EFFECT OF DIATERY CARROT MEAL SUPPLEMENTATION ON PRODUCTIVITY AND CARCASS CHARATERISTICS OF ARBOR ACRE BROILER CHICKENS

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B. AGRICULTURAL MANAGEMENT HONS (ANIMAL PRODUCTION) (UNIVERSITY OF LIMPOPO)

A DISSERTATION SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF AGRICULTURAL MANAGEMENT (ANIMAL PRODUCTION), DEPARTMENT OF AGRICULTURAL ECONOMICS AND ANIMAL PRODUCTION, SCHOOL OF AGRICULTURAL AND ENVIRONMENTAL SCIENCES, FACULTY OF SCIENCE AND AGRICULTURE, UNIVERSITY OF LIMPOPO, SOUTH AFRICA

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DECLARATION

I declare that this full-dissertation hereby submitted to the University of Limpopo for the degree of Master of Agricultural Management (Animal Production) has not been submitted by me for a degree at this or any other university, this is my own work in design and execution, and that all materials contained herein has been duly acknowledged.

Signature …… Date ……..

Mokgope Precious Kgomotso

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I would like to give my utmost praise to the Almighty God, who gave me the strength, knowledge, hope, wisdom and understanding. To God be the glory.

DEDICATION

This work is dedicated to my mother, Ellen Ella Mdluli, who is my role model, strength, who believed in me more than I did myself and my brother and son for the support, love and care.

ABSTRACT

This study determined the effect of carrot meal supplementation on productivity and carcass characteristics of Arbor acres broiler chickens aged one to six weeks. Experiment I determined the effect of carrot meal supplementation on productivity of Arbor acre broiler chicks aged one to 21 days. Two hundred unsexed Arbor acre broiler chickens were randomly assigned to five treatments with five replicates, each replicate having ten birds. A completely randomized design was used in the first experiment. The treatments were 0 (UA_0), 20 (AU_{20}), 50 (AU_{50}), 75 (AU_{75}) or 100 (AU_{100}) g of carrot meal supplementation per kg DM feed. Quadratic equations were used to determine levels of carrot meal supplementation for optimal feed intake, metabolisable energy intake and nitrogen retention of Arbor acre broiler chickens aged one to 21 days. Linear equations were used to determine relationships between carrot meal supplementation and productivity variables. Dietary carrot meal supplementation had no ($P>0.05$) effect on growth rate, live weight and feed conversion ratio of unsexed Arbor acre broiler chickens aged one to 21 days. Carrot meal supplementation, however, improved ($P<0.05$) metabolisable energy intake and nitrogen retention of the chickens. Dietary metabolisable energy intake and nitrogen retention of the chickens were optimized at different carrot meal supplementation levels of 40.5 and 53.57 g/kg DM feed, respectively. No chicken deaths were recorded.

Experiment II determined the effect of carrot meal supplementation on productivity and carcass characteristics of female Arbor acre broiler chickens aged 22 to 42 days. The chickens were randomly allocated to five treatments with five replicates, each having 10 birds, in a completely randomized design. The supplementation levels were 0 (FA_0), 20 (FA_{20}), 50 (FA_{50}), 75 (FA_{75}), or 100 (FA_{100}) g of carrot meal per kg DM feed. Quadratic equations were used to determine levels of carrot meal supplementation for optimal feed intake, feed conversion ratio, live weight, metabolisable energy intake and nitrogen retention of broiler chickens aged 22 to 42 days. Linear equations were used to determine relationships between carrot meal supplementation and production variables. Dietary carrot meal supplementation had no ($P>0.05$) effect on growth rate, live weight and carcass parts of female Arbor acre broiler chickens aged 22 to 42 days. Carrot meal supplementation improved ($P<0.05$) feed intake, feed conversion ratio, metabolisable energy intake and nitrogen retention of Arbor acre broiler chickens aged

22 to 42 days. Dietary feed intake, feed conversion ratio, live weight, metabolisable energy intake and nitrogen retention were optimized at different dietary carrot meal supplementation levels of 52.8, 63.8, 38.0, 42.0 and 44.3 g/kg DM feed, respectively. Dietary carrot meal supplementation had no effect ($P>0.05$) on tenderness and flavour of female Arbor acre broiler meat. Broiler chickens on diets supplemented with 20, 50 or 100 g of carrot meal per kg DM feed produced meat with better ($P<0.05$) juiciness values than those of meat from chickens not supplemented with dietary carrot meal and those supplemented with 75 g/kg DM feed. There was a positive relationship between carrot meal supplementation and chicken meat juiciness.

It is concluded that carrot meal supplementation improved ($P<0.05$) metabolisable energy intake and nitrogen retention of unsexed Arbor acre broiler chickens aged one to 21 days. However, carrot meal supplementation had no effect ($P>0.05$) on growth rate, live weight and feed conversion ratio of unsexed Arbor acre broiler chickens aged one to 21 days. Carrot meal supplementation improved ($P<0.05$) intake, feed conversion ratio, metabolisable energy and nitrogen retention of female Arbor acre broiler chickens aged 22 to 42 days. However, carrot meal supplementation did not ($P>0.05$) improve growth rate and live weights of the chickens.

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CHAPTER 1

INTRODUCTION

1.1 Background

Poultry production is nutritionally, economically and socially important in Limpopo province and the world as a whole. Chicken production is an important source of income and employment, and it contributes substantially to food security among rural people in Africa (Yami, 1995). Much of the poultry meat comes from broiler chickens. Not only are broiler chickens heavier at an early age but they also have better feed conversion ratio (Havenstein *et al*, 2004). High mortality in broiler chickens leads to poor productivity and income for rural people. Carcasses from broiler chickens have a high fat content that reduces carcass quality and feed efficiency. Meat having high fat content is also not preferred by consumers (Steenfeldt *et al*., 2007).

1.2 Problem statement

Broiler chickens are selected for their better feed conversion ratio and growth rates (Richards, 2003). However, mortality is high in broiler chicks. Also, broiler chicken carcasses have high fat contents. Excessive fat is one of the main problems faced by the broiler chicken industry, since it does not just reduce carcass quality and feed efficiency but also causes rejection and difficulties in processing the meat (Macajova *et al., 2003*). There is however some evidence that carrot meal supplementation reduces chick mortality and improves carcass characteristics (Chamber and Bower, 1990; Steenfeldt *et al*., 2007).

1.3 Motivation

Results of this study will indicate the effects of supplementing carrot meal on feed intake, growth, mortality and carcass characteristics of Arbor acre broiler chickens. Such results will add knowledge on the manipulation of production, mortality and carcass characteristics of Arbor acre broiler chickens through nutrition. Thus, such information will help in formulating strategies aimed at improving productivity and carcass characteristics of Arbor acre broiler chickens. Improvement of productivity of broiler chickens may enhance the economic, nutritional and social status of broiler chicken farmers.

1.4 Objectives

The objectives of this study were as follows:

i. To determine the effects of supplementing diets with carrot meal on feed intake, digestibility, live weight, growth, feed conversion ratio, mortality and carcass characteristics of Arbor acre broiler chickens.

ii. To determine carrot meal supplementation levels for optimal responses in feed intake, digestibility, live weight, growth, feed conversion ratio, mortality and carcass characteristics of Arbor acre broiler chickens.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Broiler chickens are nutritionally and economically very important to South African households. Broiler chickens have been bred to grow fast and reach the market weight at around 35 days of age (Hafez and Hauck, 2005). However, they have high mortality rates and their carcasses have high fat contents (Carrate *et al*., 2007). There is evidence that carrot meal supplementation reduces mortality rates and carcass fat contents of layer chickens (Steenfeldt *et al.,* 2007). However, such evidence is not extensive and conclusive.

2.2 Description and nutrient composition of carrot meal

The carrot (*Daucus carota* L.) is an annual or biennial herb with a thick fleshy taproot, which is the primary organ of agricultural importance. Carrot roots are usually orange, but there are also white, black, yellow, red and purple varieties. The roots range in length from 5 cm to more than 50 cm and are generally conical. However, there is tremendous diversity in root shapes and sizes. The leaves are alternate and compound and organized as a rosette. Carrot roots are an important food product. Depending on the variety, carrots are sold fresh or processed: pre-packed, boiled and canned, frozen, diced and sliced, etc. (Bradeen *et al*., 2007). It has been suggested that carrots originated in Afghanistan and later spread westwards (Southern and north-western Europe) and eastwards (Asia Minor, China, Japan) (FAO, 2011).

Carrots are now found in Europe, south-western Asia, Africa, and America. Carrots cultivated in north-western Europe were all purple or yellow with long roots until modern orange cultivars (containing carotenoids rather than anthocyanins) were developed in the Netherlands in the 17th century (Vaughan and Geissler, 2009). China is by far the main producer, with 47 % of the 33.7 million tonnes of carrots and turnips produced worldwide in 2010. The USA and the Russian Federation come next, with only 4 % of the production each (FAO, 2011). Most of the production is done in cold or temperate areas, and little effort has been dedicated to developing cultivars for tropical and subtropical areas (Bradeen *et al*., 2007).

However, some varieties can be grown at all altitudes in the tropics (Göhl, 1982). Carrots are seasonally available in areas that produce carrots for human consumption (Goby and Gidenne, 2008). In temperate climates, they can be used as a winter feed. Because of the weight and bulk of carrots, their transportation is expensive and losses during handling and storage incur additional costs (Morel d'Arleux, 1990).

Carrots are excellent sources of carotene (pro-vitamin A), vitamins C, D, E and K. They are also rich in biotin, potassium, calcium, magnesium, phosphorus, organic sodium, some trace minerals and phytonutrients. The common phytonutrients found in carrots are lycopene, lutein, zeaxanthin, anti-oxidants alpha, beta and gamma carotenes. Carrots are vegetables that are quite low in fat and cholesterol. Carrot meal contains 54 to 65 mg of xanthophyll/kg DM (Sikder *et al.,* 1998). Carrots contain 1.2 g of protein per kg DM and are mostly carbohydrates. Carrots contain 4 grams of fibre per kg DM. They are, also, a low sodium food, containing 88 mg of this nutrient per kg DM (Bradeen *et al*., 2007).

