EFFECT OF FEEDING GRADED LEVELS OF PALM KERNEL CAKE DURING CHICK AND GROWER PHASES ON SUBSEQUENT PERFORMANCE OF LAYERS

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DECLARATION

I hereby declare that this thesis is wholly the result of the author's research work. The works of other investigators referred to are duty acknowledged. No part of this thesis has been previously submitted for any other qualification.

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CERTIFICATION

This thesis " Effect of feeding graded levels of palm kernel cake during the chick and grower phases on subsequent performance of layers" by Comfort Manshop meets the regulation governing the degree, Master of Science of Ahmadu Bello University and is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

With love,

I dedicate this work to my TWINS:

Daniel and Deborah.

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ABSTRACT

Egg-type chickens were fed graded levels of palm kernel cake (PKC) during the chick and grower phases. The subsequent performance of these birds during the laying phase was investigated. In the first trial, 390 day old ShikaBrowm® chicks were fed diets containing 0, 10, 20, 30 and 40% palm kernel cake. All diets were formulated to be isonitrogenous (20%). The birds were divided into five (5) groups of seventy eight birds (78) after balancing for live weight. The 78 birds were further divided into three (3) replications of twenty six (26) birds each in a completely randomized experimental design. There were 3 replications per treatment. At the end of the 8 - week trial period, weight gain and feed intake were not significantly different ($P > 0.05$) from those of the control. Feed cost per gram gain was affected ($P < 0.05$) by the level of PKC in the diets. The least feed cost per gram gain was observed on diets containing 20% PKC level, closely followed by 10 and 30% PKC levels. In the second trial, 225 ShikaBrown®, 9 weeks old growers were fed diets containing 0, 10, 20, 30 and 40% PKC. All diets were formulated to be isonitrogenous (16%). The birds were divided into five (5) groups (treatments) of three (3) replicates is a completely randomized experimental design. Each pen had 15 birds. At the end of the 11- week trial period the inclusion of PKC in the grower pullet diets significantly affected ($P < 0.05$) the live weight gain of the pullets as the level of PKC was increased in the diets. It however, did not affect the feed intake ($P > 0.05$). Feed conversion ratio and feed cost per gram gain were affected by the level of PKC in the diets. In the third trial, 180 ShikaBrown® 20 weeks old layers, were fed a common layer diet which had no PKC and performance characteristics were measured. At the end of the trial, it was observed that PKC fed previously to grower pullets did not significantly affect the subsequent average feed intake ($P > 0.05$), feed to gain ratio, hen-day egg production, hen-housed egg production, weight at first egg and age at 5% egg production. Age at 1st egg and age at 50% egg production were significantly affected by the previous feeding of PKC during the chick and grower phases. It is concluded that up to 20-30% PKC can be used in the diet of pullet chicks and growers without any detrimental effect on growth rate and feed intake of the birds. Palm kernel cake can be a valuable feedstuff in the diets of chicks and growers and does not have any detrimental effect on the subsequent egg production of laying birds.

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ABBREVIATION

DE	-	Digestible energy.
GE	-	Gross energy
ME	-	Metabolisable energy
DM	-	Dry matter
CP	-	Crude protein
EE	-	Ether extract
NFE	-	Nitrogen free extract
NDF	-	Neutral detergent fibre
PKC	-	Palm Kernel cake
Ca	-	Calcium
P	-	Phosphorus
g	-	gramme
Kg	-	Kilo gramme
Kcal	-	Kilo calorie
Mcal	-	Mega calorie
Avg	-	Average
%	-	Percent

CHAPTER ONE

1.0 INTRODUCTION

Animal production industry is geared towards converting cheap and available feedstuffs into a more balanced animal protein. A major constraint of the livestock industry in Nigeria is inadequate and poor quality feed. Feed alone accounts for over 75-80% of the total cost of production (Oluyemi and Roberts, 2000; Agbede and Aletor, 2003). Feed insufficiency is due to stiff competition for feedstuffs between human, industry and livestock, particularly for the fast growing and prolific monogastric species (Esonu, 1999; Tewe and Bokanga, 2001; Amaefule *et al*., 2004 and Iyayi and Davies, 2005).

Conventional sources of protein and energy such as groundnut cake, maize and sorghum are directly utilized by man and have become increasingly expensive. The over dependence on conventional protein and energy concentrates for feeding livestock is currently threatening the development of the industry. This has stimulated research efforts directed towards the use of non-conventional feedstuffs that are non-competitive, readily available and cheap (Akinmutimi, 2007). These can partly replace the traditional energy and protein feedstuffs in animal feed formulation. Non-conventional feedstuffs offer the best alternative in our environment for the reduction of feed cost and therefore a reduction in the cost of meat and other animal products (Dafwang *et al.*, 2001).

Palm kernel cake (PKC) is a by-product of palm kernel oil extraction. It is one of the non-conventional feedstuffs. Palm kernel cake is a high fibre medium protein and energy source. It is cheaper than maize and other conventional feed sources. It is abundant in tropical areas of the world (Rhule, 1996). It is readily available in Nigeria and is not normally consumed as food by man. In Nigeria, annual production is estimated to be about 785,000 metric tones (OSAN survey, 2003).

In Nigeria, groundnut cake (GNC) and soyabean meal (SBM) are the major plant protein components of poultry feed. In the last few years, groundnut production among the African countries has continued to decline and GNC became scarce and expensive (Enwere, 1998).

Reports on the analysis of PKC showed that it contains 18.5-21.3% crude protein (Aduku, 1993) and 9.07- 24.9% crude fibre (Onifade and Babatunde, 1998; Perez *et al*., 2000). The metabolisable energy values reported for PKC ranged from 6.20$MJkg^{-1}$ (Iyayi and Davies, 2005) to 6.74$MJkg^{-1}$ (McDonald *et al*, 1995). Palm kernel cake has been used both as protein and energy sources in laying hens (Olorede and Longe, 2000; Perez *et al*.,2000; Odunsi *et al*., 2002), broilers (Okon and Ogunmodede, 1996; Ezieshi and Olomu, 2004), pigs (Jegede *et al*., 1994; Kim *et al*., 2001; Ekenyem, 2002), rabbits (Daudu, 2007), sheep and goats (Devendra, 1978), fish (Wingkeong *et al*., 2002) and cattle (Bedingar and Degefa,1990; Onwueme and Sinha, 1991; Chin, 2007). In earlier studies, Jegede *et al*., (1994), Onifade and Babatunde (1998) and Hair-Bejo and Alimon (1995) recommended limited levels for pigs, poultry and sheep base on its high fibre content and poor availability of energy, protein, minerals and high copper content. However, studies by Akpodiete *et al*., (2006) have shown that PKC could replace up, to 60% of the protein in groundnut meal in the diet of broilers, pullet chicks and growers thereby permitting incorporation of 28-38% of PKC.

Boateng *et al.,* (2008) observed that feeding PKC up to 40% to broilers, depressed body weight gain and feed efficiency at levels beyond 30%. Yeong and Mukherjee (1983) also observed that feeding 15 and 30% PKC to poultry without balancing the energy and other components of the diets affected feed intake. They observed that birds on lower levels of PKC (15%) had higher body weight gain and better feed to gain ratios than birds receiving rations with higher level (30%) of PKC. This suggests that reduction of the dietary energy, which accompanies PKC inclusion into poultry diets, may be a major problem in the feeding of this by-product. Poor palatability and lowered acceptability, attributable to the grittiness of such diets also resulted in consequent reduction in feed intake (Duran *et al*., 1990 and Hair-Bejo and Alimon, 1995).

Armas and Chicco (1977) fed 0, 15, 30 and 45% levels of PKC with or without lysine and methionine supplementation to 5-day old broiler chicks. They observed that the average weight at 4 or 6 weeks of age was less with 45% PKC diets than with other groups. They attributed the reduced performance of the birds as the levels of PKC increased in the rations to the increased level of dietary fibre, which resulted in depressed digestibility of other nutrients in the diets. It was further observed that the abdominal fat decreased significantly as the level of PKC in the diets of broiler chicks increased (Odunsi *et al*., 2002).

Palm kernel cake is less competitive. It is cheaper than GNC and soyabean meal. It has been worked on by many researchers and is known to have good nutrient profile. As a result, incorporating it in the diet of egg-type pullets will bring down the cost of feed which presently accounts for 60-70% of cost of production.

There is therefore the need for more studies on the possibility of using this cheap and more readily available protein source in diets of egg-type pullets.

1.1 OBJECTIVES

The main objectives of this study are:-

1. to evaluate the growth performance of egg-type pullets fed palm kernel cake.
2. to determine the level at which PKC can be incorporated into the diets of chicks and growers.
3. to evaluate the subsequent laying performance of birds previously fed PKC based diets during the growing phase.
4. to investigate the cost effectiveness of using PKC in diets of chicks and growers.

1.2 NULL HYPOTHESIS

1. Growth performance of egg-type pullets will be affected when fed graded levels of PKC.
2. Palm kernel cake cannot be incorporated at any level into the diets of chicks and growers.
3. Subsequent laying performance of birds fed graded levels of PKC during the growing phase will be affected.
4. No cost benefit is derived when PKC is incorporated in the diets of egg-type chicken.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 PRODUCTION AND UTILIZATION

The oil palm tree (*Elaesis guineensis* Jacq.) grows abundantly in the tropical rain forest laying between 12^0N and 12^0S. It is essentially grown in tropical rain and savannah forests e.g. Southern Nigeria (Olorede and Longe, 2000). The major economic products of the oil palm tree are palm oil and palm kernel oil which are obtained from the fruits. These products are used either in the homes or industries.

