195.68±2.19	199.65±2.5	199.143±1.42	199.12±2.74	0.2
Week 3	BW(g)/chick	663.26±4.71	667.450±5.72	668.81±4.44	667.31±1.81	0.98
	BWG(g)/chick	314.790±3.31	316.93±4.20	318.95±3.58	317.45±2.58	0.97
Week4	BW(g)/chick	1073±15.48	1120.44±19.06	1089.38±5.80	1083.34±10.68	0.16
	BWG(g)/chick	409.79±16.20	452.99±16.15	440.56±21.00	437.69±8.53	0.34
Week 5	BW(g)/chick	1568.20±21.04^{b}	1620.82±8.11^{a}	1623.15±9.43^{a}	1603.20±3.09^{a}	0.04
	BWG(g)/chick	491.81±10.90	500.37±20.43	553.77±8.71	519.85±13.73	0.2
Week 6	BW(g)/chick	2113.3±9.90^{b}	2177.29±14.40^{a}	2184.44±1.96^{a}	2171.25±5.6^{a}	0.01
	BWG(g)/chick	545.13±3.58	556.48±6.45	561.29±9.70	568.05±2.87	0.14
Over all	BWG(g)/chick	2057.53±18.54^{b}	2121.59±14.33^{a}	2128.54±2.51^{a}	2115.32±5.79^{a}	0.01

In each row, means with different superscript letters are significantly different ($P<0.05$). T1= Control , T2= 5% PPM, T3= 10%PPM, T4= 15% PPM, PV= Probability Value, IBW=Initial Body Weight, BWG= Body Weight gain, BW= Body Weight.

4.2.3.Feed Conversion Ratio

The results of the feed conversion ratio of the experimental chicks are shown in Table 7. There was no significant difference between all the treatment groups in feed conversion ratio. The current result indicated that feed conversion ratio of 1.17, 1.16, 1.17 and 1.18 was recorded for the groups fed on T1, T2, T3, T4, during the first week of the experimental period respectively, without showing significant difference (P>0.05) between each other. The current result of feed conversion ratio recorded was in line with the result of Dessie *et al.*(2016), who reported that the feed conversion ratio of Cobb-500 placed on commercially produced feed was 1.149. The feed conversion ratio obtained from the current study was slightly lower than the target performance of the breed which is reported to be below 1.00. According to the results of this study, the amount of starters ration required to produce 1 gram of body weight gain was 1.5 and 1.6 g during the 2nd and 3rd week of the feeding trial for all treatments . The results of the current study indicated that maize grain could safely and efficiently be replaced by potato peel meal at 5-15% in broilers starters ration without affecting feed conversion ratio.

The results of the feed conversion ratio of the experimental chicks during the finishing period are also shown in Table 7. There was no significant difference (P>0.05) between all the treatment groups in feed conversion ratio during the finishing period. The current result indicated that T1, T2, T3 and T4 consumed mean finishers ration of 1.78 ,1.71, 1.72 and 1.76g respectively, for each gram of live body weight gained during the 4th week of the feeding trial. The amount of finishers ration required to produce 1 gram of body weight gain was 1.85, 1.85, 1.84 and 1.85 for the groups fed on T1, T2, T3 and T4 respectively, during the 5th week of the feeding trial. The amount of finisher ration required to produce 1 gram of body weight gain was 1.96, 1.95, 1.96 and 1.98 for the groups placed on T1, T2, T3 and T4 respectively during the final week of the feeding trial, indicating that substitution of maize by potato peel meal up to 15% does not affect feed conversion ratio of the experimental Chicks. The entire feed conversion ratio of Cobb-500 under the current study was 1.75,1.75, 1.76 and 1.77 for T1, T2, T3 and T4 respectively. The current result was relatively lower than the result obtained by Yared (2019), which was 1.6 during the entire period.

The result of the current study was in agreement with that of Ekenyem *et al.*,(2006), who reported that there was no significant difference (P>0.05) in feed conversion ratio of Anak 2000 broiler chicks as a result of substitution of Maize with yam peel meal up to 15%. Akira *et al.*(2019) also reported that there is no significant difference (P>0.05) in feed conversion ratio of Ross 308 between control and dry heat processed sweet potato waste substituted groups during the entire period. On the other side, the result of the current study was contrary to the result of Badr *et al.* (2019) who reported that substitution of maize by prickly pear peal up to 15% improves feed conversion ratio of Cobb 500 broiler.

