GROWTH RESPONSE OF GUINEA FOWLS FED DIETS CONTAINING BOVINE BLOOD BLENDED WITH CASSAVA

By

ALIDU IDDRISU, B.Sc. (HONS) AGRICULTURE TECHNOLOGY

A Thesis submitted to the Department of Animal Science, Kwame Nkrumah University of Science and Technology, Kumasi, in partial fulfilment of the requirements for the degree of

Master of Science

(Animal Nutrition)

Faculty of Agriculture,

College of Agriculture and Natural Resources

MAY, 2014

DECLARATION

I, **Alidu Iddrisu,** hereby declare that the work presented in this thesis is the result of an experiment I personally undertook and no such previous application for a degree in this university or elsewhere has the same work been presented. All sources of information cited in this work have duly been acknowledged.

Alidu Iddrisu (PG2129608)	…………………………	…………………………
(Student)	Signature	Date

Certified by

Prof. Armstrong Donkoh	…………………………	…………………………
(Supervisor)	Signature	Date

Certified by

Dr. (Mrs) V. A. Kotoku	…………………………	…………………………
(Co-Supervisor)	Signature	Date

Dr. (Mrs) V. A. Kotoku	…………………………	…………………………
((Head of Department)	Signature	Date

ABSTRACT

An 18 – week feeding trial was conducted to assess the effect of four types of bovine blood blended with cassava, hereafter referred to as BBLOCAM, to partially replace maize on the growth performance, haematological and blood biochemical parameters of guinea fowl keets. Two hundred and eighty five, 35 – day old local keets with a mean weight of 85.2g were randomly allocated to five dietary treatments with 57 keets in each treatment with 3 replicates per treatment. The dietary treatments consisted of T1 (the control diet), which contained maize as the main energy source; T_2 (BBLOCAM II, 100 units cassava flour: 25 units fresh blood); T_3 (BBLOCAM III, 100 units cassava flour: 33.33 units fresh blood), T_4 (BBLOCAMIV, 100 units cassava flour: 50units fresh blood) and T_5 (BBLOCAM V, 100 units cassava flour: 100 units fresh blood).Feed and water were provided *ad libitum*.

The mean daily feed intakes were 42.63g (T1), 43.56g (T2), 43.50g (T3), 43.33g (T4) and 42.69g (T5). The mean body weight gain for the dietary treatments T1, T2, T3, T4, and T5 were 996.40g, 958.00g, 982.70g, 965.00g and 942.70g, respectively. The intake of BBLOCAM did not have any significant ($P>0.05$) effect on growth performance. The feed conversion efficiency (FCE) did not vary significantly among treatment means. The dressed weight and dressing percentage showed significant differences among dietary treatments, which were variable and did not show a clear trend that could indicate the influence of BBLOCAM in the diets on the parameters.

There was a significant ($P > 0.05$) difference in the total cholesterol values between T1 and T4 but both T1 and T4 were not significantly different from T2, T3 and T5. The values for the high density lipoproteins were not significantly different among all the treatment means but the low density lipoproteins and triglycerides values differed

significantly (P < 0.05) among their respective treatment means. The albumin, globulin and total protein values did not differ among dietary treatments. Hb, HCT, MCH, RBC and WBC did not also differ but MCHC and MCV values differed among the treatments but were within the reference range values.

A total of 15 mortality cases were recorded during the period which did not follow any trend attributable to the feeding of BBLOCAM as the highest percentage (33.3%) of mortality was recorded among the birds fed the control diet (T1) which contained none of the BBLOCAMs.

BBLOCAM diets confer better economic benefits compared to maize by greatly reducing feeding and production cost. It was therefore, concluded that increased productivity of poultry particularly guinea fowls could be achieved by feeding BBLOCAM based diets which could reduce cost significantly.

ACKNOWLEDGEMENTS

I wish to express my sincere and immeasurable thanks to the Almighty Allah for His guidance and protection throughout the course. My sincere appreciation also goes to Prof. A. Donkoh and Dr. (Mrs) V. A. Kotoku, my project supervisor and co-supervisor, respectively for their constructive criticisms and technical advice during the design, execution and presentation of the results of this project.

I am highly indebted to Dr. Michael Boateng for painstakingly assisting me in the analysis of the data and the brotherly care and advice given during the research period. I also wish to thank Prof. (Mrs) C.C. Atuahene; Prof. D.B.Okai, and Prof. E.L.K.Osafo (Head of Department of Animal Science) and all other senior members of the Department for their invaluable support during the course of my studies.

My special thanks go to Mr. J.A. Bentil, the Laboratory Technician, who immensely assisted me in the analysis of the feed ingredients and the experimental diets and Mr Gariba of KNUST Hospital for assisting in the haematological and blood biochemical analysis. Mention must be made of the following towards the research work: Messrs Francis Sakobeh, Adamah Sumaila, Nixon Faakye and most especially the late Mohammed A. Rashid, all of the Animal Science Department, for helping in the feed preparation and feeding of the birds.

I am also grateful to my family particularly my mother and wife, for the encouragement and support and all those who contributed in diverse ways to make my studies a success. God richly bless you all.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF PLATES

LIST OF ABBREVIATIONS

ABBREVIATION	MEANING
ADFI	Average daily feed intake
ADG	Average daily gain
ADI	Average daily intake
BBLOCAM	Bovine blood blended with cassava
BLOCASSAP	Cassava peels and blood mixture
BLOMC	Blend of blood and maize cob
CF	Crude fibre
CP	Crude protein
CRD	Completely Randomised Design
DM	Dry matter
EDTA	Ethylenediamine tetra acetic acid
EE	Ether extract
EGF	Exotic Guinea fowl
FCR	Feed conversion ratio
GIZ	German International Co-operation
HB	Haemoglobin
HCT	Haematocrits
HDL	High density lipoproteins
IFAD	International Fund for Agricultural Development
IGF	Indigenous guinea fowl
LDL	Low density lipoproteins
MCH	Mean corpuscular haemoglobin

MCHC	Mean corpuscular haemoglobin concentration
MCV	Mean corpuscular volume
ME	Metabolizable energy
MOAP	Market Oriented Agriculture Development Project
MOFA	Ministry of Food and Agriculture
NFE	Nitrogen free extract
NRC	National Research Council
OPS	Oil palm slurry
PCV	Packed cell volume
PPCB	Processed product from cassava and blood
RBC	Red blood cells
RIB	Rice bran
RIBROPS	Rice bran and oil palm slurry
SADEP	Small holder Agricultural Development Project
T.CHOL	Total cholesterol
TG	Triglycerides
T.P	Total proteins
WBC	White blood cells
Wk	Week
Wt	Weight

CHAPTER ONE

1.0 INTRODUCTION

The Guinea fowl (*Numida meleagris*) is a bird native to Africa (Annor *et al.*, 2012; Smith, 1990; Payne, 1990). There are three breeds of Guinea fowls namely; the pearl, the lavender and the white. Outside Europe, virtually all Guinea fowls are raised as free ranging birds (NRC, 1991). They are relatively disease-free and require little water or attention (NRC, 1991) hence; capital investment for engaging in their rearing is low and this makes it possible literally for anyone to raise Guinea fowls. Therefore, their potential as an asset for poverty reduction is great especially for disadvantaged groups such as women and children (Naazie *et al.*, 2002). Northern parts of Ghana represent the major zone of production of this bird in the country and in almost all households; males and females as well as children rear these birds (Naazie *et al.*, 2002).

Guinea fowls are an integral part of the lives of the people of Northern Ghana and are used for varied functions including; courtship and dowry, gifts and sacrifice (Naazie *et al.*, 2002). They also serve as a means of individual and social wealth generation since ruminants are bought from initial investment in Guinea fowl rearing (Karbo *et al.*, 2002).The bird is also used by the Gonjas in the Northern region for the celebration of Guinea fowl festival Annor *et al.* (2012). In Ghana, the Guinea fowl is usually raised traditionally under the extensive system just as the local fowl where they fend for themselves by scavenging. As a result, their productivity is very low. Factors responsible for low productivity include; inadequate nutrition, high mortality of keets, worm infestation, predation and poor egg hatchability (Annor *et al.*, 2012 ; Karbo *et al.*, 2002) among others. Inadequate nutrition has been singled out as one of the key factors affecting productivity. A shift to ingredients for which there is less competition between man and animals, such as agro-industrial by-products or non-conventional feedstuffs, might help if they are sufficiently available (Oluyemi and Roberts, 1988). Cassava is produced in abundance in many tropical areas and can be fed to cattle, pigs and poultry (Gopalakrishnan and Lal, 1996; McDonald *et al.*, 2002). The protein content of cassava is very low and therefore its use in poultry diets would require its supplementation with high protein diets such as fishmeal and soyabean meal which are also very expensive.

Blood, a slaughter house by-product, is an untapped feed resource in the tropics. It has high protein content and a good amino acid profile which makes it a potential replacement for the expensive soya bean meal or fishmeal. Blood meal has a crude protein content of 800g/kg (80%), and small amounts of ash and fat. It is important nutritionally as a source of lysine, arginine, methionine, cystine but it is very poor in isoleucine and contains less glycine than fish, meat, meat and bone meals (McDonald *et al*., 1987; Pond *et al.*, 1995).

The use of blend of blood and ground corncobs (BLOMC) as a replacement for wheat bran up to a level of 120 g/kg diet in broiler chickens has shown positive effects on growth performance (Donkoh *et al.*, 2003). Other researchers have used the blend of blood and cassava meals in feeding pigs and chickens with positive results but have not been used for feeding Guinea fowls, which have the potential for both egg and meat production (Biswas, 1999).

1.1 OBJECTIVES OF STUDY

1.1.1 General Objective

The general objective of the study was to determine the growth performance and the economics of production of Guinea fowls fed on diets containing bovine blood blended with cassava (BBLOCAM) as partial replacement for maize.

1.1.2 Specific objectives

The specific objectives were to determine the effect of bovine blood blended with cassava on:

1. the growth performance of guinea fowls.
2. the economics of production of Guinea fowls.
3. blood cellular and biochemical indices.

CHAPTER TWO

LITERATURE REVIEW

2.1 Importance of Guinea fowl production

Guinea fowl performs various functions such as provision of income and protein (Awotwi, 1987; Adam, 1997; Teye, 2000; Adam, 2000; Annor *et al*., 2012).Guinea fowls act as watch dogs on plantations, homes and in the control of insects on fruits and vegetable farms (Blackely and Bade, 1994). According to Karbo *et al.* (2002), within the poultry subsector, the Guinea fowl plays important roles as a means of individual and social wealth generation and socio-culturally, Guinea fowls are used for payment of dowries(Karbo *et al*., 2002).

The Guinea fowl meat and eggs are delicacies particularly to those from the southern zone and a source of quality protein and contain less cholesterol and fats (Ayeni and Ayanda, 1982; Okaeme, 1982; Biswas, 1999; Annor *et al*., 2012). The Guinea fowl has less taboo associated with the consumption of its meat or eggs and the protein content (28%) of the meat is higher compared to that of the domestic fowl (about 20%) (Koney,1993).

The bird is use culturally for different purposes such as in funeral celebrations, sacrifices, courtship and as token for settling disputes (Karbo *et al*., 2002; Naazie *et al.*, 2007 ; Annor *et al*., 2012). Guinea fowls play a central role during courtship and marriage among the Mamprusis, Frafras and the Kusasis while the Gonjas celebrate an annual Guinea fowl festival (Naazie *et al.*, 2007; Annor *et al*., 2012).

In most households in Northern Ghana the sale of poultry forms the first line for meeting immediate cash needs followed by sheep and goats and therefore, Guinea fowls play a central role in ensuring food security for people in the North (Annor *et al*., 2012).

