# REPLACEMENT OF TWO CONVENTIONAL PROTEIN SOURCES WITH ROSELLE SEED (*Hibiscus sabdariffaL*) CAKE IN BROILER DIETS

**BY**

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## DECLARATION

I declare that the work in this thesis entitled**"REPLACEMENT OF TWO CONVENTIONAL PROTEIN SOURCES WITH ROSELLE SEED(*Hibiscus sabdariffaL.*) CAKE IN BROILER DIETS**" has been carried out by me in the Department of Animal Science, Ahmadu Bello University, under the supervision of Dr.P.A. Onimisi and Professor J.JOmage. The Information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this thesis was previously presented for another degree or diploma at this or any other institution.

| _____ | _____ | _____ |
|---|---|---|
| Name | Signature | Date |

## CERTIFICATION

This thesis entitled "**REPLACEMENT OF TWO CONVENTIONAL PROTEIN SOURCES WITH ROSELLE SEED (*Hibiscus sabdariffa L.*) CAKE IN BROILER DIETS"**meets the regulations governing the award of the degree of Master of Science in Animal Science of the Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

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## DEDICATION

This work is dedicated to God Almighty, the Alpha and Omega for seeing me through this program. I say, thank you Lord.

## ABSTRACT

Two feeding trials were carried out to evaluate the growth performance, nutrient digestibility, carcass characteristics, haematological parameters, blood biochemical parameters and the economic advantage of broiler chickens fed graded levels of Roselle Seed Cake (RSC) asreplacement of two conventional protein sources. Proximate composition was done to determine the nutrient content of RSC and experimental diets. Experiment 1 contained graded levels of RSCreplacinggroundnut cake (GNC) while experiment 2contained graded levels of RSCreplacing soya bean cake (SBC). Three hundred (300) day old Ross broiler chicks were used in each experiment in a completely randomized design (CRD).The broiler chicks were assigned to five dietary treatments with three replicates each with 20 birds per replicate and 60 birds per treatment.Five isonitrogenous and isocaloricdietswere formulated for the broiler starter and finisher phases respectively of the two feeding trials. Diet 1 served as the control diet while diets 2, 3, 4 and 5 contained 8%, 16%, 24% and 32% RSC respectively. Data were collected andanalyzed using analysis of variance and the mean was separated using Dunnet. The results for the first feeding trial at starter phase showed that final body weight, total weight gain and average daily weight gain were significantly (P□0.05) higher with birds on 16% RSC inclusion(1009.17, 954.17 and 34.08g). FCR was higher at 32% RSC inclusion(2.25). Feed cost per kg gain was better with the16% RSC group (₦157.60). At finisher phase, final weight, total weight gain and average daily weight gain were better at 8% RSC inclusion (2602.14,1597.14 and57.04g) but was not significantly different(P□0.05) with birds on16% RSCinclusion (2571.67,1568.33 and 56.01g).Feed conversion ratio was better with the control diet (2.68) but not significantly (P□0.05) different withthe 8% and 16% RSC groups (2.78 and 2.82) while feed cost per kg gain was significantly (P□0.05) higher with the control diet (₦288.34). The dressing percentage wassignificantly (P□0.05) higher with birds on 8% RSC inclusion (82.23%).Nutrient digestibility were significantly (P□0.05) different in all parametersexcept for crude fibre. The parameters measured for blood quality showed no

significant (P□0.05) differences across dietary treatments except for white blood cell (WBC). The blood biochemical parameters showed no significant (P□0.05) differences in total protein, low density lipoprotein (LDL) and creatinine. In the second feeding trial at the starter phase, birds on 24% RSC inclusionhad the highest final weight (996.67g).There were no significant (P□0.05) differences in FCR across dietary treatment means. Feed cost per kg gain was better with birds on 32% (₦211.59) RSC but not significantly (P□0.05) different with birds on 24% (₦219.20) RSC.At finisher phase, birds on 24% RSC had a better result in final weight, total weight gain, average daily weight gain and feed cost per kg gain (2077.78, 1231.11, 43.97g and ₦173.44). FCR was significantly (P□0.05) better with birdson the 24% (2.45) RSC inclusion.Dressed weight was significantly (P□0.05) higher with birds on the 24% (1600.67g) RSC but similar to the 32% (1533.33g) RSC group.Dry matter digestibility was significantly (P□0.05) higher withbirds on the 24% (97.44) RSC group. Ether extract digestibility were not significantly (P□0.05) different withbirds on the 24% (60.54%) and 32% (59.65%) RSC groups. There were no significant (P□0.05) differences in crude fibre and crude protein digestibility across dietary treatment means. There were no significant (P□0.05) differences in all the parameters measured for haematology across dietary treatment means except for the white blood cell. The blood biochemical composition showed no significant (P□0.05) differences in total protein, high density lipoprotein, low density lipoprotein and creatinine across dietary treatments.RSC as an alternative feedstuff can replace GNC at 16% inclusion and soyabean cake at 24% in the diet of broiler chickens for improved performance, haematological and blood biochemicalof broilers. The cost of broiler production was reduced by 8.46%; 22.45% and 8.26%; 15.28% per bird both at the starter and finisher phases respectivelywith the replacement of 50% GNC and 75% SBC in the diets. Roselle seed cake can replace GNC and SBC at the broiler starter and finisher phases at 50% and 75% (16% and 24% dietary RSC) inclusion for better performance.

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**CHAPTER ONE**

## 1.0 INTRODUCTION

Feed cost and continuous effort to get better understanding of the feeding value of available alternative feed ingredients has been a major challenge in the poultry industry in Nigeria. Inadequate knowledge and non-availability of alternative and cheaper feed resources and competition between man and animals for most of the conventional feedstuffs have been identified as the root cause (Afolayan *et al*., 2012).

Protein is a very important nutrient that is responsible for growth and its deficiency leads to growth depression. Proteins are used in the construction of body tissues such as muscles, nerves, cartilage, skin, feathers, beak, and so on. All animals require protein for growth, reproduction and production depending on the age, productivity of the animal and their environment (Olomu, 1995).

The livestock industry is having difficulties in meeting the demand for animal feeds which accounts for about 70% of the cost of production in animal production enterprise. The Nigerian livestock industry is operating below its capacity because of the high cost and scarcity of feed resources (Aduku and Olukosi, 1990).

Alternative feed ingredients with good protein source could be used to replace the conventional ones like cotton seed cake (CSC), Soya bean meal (SBM) and groundnut cake (GNC).This could maximize the returns from poultry enterprise and reduce feed cost. Over-dependence on SBM and GNC as major conventional protein concentrates for feeding livestock in Nigeria and other developing countries is a major constraint for the progressive growth of the livestock industry. It has

been observed that commercial feed operators have compromised on standards (Kudu *et al*., 2008) such that, the composition labels on branded feed bags do not truly reflect the actual

nutrients composition of the feed. There is the need for nutritionists to explore the possibilities of incorporating other useful and cheaper sources of protein into poultry diets such as Roselle seedcake.Roselle seeds (*Hibiscus sabdariffaL*.) are reported to be rich in proteins, dietary fibre, carbohydrates and fats (El-Adawy and Khalil, 1994; Rao, 1996; Abu Tarboush *et al*., 1997). They also contain high amount of minerals such as calcium, magnesium and phosphorus. The seeds from Nigeria are reported to contain about 35.90% crude protein, 10.14% ether extract, 10.09% ash and 15-17% crude fibre (Dashak and Nwanegbo 2002; Kwari *et al*., 2011). The seeds possess some anti-oxidative and anti-hypercholesterolemic properties. It is a potential source of protein for poultry nutrition (Diarra *et al*., 2011). Roselle seed cake is a by-product obtained after oil extraction from roselle seed.

## 1.1 Justification

Affordability and availability of conventional feed sources have been a challenge in the poultry industry and the ever rising pressure on legumes such as soya beans and groundnut particularly as the major sources of protein in poultry feeds has been more challenging. Most of the feed sources used in poultry industry such as maize, soya bean, and groundnut are also being consumed by humans. Therefore, it is necessary to look for alternative feed sources which could be incorporated into poultry diet. Several legumes have been investigated for their potentias as alternative protein feedstuffs in poultry nutrition. Roselle seeds for instance have been investigated for their nutritional value in poultry while the cake have been studied for feeding value with and without amino acid supplementation in poultry nutrition (Igoche, 2015). However, the effect of the cake as replacement

for conventional protein ingredients like groundnut cake (GNC) and soyabean cake (SBC) has received little attention.The cake can be

a potential alternative protein ingredients in poultry diets.Roselle seedcake (RSC) is not consumed by humans, it is cheap and readily available therefore pose no threat of scarcity. This

study was designed to evaluate the effect of graded levels of Roselle seed cake as an alternative protein source as replacement of two conventional protein sources in broiler diets.

## 1.2 Objectives

The objectives of this study are to evaluate:

1. The growth performance, nutrient digestibility andcarcass characteristics of broiler chickens fed graded levels of Roselle seedcake as replacement of two conventional protein souces.
2. The haematological and blood biochemical parameters of broiler chickens fed graded levels of Roselle seedcakeas replacement of two conventional protein sources.
3. The economic advantage of using Roselle seed cake as replacement of two conventional protein sources in broiler diets.

### 1.3 Research Hypotheses

Ho: Roselle seed cake as replacement of two conventional protein sourceshas no significant effect on growth performance, nutrient digestibility andcarcass characteristics of broiler chickens.

Ha: Roselle seedcake as replacement of two conventional protein sourceshas significanteffect on growth performance,nutrient digestibility andcarcass characteristicsofbroiler chickens.

Ho: Roselle seed cake as replacement of two conventional protein sources has no significant effect on haematology and blood biochemical parameters on broiler chickens.

Ha: Roselle seed cake as replacement of two conventional protein sources has significant effect onhaematological and blood biochemical parameters on broiler chickens.

Ho: Feeding Roselle seed cake as a replacement of two conventional protein sources has no economic advantage in poultry nutrition.

Ha: Feeding Roselle seed cake as a replacement of two conventional protein sources has economic advantage in poultry nutrition.

## CHAPTER TWO

## 2.0LITERATURE REVIEW

## 2.1Alternative Feedstuffs

Alternative or Non-conventional feed stuffs (NCFS) generally refer to all those feedstuffs that are not traditionally used for feeding livestock and are not commercially used in the production of livestock feeds. Several known examples include palm leaf meals, palm press fibre, cassava foliage, spent brewer's grains, sugar cane bagasse, rubber seed meal and some aquatic plants (Chadhokar, 1984). Also, Rosell seed cake (RSC) is one of the NCFS that is not traditionally used for feeding of livestock. Defined in this manner non-conventional feed stuffs can be looked at as covering a wide diversity of feedstuffs and their nutrient contents.

Two major agricultural by-products, cocoa pod husk and mango kernels i.e crop residues usually wasted, have been tested with broilers (Teguia 1995; Teguia *et al*., 2004) leaves and forages traditionally used for other purposes or even wasted have also been tested namely sweet potato leaves, bitter leaves, perennial peanuts and *Desmodium spp* (Teguia *et al*. 1993; Teguia *et al*., 2002)

A common feature about feeds is that the traditional feeds of tropical origin tend to be mainly from annual crops and feeds of animal and industrial origin. However, it is sometimes difficult to draw a distinct line between traditional feeds and NCFS. In some countries such as India and Pakistan, what may now be classified as NCFS may in fact be conventional/traditional owing to the fact that it may have been in use as livestock feed over a long time, an example is wheat straw which is very widely used in these two countries, in addition, the availability of NCFS, especially of plant origin, is dependent to a large extent on the type of crops being cultivated and the prevailing degree of application of the crop technology (Younas and Yaqoob, 2005).

## 2.2 Origin of Roselle Plant

Roselle is a shrub belonging to the family Malvaceae. It is believed to have originated from tropical Africa (McClean, 1973). The plant is widely grown in the tropics including Caribbean, Central America, India, Africa, Brazil, Australia, Hawaii, Florida and Philippines as home garden crop (Mahadevan *et al*., 2009).Roselle *(Hibiscus sabdariffa L*.) is a leguminous shrub well adapted to Guinea and Sudan Savannah vegetation belts of Nigeria (Alegbejo, 2000). Also known as Roselle, Sorrel, and is popular plant in Middle Eastern countries (Abu Tarboush *et al*., 1997;Morton, 1987).

## 2.3 Varieties of Roselle Plant

There are the green and red varieties of roselle plants

### The green variety

The green calyx is more predominant in the southern parts of Nigeria but is scarce while the other two red varieties are predominant in the northern parts of Nigeria. However, the green variety is also common in the northern part of the country. The calyces from these varieties have a number of uses and promising prospects for industrial purposes (Alegbejo, 2000). The calyx of the green variety is used to cook soup, stew and sauces. It is rich in vitamin C and riboflavin with some major minerals present (Babalola, 2000).

### The Red Variety

The dried plant of the redcalyces variety are exported to America and Europe where they are being used as food colourings. It can be found in some market places in France where it's used as flowers or syrup. The crimson red colour is the characteristics and most popular and desirable colour of roselle while other shades and colour exist including the white or greenish white colour (El Naim and Ahmed, 2010).

## 2.4Production of Roselle (*Hibiscus sabdariffa L.*) in Nigeria

*Hibiscus sabdariffa L.*is a shrub with bushy branches, which are either reddish or greenish in colour, and with red or pale yellow inflated edible calyces. It is an erect and branched annual sub-shrub, (0.5-3m tall) with a strong tap-root system. The flowers are borne on very short peduncles in the axils of the upper leaves, the epicalyxes aremade up of 10 linear fleshy bracteoles and the calyx is 8 lobed, becoming large and fleshyafter flowering (Gibbon and Pain, 1985). It is grown extensively in the Semi-Arid savannah for local consumption and for export to the Middle East and Europe.