When the nut is processed, it yields palm kernel oil and palm kernel cake or meal depending on the method of extraction. According to Okeudo *et al*., (2005) the by-product from the mechanical expeller procedure is referred to as palm kernel cake (PKC), whilst that from solvent extraction technique is called palm kernel meal (PKM). Literature indicated that palm kernel cake has been fed to various livestock and poultry (Ojewole *et al*., 2003; Okai *et al*., 2006). These reports showed that the animals performed satisfactorily well when fed certain levels of palm kernel cake in their diets.

2.2 NUTRITIVE VALUE OF PALM KERNEL CAKE

The chemical make up of any feedstuff, to a great extent determines its nutritive value especially when it is to form part of the ration of an animal. Variations do occur in the chemical composition (dry matter, energy crude protein, crude fibre, ether extract, ash and nitrogen free-extract) of sample from the same feedstuff (Omara *et al*., 1999).

In the case of palm kernel cake these compositional variation may be due to the variety, soil type, method of processing (e.g mechanical or solvent extraction) and the extent to which oil had been extracted (Omara *et al*., 1999; Alimon, 2004; Sundu *et al*., 2006). Chin (2001) analysed samples of PKC in Malaysia and compared with samples from elsewhere. He observed that there were regional differences in the composition of PKC. The accuracy and method of laboratory analysis also contributed to these differences. The chemical composition of PKC by various workers is shown in Table 1.

Table 1: Proximate Composition of Palm Kernel Cake by Various Authors

Authors	DM (%)	GE	DE	ME(SWINE) Kcal/g	ME(poultry) Kcal/g	Total carbohydrate	CP (%)	CF (%)	EE (%)	NFE (%)	Ca (%)	P (%)	Ash (%)
Akinyeye *et al*.,2011	91.66	-	-	-	-	48.16	20.15	9.06	8.36	-	-	-	5.69
Wallace *et al*.,2010	93.21	19.74	-	-	-	53.17	14.13	-	22.48	--	0.16	0.24	3.29
Daudu,2007	95.12	-	-	-	-	-	23.33	13.29	4.56	58.13	-	-	3.89
Adesehinwa *et al*.,2007	-----	-	-	-	3.02	-	14.71	6.02	19.50	-	-	-	3.06
Sundu *et al*.,2005	94.00	4.99	-	-	-	-	14.12	21.23	8.17	-	-	-	3.60
Aduku,1993	-	-	-	1.87	2.70	-	18.80	11.00	4.80	-	0.24	0.74	-

2.2.1 Dry Matter Content of Palm Kernel Cake

This refers to the amount of moisture in the feedstuff. The moisture content or dry matter determination is important in bulk purchasing and storage of feed ingredients. Hartley (1988) observed that feeds containing more than 14% moisture could not be stored in bulk since they were likely to be mouldy. Conversely, animals, universally dislike dusty feed, that is, feeds with low moisture content, and consequently eat rations prepared from powdery ingredients less readily than rations with a more granular composition. Various workers have recorded a range of 89.00 – 95.00% dry matter for samples of PKC (Daudu, 2007; Wallace *et al*.,2010).

2.2.2 Protein Content of Palm Kernel Cake

Compared with the conventional plant protein supplements like groundnut cake and soybean meal, palm kernel cake is low in its protein content. Reports in the literature indicate that the crude protein content of PKC ranges between 18.5 and 21.35%while for groundnut cake and soybean meal, the crude protein ranges from 45.0-49.9% and 44.0-51.2% respectively (Jegede *et al*., 1994; Aduku, 1993; Sundu *et al*., 2006).

2.2.3 Amino Acid Profile of Palm Kernel Cake

The protein content serves as an index of the total amino acids of a feedstuff and at the same time as a source of energy. The amino acid quality of a feedstuff determines the extent to which its protein is utilized (Olomu, 1995).

McDonald *et al*., (1995); Olomu (1995) and Sundu *et al*., (2005), observed that the protein of PKC contained all the essential amino acids except for lysine and methionine which was limiting and they noted that it would be a useful feed ingredient for livestock. Boateng *et* a*l*., (2008) also obtained amino acid levels of PKC samples from Ghana which were similar to those reported by other workers except that the Ghanaian PKC was low in sulphur amino acids, methionine and cystine – which might be due to acid hydrolysis. They also observed that the first limiting amino acid in PKC was lysine followed by methionine and tryptophan and reported the values of 3.12 and 1.22g/16gN for tryptophan and methionine respectively. Alimon (2004) recorded values of 2.68g/16gN and 1.75g/16gN for lysine and methionine respectively for PKC. Amino acid availability in some feedstuffs is shown on Table 2.

Table 2: Amino Acid profile of Palm Kernel Cake (PKC), Groundnut Cake (GNC) and Soyabean Meal (SBM), %.

Amino Acid	PKC*	GNC**	SMB***
Phenylalanine	0.73	1.30	1.21
Lysine	0.59	1.60	2.80
Histidine	0.29	0.63	1.09
Tyrosine	0.38	1.02	1.54
Glycine	0.82	1.51	1.88
Valine	0.93	1.05	2.03
Leucine	1.11	1.63	3.31
Isoleucine	0.62	0.88	1.97
Threonine	0.55	0.86	1.77
Serine	0.69	1.24	2.36
Methionine	0.30	0.48	0.59
Arginine	2.18	3.00	3.15
Cystine	0.20	0.80	06
Tryptophan	0.17	0.24	0.59

Sources:
* - Yeong *et al.,* 1983
** - "Peanut" Online wikepedia.org.
*** - "Soyabean" Online wikepedia.org.

2.2.4 Crude Fibre Content of Palm Kernel Cake

The crude fibre of a feed is that portion which remains insoluble after it has been boiled with dilute acid or alkali. It consists mainly of lignin and cellulose (Hertland *et al*., 2004). The crude fibre is an index that can be used to predict the feeding value of feed ingredients. A feed ingredient that is high in crude fibre content is usually less digestible and less nutritive to the monogastric animals since they do not have the inerte enzyme complex for digesting fibre.

Reports show that the crude fibre content of PKC varies from 10.21 (Bello *et al*., 2008) to 24.9% (Onifade and Babatunde, 1998). Sundu and Dingle (2003) reported that the acid detergent fibre and acid detergent lignin of PKC were 43.7 and 21.1% respectively. These results showed that PKC has a higher crude fibre content compared to groundnut cake with 4.57% CF (Olomu, 1995). McDonald *et al*., (1995) observed that the high fibre content of PKC did not allow animals to accept it readily in their rations.

2.2.5 Ether Extract Content of Palm Kernel Cake

This is the oil content of the feedstuff and its value depends largely on the extent of the oil extraction. Perez *et al*., (2000) recorded a value of 12.0%; Onifade and Babatunde (1998), 7.98% while Aduku (1993) indicated a value of 7.0% as the ether extract of PKC samples.The ether extract portion of the food, apart from providing some essential fatty acids, results in improved energy utilization.

2.2.6 Ash Content of Palm Kernel Cake

This is the inorganic residue from the firing of a sample at between 550–600^{0}C. The nutritional significance of the ash or mineral content depends on the feed under consideration. The total ash values of PKC as recorded by several workers ranges between 2.9 and 5.6% (Aduku, 1993; Jegede et a*l.,* 1994; Bello *et al*., 2008).

In a recent report, Akinyeye et a*l*., (2011) observed that the mineral content of PKC (mg/100g) were calcium, 27.6ppm, magnesium, 15.8ppm, manganese, 1.3ppm, zinc, 21.4ppm, sodium,18.7ppm, potassium, 36.5ppm and iron, 0.75ppm .

2.2.7 Nitrogen-Free Extract of Palm Kernel Cake

This is the water soluble portion of the carbohydrates of a feeding stuff it is primarily a source of energy to the animal. The range of nitrogen-free extract recorded for PKC samples by various workers is 38.19-58.13% (Osei and Amo, 1987; Daudu, 2007).

2.2.8 Gross Energy Value of Palm Kernel Cake

An accurate knowledge of the energetic worth of a feed is essential for an efficient production. The energy density in the diets of animals governs the intake of all the nutrients. The gross energy (GE) of the feedstuff is the total potential energy of that feedstuff when it is completely oxidized in a bomb calorimeter at 25-30 atmospheres of pressure (Maynard, 1953). The GE is not usually all available to the animals because there are losses at various stages of food digestion and utilization.

The gross energy value of palm kernel cake depends, to a certain extent on the method of extraction. Palm kernel cake samples extracted by mechanical method have higher gross energy value than those obtained by solvent extraction. This is because the former retains more oil and hence the higher caloric value.

Reports indicate that PKC samples had a range of between 4.28 and 4.99Kcal/g gross energy value. Sundu *et al.*, (2006) obtained a value of 4.99Kcal/g for the gross energy of palm kernel cake sample while slightly lower value of 4.42Kcal/g recorded by Iyayi and Davies (2005) as the gross energy of palm kernel cake sample.

2.3 DIGESTIBILITY OF NUTRIENTS IN PALM KERNEL CAKE

Digestibility refers to the breakdown of a feedstuff by the digestive enzymes in the gastrointestinal tract to a form that is readily available to the animal (McDonald *et al*., 1995)

Research findings indicate that the digestibility of other nutrients in the diets of animals is depressed as a result of feeding fibrous feedstuffs (Tamir and Alumot, 1996). They reported that wheat, rice hull, barley and rye contain anti-nutritive factors that interfere with digestion and absorption of nutrients when these cereals are fed to poultry. Consequently, feed conversion ratio and growth rate are reduced and the degree of vent passing is increased (Friesen *et al*., 1992; Marquardt and Rotted, 1994). Odunsi *et al*., (2002) observed that the crude fibre contents of African locust bean (10.2%) and PKC (10.3%) were very high compared to that of cashew meal (1.25%) and concluded that fibre could result is lowered digestibility of the protein of PKC thus reducing the extent to which the associated amino acid could be utilized. These workers indicated that the fibres in the PKC were structural in nature and might be arranged and distributed in such a way that protein is trapped by the fibre. This would resist the digestion by enzymes and bacteria in the gastro-intestinal tract of monogastric animals and might even protect some proteinous materials trapped within them from the hydrolytic breakdown in the digestive tract.