2.3 Nutritional benefits of carrot meal

There is a long tradition of feeding carrots to livestock but their use in animal feeding is marginal nowadays. Carrots used as animal feed are usually cull (grade-out) or surplus carrots obtained during periods of overproduction. They are typically fed fresh and are available whole or chopped, unwashed or washed (Morel d'Arleux, 1990). Carrots can also be ensiled. Dehydrated carrots are popular treats for horses and pets. Other carrot products that are occasionally fed to livestock include the tops, resulting from harvesting, and various by-products of carrot processing (juice, aromas, etc). Fresh carrot roots have high water content (about 88%) and are, therefore, a refreshing feed. However, animals consuming large amounts of carrots may consume less dry matter, resulting in decreased nutrient and energy intakes (Wolter, 1999). The dry matter contains up to 60 % sugars, mostly sucrose, which make carrots both highly digestible and palatable (Alabran and Mabrouk, 1973). Because of their high carbohydrate content, carrots can be

considered as an energy feed. Protein content is low (4-12 % DM) and they contain moderate amounts of fibre (<10% ADF). Like other roots and tubers, they may contain high levels of mineral matter (more than 10 %) due to residual dirt and it is, therefore, preferable to wash them before feeding (Wolter, 1999).

An important benefit of carrot roots is their high carotenoid content, and particularly ß-carotene, a precursor of vitamin A (retinol), involved in eye function, reproduction, growth and maintenance of skin and mucous membranes. Carotene content depends on carrot variety: orange types contain mostly α- and ß-carotene but purple, red and yellow carrots have a different carotenoid composition (Hammershøj *et al*., 2010). Raw orange carrots contain 200-1000 mg/kg DM of ß-carotene (ANSES, 2008). ß-carotene is located in the chromoplasts as crystals and stabilized by lipoproteins, and its stability is rather high (Frias *et al*., 2010). However, processes like ensiling and drying can significantly decrease the ß-carotene content (Nonaka *et al*., 1994; Frias *et al*., 2010). Autocatalytic oxidation of ß-carotene may be caused by the reduction of moisture content during the dehydration process. However, certain drying processes (e.g. shade drying) are less destructive than others (Frias *et al.*, 2010). For herbivores, the ß-carotene content of carrots makes them particularly valuable when hay and straw are the only other feeds (Fuller, 2004). Carrots have also been tested as a natural source of pigments in animal productions where product colour is important, such as poultry egg production, fish and crustaceans (Frias *et al*., 2010).

Carrots are particularly rich in vitamin C (ascorbic acid) and containing about 300-700 mg/kg DM of this vitamin (ANSES, 2008). However, as vitamin C is highly heat-labile, it is very susceptible to dehydration (Frias *et al*., 2010). Carrot tops contain about 11-12 % crude protein in the DM, 17 % crude fibre and up to 18 % ash, depending on the amount of residual dirt. Carrot juice residue has a relatively low protein content (7.7 % DM) and a high amount of fibre (ADF 28 % DM) (Enishi *et al*., 2004).

2.4 Effect of carrot meal supplementation on productivity of chickens

There is limited information on the use of carrots in poultry feeding. Carrot roots and tops can provide carotenoids to laying hens. In Denmark, carrots have become common as forage in organic egg production. In organic laying hens fed a diet supplemented with 70 g/d of orange, yellow or purple carrots, a decrease in certain performance parameters (egg and yolk weight for all carrot colours, egg mass for orange carrots) but increased yolk colour parameters and carotenoid content were noted. Purple carrots were beneficial for egg laying rate and egg and yolk mass (Hammershøj and Kidmose, 2006; Hammershøj *et al*., 2010). Giving egg-laying hens' access to maize silage, barley-pea silage and carrots as foraging materials decreased pecking behaviour, thus improving animal welfare (Steenfeldt *et al*., 2007).

Dried carrot meal included at 8 % in the diet of laying hens significantly improved yolk colour when compared with a wheat-based control diet. This improvement was similar to that obtained with a yellow maize-based diet. Carrots at 4 % inclusion level also improved yolk colour score but body weight gain, egg production and feed conversion ratio were not significantly affected (Sikder *et al*., 1988). Contrary to these reports, Steenfeldt *et al*., (2007); La´zaro *et al*., (2003) and Jeroch (1986) reported that carrot fed hens had a higher final body weight, suggesting that large amounts of easily fermented components like sugars and soluble non-starch polysaccharides contributed some energy to the hens. Similarly, feeding carrot to birds influenced the development of the gastrointestinal tract and composition of the micro-flora and decreased feed intake for egg laying hens (Steenfeldt, *et al*., 2007). Egg production was highest in hens fed carrots and mortality was reduced dramatically (Jeroch, 1986).

Carrot tops fed at 5 % to laying hens improved the ß-carotene content and the colour score of egg yolk. This increase was obtained at 5 a % inclusion rate and did not affect egg weight, Haugh unit, egg-shape index and strength and thickness of egg shell (Ishikawa *et al*., 1999; Ishikawa *et al*., 2001). Feeding egg-laying hens'

coloured carrots efficiently increased yolk colour parameters and carotenoid contents, which give opportunities for improved nutritional value of eggs (Ishikawa *et al., 2001).* Carotenoid pigments are growth promoters and antioxidants. Laying hens fed with carrots had heavier gizzards due to the increased mechanical requirements of the organ to digest the dietary fibre and coarser feed. According to Steenfeldt *et al*., (2007), a full gizzard was more likely to lead to a feeling of satiation resulting in calmer birds which may contribute to a decrease in feather pecking. Carrot meal has a positive effect on yolk colour when included in diets for laying hens (Jeroch, 1986) and egg production is highest in hens fed with carrots. Mortality is also reduced with carrot supplementation (Steenfeldt *et al*., 2007; Jeroch, 1986).

Carotenoids are used for skin pigmentation, growth metabolism and fertility (Schiedt, 1998). Carotenoids are required by the immune system, and as detoxifiers. Carotenoids serve as precursors for the synthesis of vitamin A (Sklan *et al.,* 1989; Surai and Speake, 1998), and some provide protection against damaging reactions in the body, acting as physiological antioxidants and thus enhancing the immune response (Bendich, 1989; Prabhala et al., 1991) because of dietary pigments on shanks and breast skin.

Rizal *et al*. (2010), in their study on the utilization of carrot juice wastes as corn replacement in the broiler chicken diet, reported that the feed consumption of broiler chickens was improved by the treatments. They attributed this to the increase in the palatability of diets. The authors further reported that daily gain of broilers was highly improved by treatments. Increase in the juice wastes mixture in diets increased the average daily gain of broiler chickens. In the same study, increase in the level of juice wastes mixture in diets improved the feed conversion ratio or the efficiency of feed utilization of broiler chickens. Their results indicated that the increase in the average daily gain was not in the same proportion with the increase in the feed consumption. More daily gain was obtained from every unit of feed consumption. The authors concluded that carrot and fruit juice waste mixture

could be included up to 20 % for broiler diets to effectively replace 40 % corn in the diet. High crude fibre content in juice waste mixture limits its utilization in the broiler diets.

In rabbits, carrot could replace up to 75 % of soybean meal in growing rabbits' diets, resulting in higher nutrient digestibility, live weight and feed conversion ratio efficiency (Magouze *et al*., 1998). Yushkova and Kertieva, (2010) also reported that inclusion of carrot meal in the diet of sows improved live weight. Abdu *et al*. (2012) reported that feeding rabbits carrot meal improves live weight of rabbits. However, these contradict with those of Mona and Hanan. (2002) who observed no improvement in live weight of laying hens supplemented with carrot meal. Carrot meal supplementation improved the feed conversion ratio of growing rabbits (Eleraky, 1996). However, these contradict with those of El-kerdwy *et al.* (1992) who stated no improvement in feed conversion ratio of rabbits supplemented with carrot meal. Similar findings were observed by Silker *et al*. (1998) who found no improvement in feed conversion ratio of laying hens supplemented with carrot meal. Feeding high-yielding cows with a diet containing 10 kg of fresh carrots resulted in a significant improvement in reproductive performance and an increase in calving rate from 84.5 to 92 %, but milk yield and fat content were unchanged (Car, 1985). Göhl (1981) stated that carrot meal decreased metabolisable energy intake in laying hens. However, there is limited information on the effect of carrot meal supplementation on productivity of broiler chickens.

2.5 Effect of carrot meal supplementation on carcass characteristics of chickens

High fat pads in broiler chickens result in high levels of cholesterol in broiler meat (Grundy and Danke, 1990; Sacks, 2002). Abdominal and subcutaneous fat are regarded as the main sources of waste in slaughter houses (Ibrahim, 2000).

Schiedt (1998) reported that poultry use carotenoids for pigmentation, and these substances are also involved in growth metabolism and fertility. Carotenoids and xanthophylls give poultry carcasses their desirable yellow colour (Ponte *et al.,* 2004). El-Kerdawy *et al.* (1992) reported that inclusion level of carrot tops in the diet of growing rabbits up to 60 % of the DM reduced carcass characteristics. According to Ibrahim (2000), carrot tops replacing 67 to 100 % of clover hay in the diet of growing rabbits was detrimental to carcass characteristics. Contrary to the reports, Mona and Hanan (2000) reported that carrot tops could also substitute for up to 75 % of soybean meal in commercial diets for does and bucks without any negative effects on carcass characteristics. Also, Ngoshe *et al.* (2013) reported that feeding carrot leaf meal to growing rabbits, the live weight and dressing carcass weight numerically higher than the controls. In another study Abdu *et al*. (2012) reported that carrot meal inclusion in the diets of rabbits significantly influenced the live and carcass weights. Prolonged use of carrots in the diets of beef cattle may give a yellow colour to the carcass fat (Fuller, 2004).

Research work on the effect of carrot meal on broiler chicken's carcass is limited. For decades, carotenoids a major component of carrots have attracted attention for promoting health and skin coloration, improved sexual behaviour, vitamin A precursors and antioxidant. It was observed that broiler chicken carcass skin and meat colour affect the consumer's final judgment on the quality and value of poultry products. Broiler chickens with a yellow skin colour have been shown to be considered desirable by consumers while chickens with less desirable colouring have a lower market value, and are purchased less often by consumers (Tarique *et al*., 2013). Siebert *et al* (2000) reported that adipose tissue from lambs fed a diet containing low ß-carotene had decreased C18: 0 (stearate) and increased C18:1 n-9 cis (oleate), resulting in 14.9 percentage points reduction in saturated fat. In addition, there was a 10℃ lower melting point for fat from lambs on the diet with low ß-carotene than those on the high b-carotene diet. This contradicts the results from cattle (Siebert *et al*., 2000).