Guinea fowl production is lucrative because there is high demand for both the meat and the eggs and also, unlike the rearing of cattle and to some extent small ruminants, poultry ownership in most parts of the north generally has no gender limitations (Annor *et al*., 2012).

According to Naazie *et al.*(2007) and Annor *et al*.(2012), poultry production including the rearing of Guinea fowls, if given the necessary boost can act as an income generating activity for most rural poor women in the North.

2.2 Guinea Fowl Production in Ghana

The Guinea fowl has proven to be adaptable wherever it has been taken to ranging from the tropics to the Siberia although its natural habitat is woodland savannah with ground level cover for its nest and trees for roosting at night (Biswas, 1999).

Guinea fowls are reared on commercial basis in India, Belgium, France, Italy and South Africa. However, in West Africa where the Guinea fowl originates, it is still raised on small scale basis under the traditional system of management with a local chicken hen or a Guinea hen brooding on the eggs to hatch and taking care of the keets. Plate 2.1and 2.2 show typical Guinea fowl nests and Guinea fowl hen and its keets.

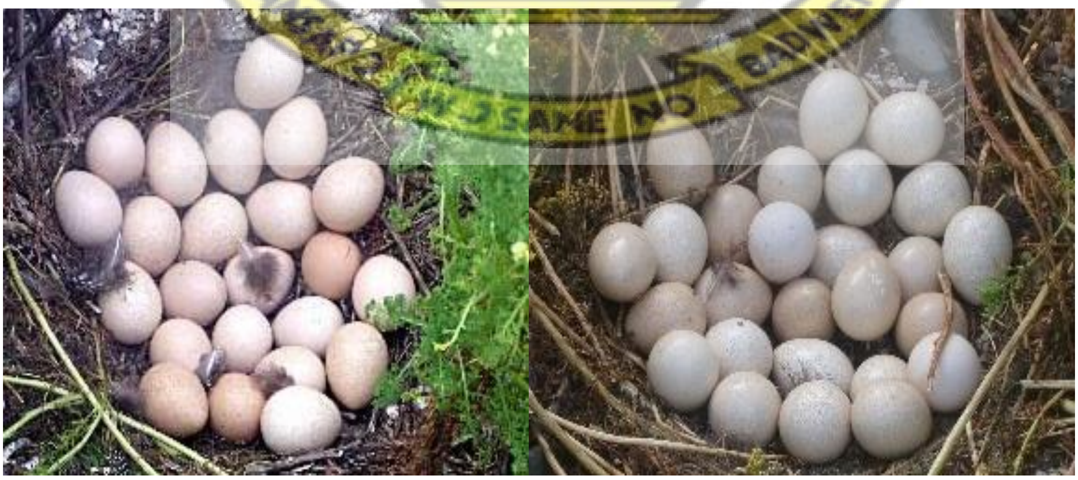

Plate 2.1 Typical guinea fowl nests

Plate 2.2 Typical guinea fowl hen and its keets

In Ghana, Guinea fowls are found mostly in the Northern Savannah (Northern, Upper East and Upper West Regions) where they live in groups, either in the wild or domesticated in semi intensive systems although they are also found in Southern Ghana especially in the transitional zone and in the coastal Savannah zone (Annor *et al*., 2012).

Throughout Ghana, Guinea fowls are mostly on free range system and it is estimated that 9 out of every 10 households in the Savannah zone rear this bird which plays significant roles in the food and nutrition security in many farm households with limited gender bias (Karbo *et al*., 2002; Naazie *et al.*, 2002; Annor *et al*., 2012).

The grey breasted and helmeted Guinea fowl (*Numida meleagris*) is the indigenous and predominant breed in the Savannah zone of Ghana where the estimated population of Guinea fowl is about 1,030,000 accounting for 25% of the total population of poultry in that zone (Annor *et al*., 2012). According to Annor *et al.*(2012), for generations farmers in the three Northern regions have been producing Guinea fowls alongside their core farming activities and have been the source of a large portion of the guinea fowl products consumed in the country. That the average household in suburban farming areas and in the villages would keep an average of five Guinea hens and a Guinea cock for a period of one year.

Guinea fowl farmers acquire Guinea fowl stock by purchasing the eggs from other farmers or from the market, the eggs are set for the local female domestic fowl (hen) to incubate for a brooding period of about 28 - 30days(Annor *et al*., 2012).

The system of production of Guinea fowl in Ghana is mostly extensive (free-range), and in some cases, some farmers provide the birds with poorly ventilated accommodation during the night but in majority of cases, the birds sleep in trees around houses(Karbo *et al*., 2002;Naazie *et al.*, 2007; Annor *et al*., 2012). According to Annor *et al*. (2012), apart from being left on free-range to scavenge for feed Guinea fowls are fed with a variety of feed supplement such as grains (maize, millet and sorghum), termites and other agro-industrial by-products such as pito mash, corn chaff, rice bran, and left over from around the household in the mornings and evenings as a means of taming the birds so that they always return to the house.

Inbreeding is a major concern of Guinea fowl breeding in rural communities of Ghana as the birds are hatched together from the same parents and live together and interbreed among themselves; the consequence of this in most communities is reduction in growth rate and size of birds, poor reproductive performance, genetic defects and unexpected high mortality (Annor *et al*., 2012).

Of late commercial Guinea fowl famers are emerging in both southern and northern Ghana. Asamoah and Yamoah and Akate farms are examples in the southern Ghana whilst Alhassan and Atibire farms are examples in the northern Ghana. In both cases, the farmers practice intensive system of Guinea fowl production with some of the day-old keets imported from Europe Annor *et al*. (2012).

Mortality of both keets and adult birds can be very high and keet mortality ranging from 40% and 100% has been recorded in Ghana. Pneumonia and dehydration are major causes of death in keets from day 1 up to 6 weeks of age and the most important post-brooding mortality has been associated with worm infestation (Annor *et al*. 2012).

The productivity of the Ghanaian local Guinea fowl is far below that observed in European breeds (Table 2.1). According to Annor *et al*. (2012), the low productivity of the Ghanaian Guinea fowl breeds may be due to the extensive production system with its accompanying poor feeding, poor health care and management in addition to the use of unimproved breeds of birds unlike in Europe, where within breed selection has been carried out over a long period of time and genetic improvement has been achieved in egg size, growth rate and body weight, and birds are reared intensively.

Table 2.1: Productivity of Ghanaian and European Guinea fowls

Parameter	Productivity in Ghana	Productivity in Europe
Annual egg production	100	180
Laying period (week)	20	40
Egg size (g)	32	60
Fertility rate (%)	42	88
Hatchability (%)	45	83
Mortality (%)	40-100	3-4
6 weeks weight (g)	245	650
12 weeks weight (g)	500	1600
24 weeks weight (g)	1200	2500

Source: Annor *et al*. (2012)

There have been many Guinea fowl development projects in Ghana since independence. One of such projects was Smallholder Agricultural Development project (SADEP) which was funded by Government of Ghana and International Fund for Agricultural Development (IFAD) with the main objective of the project being to upgrade the productivity of the local Guinea fowls by increasing egg size and mature body weight through cross breeding (Annor *et al*., 2012). According to Annor *et al*. (2012), another project that is promoting the value chain of Guinea fowl in the northern part of Ghana through increasing production, processing, marketing and consumption is Market Oriented Agriculture Development Project (MOAP) which was implemented jointly by the Ministry of Food and Agriculture (MOFA) and German International Cooperation (GIZ)

2.3 Origin and distribution of Guinea fowl

Guinea fowls are one of the lesser known poultry species native to the African continent (Smith, 1990) where wild species are still found. The Guinea fowl derives its name from the Guinea coast of West Africa where it originated (Roy and Wibberley, 1979; Anthony, 1990; Payne, 1990; Annor *et al*., 2012). Guinea fowls are domesticated and are usually managed under the same principles as the domestic fowl. They belong to the order *Galliformes* and family *Numididae* (Payne, 1990: Annor *et al*., 2012). (Table 2.2) shows a list of Guinea fowl species in taxonomic order.

Table 2.2: list of guinea fowl species in taxonomic order

Genus	Species	Description
Agelastes	Agelastes meleagrides Agelastes niger	White breasted guinea fowl Black breasted guinea fowl
Numida	Numida meleagris	Helmeted guinea fowl
Guttera	Guttera plumefera	Plumed guinea fowl
	Guttera pucherani	Crested guinea fowl
Acryillium	Acryillium vulturinum	Vulturine guinea fowl

Source: Annor *et al*.(2012)

According to Biswas (1999), Guinea fowls are described as gallinaceous birds native to Africa. He further stated that the domesticated species is the helmet Guinea fowl (*Numida meleagris)*, which the European Economic Community marketing regulations require its scientific name to bear the suffix "domesticus" in common with the other domestic poultry. Guinea fowls appear to have been domesticated for almost as long as the chicken and they were reared by the ancient Greeks and Romans (Parkhurst and Mountney, 1998*)*.Although the Romans bred the Guinea fowls, their African origin was acknowledged (Payne, 1999).

2.4 Species and Breeds of Guinea fowl

The most numerous and widely distributed species is the helmeted Guinea fowl *Numida meleagris* (Biswas, 1999). There are three well-known types of helmeted Guinea fowl, namely, pearl (plate 2.3), lavender (plate 2.4) and the white (plate 2.5) (Annor *et al*., 2012; Payne, 1990). The pearl is the most abundant and it possesses a purplish-grey plumage dotted or 'pearled' with white. It is also characterized by shanks of slate grey colour and more or less dark grey-blue plumage with many rounded small white spots. The lavender type has paled purple colour with black shanks, pink slate or mixture of pink and black shanks. The white type has the ordinary white colour with pink shanks or slate shanks and white or pink wattles (Payne, 1990; Koney, 1993; Annor *et al*., 2012).

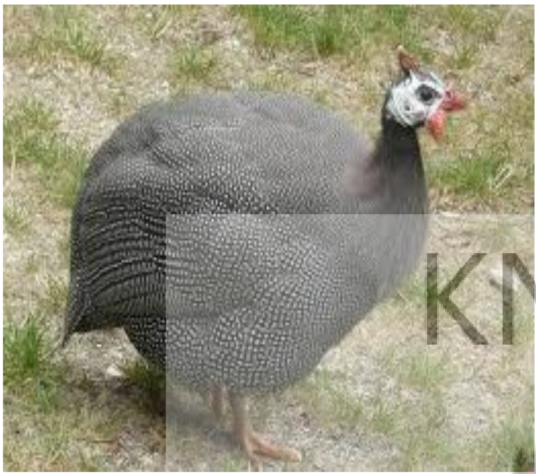

Plate 2.3 Pearl guinea fowl

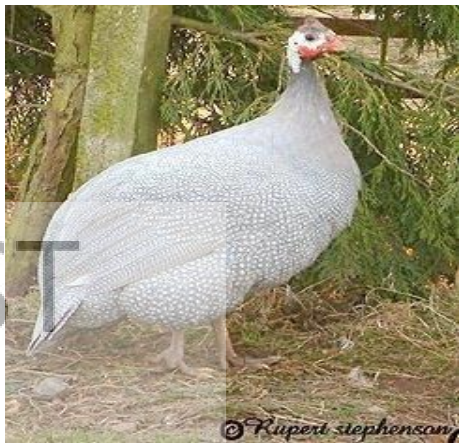

Plate 2.4 Lavender guinea fowl

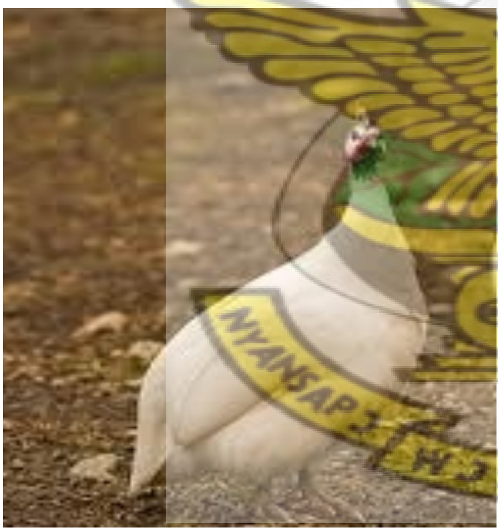

Plate 2.5White guinea fowl

Wild Guinea fowls are, however, still numerous in some regions of Africa (Payne, 1990). According to Adam (1997), the wild Guinea fowl is normally bigger than the domesticated one. It usually has black feet, mostly pearl colour and a flat comb while the domestic one has feet and feathers of varied colours and has pointed or raised comb or helmet. There are also exotic breeds called “industrial” broilers or layers being imported into the country from the Western countries such as France and Belgium. These exotic breeds are fast growing and heavier and lay more eggs that are bigger than the local breeds (Biswas, 1999). A study of colour inheritance has made sex linked day-old selection possible (Biswas, 1999).