The main areas of production in Nigeria are Kagara and Mokwa (Niger State), southern Jos (Plateau State), and around Ibadan (Oyo state). It is also widely grown in Kogi, Kwara, Kebbi, Sokoto, Zamfara, Katsina, Borno, Kaduna, Bauchi and Kano States (Dike, 1987; Alegbejo,1998). Inspite of its economic importance and the fact that the crop originated in West Africa, not much research work has been conducted on it when viewed in relation to the amount of work undertaken on its closely related species, such as cotton (Kumar *et al.,* 1986;Dike,1987). Some of the names of roselle seed are “Egana” in idoma,“Sour-sour” in Sierra Leone, “Sorrel” in Jamaica or India, “Isapa” in Yoruba, “Mmany Ojo” in Igbo, “Bissap” in Senegal, “Osseille deguinea” in French, “Asam-paya” in Malaysia and “Karkade” in Sudan (Igoche, 2015).

### 2.4.1 Climatic Requirement for Roselle Production

Roselle is very sensitive to frost. It succeeds best in tropical and subtropical regions from sea-level up to 3,000 ft. (900 m) with a rainfall of about 72 inches (182 cm) during its growing season. Where rainfall is inadequate, irrigation has given good results. It can be grown as a summer crop in temperate regions. The fruits will not ripen, but the herbage is usable (Morton, 1987).

## 2.5 Uses of Roselle (*Hibiscus sabdariffa* L)

The crop is used for making wine, juice, jam, jelly, syrup, gelatin, pudding, cakes, ice-cream and also dried and brewed into tea as well as flavours and carbonated soft drinks, other acidic foods, spice and used for butter, pies, sauces, fats and other desserts (Walford, 1984; Qi *et al*, 2005). The grinded leaves and seeds are added to curries as seasoning. The calyces or petals of the flower are widely used to prepare jam, jelly (Morton, 1987), soup and the popular Zobo drink in Nigeria. The fresh calyces are known for their unique flavour characteristics that make them appealing to taste. Roselle calyces are used as digestive and purgative agent and a folk remedy for abscesses, billows, cancer, hypertension etc.(Duke, 1985).Roselle drink had been improved nutritionally by producing fruit-flavoured Roselle drinks which are richer in vitamins and minerals by addition of different fruits with higher consumption acceptability (Fasoyiro *et al*., 2004).

## 2.6 Nutrient Composition of Roselle Seed

Roselle seeds has been reported to contain 21.35%protein; 15.4% ether extract, 21.04 Metabolizable energy (MJ/kg), 11.98% crude fibre and is also a good source of calcium and

phosphorus (Abu El' Gasim *et al.*, 2008 and Mukhtar, 2007). Roselle seed has recently been foundto contain 38.57%CP, 13.5% EE, 16.5% CF, 5.18% Arginine, 2.58 Lysine and 1.33% Methionine (Kwari *et al*., 2011). The oil from the seed is also reported to contain some unusual fatty acids, namely epoxy oleic and cytopropenoid (Bakheit, 1993).

### 2.6.1 Lipid Content of Roselle Seed

Roselle seed oil has been reported to have similar properties to cotton seed oil as a substitute for crude castor oil. A high content of the unsaturated fatty acid constitutes more than 70% of the polyunsaturated fatty acid of roselle seed. The ratio of saturated to unsaturated fatty acid was 1:2 (El-Aldawy and Khalil, 1994). It was reported byAli and Ali (2014) that the major saturated

fatty acids in Roselle seed oil for red calyces were myristc (1.9609%) and palmtic (3.9494%) acids and the main unsaturated fatty acids are oleic (47.0555%), linoleic (30.5836%) and elaidic (14.3159%)

### 2.6.2 Protein Content of Roselle Seed

Many studies have been carried out to assess the potential of Roselle seeds a as a new source of protein and oil (El-Adawy and Khalil, 1994; Rao, 1996; Abu Tarboush *et a*l., 1997).The protein content in Roselle seed was found to be high as reported by El-Adawy and Khali (1994), Abu-Tarboush*et al.* (1997) and Hainida*et al*, (2008) while Sammy,(1980) and Rao, (1996) noted a lower protein content. These differences may be as a result of the variations of cultivated regions. The protein content of Roselle seeds is higher than that of other common seeds, grains such as black seeds (Salleh, 1992).

El-Adawy and Khalil (1994) published the amino acid profile of 3 Egyptian Roselle seeds from 3 different cultivars, they found out that Roselle seed protein content was as high as 31.02% which makes it a potential high protein source.

### 2.6.3 Energy content of Roselle Seed

The main function of dietary carbohydrate is to supply energy. (Kretchmer and Zimmermann, 1997). A study by Hainida, *et al*(2008) reported a low (13%) carbohydrate content in roselle seed. Nevertheless, El-Adawy and Khalil (1994) found that roselle seed of different cultivars have a high content of total carbohydrates ranging from 36-38%.

### 2.6.4 Mineral Composition of Roselle Seed.

The minerals in Roselle seeds are calcium (647±1.27mg/100g dry matter),potassium (1329±1.47mg/100g dry matter), sodium (510±1.25mg/100g dry matter), phosphorus (510±1.25mg/100g dry matter) and magnesium (139±1.47 mg/100 g dry matter).

Potassium is an essential mineral and has an important role in the synthesis of amino acids and proteins (Malik and Srivastava, 1982)Calcium and Magnesium play a significant role in photosynthesis, carbohydrate metabolism, nucleic acid and binding agents of cell (Igoche, 2015).

## 2.7 Anti- Nutritional Factors in Roselle Seeds

Roselle seed contains some anti-nutritional factors despite its rich nutritional composition.The most commonly reported toxic factors are total phenols and tannins (Abu El Gasim *et al*., 2008; Kwari *et al*. 2011) and phytic acid. Mukhtar,(2007) reported that Roselle seed contains traces of gossypol, a

phenolic compound which causes undesirable physiological effects in poultry. Abu Tarboush and Ahmed, (1996) reported low levels of tannin, amylase inhibitors, protease inhibitors, phytic acid and gossypol in Roselle seeds.

## 2.8 Anti-Nutritional Factors Present in Roselle Seed Cake

The anti-nutritional factors present in roselle seed cake (RSC) as reported by Igoche (2015) showed that RSC had higher values for phytate and oxalate compared to groundnut cake (GNC) where saponin and tannins were higher. Tanin level of 3.35mg/100g was lower than 5.30% reported by Ojokoh (2006), phytate level of 0.44% was also lower than the 8.88% reported by Yagoub and Abdalla (2007) to be present in roselle seed. This is an indication that RSC has better nutrient value compared to the seed (Igoche, 2015).

Table 2.1 shows some anti-nutritional factors in roselle seed while table 2.2 shows the anti-nutritional factor present in roselle seed cake and groundnut cake.

**Table 2.1: Some Anti-Nutritional Factors in Roselle Seed**

| Anti-nutritional Factors | Sources |
|---|---|
| | Ojokoh (2006);Yagoub *et al.* (2007);Kwari *et al*. (2010) |

| | | | |
|---|---|---|---|
| Total phenols (%) | ND | 8.7 | 7.19 |
| Tannin (%) | 5.30 | ND | 3.29 |
| Phytic acid (%) | 2.14 | 8.88 | ND |
| Cyanide (mg/kg) | 3.50 | ND | ND |

Source: Igoche, (2015)

ND: Not determined

**Table 2.2: Anti-Nutritional factors in Roselle Seed Cake and Groundnut Cake (mg/100g)**

| | **Saponin** | **Tanin** | **Phytate** | **Oxalate** |
|---|---|---|---|---|
| Roselle seed cake | 22.17 | 3.35 | 0.44 | 3.31 |
| Groundnut cake | 28.50 | 5.45 | 0.28 | 2.36 |

Source: Igoche, (2015).

## 2.9 Effect of Processing on the Anti-nutritional Factor Content of Roselle Seeds

Various processing methods have been applied and reported to reduce toxicity in feeds. Processing methods such as cooking, sprouting and soaking have been observed by Yagoub and Abdalla (2007) to significantly improve the nutritional and functional properties of plant seeds. There have been some reports on the processing of Roselle Seed with the view of reducing the toxic factors and improve its feeding value.Kwari *et al.*(2011) observed significant reduction of total phenolic and condensed tannins of the seed by cooking, sprouting or fermentation. These processing methods had both beneficial and adverse changes in the profile of certain nutrients. In a similar study, Abu El Gasim *et al.*(2008) reported a significant reduction of phenolic compounds in the soaked, cooked or sprouted sorrel seed compared to the raw, but the phytic acid content was not affected by processing. In their study, they observed that the reduction of phenolic by soaking, cooking or sprouting were accompanied by significant increase in protein, fat and crude fibre contents while ash and soluble carbohydrate contents were reduced. The authors also reported an increase in the sulphur aminoacid (methionine and cysteine) and decrease in lysine contents of the soaked compared to the raw seeds. In contrast, Kwari *et al.*(2011) observed that soaking reduced the methionine but had no adverse effect on lysine contents of sorrel seed.Though these differences could be as a result of differences in medium and duration of soaking because Abu El Gasim *et al*(2008) soaked the seed in sodium oxide solution for 12hours while Kwari *et al*(2011) soaked the seed in tap water for 24hours.

## 2.10 Roselle Seed Cake in Poultry Diets

Feeding of Roselle seed cake to poultry has been cited in different studies. For instance, Sanni (2015) fed RSC to laying japanese quails with enzyme supplementationwhile Igoche (2015) fed graded levels of roselle seed cake with and without amino acids (methionine and lysine) supplementation in the diet of broilers and reported that roselle seed cake significantly improved

feed intake thereby increased weight gain, average daily gain and final weight across the dietary treatments.

Mukhtar,(2007) fed graded levels of raw Roselle seed meal in the diet of broiler chickens at 0. 0, 7.5, 15.0 and 22.5 % respectively and observed decreased feed intake, weight gain and feed conversion ratio when the inclusion level increased above 7.5%.

Guluwa and Damang (2009) included up to 30% raw Roselle seed meal in the diet of broiler chickens and reported no adverse effects on the performance of the birds at starter and finisher phases.

The haematology, serum biochemistry and organs (gizzard, heart and liver) weight of cockerels were also not affected by feeding raw compared to processed sorrel seeds (Kwari *et al*.,2010).

Kwari *et al*(2010) reported no adverse effects of feeding raw Roselle seed meal on feed intake, growth, feed conversion ratio and carcass yields of cockerels.

In another experiment, Kwari *et al* (2011) and Diarra *et al.*(2011) replaced soya bean meal with raw Roselle seed meal at 0.0, 25.0, 50.0, 75.0 and 100.0 % in broiler diets andreported decrease in performance.(feed intake, weight and feed conversion ratio) only above 50.0% (12% dietary Roselle seed).

In a study by Kwari *et al.* (2011) to evaluate the performance of caged laying hens fed raw, soaked, boiled, sprouted and fermented Roselle seed meal in a semi arid environment, reports showed no dietary effects on feed utilization, egg production, egg weight and shell quality. The cost of feed was reduced with the inclusion of Roselle seed meal in the diet resulting to a lower cost of egg production on those diets compared to the control. No mortality was recorded during the period of the experiment. It was concluded that up to 50 % of dietary soya bean meal can replace Roselle seed meal raw or processed without adverse effects on the performance of laying hens. The replacement reduced the cost of the feed and thus the cost of egg production.

Duwa *et al.* (2012) investigated the effect of Roselle seed meal on the haematological and biochemical indices of broiler chickens and reported that serum biochemistry showed significant differences among treatments except for blood cholesterol and hydrogen carbonate which showed no significance. However, significant differences were observed for the haematological parameters.

### 2.11 Roselle Seed Meal in Rabbit Diets

Roselle seed meal was replaced with GNC at 0% which was the control, 10%, 20%and 30% levels in the diet (Igwebuike *et al.,* 2010). There was no significant dietary effect on feed intake and feed conversion ratio. However, there was a significantly higher daily weight gain at 20% level compared to the control and the 30% level of GNC replacement diets.

### 2.12 Carcass of Broiler Chickens

Carcass is the remains of a cooked bird after the edible parts have been removed. In production, carcass and parts yields provide useful information to guide farmers on the strain, sex and slaughter age options that would supply consumer's demands. Carcass weight, nutrition, sex, age and environmental conditions influence the yield of broiler parts, the carcass composition and the processing quality of poultry meat (Abdullah and Materneh, 2010).

### 2.12.1 Effect of Roselle Seed Meal on Carcass of Broiler Chickens

The effect of roselle seed cake on carcass of broiler chickens has been cited in different studies.

In a study by Kwari *et al*. (2010) on the growth performance and carcass measurement of broiler chickens fed different levels of raw sorrel (*Hibiscus sabdariffa*) seedmeal reports showed that dressing percentage and the yields of the wings, thighs and drumstick were not affected by the level of roselle seedmeal inclusion in the diet. Breast muscle yield was significantly improved from the 50% replacement group.

In another experiment, Ibrahim *et al*. (2010) fed differently processed sorrel seedmeal to growing cockrels and reported no adverse effect on carcass and organs measurements. The carcass yield obtained in the study were generally lower than than the 65-70% reported by Salami *et al.* (2004) and stated the reason for the difference could be the age at slaughter. It was also observed that the differences observed in the yield of legs, thighs, drumstick, breast, back and neck could not be explained since they did not follow any pattern.

Stephen *et al*. (2014) fed processed roselle seedmeal to finisher broiler chickens and reported no adverse effect on the weight of carcass and cut-up parts and internal organs measurement.

According to a review by Maikano, (2014) differently processed roselle seed were fed to broiler chickens and it was observed that there were no significant differences in the liveweight, plucked weight and plucked weight percentage. The cut up parts like the head, shank, neck and back varied significantly.

Igoche, (2015) evaluated the nutritional value of roselle seed cake with or without amino acid supplementation in broiler diets and reported that dietary treatments had no significant effect on the percent liveweight of heart,gizzard, liver and spleen.

