UNIVERSITY FOR DEVELOPMENT STUDIES, TAMALE

EFFECTS OF CHARCOAL IN DIETS CONTAINING FALSE YAM (*Icacina oliviformis*) TUBER MEAL ON GROWTH PERFORMANCE OF BROILER CHICKENS

BY

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DECLARATION

Student

I, Abdul-Rasheed Sayibu hereby declare that this work is the result of a research carried out on my own. I further certify that this work has not been submitted for another degree elsewhere. All sources of information and assistance received in the preparation of this work have been duly acknowledged by way of reference.

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ABSTRACT

Two experiments were conducted concurrently to determine the effects of charcoal incorporation at 3 and 6% in diets containing 5%sun-dried false yam tuber meal (SDFYTM) and 15%soaked false yam tuber meal (SFYTM) on growth performance and carcass characteristics of broiler chickens, and a digestibility trial to determine nutrient digestibility of the experimental diets. False yam tubers were peeled, diced with some sun-dried and milled for a feeding trial in Experiment 1. The other diced tubers were soaked in water, sun-dried, milled, for a feeding trial in Experiment 2. Wood charcoal was crushed into flour and incorporated in diets containing false yam tuber meals in both experiments. Experiment 1 involved the addition of 3 and 6% charcoal in diets containing 5%SDFYTM; whilst Experiment 2 involved the addition of 3and 6% charcoal in diets containing15%SFYTM. Both experiments lasted for five (5) weeks. At 4weeks of age, a total of 96female chicks (Cobb strains) were selected at random and divided into 16 groups of 6birds each in each experiment. Each experiment comprised of four dietary treatments of treated false yam tuber meal (Control diet with no charcoal and false yam, and false yam-based diets with 0%, 3% and 6% charcoal). Each diet was replicated four times in a Completely Randomized Design. Parameters measured included mean feed intake, weight gain, gain-feed ratio, dressing percentage of carcass, haematology and serology. Data collected were analysed by ANOVA. Results of Experiment 1 indicated that broiler chickens fed SDFYTM diets at 5% showed no differences ($P>0.05$) interms of feed intake, weight gain, gain-feed ratio and dressing percentage of carcass. The findings of this experiment indicated that SDFYTM at 5% can replace maize in diets of broiler chickens without any adverse effects on their growth performance.

In Experiment 2, broiler chickens fed the 15%SFYTM diets significantly ($P<0.05$) affected their growth performance.

The addition of the wood charcoal (at 3 and 6%) in both false yam tuber meal broiler chicken diets, in the two experiments, failed to attenuate the anti-nutritional factors in the false yam tuber.

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I dedicate this work to my parents, Iddrisu Sayibu Alhassan (late) and Fuseina Yahaya, siblings and my entire family.

LIST OF ACRONYMS

ADF	Acid Detergent Fibre
ALP	Alkaline Phosphatase
ALT	Alanine Transferase
ANFs	Anti-Nutritional Factors
ANOVA	Analysis of Variance
AOAC	Association of Official Analytical Chemists
AST	Aspartate Transferase
BDG	Brewers Dried Grains
BFYSM	Boiled False Yam Seed Meal
BFYTM	Boiled False yam tuber meal
CB	Corn Bran
CP	Crude Protein
DM	Dry Matter
EDTA	Ethylene Diaminetetra Acetic Acid
EU	European Union
F:G	Feed to Gain Ratio
FAO	Food and Agriculture Oganizations
FAOSTAT	Food and Agriculture Organization Statistics
FFYTM	Fermented False Yam Tuber Meal
FYLM	False Yam Leaf Meal
Hb	Haemoglobin
IBD	Infectious Bursal Disease

LSD	Least Significant Difference
MCH	Mean Corpuscular Haemoglobin
MCHC	Mean Corpuscular Haemoglobin Concentration
MCV	Mean Corpuscular Volume
NaCl	Sodium Chloride
NAS	National Academy of Sciences
Nd	Not Determined
NDF	Neutral Detergent Fibre
NRC	National Research Council
NRI	National Research Institute
NS	Not Significant
OM	Organic Matter
PAHs	Policyclic Aromatic Hydrocarbons
PCV	Packed Cell Volume
PKM	Palm Kernel Meal
Ppb	Parts Per Billion
RB	Rice Bran
RBCs	Red Blood Cells
SARI	Savannah Agriculture Research Institute
SBFYSM	Soaked or Boiled False YAM seed Meal
SBFYTM	Soaked or Boiled False Yam Tuber Meal
SBM	Soybean Meal
SDFYTM	Sun- Dried False Yam Tuber Meal

SED	Standard Error of Difference
SEM	Standard Error of Means
SFYSM	Soaked False Yam Seed Meal
SFYTM	Soaked False Yam Tuber Meal
SRID	Statistical Research and Information Directorate
USA	United States of America
USDA	United States Department of Agriculture
w/w	Weight per Weight
WBCs	White Blood Cells
WC	Wood Charcoal
WG	Weight Gain

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CHAPTER ONE

1.0 INTRODUCTION

The poultry industry especially broiler production has provided an essential function in the economies of both developed and developing countries. According to Parkhurst and Mountney (1988), poultry enterprises, when compared to other livestock businesses, are easy and cost effective to establish. Rajendran and Mohanty (2003) indicated that poultry farming has taken a lead among the many ventures by farmers to supplement their incomes because it provides rapid returns, needs little space and investment and can be carried out by ordinary farmers. The key to successful broiler rearing is provision of feed. According to Koney (1993), feed alone costs more than 60% of broiler production. Maize as a major source of energy, forms about 85% of dietary energy of chicken worldwide (Bell and Weaver, 2002). Reddy and Qudratullah (2004) reported that cereal grains (e.g. maize) production in Africa, Asia and Pacific nations have not been enough for human and industrial use, thereby resulting in its scarcity. Thus high feeding cost comes into focus as the greatest constraint that must be dealt with through the use of non-conventional feedstuffs; thus a need for alternative feed resources to spare maize for human consumption.