2.6 Conclusion

The information on the effects of dietary carrot meal supplementation on feed intake, digestibility, productivity, mortality and carcass characteristics of broiler chickens is not extensive and conclusive. It was, therefore, important to determine the effects of dietary carrot meal supplementation on productivity and carcass characteristics of Arbor acre broiler chickens.

CHAPTER 3
MATERIALS AND METHODS

3.1 Study site

This study was conducted at the Pahlomoje Poultry Project, Shikwane village in Maruleng Municipality, South Africa. The project is 64 km north-west of Tzaneen. The temperature in winter ranges between 16 and 25 °C, whereas in summer it

ranges between 36 and 43 °C. The mean annual rainfall ranges between 450 and 550 mm (Shiringani, 2007).

3.2 Preparation of the house

The experimental house was cleaned properly with water and jeyes fluid disinfectant and then fumigated with virokill (NTK Company, Trichardstdal). The house was left for two weeks after cleaning to break the life cycle of any disease causing organisms that were not killed by the disinfectant. After drying, the experimental house was divided into 20 floor pens of 2 m^2 each. Fresh saw dust was placed on the floor 7 cm thick from the floor. All equipment such as drinkers and feeders were properly cleaned and disinfected.

3.3 Acquisition of materials and chickens

All materials were purchased from NTK Company in Trichardstdal before the start of the experiment. A commercial grower diet, purchased from Meadow Feeds, Limpopo, was used in this study. Chickens used in the experiment were obtained from Lufafa Hatchery in Letsitele, South Africa. The carrots used in the experiment were purchased from the Fruit and Vegetable Company in Tzaneen, South Africa. The carrots were cut into pieces, dried in a shade and then milled to pass through a 2 mm sieve.

3.4 Experimental procedures, dietary treatments and designs

This study was conducted between December, 2011and February, 2012. The first part of the experiment commenced with 200 unsexed day-old Arbor acre broiler chicks with an average live weight of 44.3 ± 3 g, and lasted for three weeks. The broiler chicks were randomly assigned to five treatments with five replicates, with ten chicks per replicate. Thus, 20 floor pens were used in total. A completely randomized design was used. The five dietary treatments were as follows:

UA_0: Unsexed Arbor acre broiler chickens fed a commercial grower diet (20 % CP) without carrot meal supplementation (control diet)

UA_{20}: Unsexed Arbor acre broiler chickens fed a commercial grower diet (20 % CP) supplemented with 20 g of carrot meal per kg DM

UA_{50}: Unsexed Arbor acre broiler chickens fed a commercial grower diet (20 % CP) supplemented with 50 g of carrot meal per kg DM

UA_{75}: Unsexed Arbor acre broiler chickens fed a commercial grower (20 % CP) supplemented with 75 g of carrot meal per kg DM

UA_{100}: Unsexed Arbor acre broiler chickens fed a commercial grower diet (20 % CP) supplemented with 100 g of carrot meal per kg DM

Diet and nutrient compositions of the treatment are presented in Tables 3.01 and 3.02, respectively. The diets contained similar nutrients but different carrot meal levels ranging from zero to 100 g per kg DM. The carrot meal contained 12 % crude protein, 17.1 MJ of gross energy/kg DM, 18 % ash, 13.3 % NDF, 8.8 % ADF and 300-700 mg/kg DM of vitamin C. The grower diet was formulated and produced by a commercial feed company, Meadow Feeds, South Africa.

Table 3.01 Diet composition of grower feed for Arbor acre chickens

Ingredient	Quantity (g/kgDM)
Yellow Maize	567
Sunflower meat	100
Full fat soya meal	290
Fish meal	10
Monocalcium phosphate	13.6
Limestone	13.6
Iodised salt	0.5
DL Methionine	0.3
L Threonine	0.0
Vitamin/mineral premix	5.0
Total	1000
CP (%)	20
Gross Energy (MJ/kg DM)	16.9

Table 3.02 Nutrient composition of the diets for Arbor acre broiler chickens (units are in g/kg DM except energy as MJ/kg DM feed and dry matter as g/kg feed)

Diet code	Nutrient			
	Dry matter	Energy	Protein	Carrot meal Supplement
UA_0	930	16.9	200	0
UA_{20}	930	16.9	200	20
UA_{50}	930	16.9	200	50
UA_{75}	930	16.9	200	75
UA_{100}	930	16.9	200	100

The second part of the experiment commenced with 200 female Arbor acre broiler chickens, weighing 650g ± 4 per chicken. These chickens had been raised on a grower mash for 21 days before commencement of the experiment. These were different from those used in the first part of the experiment. The second part of the experiment was, thus, carried out with chickens aged 22 days and lasted up to the time the chickens were 42 days of age. The chickens were randomly allocated to five treatments with five replicates, each replicate having 10 Arbor acre female chickens. Thus, 20 floor pens were used in total. A completely randomized design was used. A grower diet (Table 3.01) was offered for 21 days with different carrot supplementation levels. Feed intake, live weight, growth rate, feed conversion ratio, mortality and carcass characteristics of the chickens were determined. The dietary treatments were as follows:

FA_0: Female Arbor acre broiler chickens fed a grower diet (20% CP) without carrot meal supplementation (control diet)

FA_{20}: Female Arbor acre broiler chickens fed a grower diet (20% CP) supplemented with 20 g of carrot meal per kg DM

FA_{50}: Female Arbor acre broiler chickens fed a grower diet (20% CP) supplemented with 50 g of carrot meal per kg DM

FA_{75}: Female Arbor acre broiler chickens fed a grower diet (20% CP) supplemented with 75 g of carrot meal per kg DM

FA_{100}: Female Arbor acre broiler chickens fed a grower diet (20% CP) supplemented with 100 g of carrot meal per kg DM

3.5 Data collection

Daily feed intake was measured throughout the experiment by subtracting the weight of the feed refusals from that offered per day, and the difference was divided by the total number of chickens in the pen. The initial weight of the chickens was measured at the beginning of each part of the experiment. Thereafter, average live weights were measured weekly by weighing all the chickens in each pen. The live weights were used to calculate growth rates. Feed conversion ratio was also calculated as the total amount of feed consumed divided by the weight gain of live chickens plus the weight gain of dead or culled chickens in the pen. Deaths were recorded daily. Mortality rate of the chickens was calculated as the total number of deaths divided by total number of chickens in the pen multiplied by 100. At Day 15, one chicken per replicate was randomly selected and placed in a metabolic cage to determine diet digestibility. Feed offered and refusals were measured and all excreta was collected from each replicate and stored at -15 °C during the collection period. The excreta were stored at – 15º until analysed for nutrient contents. Digestibility was also determined when the chickens were 6 weeks old.

Apparent metabolisable energy (AME) of the diet was calculated (AOAC. 2008).

On Day 42, the chickens were slaughtered. After slaughtering, carcass weight of each chicken was measured. Dressing percentage was determined by dividing carcass weight by live weight and then multiplying by 100. Breast, fat pad, thigh, wing, drumstick, gizzard and liver weights were measured using an electronic

scale. Breast meat from each replicate was taken and dried in an oven and stored until analysed for nitrogen content.

3.6 Meat sensory evaluation

Meat samples which had been frozen at -20 °C were thawed for 24 hours in a cooler room for sensory evaluation. The meat was cut into 5 cm pieces according to their treatments and replicates. These pieces were grilled for 30 minutes in an oven set at 105 °C. A taste panel of assessors evaluated the meat for tenderness, flavour and juiciness using a 5-point scale (Table 3.03). Lemon juice and water were used to rinse and cleanse the palate before moving to the next sample. Each member of the panel had a chance to taste all 20 samples.

Table 3.03 Evaluation scores used by the sensory panel

	Sensory Attributes		
Score	Tenderness	Juiciness	Flavour
1	Too tough	Much too dry	Very bad flavour
2	Tough	Dry	Poor flavour
3	Neither tough nor tender	Neither dry nor juicy	Neither bad nor good flavour
4	Tender	Juicy	Good flavour
5	Too tender	Too juicy	Very good flavour

3.7 Chemical analysis

Dry matter contents of feeds, feed refusals, faeces and meat samples were determined by drying the samples at a temperature of 105 °C for 48 hours. Diets were analysed for energy according to the method described by AOAC (2008). Semi-micro Kjeldah method was used to analyze nitrogen contents of feeds, faeces and meat samples (AOAC, 2008).

3.8 Statistical analysis

Data on feed intake, feed conversion ratio, growth rate, live weight and carcass characteristics of Arbor acre broiler chickens were analyzed using the general linear model procedures of the statistical analysis of variance (SAS, 2008) for both the first and second parts of the study. Where there was a significant F-test ($P<0.05$), the Duncan test for multiple comparisons was used to test the significance of differences between treatment means (SAS, 2008). The dose - responses in feed intake, live weight, growth rate, feed conversion ratio, metabolisable energy, nitrogen retention and carcass characteristics of the chickens were modelled using the following quadratic equation:

$$Y= a + b_1x + b_2x^2$$

where y = feed intake, digestibility, live weight, growth rate, feed conversion ratio, metabolisable energy, nitrogen retention and carcass characteristics; a = intercept; b_1 and b_2 = coefficients of the quadratic equation; x = dietary carrot meal supplementation level and $-b_1/2b_2$ = x value for optimum response. The quadratic model was fitted to experimental data by means of the NLIN procedure of SAS (SAS, 2008). The quadratic model was used because it gave the best fit.

The relationships between carrot meal supplementation and optimal responses in meat tenderness, flavour and juiciness were modelled using a linear regression equation (SAS, 2008) of the form:

$$Y= a + bx$$

where Y = optimal tenderness, juiciness and flavour; a = intercept; b = coefficient of the linear equation and x = dietary carrot meal supplementation level.