### 2.13 Effect of Nutrition on Haematological Components of Broilers

The haematological and biochemical components of the blood are influenced by the quantity and quality of the feed and also the level of anti-nutritional factors present in the feed (Akinmutimi *et al*., 2004). The haematological parameters are good indicators of the physiological status of the animal and its changes are of value in assessing the response of animals to various physiological situations (Esonu *et al*., 2006). The haematological values of avian species are also significantly influenced by poultry diseases likeavian coccidiosis (Koinarski and Angelov, 2001) and Newcastle disease (Galindo-Muniz *et al*., 2001).

#### 2.13.1 Red Blood cells

There is a relationship between the red blood cells (RBC) and the haemoglobin (Hb). The red blood cells (RBC) transports haemoglobin (Hb), which in turn carries oxygen from the lungs into the tissues (Waugh and Grant, 2001). Reduction in the haemoglobin may be accompanied by a fall in the RBC

and packed Cell Volume (haematocrit) and low readings for RBC, Hb and haematocrit can indicate anaemia (Moss, 1999).

### 2.13.2 White Blood Cells

The major functions of the White Blood Cells (WBC) and its differentials are to fight infections, defend the body by phagocytocis in immune response. Thus, animals with low WBC are exposed to high risk of infection while those with high counts are capable of generating antibodies in the process of phagocytocis and have high degree of resistance to diseases (Soetan *et al*., 2013).

### 2.13.3 Heterophils

This is a type of white blood cell found in birds and makes up to 20-30% of the total WBC. They attack infections, inflammations and bacteria. Severe heterophils (ahigh number of heterophils) can indicate chlamydophilosis or aspergillosis in the white cells. Too low amount

of heterophils may cause a vulnerable condition for infection (Chinrasri and Aengwanich, 2007).

### 2.13.4 Lymphocytes

The normal proportion of lymphorcytes is 20-50% but this varies among species. They are important part of the immune system.

### 2.13.5 Monocytes

These are the largesttype of WBC in avian blood, they are similar to lymphocytes and exist in small numbers. They range from 0-3% and increase number up to 10% is seen with chronic diseases.

### 2.13.6 Eosinophils and Basophils

These are similar in appearance to heterophils but the cytoplasmic granules have a different colour and shape and they have a dark stained nucleus. Low percentage in chickens could also cause poor immunity against diseases and low percentage may possibly indicate poor health conditions as a result of parasitic disturbance (Bush, 1991).

## 2.14 Biochemical Composition of Broiler Chickens

### 2.14.1 Total Protein (TP)

Biochemical components are sensitive to elements of toxicity in feeds. Total serum protein retained is an indication of the protein retained in the animal's body (Akinola and Abiola, 1991; Esonu *et al*., 2001) while total blood protein and creatinine contents have been shown to depend on the quality and quantity of dietary protein (Esonu *et al*.,2001).

### 2.14.2 High Density Lipoprotein (HDL)

Is a combination of lipids and protein. It transports cholesterol from the tissue of the body to the liver so it can be gotten rid of in the bile. The higher the HDL, the lower the risk of coronary arterydisease (Peter, 2002).

### 2.14.3 Creatinine

Creatinine is a test of kidney function. High creatinine indicates poor utilization of nutrient due to muscle wastage (Udoyong *et al*., 2010).

## CHAPTER THREE

## 3.0MATERIALS AND METHODS

### 3.1Experimental Site

The experiment was carried out at the poultry unit, Department of Animal Science Teaching and Research Farm, Ahmadu Bello University, Zaria, Kaduna State located within the Northern Guinea Savannah zone of Nigeria, longitude, $11^0$ 09' 01.78''N and latitude $7^0$ 39' 14.79'' E, at an altitude of 671m above sea level (Ovimaps, 2014) The temperature ranges between 26-$40^0$ depending on the season while the relative humidity during the dry and wet seasons are 21 and $72^0$ respectively. The wet periods in Zaria is between May and October with annual rainfall of about 1500mm (Institute of Agricultural Research and Meteorological Unit, 2012). The experiments were carried out between the months of January-March for the first experiment and June –August for the second experiment.

### 3.2Sources of the Experimental Materials

Roselle seedcake, groundnut cake, soya bean cake and all other ingredients used for the experiment were purchased from Rebson feed mill in Samaru, Zaria, Kaduna State.

### 3.3Proximate Analysis

Samples of the Roselle seedcake and experimental diets were taken to the Animal Science Biochemical Laboratory for proximate analysis using the methods described by A.O.A.C (2005). The analysis was done to obtain the nutrient composition (Dry matter, Ash, ether extract, crude protein, crude fibre and nitrogen free extract) of the experimental diet. The metabolizable energy was determined using the Janssenformula(Janssen, 1989). $ME_n$= 29.68× DM + 60.95 × EE – 60.87 × CF

### 3.4 Experiment 1: Performance of Broiler Chickens Fed Graded Levels of Roselle Seed Cakeas Replacement for Groundnut Cake

#### 3.4.1 Experimental Diet

Five isonitrogenous and isocaloric diets (23.62% CP; 2959kcal/kg ME) and (19.28%CP; 2981kcal/kg ME)were formulated for the experiment for both the broiler starter and finisher phases respectively. Groundnut cake was replacedwhile Soya bean cake was fixed. The inclusion level of Roselle seed cake in the formulation is as follows:

Diet 1: 0% of Roselle seedcake in the diet(control)

Diet 2: 8% level of Roselle seedcake in the diet.

Diet 3: 16% level of Roselle seedcake in the diet.

Diet 4: 24% level of Roselle seedcake in the diet.

Diet 5: 32% level of Roselle seedcake in the diet.

Compositions of the experimental diets are presented in Tables 3.1 and 3.2 respectively. Both starter and finisher diets were formulated to meet nutrient requirement standards for broilers (NRC, 1994).

### 3.4.2 Design and Management of Experimental Birds

Three Hundred (300) day old Ross broiler chicks purchased from a reputable farm were used for the starter and finisher phases.The broiler chicks on arrival were counted and were given a common ration for one day and allowed to adapt to the environment. Their initial average weight was recorded and the chicks were randomly distributed into five treatment groups of 60 chicks each with three replicates of 20 chicks per pen in a completely randomized design. (CRD). Each group was assigned to the five experimental diets and they were all subjected to the same management practices all through the period of the experiment.

**Table 3.1 Experimental Diets for Broiler Starter with Roselle Seed Cake asReplacement for Groundnut cake(0-4weeks)**

| **Levels of Roselle Seed Cake (RSC) Inclusion (%)** | | | | | |
|---|---|---|---|---|---|
| **Ingredient (%)** | **0** | **25** | **50** | **75** | **100** |
| Maize | 58.05 | 59.45 | 56.55 | 53.85 | 50.85 |
| Roselle seedcake | 0.00 | 8.00 | 16.00 | 24.00 | 32.00 |
| Soyabean cake | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 |
| Groundnut cake | 24.00 | 15.40 | 10.30 | 5.00 | 0.00 |
| Blood meal | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| Bonemeal | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Limestone | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Common salt | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Methionine | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Lysine | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |

| | | | | | |
|---|---|---|---|---|---|
| *Vitamin premix | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| **Total** | **100** | **100** | **100** | **100** | **100** |
| **Calculated Analysis** | | | | | |
| ME (Kcal/kg) | 2959.00 | 2959.00 | 2965.00 | 2945.00 | 2916.00 |
| Crude protein (%) | 23.62 | 22.62 | 22.65 | 22.62 | 22.69 |
| Crude fibre (%) | 4.49 | 3.02 | 3.22 | 3.38 | 3.50 |
| Ether Extract (%) | 4.12 | 4.24 | 4.43 | 4.61 | 4.80 |
| Calcium (%) | 1.30 | 1.28 | 1.30 | 1.30 | 1.31 |
| Phosphorus (%) | 0.80 | 0.76 | 0.73 | 0.70 | 0.67 |
| Lysine (%) | 1.20 | 1.20 | 1.25 | 1.26 | 1.25 |
| Methionine (%) | 0.54 | 0.54 | 0.54 | 0.55 | 0.55 |
| Cost/kg (₦) | 89.15 | 83.01 | 78.91 | 76.83 | 74.61 |

*Bio-mix broiler starter premix per 2.5kg of diet: Vit A, 10,000 I.U; Vit $D_3$, 2,000 I.U; Vit E, 23,000mg; Vit $K_3$, 2000mg; Vit B1,(thiamine) 1,800; Vit $B_2$(riboflavin),5,500mg; Niacin, 27,500; Panthonenic acid, 7,500; Vit B6(pyridoxine),3000mg; Vit $B_{12}$, 15.00; Folic acid, 750.00mg; Biotin $H_2$, 60.00mg; Cholin Chloride, 300,000mg; Cobalt, 200mg; Copper,3000mg; Iodine, 3,000mg; Iron, 1,000mg; Manganese, 40,000.00mg; Selenium, 40,000mg; Zinc, 200mg; Antioxidant,1,250mg

ME= Metabolizable Energy

**Table 3.2 Experimental Diets For Broiler Finisher with Roselle Seed Cake as Replacement for Groundnut cake (5-8weeks)**

| **Levels of Roselle Seed Cake (RSC) Inclusion (%)** | | | | | |
|---|---|---|---|---|---|
| **Ingredients (%)** | **0** | **25** | **50** | **75** | **100** |
| Maize | 62.85 | 58.85 | 55.25 | 52.24 | 49.65 |
| Roselle seed cake | 0.00 | 8.00 | 16.00 | 24.00 | 32.00 |
| Soya bean cake | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 |

| | | | | | |
|---|---|---|---|---|---|
| Groundnut cake | 20.80 | 15.60 | 10.40 | 5.24 | 0.00 |
| Maize offal | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| Bone meal | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 |
| Limestone | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Common salt | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Methionine | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Lysine | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| *Vitamin premix | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| **Total** | **100** | **100** | **100** | **100** | **100** |
| **Calculated Analysis** | | | | | |
| ME (Kcal/kg) | 2961.00 | 2966.00 | 2971.00 | 2976.00 | 2981.00 |
| Crude protein (%) | 19.28 | 19.28 | 19.28 | 19.28 | 19.28 |
| Crude fibre (%) | 3.63 | 3.48 | 3.48 | 3.84 | 4.02 |
| Ether Extract (%) | 4.16 | 4.35 | 4.53 | 4.72 | 4.90 |
| Calcium (%) | 1.65 | 1.66 | 1.66 | 1.66 | 1.67 |
| Phosphorus (%) | 0.87 | 0.85 | 0.80 | 0.84 | 0.81 |
| Lysine (%) | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Methionine (%) | 0.45 | 0.46 | 0.46 | 0.46 | 0.46 |
| Cost/kg (₦) | 100.70 | 95.90 | 91.70 | 89.20 | 86.10 |

*Bio-mixbroiler finisher premix per 2.5kg of diet: Vit A, 10,000 I; Vit $D_3$, 2,000 I.U, Vit E, 23,000mg, Vit $K_3$, 2,000mg; Vit $B_1$, 1,800mg; Vit$B_2$, 5,500mg; Niacin, 27,500; Panthonenic acid, 7,500; Vit $B_6$, 3000mg; Vit $B_{12}$, 15mg; Folic acid, 7,500mg; Biotin $H_2$, 60mg; Cholin Chloride, 300.000mg; Cobalt, 200mg; Copper,3000mg; Iodine,3,000mg;Iron,1000mg; Manganese, 20,000mg; Selenium, 40,000mg; Zinc, 200mg; Antioxidant,1,250m

ME= Metabolizable Energy

The birds were given lasota Intra ocular (I.O) vaccine on arrival and vitalyte was added to their water to reduce stress. They were given their first dose of gumboro at 7 days old, first dose of lasota at 14

days old while second dose of gumboro and second dose of lasota were administered at 21 days and 28 days old respectively. The birds were also treated against coccidiosis at 3weeks of age and the mode of administration was oral.

### 3.4.3 Starter Phase

In the starter phase (0-4weeks) the birds were assigned to five treatments where RSC was included at 0, 8, 16, 24 and 32% respectively. The 0% represents the control group. Feed and water were provided *ad libitum* throughout the study period.

### 3.4.4 Finisher Phase

In the finisher phase (5-8weeks) birds from the starter phase were used. The birds were assigned to five dietary treatments as in the starter phase only that the feed was changed to broiler finisher feed. Feed and water were provided *ad libitum.*

### 3.4.5 Growth Study

The birds were weighed on arrival and weekly thereafterwith the following parameters measured; Initial Weight; Final Weight; Total Weight Gain; Average Daily Weight Gain; Total Feed Intake; Daily Feed Intake; Feed Conversion Ratio; Cost of Bird Per Kilogram Weight Gain were computed. Mortality was recorded as they occured.

### 3.4.6 Digestibility Trial

Nutrient digestibility trial was carried out at the end of the experiment (8weeks of age). This was done by randomly selecting one bird from each replicate making a total of 3 birds per treatment.

The birds were housed in metallic cages for a period of 3days adjustment period and faecal collection lasted for a period of 5 days. Each group was fed known quantities of their respective

experimental diets and water was also made available *ad libitum*. Trays were placed under each cage for faecal collection, faecal droppings were collected daily and air dried. They were weighed after they were thoroughly pooled together for each treatment and oven dried for 24 hours at $65^{o}$c. The dried samples and samples of their feeds were assayed for their proximate composition (Dry matter, ash, crude protein, ether extract, crude fibre and nitrogen free extract) at the National Animal Production and Research Institute (NAPRI) Laboratory, Shika, Zaria using the methods described by Association of Official Analytical Chemist (A.O.A.C, 1990). The nutrient digestibility coefficients was calculated using the equation below:

$$\text{Digestibility} = \frac{\text{Nutrient intake} - \text{Nutrient output}}{\text{Nutrient intake}} \times 100$$

Where, Nutrient intake (g) = Dry feed intake × Nutrient in diet (%)

Nutrient output (g) = Dry faecal output ×Nutrient in faeces (%)

### 3.4.7 Carcass Analysis

At the end of the experiment, three birds from each replicate (Nine birds per treatment) were randomly selected based on average group weight and used for carcass analysis. They were fasted of feeds overnight, weighed, slaughtered for carcass analysis and the following parameters were recorded: Live weight; dressed weight; dressing percentage; weight of the prime cuts and organs

weight. The prime cuts were expressed as percentage of the dressed weight while the organs weight were expressed as percentage of the live weight. Organs weight recorded were the liver, heart, kidney, spleen, gizzard, lungs and abdominal fat.The abdominal fat was carefully removed from the abdominal section and weighed carefully using a digital scale.