Hair-Bejo and Alimon (1995), observed that low digestibility of palm kernel cake might be due to its fibrous, dry and gritty nature which could cause considerable salivation during mastication in the monogastric animals. They therefore suggested the feeding of PKC to monogastric animals on a limited basis. Boateng (2008) emphasized that PKC should be introduced gradually into the rations of monogastric animals and fed in small quantities mixed with other palatable feedstuff like molasses. The author recommended the use of PKC in the diets of ruminant animals. Nworgu and Ologhobo (2006) reported decreased protein and amino acid peptides by fibre or preventing their absorption from the gastro- intestinal tract (GIT).

Research findings indicate that the average percent digestibility of PKC ranged between 64.4 and 84.5% (Sundu *et al.,* 2006). In a trial with broiler chicks, they reported that the percent amino acid availability of PKC ranged between 63.3% for glycine and 93.2% for arginine. They recorded an overall average of 84.5%. These workers indicated that lysine (90.0%) and methionine (91.4%) in PKC were highly available.

Working also with pigs, Ziggers (2000) obtained an average of 64.4% of available amino acids in PKC. The values of 58.6 and 72.1% were recorded for lysine and methionine respectively.

In another trial involving starter and grower chicks, Onwudike (1986a) observed that the percent amino acid availability in PKC ranged between 52.15 (glycine) and 92.7% (Arginine) and an overall average of 84.35%. This author recorded the values of 88.9 and 92.1% for lysine and methionine respectively.

Reports indicated that the mineral content of PKC is averagely available to monogastric animals, Wong and Zahari (1997) noted that calcium and phosphorus were highly available compared with other mineral. These authors obtained the following values as the percent availability of the different minerals in PKC; calcium (68.6%), phosphorus

(70.8%), magnesium (56.4%), copper (44.7%) and zinc (13.9%) and an overall mineral availability as (50.15%).

The efficiency of feed utilization depends greatly on the proportion of the energy of the feed that is available to the animal, the intake of other feed nutrients is affected by energy availability of the feedstuffs (Sundu *et al*., 2006).

The digestive energy (DE) is the gross energy of a feedstuff less the faecal energy, for farm animals on well-balanced diets, the faecal energy losses ranged from 20 to 50% of the gross energy (McDonald *et al*., 1995)

In trials involving poultry, several investigators have reported varying values for metabolizable energy of palm kernel cake. The values reported include 2.79kcal/g Oluyemi *et al*., (1986), 2.65kcal/g Ariff Omer *et al*., (1998) while lower values of 1.48 and 1.61kcal/g were reported by Yeong (1981) and McDonald *et al.,* (1995) respectively. Oluyemi *et al*., (1986) observed that with oil seed meals the G.E., D.E. and ME values may vary widely for different batches of the feedstuff. This is because of the variable levels of residual oil in those meals depending on whether the oil is extracted by mechanical or solvent method.

Wong and Zahari (1997) showed that the ME of alkali treated PKC samples (1.845kcal/g) was significantly ($P< 0.01$) lower than the ME of the untreated PKC (2.80kcal/g). They observed that alkali treatment of PKC was not a useful process for improving its energy availability to poultry birds. In formulating the rations for birds Yeong *et al*., (1981) suggested that PKC should be kept at a lower level so that the dietary energy level could be increased to a higher level by adding energy-rich feedstuffs like grains or other by-products.

The workers reported that this was due to the fibrous nature of PKC which depressed the digestibility of other nutrients when fed at high levels in the diets.

2.4 UTILIZATION OF PALM KERNEL CAKE BY POULTRY

The use of palm kernel cake in poultry rations has been on a limited basis. The high fibre content has been identified as the main limitation to its optimum utilization in the feeding of non-ruminant livestock. Boateng (2008) observed that palm kernel cake was not palatable to poultry because of its gritty and dry nature and should be gradually introduced into rations of the birds.

Temperton and Dudley (1981) however, used PKC in combination with the groundnut meal in poultry diets and concluded that when PKC substituted for wheat middling and groundnut meal for fish meal and skimmed milk, satisfactory egg production was maintained in battery cages over a period of nine months.

It appears that the formulation of the diets containing PKC plays significant role in the utilization of the diets by the various classes of poultry. Onifade and Babatunde (1998) observed that an effective use of PKC in poultry could be achieved by combining it with other protein sources to provide a better and balanced diet especially in terms of amino acid combination.

The resistance of dietary fibre in palm kernel cake to monogastric digestive enzymes has also been reported by Sundu and Dingle (2003). The fibre content of palm kernel cake (21-23%) has been associated with a decline in nutrient digestibility of palm kernel cake, especially when fed to monogastrics.. They reported that during processing, palm kernel cake undergo Maillard reaction (the reaction of mannose with amino groups leading to the formation of brown complex) due to heat applied in the process before oil extraction or due to heat evolved during oil extraction, and this adversely affected the digestibility of the feedstuff. Sundu and Dingle (2003) attributed the reduced performance of the bird as the level of PKC increased in the rations to the increased level of dietary fibre which resulted in depressed digestibility of other nutrients in the diets.

Palm kernel cake is not palatable in poultry rations and is generally used at up to 20% in the diets. Recent observations (Boateng, 2008) indicate acceptable results with 30% in the rations for chicks but reduced gains at a 45% level.

Palm kernel cake is lower in nearly all of the essential amino acids particularly the sulphur acids as compared with other oil seed meals. Although PKC is relatively low in some essential amino acids it is a comparatively safe feedstuff, when compared with other oil seed meals, whose content of toxic compounds calls for additional processing to render them usable. PKC therefore, has a more ready usage in areas where additional processing is not available.

The inclusion of palm kernel cake in the diet improves the immune system of birds and reduces pathogenic bacteria. It also increases the population of non- pathogenic bacteria in the intestine (Sundu *et al*., 2006).

Friesen *et al*., (1992) reported an optimum level of inclusion of PKC in the diets of chicken to be between 10 and 40%. Boateng (2008) reported that PKC could be used in complete poultry feeds at up to 30% without any adverse effect.

In Malaysia, Yeong and Mukghejee (1983) compared levels of 0-30% PKC in the diets of broiler chicks and recommended 15% level of PKC for optimum performance of broiler chicks. They further observed that feeding 0, 15 and 30%) PKC to poultry without balancing the energy and other components of the diets affected feed intake. They observed that body weight gain and feed to gain ratios of birds receiving rations with lower levels (0 and 15%) of PKC were superior to those on higher level (30%) of palm kernel cake.

Onwudike (1986a) fed PKC at 28 and 35% levels in a trial with starter and grower chicks. He concluded that with starter pullet, PKC protein could replace up to 60% in the diets of the protein supplied by groundnut cake (that is, 28% of PKC) without any deleterious effects on their performance. Beyond this level, the rate of growth and feed conversion ratio were significantly depressed. He also confirmed the value of PKC for poultry, with the high fibre level only serving to enlarge the gizzard. The replacement of all the groundnut cake protein by palm kernel cake in the diets of grower pullets did not produce any significant effect on the performance of birds. At laying, egg production, egg weight, weight of first egg dropped and feed intake were not significantly affected but the cost of feed per kilogramme gain decreased significantly with increasing levels of palm kernel cake (Onwudike, 1986a).

2.5 EFFECT OF FIBRE IN POULTRY DIETS

Monogastric animals unlike ruminants do not have the necessary enzymes for degrading cellulose, but according to Sundu and Dingle (2003), microbes present in the caecum sometimes can effect little breakdown of cellulose. They pointed out that the fibre content of a feedstuff is probably the single most important determinant of the nutritive value. This is because it largely determines the proportion of chemically available nutrients which can be utilized by the animals

The studies of Dogari (1985) and Boateng (2008) showed that poultry can digest fibre up to between 20 and 30% of PKC. The reports showed that the feed efficiency in broiler fed a ration with 6% added cellulose was significantly ($P < 0.05$) less than that of the control only during the fourth to the sixth week. By the seventh week of the experiment, the feed efficiency had improved. Favourable effects of fibre in poultry diets have been documented. Fibre provides bulk in the feed. The necessity for making up a concentrate mixture so that it will have a certain amount of bulk has been stressed. This is to avoid the formation of dough – like mass in the stomach which is not readily attacked by digestive enzymes. Sundu *et al*., (2006), reported that fibre aids digestion because its bulk stimulates peristalsis and secretion. It also opens up concentrate feeds so that digestive juices can come in closer contact with them. The author also considered bulk to be important also from the stand point that a certain distension of the digestive tract is desirable for effective digestive activity. It is believed that the distension can be brought about by a large intake of any kind of feed but is particularly accomplished by such indigestible materials like crude fibre. They also considered the influence as a laxative effect. They explained that feeds high in fibre tend to be laxative and that fibre which readily absorbs water and swells is more laxative than the one which does not.

Alimon (2004), reported that hemi-cellulose and to a lesser extent cellulose can increase stool weight by absorbing water. He stated that the lignin component of the plant materials can absorb organic materials and so enhance the rate at which materials are lost in the stool. The author further maintained that bulk is not the only cause of laxative effect as many feeds are laxative because of specific chemical substances in them.