CHAPTER 4

RESULTS

Results of the effects of carrot meal supplementation on feed intake, growth rate, feed conversion ratio, live weight, metabolisable energy intake and nitrogen retention of unsexed Arbor acre broiler chickens aged one to three weeks are

presented in Table 4.01. Carrot meal supplementation had no effect (P>0.05) on live weight, growth rate and feed conversion ratio of unsexed Arbor acre broiler chickens. However, carrot meal supplementation had effect (P<0.05) on feed intake, metabolisable energy intake and nitrogen retention of the chickens. Unsexed chickens not supplemented with carrot meal had higher (P<0.05) feed intakes than those on diets supplemented with 50, 75 or 100 g of carrot meal per kg DM. Broiler chickens on a diet not supplemented with carrot meal and those on a diet supplemented with 20 g of carrot meal per kg DM had similar (P>0.05) feed intakes. Similarly, broiler chickens on diets supplemented with 20, 50, 75 or 100 g of carrot meal per kg DM had similar (P>0.05) feed intakes.

Unsexed broiler chickens on a diet supplemented with 20 g of carrot meal per kg DM had higher (P<0.05) metabolisable energy intakes than those on a diet not supplemented with carrot meal and those on diets supplemented with 50, 75 or 100 g of carrot meal per kg DM. Broiler chickens on diets supplemented with 50 or 75 g of carrot meal per kg DM had higher (P<0.05) metabolisable energy intakes than those on a diet not supplemented with carrot meal. Broiler chickens on diets supplemented with 50, 75 or 100 g of carrot meal per kg DM had similar (P>0.05) metabolisable energy intakes. Similarly, broiler chickens on a diet not supplemented with carrot meal and those on a diet supplemented with 100 g of carrot meal per kg DM had similar (P>0.05) metabolisable energy intakes.

Chicks on the diets supplemented with 20 or 50 g of carrot meal per kg DM did not differ in N retention, but retained more N than those on the other three diets. Chicks on the three latter treatments however did not differ in N retention. No chicken deaths were recorded during this study.

A negative relationship was observed between carrot meal supplementation to the diets and feed intake (r^2 = 0.826) (Figure 4.01). Metabolisable energy intake and nitrogen retention were optimized at dietary carrot meal supplementation levels of

40.5 (r^2= 0.498) and 53.57 (r^2 = 0.753) g/kg DM, respectively (Figures 4.02 and 4.03, respectively and Table 4.02).

Table 4.01 Effect of carrot meal supplementation on feed intake (g DM/bird/day), growth rate (g/bird/day), feed conversion ratio (FCR) (g DM feed/g live weight gain), live weight (g/bird aged 21 days), metabolisable energy intake (MJ/kg DM) and nitrogen retention (g/bird/day) of unsexed Arbor acre broiler chicks aged one to 21 days

Variable	Treatment					SEM
	UA_0	UA_{20}	UA_{50}	UA_{75}	UA_{100}	
DM intake	40.74^{a}	39.94^{ab}	39.71^{b}	39.53^{b}	39.39^{b}	0.163
Growth rate	32.6	31.7	30.9	31.8	32.0	0.33
FCR	1.25	1.26	1.28	1.24	1.27	0.015
Live weight	730	711	694	693	698	8.37
ME intake	9^{c}	12.5^{a}	11.0^{b}	11.0^{b}	10.0^{bc}	0.387
N retention	2.0^{b}	2.9^{a}	3.1^{a}	2.6^{b}	2.5^{b}	0.115

^{a,b,c} : Means in the same row not sharing a common superscript are significantly different (P<0.05)

SEM: Standard error of the mean

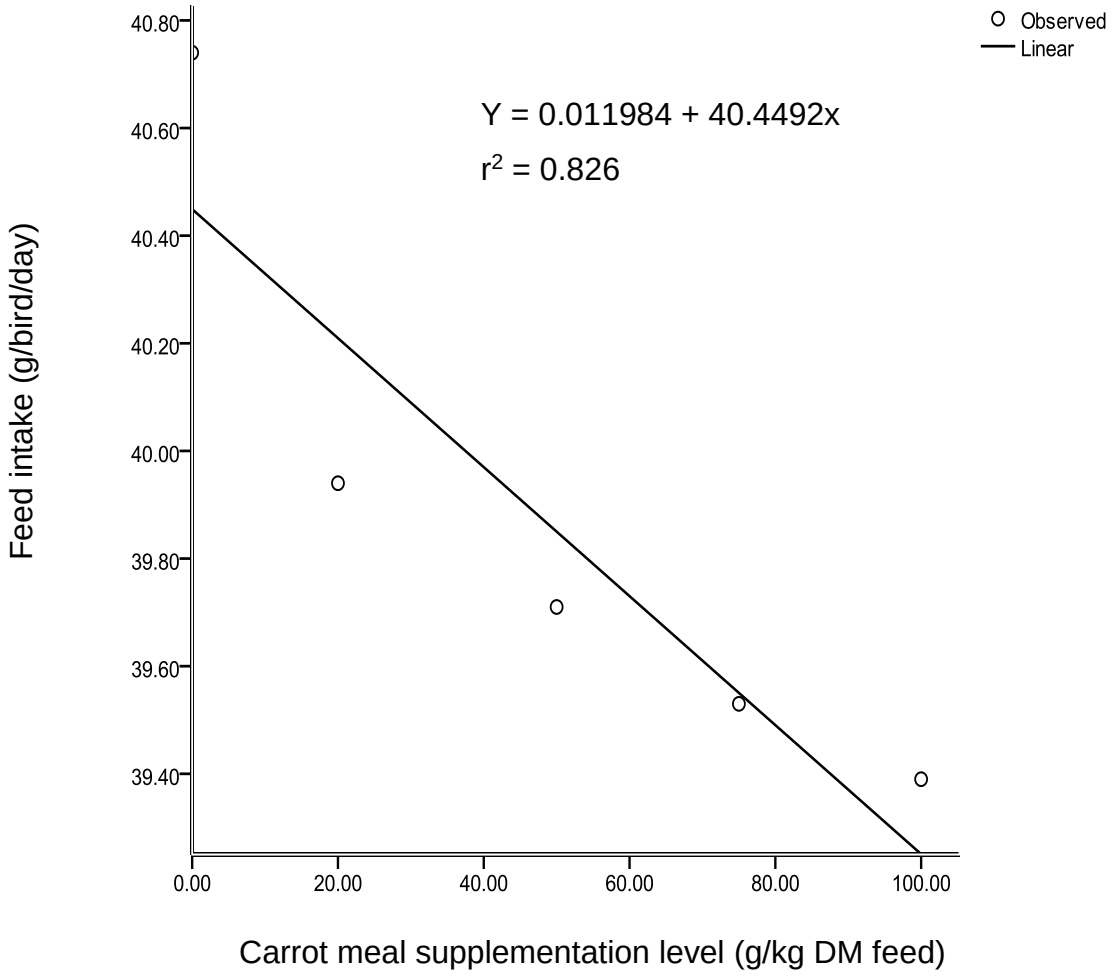

Figure 4.01 Relationship between carrot meal supplementation level and feed intake of unsexed Arbor acre broiler chickens aged one to three weeks

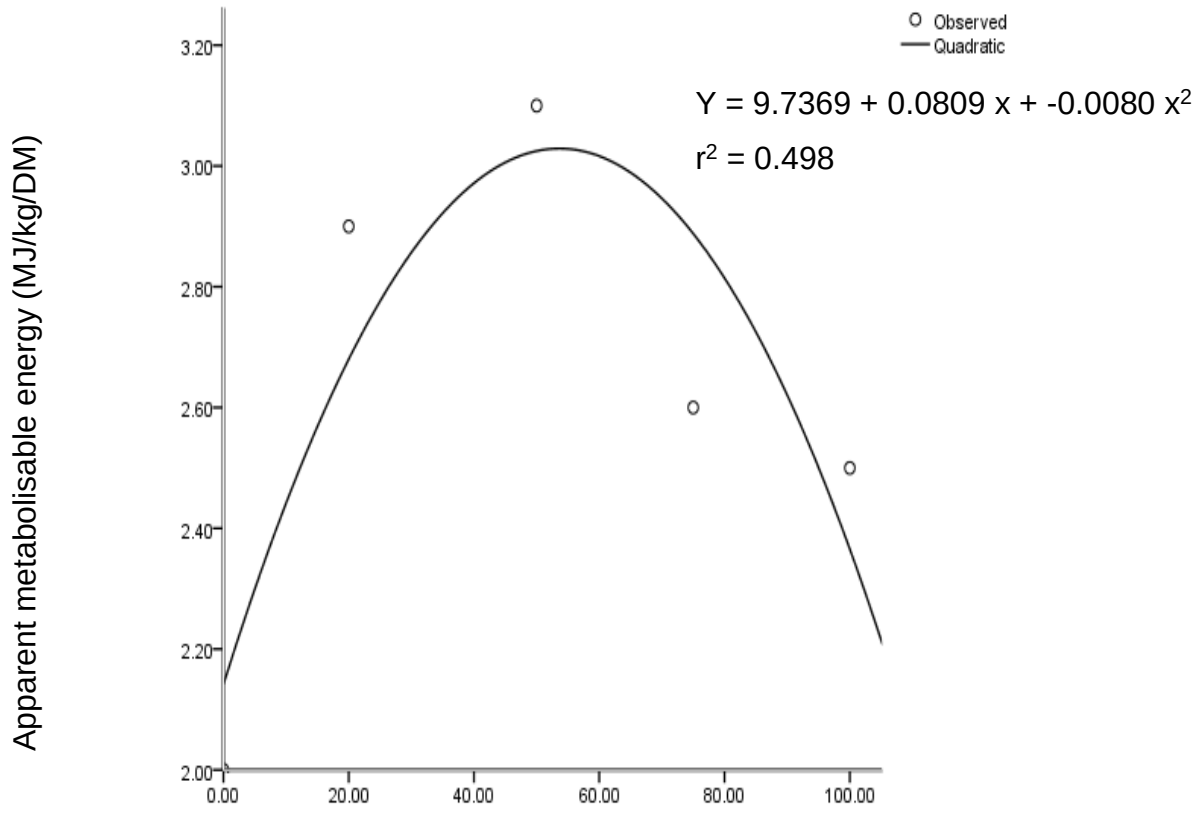

Figure 4.02 Effect of carrot meal supplementation level on apparent metabolisable energy intake of unsexed Arbor acre broiler chickens aged three weeks