### 3.4.8 Haematological Parameters

Two millilitres (2.0mls)of blood were collected from the wing veinof each bird at the end of the growth phase. Three birds per replicate making a total of nine birds per treatment were randomly selected. Blood samples were collected into labelled bottles containing Ethylene Diamine Tetra acetic Acid (EDTA) and taken to the Chemical Pathology Laboratory, Faculty of Veterinary Medicine, Ahmadu Bello University, Samaru, Zaria, Kaduna State for haematological analysis. The samples were assayed for: Packed cell volume (PCV), haemoglobin content (hb), white blood cell (WBC), red blood cell (RBC) and differential blood count (heterophils, lymphocytes, monocytes, eosinophils, basophils and band cell). The haematological analysis was performed using a semi-automatic cell counter (Sysmex-F820). Blood smears was ethanol-fixed and stained according to the May-Grunwald-Giemsa technique. The blood smears was used to determine the differential blood count by immersion microscopy and quantified by immersion refractometry.

### 3.4.9 Blood Biochemical Parameters

Three birds per replicate were randomly selected and fasted of feeds overnight and 2.0mls of blood samples were collected into labelled bottles containing Ethylene Diamine Tetra Acetic Acid (EDTA) and samples were analysed for total protein, total cholesterol, tryglycerides, high density lipo protein (HDL), low density lipoprotein (LDL), albumin and creatinine. Analysis was done at the Chemical PathologyLaboratory, University Teaching Hospital, Shika, Zaria, Kaduna State. The total blood protein concentration was determined based on the biuret reaction (Dioumas *et al.,* 1981) and albumin determination as described by Doumas and Biggs (1972). Creatinine determination was done according to the method by Ambrose *et al*., (1983). Total cholesterol levels were estimated using the Liebermann Buchard reaction according to the principles of Huang *et al*. (1961) and modified by Ness *et al*. (1964). Tryglycerides, HDL and LDL were determined using spectrophotometer.

### 3.4.10 Data Analysis

The data obtainedfrom the study were analysed using One-way ANOVA. The General Linear Model procedure of Statistical Analysis System (SAS, 2002) was used and the mean was separated using Dunnet because the control diet was used to compare with other treatments (Dunnet, 1964).

The linear model of the experiment is as follows:

$Y_{ij} = \mu + T_j + e_{ij}$

Where $Y_{ij}$ = Any observation

$\mu$= Overall mean

$T_j$= Treatment effect

$e_{ij}$= Error term assumed to be identically independent with zero mean and equal variance

### 3.5 Experiment 2: Performance of Broiler Chickens Fed Graded Levelsof Roselle Seed Cake as Replacement for Soya Bean Cake

In this second experiment, Soyabean cake which was one of the protein sources in the diet was replaced while Groundnut cake another protein source was fixed to test the birds performance.

### 3.5.1 Experimental Diet

Five isonitrogenousand isocaloric diets (23.33 %CP; 3001kcal/kg ME) and (20.10 %CP; 2960kcal/kg ME) were formulated for the broiler starter and finisher phases respectively as follows:

Diet 1: 0% of Roselle seedcake in thediet (control)

Diet 2: 8% level of Roselle seed cake in the diet

Diet 3: 16% levelof Roselle seed cake in thediet

Diet4: 24% levelof Roselle seed cake in thediet

Diet 5: 32% levelof Roselle seed cake in thediet

Compositions of the experimental diets are presented in Tables 3.3 and 3.4 respectively.

### 3.5.2 Design and Management of Experimental birds for Experiment 2

Procedure same as that of experiment 1

### 3.5.3 Starter Phase

Procedure same as that of experiment 1

### 3.5.4 Finisher Phase

Procedure same as that of experiment 1

**Table 3.3 Experimental Diets for Broiler Starter with Roselle Seed Cake as Replacement for Soyabean Cake (0-4weeks)**

| **Levels of Roselle Seed Cake (RSC) Inclusion (%)** | | | | | |
|---|---|---|---|---|---|
| **Ingredients (%)** | **0** | **25** | **50** | **75** | **100** |
| Maize | 61.36 | 57.05 | 54.30 | 51.94 | 48.85 |
| Roselle seed cake | 0.00 | 8 .00 | 16.00 | 24.00 | 32.00 |
| Soya bean cake | 19.70 | 16.00 | 10.70 | 5.00 | 0.00 |
| Groundnut cake | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |
| Blood meal | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| Bone meal | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Limestone | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Common salt | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Methionine | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Lysine | 0.04 | 0.05 | 0.10 | 0.16 | 0.20 |
| *Vitamin premix | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| **Total** | **100** | **100** | **100** | **100** | **100** |
| **Calculated Analysis** | | | | | |
| ME (Kcal/kg) | 3001.00 | 3002.00 | 3019.00 | 3037.00 | 3050.00 |
| Crude protein (%) | 23.33 | 23.30 | 23.32 | 23.34 | 23.36 |
| Crude fibre (%) | 3.06 | 3.32 | 3.57 | 3.40 | 3.51 |
| Ether Extract (%) | 3.79 | 4.10 | 4.51 | 4.73 | 5.04 |
| Calcium (%) | 1.26 | 1.20 | 1.27 | 1.27 | 1.28 |
| Phosphorus (%) | 0.80 | 0.77 | 0.64 | 0.71 | 0.68 |
| Lysine (%) | 1.25 | 1.25 | 1.25 | 1.25 | 1.25 |
| Methionine (%) | 0.50 | 0.51 | 0.81 | 0.50 | 0.50 |
| Cost/kg (₦) | 120.55 | 116.56 | 112.12 | 107.58 | 103.21 |

*Bio-mix broiler starter premix per 2.5kg of diet: Vit A, 10,000 I.U, Vit $D_3$, 2,000 I.U, Vit E, 23,000mg, Vit $K_3$, 2,000mg; Vit B1, 1,800; Vit$B_2$, 5,500mg; Niacin, 27,500; Panthonenic acid, 7,500; Vit $B_6$, 3000mg; Vit $B_{12}$, 15mg; Folic acid, 750mg; Biotin $H_2$, 60mg; Cholin Chloride, 300.000mg; Cobalt, 200mg; Copper,3000.00mg; Iodine,3000mg;Iron,1,000mg;Manganese,20,000mg;Selenium,40,000mg;Zinc,30.000.00mg;Antioxidant,1,250mg

ME= Metabolizable Energy

**Table 3.4Experimental Diets for Broiler Finisher with Roselle Seed Cake as Replacement for Soyabean Cake (5-8weeks)**

| **Levels of Roselle Seed Cake (RSC) Inclusion (%)** | | | | | |
|---|---|---|---|---|---|
| **Ingredients %** | **0** | **25** | **50** | **75** | **100** |
| Maize | 59.95 | 56.92 | 54.17 | 51.37 | 48.75 |
| Roselle seed cake | 0.00 | 8.00 | 16.00 | 24.00 | 32.00 |
| Soya bean cake | 21.00 | 16.00 | 10.70 | 5.40 | 0.00 |
| Groundnut cake | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |
| Maize offal | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| Bone meal | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Limestone | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Common salt | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Methionine | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Lysine | 0.10 | 0.13 | 0.18 | 0.28 | 0.30 |
| *Vitamin premix | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| **Total** | **100** | **100** | **100** | **100** | **100** |
| **Calculated Analysis** | | | | | |
| ME (Kcal/kg) | 2960.00 | 2973.00 | 2952.00 | 3003.00 | 3021.00 |
| Crude protein (%) | 20.11 | 20.11 | 20.11 | 20.11 | 20.11 |
| Crude fibre (%) | 3.59 | 3.70 | 3.79 | 3.89 | 3.98 |
| Ether Extract (%) | 3.93 | 4.25 | 4.56 | 4.87 | 5.19 |
| Calcium (%) | 1.25 | 1.26 | 1.26 | 1.26 | 1.27 |
| Phosphorus (%) | 0.79 | 0.76 | 0.73 | 0.70 | 0.67 |
| Lysine (%) | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Methionine (%) | 0.47 | 0.47 | 0.47 | 0.47 | 0.47 |
| Cost/kg (₦) | 118.54 | 114.10 | 109.67 | 105.58 | 100.89 |

*Bio-mixbroiler finisher premix per 2.5kg of diet: Vit A, 10,000I.U, Vit $D_3$, 2,000 I.U, Vit E, 23,000mg, Vit $K_3$, 2,000mg; Vit $B_1$, 1,800; Vit$B_2$, 5,500mg; Niacin, 27,500; Panthonenic acid, 7,500; Vit $B_6$,(pyridoxine) 3,000mg; Vit $B_{12}$, 15mg; Folic acid, 750mg; Biotin $H_2$, 60mg; Cholin Chloride, 300.000mg; Cobalt, 200mg; Copper,3.0mg; Iodine,3,000mg;Iron,1000.00mg;Manganese,20,000mg; Selenium, 40,000mg; Zinc, 200mg; Antioxidant,1,250mg

ME= Metabolizable Energy

### 3.5.5 Growth Study

Procedure same as that of experiment 1

### 3.5.6 Digestibility Trial

Procedure same as that of experiment1

### 3.5.7 Carcass Analysis

Procedure same as that of experiment 1

### 3.5.8 Haematological Parameters

Procedure same as that of experiment 1

### 3.5.9 Blood Biochemical Parameters

Procedure same as that of experiment 1

### 3.5.10 Data Analysis

Procedure same as that of experiment 1

# CHAPTER FOUR

## 4.0 RESULTS AND DISCUSSION

### 4.1 Proximate Composition of Roselle seed cake (RSC) and the Experimental diets

Table 4.1 shows the proximate composition of Roselle Seed Cake.Dry matter content was 95.17%, crude protein 30.45%, crude fiber 4.20%, ash 7.25%, ether extract 8.05% and nitrogen free extract content was 50.05%.

The crude protein value of 30.45% observed for Roselle seed cake in this study is similar with the findings of Igoche (2015) who reported that the crude protein of RSC is 30.50 and it agrees with the findings of Isadahomen *et al*. (2006) and Kwari *et al.* (2011) that Roselle seed cake contains between 21.40-38.75% crude protein. Crude fibre value of 4.20% obtained was lower than the value 11.98% reported by Mukhtar,(2007) and also 10.20% reported by Sanni, (2015) but similar to the value 4.18% reported by Igoche, (2015). Ether extract value of 8.05% was quite lower than the value of 17.43% reported by Mukhtar (2007) and higher than 5.78% reported by Sanni, (2015). However, it was closer to the value of 10.28% reported by Igoche (2015). The metabolizable energy value of 3561.92kcal/kg agreed with the range of 2880-3500kcal/kg reported by various authors (Isidahomen *et al*.2006; Mukhtar,2007; Diarra *et al*.,2011 and Kwari *et al*.,2011). This variations in values obtained could be attributed to different sources of the cake and differences in processing methods employed and storage conditions.

The proximate composition of the experimental diets are presented in Tables 4.2, 4.3, 4.4 and 4.5 respectively. The crude protein, crude fibre, ether extract, ash and energy content of the diets meet nutrient requirement for broilers starter and finisher chickens as recommended by NRC (1994).

**Table 4.1 Proximate Composition and Energy Value of Roselle Seed Cake**

| **Parameters Composition (%)** | |
|---|---|
| Dry matter | 95.17 |
| Crude protein | 30.45 |
| Crude fibre | 4.20 |
| Ash | 7.25 |
| Ether extract | 8.05 |
| Nitrogen Free Extract | 50.05 |
| ME(Kcal/kg) | 3059.64 |

ME= Metabolizable Energy

Determined at the Department of Animal Science Biochemistry Laboratory,Ahmadu Bello University, Zaria

**Table 4.2 Proximate Composition and Energy Valueof Broiler Starter Diets with Roselle Seed Cake as Replacement for Groundnut cake**

| **Levels of Roselle SeedCake (RSC) Inclusion (%)** | | | | | |
|---|---|---|---|---|---|
| **Parameters (%)** | **0** | **8** | **16** | **24** | **32** |
| Dry matter | 95.30 | 94.45 | 93.45 | 92.36 | 93.83 |
| Ether extract | 6.20 | 6.74 | 6.78 | 6.84 | 6.75 |
| Crude fibre | 5.27 | 5.32 | 5.62 | 5.65 | 5.66 |
| Crude protein | 22.92 | 22.82 | 22.88 | 22.77 | 22.82 |
| Ash | 6.63 | 5.24 | 6.44 | 6.76 | 5.58 |
| NFE | 58.98 | 59.88 | 58.28 | 57.98 | 59.19 |
| ME (Kcal/kg) | 2885.61 | 2890.25 | 2844.75 | 2814.43 | 2852.04 |

NFE = Nitrogen Free Extract, ME= Metabolizable Energy

Determination done at the Biochemical Laboratory, Product Development Research Programme, Institute for Agricultural Research (I.A.R) Samaru, Ahmadu Bello University, Zaria.