Examples of non-conventional feed resources useful for poultry production include; cassava (Oluyemi and Robert, 1979), blood (Donkoh *et al.*, 1998), oilseed cakes (Nelson, 1998) and cereal brans (Smith, 1990) as well as new plant resources like the false yam (Dei *et al.*, 2011).

The false yam is a potential non-conventional feed that can be used to feed poultry to supply them with energy (Dei *et al.*, 2011).

The false yam is a drought resistant shrub (1m in height with tillers) that grows in the wild in the dry Savannah belt of West and Central Africa (Fay, 1987).

It produces appreciable yields of tuber (2~20mt/ha) and seed (~0.214mt/ha) (Fay, 1993). Both products are high in starch (Fay, 1991) and can serve as a source of dietary energy for poultry.

The plant is presently not cultivated for its products due to a toxic principle called 'gum resins' (NRI, 1987) which has been identified as terpenes (Vanhaelen *et al*., 1986). The toxic substances limit their utilization as food for humans and as feed for animals; hence both products are available in abundance. However, it is envisaged that with proper methods of detoxification, nutritive value of the tuber can be substantially improved for feeding monogastric animals (Dei *et al.*, 2011). Earlier findings of Dei *et al*. (2015) indicated that broiler chicken can be fed diets containing soaked false yam tuber meal up to 9% without any adverse effect on their growth performance. In another experiment, high residual concentration of toxins in the soaked false yam tuber meal diets beyond 120g/kg affected the growth of broiler chicken (Dei et al., 2015a).

Wood charcoal in situations of poisoning can act as a toxin binder (Gerlach and Schmidt, 2012). However little is known of the effect of combining charcoal and false yam tuber in diets of broiler chickens, hence this study.

1.1 Objectives of the study

The objectives of this study were to determine the effects of charcoal incorporation at 0%, 3%, and 6% in diets containing Sun-dried False Yam Tuber Meal (5%SDFYTM) and Soaked False Yam Tuber Meal (15%SWFYTM) on:

1. Nutrient digestibility of finisher broilers.
2. Growth performance of finisher broilers.
3. Hematological profile of finisher broilers.
4. Serum biochemistry of finisher broilers.
5. Carcass and organ characteristics of finisher broilers

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1.0 Poultry production

2.1.1Definitions and species of poultry

Oluyemi and Roberts, (1988) defined poultry as birds bred for profit. They are domesticated birds. Poultry species mainly include: the domestic fowl (*Gallus gallus*), domestic duck (*Anas platyrnchos*), turkey (*Meleagris gallopavo*), guinea fowl (*Numida meleagris*), pigeon (*Columbia livia)*, goose (*Anser anser*), and ostrich (*Struthio camelus*). Of these, chicken and guinea fowl are mostly reared, useful and profitable in the tropical regions (Ayivor and Hellins, 1986).

Gillespie (1983) reported that there are two main types of chicken namely, the meat -type and the egg –type. The meat- types are the broilers used for meat production. They are produced by the crossing between breeds or inbreeding within a breed, and few pure strains of chicken are used for commercial purposes.

The egg-type chickens are called layers and produce two kinds of eggs. That is table eggs particularly for consumption and hatching eggs which are fertile for breeding purpose (Bell and Weaver, 2002).

2.1.2 Poultry Meat Industry

Poultry farming refers to the rearing of birds including chicken, turkeys, ducks and geese basically for their meat, eggs or feathers (Ray and Roy, 1991). The various systems operated in keeping birds are the battery cage or intensive, semi-intensive and free range (Aryee *et al*., 1989).

Poultry industry in Ghana grew rapidly during the 1980's to 1990's, becoming a strong force in agricultural development that supplied about 95% of chicken meat and eggs in the country (Flake and Ashitey, 2008). Since 2000, Ghana's poultry industry has experienced a slow growth because of very high cost of production (feed, inputs and energy) and lack of credit (Flake and Ashitey, 2008). This has hindered poultry production and products supply in the local sector to meet its growing human population. The poultry industries consist of traditional sector which accounts for the meat and egg needs of many rural people and the commercial sector based on imported hybrid layer and broiler strains that supply the needs of urban communities (Koney,1992).The industry in Ghana scopes from backyard with few hundred birds to commercial production which amounts in thousands (Appiah, 1993).

These commercial sectors are mainly concentrated in the Greater Accra, Ashanti and Brong Ahafo Regions. Demand for livestock products including poultry is expanding in West Africa due to population growth and increased urbanization (Killebrew and Plotnick, 2010). Farmers that are actively involved in commercial poultry production in Ghana are categorized into those producing birds on large scale (above 10,000), medium scale (5,000 to 10,000) and small scale (50 to 5,000) as reported by the USDA (2008).