Table 7: Effect of Partial Substitution of Potato Peel Meal with Maize on Weekly Feed Conversion Ratio of Experimental Chicks (Mean±SE)

Week	Dietary treatments				
	T1	T2	T3	T4	PV
Week 1	1.17±0.01	1.16±0.006	1.17±0.003	1.18±0.012	0.57
Week2	1.58±0.013	1.57±0.01	1.58±0.012	1.58±0.013	0.23
Week 3	1.62±0.017	1.61±0.018	1.62±0.04	1.63±0.01	0.98
Week 4	1.78±0.003	1.71±0.06	1.72±0.03	1.76±0.045	0.63
Week5	1.85±0.01	1.85±0.006	1.84±0.01	1.85±0.02	0.86
Week 6	1.96±0.006	1.95±0.003	1.96±0.006	1.98±0. 0.006	0.25
Over all	1.75±0.012	1.75±0.02	1.76±0.006	1.77±0.01	0.71

T1= Control , T2= 5% PPM, T3= 10%PPM, T4= 15% PPM, PV= Probability Value

4.3. Carcass and Internal Organ Characteristics

4.3.1. Carcass Characteristics

The results of carcass yield and characteristics of the experimental chicks are shown in Table 8. The result obtained showed that there was significant difference (P<0.05) among the treatment groups in dressing percentage. Comparatively higher (P<0.05) carcass dressing percentage of 66.3% was recorded for the groups fed on the treatment ration containing 5% of potato peel meal as substitute for maize, followed by that of the group fed on the treatment containing 10 and 15% of potato peel meal as substitute of maize respectively. The result of the current study was in agreement with that of Yibrew *et al.,* (2012) who reported that substitution of maize with mango fruit waste resulted in increase in dressing percentage of Cobb-500 broiler compared to the groups fed on maize based control treatment.

There was no statistically significant difference (P>0.05) among all the treatment groups in carcass cut parts as indicated in Table 8. However, the groups placed on the treatment containing 5-15% potato peel as substitute of maize had higher numerical value of carcass and carcass cut parts. The result of this study was in line with that of Batta *et al* .(2019), who reported that Rabbits fed on 15% prickly pear peel ration had the higher values in terms of carcass weight and carcass parts than the control treatment group. Similarly, Badr *et al* .(2016) reported that inclusion of up to 15% of prickly pear peel as substitute for yellow maize resulted in increase in carcass weight and dressing percentage of Cobb 500 broilers.

Table 8: Effect of partial substitution of Potato Peal Meal with Maize on Weight of Carcass and Carcass cut parts of Broiler(Mean±SE)

Parameters	Dietary Treatments				
	T1	T2	T3	T4	PV
Live weight (g)	2123.50 ±5.50	2131.50±13.38	2131.33±26.89	2129.17±28.99	0.99
Carcass (g)	1384.17±2.006	1406.67±9.93	1406.33±17.32	1403.50±21.23	0.61
Dressing percentage (%)	65.18±0.001^{b}	66.3±0.001^{a}	65.9±0.001^{a}	65.9±0.002^{a}	0.002
Breast (g)	540.35±0.80	548.50± 3.83	548.66± 6.81	547.833±6.79	0.625
Drumstick with thigh(g)	470.93± 0.742	478.16±3.42	478.16± 5.95	476.83±6.56	0.67
Back	229.058± 0.51	232± 1.59	231.83± 2.83	231.5± 3.06	0.77
Neck	48.44±0.20	49.66±0.49	49.33± 0.66	49.33±0.80	0.50
Wing (g)	97.05±0.26	98.33± 0.61	98.16± 1.10	99±1.483	0.80

In each row, means with different superscript letters are significantly different ($P<0.05$).

T1= Control , T2= 5% PPM, T3= 10%PPM, T4= 15% PPM, PPM =Potato Peel Meal, PV= Probability Value

4.3.2. Internal organs of the Experimental Chicks

The result of internal organs of the experimental chicks are shown in Table 9. The current result indicated that there was no significant difference ($P<0.05$)between all the treatment groups in internal organs (Gizzard, kidney, heart and liver), indicating that there were no negative effects on the physiological and anatomical functions of the internal organs as a result of substitution of maize by potato peel meal at a level of 5-15%. The current result was in agreement with that of Guluwa *et al*.(2014) who reported that water soaked sweet orange peel did not affect internal organs like heart, liver, gizzard, intestinal weight. Akira *et al*.(2019) also reported that there is no significant difference ($P>0.05$) in internal organ of Ross 308 fed on control and dry heat processed sweet potato waste substituted groups. The current result was also in line with that of Badr *et al*.(2019), who reported that substitution of prickly pear peel up to 15% had no effect on the giblet percentage of Cobb-500 broiler chicks.