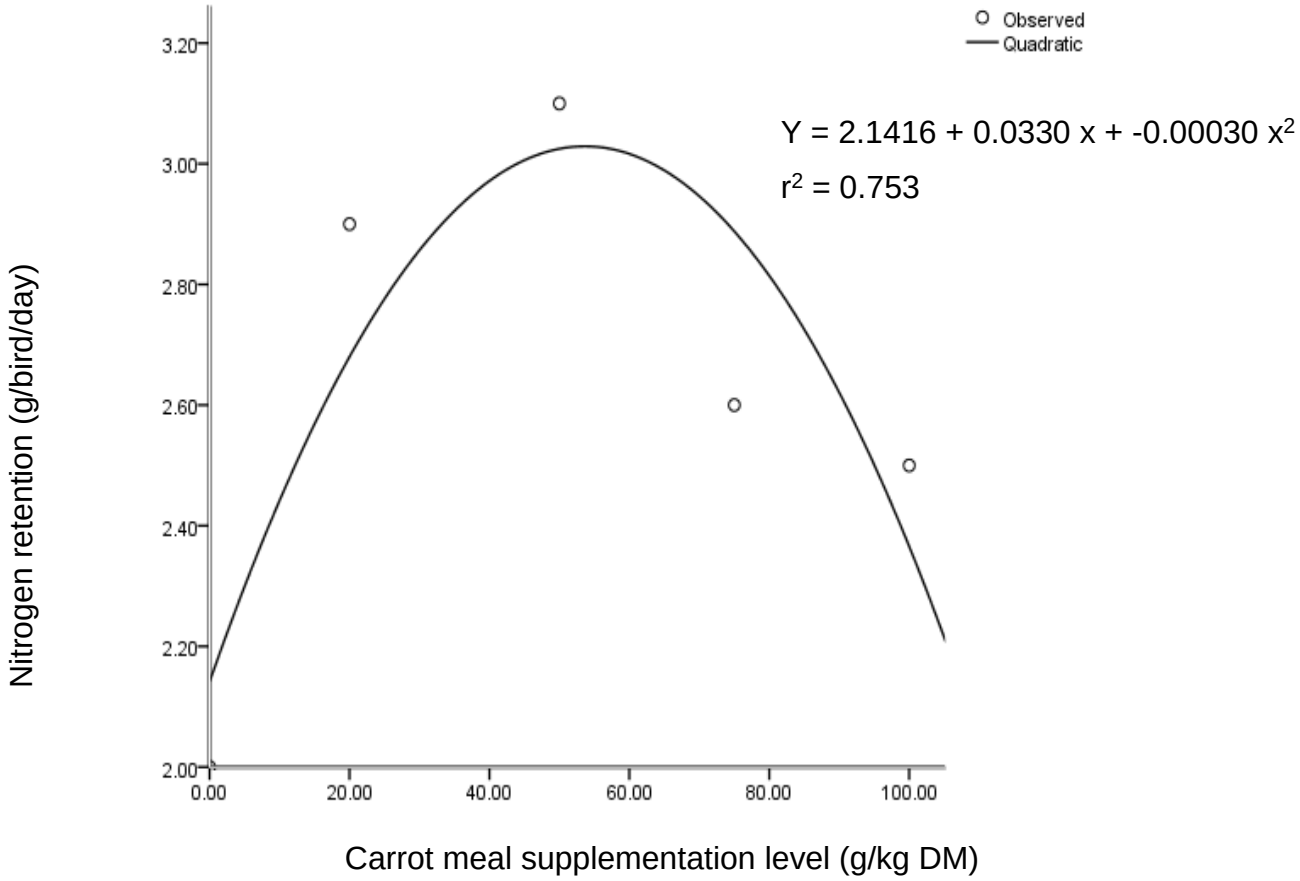

Figure 4.03 Effect of carrot meal supplementation level on nitrogen retention of unsexed Arbor acre broiler chickens aged one to three weeks

Table 4.02 Carrot meal supplementation levels for optimal feed intake (g/bird/day), metabolisable energy (ME) intake (MJ/kg DM) and nitrogen retention (g/bird/day) of unsexed Arbor acre broiler chickens aged one to 21 days

Variable	Formula	r^2	Carrot Meal	Optimal Y-value
ME intake	$Y = 9.7369 + 0.081x + -0.00081x^2$	0.498	40.5	11.69
N retention	$Y = 2.1416 + 0.033x + -0.0003x^2$	0.753	53.57	3.03

r^2 : Regression coefficient

P : Probabilty

Carrot meal : Carrot meal supplementation level for optimal variable

Results of the effect of carrot meal supplementation on feed intake, growth rate, feed conversion ratio, live weight, metabolisable energy intake and nitrogen retention of female Arbor acre broiler chickens aged three to six weeks are presented in Table 4.03. Carrot meal supplementation had an effects ($P<0.05$) on feed intake, feed conversion ratio, live weight, metabolisable energy intake and nitrogen retention of the chickens, but not on growth rate ($P>0.05$). Broiler chickens on a diet supplemented with 50, 75 and 100 g of carrot meal per kg DM had higher ($P<0.05$) feed intake than those on the control diet, and those on diets supplemeted with 20 or 100 g of carrot meal per kg DM feed. Chickens on diets supplemented with 50 or 75 g of carrot meal per kg DM had similar ($P>0.05$) feed intakes. Similarly, female broiler chickens on a diet not supplemented with carrot meal and those on diets supplemented with 20, 75 or 100 g of carrot meal per kg DM had the same ($P>0.05$) diet intakes.

Supplementation with 50 g of carrot meal per kg DM feed improved ($P<0.05$) feed conversion ratio as compared to the values of those female chickens not supplemented with carrot meal (Table 4.03). Female broiler chickens on diets supplementated with 20, 50, 75 or 100 g of carrot meal per kg DM had similar ($P>0.05$) feed conversion ratios. Similarly, female broiler chickens on a diet not

supplemented with carrot meal and those on diets supplemented with 20, 75 or 100 g of carrot meal per kg DM had the same ($P>0.05$) feed convesion ratio.

Female broiler chickens on a diet supplemented with 50 g of carrot meal per kg DM had higher ($P<0.05$) live weights than those on diets supplemented with 20 or 100 g of carrot meal per kg DM feed. Broiler chickens on a diet supplemented with 20 g of carrot meal per kg DM feed had higher ($P<0.05$) live weights than those on a diet supplemented with 100 g of carrot meal per kg DM. Female broiler chickens not supplemented with carrot meal and those on diets supplemented with 50 or 75 g per kg DM had similar ($P>0.05$) live weights. Similarly, broiler chickens not supplemented with carrot meal and those on diets supplemented with 20 or 75 g per kg DM had the same ($P>0.05$) live weights.

Female broiler chickens on a diet supplemented with 20 g of carrot meal per kg DM had higher ($P<0.05$) metabolisable energy intake than those on a diet not supplemented with carrot meal and those on diets supplemented with 50, 75 or 100 g of carrot meal per kg DM. Also chickens on diets supplemented with 50, 75 or 100 g of carrot meal per kg DM did not differ in metabolisable energy intake but consumed more ($P<0.05$) metabolisable energy intake than those on the control diet.

Female broiler chickens on diets supplemented with 20 or 50 g of carrot meal per kg DM had higher ($P<0.05$) nitrogen retention values than those on the three other diets , but birds on the 20 or 50 g of carrot meal per kg DM supplemented diets did not differ ($P<0.05$). However, female chickens on the control diet and the diets supplemented with 75 or 100 g of carrot meal per kg DM had similar ($P>0.05$) nitrogen retention values.

Feed intake, feed conversion ratio, live weight, metabolisable energy intake and nitrogen retention of female Arbor acre broiler chickens aged three to six weeks were optimized at dietary carrot meal levels of 52.8 ($r^2 = 0.888$), 63.8 ($r^2 = 0.780$),

38.0 (r^2 = 0.673), 42.0 (r^2 = 0.385) and 44.3 (r^2 = 0.603) g/kg DM, respectively (Figures 4.04 to 4.08, and Table 4.04).

Table 4.03 Effect of carrot meal supplementation on feed intake (g DM/bird/day), growth rate (g/bird/day), feed conversion ratio (FCR) (g DM feed/g live weight gain), live weight (g/bird aged 42 days), metabolisable energy (MJ/kg DM) and nitrogen retention (g/bird/day) of female Arbor acre broiler chickens aged three to six weeks

Variables	Treatment					SEM
	FA_0	FA_{20}	FA_{50}	FA_{75}	FA_{100}	
DM intake	140.0^{b}	150.5^{b}	172.0^{a}	160.3^{ab}	147.5^{b}	3.80
Growth rate	33.3	29.5	27.8	31.8	28.0	1.13
FCR	5.3^{a}	4.5^{ab}	3.3^{b}	4.2^{ab}	4.0^{ab}	0.22
Live weight	1834^{ab}	1755^{b}	1891^{a}	1835^{ab}	1609^{c}	36.84
ME intake	9.4^{c}	13.8^{a}	11.4^{b}	11.4^{b}	10.4^{bc}	0.388
N retention	2.0^{b}	2.8^{a}	3.0^{a}	2.0^{b}	2.0^{b}	0.115

^{a,b,c} : Means in the same row not sharing a common superscript are significantly different (P<0.05)