They produce meat from these farms to meet the nutritional needs of their families and the wider population. Poultry meat is one of the major sources of animal protein and contributes to the total meat output in many developed and developing countries in the world. Bell and Weaver (2002) reported that poultry production makes a substantial degree of the global total meat output and it is the second most popular meat consumed in the world after pork.

For thousands of years, poultry supplied meat and eggs and it accounts for about 35% of total meat in 2014 (FAOSTAT, 2014).

Table 1: Estimated world livestock numbers (million head)

Specie	1990	2000	2012	% change 1990-2012
Cattle and Buffaloes	1445	1467	1684	16.5
Pigs	849	856	966	13.8
Poultry	11788	16077	24075	104.2
Sheep and Goats	1795	1811	2165	20.6
Total	15877	20211	28890	155.1

Source: FAO (2014)

From Table1 it can be noticed that the number per head of each animal species increased after ten years; poultry is noticed to be fastest.

This is evident in the utilization and consumption of poultry having a higher percentage change (104.2%) from the year 1990 to 2012 among the other species due to cultural preferences and religious beliefs.

Poultry production is the fastest growing meat sector in the world, increasing by 4.7 percent in 2010 to 98million tons (World Watch Institute, 2016).

2.2.0 Challenges of the Poultry Industry

In Ghana (SRID, 2013), poultry recorded the highest numbers out of the estimated livestock population between 2003 and 2012 but with a slow growth rate. This might be due to many problems that are faced in the poultry industry in Ghana thereby affecting the growth of the industry. These problems include poor access to credit, diseases, high environmental temperatures, irregular supply of day-old chicks, poor management, influx of cheap imported poultry products and scarcity or cost of feed.

2.2.1 Poor Access to Credit or Capital

High rate of poverty in Ghana has forced many farmers especially in the North to find it difficult to establish or start a business. This has become a major issue as reported by Afful (1971) that poultry production is a more costly business and for any plan for a large scale production to be achieved, will require a large amount of capital. This is because the cost of commercial loans for poultry production in Ghana is escalating to an extent that it would not be prudent using them to support poultry production activities (Otoo, 2009). According to Darko (2010), interest rates in Ghana are seen to be higher compared to the international rates and due to the high risk involved, it is important for interest rates to be as low as 10% for instance to entice farmers to access credit facilities from credit bodies (Osei, 1990) in order to go into commercial poultry production. Koney (2004) reported that bank loans are difficult to obtain which is characterized by unattractive terms of payment, prevent people to indulge in these activities for expansion of the poultry industry.

2.2.2 Diseases

Koney (1993) reported a number of diseases that affect chicken and their prevalence are as a result of different organisms and factors which are a major concern in the poultry industry (Appiah, 1993). Adene (1996) indicated that the poultry industries in Africa are challenged with diseases such as Newcastle disease (ND), infectious bursal disease (IBD) or Gumboro, Marek disease, Fowl typhoid, Cholera, Mycoplasmosis and Coccidiosis. According to Allan *et al.* (1978), the Newcastle disease is enzootic and worldwide can spread rapidly causing breathing problems, trembling, facial swelling and sneezing with muscular in-balances and partial paralysis (Butcher *et al*., 2012). Jordan and Pattison (1996) reported that the Infectious Bursal disease (Gumboro) which affect young chickens is an acute, highly contagious immunosuppressive disease (Van Den Berg *et al.*, 2000) characterized by discharge of watery droppings, ruffled feathers, dehydration among birds, and darkening of the muscle (Butcher *et al*., 2012). It has detrimental effects among young chickens and can result in mortality rates between 10 and 100% (Jordan and Pattison, 1996).

Most of these diseases occur as a result of the inadequate skilled personnel to educate farmers in the poultry sector therefore the cause of the downward fall of the poultry industry (Daghir, 1995).

Buamah (1992) reported that the availability of vaccines and vaccinations programmes can effectively be implemented to curtail these diseases. But the vaccines and other medicines are expensive and as a result can reduce the profit margins for farmers.

2.2.3 High Environmental Temperatures

Temperature describes the degree of hotness or coldness of the environment or body. This has a reverse relationship with humidity whether high or low. According to Kasei (1988), the Northern part of Ghana particularly is located in the Guinea Savannah zone, which experiences a recurrent temperatures ranging from 28 to 42^{0}C in the dry periods somewhere November and April and a daily humidity averagely of 50% annually (SARI, 2001).

According to Sturkie (1976), birds can thrive well under a thermo-neutral zone of 12-26^{0}C therefore having temperatures higher than this can be detrimental to poultry life. Donkoh (1989) indicated that unfavorable climatic conditions adversely affect poultry production in the tropics, resulting in low intake of feed as birds are conditioned to counter metabolic heat pressure.

Temperature and moisture are major contributory factors, which influence heat stress on livestock (Bouraoui *et al.,* 2002; St-Pierre *et al.*, 2003). Heat stress suppresses egg production in laying hens (Marsden *et al*., 1987) and consequently egg weight (Vohra *et al.,* 1979). Due to heat stress, egg size, laying gradients, mortality, body weight gain and egg shell durability are affected (Sterling *et al*., 2003; Lin *et al*., 2004; Franco-Jimenez and Beck, 2007).

The reduced growth and production performance due to heat stress may be attributed to low feed intake for broilers (Hurwitz *et al.*, 1980) as well as laying chicken (Sahin *et al.*, 2009).

Bell and Weaver (2002) reported that the tendency for body temperatures to increase more than core ambient temperature and above the thermo-neutral zone is high as birds are exposed to several days of heat and hence can cause health problems.