2.5 Constraints of Guinea Fowl Production in Ghana

2.5.1 Breeding (Stock acquisition)

The seasonality of breeding has been recognized as one of the major drawbacks to large-scale guinea fowl production (Oguntona, 1983; Ayorinde and Okaeme, 1984; Ayorinde, 1990; Naazie, 2007). Under the traditional system, breeding stocks are obtained from the farmers own stocks thus, fertile eggs are not available for year round production.

2.5.2 Availability of feed

Scavenging is the main feeding system under free-range Guinea fowl production in rural areas where the birds feed mainly on insects, leaves, grass seeds, tubers and sedges (Adam, 1997; Biswas, 1999), with ground millet, guinea corn and maize as supplements provided by their owners. These feed resources are quite abundant during the rainy season but are scarce during the dry season. According to Kusina and Kusina (1999), feed supply is one of the main constraints to rural poultry production in Zimbabwe. Guinea fowls have a unique ability to utilize a wide range of flora and fauna as feed resource base. They consume non-conventional feeds that are not used in chicken feeding (Bonds, 1997). Therefore, the Guinea fowl has a competitive advantage over chicken as a ranging bird (Saina, 2005). In addition, Guinea fowls digest nitrogen-free-extract and lignin components of feed better than the chicken but have a disadvantage of poor utilization of crude protein (Nwagu and Alawa, 1995).

2.5.3 Growth traits

Indigenous Guinea fowl breeds generally have slow growth rate and utilize feed less efficiently than chickens (Olomu, 1983; Annor *et al*., 2012). The slow growth rate of Guinea fowls is associated with the use of unimproved breeds, extensive production system, poor feeding poor health care and management and selection (Nwagu and Alawa, 1995; Sales and Du Prezz, 1997; Annor *et al*., 2012). Koney (1993) also indicated that the unimproved Guinea fowl has slow growth rate and that broilers grow faster than the local Guinea fowl. Guinea fowls reared under the intensive management system have superior production performance than those reared under the semi-extensive management system (Saina, 2005).

2.5.4 Research (Genetic improvement)

Interest in Guinea fowl as alternative poultry has facilitated the quest for the identification of genes of economic importance in this poultry species. A lot of work has been carried out on the Guinea fowl and breeders have achieved excellent improvement of stock (Biswas, 1999). In France, Italy and India where considerable amounts of work have been done to improve performance, Guinea fowl production has become commercially viable (Nwagu and Alawa, 1995). Petit-Jean (1970) reported the results of selection that increased weight gain by 40 – 50% per year, improved egg weight by 3 – 4g and raised fertility to 82 – 98%. Adam (1997) also reported that the keets and eggs that were imported from France and Belgium to the Poultry section of the Pong-Tamale Animal Production Unit were from exotic breeds which were fast growing and bigger, weighing between 1.8kg and 2.0kg at 20 weeks of age. The exotic Guinea fowls have been used for cross breeding to improve the local breeds for both eggs and meat quality. There are also cross breeds between the exotic and the indigenous pearl which have improved fertility (Nwagu *et al.*, 1997).

Table 2.3: Feed intake of commercial guinea fowl breeders

Age (weeks)	Feed intake g/day	cumulative (g)
	Starting period	
1	15	15
2	20	35
3	24	59
	Grower *I*	
4	28	87
5	35	122
6	43	165
7	50	215
8	55	270
	Grower *II*	
9	60	330
10	64	394
11	68	462
12	70	532
13	70	602
14	72	674
15	72	746
16	74	820
17	74	894
18	76	970
19	76	1046
20	78	1124
21	80	1204
22	80	1284
23	82	1366
24	82	1448
25	85	1533
26	90	1618

Source: Annor *et al*. (2012)

2.6 Nutrient requirements of Guinea fowls

Many studies have been carried out on the nutritional requirements of the Guinea fowl. A crude protein level of 24 %with an energy level of 3000kcal/kg for a starter with a gradual reduction in these levels in the second month is recommended (Raokari *et al.*, 1977; Biswas, 1999). Ayeni *et al.* (1983) also recommended a 9.16% crude protein diet supplemented with insects to achieve optimal commercial performance at minimal cost.

Guinea fowls have the highest protein requirements between 5 and 10 weeks of age. Protein requirements of females are lower than those of males up to 10 weeks of age after which the situation is reversed with energy requirements from 10 weeks of age also higher for females than males (Sales and Du Prezz, 1997).

Biswas (1999) and Ikani and Dafwang (2004) observed that in their natural environment in Africa, insects, grass seeds and tubers form the Guinea fowl feed, but if fed supplements such as ground maize, guinea corn, millet with chopped scraps of cooked meat or fish meal or when termites are used as supplements they grow faster (Koney, 1993; Adam, 1997).In Nigeria, Cyprus bulbs have been used to replace as much as 20%, 25%, 30%, 50% and 70% maize in starter, grower, and finisher adult male and adult female breeder diets, respectively (Ayorinde *et al.*, 1986). Guinea fowls have a unique ability to utilize a wide range of flora and fauna as feed resource base. Saina (2005) observed that there is a potential to increase Guinea fowl meat and egg production through improvements of some indigenous practices in extensive production systems. This potential is closely linked to an appropriate use of the locally available feed resources.

According to Ayeni (1983) and Ikani and Dafwang (2004), Guinea fowls have been reported to have similar gastrointestinal tract as the domestic fowl and their requirements in many nutrients are similar. This is in accordance with Koney (1993) who asserted that the nutritional requirements of feed for Guinea fowls are similar to those of chickens, but both Koney (1993) and Biswas (1999) indicated that the percentages for lysine, cystine and methionine are higher for the Guinea fowl than the chicken for fast growth with a crude protein percentage of 24% for the first four weeks. Mandal *et al*. (1999) reported that the requirements for metabolizable energy (ME) for Guinea fowl vary between11.30 and 12.13 MJ/kg DM during the 0 to 4 and 5 to 12 weeks of age, respectively with 220, 200 and 160 gCP/kg DM during 0 to 4, 5 to 8 and 9 to 12 weeks age, respectively.

Formulated rations for Guinea fowls are available from commercial feed millers in developed countries such as Australia, France and Italy (Galor, 1985; Embury, 2001). The starter ration should contain 240g CP/kg DM and should be given to keets for the first four weeks of age while growers' ration of 200 g/kg CP/kg DM should be used until eight weeks of age and finisher ration of 160 g/kg DM should be given until marketing (Embury, 2001). Galor (1983) also indicated that Guinea fowl breeders and layers are given 170g CP/kg DM diet with ME value of 2750 kcal/kg from 29 weeks of age to 40 weeks; after which the protein needs is reduced to 165 g/CP/kg DM in the diet for optimum production. According to Tadelle (1996), supplementing about 50% of the dietary needs of scavenging village poultry can improve productivity by a factor of three.

Galor (1983) reported that from day one to 25 weeks of age, the quantity of feed used under controlled feeding ranges between 9.75kg and 10kg per cock or 11.5kg and 12kg per served Guinea fowl hen. A laying Guinea fowl hen requires 110g of feed per day from 32 weeks of age to maximize egg production (Galor, 1983). Table 2.2 and 2.3 indicate the nutrient requirements of broiler and layer Guinea fowls as cited by Ikani and Dafwang (2004).It is therefore important that in the formulation of Guinea fowl ration, attention should be paid to a balanced ration that meets their nutritional requirements.

Table 2.4: Feed and feeding requirements for broiler Guinea fowl

Age (weeks)	Protein (%)	Energy values kcal/kg	Amount of feed needed per day (g)	Lysine	Methionine	Methionine + cystine	Ca	P
0 – 5	25.5	3200	25.30	1.38	0.55	1.00	1.00	0.39
5 – 8	20	3100	50 – 60	0.99	0.42	0.88	0.90	0.35
8 – 12	18	3100	70 – 80	0.79	0.33	0.66	0.80	0.33

Source: Tewe (1983) as cited by Ikani and Dafwang (2004).

Table 2. 5: Nutrient levels for breeders

Age (weeks)	Protein (%)	Energy values kcal/kg	Amount of feed needed per day (g)	Lysine	Methionine + cystine	Ca	P
1 – 6	22	3000	25 – 27	1.20	0.81	0.70	0.40
6 – 28	14.0	2800	55 – 60	0.65	0.59	0.60	0.35
Breeder	17 – 18	2800	70 – 80	0.90	0.59	2.70	0.55

Source: Offiong (1983) as cited by Ikani and Dafwang (2004).

2.7 Feed resources available for feeding poultry in Ghana

The use of conventional feed ingredients such as maize, wheat, sorghum, fish, soya bean and groundnut in feeding animals over the years has not only led to high cost of production but also increased competition over these foodstuffs between man and animals most especially poultry. Parkhurst and Mountney (1998) reported that feeding constitutes about 50 – 70% of the cost of poultry production. As a result, scientists have continued to search for non-conventional feed ingredients and agro-industrial by-products as an alternative in feeding animals to promote efficiency, at a lesser cost thereby, increasing profitability with no or minimal side effects. It is therefore important that the cheapest available feed ingredients are used in the formulation of animal diets particularly poultry.

2.7.1 Use of cassava in animal feed

Cassava (*Manihot esculenta*) is an all season crop which is produced in abundance in many humid tropic areas and ranks among the top ten food crops in the world which has a high production potential and can adapt to different types of soils (Muller *et al*., 1975; Stevenson and Jackson, 1983; Kirchgessner, 1985).Cassava tuber is primarily a source of carbohydrate and can completely replace maize as an energy source in feeds for cattle, pigs and poultry (McDonald *et al.*, 2002). While the use of cassava for livestock feeding has been advocated by many researchers, both its chemical and nutritional factors may affect the use of cassava meal in animal feeds and therefore, its nutritional characteristics requires a careful treatment and balancing for nutrients in which it is deficient, in order to ensure the satisfactory performance of livestock and cost-effectiveness.

Cassava tuber, which is essentially an energy source (2360 kcal/kg), contains very little protein (1-2.4%) which is of poor quality (Smith, 1990; FAO, 1994).It is cheaper than maize, sorghum etc. in the Northern region of Ghana where Guinea fowls are largely produced. However, both chemical and nutritional factors may affect the use of cassava meal (konkonte) in animal feeds. One important set back with the use of cassava is the presence of high levels of linamarin and lotaustralin (Gomez *et al.*, 1984). Linamarin is a cyanogenic glucoside which releases highly toxic hydrogen cyanide (HCN) during hydrolysis at the time of digestion (Stevenson and Jackson, 1983; Preston, 1987; McDonald *et al.*, 2002).It is therefore, safer to process cassava products using processing methods such as cooking, sun drying, oven drying, roasting and ensiling or fermentation to reduce the hydrogen cyanide contents before they are incorporated in diets (Mahunugu *et al.*, 1987;Dafwang *et al.*, 1986; Udedibie *et al.*, 1988; Fanimo *et al.*, 1998; Dongmo *et al.*, 2000).