Table 9: Effect of partial substitution of Potato Peal Meal with Maize on Internal organ of Broiler (Mean±SE)

Parameters	Dietary treatments				
	T1	T2	T3	T4	PV
Gizzard (g)	49.16±0.83	47.5±1.11	45.83±2.006	47.5±2.14	0.63
Liver with bile (g)	40.50± 1.60	40± 1.80	38.33±1.50	38.33±1.05	0.26
Kidney(g)	4.50±0.34	4.5±0.34	4.5±0.34	4.33±0.33	0.98
Heart (g)	9.52± 0.19	9.77± 0.134	9.77± 0.130	9.82± 0.12	0.38
Small intestine(cm)	205.166±1.97	205.50± 2.99	202.0±4.92	203.50± 1.25	0.56

T1= Control , T2= 5% PPM, T3= 10%PPM, T4= 15% PPM, PPM =Potato Peel Meal, PV= Probability Value

4.4. pH and Chemical Composition of the Meat

4.4.1. pH of meat

The breast meat pH is an important indicator of meat quality traits. In this study, the pH values observed for all the treatment groups were within the normal range reported for chicken meat (Castellini *et al* . , 2002).

4.4.2. Chemical Composition of the Meat

The results of the chemical composition of the meat of the experimental chicks are presented in Table 10. There was no significant difference between all the treatment groups ($P<0.05$) in meat composition.. There was numerical difference among the treatments groups in all the parameters considered as shown in table 10. Numerically control group meat had higher moisture and EE while lower in Ash, CP and DM content than potato peel meal substituted groups. The current result was agreed with the result of Badr *et al* .(2019), who reported that prickly pear peel substituted for maize showed increase in protein and Ash while lower in EE than control group.

Table 10: Effect partial substitution of Potato Peel Meal with Maize on Chemical Composition and pH of broiler breast Meat (Mean±SE)

Parameters	Dietary treatments				
	T1	T2	T3	T4	PV
pH after slaughter	6.39±0.003	6.39±0.006	6.39±0.003	6.48±0.09	0.75
Moisture	72.6±0.59	70.65±1.35	70.48±1.053	69.72±0.99	0.31
DM	27.4±0.59	29.34±1.35	29.51±1.05	30.27±0.99	0.31
CP	19.49±0.74	22.31±1.41	22.56±0.90	23.40±0.95	0.11
EE	4.66±0.08	3.24±0. 002	3.25±0.10	3.24±0.03	0.30
Ash	3.24±0.48	3.78±0.21	3.69±0.05	3.633±0.08	0.54

DM= Dry Matter, CP=Crude Protein, EE=Ether Extract, T1= Control , T2= 5% PPM, T3= 10%PPM, T4= 15% PPM, PPM =Potato Peel Meal, PV= Probability Value.

4.5. Partial Budget Analysis

According to the result of partial budget analysis in Table 11, feed cost was linearly decreased with increasing level potato peel meal. Broiler chick fed on T4 (ration containing 15% PPM) had the lowest feed cost/ weight gain than other treatments. The findings of Ekenyen (2002) and Lamidi *et al*. (2008) suggest that reducing feed cost/kg was only justifiable when production results are comparable with the control. This study proved that inclusion of potato peel meal up to 15% positively affect feed intake, body weight gain and final live weight. The result was also in line with the main objectives of usage of non-conventional feedstuffs as reported by (Emenalom, 2004; Esonu *et al.*, 2004; Tuleun *et al.*,2009).

The result of partial budget analysis showed that broiler chick fed on T4 (ration containing 15% potato peel meal) returned a higher profit than those fed on ration containing 5% ,10% and control group. The cost benefit analysis showed that broiler fed on 0% potato peel meal were recorded the lowest in terms of economy (cost cutting measure) of production. The highest return obtained from T4 was due to substitution of costless potato peel with greater inclusion level. Feed cost/ weight gain tended to decrease with increasing level of potato peel meal. The current result was in line with the earlier report of Jiwuba *et al*. (2018a), who reported that substitution of locally available feed decreased cost/kg feed. Accordingly the net return of broiler on T4 was 332.97 ETB. The highest MRR was recorded by T2, followed by T3 and the least MRR was recorded by T4. However, all treatments were recorded above the minimum acceptable marginal rate of return. Accordingly, the treatment with the highest net return together with an acceptable MRR becomes the tentative recommendation (CIMMYT, 1988). Therefore, the present study was revealed that the substitution of 15% potato peel meal with maize in to the broiler ration is potentially more profitable than the rest treatments.