The ability of birds to dissipate heat decreases as ambient temperature and relative humidity rises above the thermal neutral zone (Yahav *et al*. 2005; Lin *et al*. 2006). According to Dirian and Waldroup (2002), higher temperature and humidity increases the rate of respiration and panting among birds. Larbier *et al*. (1993) reported that chronic heat exposure adversely reduces protein digestion. For instance it is reported that broilers experience reduced digestibility of major diet nutrients (proteins, fats and starch) as a result of exposure to high temperatures (Bonnet *et al*., 1997). Optimum temperature for bird's (laying hens) normal growth is 20^0C (North and Bell, 1990). Heat stress is latent at temperatures 25^0C and become manifest when the temperatures are above 30^0C impacting negatively on the performance and quality egg production (Bollengier-Lee *et al*., 1999). According to Mohammed and Dei (2010) to reduce the effects of heat stress on animals, it is recommended to provide cool water or water mixed with recommended amount of alcohol at high ambient temperature in order to promote good performance. Dei and Bumbie (2011) reported also that wet feeding is appropriate to encourage good performance in poultry at hot periods.

2.2.4 Irregular Supply of Day Old-Chicks

As one of the constraints, supply of quality day-old chicks had been a worry as hatcheries are not able to make provision as scheduled.

Some hatcheries have become ineffective with regards to quality day-old chicken provision due to poor sanitation characterized by high mortalities (Appiah, 1993).

Lack of good management of hatcheries and feed mills consequently affect quality day-old chicks which adversely affect poultry production (Koney, 1993).

To address this problem the Veterinary Service Directorate should have been monitoring the operations of the hatcheries but little is done to promote good sanitation measures at the hatcheries (Koney, 1993).

2.2.5. Poor Management

Gillespie (1992) reported that a high level of management is necessary especially for major commercial producers. This when encouraged would promote good returns.

Williamson and Payne (1978) noted that small number of poultry farmers breed their own replacements and for that matter do not keep adequate records. This can result in poor selection method of major traits. Gillespie (1992) indicated that for good management practices, farmers need to be equipped with the knowledge of brooder temperatures, good housing systems for chicks, good ventilation systems, etc.

2.2.6 Scarcity and High Feed Cost

Feed is a major component that has to be given attention in poultry production. For many developing countries including those in the African continent, the poultry sector is faced with quantity production of maize including and high prices of feed raw materials (Oosthuysen, 2013) as a major source of energy in poultry diets. Maize is the most preferred energy source in broiler chicken diets due to its high energy and low fibre content, the presence of pigments and essential fatty acids (Panda *et al.*, 2010).

Daghir (1995) reported that one of the major constraints of poultry production in the tropical areas is the unavailability of adequate supply of grains (for instance maize) and protein sources (for example fish meal) that are important for feed formulation. The feed cost alone is between 60 and 65 percent in poultry production (Koney, 1993) and the variable cost of feed in broiler production is close to 80 percent (Akinwuni *et al.*, 1979). But domestic production of cereal grains is largely inadequate to meet the needs of humans as food, as livestock feed and for industrial purposes (Reddy and Qudratullah, 2004) and for starch (Corn Refiners Association, 1982). Maize forms an important component in industrial manufacture of alcoholic beverages (Potter and Hotchkiss, 1995). Ravindra and Blair (1991) reported that diversion of grains especially maize from the animal feed market to ethanol production is a more recent development that contributes to grain supply problems in the world market with a phenomenon of price hikes. Osei (1990) also indicated that volatility of price of poultry feed is as a result of the inadequate production of main feed ingredients particularly maize and fish meal to meet demand of human and as well the poultry industry. Due to this, the profitability and production of the poultry sector is eventually affected and to address this situation, maize as a major feed ingredient in poultry diet must necessarily be replaced either completely or partially with non-conventional feedstuffs (Tachie-Menson, 1991) so that we would be assured of a continuous supply of poultry meat and eggs all year round.

2.3.1 Poultry Production and the Feed Resource Issues

Feed materials available for poultry production in Ghana can be put into two main categories, namely conventional and non-conventional feed materials. Examples of conventional feed stuffs are oyster shell, limestone, fishmeal, groundnut cake, soya bean meal, wheat bran, and maize which are the ones traditionally used.

Invariably, non-conventional ones are not commonly and traditionally used in animal rations (Younas and Yaqoob, 2005).

These consist of a variety of feedstuffs from agro-industrial processing such as cassava peels, maize bran and new feed resources such as mucuna seeds and false yam tuber and seeds.

Rosenzweig *et al*. (1993) stated that the effect of climate change on crop output is more evident. As a result, there is a consistent reduction of crop productivity, increase market prices and malnutrition in sub-Sahara Africa (Thompson *et al.*, 2010).

And a contributing factor that affects demand for feed commodities are human population and income. Food-feed competition managed by substitution and affordable price tags (Yotopoulos, 1987). Mengesha (2011) stated that feed price increment has leapfrog livestock prices and feed grain demand has been exceeding production. In this regard, utilization of some poor by-products can be improved by various techniques for instance solid state complex enzyme fermentation systems.

Moreover, grain yield is also increasingly affected by global warming that can cause food feed competition (Mengesh 2011).

According to Chadd (2008) to address the nutritional state of feed ingredients, better technological systems need to be adopted and implemented. To ensure this happens, traditional or local poultry feed sources could be used as alternative feed source for poultry.