In smaller doses, cyanide is detoxified to thiocyanate, a goitrogen, by means of the enzyme -rhodanase, making use of the methionine as the sulfur donor and therefore, this amino acid becomes a limiting factor in cassava feeds (McDonald *et al*., 2002).

Nevertheless, processed cassava and its by-products can be safely and profitably used in the feeding of monogastric animals. In order to reduce the hydrogen cyanide content (HCN) the various processing methods such as cooking, sun drying, oven drying, roasting, ensiling or fermentation should be carefully considered. This will eventually result in a reduction in feeding cost.

The use of cassava meal in animal diets will require the supplementation with a cheaper protein source such as blood so as to make up for the low protein content of cassava meal.

2.7.2 Use of blood in animal diets

There is a continuous effort in finding replacement for the more expensive protein concentrates mainly fish meal in poultry diets with cheaper feed resources (Dafwang *et al*., 1986; Udedibie *et al*., 1988; Fanimo *et al*., 1998; Dongmo *et al*., 2000). This will eventually result in a reduction in feeding cost and consequently cost of producing a unit of the animal products.

Blood meal is a by-product of the animal slaughtering industry and is used as a protein source in the diet of both non-ruminants and ruminants. The quality of blood meal protein is affected by methods of preparation (McDonald *et al*., 1992) hence; variations in the quality of products from different animal processing plants exist. Blood meal has high protein content and a good amino acid profile (NRC, 1994) which makes it a potential replacement for soya bean meal and fish meal. Blood meal has a crude protein content of 800 g/kg (80%) and small amounts of ash and fat (McDonald *et al.*, 2002). It is important nutritionally as a source of lysine, arginine, methionine, cystine, and leucine but is very poor in isoleucine, and contains less glycine than fish meal, meat meal or bone meal (NRC, 1994; Pond *et al.*, 1995). Therefore, blood meal can compensate for the lysine and methionine deficiencies in plant protein based diets (McDonald *et al*., 1992). Blood meal is also used as by-pass protein ingredient in ruminant diets (Kamalak *et al.,* 2005; Taylor, 2005*).*

Work has been done on the use of non-conventional feeds such as cassava flour meal, cassava peel meal, cassava and blood meal, blood and maize cob meal etc on broiler, layer chickens and pigs which gave good results. According to Donkoh *et al.* (2003), the use of a blend of blood and ground maize cob (BLOMC) as replacement for wheat bran in broiler diet at 30, 60, 90 and 120g BLOMCkg^{-1} levels has shown improved growth performance, reduced feed cost and subsequently increased profit.

Dei *et al.* (2005) conducted a study which showed that cassava flour could be fortified with blood, a slaughter house by-product to improve the protein content and quality of the product labelled "processed product from cassava and blood" (PPCB) .The blood which is normally discarded is extremely high in crude protein (80%) and one of the richest sources of lysine. McDonald *et al.* (2002) indicated that lysine is regarded as the first limiting essential amino acid in poultry diets. Dei *et al.* (2005) indicated that preliminary studies on the nutritive value of the PPCB for broiler chickens had shown favourable results. Thus, this could serve as substitute for maize in concentrate-based broiler grower diet or replace both maize and fishmeal in broiler grower diet (Dei *et al.*, 2005) or both ingredients in a combined broiler starter-grower diet (Dei *et al.*, 2002). Dei *et al.* (2005) concluded that the use of PPCB could reduce dependency on conventional feed ingredients and lead to reduced feed cost and increased profits.

Dei *et al.*, (2007) again used PPCB on layers (21-36 weeks of age) and reported improved marginal profit on egg production but added that the rate of substitutions should be reassessed to enhance egg production. Blaha *et al.*, (1993) have found that 35% replacement of maize by cassava root meal maintained the birds at equal production efficiency however, 50% replacement slightly reduced the birds weight and worsened the feed conversion ratio while 75-100% replacement reduced production efficiency.

The use of agro-industrial by-products in animal feeding systems have generally shown positive results. In a 20 - week feeding trial by Donkoh and Zanu (2010), the inclusion of such agro-industrial by-products as wheat bran, rice bran, maize bran, brewers' spent grains and cocoa pod husk in laying chicken diets confer considerable economic advantage by reducing feed cost and increasing net revenue without sacrificing performance.

Table 2.6 Amino acid profile of blood meal

Amino acid	Percentage in blood/%	Amino acid	Percentage in blood/%
Tryptophan	1.00	Alanine	7.69
Lysine	7.00	Valine	5.20
Histidine	3.05	Methionine	1.00
Ammonia	1.13	Isoleucine	8.00
Arginine	2.35	Leucine	10.00
Aspartic acid	10.84	Tyrosine	2.34
Theonine	3.80	Phenylalanine	5.10
Serine	4.56	Taurine	-
Glutamic acid	8.79	Cystine	1.40
Glycine	4.40	Proline	4.62
Hydroxyproline	-	Glucosamine	-

Source: www.Johnrothandsons.com/bloodspecs.htm

2.8 Inferences from the Literature Review

The Guinea fowl (*Numida meleagris*) compares favourably in terms of egg and meat production, with the domestic fowl (Blum *et al.*, 1975). Within the poultry sub-sector, the Guinea fowl plays such important roles as ready sources of income, food, sacrifices, marriage and funeral rites among others (Karbo *et al.*, 2002).Unfortunately, the domestic Guinea fowl has been neglected for a long time in Africa where it originated from as far as nutritional, management and production studies are concerned (Awotwi, 1975).

Karbo *et al.,* (2002) observed that producers of Guinea fowls particularly in the Northern, Upper East and West Regions where most Guinea fowls are produced, have been plagued with high keet losses and poor nutrition. The causes of high keet losses have been attributed to poor brooding management of keets. Unfortunately, the majority of the Guinea fowl producers are the poor local farmers who cannot afford the expensive conventional feed ingredients. This trend poses a major threat to food security and the livelihood system of many families in the Guinea fowl rearing areas if the situation is not remedied.

This calls for the need to identify and develop cheaper alternative ways of feeding the Guinea fowls for at least during the brooding period using locally available non-conventional feed ingredients in order to reduce mortalities, maximize profits with no or minimal side effects and eventually improve the standard of living of local farmers. Thus, the use of cheaper feed ingredients will help reduce the cost of production and increase profitability of rural farmers. Feed cost alone constitutes about 50 – 70% of the poultry production cost (Parkhurst and Mountney, 1998). It is therefore, important that the cheapest available feed ingredients are used in the formulation of poultry diets (Dei *et al.*, 2007).

Further studies are, however, required to ascertain the suitable methods of processing blood and cassava meal to ensure minimal nutrient loss and contaminations and also determine the levels of optimum inclusion of the product (BBLOCAM) in Guinea fowl diets in particular and poultry in general.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Location and duration of the experiment

An eighteen-week study was carried out at the Poultry Section of the Animal Science Department of the Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana. The area lies within latitude 06°43'N and longitude 01°36'W in the forest zone of Ghana. The environmental temperature generally fluctuates between 21°C and 34°C. High temperatures occur during the months of November to April with average maximum temperatures occurring in February and March while the lowest are experienced in July. Rainfall in the area is basically bimodal with an annual mean of 1500mm. The rainy season covers April to June and September to October. A short dry season separates the two periods in August. The major dry season (harmattan) lasts from November to February (Tuah *et al.*, 1990).

3.2 The experimental birds and management

A total of 285 five-week old local breed of the helmeted Guinea fowl, with a mean weight of 85.2 g, was purchased from the Poultry Section of the Pong-Tamale Animal Production Department in the Northern Region of Ghana and used for the 18 – week experiment. All the birds were raised in a deep litter house with a concrete floor. Plates 3.1 and 3.2 show nine-week old Guinea fowls in the deep litter house during the experimental period. The pens were partitioned into replicates with wire mesh. The two hundred and eighty-five 5-week old keets were allocated to one of the five treatments in a Completely Randomised Design (CRD). In all, there were 15 replicates with a floor spacing of 2.84m x

1.63mand1.83m each in length, breadth and height, respectively. The keets had free access to their respective diets for the 18-week period and water was available *adlibitum*.

Plate 3.1 Nine-week old guinea fowls

Plate 3.2 Nine-week old guinea fowls

3.3 Sources of blood and cassava flour

The fresh blood (bovine blood) used in the study was obtained from the Kumasi Abattoir as a by- product of the slaughtering activities and kept in clean plastic containers. The sun-dried cassava was obtained from Salaga market in the Northern Region. The dried cassava was milled in a hammer mill. Hot water (100°C), cassava flour and the blood was then mixed on weight basis in the ratios of 2:2:0.5, 3:3:1, 2:2:1, and 1:1:1 for dietary ingredients II, III, IV and V, respectively, heated and stirred regularly for 10 minutes, taken off from the fire, allowed to cool, after which it was moulded into boluses and sun dried for a week. The products were then designated as “Bovine blood blended with cassava” (BBLOCAM) II III, IV, V (Table 3.1) and stored in sacs until used for formulating the various experimental diets.

Table 3.1: Proportions of water, cassava and blood for the four types of BBLOCAM (II, III, IV and V)

BBLOCAM	Proportions of water, cassava and blood
II	100 units water: 100 units cassava flour: 25 units blood
III	100 units water: 100 units cassava flour 33:33 units blood
IV	100 units water: 100 units cassava flour: 50 units blood
V	100 units water: 100 units cassava flour: 100 units blood.

3.4 Dietary treatments

Five experimental diets based on maize, fishmeal, soyabean meal, wheat bran and BBLOCAM, were formulated (Table 3.2). The control diet, designated as dietary treatment I, contained none of the BBLOCAM. The other four diets, designated as dietary treatment II, III, IV and V contained a fixed amount of 100g/kg each of the various types of BBLOCAM to replace part of the maize portion in the control diet.

Table 3.2 Composition of diets fed to Guinea fowls

Ingredients(gkg^{-1}diet)	T1	T2	T3	T4	T5
BBLOCAM	0	100	100	100	100
Maize	590	490	490	490	490
Wheat bran	60	60	60	60	60
Fish meal	190	190	190	190	190
Soya bean meal	150	150	150	150	150
Dicalcium phosphate	2.5	2.5	2.5	2.5	2.5
Oyster shell	2.5	2.5	2.5	2.5	2.5
Salt(NaCl)	2.5	2.5	2.5	2.5	2.5
Vitamin premix	2.5	2.5	2.5	2.5	2.5
Total	1000	1000	1000	1000	1000

3.5 Chemical analysis

Samples of the five experimental diets prepared and the four types of BBLOCAM (II, III, IV and V) were analyzed for dry matter (DM), crude protein (CP), ether extract (EE) and crude fibre (CF) according to the Association of Official Analytical Chemists (1990) standard methods. Calcium and phosphorus analysis followed the procedure of Fick *et al.* (1979).

Table 3.3: Chemical composition of experimental diets

Nutrient	Treatments				
	T1 (control)	T2	T3	T4	T5
Moisture %	13.75	13.78	13.78	13.83	13.76
Crude protein (CP) %	24.00	22.00	22.00	23.00	24.00
Ether extract (EE) %	4.00	4.10	3.90	3.65	3.75
Crude fibre (CF) %	2.26	2.14	2.14	2.20	2.14
Calcium (Ca) %	0.60	0.60	0.61	0.60	0.61
Phosphorus %	0.45	0.41	0.42	0.55	0.48
Ash %	5.5	2.00	2.00	3.50	2.50
Nitrogen free extract (NFE)	52.85	57.89	57.93	56.49	56.38
Metabolizable energy (ME) (Kcal/kg)	3,026.25	3152.70	33142.70	33075.95	3118.40

3.6 Parameters measured

Guinea fowls were individually weighed and feed consumption per replicate of each dietary treatment was recorded weekly. Feed: gain (feed conversion efficiency) was determined weekly for individual replicates of each dietary treatment. Records of mortality were also kept.