Table 11: Partial budget analysis of substituting Potato Peel Meal with Maize

Parameters	Dietary treatments			
	T1	T2	T3	T4
Total cost of feed (ETB)/chick	65.52	64.94	63.78	61.93
Cost of maize (ETB)	36.13	34.89	33.41	31.55
Cost of other ingredients(ETB)	29.55	30.05	30.37	30.37
Cost of chick(ETB)	26	26	26	26
TVC	91.52	90.94	89.78	87.93
Feed consumed (kg)/chick	3.64	3.71	3.75	3.75
Final body weight gain(kg)/chick	2.05	2.12	2.12	2.11
Feed cost/kg gain/chick	31.8	30.63	30.08	29.35
Final carcass weight(kg)/chick	1.385	1.406	1.406	1.403
TR (meat sale)* /chick	415	421.8	421.8	420.9
NR (Birr)/chick	323.48	330.86	332.02	332.97
ΔTVC	-	-0.58	-1.74	-3.59
ΔTR	-	6.8	6.8	5.9
ΔNR	-	7.38	8.54	9.49
MRR	-	12.72	4.90	2.64

TVR= Total Variable Cost, NR= Net Return, ΔTVC= Change in Total Variable, ΔTR= Change in Total Return, ΔNR= Change in Net Return, MRR= Marginal Rate of Return ETB=Ethiopian Birr, PPM= Potato peel meal, T1=Control (ration without PPM), T2= ration containing 5%PPM, T3= ration containing 10%PPM, T4= ration containing 15% PPM

1kg concentrate feed =18ETB, *1kg of meat =300ETB at Jimma Town, Fixed costs are not included in this table (Fixed costs = 0).

5. CONCLUSION AND RECOMMENDATIONS

The results of the current study showed that sun dried potato peel meal contained 13% CP, 0.7% EE, 7.63% ash, 64.85% NFE , 5.71% CF and 2826 Kcal of ME. Inclusion of potato peel meal up to 15% as substitute for maize negatively affected body weight and feed intake of the experimental chicks ($P<0.05$) during the first week of the feeding trial. However, there was no significant difference ($P>0.05$) between all the treatment groups in body weight and feed intake at the end of 21 days of the feeding period. Better final live body weight was attained by the groups receiving 5-15% potato peel meal as substitute for maize at the end of 42 days of the feeding trial ($P<0.05$). There was no significant difference in feed conversion ratio of experimental chicks substituted 5-15% of potato peel meal for maize and control group. Carcass yield, internal organ and meat chemical composition of experimental chicks were not affected due to substitution of 5-15% of potato peel meal for maize . Based on the results of current study the following points are recommended.

- On the basis the promising findings presented in this paper, potato peel meal could be included up to 15% as substitute of maize in broiler feed to decrease cost of feed thereby increase profit.
- Further research should be conducted on its effectiveness on layers.

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7. LIST OF TABLES IN APPENDIX

Appendix in Table 1: ANOVA MS for Performance of Starter

Source of variation		W1			W2			W3		
	DF	FI	BW	FCR	FI	BW	FCR	FI	BW	FCR
Treatment	3	5.8^{*}	5.66^{*}	0.00016^{NS}	2.0	2.21^{NS}	0.0009	16.6	2.56^{NS}	0.00002
Error	8	0.58	0.540	0.0001	1.0	8.07	0.0005	36.8	59.48	0.0004
Total	11									
CV		0.6	0.48	0.92	0.3	0.81	1.50	1.18	1.15	1.23

* Significant, NS= Not Significant DF=Degree of Freedom, W= Week, BW =Body weight, FCR= Feed Conversion Ratio

Appendix in Table 2: ANOVA MS for Performance of finisher

		W4			W5			W6		
Source of variation	DF	FI	BW	FCR	FI	BW	FCR	FI	BW	FCR
Treatment	3	1474^{NS}	1133.91^{NS}	0.0019^{NS}	3030.55^{NS}	1931^{*}	0.0001^{NS}	1025^{*}	3190^{*}	0.0001^{NS}
Error	8		645.20	0.0025	2025	455.4	0.0006	408.33	440	0.00006
Total	11									
CV		3.43	2.32	2.85	4.75	1.33	1.36	1.852	0.97	0.41