2.4.0 How to address the Increasing feed cost and scarcity

Feed alone as a component in production cost takes 70-75% (Ademola and Farinu, 2006). Irregular supply of poultry feeds resources such as maize, forming a major component constitute about 60% of the total animal ration prepared is as a result of using this ingredients as a staple food for human and as well livestock (poultry) in tropical countries (Ashitey and Flake, 2010).

In this regards, Koney (1992) reported that it will be very important that the level of grain in standard poultry ration be reduce without adversely hampering the production of the poultry birds. Some certain programs have been put in place to reduce the high cost of feeding poultry including the use of Agricultural by-products, ingredients substitution and the use of new feed resources.

2.4.1 Use of agro by – products

According to Oluyemi and Roberts (1988), agricultural by-products are obtained from the processing of agricultural products and they are not directly used by man but in animal diets (Farrell, 1997). The use of alternative feed ingredients in poultry diets can be an interesting choice from an economical perspective. But the nutritional value of the alternative ingredients should be kept in mind particularly the presence of anti-nutritional factors.

Scarcity and soaring feed prices have occasioned the use of agro-by product as a substitute for traditional feedstuffs. Agro by-products are mostly industrial by – products obtained from the processing of agricultural products from animals and crops. They include copra kernel meal, soya bean meal, molasses and cereal brans which are important for feeding poultry (Oluyemi and Roberts, 1979). Fermented by-products from the brewing and wine industries like "pito mash" contain a high content of vitamin B and can be used in feeding poultry (Buamah, 1992).

Having a better quality protein than that of wheat and maize brans, "pito mash" is seen to be among the highest of all common feeds (McDonald*et al*., 1995) and also serve as source of phosphorus.

A number of agro-industrial – products are available for animal feeding (Qureshi, 1987). Although they constitute the main feed resources in many developing countries (Qureshi, 1993), no statistical data is reported on particular countries using these (Nordblom and Shomo, 1995).

Some of these by – product's nutritional values can be enhanced by several methods.

2.4.2 Ingredients substitution

The feed market has become a lot more volatile over the past few years and prices have been soaring due to competition between the use of cereals and grains as a staple for human consumption and as poultry feed causing scarcity. In this regard, substitution of conventional feed ingredients would be necessary (Kekeocha, 1984). For that matter, feed ingredients that have comparable nutritional contents in one or more important nutrients may be replaced either partially or fully for one another in poultry feed and less expensive and readily available ones are used to replace the more expensive and scarce feedstuffs. The volatile nature of food prices accompanied by scarcity has forced animal nutritionists to exploit root and tubers (for example, cassava) as a cheaper substitute for energy (Chauynarong *et al.* 2009).

A properly processed cassava root can completely substitute for maize in broiler feed to provide energy (Okeke *et al*. 1992). Osei *et al*. (1994) reported that due to the superior nature of quality protein maize over normal maize, it can be used to replace normal maize in order to substitute for some protein feed ingredients such as fish meal in animal rations.

One plant that can be exploited as a non-conventional feed is false yam (Dei *et al*., 2011a).

2.5.0 The False Yam Plant

2.5.1Taxonomy

The false yam plant scientifically is known as *Icacina oliviformis*. The false yam is a perennial plant that belongs to the family, Icacinacea. In the olden days it was first named by J. Poiret as *Hirtella oliviformis* (Fay, 1987). Raynal changed the name to *Icacina oliviformis* in 1975 which is the present name of the false yam plant (Fay, 1987). The plant however, has several different local names in different parts of Africa including Ghana. In the Gambia it is called “Manankaso”, “Paore” in Sudan, “Kuraba” in Senegal, and in Ghana it is called ‘Anyigbafedzi’ in Ewe,‘Aborntupe’ in Asante, ‘Tankwara’ in Hausa and Dagomba (Fay, 1991). It is also known as “Urumbia” or “Eriagbo” among the

Ibos, “Gbegbe” by the Yorubas (Asuzu and Abubakar, 1995) and “Efikison” by the Ibibios (Etukudo, 2003) in Nigeria.

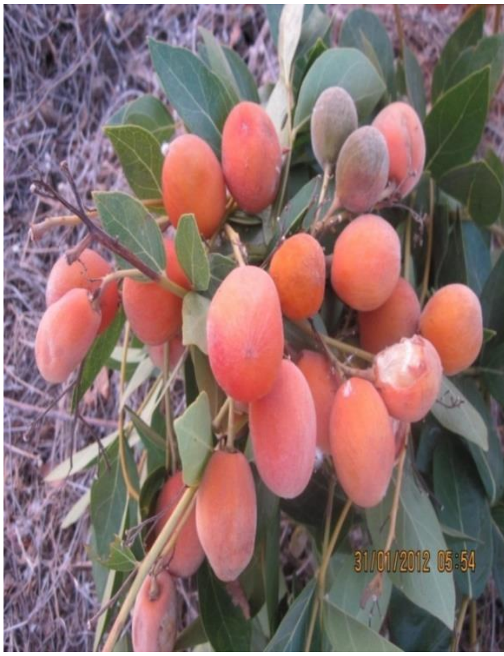

Plate 1: False yam plant with fruits **Plate 2: False yam tuber**

The plant develops vegetative leaves forming part of its shoot system from its underground tuber at or before onset of the rainy season. Its aerial stem can reach about 1m in height.