The work of Van Krimpen *et al*., (2005), showed that fibrous feeds might decrease the digestibility of crude protein and ether extract. This according to them is so because the greatly increased bulkiness of the ration due to the inclusion of fodder cellulose may lead to a more imperfect contact between proteolytic enzymes and the basal feed. There is also the possibility that the presence of the fibre may speed up the rate of passage of feed through the simple stomach of monogastric. The author further stated that fibrous feeds may increase the output of nitrogenous materials in the faeces thus causing a depression of the apparent digestibility of the basal ration. This is supported by the work of Nworgu and Ologhobo (2006), who working with fibre from wheat bran obtained results which supported the hypothesis that dietary fibre constituent may reduce protein digestibility and increase nitrogenous excretion and modification of filtration characteristics of the fibre component.

Fibre is known to promote constant passage of materials through the alimentary tract. Hertland *et al*., (2004) reported that the addition of fibre to the diets of chicks stimulated growth.

Nutritionally, birds would continue to eat until their energy requirement is met. This invariably means that providing birds with low energy density diet (dilution with fibre) would increase their feed intake and eating time, thus reducing feather pecking and cannibalism (Savoury, 1995; Aerni *et al*., 2000; Hartini *et al*., 2003; Van Krimpen *et al*., 2005). According to Hertland *et al*., (2004), birds fed high fibre diet spend more time eating and appear quieter than those fed low fibre diets. Hartini *et al*., (2003) stated that birds behavior is positively enhanced by increased dietary fibre. According to Van Krimpem *et al*., (2005), chicken prefer not just fibre but coarse fibre to satisfy their foraging habit. Feather pecking and cannibalism can be controlled nutritionally by the manipulation of diet through the use of fibre. Soluble fibre increases viscosity of gut digestion decreasing passage rate and emptying of the gut contents. Fibre could be used to increase feed intake by feed dilution to lower dietary energy in period of high temperature and heat. Hertland *et al*., (2004) in their review noted that birds fed low to moderate contents of fibre will search for coarse materials. Birds require coarse fibre in their diets for gizzard activity (Hertland and Svinus, 2001). Boateng *et al*., (2008), worked on increasing fibre level in feed of broilers and layers and found that if the level is above 30% of the total laying hen diet, performance of both type of birds were adversely affected.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 EXPERIMENTAL SITE

This study was carried out at the Poultry Research Programme (PRP) of National Animal Production Research Institute (NAPRI), Ahmadu Bello University, Shika-Zaria, Kaduna state. Shika lies between $11^{0}12'$N, at an altitude of 640m above sea level (Encarta Encyclopedia, 2009 PC Version). The area falls within the Northern Guinea Savannah zone having an annual rainfall of 1100mm.The mean maximum temperature varies from 26^{0}C to 35^{0}C depending on the season with a mean relative humidity of 21% during the harmattan and 72% during the wet season respectively (Malau-Aduli *et al*., 1993).

3.2 ANIMALS AND THEIR MANAGEMENT

Palm kernel cake (PKC) was included in the formulated experimental diets at graded levels of 0, 10, 20, 30 and 40% of total feed. This amount of dietary inclusion at 5 different levels of the diet constituted treatments 1-5 respectively. The diets were formulated to be isonitrogenous (20% CP) for chicks and (16% CP) for growers. The feeding of PKC based diets was carried out in the chick phase (0-8 weeks) and the grower phase (9-20 weeks), while the effect of PKC feeding in the grower stage on subsequent laying performance was investigated in the egg production phase (20-40 weeks).

3.2.1 Experiment I: Chick Phase (0 – 8 Weeks)

Three hundred and ninety (390) ShikaBrown® day old pullet chicks, were divided into seventy eight birds (78) in a completely randomizd experimental design after balancing for live weight. The 78 birds were further subdivided into three replicates of twenty six birds each in a pen. There were three replications per treatment. Five experimental diets (Table 3) were randomly assigned to the pens. Feed was provided *ad libitum* and the birds had free access to water throughout the 8- week trial period. Routine vaccination and medication were given to the birds, (see appendix). Birds were weighed weekly and the left over feed was collected and weighed. The performance of the birds was monitored in terms of feed consumption, weight gain and feed to gain ratio throughout the trial period. Mortality record was kept and at the end of the trial, the cost analysis of the feed consumed was carried out.

3.2.2 Experiment II: Grower Phase (9-20 Weeks)

Two hundred and twenty five (225), 9 weeks old ShikaBrown® birds were assigned to pens in a completely randomized experimental design. There were five treatments (Table 4) with three replications. Each pen had 15 birds. Feed and water were provided *ad libitum* throughout the 11- week's trial period. Routine vaccination and medication (see appendix) were given to the birds. There was one (1) week adaptation period between the chick and grower phases. The birds were weighed forthnightly and the performance characteristics in terms of feed consumption, weight gain and feed to gain ratio were monitored throughout the trial period. At the end of the trial period, the cost analysis of the feed consumed was carried out.

3.2.3 Experiment III: Effect of Grower Phase on Subsequent Egg Production Phase (20 – 40 Weeks)

One hundred and eighty (180) twenty weeks old ShikaBrown® birds from the grower phase were allowed to maintain their pens in Experiment II above. There were five treatments and three replications. The birds were fed same layer diet (Table 5). Each pen had 12 birds. Feed and water were provided *ad libitum.*

The experiment was carried out for a period of 20 weeks. Routine medications were given to the birds. The birds were monitored monthly in terms of feed consumption, feed to gain ratio, age of bird at first egg, laying house mortality, hen-house egg production and hen-day egg production throughout the trial period.

3.3 PROXIMATE ANALYSIS

The proximate compositions of the major feed ingredients used in the formulation of the diets are given in Table 6 using the methods of A.O.A.C (1990).

3.4 STATISTICAL ANALYSIS

All the data collected were statistically analyzed using the Analysis of Variance procedure of SAS (1995) and statistically significant differences between treatment means were assessed by Duncan's multiple range tests (Steel and Torrie, 1980). The trend of effect of PKC levels of inclusion on egg-type chickens was compared using polynomial regression analysis.

For PKC level of inclusion in each trial of the design, data was fitted to the model;

$$Y_i = \mu + t_i + e_i$$

Where,

Y_i = Individual observation

μ = Overall mean

t_i = Individual treatment

e_i = Random error.

Table 3: Percentage Composition of Experimental Diets for Chicks (0-8 weeks)

	Levels of PKC (%)				
Ingredients	**0**	**10**	**20**	**30**	**40**
Maize	55.28	48.06	41.03	33.61	26.39
Soybean Meal	10.00	10.00	10.00	10.00	10.00
Groundnut Cake	19.82	17.04	14.07	11.49	8.71
Palm Kernel Cake	0.00	10.00	20.00	30.00	40.00
Wheat Offal	10.00	10.00	10.00	10.00	10.00
Bone Meal	3.00	3.00	3.00	3.00	3.00
Limestone	1.00	1.00	1.00	1.00	1.00
Methionine	0.15	0.15	0.15	0.15	0.15
Lysine	0.20	0.20	0.20	0.20	0.20
Salt	0.30	0.30	0.30	0.30	0.30
Premix	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Feed Cost /kg(N/kg)	71.60	67.51	63.37	59.32	55.23
Calculated Analysis:					
Energy (kcal/kg)	2854.46	2746.08	2644.20	2547.15	2435.85
Crude Protein (%)	20.00	20.00	20.00	20.00	20.00
Crude fibre (%)	4.35	4.85	5.30	5.61	5.84
Calcium (%)	1.54	1.54	1.54	1.54	1.54
Phosphorus	0.87	0.87	0.87	0.87	0.87
Iysine (%)	0.70	o.70	0.70	0.70	0.70
Methionine (%)	0.43	0.43	0.43	0.43	0.43
Methionine + Cystine (%)	0.53	0.53	0.51	0.50	0.52

Bio Mix Chicks provided the following per kg diet: Vit. A 2500iu, Vit. D_3, 500i.u, Vit. E 5.75mg, Vit. K_3 0.5mg, Vit. B_1 0. 45mg, Vit. B_2 1.25mg, Niacin 6.875mg, Pantothenic Acid 1.875mg, Vit. B_6 0.75mg, Vit. B_{12o} 0.00375mg, Folic Acid 0.1875mg, Biotin H_2 0.015mg, Choline Chloride 75mg, Cobalt 0.05mg, Copper 0.75mg, Iodine 0.25mg, Iron 5mg, Manganese 10mg, Selenium 0.05mg, Zinc 7.5mg and Antioxidant 0.3125mg.

Table 4: Percentage Composition of Experimental Diets for Growers (9-20 weeks)

	Levels of PKC (%)				
Ingredients	**0**	**10**	**20**	**30**	**40**
Maize	59.60	52.38	45.16	37.93	30.71
Groundnut Cake	17.20	14.42	11.64	8.87	6.09
Palm Kernel Cake	0.00	10.00	20.00	30.00	40.00
Wheat Offal	10.00	10.00	10.00	10.00	10.00
Maize Offal	8.00	8.00	8.00	8.00	8.00
Bone Meal	3.00	3.00	3.00	3.00	3.00
Limestone	1.45	1.45	1.45	1.45	1.45
Methionine	0.10	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10	0.10
Salt	0.30	0.30	0.30	0.30	0.30
Premix	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Feed Cost /kg(N/kg)	63.64	59.54	55.45	51.36	47.26
Calculated Analysis:					
Energy (kcal/kg)	2895.12	2791.74	2688.36	2548.90	2481.52
Crude Protein (%)	16.00	16.00	16.00	16.00	16.00
Crude fibre (%)	6.40	6.45	6.52	6.57	6.60
Calcium (%)	1.68	1.68	1.68	1.68	1.68
Phosphorus (%)	0.73	0.73	0.73	0.73	0.73
Methionine (%)	0.31	0.31	0.31	0.31	0.31
Lysine (%)	0.71	0.71	0.71	0.71	0.71
Methionine + Cystine (%)	0.52	0.52	0.56	0.57	0.59

Bio Mix Grower provided the following per kg diet: Vit. A 2000iu, Vit. D_3, 375i.u, Vit.E 1.75mg, Vit.K_3 0.375mg, Vit.B_1 0.5mg, Vit.B_2 0.625mg, Niacin 3.75mg, Pantothenic Acid 1.375mg, Vit.B_6 0.5mg, Vit.B_{12} 0.0025mg, Folic Acid 0.125mg, Biotin H_2 0. 0625mg, Choline Chloride 43.75mg, Cobalt 0.05mg, Copper 0.75mg, Iodine 0.25mg, Iron 5.25mg, Manganese 10mg, Selenium 0.05mg, Zinc 7.75mg and Antioxidant 0.3125mg.