DF=Degree of Freedom, W= Week, BW =Body weight, FCR= Feed Conversion Ratio

Appendix in Table 3: ANOVA MS for Carcass characteristics

Source of variation	DF	LW (g)	Carcass(g)	Dressing %	Breast (g)	Drumstick with thigh(g)	Back (g)	Neck(g)	Wing (g)
Treatment	3	83.81^{NS}	694.77^{NS}	0.00009^{*}	96.37^{NS}	71.50^{NS}	11.35^{NS}	1.65	1.98
Error	8	2660	1129.75	0.00001	161.86	136.35	30.32		6.11
Total	11								
CV		2.42	2.40	0.55	2.32	2.45	2.38		2.52

* Significant, NS= Not Significant DF=Degree of Freedom, W= Week, BW =Body weight, FCR= Feed Conversion Ratio

Appendix in Table 4: ANOVA MS for Internal organs

Source of variation	DF	Gizzard (g)	Liver with bile(g)	Kidney (g)	Heart (g)	Intestine (cm)
Treatment	3	30.5^{NS}	694.77^{NS}	0.041^{NS}	6.94^{NS}	15.70^{NS}
Error	8	52.91	1129.75	0.69	6.25	22.49
Total	11					
CV		1.53	10.5	1.86	2.6	2.32

* Significant, NS= Not Significant DF=Degree of Freedom

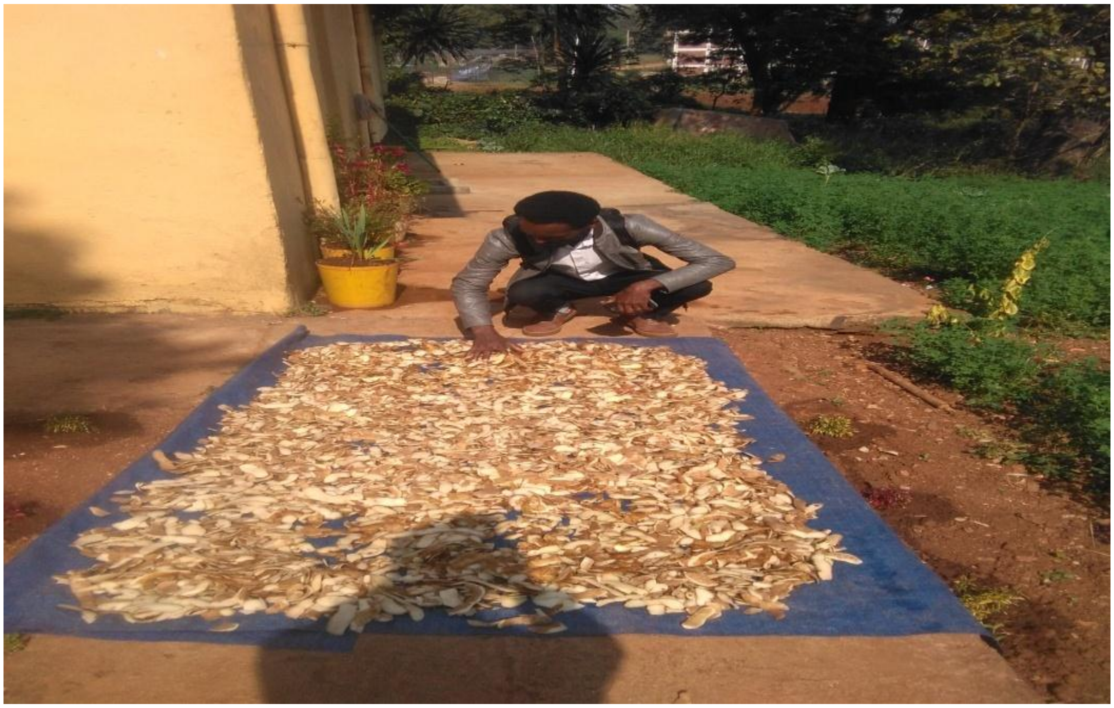
Appendix in Table 5: ANOVA MS Meat Chemical Composition

Source of variation	DF	Moisture	Ether	Ash	CP
Treatment	3	4.50^{NS}	1.25^{NS}	0.27^{NS}	8.67^{NS}
Error	8	3.22	0.08	0.314	3.22
Total	11				
CV		2.53	7.42	1.69	8.17