**Table 4.3 Proximate Composition and Energy Value of Broiler Finisher Diets with Roselle Seed Cake as Replacement for Groundnut Cake**

| | **Levels of Roselle SeedCake (RSC) Inclusion (%)** | | | | |
|---|---|---|---|---|---|
| **Parameters (%)** | **0** | **8** | **16** | **24** | **32** |
| Dry matter | 93.30 | 93.45 | 92.85 | 92.06 | 92.83 |
| Ether extract | 7.14 | 6.49 | 7.48 | 7.55 | 6.54 |
| Crude fibre | 5.38 | 5.25 | 5.32 | 5.38 | 5.32 |
| Crude protein | 19.68 | 19.54 | 19.56 | 19.65 | 19.67 |

| | | | | | |
|---|---|---|---|---|---|
| Ash | 8.95 | 8.98 | 8.45 | 8.61 | 7.62 |
| NFE | 58.85 | 59.74 | 59.19 | 58.81 | 60.85 |
| ME (Kcal/kg) | 2876.85 | 2849.59 | 2887.87 | 2865..03 | 2829.98 |

NFE = Nitrogen Free Extract, ME= Metabolizable Energy

Determination done at the Biochemical Laboratory, Product Development Research Programme, Institute for Agricultural Research (I.A.R) Samaru, Ahmadu Bello University, Zaria.

**Table 4.4 Proximate Composition and Energy Valueof Broiler Starter Diets with Roselle Seed Cake as Replacement for Soyabean Cake**

| **Levels of Roselle SeedCake (RSC) Inclusion (%)** | | | | | |
|---|---|---|---|---|---|
| **Parameters (%)** | **0** | **8** | **16** | **24** | **32** |
| Dry matter | 94.15 | 94.45 | 92.45 | 93.06 | 92.83 |
| Ether extract | 7.21 | 7.25 | 7.10 | 6.75 | 6.43 |
| Crude fibre | 4.62 | 4.84 | 4.62 | 4.40 | 4.22 |
| Crude protein | 23.12 | 23.08 | 23. 15 | 23.20 | 23.24 |
| Ash | 8.22 | 8.61 | 8.08 | 8.42 | 8.38 |
| NFE | 56.83 | 56.22 | 57.05 | 57.23 | 57.73 |
| ME (Kcal/kg) | 2952.60 | 2950.55 | 2895..44 | 2905.61 | 2890.23 |

NFE = Nitrogen Free Extract, ME= Metabolizable Energy

Determination done at the Biochemical Laboratory, Product Development Research Programme, Institute for Agricultural Research (I.A.R) Samaru, Ahmadu Bello University, Zaria.

**Table 4.5 Proximate Composition and Energy Valueof Broiler Finisher Diets with Roselle Seed Cake as Replacement for Soyabean Cake**

| **Levels of Roselle SeedCake (RSC) Inclusion (%)** | | | | | |
|---|---|---|---|---|---|
| **Parameters (%)** | **0** | **8** | **16** | **24** | **32** |
| Dry matter | 93.45 | 93.25 | 92.85 | 92.06 | 93.83 |
| Ether extract | 7.02 | 7.11 | 7.18 | 6.85 | 6.54 |
| Crude fibre | 7.15 | 6.68 | 7.22 | 7.12 | 6.42 |
| Crude protein | 20.48 | 20.44 | 20.56 | 20.55 | 20.60 |
| Ash | 8.95 | 8.90 | 7.45 | 8.11 | 7.62 |
| NFE | 56.40 | 56.87 | 57.59 | 57.37 | 58.82 |
| ME(Kcal/kg) | 2866.24 | 2894.40 | 2853.93 | 2816.45 | 2892.70 |

NFE = Nitrogen Free Extract, ME= Metabolizable Energy
Determination done at the Biochemical Laboratory, Product Development Research Programme, Institute for Agricultural Research (I.A.R) Samaru, Ahmadu Bello University, Zaria.

## 4.2 Experiment 1: Performance of Broiler Chickens fed Graded Levels of Roselle Seed Cake as Replacement for Groundnut Cake.

### 4.2.1 Growth Performance of Birds at Starter Phase (0-4weeks)

The performance of broiler chickens fed graded levels of roselle seed cake as replacement for groundnut cake is presented in Table 4.6. Final weight, total weight gain and average daily weight gain were significantly (P□0.05) higher with birds on 16% and 24% RSC. From the result obtained, it was observed that the weight gain upto 24% conforms to the feed intake. The increase in weight gain maybe attributed to the reduction in anti-nutritional factor of the cake since raw roselle seed contains higer level of anti-nutrient which limits feed intake thereby decrease in weight gain.This

findings is similar to the report of Igoche, (2015) who fed graded levels of RSCdiet and had the highest value for final weight at 30% inclusion level of RSC while the result is not in line with the report of Mukhtar, (2007) who reported a decreasing order in final weight as the level of roselle seed increased in the diets.This implies that RSC has better nutritive value as compared to the seed.

The total feed intake and daily feed intake were significantly (P□0.05) lower with the control diet (1280.83 and 45.74g) compared to the other dietary treatments.There was a linear increase in total and daily feed intake of the birds as the inclusion level of RSC increased.Animals are generally known to eat in order to satisfy their energy requirement (NRC, 1994), birds increase their feed intake as the energy level of the diets decrease. In this present study, the increase in feed intake of birds as the inclusion level of RSC increased may not be attributed to that known fact (birds eating to satisfy their energy requirement) since the energy level of the diets meets the requirement for starter birds.

There are factors responsible for increase in feed intake like palatability, the nature of the feed material (if it's easily digestible), age of the animal, physiology of the animal and nutrient

**Table 4.6 Performance of Broiler Chicks fed Graded Levels of Roselle Seed Cakeas Replacement for Groundnut Cake (0-4weeks)**

| **Levels of Roselle SeedCake (RSC) Inclusion (%)** | | | | | | |
|---|---|---|---|---|---|---|
| **Parameters** | **0** | **8** | **16** | **24** | **32** | **SEM** |
| Initial weight (g/bird) | 55.00 | 54.17 | 55.00 | 55.00 | 55.00 | 0.37 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Final weight (g/bird) | 718.33$^{c}$ | 870.83$^{b}$ | 1009.17$^{a}$ | 996.67$^{a}$ | 884.17$^{b}$ | 10.94 |
| Total weight gain (g/bird) | 663.33$^{d}$ | 816.67$^{c}$ | 954.17$^{a}$ | 941.67$^{a}$ | 862.50$^{b}$ | 11.32 |
| Avg. daily wt. gain (g/bird) | 23.69$^{d}$ | 29.17$^{c}$ | 34.08$^{a}$ | 33.63$^{a}$ | 30.80$^{b}$ | 0.40 |
| Total feed intake (g/bird) | 1280.83$^{d}$ | 1607.50$^{c}$ | 1905.83$^{b}$ | 2029.83$^{a}$ | 2082.50$^{a}$ | 38.18 |
| Daily feed intake (g/bird) | 45.74$^{d}$ | 57.41$^{c}$ | 68.07$^{b}$ | 72.49$^{a}$ | 74.37$^{a}$ | 1.36 |
| Feed conversion ratio | 1.93$^{ab}$ | 1.97$^{a}$ | 1.99$^{a}$ | 2.16$^{b}$ | 2.41$^{c}$ | 0.06 |
| Feed cost/kg gain (₦/kg) | 172.16$^{b}$ | 163.49$^{a}$ | 157.60$^{a}$ | 165.54$^{ab}$ | 180.39$^{bc}$ | 4.19 |
| Mortality (%) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |

abcd= Means with different superscripts on the same row are significantly different P□0.05

Avg= Average, Wt= weight

SEM= Standard Error of Mean

balance of the diet. This observation may be that RSC is easily digestible thereby increased feed intake.

The feed conversion ratio was significantly (P□0.05) higher with the 32% RSC groups (2.41) compared to the other treatment groups. The poor feed conversion ratio of birds in this group may be due to the poor utilization of feeds due to the effect of anti-nutritional factor as the level of RSC increased upto 32%. This result is not in line with the report of Sanni, (2015) who observed no significant differences in feed conversion ratio for Japanese quails fed roselle seed cake with enzyme supplementation. This difference could be as a result of the different specie of birds used.

Feed cost per kg gain was significantly (P□0.05) better with the 16% RSC groups (₦157.60) compared to the control group (₦172.16) but similar to the 8% RSC group (₦163.49). The present study indicates that cost of broiler production at the starter phase was reduced by 5.04% and 8.46% with the inclusion of 8% and 16% RSC in the diet.This disagreed with the findings of Igoche, (2015) who recorded a better cost of production in the control diet.

There was no record of mortality across dietary treatment means at the starter phase.

### 4.2.2 Growth Performance of Birds at Finisher Phase (5-8weeks)

The growth response of broiler chickens fed graded levels of Roselle seed cakeas replacement for groundnut cake at the finisher phase is presented in Table 4.7. Final weight and total weight gain were significantly (P□0.05) higher with the 8% (2602.14g ; 1597.14g) and 16% (2571.67g; 1568.33g) groups compared to the other treatment groups.The average daily weight gain was significantly (P□0.05) lower withthe 0%group (47.28g)compared to the other treatment groupsbut similar to the 32% group (50.77g). Thisresult contradicts the work of Kwari *et al*. (2010) who reported a decrease

in final weight and average daily weight gain as the level of roselle seedmeal (RSM) increased above 7.5% when raw RSM was fed in broiler chickens diet.

**Table 4.7 Performance of Broiler Chickens fed Graded Levels of Roselle Seed Cake as Replacement for Groundnut Cakeat the Finisher Phase**

| Levels of Roselle SeedCake (RSC) Inclusion (%) | | | | | | |
|---|---|---|---|---|---|---|
| **Parameters** | **0** | **8** | **16** | **24** | **32** | **SEM** |
| Initial weight (g/bird) | 1003.33 | 1005.00 | 1003.00 | 1005.00 | 1005.00 | 1.05 |
| Final weight (g/bird) | 2327.28$^{c}$ | 2602.14$^{a}$ | 2571.67$^{a}$ | 2481.67$^{b}$ | 2420.67$^{bc}$ | 52.4 |
| Total weight gain (g/bird) | 1323.95$^{c}$ | 1597.14$^{a}$ | 1568.33$^{a}$ | 1476.67$^{b}$ | 1421.67$^{bc}$ | 53.28 |
| Avg. daily wt. gain (g/bird) | 47.28$^{b}$ | 57.04$^{a}$ | 56.01$^{a}$ | 52.74$^{a}$ | 50.77$^{ab}$ | 1.90 |
| Total feed intake (g/bird) | 3780.60 | 3818.30 | 3825.00 | 3935.80 | 3926.90 | 134.71 |
| Daily feed intake( g/bird) | 135.02 | 136.37 | 136.60 | 140.56 | 140.25 | 4.81 |
| Feed conversion ratio | 2.68$^{a}$ | 2.78$^{a}$ | 2.82$^{ab}$ | 3.04$^{b}$ | 2.98$^{b}$ | 0.11 |
| Feed cost/kg gain (₦/kg) | 288.34$^{b}$ | 229.01$^{a}$ | 223.61$^{a}$ | 237.77$^{a}$ | 238.92$^{a}$ | 9.37 |
| Mortality (%) | 8.33$^{b}$ | 8.33$^{b}$ | 0.00$^{a}$ | 0.00$^{a}$ | 3.33$^{b}$ | 3.16 |

abc= Means with different superscripts on the same row are significantly different P  0.05

Avg= Average, Wt=weight

SEM= Standard Error of Mean

It was observed from the results obtained that their was a significant increase in final and total weight gain of the birds upto 16% which may be due to reduced level of anti-nutritional factor in RSC. This indicates a better nutritional value in RSC.

There were no significant differences (P□0.05) in the total feed intake and daily feed intake across the treatments.

Feed conversion ratio for birds on the 24% and 32% (3.04 and 2.98) RSC diet were significantly (P□0.05) poorer compared to those on the control, 8% and 16% groups (2.64, 2.52 and 2.46) but similar to the 16% group (2.82). This result appears to be better than the observation of Nyameh *etal*., (2012) who reported that the feed conversion ratio of about 4.8 was recorded when 50% of groundnut cake was replaced with processed roselle seed meal in broiler diet. This impliesthat the birds wereable to properly utilize their RSC diet as efficiently as the control diet up to 16% inclusion.

Feed cost per kg gain was significantly (P□0.05) higher with the control group (₦288.34) compared to the other dietary treatments.This means that the cost of producing 1kg of meat at the finisher phase was quite high with the control diet compared to the rest dietary treatments. The cost of production was reduced by 20.58%, 22.45%, 17.54% and 17.72% by the inclusion of 8%, 16%, 24% and 32% RSC in the diets respectively at the finisher phase.

Mortality was significantly (P□0.05) higher with birds on the 0%, 8% and 32% groups. The mortality observed may not be attributed to the test ingredient since the birds on the control diet were equally affected.

### 4.2.3 Nutrient Digestibility of Broiler Chickens fed Graded Levels of Roselle Seed cake as Replacement for Groundnut Cake

The nutrient digestibility of broiler chickens fed graded levels of roselle seed cake (RSC) as replacement for groundnut cake is presented in Table 4.8. Dry matter, crude protein and nitrogen free extract digestibility were significantly (P□0.05) lower with the 32% group compared to the other treatment groups. According to Oke (1969) oxalate affects calcium and magnesium metabolism mainly by reducing the utilization of the protein activity of the digestive enzymes. This might have contributed to the poor performance observed in birds fed 32% RSC inclusion level. At this inclusion level the birds were not able to properly digest and utilize the test diet. It was reported by Igoche

(2015) that the level of oxalate was higher in RSC than GNC. Ether extract digestibility was significantly (P 0.05) higher with the 16% RSC group compared to the control group. This implies that broiler birds can utilize RSC at 16% inclusion level without adverse effect on ether extract digestibility. Crude fibre digestibility was not significantly (P 0.05) different across dietary treatment means.