Table 5: Percentage Composition of Diet Fed During the Subsequent Egg Production Phase (20-40 weeks)

Ingredients	% Inclusion
Maize	40.73
Groundnut Cake	23.02
Palm Kernel Cake	0.00
Wheat Offal	9.00
Maize Offal	16.00
Bone Meal	3.00
Limestone	7.50
Methionine	0.10
Lysine	0.10
Salt	0.30
Premix	0.25
Total	100.00
Feed Cost /kg(N/kg)	61.12
Calculated Analysis:	
Energy (kcal/kg)	2662.98
Crude Protein (%)	17.00
Crude fibre (%)	5.85
Calcium (%)	3.44
Phosphorus (%)	0.77
Methionine (%)	0.34
Lysine (%)	0.70
Methionine + Cystine (%)	0.54

Bio Mix Layer provided the following per kg diet: Vit.A 21250iu, Vit.D_3, 375i.u, Vit.E 2.5mg, Vit.K_3 0.25mg, Vit.B_1 0.375mg, Vit.B_2 1.125mg, Niacin 3.75mg, Pantothenic Acid 1.125mg, Vit.B_6 0.75mg, VitB12 0.00375mg, Folic Acid 0.15mg, Biotin H_2 0.125mg, Choline Chloride 43.75mg, Cobalt 0.05mg, Copper 0.75mg, Iodine 0.25mg, Iron 5mg, Manganese 10mg, Selenium 0.05mg, Zinc 7.5mg and Antioxidant 0.3125mg.

Table 6: Proximate Composition of the Major Feed Ingredients Used in Formulation of the Diets (% DM basis)

Ingredients	Dry matter	Crude Protein	Ether Extract	Crude Fibre	Ash
Palm Kernel cake	98.09	20.13	14.33	11.62	4.85
Groundnut Cake	92.01	38.00	7.31	13.00	5.42
Soybean Meal	91.00	43.00	1.13	7.50	6.15
Maize	90.00	7.25	3.79	2.10	2.50
Maize Offal	89.11	8.91	1.26	10.66	2.08
Wheat Offal	93.00	16.00	3.00	11.04	2.24

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 EXPERIMENT I (CHICK PHASE, 0-8 weeks)

The effect of feeding graded levels of PKC on the performance characteristics of pullet chicks are shown in Table 7. There was no significant difference in the average daily weight gain of the birds although there seems to be a numerical gradual decrease in average live weight gain with increasing level of PKC in the diets. The numerical body weight gain decreases with increasing concentrations of the test ingredients is in agreement with previous reports (Summers and Leeson, 1986; Gous *et al*., 1990; Boateng *et al*., 2008). Ezieshi and Olomu (2004) also reported that broiler chicks fed diets containing PKC did not show any significant difference in body weights ($p>0.05$). This could be due to the amino acid balance and adequate metabolizable energy of PKC diets as shown in Table 3. Although the first limiting amino acid in PKC is lysine followed by methionine (McDonald *et al*., 1995; Olomu, 1995; Sundu *et al*., 2005), these were balanced for in the diets. This result is in agreement with the reports in literature (Jegede *et al*., 1994; Loh *et al*., 2002) and suggests that the high fibre levels in the PKC diets did not cause a significant decrease in the performance of the chicks. The range for the live weight gain values of the chicks were between 14.03g/bird for the control diet and 13.4g/bird for the diet containing 40% PKC level of inclusion. This result is in conformity with those of Olorede and Longe (2000). They reported a non-significant difference in the live weight gain of starter pullets fed different levels of PKC which replaced up to 60% of the protein (34% inclusion) of groundnut cake in the diet.

Average daily feed intake ranged between 34.92 and 40.25g/bird and there were significant differences ($P<0.05$) between treatments. Diets containing 40% PKC was most consumed ($P < 0.05$). There was however, no significant difference for intakes of the diets containing 0 and 30% PKC. Intake of diets containing 10%, 20% and 30% PKC were also similar ($P > 0.05$).

The decreasing intake of the diets as the level of PKC increased (Table 7) could be due to lower metabolisable energy content of the diets resulting from increase in PKC level. As a result of this, the birds will have to increase their level of intake to meet up with their energy requirement (Ezeishi *et al*., 2004). Also palatability seems not to be affected. This result is in agreement with the findings of Onwudike (1986a); Osei and Amo (1987) and Loh *et al*., (2002), who fed diets containing PKC to grower chicks, broilers and rats respectively at different levels.

Crude fibre of the experimental diets ranged from 4.35 to 5.84%. Although, crude fibre level of the diets increased (Table 3) as the level of PKC increased in the diets, the levels did not affect the live weight gain of the chicks. This is an indication that the chicks could tolerate diets containing PKC up to 30% level of inclusion. Inclusion of up to 30% PKC did not have any negative effect on feed efficiency. This result is similar to the report of Boateng *et al*., (2008). They reported an increase in body weight, improved feed efficiency of broilers and layers, reduced egg numbers and quality when fed PKC beyond 30% level of inclusion. Feed to gain ratios were better on the PKC diets with the exception of 40% level of inclusion indicating that lower amounts of PKC diets were more efficiently utilized for gain. This suggests that 30% may be the optimum level of

PKC inclusion in starter pullet diets. This result is in conformity with the findings of Onwudike (1986b) and Boateng *et al*., (2008). Onifade and Babatunde (1998) reported a similarity in feed utilization efficiency ($P<0.05$) when broiler chicks were fed 10, 15 and 25% PKC levels in the diet.

The feed conversion ratios were significantly affected by the levels of PKC in the diets (Table 7). Diet containing 20% PKC level was most efficiently utilized. This was however similar to those containing 10 and 30% PKC levels. Diets containing 0, 10 and 30% PKC had similar feed conversion ratios and these were similar ($P > 0.05$) to the control diet with 0% PKC. This result is similar to that of Onwudike (1986b) who observed a depressed live weight, depressed efficiency in chicks and growers fed diets containing up to 40% PKC inclusion.

Feed cost/g gain of raising the birds were significantly affected ($P < 0.05$) by the level of PKC in the diets. The feed cost/g gain per bird recorded for diet containing 20% PKC level was least and was closely followed by those containing 10% and 30% PKC levels. The control diet (0% PKC level) and 40% were significantly higher in terms of feed cost/g gain. There was an advantage in including PKC in the diets when compared with the control. This is similar to the findings of Jegede *et al*., (1994) and Daudu (2007).

It can be concluded from this work that, pullet chicks can be raised on diet containing 20-30% of PKC. This has resulted in better feed utilization and feed cost/g gain. At higher levels of PKC inclusion (40%), the diets were less efficiently utilized leading to higher feed to gain ratio.

Table 7: Performance of Chicks Fed Graded Levels of PKC (0-8 weeks)

	Levels of PKC, %					
Parameters	**0**	**10**	**20**	**30**	**40**	**SEM**
Avg. Initial weight (g/b)	29.87	29.73	30.00	29.73	29.60	0.013
Avg. Final weight (g/b)	815.48	814.29	808.99	799.06	783.33	21.78
Weight gain (g/b)	785.61	804.56	778.89	769.33	753.73	0.049
Avg. daily weight gain (g/b)	14.03	14.01	13.91	13.73	13.46	0.39
Avg. daily feed intake (g/b)	39.00^{ab}	36.92^{bc}	34.92^{c}	37.25^{abc}	40.25^{a}	0.92
Feed conversion ratio*	2.79^{ab}	2.64^{bc}	2.51^{c}	2.71^{bc}	2.99^{a}	0.09
Feed cost/g gain (N/b/d)*	39.14^{c}	36.99^{b}	34.91^{a}	37.21^{b}	40.25^{c}	0.37
Total feed cost (N/b)*	231.91^{a}	230.39^{b}	227.33^{c}	227.93^{c}	229.83^{b}	0.36
Mortality (%)	24.49	24.49	17.43	18.53	8.16	6.77

^{a,b}…,Means with different superscript are significantly different ($p<0.05$).

SEM= standard error of the means.

* Significant quadratic effect of level of feeding ($p<0.05$)

4.2 EXPERIMENT II (GROWER PHASE, 9-20 weeks)

The performance of grower pullets fed graded levels of PKC are presented in Table 8. Final weight of birds fed PKC was significantly (P< 0.05) affected by the levels of PKC in the respective diets. There was a significant difference in the weight gain across the treatments. However, birds having 20% PKC in the diet had the highest weight gain value while the diet containing 40% PKC had the least weight gain value. The poor performance of the grower pullets at 40% PKC inclusion level could be attributed to low amino availability from PKC (Sundu *et al.,* 2006). Weight gains were similar with diets containing 0, 10, 20 and 30% PKC. Also, diets containing 30 and 40% level of PKC were also similar.

Average daily gain was also affected significantly across the dietary treatments. Diets containing 0, 10, 20 and 40% PKC were similar. The dietary treatment with 30% PKC had the least weight gain value.

Feed intake ranged between 79.00 g/bird to 86.67 g/bird. There was no significant difference between the treatments. The non-significant difference observed on the feed intake means that palatability of the diets was not negatively affected. This result is in conformity with the findings of Ezieshi and Olomu (2004) and Onwudike (1986b) who fed diets containing PKC to broilers and grower pullets respectively at 34% and 44.95% levels. Boating *et al* (2008) however, reported reduced feed intake at level's above 30% PKC inclusion.