All dead Guinea fowls were sent to the Veterinary Laboratory of the Department of Animal Science, KNUST, for post-mortem examination so as to establish the cause of death.

At 23 weeks of age,4 Guinea fowls from each 15 replicates were selected at random, starved of feed for 18 hours to empty their crops, killed by cutting the jugular vein, exsanguinated, defeathered and eviscerated. Carcass yield was calculated from eviscerated weight and live weight. The heart, liver, gizzard and intestine were excised, weighed immediately and expressed as kg^{-1} body weight. The heart, liver, gizzard and intestine were examined to determine whether the diets had resulted in any gross pathological changes.

3.7 Blood collection and assays

To avoid a macrocytic hypochromic anaemia (Christie, 1978) caused by repeated bleeding, the Guinea fowls were bled only after100 days of the study between 09.00 and 11.00h. The Guinea fowls were fasted for 18h prior to collection of blood samples to avoid post-prandial lipenia (Kirk *et al*., 1990). Various blood parameters studied included: red blood cell count (RBC), haemoglobin, Haematocrits (packed cell volume, PCV), blood protein, albumin and globulin concentrations, total cholesterol, high density lipoproteins, and low density lipoproteins.

The series of blood tests were performed on blood drawn from the brachial vein. Blood samples for the haematological tests were mixed with the dipotassium salt of EDTA (1.5 mg/ml blood) as anticoagulant. Two separate counts were made for each blood sample and the mean of the two counts calculated. The haematological parameters were determined in duplicate by the use of a Mindray Auto Haematology Analysis (Shenzhen, China) while the total plasma protein was determined in duplicate by the Biuret method outlined by

Kohn and Allen (1995). The albumin content of blood was determined by the procedure of Peter *et al*. (1982). The globulin concentration was estimated as the difference between total protein and albumin concentration whilst the albumin/globulin ratio was calculated by dividing the albumin value by the estimated globulin value.

Blood samples for serum cholesterol were allowed to clot to obtain serum and analysis in duplicate for total cholesterol by the procedure outlined by Varley (1963).

3.8 Statistical analysis

The dietary treatment effects for all the variables measured were statistically analysed using the Analysis of Variance Technique. SAS (2003).

Before analysis, all percentages were subjected to logarithm transformation ($\log_{10}^{X+1}$) to normalise data distribution. The differences among means were determined by the use of the Duncan's multiple range tests (Steel *et al*., 1997)

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Nutrient composition of BBLOCAM

The proximate composition of the four types of BBLOCAM compared to other energy sources are shown in Table4.1. The various bovine blood blended with cassava (BBLOCAM; II, III, IV and V) had the lowest dry matter percentage compared to the values reported by Onifade and Tewe (1993) and Akinfala *et al.* (2002). The blend or product designated as BBLOCAM V, registered the highest crude protein content compared to maize meal and cassava root meal.

Cassava root meal compared with the four types of BBLOCAM and maize contained the highest NFE among other energy sources. The ether extract content of maize is higher than that of the four types of BBLOCAM and the cassava root meal. Cassava root meal had the lowest ether extract content.

Compared to maize and cassava root meal, all the four types of BBLOCAM were the lowest in crude fibre content. The calcium levels obtained for the four types of BBLOCAM ranged from 0.60 to 0.72% while the phosphorus content ranged from 0.09 to 0.22%, the highest being for BBLOCAM V.

Nevertheless, the results of this study have shown that, the BBLOCAMs particularly BBLOCAM IV could appropriately serve as a cheaper substitute for maize in poultry production, particularly Guinea fowls.

Table 4.1: Chemical composition of the four types of BBLOCAM; maize and cassava root meal.

Parameter	BLOCAM II	BLOCAM III	BLOCAM IV	BLOCAM V	Maize	Cassava Root Meal
DM	86.00	86.00	85.50	86.25	90.75	90.32
CP	7.15	8.70	10.23	21.03	9.89	2.25
EE	0.55	1.00	1.45	1.80	2.43	0.85
CF	1.06	1.06	1.57	1.03	3.86	3.40
Ash	1.40	1.35	1.50	1.80	1.53	1.35
NFE	86.72	87.26	86.48	77.53	82.29	92.15
Calcium	0.64	0.68	0.60	0.72	-	-
Phosphorus	0.09	0.11	0.09	0.22	-	-

Source: Onifade and Tewe, (1993).

4.2 Estimated cost of producing 100 kg of BBLOCAM

The blood and cassava flour are of greater interest in terms of cost and availability as raw materials in the manufacture of BBLOCAM. The cost of 100kg dried BBLOCAM was estimated to be GH¢19.90, 14.41, 13.92 and 13.47, respectively for BBLOCAMs II, III, IV and V, taking into account the raw materials used and operating cost. The costs of producing 100kg of BBLOCAMs were lower for BBLOCAMs II, III, IV and V as compared to the current market price of maize which was GH¢54.00/100 kg bag at the time of the study, indicating a price difference of GH¢34.10, 39.59, 40.08 and 40.53or 63.15%, 73.32%, 74.22% and 75.06% respectively. The bovine blood and cassava flour together contributed, on an average, very high GH¢15.43 or 88.17% to the overall cost of 100kg BBLOCAM. The cost assigned to the blood is actually handling charges or labour cost paid to the abattoir workers who helped in collecting the fresh blood while operating cost include milling, transportation cost and cost of labour.

4.3 Growth performance

The growth performance of the experimental Guinea fowls is presented in Table 4.2.

Table 4.2Growth performance and organ weight of Guinea fowls fed the experimental diet over the period from 5 to 23 weeks of age

	Dietary treatment						
Response criteria	T_1 (control)	T_2	T_3	T_4	T_5	LSD	SIG
Initial body weight, kg	0.088	0.082	0.085	0.086	0.085	0.006	ns
Final body weight, kg	1.085	1.040	1.067	1.050	1.028	0.060	ns
Body weight gain, kg	0.997	0.958	0.982	0.964	0.943	0.060	ns
Feed intake, kg	5.38	5.50	5.48	5.46	5.39	0.386	ns
Feed conversion ratio, kg feed/kg gain	5.40	5.74	5.58	5.66	5.71	0.45	ns
Weight of carcass organs (% of LBW)							
Carcass	84.2^{ab}	83.6^{ab}	81.6^{b}	82.9^{b}	86.8^{a}	3.57	*
Gastro intestinal tract	2.04	2.38	2.30	2.52	2.51	0.507	ns
Liver	1.33	1.52	1.51	1.63	1.52	0.281	ns
Gizzard	1.49	1.52	1.49	1.55	1.54	0.510	ns
Cost kg^{-1} feed (GH₵)	0.70	0.66	0.65	0.64	0.63	-	-
Feed cost kg^{-1} weight gain (GH₵)	3.78	3.79	3.63	3.62	3.60	-	-
Price/ live bird (GH₵)	9.00	9.00	9.00	9.00	9.00	-	-
Profit/bird (GH₵)	5.26	5.37	5.40	5.42	5.47	-	-

*- significance ($p<0.05$), ns – non-significance ($p>0.05$).

4.3.1 Feed intake

Average feed consumption per bird for the 18-week period ranged from 5.38kg to 5.50kg (Table 4.2). Feed intake by the Guinea fowls was not significantly ($p>0.05$) influenced by the various BBLOCAM in diets. Similar results were obtained by Mettle (2009) with pigs. However, significantly ($p<0.05$) higher feed intake was recorded by Onyimonyi and Ugwu (2007) when a diet containing a mixture of blood and cassava peel compared to maize-soyabean based diets were fed to broiler chicks. Dei *et al*. (2007) also reported lower feed intake values when a processed product from cassava and blood was fed to layer chicken.

4.3.2 Body Weight Changes and Efficiency of Feed Utilisation

There was little difference ($p>0.05$) in average Guinea fowl weight at the start of the feeding trial (Table 4.2). In general, the inclusion of the various BBLOCAM in diets did not have any significant ($p>0.05$) impact on body weight gains of the Guinea fowls (Table 4.2). Similar to the values obtained in the present study, Adeyemo *et al*. (2006) recorded weight gain values of 996.08, 968.08, 961.20 and 941.20 g for Guinea fowl growers fed diets containing varying amounts of a mixture of cassava and blood meals from a period of 7 to 20 weeks of age.

The efficiency with which feed was converted to gain (feed: gain ratios) showed no difference ($p>0.05$) (Table4.2) that could be attributed to the inclusion of the various BBLOCAM in diets compared with Guinea fowls fed the BBLOCAM-free diet (control). Generally, the efficiency of feed conversion values of the local Guinea fowls used in the present study were poor compared to values for broiler chickens and improved broiler Guinea fowls(ISA ESSOR) as reported by Teye *et al*.,(2001) . This is in agreement with the observation of Olomu (1983) and Mareko *et al*., (2006) who reported that local Guinea fowls grow slowly and utilise feed less efficiently compared to broiler chickens and improved breeds of Guinea fowls.

It can therefore be inferred from the poor efficiency of feed utilisation and its subsequent slow growth that, there is the need for intensive selection and improvement in the genetic make-up of the local Guinea fowl and also the identification of other factors which influence growth performance, such as nutrition, to be able to tap the full potential of Guinea fowl as a rapid source of animal protein.

4.4 General health and mortality

Generally, the birds in the various treatment groups maintained good health during the course of the study and the mortality figures were also relatively low. Post-mortem autopsies indicated that the mortalities were not due to the inclusion of BBLOCAM in the diets of the Guinea fowls. A total of 15 mortality cases were recorded during the experimental period. The mortality values in this work were variable and did not follow any particular trend that could be attributed to the inclusion of BBLOCAM. Out of the 15 deaths, five (33.3%) occurred among birds fed the control diet (T1) which was devoid of any of the four BBLOCAMs, four (26.7%) occurred among birds fed BBLOCAM V, three (20%) occurred among birds fed BBLOCAM III and two (13.3%) occurred among birds fed the BBLOCAM II, with no deaths in BBLOCAM IV. This observation is in agreement with that obtained by Donkoh *et al.* (2003) who recorded the highest mortality (8.33%) among broilers fed on a control diet as against those fed on a blend of blood and ground maize cob (BLOMC). Dei *et al.* (2007) also recorded mortality of 8.3%on only layers fed on diets devoid of a processed product from cassava and blood (PPCB).

4.5 Carcass Yield and Organ Weights

Average carcass yield of Guinea fowls on the diets containing the various types of BBLOCAM ranged from 81.6% to 86.8%. In general, the carcass yields of the experimental Guinea fowls were generally high (up to 86.8%) compared with that reported for chickens (about 65%). Koney (1993) attributed the high carcass yields of Guinea fowls to the slenderness of the skeleton of Guinea fowls. Mareko *et al.* (2006) also recorded 94.4% and 93.59% dressing out percentage and dress weights of 949 g and 1081 g for 14-week- old Guinea fowls raised on concrete and earth floors, respectively.

The lower gizzard and intestinal weights for Guinea fowls fed on diets containing the various types of BBLOCAM were, however, not significantly different from those fed the control diet.

At the termination of 18 week study, examination of several organs (spleen, liver, heart, gizzard and intestine) obtained from all sacrificed birds revealed no macroscopic deviation from the normal in terms of gross tissue changes.