It bears flowers that are conspicuously white or creamy and pedunculate on an ascending or an erect panicle. The fruit is a bright red oval berry covered with short hairs, and a thin layer of white pulp which is 0.2cm thick surrounds a single spherical seed. The false yam is usually 2.5 to 3cm in length and 2 to 2.5cmin width and can yield about 214kg/ha (Fay, 1993). The false yam tuber appears in different sizes, measuring 100cm in length with a diameter of about 30cm (Fay, 1987).

The false yam tuber is typically about 50cm wide and is usually speckled with yellow spots believed to be toxic compounds called resins (Fay, 1987).

A research done by Kay (1973) revealed the tuber to contain 10 – 15% starch. The tuber yields about 20 t/ha in certain parts of West Africa (Kay, 1973).

2. 5.2 Geographical Distribution

Icacina is native to West and Central Africa, and can be found growing in the Savanna areas of Senegal, Gambia, Guinea Bissau, Northern Ghana, Benin, Nigeria, Central African Republic, Congo (Brazaville and Democratic Republic) Chad and parts of Sudan. Of all these places, it grows abundantly in Senegal, Guinea Bisau, Ghana and Central Africa Republic (National Research Council, 2008).The species grow on a wide variety of soils and in numerous plant communities (Fay, 1991).

2.5.3 Importance of false yam plant as human and animal food

False yam tuber prepared as food is similar in almost all species and the fruit of *Icacina guessfeldtii* are eaten in Congo (NRC, 2008).

The fruits can be eaten raw, but the seeds and tubers can be processed into flour and be used as food for humans (Fay, 1987). For use as animal feed, the leaves (though poisonous) of the false yam can be fed to non-ruminant like rabbits (Ansah and Aboagye, 2011). The seeds and tubers when treated by boiling and soaking have an improved nutritive value for broilers when used to substitute maize at 9% (Dei *et al*., 2011a).

Starch can sometimes be obtained from the tuber and used as food and other commercial purposes (Fay, 1987).

2.5.4 Ethno medicinal uses of false yam plant

Members of the *Icacina* genus have been noted to have ethno botanical properties. The parts of *Icacina* plants that are used for ethno botanical reasons include the leaves and tubers. *Icacina trichantha* is indicated to be used as medicine in rural communities in Nigeria (Asuzu and Abubakar, 1995; Timothy and Idu, 2011).

Because of its use as a source of medicine it is mostly found in most houses in corked bottles macerated tubers in ethanol. This species has also been reported by other researchers to possess analgesic anti- inflammatory and anti-diabetic properties and have antimicrobial activities (Asuzu and Abubakar, 1995). Mumps can be treated using the tuber of *Icacina trichantha* as indicated by Rufus (2010). Antioxidant activities are found to be present in some species (Odukoye *et al*., 2006). The leaves of some species can be used to treat malaria as they are found to have some antiplasmodial activity (Sarr *et al.*, 2011).

Other species are however known to show anesthetic effects in guinea pigs (Asuzu and Abubakar, 1995). *Icacina trichantha* have also noted to have anticonvulsant attributes (Lucindo *et al*., 2008; Asuzu and Abukar, 1995). The tubers of *Icacina* have been reported to be used to treat constipation, poisoning, and malaria and to induce emesis by some herbalists (Asuzu and Abubakar, 1995). Igbo people in Nigeria consider the species, *Icacina tricnantha*, to be an aphrodisiac, and they use it on soft tumours (Burkill, 1985). False yam tubers, leaves and stems are being used for several different treatments. Leafy twigs in decoction are used for internal hemorrhages and in baths and washes, for cough and all chest problems; and for feverish states, on patients should sleep over night on a bed of newly cut leaves (Kay, 1973).

Extracts from some species have been shown to induce sleepiness and reduce pain in a rodent study (Asuzu and Abubakar, 1996).Aqueous and methanol extracts of newly harvested leaves of *Icacina trichantha* have shown a wide range of antimicrobial activities with the methanol extract exhibiting preferable activity than same concentrations of the aqueous extract. Proper phytochemical screening undertaken has revealed the presence of alkaloids, saponins and tannins in both aqueous and methanol extracts of leaves of the plant.

Concentrations of these phytochemicals were recorded to be higher in the methanol extract than the aqueous extract. Methanol extract containing higher amounts of phytochemicals may account for its activity to the aqueous extract. Flavonoids, glycosides, steroids and anthraquinone were however, absent in aqueous and methanol extracts of *Icacina trichantha* leaves. Aqueous and methanol extracts both of the plants leaves have shown activity against gram- positive and gram- negative bacteria, and fungi.

The antimicrobial potentials demonstrated by these extracts have been dose dependent. In vitro investigations of these extracts have demonstrated growth inhibition of S*taphylococcus aureus*, *pseudomonas aeruginosa*, Escherichia coli, *Bacillus subtilis*, *Aspergillus niger*, and *Candida albicans* (Timothy and Idu, 2011). Rufus (2010) revealed that the juice from its tubers of *Icacina trichantha*, can be used in the treatment of mumps. Through the use of both 1, 1 – diphenyl 1-2- picryhydrazyl free radical scavenging and the reducing power (Fe^{3+}) approaches, methanol extract from *Icacina trichantha* leaves has exhibited anti-oxidant activity which is dose specific. In similar study conducted, phytochemical screening revealed the presence of phenols in the plant leaves.