Feed conversion ratio was significantly affected (P< 0.05). Feed to gain values of diets containing 0, 10, 20 and 40% PKC were similar. Birds on 30% PKC in the diets had the highest/poorest feed to gain ratio while the least was observed with birds on diet containing 10% PKC.

Feed cost/g gain was significantly affected. Feed cost/g gain for birds on diets containing 0, 10, 20 and 30% PKC were similar ($P > 0.05$). There seem to be a decrease in feed cost/g gain as the levels of PKC in the diets increased. The least feed cost/g gain value was observed with birds on 40% PKC level diet because of the low cost of PKC and the high inclusion level.

Mortality of the birds was not affected by the level of PKC in the diet. It was due to the outbreak of fowl typhoid on the farm.

It is concluded from this trial that PKC can be a valuable feedstuff in diets of growing pullets and can be incorporated into grower diets at up to 20 – 30% level without any detrimental effect to the performance of the birds.

Table 8: Performance of Growers Fed Graded Levels of PKC (9-20 weeks)

	Levels of PKC (%)					
Parameters	**0**	**10**	**20**	**30**	**40**	**SEM**
Avg. Initial weight (g/b)	690.00	703.33	663.33	670.00	646.67	16.931
Avg. Final weight (g/ b)	1830.00^{a}	1776.70^{a}	2003.30^{a}	1706.70^{ab}	1526.70^{b}	110.855
Weight gain (g/b)	1140.00^{a}	1073.30^{a}	1340.00^{a}	1036.70^{ab}	880.03^{b}	120.351
Avg. daily weight gain (g / b)	15.88^{a}	15.96^{a}	15.27^{a}	11.43^{b}	14.89^{a}	0.529
Avg. daily feed intake (g/ b/d)	85.33	82.33	86.67	79.00	81.67	4.126
Feed conversion ratio	5.38^{b}	5.16^{b}	5.56^{b}	6.85^{a}	5.46^{b}	0.279
Feed cost/g gain (₦/b)	342.38^{a}	307.03^{a}	308.49^{a}	351.82^{a}	258.04^{b}	4.851
Mortality (%)	3.81	9.52	2.86	2-86	10.38	3.385

^{a,b,c}…Means with different superscript are significantly different ($p<0.05$).

SEM= standard error of the means.

4.3 EXPERIMENT III: Subsequent Performance of Layers Previously Fed Graded Levels of PKC During Grower Phase (20-40 weeks)

Performance of layers previously fed different levels of PKC is presented in Table 9. Feeding PKC in the grower diet did not significantly affect the subsequent average daily feed intake (P> 0.05). Hen-day egg production, Hen-housed egg production, age at first egg and weight of first egg were not significantly different across the treatments. This result is in agreement with the findings of Onwudike (1986b) who replaced up to 80% of the protein in GNC with PKC and did not observe any negative effect on the subsequent laying performance of the birds.

Hen-day egg production (HDEP) and Hen-housed egg production (HHEP) were not significantly affected by previous dietary treatments. There was significant difference on age at 1st egg. Birds on the control diet (0 % PKC) came into lay earlier than those on 40% PKC diet. The birds on diets containing 10, 20 and 30% PKC were similar to the control. This result is in conformity with the work of Onwudike (1986b) who fed graded levels of PKC during the grower phase and observed a significant difference in the age at 1st egg. He reported that production at the time the first eggs were laid was erratic as many of the birds did not come to lay at the same time.

Egg weight was not significantly affected by the levels of PKC in the previous treatments (P> 0.05). This result is in conformity with the findings of Onwudike (1986b), who fed different levels of PKC to laying hens. The similarity in performance for all the birds raised on different dietary treatments may be due to the fact that all groups consumed sufficient nutrients from the growers diet for optimum performance during the laying phase. Also, the levels of lysine and methionine + cystine in the laying diets were within the range of 0.8% and 0.5% respectively recommended for laying hens (Olomu, 1995).

There was no significant difference in the age at 5% egg production. Age at 50% egg production was significantly affected ($P<0.005$) by previous feeding of PKC during the growing phase. Birds on diets containing 0, 20, 30 and 40% PKC were similar. Also, birds on diets containing 0, 10, 20 and 30% PKC were similar.

Income after feed expenses decreased as the level of PKC increased in the previous growing phase. As the level of GNC decreased the income after feed expenses increased with diet containing 40% PKC having the highest value and the least value with diet containing 0% PKC.

It is evident from this study that PKC can be a valuable feedstuff in the diet of growing pullets and subsequently on the performance of laying hens. The increased use of this locally available feedstuff (PKC) with improved efficiency of utilization represent a potential means of cutting down on cost of feeding laying hens. The lower cost of PKC in relation to the cost of GNC also gives it an additional advantage economically.

Table 9: Subsequent Performance of Layers Previously Fed Graded Levels of PKC during the chick and grower phases (20-40 weeks)

	Levels of PKC (%)					
Parameters	**0**	**10**	**20**	**30**	**40**	**SEM**
Avg. Daily Feed intake (g/b)	79.00	79.00	78.00	79.00	78.00	0.004
Feed efficiency	0.163	0.163	0.147	0.153	0.153	.006
Hen-day (%)	53.99	53.53	52.51	51.19	50.06	2.013
Hen-Housed (%)	53.99	53.53	52.51	51.19	50.06	2.013
Age at 1st egg, day	150.57[a]	154.33[ab]	157.00[ab]	154.33[ab]	159.67[b]	1.885
Weight of 1st egg (g)	44.66	43.33	41.12	46.43	44.43	3.417
Age at 5% egg production, day	157.00	155.33	158.33	155.33	160.67	2.328
Age at 50% egg production, day	190.00[ab]	189.33[b]	192.33[ab]	191.33[ab]	197.67[a]	2.328
Feed cost/g eggs (₦/b)	641.07	554.34	626.25	584.61	570.29	27.498
Income after feed expenses (₦/b)+	900.05	898.74	883.05	869.81	837.45	45.010

[a,b,c]…,means with different superscript are significantly different(p<0.05).

SEM= Standard error of the means.

+ Shows Linear effect of treatment (p < 0.05).

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 SUMMARY

The results obtained from this study suggest that inclusion of palm kernel cake in the diets of chicks and grower pullets is beneficial. In the diets of chicks, up to 30% PKC inclusion rate has no detrimental effect on the growth rate and feed intake of the birds. Feed cost per gram gain was affected ($P < 0.05$) by the level of PKC in the diets. The least feed cost/g gain was obtained on diets containing 20 and 30% PKC levels, closely followed by 10 and 40% PKC. Feeding of PKC in the diets of pullet chicks is cost effective.

With growing pullets, the results indicate that the performance characteristics of the birds were not adversely affected by feeding low levels of PKC in the diets. Inclusion of PKC in the grower pullet diets significantly decreased ($P < 0.05$) the live weight gain of the pullets as the level of PKC increased in the diets. The inclusion of PKC in the diets of the pullets did not affect the feed intake. Feed conversion ratio was also significantly affected. Feed cost/g gain was significantly affected. Birds consuming the control diet (0% PKC) had the highest feed cost/g gain value. There seem to be a decrease in the feed cost/g gain as the levels of PKC in the diets increased. Mortality of the birds was also not affected by the level of PKC in the diets but was due to the outbreak of fowl typhoid.

Also, egg production parameters such as; Hen-day Egg production and Hen-House Egg production were not affected by the previous dietary treatments. There was significant effect of the previous treatment in the age at first egg. Egg weight was not affected by the levels of PKC in the previous treatments ($p>0.05$). Age at 5% egg production was not significant. Age at 50% egg production was significantly affected ($P < 0.005$) by previous feeding of PKC during the growing phase. It is evident from this study that PKC can be a valuable feedstuff in the diets of chicks and growing pullets and subsequently on the performance of laying hens.

5.2 CONCLUSION

It is concluded from this study that up to 20-30% level of PKC has no detrimental effect on the performance characteristics of chicks and growing pullets. The results obtained for the performance of layer previously fed different levels of PKC, giving PKC in the growers' diet did not significantly affect the subsequent average feed intake ($P > 0.05$). Also, Hen-day production, Hen-housed production and weight at first egg were not significantly affected ($P > 0.05$) but there were significant differences in the age at 1st egg and age at 50% egg production.

It is concluded from this study that PKC can be a valuable feedstuff in the diets of chicks and growing pullets.

5.3 RECOMMENDATION

It is expected that as the demand for animal protein increases with increasing population and improvements in living standards, conventional feedstuffs are likely to be insufficient to sustain monogastric animal production. Therefore, it is recommended that;

- Incorporating PKC in the diets of chicks can reduce feed cost up to 20%.
- 20-30% of PKC can be incorporated into the diet of chicks without any detrimental effect.

- 20-30% of PKC can be incorporated into the diet of growing pullets without any detrimental effect on the subsequent laying performance.
- It is cost effective to use PKC in the diets of chicks and growing pullets.

REFERENCES

Adesehinwa, A.O.K. (2007). Utilization of Palm Kernel Cake as a Replacement for Maize in Diets of Growing Pigs: Effects on Performance, Serum Metabolies, Nutrient Digestibility and Cost of Feed Convrsion. *Bulgarian Journal of Agricultural Science*, 13:593-600.

Aduku, A. O. (1993). Tropical Feedstuff Analysis Table. Faculty of Agriculture, Ahmadu Bello University, Samaru- Zaria, Nigeria.

Aerni, V., E.I., Lethey, H. and Wechsler, B. (2000).Effect of foraging materials and feed form on feather pecking in laying hens. *British Poultry Science*, 41:16-21.