SEM : Standard error of the mean

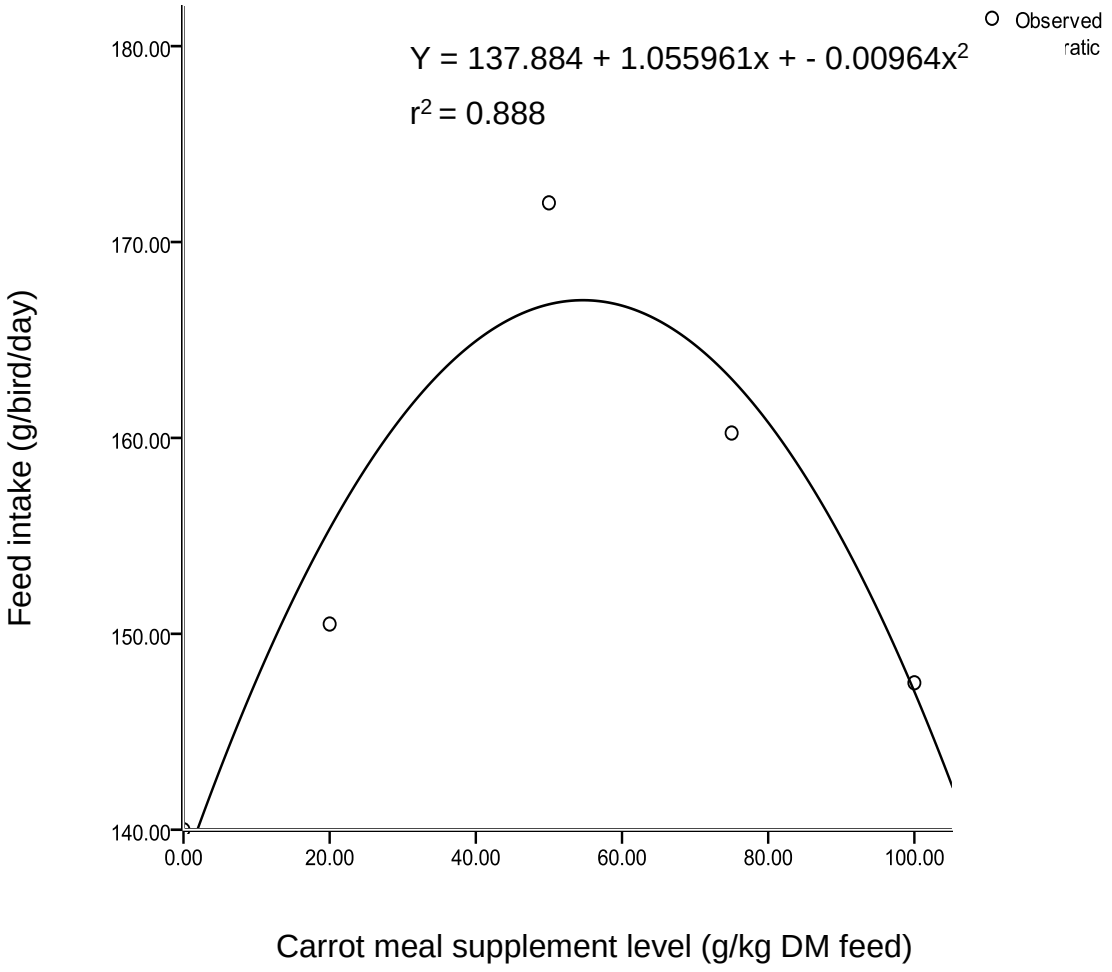

Figure 4.04 Effect of carrot meal supplementation level on feed intake of female Arbor Acre broiler chickens aged three to six weeks

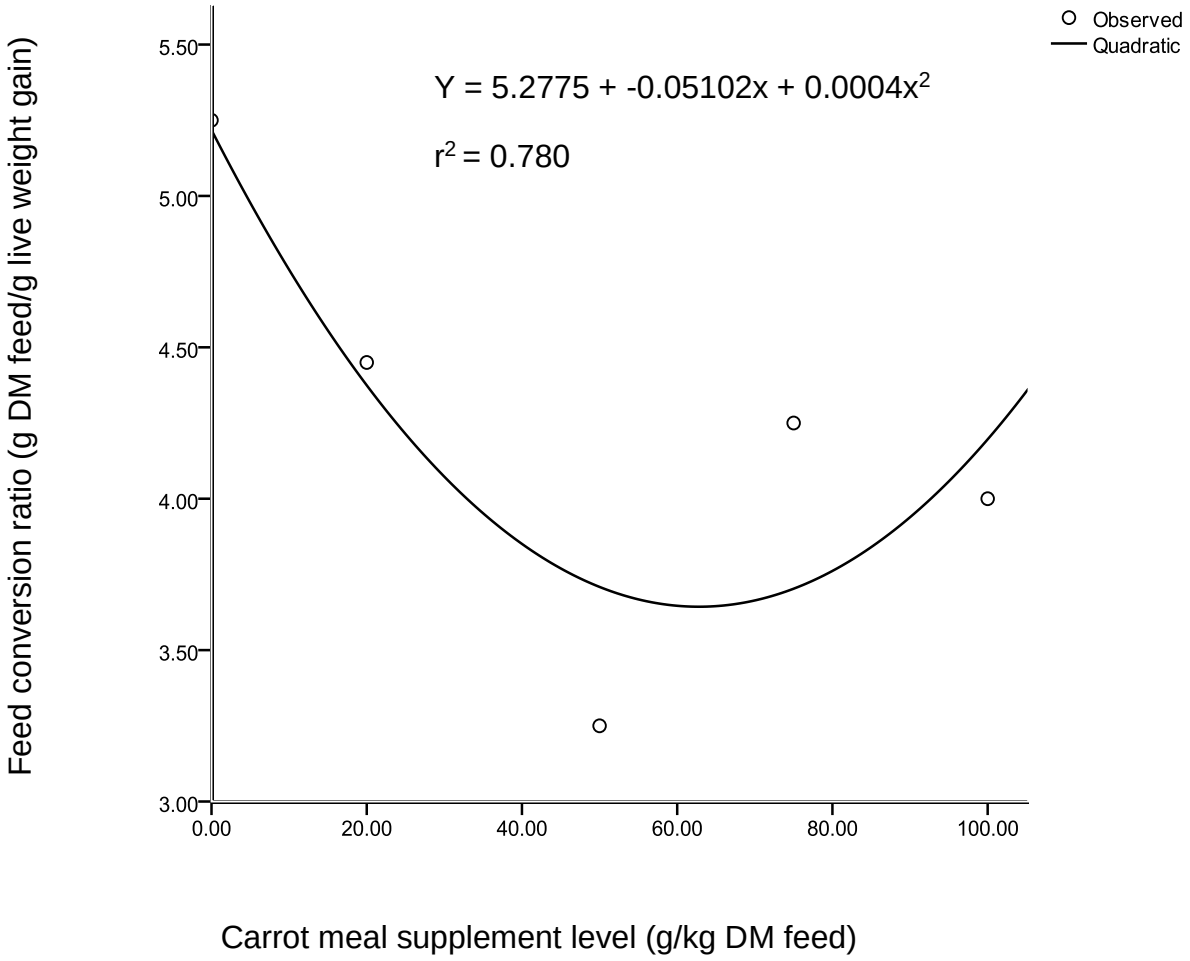

Figure 4.05 Effect of carrot meal supplementation level on feed conversion ratio of female Arbor acre broiler chickens aged three to six weeks

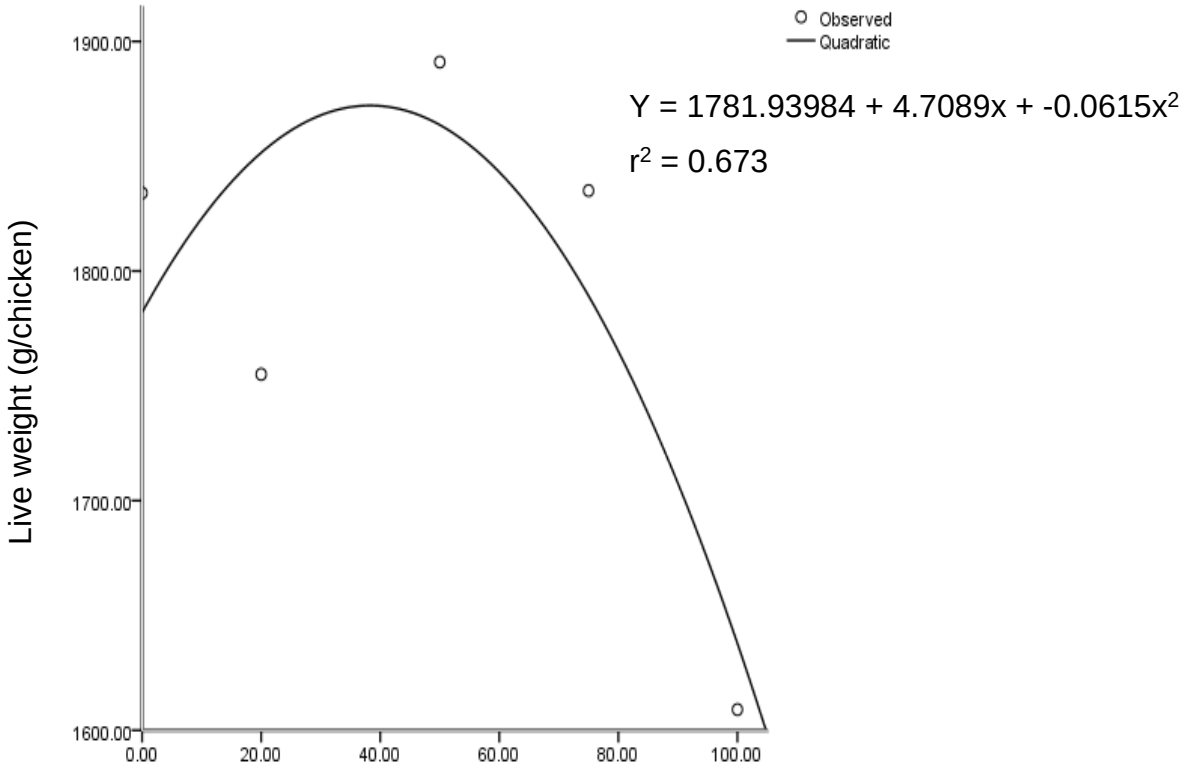

Figure 4.06 Effect of carrot meal supplementation on live weight of female Arbor acre broiler chickens aged 42 days