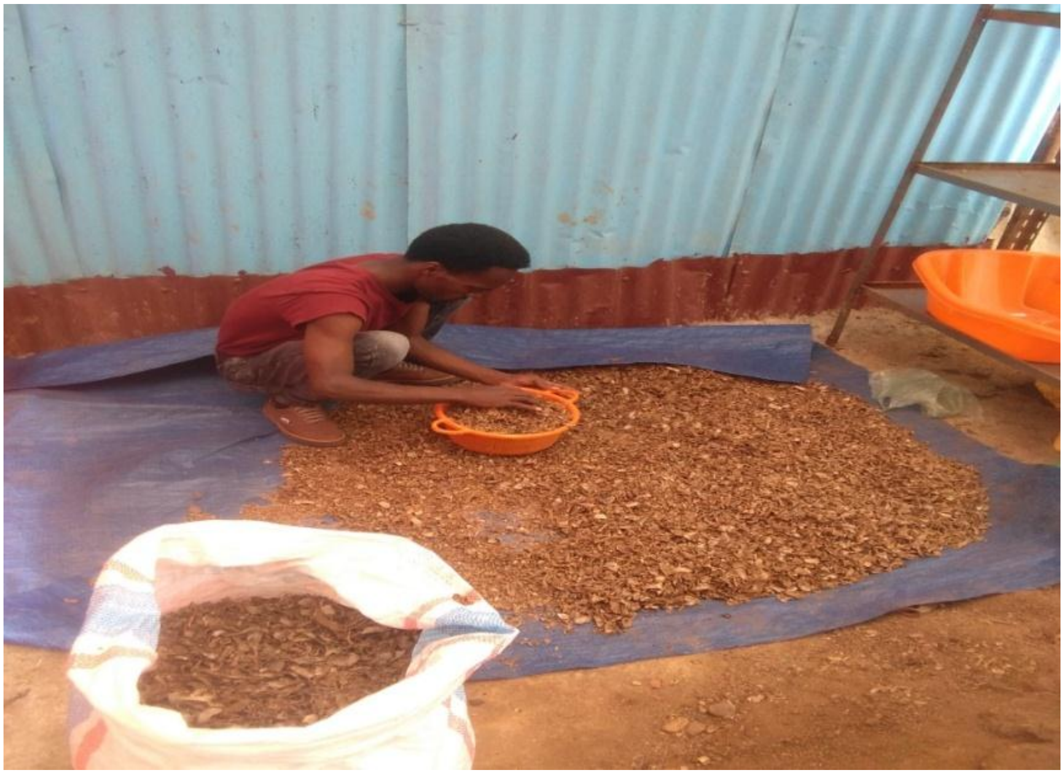
* Significant, NS= Not Significant , DF=Degree of Freedom, CP= Crude Protein

8. LIST OF FIGURES

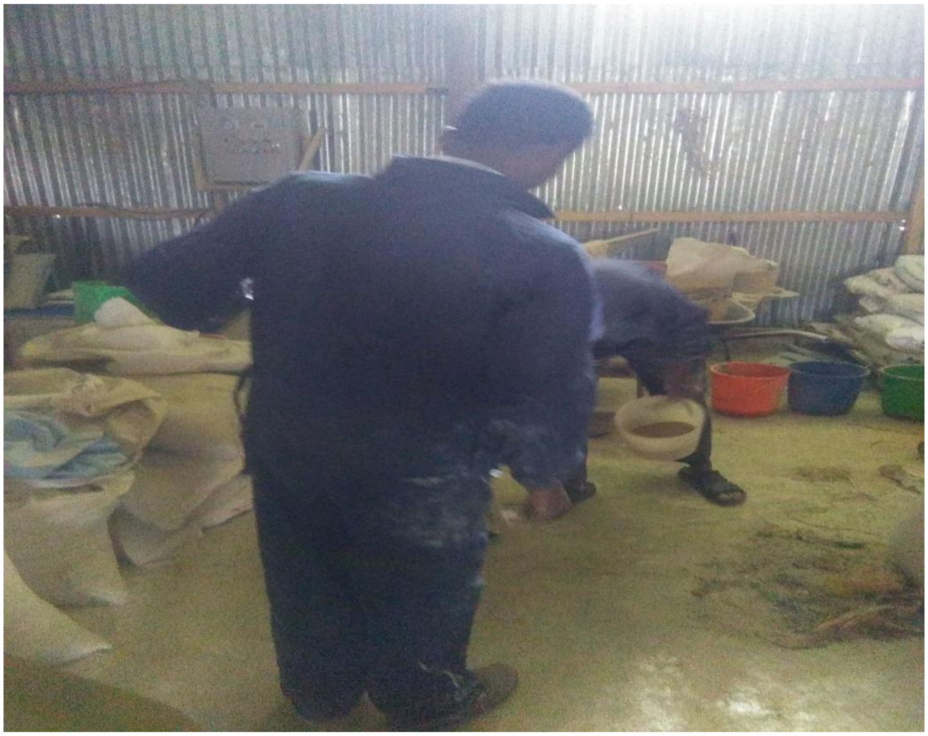
Appendix in Figure 1: Washing of potato peels