**Table 4.8 Nutrient Digestibility of Broiler Chickens fed Graded Levels of Roselle seedCake as Replacement for Groundnut Cake**

| | Levels of Roselle SeedCake (RSC) Inclusion (%) | | | | | |
|---|---|---|---|---|---|---|
| **Parameters (%) 0** | **8** | **16** | **24** | **32** | **SEM** | |
| Dry matter | 97.30[a] | 96.83[c] | 96.45[d] | 97.06[b] | 95.45[e] | 0.01 |
| Ether extract | 60.74[b] | 60.66[b] | 61.96[a] | 61.75[ab] | 61.43[ab] | 0.6 |
| Crude fiber | 64.31 | 64.32 | 64.31 | 64.30 | 64.31 | 3.48 |
| Crude protein | 71.40[a] | 65.40[b] | 68.12[ab] | 70.74[ab] | 63.05[c] | 2.04 |
| Nitrogen Free Extract | 60.22[b] | 61.45[a] | 58.51[c] | 57.43[d] | 54.53[e] | 0.3 |

abcde= Means with different superscripts on the same row are significantly different P 0.05

SEM= Standard Error of Mean

Determined at the biochemical laboratory of National Animal Production Research Institute, (N.A.P.R.I) Ahmadu Bello University Shika, Zaria.

### 4.2.4 Carcass Characteristics and Organ weights of Broiler Chickens fed Graded Levels of Roselle Seed Cake as Replacement for Groundnut Cake

Table 4.9 shows the carcass characteristics, major cuts and organ weight of broiler chickens fed graded levels of Roselle seed cake as replacement for groundnut cake in the finisher phase (0-8weeks). Dressed weight was significantly (P□0.05)higherwith birds fed 8% level of RSC(2083.30g) compared to the control group (1636.70g) and similar to the 16% RSC group (1970.00g). The dressing percentage was significantly(P□0.05) higher with birds fed 8% RSC diet (82.23%) compared to the control group and 24% RSC group (71.68 and 72.92%). Kwari *et al*. (2010) reported a slightly lower dressing percentage for broilers fed unprocessed roselle seed diet. It was observed that the carcass yield was higher than the 65-70% reported by Salami *et al.*(2004). This is an indication that RSC improved carcass characteristics of the birds which may be as a result of the relatively higher liveweight and dressed weight in birds in this group. The thigh was significantly (P□0.05) higher with the control diet (16.69%) compared to those on the 8% and 32% groups (13.54 and 14.88%) but similar to those on the 16% and 24% groups (14.97 and 16.47%).The breast showed no significant (P□0.05) differences across dietary treatments. The drumstick was significantly (P□0.05) higher with 8%, 16% and 24% groups (14.71, 14.46 and 13.73%) compared to thecontrol group (13.15%) which was similar to the 24% and 32% groups (13.73 and 12.13%). The back was observed to be significantly lower with the 8% and 16% groups (13.55 and 14.52%) compared to other groups but similar to the 32% group (14.74%). Oluyemi and Roberts (2000) reported a lower yield of drumstick,

thigh and breast. (11.67, 12.95 and 17.40%). This result reveals that RSC can efficiently convert feed into meat.

The liver showed a significantly (P□0.05)higher value in the 0%, 24% and 32% groups (2.65 2.54 and 2.68%) compared to other groups.The heart was observed to be significantly (P□ 0.05) different with the 32% RSC compared to the rest dietary treatment means.

**Table 4.9 Carcass Characteristics and Organ Weights of Broiler Chickens fed Graded Levels of Roselle SeedCake as Replacement for Groundnut Cake**

| | **Levels of Roselle SeedCake (RSC) Inclusion (%)** | | | | | |
|---|---|---|---|---|---|---|
| **Parameters** | **0** | **8** | **16** | **24** | **32** | **SEM** |
| Live weight (g) | 2283.33$^{b}$ | 2533.33$^{a}$ | 2516.67$^{a}$ | 2400.00$^{ab}$ | 2383.33$^{ab}$ | 50.55 |
| Dressed weight (g) | 1636.70$^{c}$ | 2083.30$^{a}$ | 1970.00$^{ab}$ | 1750.00$^{bc}$ | 1800.00$^{b}$ | 89.54 |
| Dressing percentage (%) | 71.68$^{c}$ | 82.23$^{a}$ | 78.28$^{b}$ | 72.92$^{c}$ | 75.52$^{b}$ | 1.58 |
| **Major cuts expressed as percentage of dressed weight (%)** | | | | | | |
| Thigh | 16.69$^{a}$ | 13.54$^{b}$ | 14.97$^{ab}$ | 16.47$^{a}$ | 14.88$^{b}$ | 0.86 |
| Breast | 22.25 | 24.33 | 24.28 | 23.70 | 22.36 | 1.90 |
| Drumstick | 13.15$^{b}$ | 14.71$^{a}$ | 14.46$^{a}$ | 13.73$^{ab}$ | 12.13$^{b}$ | 0.66 |
| Back | 15.85$^{a}$ | 13.55$^{b}$ | 14.52$^{b}$ | 16.13$^{a}$ | 14.74$^{ab}$ | 1.09 |
| **Organs expressed as percentage of live weight (%)** | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Liver | 2.65[a] | 1.83[b] | 1.76[b] | 2.54[a] | 2.68[a] | 0.19 |
| Heart | 0.75[a] | 0.72[a] | 0.74[a] | 0.72[a] | 0.56[b] | 0.04 |
| Kidney | 0.88[a] | 0.71[b] | 0.73[b] | 0.97[a] | 0.89[a] | 0.05 |
| Spleen | 0.12 | 0.07 | 0.09 | 0.09 | 0.08 | 0.04 |
| Gizzard | 3.86 | 3.44 | 3.47 | 3.78 | 3.49 | 0.25 |
| Lungs | 0.76 | 0.61 | 0.61 | 0.87 | 0.63 | 0.08 |
| Abdominal fat | 2.05[b] | 1.99[b] | 1.97[b] | 2.95[a] | 2.89[a] | 0.42 |

ab= Means with different superscripts on the same row are significantly different P  0.05

SEM= Standard Error of Mean

The kidney of birds fed with 8% and 16% RSC were significantly (P0.05) lower (0.71 and 0.73%) compared to the other groups. This observation in the results obtained varied with no particular pattern between the control and the test diets. This impliesthat RSC can effectively build up the vital organs of broiler chickens. Dietary treatments was observed to show no significant (P0.05) differences in organ weights such as spleen, gizzard and lungs.

The abdominal fat was observed to be significantly(P0.05) higher in birds fed 24% level of RSC (2.95%) as compared to the other treatment groups and also similar to the 32% RSC group

(2.89%).This increase in abdominal fat content may be due to the relative increase in ether extract content of the diet as the level of RSC increased.

### 4.2.5 Haematological parameters on Broiler Chickens fed Graded Levels of Roselle Seed cake as Replacement for Groundnut Cake at Finisher Phase.

The result of the haematological parameters of Broiler chickens fed graded levels of Roselle seed cake as replacement for groundnut cake at finisher phase are shown in Table 4.10. All parameters measured were similar across the treatments except for white blood cell (WBC) which was significantly (P□0.05) higher in treatment with 32% graded level of RSC in the diet ($7.73\times10^3$/ml) compared to the control group ($4.29\times10^3$/ml). There were no significant (P□0.05) differences in packedcell volume (PCV), haemoglobin (Hb) and red blood cell (RBC) in broiler chickens fed graded levels of RSC at the finisher phase. The PCV values obtained (28.67-37.33%) fell within the normal range (30-40%) for healthy chickens reported by Siegmind (1979) and also similar to the values (25-45%) by Mirtuka and Rawnsley(1997). The values obtained for red blood cell count (4.00-$4.83\times10^6$/dl) was also within the normal range values (3.00-$6.00\times10^6$/dl) reported by Madubuike and Ekenyen (2006).This simply implies that the birds were not anaemic.

**Table 4.10 Haematological Parameters on Broiler Chickens fed Roselle SeedCake as Replacement for Groundnut Cake at Finisher Phase**

**Levels of Roselle SeedCake (RSC) Inclusion (%)**

| Parameters | 0 | 8 | 16 | 24 | 32 | SEM |
|---|---|---|---|---|---|---|
| PCV (%) | 35.33 | 37.33 | 33.67 | 35.00 | 28.67 | 3.09 |
| Hb (g/dl) | 11.73 | 12.43 | 11.07 | 11.63 | 9.53 | 1.04 |
| RBC ( $\times 10^6$/dl) | 4.83 | 4.10 | 4.63 | 4.00 | 4.07 | 0.51 |
| WBC ( $\times 10^3$/ml) | $4.29^b$ | $4.32^b$ | $4.07^b$ | $4.23^b$ | $7.73^a$ | 1.21 |
| Heterophils (%) | 14.33 | 14.00 | 16.00 | 15.67 | 13.00 | 3.56 |
| Lymphocytes (%) | 50.00 | 53.33 | 51.33 | 53.00 | 55.00 | 3.62 |
| Monocytes (%) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Eosinophils (%) | 0.00 | 0.00 | 0.00 | 0.00 | 3.67 | 0.83 |
| Basophils (%) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Band cell (%) | 0.67 | 0.00 | 0.00 | 0.00 | 0.33 | 0.35 |

ab= Means with different superscripts on the same row are significantly different P 0.05

PCV: Packed cell volume, Hb: Haemoglobin , WBC: White blood cell , RBC: Red blood cell

SEM= Standard Error of Mean

The values obtainedfor haemoglobin (11.07-12.43g/dl) for broiler chickens on the control diet to 24% group fell within the normal range values (8.00-13.00g/dl) reported by Oluremi and Sridhar (2004) while the value obtained for birds fed 32% RSC (9.53g/dl) agreed with the rangevalues (7.55-9.68g/dl) reported by Swenson (1970) for domestic chickens. The values obtained for WBC were not significantly different in all dietary treatments except for 32% group which was higher and significantly differentfrom other treatments ($7.73\times10^3$/ml).This could be as a result of health challenge in the birds since high WBC count indicates diseases or stress (Peter, 2002). The differential counts like the heterophils, monocytes, lymphocytes, basophils, eosinophils and band cells were not significantly differentfrom each other across dietary treatments.

### 4.2.6 Blood Biochemical Parameters of Broiler Chickens fed Graded Levels of Roselle Seed Cake as Replacement for Groundnut Cake at Finisher Phase

The blood biochemical parameters of broiler chickens fed graded levels of RSCas replacement for groundnut cake is shown in Table 4.11.There were no significant (P□0.05) differencesin total protein (TP), low density lipoprotein (LDL) and creatinine across the treatments.The TP values obtained (2.56-3.03gm/dl) fell within the normal range for healthy birds (2.5-5.5gm/dl) as reported byPeter(2002). This level is an indication that RSC had no detrimental effect on the health status of the birds. The LDL and HDL are combination of lipids and proteins and the higher the HDL the better because it lowers the risk of coronary artery disease (Peter, 2002). The creatinine values obtained (0.43-0.50 mg/dl) also fell within the range values (0.2-0.5mg/dl) by Peter (2002). This implies that RSC had no detrimental effect on the kidney function of the birds.

**Table 4.11Blood Biochemical parameters of Broiler Chickens fed Graded Levels of Roselle Seedas Replacement for Groundnut Cake at Finisher Phase**

**Levels of Roselle SeedCake (RSC) Inclusion (%)**

| **Parameters** | **0** | **8** | **16** | **24** | **32** | **SEM** |
|---|---|---|---|---|---|---|
| Tryglycerides(g/dl) | 70.23$^{c}$ | 71.30$^{c}$ | 72 .57$^{b}$ | 72.59$^{b}$ | 73.97$^{a}$ | 0.61 |
| Total cholesterol(mg/dl) | 111.33$^{b}$ | 113.33$^{b}$ | 115.67$^{a}$ | 116.00$^{a}$ | 115.00$^{a}$ | 1.14 |
| Total protein(g/dl) | 3.03 | 2.96 | 3.00 | 2.67 | 2.56 | 0.64 |
| HDL (mg/dl) | 70.70$^{b}$ | 71.40$^{b}$ | 71 .56$^{b}$ | 73.56$^{a}$ | 73.86$^{a}$ | 0.60 |
| LDL (mg/dl) | 33.60 | 33.23 | 32.33 | 32.33 | 33.33 | 0.61 |
| Albumin (mg/dl) | 42.33$^{a}$ | 35.33$^{ab}$ | 43.33$^{a}$ | 31.33$^{b}$ | 31.33$^{b}$ | 2.67 |
| Creatinine (mg/dl) | 0.50 | 0.45 | 0.50 | 0.43 | 0.48 | 0.90 |

abc= Means with different superscripts on the same row are significantly different P 0.05

HDL: High density lipoprotein , LDL: Low density lipoprotein

SEM= Standard error of mean

Tryglyceride was significantly (P 0.05) higher with the 32% (73.97g/dl) RSC inclusion compared to the other treatments. HDLwassignificantly (P 0.05) higher with the 24% and 32% ( 73.56 and 73.86mg/dl) RSC groups compared to the other groups.

There were no significant differences (P 0.05) for total cholesterol with birds on the 16%, 24% and 32% RSC inclusion while the control diet and 8% were also not significantly (P 0.05) different. The increase in total cholesterol in these groups (16%, 24% and 32%) is as a result of higher concentrations of HDL in these groups. The values obtained (111.33-116.00 mg/dl) in this study fell within the range values (100-300 mg/dl) reported by Peter (2002).

The albumin showed to be significantly (P0.05) higher with the control diet (42.33mg/dl) but comparable to those on 8% and 16% levels of RSC(35.33 and 43.33mg/dl). It has been reported that

serum biochemical constituents are positively correlated with the quality of the diet (Brown and Clime, 1972; Adeyemi *et al*., 2000).

## 4.3 Experiment 2:Performance of Broiler Chickens fed Graded Levels of Roselle Seed Cake as Replacement for Soyabean Cake.