4.6 Economics of Production

From Table 4.2, it was more economical to use BBLOCAM in Guinea fowl diets and reduce maize use. The cost per kg of feed reduced with the inclusion of the four types of BBLOCAM. For example, feed cost was reduced by about GH¢70.00 per tonne when BBLOCAM IV was incorporated in dietary treatment T5. This was primarily due to the reduction in maize use; which price was almost two times the price of BBLOCAM IV at the time of the study.

The cost of feed to produce a kg body weight also reduced when the four types of BBLOCAM were included in the Guinea fowl diets compared to the control diet devoid of BBLOCAM. Consequently, profit per bird increased with the inclusion of the four types of BBLOCAM. The highest profit was obtained with Guinea fowls on BBLOCAM IV-containing diet (dietary treatment 5). The observation is similar to that of Donkoh *et al.,* (2003) who fed broiler chickens with diets which contained a blend of corn cob and blood (BLOMC) and reported that the highest profit was obtain with birds on the 120 g BLOMC kg^{-1}diet. Similar findings were reported by Dei *et al*. (2007) who fed layer chickens with processed products from cassava and blood (PPCB) with a resultant reduced total feed cost and improved margin of profit on egg production. Feed accounts for up to

80 % of the cost in production of poultry in Ghana. It is essential therefore that the dietary BBLOCAM level that will optimise profit be used in feed formulations for Guinea fowls.

4.7 Blood Cellular and Biochemical Indices

The effects of the various dietary treatments on blood components of Guinea fowls are represented in Table 4.3.

Table 4.3 Effects of four types of bovine blood blended with cassava on blood components of Guinea Fowls determined at 18 weeks of age

	Dietary Treatments						
Response criteria	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**LSD**	**SIG**
Red blood cell count ($x10^{12}$/l)	2.32	2.22	2.33	2.28	2.40	0.32	ns
Haemoglobin (g/dl)	13.24	12.64	12.77	12.91	12.46	0.96	ns
Haematocrits, PCV (%)	33.61	33.10	34.28	34.83	35.80	3.99	ns
White blood cell count (x 10^9/l)	2.70	2.67	2.67	2.67	2.65	0.64	ns
Mean corpuscular haemoglobin (MCHb, picograms)	57.02	57.05	55.11	55.15	51.86	6.11	ns
Mean corpuscular haemoglobin concentration (MCHE, g/dl)	39.77	38.50	37.67	37.21	34.81	3.98	*
Mean corpuscular volume (MCV, fl)	143.56	147.87	146.33	147.60	148.79	3.34	*
Total protein (g/l)	67.30	62.20	68.20	70.09	68.60	10.16	ns
Albumin (g/l)	31.03	29.08	30.17	33.24	32.24	4.81	ns
Globulin (g/l)	36.29	32.99	37.97	37.60	36.45	5.77	ns
Albumin/globulin ratio	0.86	0.88	0.80	0.88	0.89	0.83	ns
Total cholesterol (mmol/l)	3.40	3.53	3.86	4.01	3.73	0.53	*
High density lipoprotein (mmol/l)	1.87	1.62	1.64	1.68	1.90	0.35	ns
Low density lipoprotein (mmol/l)	0.59	0.52	0.91	1.20	1.30	0.49	*
Triglycerides (mmol/l)	1.42	1.35	1.04	1.23	1.14	0.35	*

*- significance ($p<0.05$), ns – non-significance ($p>0.05$)

The inclusion of the various types of BBLOCAM in diets did not affect ($p>0.05$) the blood cellular indices (red blood cell counts, haemoglobin, haematocrit, white blood cell counts, mean corpuscular haemoglobin) of the experimental Guinea fowls. All the values for the blood cellular indices for the Guinea fowls with the exception of the red blood cell count, MCH, MCHC and MCV, were all within the range of values reported by Jain (1993). The range of values obtained for the red blood cell counts in the present study (2.22 to 2.3 X 10^{12} /L), were slightly lower than the value of 2.5-3.5 X10^{12}/L reported by Jain (1993). Also, the reported range of values by Jain (1993) for MCH (33.0-47.0), MCHC (26.0-35.0) and MCV (90.0-140.0), were all lower than those obtained in the present study as shown in Table 4.3.

In the trial, there was no impact of inclusion of the various types of BBLOCAM on serum total protein, albumin, globulin, albumin/globulin ratio and high density lipoprotein concentration. However, low density lipoprotein, total cholesterol and triglyceride contents of blood of Guinea fowls were significantly ($P<0.05$) affected by the dietary treatments.

Many factors, including the genotype, age, physiological condition and gender of a particular species, as well as the diet, climatic conditions, rearing method, season and pathological factors, reportedly affect the values of blood cellular and biochemical indices (Meluzzi *et al*., 1992). These factors might have contributed to some of the variations in the values observed in the present study. According to Ugwu *et al*. (2008), animals on a higher plane of nutrition tend to show better haematological and blood biochemical indices than their counterparts on a low plane of nutrition.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

From the foregoing results, the following conclusions can be drawn:

- There was no evidence of poor feed utilization and low feed intake as a result of the inclusion of cassava in diets.
- BBLOCAM diets could be used to replace maize meal partially in the diets of poultry particularly, Guinea fowls, as a non-conventional energy source in Ghana, most especially in the Northern Region where cassava is readily available and both cassava and blood are cheaper, without compromising growth performance.
- The haematological and blood biochemical indices as well as the carcass characteristics of the birds showed no health problems associated with the birds as a result of the inclusion of BBLOCAM in their diets.
- BBLOCAM diets, most particularly BBLOCAM IV, confer comparative or better economic benefits compared to maize based diets by greatly reducing feeding and production costs as it is cheaper than maize.

5.2 RECOMMENDATIONS

For improved production performance, it is recommended that:

- Further research is carried out to determine the highest inclusion level of BBLOCAM at the least cost in the diets of Guinea fowls to further reduce cost and still ensure the maintenance of high growth performance and carcass quality.
- Research to support improved production techniques of BBLOCAM by local farmers is needed to enable them produce the meal at a lower cost for economic use in feeding birds at the rural level where most of the Guinea fowls are produced.
- The haematological and blood biochemical indices in this study should serve as baseline information on Guinea fowls and could be used as reference values by other researchers.
- Further researches is recommended into egg laying, egg quality and hatchability as well as determine the chemical composition and sensory attributes of Guinea fowls fed BBLOCAM-based diets.

REFERENCES

Abdou, A. (1992). Etude de la dynamique de la population de la volaille villageoise en Afrique au sud du sahara: cas du Niger .Thése de DoctoratVétérinaire,IAV Hassan 11, Rabat, Maroc.

Adam, M. (1997). The Constraints of and the Prospects for Guinea fowl Production in the Northern Region of Ghana. B.Sc. Dissertation, Faculty of Agriculture, University for Development Studies, Tamale, Ghana.

Adeyemo, A.I., Oyejola, O. and Afolayan, T.A. (2006). Performance of Guinea fowls (*Numida meleagris*) fed varying protein levels. Journal of Animals and Veterinary Advances, 5:519-521.

Aire, T.A., Ayeni, J. S. O. and Olowo-Okonrun, M.O. (1979). The structure of excurrent ducts of the testis of the Guinea fowl (*Numida meleagris*). Journal of Anatomy, 129: 633 - 643.

Akinfala, E.O., Aderibigbe, A.O. and Matanmi, O. (2002). Evaluation of the nutritive value of whole cassava plant as a replacement for maize in the starter diets for broiler chicken; Livestock Research for Rural Development (14)6. Retrieved January 20th2011, from http://www./rrd.org//rrd14/6 akin146.htm.

Alidu, I. (2003). Improving the brooding management of the local Guinea fowl (*Numida meleagris)* keets.BSc. Dissertation.Faculty of Agriculture, Department of Animal Science, University for Development Studies, Tamale.

Annor, S. Y., Apiiga, S. Y, and Ahiaba, J. (2012). A Handbook on Guinea Fowl Production in Ghana, 1stEdition. Qualitype Limited. Accra. Pp 1 – 91.

Anthony, J. S. (1990). Poultry publication. The Macmillan Press Ltd. pp. 218.

Association of Official Analytical Chemists (1990) Official Methods of Analysis.5th Edition, AOAC, Arlington, VA.

Awotwi, E. K. (1987). A review of studies on Guinea fowl in Ghana. Agricultural Research Bulletin Legon, 2:1 - 4.

Ayeni J. S. O. (1983). Studies of grey-breasted guinea fowl (*Numida meleagris galeata Pallas*) in Nigeria. World Poultry Science Journal, 39: 143 - 151

Ayeni, J. S.O., Dipeolu, O.O. and Okaeme, A. N. (1983). Parasitic infections of grey-breasted helmet guinea (*Numida meleagris galeata*) in Nigeria. Veterinary Parasitology, 12:59-63.

Ayeni, J.S.O. (1983). The biology and utilization of helmeted guinea fowl (*Numida meleagris galeata pallas*) in Nigeria. II, Food of helmeted Guinea fowl in Kainji Lake basin area of Nigeria. Africa Journal of Ecology, 21 (1): 1-10.

Ayeni, J.S.O. and Ayanda, J.A. (1982). Studies of the husbandry and social acceptance of Guinea fowl in Nigeria. Bulletin of Animal Health Production, Africa, 30: 139 – 148.

Ayorinde, K. L. and Okaeme, A. N. (1984). All year Guinea fowl - how feasible? African Farming and Food Processing, 21-22.

Ayorinde, K. L., Ayeni, J. S. O. and Falayi, B. A. (1986). The value of cyperus as dietary substitute for yellow maize in the diets of Guinea fowl breeders. KLRI Annual Report.Pp.89-94.

Ayorinde, K. L., Ayeni, J. S.O. and Oluyemi, J.A. (1989). Laying characteristics and reproductive performance of four indigenous helmeted Guinea variety in Nigeria. Tropical Agriculture (Trinidad), 66:277-280.

Ayorinde, K.L. (1990). Problems and prospects of Guinea fowl production in rural areas of Nigeria. In: Rural Poultry in Africa (Proceedings of an International Workshop on Rural Poultry Development in Africa). E. B. Sonaiya, (Ed.), African Network on Rural Poultry Production Development.pp.106-115.

Ayorinde, K.L. and Ayeni, J.S.O. (1983).Comparison of the performance of different variety of indigenous Guinea fowl (*Numida meleagris*) and imported stock (*Numida meleagris*) in Nigeria. KLRI Annual Report.pp.170-182.

Biswas, E.R.I. (1999). Guinea fowl. In: R. Ewbank, F. Kim Madlien and G.B. Hart. (Eds). Management and Welfare of Farm Animals, 4th Edition.Halstan andCo. Ltd. Amersham, Bucks, UK. pp. 273 – 277.

Blackely, J. and Bade, D. H. (1994). Guinea fowl. In: The Science of Animal Husbandry. 6th Ed. Prentice-Hall Inc. U.S.A. pp516.

Blaha, J., CaiD, V. and Skarkova,L. (1993). Possibilities to replace maize by manioc meal in broiler fattening diets. Institute of Tropical and Subtropical Agriculture. (Czech Republic), 26: 85-102.

Blum, J. C, Guillaume, J. and Leclerco, B.(1975).Studies of the energy and protein requirement of the Guinea fowl. British Poultry Science, 16:157-168.

Bonds, H. (1997).Alternative Farming; A United Nations of alternative farming on the MorningtonPeninsula.www.independentnewsgroup.com.au/archive/helmi/,pp1-4. Date accessed, 31May, 2011.

Christie, G. S (1978). Haematological and biochemical findings in an anaemia induced by the daily bleeding of ten-week-old cockerels. British Veterinary Journal, 134: 358-365.