Agbede, J. O and Aletor, V.A. (2003). Evaluation of fishmeal replaced with leaf protein concentrate from glyricidia in diets for broiler chicks: effects on performance, muscle growth, hematology and serum metabolites. *International Journal of Poultry Science*, 2(4):242-250.

Alimon, A.R . (2004). Nutritive value of Palm Kernel Cake for Animal Feed. Palm oil Development. Pp12-16.

Akinmutimi, A.H. (2007). Effects of cooking periods on the nutrient composition of velvet beans (*Mucuna pruriens*). Proceeding of the 32nd Annual conference of the Nigeria Society for Animal Production March 18-21, 2007 Calabar, Nigeria. Pp 324-331.

Akinyeye, R.O., Emmanuel, I.A., Olayinka, F and Adedunke, A. (2011). Physico-Chemical Properties and Anti-nutritional factors of Palm fruit Products(*Elaeis guineensis* Jacq.) *Electronic Journal of Environmental, Agricultural and Food Chemistry*, 2191-2198.

Akpodiete,O. J, Eruvbetine, D. and Gagiyovwe,E.E.(2006). Effect of Enzyme Supplementation on Palm Kernel based diets on broiler chicken Performance. *Nigerian Poultry Science Journal* 4:39-46.

Amaefule, K.U., Nwaokoro, C.C. and Uheukumore, F.C. (2004). The effect of feeding graded levels of raw pigeon pea (*Cajanus cajan*) seed meal in the performance nutrient retention and carcass characteristics of weaned rabbits. *Nigeria Journal of Animal Production*, 31:194-199.

Ariff Omer, M., Hayakawa, H., Zahari, M.W., Tanakak, A. and Oghio,S. (1998). Collaboration between MARDI and JICA Project Publication No.4(s).

Armas, A. B.N and Chicco, C.F. (1977): Use of palm kernel meal (*Elaeis Guineensis* Jacg). In Broiler chickens diet. *Tropical Agronomy*, 27:339-343.

A.O.A.C. (1990). Association of Official Analytical Chemist, Official Method of Analysis 15th Ed. Washington. D.C Pp 43-45.

Bello, K.M., Oyawoye, E.O. and Bogoro, S.E. (2008). Effect of Processing on Chemical Composition of Palm Kernel Meal.(*Elaeis guineensis*). Proceeding of the 13th Annual Conference of the animal science association of Nigeria, (ASAN) September, 15-19, 2008, A.B.U,Zaria. Pp 201-207.

Bedingar, T. and Degefa, G. (1990). Trends in agro-byproducts and their feeding potential in sub-saharan Africa. Working document No. 14, ILCA,Addis-Ababa http://www.fao.org/wairdocs/ILRI/x5480/x5480E00.HTM

Boateng, M., Okai, D.B, Baah, J and Donkoh, A. (2008). Palm kernel cake extraction and poultry diets in Ghana. Volume 20 Article No. 99. Retrieved August 8, 2011 from http//www.irrd.org//irrd20/7/boat20099.htm

Boateng, M. (2008). Palm kernel cake extraction and utilization in pig and poultry diets in Ghana. Volume 20 Article No. 99. Retrieved August 8, 2011 from http//www.irrd.org//irrd20/7/boat20099.htm

Chin, F.Y. (2001).Palm Kernel Cake (PKC) as a supplement for Dairy cattle. In: Malaysia on feed resources for S.E Asia. Manado, Indonesia.(s)Pp 37-41.

Chin, F.Y. (2007). Palm Kernel Cake as a supplement for fattening and dairy cow in Malaysia. www.jphpk.Gov.my/Agromil/pks.Htm.

Dafwang, I., Ikani, E. J, Chikwendu, D. O., Adesheinwa, A. O. K., Annate, A. I. and Iwuayanwu, I.E.J. (2001). An assessment of adoption of non-conventional feedstuffs by poultry and pig farmers in Nigeria.Pp 121.

Daudu, O.M .(2007). The evaluation of nutritive value of palm kernel meal on growth performance and nutrient digestibility of weaner rabbits. Unpublished MSc. thesis. Department of Animal Science, A.B.U, Zaria. Pp 24.

David, M.J., Samad, N. and Rasool, S. (1997). Proceedings of 19th MSAP Conference, 8-10 september, 1997.

Devendra, C. (1978). Utilization of Feeding Stuffs from the oil palm. In: Feedstuffs for livestock in S.E. Asia (Editors: S. Gurmit, K.H. Lim, L. Teo and D.K. Lee), Pp. 116-131.

Dogari, M. (1985). Evaluation of local sorghum bear residue in broiler chicken. M.Sc Thesis. Ahmadu Bello University, Zaria Nigeria Pp 11-16.

Duran, A.O, Lozano, E and Reyes, E. (1990). Use of African palm residue in starter, grower and finisher phases of pigs. *Livestock research and Rural Development* 2:43-50.

Ekenyem, B.Y. (2002). The growth responses of weaner pigs feed varying levels of palm kernel cake. In proceedings 27th animal conference, NSAP, FUT, AKURE, March 17-21, 2002. pp. 156-159.

Encarta Encyclopedia (2009).PC version, Study tools, a Multimedia Encyclopedia, Dictionary and an Atlas. Microsoft Student with Encarta Premium, DVD 2009. Pp 34.

Enwere, N.J. (1998). Foods of plant origin. Afro-Orbis Publications Ltd. Nsukka, Nigeria. Pp 301.

Esonu, B.O. (1999). Evaluation of graded levels of maize/sorghum based dried grains as substitute for maize on the performance and carcass characteristicsof pigs. *Nigerian Journal of Animal Production* 21:88-95.

Ezieshi, E.V and Olomu, J (2004). Comparative Performance of Broiler Chickens Fed Varying Levels of Palm Kernel Cake and Maize Offal. *Pakistan Journal of Nutrition* 3(4):254-257.

Ezeishi E.V, Okhuevbie, I.F, Ezennabike, C.C and Olomu, J. M. (2001). Performance and some physical and internal qualities of eggs of laying chickens fedof broiler chickens fed palm kernel cake based diets. In: Proceedings of the 26th *Annual Conference of the Nigerian Society for Animal Production*, 26:199-201.

Friesen,D.D, Geuter, W., Marquardt, R.R., Rotter, B.A (1992). The effect of enzyme supplementation on the apparent metabolizable energy and nutrient digestibilitiesof wheat,barley, oats and rye for the young broiler chick. Poultry Science 71:1710-1721.

Gous, R.M., Emmans, G.C., Broadbent, L.A. and Fisher, C. (1990). Nutritional effects on the growth and fatness of broilers. *British Poultry Science*,31:49-505.

Hair-Bejo, M. and Alimon, A.R. (1995). The protective role of zinc in palm kernel cake(PKC) toxicity in sheep. *Malaysian Journal of Nutrition* 1:75-82.

Hartley, C.W.S. (1988).The Oil Palm.3rd Edition. Tropical Agriculture Series. Longman, Singapore. Pp 724-729.

Hartini, S., Chost, M., Hinch, G. and Norlan, J. (2003). Effect of diet composition, gut microbial status and fibre forms on cannibalism in layers: A report for the Australian Egg Corporation Limited Publication No 03/03. Project No UNE-72A http/www.aecl.org/images/UNE-

Hertland, H., Chost, M. and Svinus, B.(2004). Role of insoluble non starch polysaccharides in poultry nutrition. *World Poultry Science Journal*, 60;415-422.

Hertland, H. and Svinus,B. (2001). Effect of oat hulls on the performance, gut capacity and feed passage time in broiler chickens. *British Poultry Science Journal*, 42:354-361

Imaseun, J. A., Ari Jeniwa, A and Etothian, C.J. (2003). Evaluation of graded levels of palm kernel cake as replacement for maize in the diet of weaned rabbits in: Proceedings of the 28th *Animal Conference of the Nigerian Society for Animal Production*. VOl. 28: 382-384.

Iyayi, E.A. and Davies, B.I. (2005). Effect of Enzyme Supplementation on Palm Kernel Meal and Brewers Dried Grain on the Performance of Broilers. *International Journal of Poultry Science* 4(2):76-80.

Jegede, T.O., Tegbe, T.S.B., Aduku, A.O. and Olorunju, S.A.J. (1994). The Effect of feeding Palm Kernel Meal on Performance characteristics of pigs. *Nigerian Journal of Animal Production*. 21:88-93.

Kim, B.G.,J.H. Lee, H.J. Jung, Y.K. Han, Park, K.M and Han, I.K.(2001). Effect of partial replacement of soyabean meal with palm kernel meal and copra meal on growth performance, nutrient digestibility and carcass characteristics of pigs. *Asian Journal of Animal Science*, 14:821-830.

Loh, T. E., Foo. H. L. Tan. B.K, and Jelan, Z.A. (2002). Effects of palm kernel cake on performance and blood lipids in rats *Australia .Journal of Animal Science* 15 (8):1165 – 1169.

Longe, O. G. and Adekoya, O.F. (1988). Response of Laying hens to difference inclusion rates of palm kernel meal. *Feed Science and Technology* 20(4) 279-286.

Malau-Aduli, A.E.O., Abubakar, B.Y. and Dim, N.T. (1993). Studies of milk production and growth of Friesian x Bunaji crosses ll growth to yearling age. *Journal of Animal Production Research* 13(1):53-61.

Marquardt, R.R. and Rotted, B.A. (1994). Studies of Enzymes Supplementation and herbal preparation of different levels of energy on the performance of broilers. *Journal of Interacademic*, 3:53-58.

McDonald, P. , Edwards, R.A and Grenhalgh, J.F.D and Morgan, C.A (1995). Animal Nutrition. 5th Edition. Longman Harlow, U.K. p517.