### 4.3.1 Growth Performance of Birds at Starter Phase (0-4weeks)

Table 4.12 shows the growth response of birds fed graded levels of Roselle seed cake as replacement for soya bean cake.Birds on 24% levels of RSCresulted in a significantly (P□0.05) higher final body weight (996.67g) compared to the control diet (575.83g).This is an indication that RSC as replacement for soya bean cake improves body weight. Mukhtar, (2007) reported a decreasing order in final weight as the level of roselle seed increased in the diets.

Total weight gain was significantly (P□0.05) higher with birds on 24% levels of RSC inclusion (765.00g) compared to the control diet(522.50g) and similar to 32% RSC (760.83g).

**Table 4.12 Performance of Broiler Chicks fed Graded Levels of Roselle Seed Cake as Relacement for Soyabean Cake at 0-4weeks**

| | **Levels of Roselle SeedCake (RSC) Inclusion (%)** | | | | | |
|---|---|---|---|---|---|---|
| **Parameters** | **0** | **8** | **16** | **24** | **32** | **SEM** |

| | | | | | | |
|---|---|---|---|---|---|---|
| Initial weight (g/bird) | 52.53 | 52.50 | 52.50 | 52.50 | 52.50 | 0.37 |
| Final weight (g/bird) | 575.83$^{c}$ | 586.67$^{c}$ | 671.67$^{c}$ | 996.67$^{a}$ | 812.50$^{b}$ | 43.31 |
| Total weight gain (g/bird) | 522.50$^{b}$ | 534.17$^{b}$ | 619.17$^{b}$ | 765.00$^{a}$ | 760.83$^{a}$ | 43.31 |
| Avg. daily wt. gain (g/bird) | 18.66$^{c}$ | 18.87$^{c}$ | 22.11$^{b}$ | 27.14$^{a}$ | 27.35$^{a}$ | 1.52 |
| Total feed intake (g/bird) | 1029.17$^{c}$ | 1085.00$^{c}$ | 1254.17$^{b}$ | 1547.50$^{a}$ | 1570.00$^{a}$ | 59.73 |
| Daily feed intake (g/bird) | 36.76$^{c}$ | 38.75$^{c}$ | 44.79$^{b}$ | 55.27$^{a}$ | 56.07$^{a}$ | 2.13 |
| Feed conversion ratio | 1.99 | 2.08 | 2.01 | 1.99 | 2.01 | 0.06 |
| Feed cost/kg gain (₦/kg) | 238.94$^{b}$ | 338. 36$^{c}$ | 229.63$^{b}$ | 219.20$^{ab}$ | 211.59$^{a}$ | 9.49 |
| Mortality (%) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |

abc= Means with different superscripts on the same row are significantly differentP  0.05

Avg= Average, Wt=weight

SEM= Standard Error of Mean

The average daily weight gain was comparatively (P 0.05) higher in diets with 24% and 32% levels of RSC (27.14 and 27.35g) compared to the other levels.

Total and daily feed intake were significantly (P 0.05) lower with the control diet (1029.17 and 36.76g) but comparable to 8% levels of RSC (1085.00 and 38.75g). Total and daily feed intake showed that broiler chickens on the control and 8% group recorded the least consumption. From the result obtained, there was an increased feed intake upto 32% RSC inclusion. This may be as a result of the nutrient composition of RSC since is one of the factors that increases feed intake in birds. This implies that voluntary feed intake of the birds was not depressed despite the higher inclusion level of RSC upto 32%. This is in line with the work of Igoche, (2015) who reported that daily feed intake increased steadily as the inclusion level of RSC increased in the diet.

Feed conversion ratio showed no significant (P0.05) difference across dietary treatment means. This means the birds were able to effectively utilize their feeds comparably to the control diet.

Feed cost/kg gain was significantly (P0.05) higher with 8% levels of RSC inclusion (₦238.36) compared to the other levels.Feed cost per kg gain recorded the least value with 32% RSC inclusion (₦211.59) but significantly (P0.05) similar to the 24% RSC inclusion (₦219.20).This implies that broiler farmers could reduce cost of production by feeding broilers with RSC at 24% and 32% as replacement for soyabean cake at the starter phase.

There was no mortality recorded at the starter phase which is an indication that RSC had no adverse effect on performance of broiler chickens fed RSC diet.

### 4.3.2 Growth Performance of Birds at Finisher Phase (5-8weeks)

The growth response of birds fed graded levels of Roselle seed cake (RSC) as replacement forsoya bean cake at finisher phase is presented in Table 4.13.The final body weight wassignificantly (P□0.05) higher with birds on the 24% RSC diet (2077.78g) compared to the control diet (1772.22g).

**Table 4.13 Performance of Broiler Chickens fed Graded Levels of Roselle Seed Cake as Replacement for Soyabean Cake at Finisher Phase**

| | **Levels of Roselle SeedCake (RSC) Inclusion (%)** | | | | | |
|---|---|---|---|---|---|---|
| **Parameters** | **0** | **8** | **16** | **24** | **32** | **SEM** |
| Initial weight (g/bird) | 850.00 | 850.33 | 850.00 | 850.67 | 850.67 | 2.58 |
| Final weight (g/bird) | 1772.22$^{c}$ | 1795.55$^{bc}$ | 1899.51$^{bc}$ | 2077.78$^{a}$ | 1912.99$^{b}$ | 61.19 |
| Total weight gain (g/bird) | 922.22$^{c}$ | 952.22$^{bc}$ | 1049.51$^{b}$ | 1231.11$^{a}$ | 1066.30$^{b}$ | 60.34 |
| Avg. daily wt. gain (g/bird) | 33.14$^{c}$ | 34.01$^{bc}$ | 37.48$^{b}$ | 43.97$^{a}$ | 38.08$^{b}$ | 2.19 |
| Total feed intake (g/bird) | 1556.40$^{c}$ | 1661.40$^{c}$ | 1923.60$^{b}$ | 2018.30$^{a}$ | 2156.20$^{a}$ | 85.45 |
| Daily feed intake (g/bird) | 55.58$^{c}$ | 59.34$^{c}$ | 68.70$^{b}$ | 72.08$^{b}$ | 77.01$^{a}$ | 3.05 |
| Feed conversion ratio | 2.64$^{b}$ | 2.52$^{a}$ | 2.46$^{a}$ | 2.45$^{a}$ | 2.65$^{b}$ | 0.09 |
| Feed cost/kg gain (₦/kg) | 204.73$^{b}$ | 200.09$^{b}$ | 201.04$^{b}$ | 173.44$^{a}$ | 204.73$^{b}$ | 9.74 |
| Mortality (%) | 13.33$^{b}$ | 15.00$^{a}$ | 11.00$^{bc}$ | 10.00$^{c}$ | 16.67$^{a}$ | 1.29 |

abc= Means with different superscripts on the same row are significantly different P□ 0.05

Avg=Average, Wt=weight

SEM= Standard Error of Mean

Total weight gain and average daily weight gain were significantly (P 0.05) higher with the 24% RSC group (1231.11g and 43.97g) compared to the control group (922.22g and 33.14g). From the results obtained, it is an indication that RSC as replacement for soya bean cake has no adverse effect on weight gain of broiler birds.

Total and daily feed intake were observed to be significantly (P0.05) lower with the 0% group (1556.40g and 55.58g) and similar to the 8% group (1661.40g and 59.34g). It was observed that the feed intake increased linearly as the inclusion level of RSC as replacement for soyabean cake increased. This maybe due to the reduced level of the anti-nutrional factor in the cake as compared to the seed thereby increase in feed intake and improved growth. This result obtained contradicts the

work of Kwari *et al*., (2011) and Diarra *et al*., (2011) who reported a decrease in feed intake only above 50.0% (12% dietary Roselle seed).

Feed conversion ratio was poorer with the control (2.64) and 32% groups (2.65) compared to the other dietary groups.This may imply a poorer feed utilization by those on the 32% group.

Feed cost /kg gain was significantly (P□0.05) better with the 24% group (₦173.44) compared to the other RSC groups.This implies a 15.28% reduction in feed cost for the broiler farmers when RSC is included at 24% level in the diet and replaced with soya bean (5.4%).

The mortality recorded was significantly (P□0.05) higher with the 8% and 32% RSC groups. (15 and 16.67%).The mortality observed at the finisher phase may not be attributed to the diet as it cuts across dietary treatments,it may be as a result of the health challenge of the birds. According to the findings of Mukhtar, (2007), he stated that increasing levels of Roselle seed in broiler diet did not influence mortality rate.

### 4.3.3 Nutrient Digestibility of Broiler Chickens fed Graded Levels of Roselle Seed as Replacement for Soyabean Cake

The nutrient digestibility of broiler chickens fed graded levels of RSC as replacement for soyabean caka is presented in Table 4.14. Dry matter digestibility was significantly (P□ 0.05) higher with birds on

the 24% (97.44%) RSC group. Ether extract digestibility was significantly (P 0.05) higher with birds on the 24% and 32% (60.54 and 59.65%) RSC groups compared to the other groups. There were no significant (P 0.05) differences in crude fibre and crude protein

digestibilities across dietary treatment means. Nitrogen free extract digestibility was significantly (P 0.05) higher with the 24% (61.21%) RSC group compared to the other groups.

From the result obtained, it was observed that there was a linear increase in ether extract, crude protein and nitrogen free extract digestibilities as the inclusion level of RSC increased upto 24%. This indicates that RSC as replacement for soya bean cakecan be better utilized by broiler chickens upto24% inclusion without any adverse effect on the digestibilities of the nutrient in the diets. The non significant differences in crude fibre and crude protein digestibilities is an indication that RSC can effectively be utilized by broiler chickens as the control diet.

**Table 4.14 Nutrient Digestibility of Broiler Chickens fed Graded Levels of Roselle SeedCake as Replacement for Soyabean Cake**

| **Levels of Roselle SeedCake (RSC) Inclusion (%)** | | | | | | |
|---|---|---|---|---|---|---|
| **Parameters (%)** | **0** | **8** | **16** | **24** | **32** | **SEM** |
| Dry matter | 97.32[b] | 96.43[c] | 96.41[c] | 97.44[a] | 96.33[d] | 0.10 |
| Ether extract | 55.24[b] | 56.53[b] | 57.43[b] | 60.54[a] | 59.65[a] | 1.29 |
| Crude fiber | 60.29 | 60.34 | 61.45 | 64.24 | 63.57 | 4.32 |
| Crude protein | 69.34 | 70.63 | 71.45 | 74.22 | 73.31 | 2.35 |
| Nitrogen Free Extract | 54.33[e] | 55.52[d] | 56.44[c] | 61.21[a] | 60.55[b] | 0.22 |

abcde= Means with different superscripts on the same row are significantly different P 0.05

SEM= Standard Error of Mean

Determination done at the Biochemical Laboratory,Food Science and Technology Research Programme, Institute of Agricultural Research (I.A.R) Samaru, Zaria

**4.3.4Carcass Characteristics and Organ Weights of Broiler Chickens fed Graded Levels of Roselle Seed Cake as Replacement for Soyabean Cake**

The carcass characteristics and organ weights of birds fed graded levels of Roselle seed cake as replacement for soyabean cake at the finisher phase are presented in table 4.15. Dressed weight was significantly (P 0.05) lower with birds on the control diet (0%) (1433.33g) but similar to the 8% (1466.67g) and 16% (1566.67g) RSC groups while birds on the 24% (1600.67g) RSC had a higher value but similar to the 32% (1533.33g) RSC group which was not significantly (P 0.05) different from the 16% (1566.67g) RSC group. Dressing percentage with the control diet (79.62%) and 24% (77.45%) RSC were at par and significantly (P 0.05) lower compared to the other groups.The thigh showed a significantly (P 0.05) higher value withbirds on 24% (16.94%) RSCinclusion but similar to birds on the 16% (16.66%) RSC while the control diet (0%) (14.67%) was not significantly (P 0.05) different from the 8% (15.21%), 16% (16.66%) and 32% (15.16%) RSC groups respectively. The breast cut showed no

significant difference (P 0.05) across dietary treatment meansThe drumstick showed no significant (P 0.05) differencesin birds on the control diet (10.65%), 8% (10.82%) and 32% (11.15%) levels of RSC groups respectively. The back cut showed no significant (P 0.05) differences with birds on the 16% (14.40%), 24% (14.46%) and 32% (13.98%) levels of RSC groups respectively while birds on the 8% (13.30%) RSC group showed the least value but similar to the control group (13.65%). The liver showed a significantly (P 0.05)higher value with the control diet (2.10%) but was not significantly (p 0.05) different in birds on the 8% (2.02%), 16% (1.90%)and 32% (2.17%) RSC groups respectively while birds on the 24% (1.68%) RSC recorded the least value but similar to those on the 16% (1.90%) RSC group. The heart and spleen showed no significant (P0.05) differences across dietary treatment means. The kidney, gizzard and abdominal fat were observed to be significantly (P 0.05) higherwith birds on the 8% RSC inclusion compared to those on the control group (0%), 16%, 24% and 32% RSCgroups.The value for lungs was observed to be significantly (P 0.05) higher with birds on the 8% (0.63%) and 16% (0.71%) RSC groups