The occurrence of phenols in the leaves of *Icacina trichantha* agree with a study that shows a high correlation between phenolic content and antioxidant activity (Odukoye *et al*; 2005; Odukoye *et al*., 2006). Methanol extracts of *Icacina trichantha*, folium; *Icacina trichantha*, lignum; *Icacina trichantha*, radix have been indicated to exhibit antioxidant activity and the presence of polyphenols with alkaloids (Oke and Hamburger, 2002). The antioxidant or antiradical property exhibited is an indication of the presence of flavonoids (Nakayoma and Yamada, 1995). *Icacina trichantha* leaves have been found to decrease blood glucose levels significantly ($P<0.01$) in a dose-dependent manner for the treatment of alloxan – induced diabetic mice with methanolic crude extract (Ezeigbo, 2010).

Methanol extract doses of *Icacina trichantha* tuber had stimulated sleep in rats and local anaesthetic effect in guinea – pigs. The time for which rats slept was observed to be dose dependent. The extract was able to give 80% protection to rats poisoned with pentylene tetrazole yet failed to prevent rats from strychinine poisoning. It also influenced significant dose dependant analgesia in rats and showed significant muscle relaxant property in mice (Asuzu and Abubakar, 1995). Chloroform extract from *Icacina trichantha* tubers is found to inhibit croton oil which is use to induced ear edema in mice in a dose dependent manner compared to hexane, ethyl acetate, methanol and water extracts.

The chloroform extract has also been demonstrated to significantly reduce problems of carrageenan induced paw edema in rats, after it is orally administered: (50, 100 or 200) mg/kg of the proportion decreased the global edematous response by 15, 20 or 34%, but 10mg/kg of indomethacin stimulated 40% inhabitation (Asuzu et al., 1999).

It is also found that the central nervous system active component of *Icacina trichantha* tuber extract resides almost completely in the chloroform soluble.

This is supported by the view that chloroform extract of *Icacina trichanta* tuber significantly increased pentobarbitone induced sleep, reduced response of mice to pain (analgesia), which prevented mice from death because of leptazole – stimulated convulsions and decrease motor co-ordination in treated mice. Another revealing thing about the *Icacina trichantha* leaf is that an extract obtain from it (ethyl acetate extract) at a dose of 400mg/kg could reverse paracetamol-induced hepatic damage in adult Wista rats better than filymavin ($P < 0.05$). An invivo study reveal the same extract demonstrated antioxidant and hepatoprotective activities on paracetamol – stimulated liver damage in rats.

Compared to ascorbic acid, the antioxidant activity could not give favourable results. For this reason, no symptoms of toxicity and death were recorded among the wister rats. At a dose of 2000 mg/kg, the ethyl acetate extract of *Icacina trichantha* did not show adverse effects on rats. For that matter, it is relatively safe and corroborates its use in local medicine particularly as a solution for hyperglycemia (Ezeigbo, 2010; Udeh and Nwaehujor, 2011). The report on the hepatoprotective properties of ethyl acetate leaf extract of *Icacina trichantha* at the different levels showed a reversal of all the increased levels in the liver enzymes, bilirubin as well as protein (Udeh and Nwaehujor, 2011).

In the initial in vitro tests investigated on the biological activities of *Icacina trichantha* in mice, the ethanol, petroleum ether and aqueous extract of tuber, roots, stems and leaves did not indicate contraction of isolated guinea pigs ileum to an amount of 40.5 mg/ml.

2.5.5 Non – medicinal uses of false yam

The false yam, apart from the fact that it is used for medicinal purposes involving the leaves, tubers and even extracts of it, are also used for non-medicinal functions. For instance in Nigeria, the Yorubas use the leaves of *Icacina trichantha* to crown their chiefs (Ezeigbo, 2010). Among the Ibo in Nigeria, the leaves of *Icacina trichantha* is used to wrap processed oil bean seeds known as 'Ugba' (Asuzu and Abubakar, 1995).

2.5.6 Limitation of the false yam plant

In spite of the numerous usefulness of the false yam plant it is however limited by a number of factors that makes it difficult to be used easily for the benefits. Both the tubers and seeds of the false yam contain bitter substances that need to be washed out. Also, harvesting and processing of both the seeds and tubers to be used as food are found to be tedious. According to Fay (1987), the plant is noted to be a notorious weed in the savannah lands and road sides, destroying not only shovels and ploughs but also making people lose their patience

2.5.6.1 Anti- Nutritional factors in the false yam plant

The false yam shrub is drought resistant (StyIslinger, 2011) and the tubers and seeds contain poisonous substances called gum resins, which have been identified as terpenes (Vanhaelen *et al.*, 1986). Sitosterol 3 – 0- β-D glupyranoside, (Cacenone and sigmastero) 3-0-β-D- glupyranoside are the three major components of Icacenone (Vanhaelen *et al*., 1986).

These terpenes are present in quantities ranging from 0.9 – 2.8% (NRI, 1987). Dei *et al.* (2011b) indicated that soaked false yam tuber contains 3.75% gum resins.

Terpenes/resins in false yam tuber meal at least contribute negatively to the growth performance of broiler chickens (Dei *et al*., 2011).

Gershenzon and Dudareva (2007) reported that terpenes contains cytotoxic properties which act as growth inhibitors when given to animals. According to Jansman *et al*. (1995), anti-nutritional factors form complexes with proteins and enzymes in the digestive tract of animals and as a result affect protein and carbohydrate digestibility.