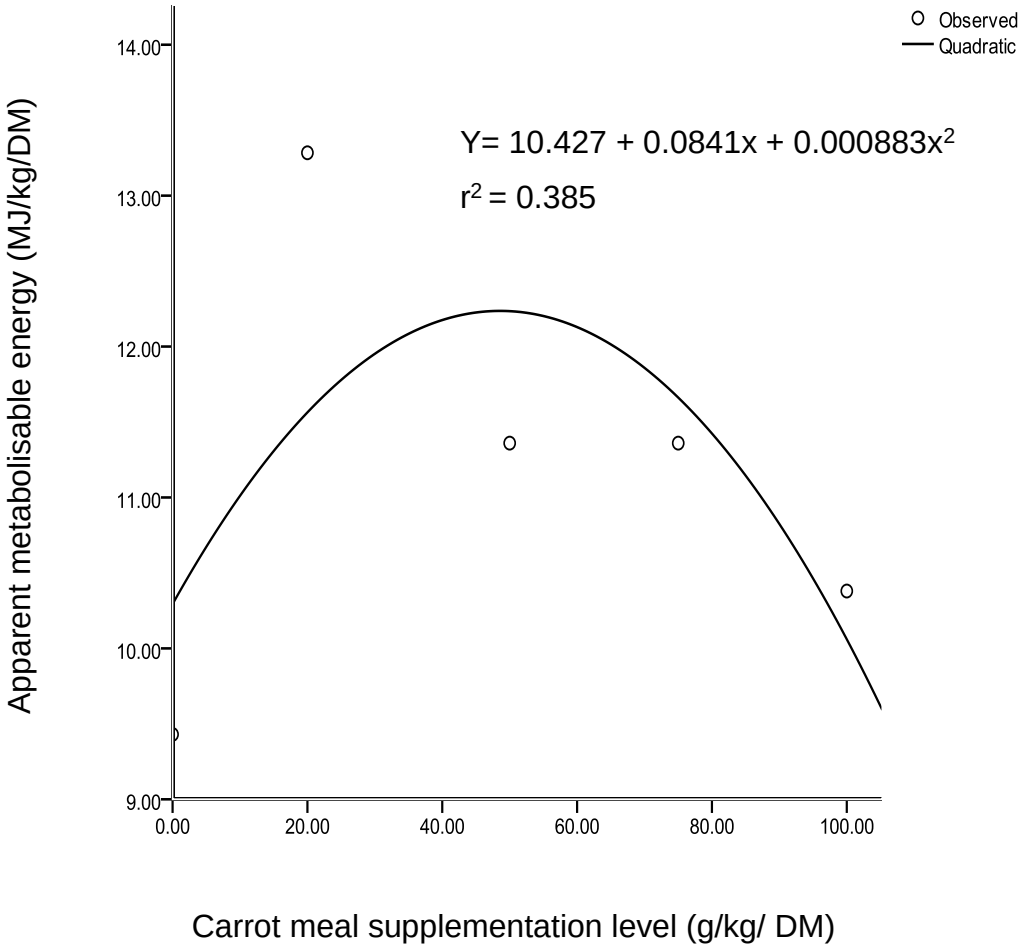

Figure 4.07 Effect of carrot meal supplementation level on apparent metabolisable energy intake of female Arbor acre broiler chickens aged six weeks

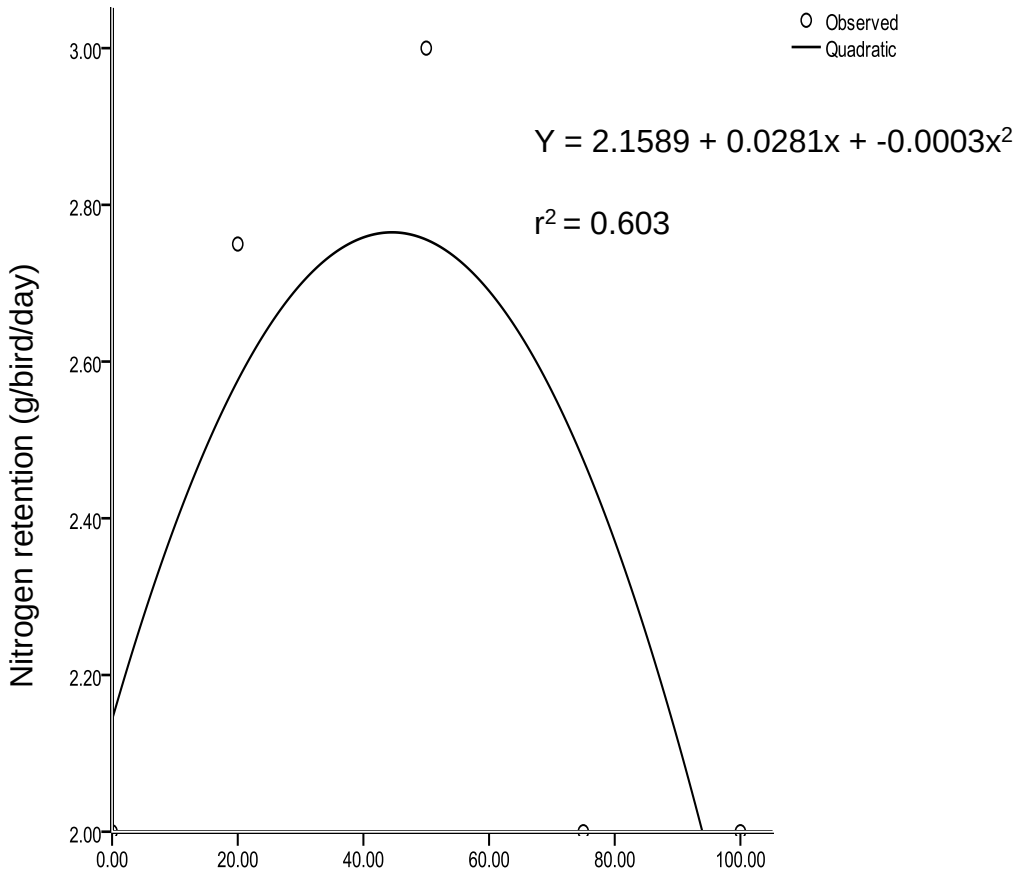

Figure 4.08 Effect of carrot meal supplementation level on nitrogen retention of female Arbor acre broiler chickens aged six weeks

Table 4.04 Carrot meal supplementation levels for optimal feed intake (g/bird/day) ,feed conversion ratio (g DM feed/g live weight gain), live weight (g/bird aged 42 days), metabolisable energy (ME) (MJ/kg DM) and nitrogen retention (g/bird/day) of female Arbor acre broiler chickens aged 22 to 42 days

Trait	Formula	r^2	Carrot meal	Optimal Y-value
Feed intake	$Y = 137.884 + 1.0559x + -0.0094x^2$	0.888	52.8	166.8
FCR	$Y = 5.2775 + -0.0510x + 0.0004x^2$	0.780	63.8	3.65
Live weight	$Y = 1781.939 + 4.7089x + -0.0615x^2$	0.673	38.0	1872
Apparent ME	$Y = 10.427 + 0.0841x + -0.0008x^2$	0.385	42.0	12.4
N retention	$Y = 2.15894 + 0.2811x + -0.0003x^2$	0.603	44.3	2.78

r^2 : Regression coefficient

P : Probabilty

Carrot meal : Carrot meal supplementation level for optimal variable

Results of the effect of carrot meal supplementation on carcass characteristics of female Arbor acre broiler chickens aged 42 days are presented in Table 4.05. Carrot meal supplementation had no effects (P>0.05) on carcass, breast, drumstick, thigh, liver, gizzard and fat pad weights of female Arbor acre broiler chickens aged 42 days.

Results of the effect of carrot meal supplementation on tenderness, juiciness and flavour of meat of female Arbor acre broiler chickens aged 42 days are presented in Table 4.06. Carrot meal supplementation did not improve (P>0.05) meat tenderness and flavour of female Arbor acre broiler chickens aged 42 days. However, female broiler chickens supplemented with 20, 50 or 100 g of carrot meal per kg DM feed produced meat with higher (P<0.05) juiciness than those of meat from diets not supplemented with carrot meal and those on a diet supplemented with 75 g of carrot meal per kg DM. However, meat from chickens on diets supplemented with 20, 50 or 100 g of carrot meal per kg DM had similar (P>0.05)

juiciness values. Similarly, meat from chickens not supplemented with carrot meal and those supplemented with 100 g of carrot meal per kg DM had the same (P>0.05) juiciness values. A positive relationship was observed between carrot meal supplementation to the diets of female Arbor acre broiler chickens and meat juiciness (r^2 = 0.083) and Figure 4.09).

Table 4.05 Effect of carrot meal supplementation on carcass characteristics (g) of female Arbor acre broiler chickens aged 42 days

	Treatment					
Variable	FA_0	FA_{20}	FA_{50}	FA_{75}	FA_{100}	SEM
Carcass	1569	1434	1534	1461	1526	26.03
Breast	205	221	207	214	202	8.42
D/stick	102	99	88	89	96	2.15
Thigh	108	112	104	76	107	5.75
Liver	68	62	62	55	54	3.01
Gizzard	41	34	32	37	33	1.65
Fat pad	39	43	44	31	42	2.62

SEM: Standard error of the mean

Table 4.06 Effect of carrot meal supplementation level on tenderness, juiciness and flavour of meat of female Arbor acre broiler chickens aged 42 day

Sensory	Treatment					
attributes	FA_0	FA_{20}	FA_{50}	FA_{75}	FA_{100}	SEM
Juiciness	2.50^b	3.50^a	3.70^a	2.50^b	3.60^a	0.153
Tenderness	3.30	3.30	3.00	3.00	3.30	0.131
Flavour	3.00	3.10	3.00	3.00	3.20	0.131

^{a,b} : Means in the same row not sharing a common superscript are significantly different (P<0.05)