Dafwang, I.I., Olomu, J.M. Offiong, S.A. and Bello, S.A. (1986). The effects of replacing fish meal with blood meal in the diets of laying chickens. Journal of Animal Production and Research, 6: 81-92.

Dei, H.K., Ofosu, B.Y., Otchere, E.O., Djang-Fordjour, K.T. and Dzoagbe, G.K.S. (2002). Processed product from cassava and blood (PPCB): an alternative low cost feed for broiler chickens. Development Spectrum, 2: 58-67.

Dei, H.K., Manukure, S.A., Teye, G.A., Gyawu, P., Djang-Fordjour, K.T. and Otchere, E.O. (2005). Nutritive value of a processed product from cassava and blood for broiler finishers. Ghanaian Journal of Animal Science, 1(1):1-6.

Dei, H.K., Tetteh, E. and Otchere, E.O. (2007). Nutritive value of a processed product from cassava and blood in the diets of layer chickens. Ghanaian Journal of Animal Science, 2 and 3(1):45 – 50.

Dongmo, T., Ngoupayou, J.D.N. and Duplaix, M.P. (2000).Use of some local animal protein sources in the feeding of broilers. Tropicultura, 18: 122-125.

Donkoh, A., Otchere, S., Asare, U.O., Okyere-Boakye, E., Tawiah, R. Y. and Nyannor, E. K. D. (2003). A note on nutritive value of blend of blood and ground maize cob for broiler chickens. Journal of Animal and Feed Sciences, 12: 597-603.

Donkoh, A.and Zanu, H.K. (2010).Development of feed package for layers using low energy agro-industrial by products. African Journal of Agricultural Research, 5(20): 2782 - 2786.

Embury, I. (2001). Raising Guinea fowl. Agfact. A5.0.8. New South Wales Agriculture Publications, New South Wales, USA. Pp.4.

Fanimo, A. O., Mudama, E., Umukoro, T. O. and Oduguwa, O. O. (1996). Substitution of shrimp waste meal for fish meal in broiler chicken rations. Tropical Agriculture, (Trinidad), 73:201-205.

Fick, K.R., McDowell, L.R., Miles, P.H., Wilkinson, N.S., Funk, J.D., Conrad, J.H. (1979). Methods of Mineral Analysis for Plant and Animal Tissues, 2nd ed. Department of Animal Science, University of Florida, Gainesville, USA.

Food and Agriculture Organization (FAO) (1994). Food Outlook, Rome, Italy.

Galor, (1983). The French Guinea fowl. Presentation. Service Technique, Galor, Amboise France. Pp15.

Galor, (1985). Note book for keeping Guinea fowl broilers. The Technical Service, Amboise, France. pp. 17.

Gomez, G., Valdiviesco, M., De la Guesta, D. and Salcedo, T.S.(1984).Effect of variety and plant age on the cyanide content of whole root, cassava chips and its reduction by sun-drying. Animal Feed Science and Technology, 11: 143-152.

Gopalakrishnan, C.A. and Lal, G.M. (1996). Livestock and Poultry Enterprise for Rural Development. Vikas Publishing House PVT Ltd., India.Pp.439-534.

Ikani, E. I. and Dafwang, I.I. (2004). The Production of Guinea fowl in Nigeria. In: National Agricultural Extension and Research Liaison Services (NAERLS). Ahmadu Bello University, Nigeria.

Jain, N.C. (1993). Essentials of Veterinary Haematology, N.C. Jain (ed).Lea and Febiger, Philadelphi. USA.

John Roth and Son Inc. (2011). Blood meal specs. www.johnrothandson.com/blood specs.

Date accessed (15th April, 2014)

Kamalak, A., Canbolat, O., Gurbuz, Y.and. Ozay, O. (2005). In situ ruminal dry matter and crude protein degradability of plant and animal-derived protein sources in Southern Turkey. Small Ruminant Research, 58:135-141.

Karbo, N., Avornyo, F.K. and Apiiga, S.Y. (2002). Preliminary studies on the pattern andcauses of Guinea fowl *(Numida melegris*) keet losses in Garu, Bawku East District. The Savanna Farmer (July), 1: 15 – 17.

Kirk, R.W., Bistner, S.I. and Ford, R.B. (1990). Clinical procedures - blood collection. In: Handbook of Veterinary Procedures and Emergency Treatment, 5th edn. Saunders, Philadelphia, USA, pp.448-455.

Kirchgessner, M. (1985). Tierernährung: Leitfaden für Studium, Beratung und Praxis. 6. Verb. Auflage, DLG-verlag, Frankfurt (Main).

Kohn, R.A. and Allen, M.S. (1995). Enrichment of proteolitic activity relative to nitrogen in preparation from the rumen for *in vitro* studies. Animal Feed Science and Technology, 52 (1and 2): 1-14.

Koney, E.B.M. (1993). Poultry Health and Production. Advent Press, Accra – Ghana. pp. 104 – 107.

Kusina, J.F. and Kusina, N.T. (1999). Feasibility study of agricultural and household activities as they relate to livestock production in Guruve District of Mashonaland province with emphasis on poultry. University of Zimbabwe, Zimbabwe. pp. 93.

Kwari, I. D. (1984). Studies on the growth potential and egg production of indigenous Guinea fowl fed commercial chicken diets. Lake Chad Research Institute Annual Report. pp. 78-84.

Mahunugu, N. M., Yamaguchi, Y., Almazan, A. M. and Hahn, S.K. (1987). Reduction of cyanide during processing of cassava to some traditional African foods. Journal of Food and Agriculture, 1:1-15.

Mandal, A. B., Pathak, N. N. and Singh, H. (1999). Energy and protein requirements of Guinea keets (*Numida meleagris*) as meat birds in a hot climate. Journal of the Science of Food and Agriculture, 79:523-531.

Mareko, M.H.D., Nsoso, S.J. and Tibelang, K. (2006). Preliminary carcass and meat characteristics of Guinea fowl *(Numida meleagris*) raised on concrete and earth floors in Botswana. Journal of Food Technology, 4(4): 313 -317.

McDonald, P., Edwards, R. A. and Greenhalgh, J. F. D. (1987). Animal Nutrition, 4th Edition, Longman Group Ltd, Essex, England pp.405-491.

McDonald, P., Edwards, R. A., Greenhalgh, J.F.D. and Morgan, C.A. (2002). Animal Nutrition. 6th Edition. Pearson Prentice Hall, Singapore pp. 389-614.

McDonald, R.D., Edwards R.A. and. Greenhalgh, J.F.D. (1992). Animal Nutrition. 4th Edn. John Wiley and Sons. Inc. New York. pp. 455-483.

Meluzzi, A., Promiceri, G., Giodani, R. and Fabrik, G. (1992). Determination of blood constituents' reference values in broilers. Poultry Science, 71:337-345.

Mettle, S.S. (2009). The effects of a cassava peel and blood mixture (Blocassap) on the growth performance of starter-grower pigs. MSc. Thesis. Faculty of Agriculture, Department of Animal Science, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.

Microlivestock (1991). Little known small animals with promising economic future. Board on Science and Technology for International Development. Washington, DC: National Academy Press, Washington. pp. 115-125.

Muller, Z., Chou, X.C. and Nah, X.C. (1975). Cassava as a total substitute for cereals in livestock and poultry rations. Proceedings of the 1974 Tropical Products Institute Conference, 1–5 April. pp. 85–95.

Naazie, A., Canacoo, E.A. and Mwinbong, C. (2002). Guinea Fowl Production in the Upper East Region of Ghana. Final Report to Land Conservation and Smallholder Rehabilitation Project, Phase II (LACOSREP II), Ministry of Food and Agriculture, Upper East Region, Ghana.

Naazie, A., Canacoo,E.A. and Mwinbong, C. (2007). Socio-Cultural Aspects of poultry production in the Upper East region of Ghana. Ghanaian Journal of Animal Science, 2 and 3:35-44.

National Research Council (NRC) (1991). Guinea fowl. In: Micro Livestock, Little Known Small Animals with a Promising Economic Future. National Academy Press, Washington DC. pp. 115 - 123.

National Research Council (NRC). (1994). Nutrient Requirements of Poultry. 9th revised edition.National Academy Press, Washington, D.C.

Nwagu, B.I. and Alawa, C.B.I. (1995). Guinea fowl production in Nigeria. World's Poultry Science Journal, 1(51): 261 – 270.

Nwagu, B. I., Fulayi, B. A. and Nwagu, F. O. (1997). Hatchability of Guinea fowl eggs in Nigeria. Tropical Animal Health Production, 29: 63-64.

Oguntona, T. (1983). Current knowledge of nutrient requirements of the grey breasted helmet Guinea fowl. In: The helmet Guinea fowl (J.S.O.Ayeni,J.M. Olomu, and T.A. Aire,Eds,.) Kainji Lake Research Institute, New Bussa, Nigeria.pp.121-128.

Okaeme, A. N. (1982). Guinea fowl production in Nigeria. World's Poultry Science Journal, 39: 179-184.

Olomu, J.M. (1983). Aspect of the nutrition of the Guinea fowl. In: The Helmet Guinea fowl (J.S.O.Ayeni,J.M. Olomu andT. A.Aire, Eds.), Kainji Lake Research Institute, New Bussa, Nigeria pp108-120.

Oluyemi, J.A. and Roberts, F.A. (1988). Poultry Production in Warm Wet Climates. Macmillan, Hong Kong.

Onifade, A.A. and Tewe, O. O. (1993). Alternative tropical energy feed resources in rabbit diets: growth performance, diets digestibility and blood composition. World Rabbit Science, 1(1): 17-24.

Onyimonyi, A. E. and Ugwu, S. O. S. (2007). Bioeconomic indices of broiler chicks fed varying ratios of cassava peel/bovine blood. International Journal of Poultry Science, 6(5): 318 - 321.

Parkhurst, C.R. and Mountney, G.J. (1998). Poultry Meat and Egg Production. Avi Nostrand Reinhold Company Inc., New York. pp. 110.

Payne, W.J.A. (1990). An Introduction to Animal Husbandry in the Tropics.4th Ed. Longman Group Ltd. Singapore. pp. 739 – 740.

Peter, T., Biamonte, G.T. and Doumas, B.T. (1982). Protein (total protein) in serum, urine and cerebrospinal fluids; Albumin in serum. In: Selected Methods of Clinical Chemistry. (Paulkner, W.R, and Meites, S. Eds) 9. American Association for Clinical Chemistry, Washington, D.C.

Petit-Jean, M.J. (1970). Resultats experimentaux sur la subfertilite liee a la crete rosaceechez le coq. Proceedings of the World's Poultry Congress, Madrid, 2:313.

Pond, G.W., Church, D.C. and Pond, K.R. (1995). Basic Animal Nutrition and Feeding; 4th Edition. John Wiley and Sons, Inc., USA. pp. 309 – 337.

Preston, T.R. (1987). Porcs et volailles sous les tropiques. CTA.Wageningen, Pays teas.pp. 27.

Raokari, R., Hyman, D. L., Thornton, E. J. and Norman, R. (1977). Protein Requirement of Guinea Keets. U .S .D. A. Poultry Science, 57A: 186-189.

Roy, D.and Wibberley, E. H. A. (1979). A Tropical Agric. Hand Book. Comelet Press Ltd., Southampton, pp. 219.

Saina, H. (2005). Guinea fowl (Numida *meleagris*) production under smallholder farmer management in Guruve District in Zimbabwe. MPhil. Thesis. Department of Animal Science. University of Zimbabwe, Zimbabwe.

Sale, J. and DuPrezz, J.J. (1997). Protein and energy requirements of the pearl Grey Guinea fowl. World's Poultry Science Journal, 54 (3): 381 – 385.