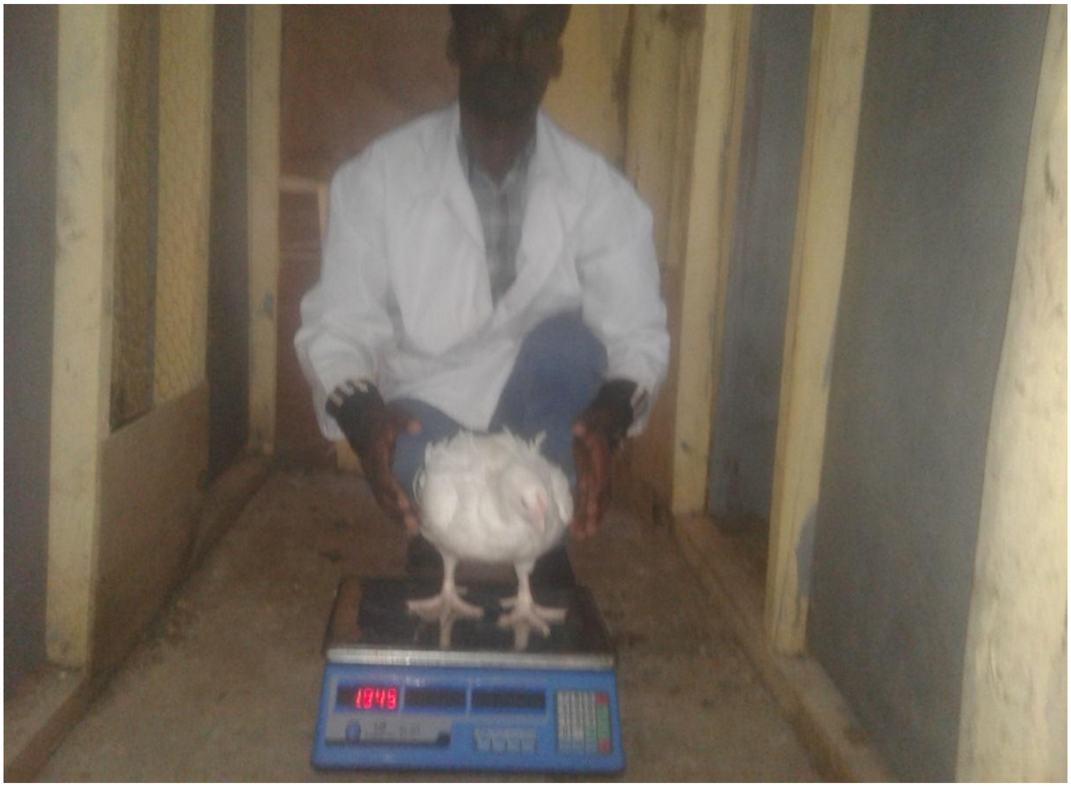
Appendix in Figure 2: Sun drying of Potato Peel