SEM : Standard error of the mean

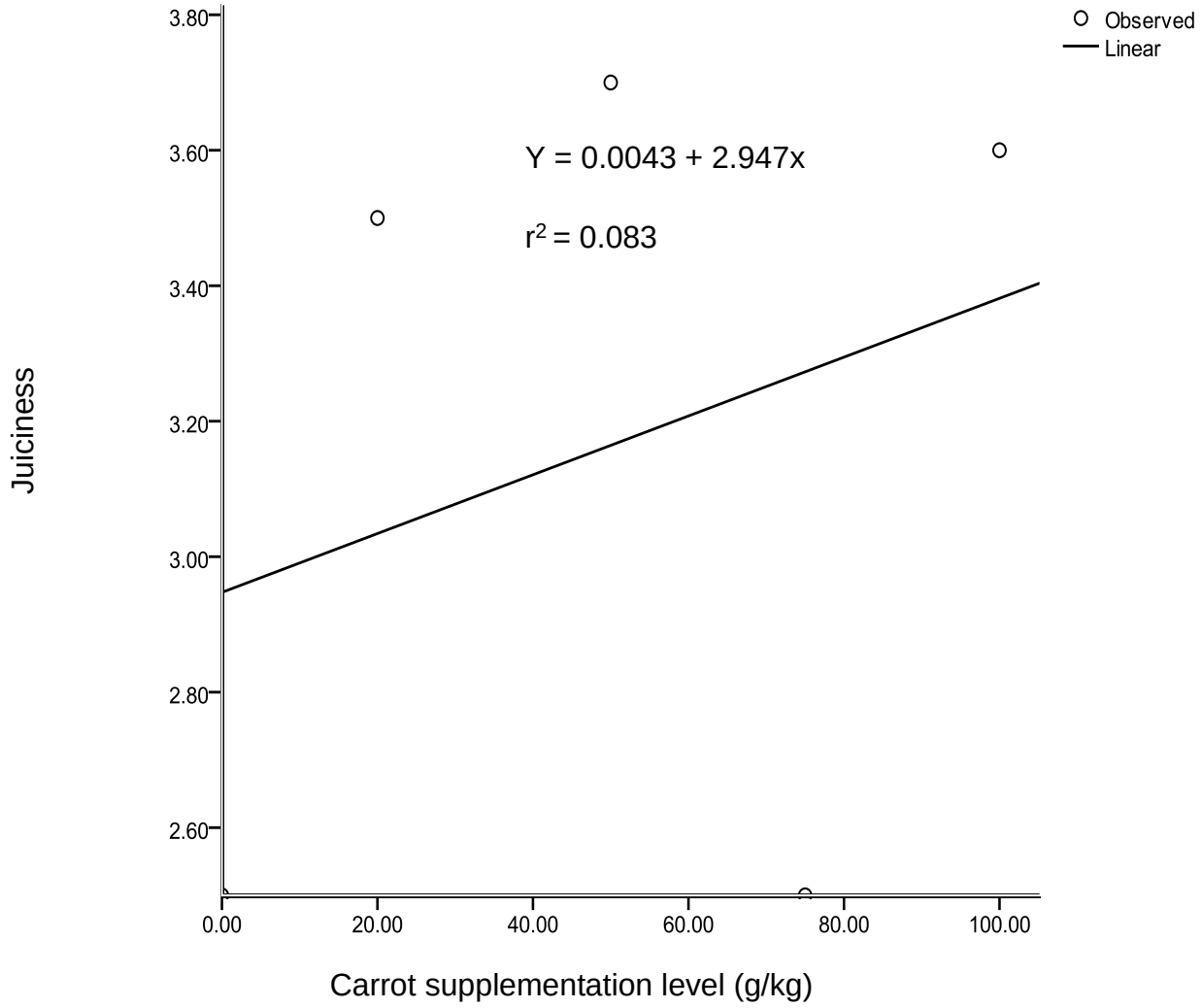

Figure 4.09 Relationship between carrot meal supplementation and juiciness of meat of female Arbor acre broiler chickens aged 42 days

CHAPTER 5
DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1 Discussion

Carrot meal supplementation improved metabolisable energy intake and nitrogen retention of unsexed Arbor acre broiler chicks aged one to three weeks. However, these improvements did not impact on growth rate and feed conversion ratio of the chickens. Similarly, the improvements in dietary intake, metabolisable energy intake and nitrogen retention did not impact on diet intake and live weight of the chickens aged one to 21 days. Hammershoj *et al.* (2010) stated that carrot meal supplementation to the diets of laying hens improved dietary feed intake of the chickens. Similarly, Faniyi (2006) reported improvements in dietary intake of rabbits supplemented with carrot meal. Similar findings were observed by Steenfeldt *et al.* (2007) who stated that carrot meal supplementation improved dietary intake in laying hens. However, Wolter (1999) reported no improvements in dietary intake of rabbits supplemented with carrots. Improvements in dietary metabolisable energy intakes observed in the present study are similar to those observed by Steenfeldt *et al.* (2007) in layer hens. However, Ibrahim (2000) did not report any improvements in metabolisable energy intake of growing rabbits supplemented with carrot meal.

Carrot meal supplementation improved dietary intake, feed conversion ratio, metabolisable energy intake and nitrogen retention of female Arbor acre broiler chickens aged 22 to 42 days. However, these improvements did not have any impact on growth rates of the chickens. Similarly, improvements in dietary intake, feed conversion ratio, metabolisable energy intake and nitrogen retention did not result in any improvement of live weights of the chickens. These results are similar to those of Mona and Hanan. (2006) who reported no improvement in live weight of laying hens supplemented with carrot meal. Similarly, Ibrahim (2000) reported no improvements in live weights of growing rabbits supplemented with carrot meal. However, the present results are contrary to those of Yoshkova *et al.* (2010) who observed improvements in live weights of sows supplemented with carrot meal. Similarly, Abdu *et al.* (2012) reported improvements in live weights of rabbits with

carrot meal supplementation. Rizal *et al*. (2010) reported an improvement in feed conversion ratio of broiler chickens supplemented with carrot meal. Improvements in dietary feed conversion ratio observed in the present study are similar to those observed by Eleraky (1996) who found that carrot meal supplementation to the diets of growing rabbits gave a better feed conversion ratio. Similarly, Hammershoj and Steenfeldt. (2005) and Hammershoj *et al.* (2010) reported improvements in feed conversion ratio of laying hens when they were supplemented with carrot meals. The present findings are, also, similar to those of Magouze *et al.* (1998) who reported an improvement in feed conversion ratio of rabbits supplemented with carrot meal. However, El-kerdawy *et al.* (1992) did not report any improvements in feed conversion ratio of rabbits supplemented with carrot meal. Similarly, Sikder *et al*. (1998), also, observed no improvements in feed conversion ratio of laying hens supplemented with carrot meal. In the present study, dietary intake and feed conversion ratio and live weight of female Arbor acre broiler chickens aged 22 to 42 days were optimized at different dietary carrot meal supplementation levels of 52.8 and 63.8 g/kg DM feed, respectively. This means that carrot meal levels for optimal productivity will depend on the particular variable of interest. This has implications on ration formulation where carrot meal is included.

Carrot meal supplementation improved dietary metabolisable energy intakes of female Arbor acre broiler chickens aged 22 to 42 days. These results are similar to those of Magouze *et al.* (1998) who observed that carrot meal supplementation in growing rabbits improved their metabolisable energy intakes. However, El-Kerdawy *et al.* (1992) and Göhl (1981) found that carrot meal supplementation to the diets of growing rabbits decreased their metabolisable energy intakes. Similarly, Steenfeldt *et al.* (2007) observed a decrease in metabolisable energy intakes of laying hens supplemented with carrot meal. The results of the present study indicate that carrot meal supplementation increased nitrogen retention in female Arbor acre broiler chickens aged 22 to 42 days. However, these results contradict with those of El-Kerdawy *et al.* (1992), which indicated that carrot meal

supplementation to the diets of growing rabbits decreased nitrogen retention. Similarly, Steenfeldt *et al.* (2007) found that nitrogen retention in laying hens supplemented with carrot meal was decreased. In the present study, metabolisable energy intake and nitrogen retention of female Arbor acre broiler chickens were optimized at different carrot meal supplementation levels of 42.0 and 44.3 g/kg DM feed, respectively. This means carrot meal levels for optimal metabolisable intake and nitrogen retention intake will depend on the variable of interest.

Carrot meal supplementation did not affect tenderness and flavour of female Arbor acre broiler chicken meat. However, carrot meal supplementation improved the juiciness of female Arbor acre broiler chicken meat. Thus, there was a weak but positive relationship between carrot meal supplementation and juiciness of female Arbor acre broiler chicken meat. No such information was found for either indigenous or broiler chicken breeds.

5.2 Conclusion

Carrot meal supplementation did not increase diet intake, growth rate, feed conversion ratio and live weight of unsexed Arbor acre broiler chickens aged one to 21 days. Mortality rate of the chickens aged one to 21 days was not affected by carrot meal supplementation. Similarly, carrot meal supplementation did not have any effect on growth rate, live weight, carcass weight, meat tenderness and flavour of Arbor acre broiler chickens aged 22 to 42 days. However, carrot meal supplementation improved intake, feed conversion ratio, metabolisable energy intake, nitrogen retention and meat juiciness of female Arbor acre broiler chickens aged 22 to 42 days. Optimal improvements of these parameters were achieved at different carrot meal supplementation levels. Thus, carrot meal levels for optimal productivity will depend on the parameter in question. This has a lot of implications in diet formulation where carrot meal is included.

5.3 Recommendation

Carrot meal supplementation improved feed intake, feed conversion ratio, metabolisable energy intake, nitrogen retention and meat juiciness of broiler chickens aged 22 to 42 days. Optimal responses for these variables were achieved at different carrot meal levels. It is, therefore, recommended that more research be done to explore carrot meal supplementation levels for optimal productivity of the various parameters. There is a also need to explore biological reasons for the improvements.

CHAPTER 6
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CHAPTER 7
APPENDIX A

APPENDIX A: VACCINATION PROGRAMME

The vaccination programmes of the study were as indicated below:

Day one:	On arrival chicks were vaccinated against Newcastle disease form the hatchery using lone 30,secondly Vita stress was added in the drinking water immediately on arrival for the first two days calm down the chicks due to stress they might have experienced through transportation and handling.
Day three	Tylo tad was added in the drinking water for prevention of *Escheria coli* bacteria and other disease causing microorganisms.
Day seven	Chicks vaccinated against infectious bronchitis using “IBH 120”
Day twelve	Chicks were vaccinated against Gumbora using D78 through drinking water
Day eighteen	Chicks were vaccinated against Gumbora using D78 through drinking water
Day twenty one	Tylo tad was added in the drinking water
Day twenty three	Chickens were vaccinated against Newcastle disease using Clone