Smith, A. J. (1990). Poultry. Macmillan Publishers Ltd. London and Basingstoke. Pp. 218.

Statistical Analysis Systems Institute, (200). SAS User's Guide: Statistics, SAS Institute, Cary, NC, USA, 2003.

Steel, R.G.D., Torrie, J.H., and Dickey, D.A. (1979). Principles and Procedures of Statistics. A Biometrical Approach, 3rd Edn. McGraw-Hill, New York, NY, USA,

Stevenson, M.H. and Jackson, N. (1983). The nutritional value of dried cassava root meal in broiler diets. Journal of the Science of Food and Agriculture, 34: 1361-1367.

Tadelle, D. (1996). The role of scavenging poultry in integrated farming systems in Ethiopia. In: Livestock Feed Resources within Integrated Farming Systems. Second FAO Electronic Conference on Tropical Feeds. pp. 377-399.

Taylor, W.B. (2005). Protein sources with differing ruminal degradation characteristics on nutrient digestibility and flows through various segments of the gastrointestinal tract of non-lactating Holstein cows. M.Sc. Thesis. Louisiana State University and Agricultural and Mechanical College.

Teye, G. A. and Adam, M. (2000). Constraints to Guinea fowl production in Northern Ghana: A case study of the Damango area. Ghanaian Journal of Agricultural Science, 33: 153 - 157.

Teye, G.A., Gyawu, P. and Agbolosu, A.A. (2001). Growth potential and carcass yields of exotic and indigenous Guinea fowls in Ghana. Development Spectrum, 1(1):34-40.

Tuah, A. K., Oppong-Anane, K. and Owusu-Aduomi, K. (1990). Lambing and neonatal behaviour of Djalonke×Sahel crossbred. Maternal behaviour. Ghanaian Journal of Agricultural Science, 20-23: 111- 115.

Udedibie, A.B.I., Anyanwu, G., Ukpai, U.I.and Oyet, A.J. (1988). Poultry offal meal as a protein supplement in the diets of broiler starters and finishers. Nigerian Journal of Animal Production, 20: 103-109.

Ugwu, S. O.C., Onyimonyi, A. E. and Ozonoh,C. T. (2008). Comparative performance and haematological indices of finishing broilers fed palm kernel cake, bambara offal and rice husk as partial replacement for maize. International Journal of Poultry Science, 7(3): 299-303.

Varley, H. (1962). Practical Clinical Biochemistry, 3rd ed. White friars Press, London.

APPENDICES

ANALYSIS OF VARIANCE OF DATA COLLECTED

GROWTH PERFORMANCE

***** Analysis of variance *****

Variate: Initial_wt

Source of variationd.f.s.s.m.s.v.r.F pr.LSD

TRT459.8814.971.410.3015.938

Residual10106.5310.65

Total14166.40

***** Analysis of variance *****

Variate: ADG6

Source of variationd.f.s.s.m.s.v.r. F pr.LSD

TRT40.77310.19330.44 0.7801.211

Residual10 4.43130.4431

Total14 5.2044

***** Analysis of variance *****

Variate: ADG12

Source of variation d.f.s.s.m.s.v.r.F pr.LSD

TRT40.42080.10520.560.6960.787

Residual101.87360.1874

Total142.2944

***** Analysis of variance *****

Variate: ADG18

Source of variationd.f.s.s.m.s.v.r.F pr. LSD

TRT40.332490.083121.160.3830.486

Residual10 0.714000.07140

Total141.0464

***** Analysis of variance *****

Variate: ADI6

Source of variationd.f.s.s.m.s.v.r.F pr.LSD

TRT44.23031.05761.79 0.2081.400

Residual10 5.92330.5923

Total14 10.1536

***** Analysis of variance *****

Variate: ADI_12

Source of variationd.f.s.s.m.s.v.r.F pr.LSD

TRT42.9980.7500.540.7112.146

Residual1013.9171.392

Total1416.915

***** Analysis of variance *****

Variate: ADI_18

Source of variationd.f.s.s.m.s.v.r. F pr.LSD

TRT42.4080.602 0.210.9253.060

Residual1028.297 2.830

Total1430.705

***** Analysis of variance *****

Variate: Intake_6

Source of variationd.f.s.s.m.s.v.r.F pr.LSD

TRT 47470.1868.1.780.20958.86

Residual1010468.1047.

Total1417938.

***** Analysis of variance *****

Variate: Intake_12

Source of variationd.f.s.s.m.s.v.r.F pr.LSD

TRT4 21172.5293.0.540.710180.0

Residual10 97909.9791.

Total14 119081.

***** Analysis of variance *****

Variate: TOTAL_Intake-18

Source of variationd.f.s.s.m.s.v.r.F pr. LSD

TRT438498.9625.0.210.925385.6

Residual10449169.44917.

Total14487668.

***** Analysis of variance *****

Variate: Gain_6

Source of variationd.f.s.s.m.s.v.r.F pr.LSD

TRT41382.4345.6 0.440.77650.87

Residual107817.9781.8

Total149200.2

Variate: Gain_12

Source of variation d.f.s.s.m.s.v.r.F pr.LSD

TRT42959.740.0.560.69766.33

Residual1013212.1321.

Total1416170.

***** Analysis of variance *****

Variate: Total_gain_18

Source of variationd.f.s.s.m.s.v.r.F pr.LSD

TRT4 5309.1327.1.160.38361.42

Residual1011397.1140.

Total1416706.

***** Analysis of variance *****

Variate:Wt at WK_6

Source of variationd.f.s.s.m.s.v.r.F pr.LSD

TRT41670.8417.7 0.50 0.73652.53

Residual108338.0833.8

Total1410008.8

***** Analysis of variance *****

Variate:Wt at WK_12

Source of variationd.f.s.s.m.s.v.r.F pr. LSD

TRT43714. 929. 0.670.626 67.63

Residual10 13821.1382.

Total1417535.

***** Analysis of variance *****

Variate:Wt at WK_18

Source of variationd.f.s.s.m.s.v.r.F pr. LSD

TRT46004.1501.1.320.328 61.39

Residual1011386.1139.

Total1417390.

***** Analysis of variance *****

Variate: FCR_6

Source of variationd.f.s.s.m.s.v.r. F pr.LSD

TRT 40.110970.027740.730.5940.356

Residual100.382200.03822

Total140.49317

***** Analysis of variance *****

Variate: FCR_12

Source of variationd.f.s.s.m.s.v.r.F pr.LSD

TRT40.181110.045281.890.188 0.2814

Residual100.239270.02393

Total140.42037

***** Analysis of variance *****

Variate: FCR_18

Source of variation d.f.s.s.m.s.v.r.F pr.LSD

TRT40.22396 0.055990.920.487 0.448

Residual100.605600.06056

Total140.82956

CARCASS CHARACTERISTICS

***** Analysis of variance *****

Variate: Bled_wt_g

Source of variationd.f.s.s.m.s.v.r.F pr.LSD

TREATMENT412211.3053.1.590.25079.6

Residual1019162.1916.

Total1431373.

***** Analysis of variance *****

Variate: Bleeding_%

Source of variationd.f.s.s.m.s.v.r.F pr. LSD

TREATMENT 48.3402.085 1.360.3142.251

Residual1015.3061.531

Total1423.646

***** Analysis of variance *****

Variate: Dressed_wt

Source of variationd.f.s.s.m.s.v.r.F pr. LSD

TREATMENT418325.4581.3.03 0.071.70.7

Residual1015123. 1512.

Total1433448.

***** Analysis of variance *****

Variate: Dressing_%

Source of variation d.f.s.s.m.s.v.r.F pr. LSD

TREATMENT4 44.67211.1682.910.078.3.565

Residual10 38.3953.839

Total14 83.06

HAEMATOLOGY AND BLOOD BIOCHEMISTRY

***** Analysis of variance *****

Variate: WBC

Source of variationd.f.s.s.m.s.v.r.F pr.LSD

TREATMENT440.2510.060.820.5426.38

Residual10122.9512.30

Total14163.20

***** Analysis of variance *****

Variate: RBC

Source of variationd.f.s.s.m.s.v.r.F pr.LSD

TREATMENT40.052310.013080.430.7860.32

Residual100.305870.03059

Total140.35817

***** Analysis of variance *****

Variate: MCV

Source of variationd.f.s.s.m.s.v.r.F pr.LSD

TREATMENT449.43212.3583.660.0443.34

Residual1033.7223.372

Total1483.155

***** Analysis of variance *****

Variate: MCHC

Source of variationd.f.s.s.m.s.v.r.F pr.LSD

TREATMENT440.32610.0822.11 0.1553.98

Residual1047.838 4.784

Total1488.165

***** Analysis of variance *****

Variate: HCT

Source of variationd.f.s.s.m.s.v.r.F pr. LSD

TREATMENT413.3303.3330.69 0.614 3.99

Residual1048.1394.814

Total 1461.469

***** Analysis of variance *****

Variate: MCH

Source of variationd.f.s.s.m.s.v.r.F pr. LSD

TREATMENT453.7113.431.190.3736.11

Residual10 112.7911.28

Total14166.51

***** Analysis of variance *****

Variate: Hb

Source of variationd.f.s.s.m.s.v.r.F pr.LSD

TREATMENT 41.05630.26410.960.4710.96

Residual102.75630.2756

Total143.8126

***** Analysis of variance *****

Variate: T_PROTEIN

Source of variationd.f.s.s.m.s.v.r. F pr.LSD

TREATMENT4 124.6931.171.000.45110.16

Residual10311.5931.16

Total14436.28

***** Analysis of variance *****

Variate: T_CHOL

Source of variation d.f.s.s.m.s.v.r.F pr.LSD

TREATMENT40.717930.179482.08 0.1580.53

Residual100.862200.08622

Total141.58013

***** Analysis of variance *****

Variate: TGs

Source of variationd.f.s.s.m.s.v.r.F pr.LSD

TREATMENT40.275430.068861.910.1850.35

Residual100.360670.03607

Total140.63609

***** Analysis of variance *****

Variate: HDL

Source of variationd.f.s.s.m.s.v.r.F pr.LSD

TREATMENT40.204490.051121.38 0.3090.35

Residual100.371000.03710

Total140.57549

***** Analysis of variance *****

Variate: ALBUMIN

Source of variationd.f.s.s.m.s.v.r.F pr.LSD

TREATMENT432.4218.105 1.160.34.806

Residual1069.7826.978

Total14102.203

***** Analysis of variance *****

Variate: GLOBULIN

Source of variation d.f.s.s.m.s.v.r.F pr.LSD

TREATMENT446.4111.601.15 0.3875.772

Residual10100.6710.07

Total14147.09

***** Analysis of variance *****

Variate: LDL

Source of variationd.f.s.s.m.s.v.r.F pr.LSD

TREATMENT41.522570.38064 5.310.015 0.49

Residual100.716400.07164

Total142.23897

***** Analysis of variance *****

Variate:_Gizzard_g

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.	lsd
REP stratum	2	0.00017	0.00009	0.00	0.51	
REP.*Units* stratum						
TRT	4	0.01070	0.00267	0.04	0.997	
Residual	8	0.58776	0.07347			
Total	14	0.59863				

***** Analysis of variance *****

Variate: Gastro_intestinal tract_g

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.	lsd
REP stratum	2	0.01610	0.00805	0.11	0.22	
REP.*Units* stratum						
TRT	4	0.47079	0.11770	1.62	0.259	
Residual	8	0.58034	0.07254			
Total	14	1.06723				

***** Analysis of variance *****

Variate: _Liver_g

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.	lsd
REP stratum	2	0.11546	0.05773	2.60	0.281	
REP.*Units* stratum						
TRT	4	0.13427	0.03357	1.51	0.286	
Residual	8	0.17758	0.02220			
Total	14	0.42731				