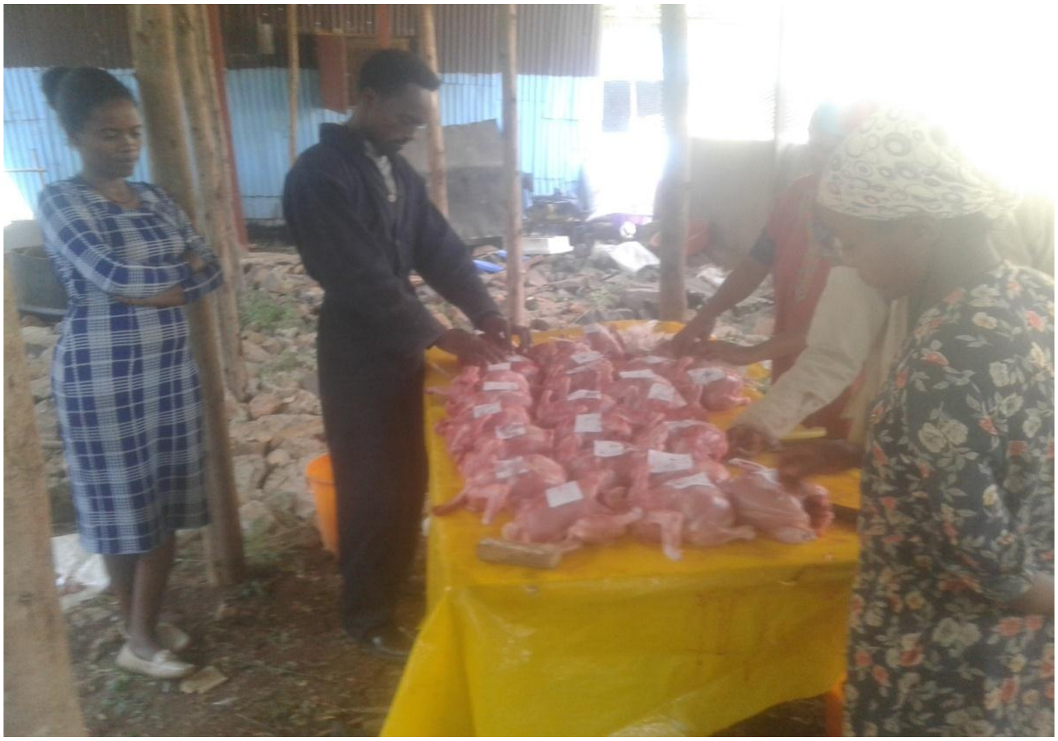
Appendix in Figure 3: Sieving of dried potato peel



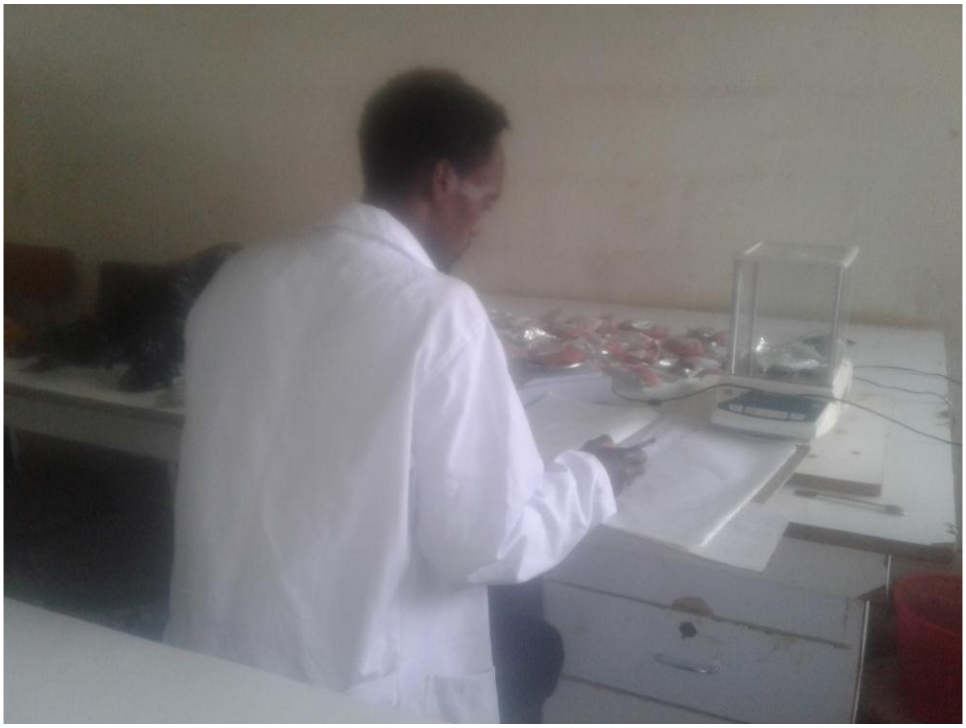
Appendix in Figure 4: Ration formulation



Appendix in Figure 5: Weighing of Chick



Appendix in Figure 6: Labeling of Carcass



Appendix in Figure 7: Laboratory analysis of meat