**Table 4.15 Carcass Characteristics and Organ Weights of Broiler Chickens fed Graded Levels of Roselle SeedCake as Replacement for Soyabean Cake**

| **Levels of Roselle SeedCake(RSC) Inclusion (%)** | | | | | | |
|---|---|---|---|---|---|---|
| **Parameters** | **0** | **8** | **16** | **24** | **32** | **SEM** |
| Live weight (g) | 1800.00$^{b}$ | 1800.00$^{b}$ | 1933.33$^{ab}$ | 2066.67$^{a}$ | 1900.00$^{ab}$ | 55.78 |
| Dressed weight (g) | 1433.33$^{c}$ | 1466.67$^{c}$ | 1566.67$^{bc}$ | 1600.67$^{a}$ | 1533.33$^{ab}$ | 51.10 |
| Dressing percentage (%) | 79.62$^{b}$ | 81.48$^{a}$ | 81.03$^{a}$ | 77 .45$^{c}$ | 80.70$^{a}$ | 1.00 |
| **Major cuts expressed as percentage of dressed weight** | | | | | | |
| Thigh | 14.67$^{b}$ | 15.21$^{b}$ | 16.66$^{ab}$ | 16.94$^{a}$ | 15.16$^{b}$ | 0.76 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Breast | 21.04 | 21.32 | 21.04 | 22.69 | 22.36 | 2.95 |
| Drumstick | 10.65$^{b}$ | 10.82$^{b}$ | 11.98$^{a}$ | 12.23$^{a}$ | 11.15$^{b}$ | 0.46 |
| Back | 13.65$^{b}$ | 13.30$^{b}$ | 14.40$^{a}$ | 14.46$^{a}$ | 13.98$^{a}$ | 0.62 |
| **Organs expressed as percentage of live weight** | | | | | | |
| Liver | 2.10$^{a}$ | 2.02$^{a}$ | 1.90$^{ab}$ | 1.68$^{b}$ | 2.17$^{a}$ | 0.09 |
| Heart | 0.40 | 0.46 | 1.07 | 0.52 | 0.46 | 0.26 |
| Kidney | 0.54$^{c}$ | 0.80$^{a}$ | 0.57$^{bc}$ | 0.57$^{bc}$ | 0.65$^{b}$ | 0.03 |
| Spleen | 0.15 | 0.11 | 0.25 | 0.05 | 0.09 | 0.08 |
| Gizzard | 3.06$^{b}$ | 3.43$^{a}$ | 3.09$^{b}$ | 3.13$^{b}$ | 2.86$^{b}$ | 0.08 |
| Lungs | 0.52$^{b}$ | 0.63$^{a}$ | 0.71$^{a}$ | 0.45$^{b}$ | 0.50$^{b}$ | 0.05 |
| Abdominal fat | 0.92$^{c}$ | 1.72$^{a}$ | 1.00$^{c}$ | 1.09$^{bc}$ | 1.36$^{b}$ | 0.15 |

abc= Means with different superscripts on the same row are significantly different P  0.05

SEM= Standard Error of Mean

compared to the control group (0.52%) which was not significantly (P 0.05) different from 24% (0.45%) and 32% (0.50%) RSC groups.

From the results obtained, there were significant differences in weight of the parameters measured. This is not in line with the work of Duwa *et al*., (2012) who reported a non sigificant

differences in weight of the parameters considered in finisher broiler chickens. Thegeneral observation from the result of carcass yield, prime cuts and organ weights obtained is that RSC as replacement for soya bean cake increased carcass weightof finisher broiler chickens. It was also observed that, the test diet was comparable to the control diet in all parameters measured which indicates a non negative effect on carcarss weight, formation and functioning of the visceral organs of broiler chickens.

### 4.3.5 Haematological Parameters of Broiler Birds fed Graded Levels of Roselle Seed Cake as Replacement for Soyabean Cake at Finisher Phase

Table 4.16 shows the Haematological parameters of the birds fed graded levels of RSC as replacement for soyabean cake. There were no significant (P□0.05) differences in the packed cell volume, haemoglobin (Hb) and red blood cell across dietary treatments except for the white

blood cell which was observed to show some significant (P□ 0.05) differences.This result is similar to the findings ofIgoche, (2015) who reported no significant differences in packed cell volume, haemoglobin and total protein in broilers fed RSC with or without amino acid supplementation. The values for WBC was quite higher than the normal range in all the treatments. The white blood cell provides the body's defense as part of the immune system and high WBC count indicates diseases or stress in the birds (Peter,2002). High mortality results to high WBC and lymphocytes. It was observed in this study that the high values of WBC had the same trend with the mortality rate of birds in the different groups.

**Table 4.16 Haematological Parameters on Broiler Chickens fed Graded Levels of Roselle SeedCake as Replacement for Soyabean Cake at Finisher Phase**

| Levels of Roselle SeedCake(RSC)Inclusion (%) | | | | | | |
|---|---|---|---|---|---|---|
| **Parameters** | **0** | **8** | **16** | **24** | **32** | **SEM** |
| PCV (%) | 23.33 | 26.00 | 28.67 | 28.33 | 29.00 | 3.92 |
| Hb (g/dl) | 7.77 | 8.63 | 9.53 | 9.43 | 9.63 | 1.31 |
| RBC ( $\times 10^6$/dl) | 3.90 | 4.10 | 4.63 | 4.00 | 4.07 | 0.68 |
| WBC ( $\times 10^3$/ml) | $10.40^{ab}$ | $12.27^{ab}$ | $9.27^{ab}$ | $7.73^{b}$ | $15.47^{a}$ | 2.01 |
| Heterophils (%) | 8.67 | 10.67 | 16.33 | 13.67 | 9.67 | 3.52 |
| Lymphocytes (%) | 90.33 | 85.33 | 82.00 | 86.33 | 90.33 | 2.99 |
| Monocytes (%) | 1.00 | 1.33 | 0.67 | 0.00 | 0.00 | 0.80 |
| Eosinophils (%) | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.45 |
| Basophils (%) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Band cell (%) | 0.00 | 1.67 | 1.00 | 0.00 | 0.00 | 0.47 |

ab= Means with different superscripts on the same row are significantly different P 0.05

PCV: Packed cell volume, Hb: Haemoglobin , WBC: White blood cell , RBC: Red blood cell

SEM= Standard Error of Mean

The differential blood counts which are the heterophils, lymphocytes, monocytes, eosinophils and basophils were not significantly (P 0.05) different from each other across dietary treatments. These differential counts are the different types of white blood cells found in the birds and the values obtained is an indication that the health challenge of the birds was not as a result of the test diet.

### 4.3.6 Blood Biochemical Parameters of Broiler Chickens fed Graded Levels of Roselle Seed Cake as Replacement for Soyabean Cake at Finisher Phase

Table 4.17 shows the result of blood biochemical parameters of birds fed graded levels of Roselle seed cake as replacement fro soyabean cake. There were no significant (P 0.05) differences in total protein, high density lipoprotein and creatinine across dietary treatment means.

Total cholesterol level and low density lipoprotein were observed to have a non significant (P 0.05) values with birds on the 16%, 24% and 32% RSC diets.

Tryglycerides level at 8% and 16% RSC inclusion were not significantly (P 0.05) with birds on the control diet and lower with birds on 24% and 32% RSC inclusion. The albumin concentration was siginificantly (P 0.05) higher with birds on the 8% and 24% inclusion compared to the rest dietary treatments.

From the results obtained, it was observed that total cholesterol level and tryglycerides increased linearly as the inclusion of RSC increased but was still within the normal range. This increase might be that higher inclusion level of RSC can increase the fat content in the birds.

**Table 4.17 Blood Biochemical Parameters of Broiler Chickens fed Graded Levels of Roselle SeedCake as Replacement for Soyabean Cake at Finisher Phase**

| | **Levels of Roselle SeedCake(RSC) Inclusion (%)** | | | | | |
|---|---|---|---|---|---|---|
| **Parameters** | **0** | **8** | **16** | **2432** | **SEM** | |
| Tryglycerides (g/dl) | 63.67[b] | 67.00[b] | 69.33[b] | 75.67[a] | 74.00[a] | 2.97 |
| Total cholesterol(mg/dl) | 114.67[c] | 120.00[b] | 124.67[a] | 125.67[a] | 128.33[a] | 2.32 |
| Total protein(g/dl) | 3.70 | 3.77 | 4.07 | 3.47 | 3.57 | 0.40 |
| HDL (mg/dl) | 86.33 | 66.67 | 74.67 | 79.00 | 86.33 | 14.08 |
| LDL (mg/dl) | 44.30 | 44.20 | 44.35 | 44.33 | 44.42 | 0.35 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Albumin (mg/dl) | 28.00[b] | 34.00[a] | 24.67[b] | 35.67[a] | 28.33[b] | 2.32 |
| Creatinine (mg/dl) | 0.48 | 0.47 | 0.50 | 0.47 | 0.49 | 0.23 |

abc= Means with different superscripts on the same row are significantly different P 0.05

HDL: High density lipoprotein , LDL: Low density lipoprotein

SEM= Standard error of mean

Creatinine is a nitrogenous waste product formed from the metabolism of creatinine in skeletal muscle. Measurement of creatinine is used as a test of kidney function and high level signifies impaired kidney function. The normal range is 0.2-0.5mg/dl (Peter, 2002).The values obtained in this

study (0.47-0.50mg/dl) is an indication that RSC had no detrimental effect on the birds kidney function and the RSC did not result in muscle wasting in the birds (Cheesbrough, 1987).

# CHAPTER FIVE

## 5.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

### 5.1 Summary

Two feeding trials were carried out to evaluate the growth performance, carcass characteristics, nutrient digestibility, haematological parameters and blood biochemical parameters of broiler chickens fed graded levels of Roselle Seed Cake (RSC) diet as replacement of two conventional protein sources. Proximate Composition of the test diet and experimental diets were conducted to determine their nutrient contents. Five isonitogenous and isocaloric dietswere formulated for the broiler starter and finisher phases respectivelyof the two feeding trials.Diet 1 served as the control diet while diets 2, 3, 4 and 5 contained 8%, 16%, 24% and 32% RSCdiets respectively. The RSC was used to replace groundnutcake (GNC) and soyabeancake (SBC). A total of 300 day old Ross broiler chicks were randomly allotted to five dietary treatments with three replicates. Each treatment consisted of 60 birds with 20 birds per replicate in a completely randomized design (CRD). Feeds and water were provided *ad libitum.*

The results for the first feeding trial at starter phase showed that, final body weight, total weight gain and average daily weight gain were significantly (p 0.05) higher in birdsfed 16% levels of

RSC (1009.17, 954.17 and 34.08g) compared to the control diet (718.33, 663.33 and 23.69g). Feed conversion ratio was worst at 32% levels of RSC (2.25) compared to the control diet (1.93) and the other dietary treatments. Feed cost per kg gain was better with the16% RSC group (₦157.60) compared to the control group (₦172.16). At finisher phase, final weight, total weight gain, average daily gain were better at 8% levels of RSC (2602.14, 1597.14 and 57.04g) but was not significantly different(P□0.05) from birds fed 16% levels of RSC (2571.67, 1568.33 and 56.01g).Feed conversion ratio was better with the control diet (2.68) but was not significantly (P□0.05) different fromthe 8% and 16% RSC groups (2.78 and 2.82) while feed cost per kg gain was significantly (P□0.05) higher with the control group (₦288.34) compared to the other dietary

treatment means. The dressing percentage was significantly (P□0.05) higher with birds fed 8% RSC (82.23%). The differences in major cuts were not in a defined pattern and may not be as a result of dietary treatment. Nutrient digestibility were significantly (P□0.05) different for dry matter, ether extract, crude protein and nitrogen free extract except for crude fibre which was not significantly (P□0.05) different across dietary treatment means.The parameters measured for blood quality showed no significant (P□0.05) differences across dietary treatment means except for white blood cell (WBC). The blood biochemical parameters showed no significant (P□0.05) differences in total protein, low density lipoprotein (LDL) and creatinine.

In the second feeding trial, graded levels of RSC with varying levels of SBC significantly (P□0.05) improved feed intake therefore increased final weight, weight gain and average daily weight gain across dietary treatments. At the starter phase, birds fed 24% RSC had the highest final weight (996.67g).There were no significant (P□0.05) differences in feed conversion ratio across dietary treatments. Feed cost per kg gain was lower numerically with birds fed 32% (₦211.59) RSC group but not significantly (P□0.05) different from birds fed 24% (₦219.20) RSC group as compared to the control diet (₦238.94). At finisher phase, birds fed 24% levels of RSC had a better result in final weight, total weight gain, average daily gain and feed cost per kg gain (2077.78, 1231.11, 43.97g and

₦173.44) compared to the control diet (1772.22g, 922.22g, 33.14g and ₦204.73). Feed conversion ratio was significantly (P0.05) better with the 24% (2.45) compared to the control diet (2.64).Dressed weight was significantly (P0.05) higher with birds on the 24% (1600.67g) RSC group as compared to the control group (1433.33g) but similar to the 32% (1533.33g) RSC group. Dry matter digestibility was significantly (P0.05) higher with birds on the 24% (97.44) RSC group. Ether extract digestibility were not significantly (P0.05) different in birds on the 24% (60.54%) and 32% (59.65%) RSC groups.There were no significant (P0.05) differences in crude fibre and crude protein digestibility across dietary treatments. There were no significant (P0.05) differences in all the parameters measured for haematology across

dietary treatment means except for the white blood cell. The blood biochemical composition showed no significant (P0.05) differences in total protein, high density lipoprotein, low density lipoprotein and creatinine across dietary treatment means.

**5.2 Conclusions**

Based on the result of these studies, it was concluded that:

- Roselle seed cake (RSC) as an alternative feedstuff can replace groundnut cake (GNC) and soyabean cake (SBC) at 50% and 75%(i.e 16% and 24% dietary roselle seed cake) inclusion levels and incorporated in the diet of broiler chickens.
- RSC improved carcass yield and nutrient digestibility of broilers birds.
- Feeding RSC did not have adverse effect on the haematology and blood biochemical of broilers birds.

- The cost of broiler production at the starter and finisher phases were reduced by 8.46% and 22.45% per bird with the inclusion 16% RSCas replacement for 50% GNC in their diets
- Roselle seed cake (RSC) can replace soya bean cake at 75% (24% dietary RSC) inclusion and improved weight gain by 45.46% above the control diet

### 5.3 Recommendations

- Roselle seedcake can replace GNC at the broiler starter and finisher phases at50% (16% dietary RSC) inclusion levels because it gives a better weight, better feed conversion ratio and low cost of production.
- Roselle seed cake can replace soya beans cake at 75% (24% dietary RSC) inclusion to achieve a better performance both at the starter and finisher phases.

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