Nworgu, F.C and Ologhobo, A.O. (2006). Effects of Agro-industrial wastes on the performance of exotic cockerels. *Tropical Journal of Animal Science, 3(1):17-21.*

Nwokolo, E. N, Bragg, D.B and Saben, M.S. (1977). A Nutritive Evaluation of Palm Kernel Meal for use in Poultry Rations. *Tropical Science* 19:147-154.

Odunsi, A.A., Akande, T.O, Yusuph, A.S and Salami, R.E. (2002). Comparative utilization of high inclusion rates of four agro-industrial by-products in diets of egg type chickens. *Archivos-de-Zootecnia*, 51:465-468.

Onwueme, I.C. and Sinha, T.D. (1991).Field crop production in tropical Africa. CTA (The Techncal Centre For Agriculture and Rural Co-operation), Ede, The Netherlands, pp. 1-480.

Ojewole, G.S., Ukachukwu, S.N. and Uzwegbu, C.P. (2003). Biological and Economic Effects of including Agro-industrial by-products in Turkey poultry diets. In Ojewole, G.S. and Ozeu, D.U.K. 2006. *International Journal of Poultry Science* 5(5):401-403.

Okai, D.B, Rhule, S.W.A, Nwyannor, E.K.D and Tandoh, I. (2006). Feed Packages Based on Local Agro-industrial By-products for Small-scale Pig Farmers in the Ashanti Region. Paper presented at the Project Leaders Meeting. AgSSIP Non-Ruminant Programme held at Animal Research Institute. Frafraha, Accra.

Okeudo, N.J., K.V., Eboh and Izugboekwe, N.V. (2005). Growth rate, carcass characteristics and organoleptic quality of broilers fed graded levels of palm kernel cake. *International Journal of Poultry Science* 4(5):330-333.

Okon, B.I. and Ogunmodede, B.K. (1996). Carcass characteristic of broilers fed periwinkle flesh and palm kernel cake. *Nigeria Journal of Animal Production*,23:16-20.

Olorede, B.R. and Longe, O.G. (2000). Effect of replacing PKC with shea butter cake in egg quality characteristics. *Nigerian Journal of Animal Production* 27:9-23.

Olomu, J.M. (1995). Nutrient requirement of poultry. In: Animal Nutrition – Principles and Practices. A. Jachem Publication, Benin City, Nigeria. P. 67-72.

Oluyemi, J.A., Fetuga, B.L and Endeley, M.N.L. (1986). The metabolizable energy values of some feed ingredients for young chicks. *Poultry Science* 55:661-618.

Oluyemi, J.A and Roberts, F.A. (2000). Poultry Production warm wet climates,, Macmillan publishers Ltd, London and Basingstoke. PP 178.

Omara, F.P., Muligan, F.J., Hath, M. and Caffrey, P.J. (1999). The nutritive value of palm kernel meal measured in vivo and using rumen fluid and enzymatic techniques. *Livestock Production Science* 60:305-316.

Onwudike, O. A. (1986a). Palm kernel meal as a feed for poultry. 1. composition of Palm Kernel meal and availability of its amino acids to chicks. *Animal Feed Science Technology* 16: 179-186.

Onwudike, O.C. (1986b). Palm Kernel meal as a feed for Poultry 1. Diets containing palm kernel meal for starter and grower pullets. *Animal Feed Science and Technology* 16:187-197.

Onwudike, O.C . (1986c). Palm Kernel Meal as a feed for poultry 2. Replacement of groundnut cake by palm kernel cake in broiler diets. *Animal Feed Science and Technology* 16:198 – 202.

Onwudike, O. C. (1986d). Palm kernel as a feed for poultry 3. Use of Palm Kernel meal by laying birds. *Animal Feed Science and Technology* 20:279-286.

Onifade, A.A. and Babatunde, G.M. (1996). Comparative response of broilers chicks to a high fibre diet supplemented with four antibiotics. *Animal Feed Science and Technology*. 64:337-342.

Onifade, A. A. and Babatunde, G.M. (1998). Comparison of the utilization of palm kernel meal brewers dried gains and maize fed by broiler chicks. *Poultry Science* 39: 245-250.

OSAN Survey (2003).In: Report on survey of Agro-Raw materials in Nigeria. OIL PALM (Maiden Edition),October,2004.Pp37.

Osei, S. A. and Amo, J. (1987). Palm kernel cake as a broiler feeding ingredient. *Poultry Science* 66:1870-1873.

"Peanut" Online Wikepedia.org. Modified 2011-7-24. Retrieved on 2011-8-6.

Perez, J.F, Gernat, A.G and Murillo, J.G. (2000). The effect of different levels of palm kernel meal in layers diets. *Poultry. Science*, 79:77-79.

Rhule, S.W.A. (1996). Growth rate and carcass characteristics of pigs fed on diets containing palm kernel cake. *Animal Feed Science and Technology* 61:167-172.

SAS (1995). Statistical Analysis System. Institute Inc. Users Guide. Statistic version, 6^{th} ed. Cary North Carolina, U.S.A.

Savoury, C.J. (1995). Feather pecking and cannibalism. *World Poultry Science Journal*, 51:215-219.

Steel, R.G.D and Torrie, J.H. (1980). Principle and procedures of statistics. A biometrical approach McGraw-Hill Book company Incorporation. New York.

"Soyabean" Online Wikepedia.org. Modified 2011-7-28. Retrieved on 2011-8-6. Summers, J.D. and Leeson, S. (1986). Influence of nutrient density on feed consumption, weight gain and gut capacity of broilers, Leghorns and turkeys reared to 26 days of age. *Animal Feed Science Technology* 16:129-141.

Sundu, B. and Dingle, J. (2003). Use of enzymes to improve the nutritive value of palm kernel meal. *Proceedings of Quensland Poultry Science Symposium.*Australia 1(14):1-15.

Sundu, B., Umar, A. and Dingle, J. (2005). Palm Kernel Meal in Broiler Diets: Effect on chicken performance and health. *Cambridge Journal of Animal science*. Accessed from: www.goggle.com.

Sundu, B, Kumar, A and Dingle, J. (2006). Palm Kernel Meal in broiler diets: effect on chicken performance and health. *World Poultry Science Journal* 62:316-325.

Tamir, M. and Alumot, E. (1996). Inhibition of digestive enzymes by condensed tannins of green and ripe carrots. *Journal of Science Food and Agriculture* 20:199-202.

Temperton, M. and Dudley, F.J. (1981). Palm Kernel and earthnut meals in the rations of laying pullets. *Nutrition Abstract. Review.* 10:626.

Tewe, O.O. and Bokanga, M. (2001). Post harvest technologies in Nigeria's livestock industry: Status challenges and capacities Paper presented at GFAR – GIPhT Workshop, 17 – 21st September, 2001. Entebbe, Uganda.Pp 224-228.

Wallace, P.A, Edu, E.K and Rhule, S.W.A. (2010). Optimal storage conditions for cocoa cake with shell, palm kernel cake and copra cake as poultry and livestock feed in Ghana. *Livestock Research for Rural Development.* Volume 22, Article No.32.Retrieved August 8, 2011, from http//www.irrd.org/irrd22/2/wall22032.htm

Wingkeong, N.G, Chen-Meiling, W.K and Chen, M.L. (2002). Replacement of Soyabean meal with palm kernel meal in practical diets for hybrid Asian-African cat fish, *Clarias macrocephlaus* X C. gariepinous. *Journal of Applied Aquaculture.* 12:67-76.

Wong, H.K. and Zahari, M.W. (1997). Nutritive value of palm kernel cake and cocoa pod husks for growing cattle. *Journal of Tropical Agriculture and Food Science*, 25:125-131.

Van Krimpen, M.M., Kwwkkel, R.P., Reuvekamp, B.F.J., and Vander Peet-Schwering, C.M.C., Den Hartog, L.A.O and Vestegen, M.W.A. (2005). Impact of feeding management on the feather pecking in laying hens. *World Poultry Science Journal*, 61:665-687.

Yeong, S.W. (1983). Amino acids availability of palm kernel cake, palm oil sludge and sludge fermented product (prolima) in studies with chickens. *MARDI Research Bulletin* 11:84-88.

Yeong, S. W and Mukherjee, T.K. (1983). The effect of palm oil supplementation in palm kernel cake based diets on the performance of broiler chicks. *MARDI Research Bulletin* 11: 178-1384.

Yeong. S. W, Mukherjee, T.K and Hutagalung, R.I. (1981). The nutritive value of palm kernel meal, as feedstuff for poultry. Proceedings of a National workshop on Oil Palm by-products Utilization Kuala-Lumpur, Malaysia. (Editors: Pushprajah and C. Poh-Soon), Pp. 100-107.

Yeong, S. W. (1981). The Nutritive Value of Palm Oil by-products for Poultry. Proc. Conference Animal Production and Health in the Tropics, University Pertanian Serdang, Malaysia, September. 2-5, 1980 Pp. 217-222.

Ziggers, D. (2000). Applied Nutrition: Excess lysine trims performance of pigs. Journal of Feed Technology, 4(4):30-31.

APPENDIX

Vaccination / Medication Schedule

Day	Duration (days)	Vaccination / Medication
1-5		Ant- stress
10		IBDV 1st dose
24		IBDV 2nd dose
Week 3	5	Coccidiostat
Week 4		NDV (L)
Week 6	5	Coccidiostat
Week 7		NDV (K) 1 st dose + FPV
Week 8	1	Dewormer
Week 9	5	Coccidiostat
Week 12	5	Coccidiostat
Week 13		Debeaking
Week 16		NDV (K) 2 nd dose

KEY

NDV (i/o) - New castle disease vaccine (intraocular)
IBDV - Infectious bursal disease vaccine
NDV (L) - New castle disease vaccine (lasota)
NDV (K) - New castle disease vaccine (komorov)
FPV - Fowl pox vaccine