2.6.0. Major effects of anti-nutritional factors in monogastric animal nutrition

Many plant components and seeds of legumes and other plant sources contain in their raw states wide varieties of anti-nutrients which are potentially toxic (D'Mello, 2000) as feed ingredients in animal diets. These anti-nutrients hinder the utilization of feedstuffs by animals, which include reduction in feed intake, reduced growth, digestibility and mineral absorption. In some instances, anti-nutritional factors inhibits blood components, system disorder and death in animals.

2.6.1 Reduction in feed intake

Naturally occurring compounds such as protease inhibitors, goitrogens, alkaloids, oxalates and phytates present in some feed components form complexes that antagonizes the availability of nutrients, depressed feed intake and reduce the growth in animals that consume them (Hathcock and Rader, 1994; Shahidi, 1997). As a dietary ingredient in broiler chicken, mucuna beans was observed to have significantly reduced feed intake (Carew *et al.* 2003). Palatability and growth rate were observed to be decreased when animals were fed diets containing tannins (Roder, 1995).

Also, mucuna seed was shown to reduce feed intake when it was fed to hens at 6% inclusion level because of the presence of tannins and trypsin inhibitors (Tuleun *et al*., 2009). Jenkins and Atwal (1994) reported a reduction in feed intake when birds were fed diets with saponins as high as 9g/kg thereby causing the feed to have a bitter taste (Cheeke, 1971).

2.6.2 Reduction in growth

Chunmei *et al*. (2010) attributed a reduction in growth rates of rats when they were fed varieties of soybeans containing trypsin in hibitors and lectin. Saponins have been observed to reduce growth and feed efficiency in chicks (Jenkins and Atwal, 1994). The effect of protease inhibitors is observed to be associated with growth inhibition and pancreatic hypertrophy (Chunmei *et al*., 2010) in animals. Goitrogenic substances which cause enlargement of the thyroid gland have been found in legumes, for instance, soybean and groundnut and these tend to inhibit the production of and release of the thyroid hormones.

Thyroid hormones help significantly in the control of body metabolism and their deficiency leads to reduced growth and reproductive performance (Olomu, 1995). Iji*et al.* (2004) reported toxicity in chicks fed sorghum grains and faba beans containing tannins.

Also, the effect of various levels of cocoa pods husk based diets in mice, pigs and poultry was reported to affect their growth (Owusu-Domfeh, 1972; Clarke and Clarke, 1979; Peckham, 1984), probably due to theobromine (Atuahene *et al*., 1998). According to McDonald *et al*., (2002) terpenes can antagonize the availability of nutrients, hence reduce growth in animals.

2.6.3 Reduction in digestibility

Aletor (1993) reported that tannins caused decreased feed consumption in animals, bind dietary proteins and digestive enzymes to form complexes that are not readily digestible. Previous findings of Chunmei *et al*., (2010) indicated poor digestibility of dry matter, protein and nitrogen free extract when rats were fed raw soybean based diets. They observed that protein digestibility significantly decreased by 22.56% when rats were fed raw soybean based diets containing the highest level of trypsin inhibitors.

An investigation by Qin (2003) showed that lectin could combine with a specific receptor (polyose) of the epithelial cell surface in the small intestine wall, destroying the brush border mucosa structure of the ileum, interfering with the function of many enzymes in the brush border mucosa, so as to decrease protein utilization efficiency. The effects of saponins in diets of chicks were reported to antagonized the absorption of dietary lipids, cholesterol, bile aciods and hence reduce digestibility (Jenkins and Atwal, 1994).

They also alter the cell wall permeability and produce some toxic effects when ingested (Belmar *et al*., 1999). Whole soybeans is said to contain 1-2% phytic acids (Weingartner, 1987; Osho, 1993), combine to form protein and mineral- phytic acid complexes, which reduce protein and mineral bioavailability (Erdman, 1979; Spinelli *et al*., 1983; Khare, 2000). It is also noted to inhibit the action of gastro-intestinal tyrosinase, trypsin, pepsin, lipase and amylase (Khare, 2000). According to Akande *et al*. (2010), oxalic acid binds with calcium to form insoluble oxalates which affects the absorption and utilization of calcium in the animal.

The findings of Mohammed and Dei (2013) attributed a reduction in protein and fat digestibility in layer diets containing soaked false yam tuber meal, to the presence of anti-nutritional factors such as gum resins in the soaked false yam tuber meal.

2.6.4 Interference in blood components

Blood is an important index of physiological, pathological and nutritional status in the organism (Olorode *et al*., 2007).

It gives a reflection of the effects of dietary treatments on the animal with regards to the type, quality and amounts of the feed ingested, which is available for the animal to meet its physiological, biochemical and metabolic necessities (Ewuola *et al*., 2004). According Jones and Hunts (1982) red blood cells (RBCs) are manufactured in the bone marrow of flat bones (chest, skull) and any toxic material affecting these points will cause a drop in RBC production. A drop in RBC values could also be due to low quality feed and protein deficiency in a diet (Awoniyi *et al*., 2000). Due to this, Johnson *et al*. (1986) reported that the effect of saponins in diets includes haemolysis of the red blood cells and toxicity to rats. They are also noted to cause a reduction in blood and liver cholesterol levels (Akande *et al*., 2010).

It is reported that glycoalkaloids effects in diets are responsible for haemolysis in humans (Saito *et al*., 1990; Aletor 1991). Pigeon pea seed is indicated to contain haenaglutinin (Amaefule, 2002) which is known to affect blood formation in animals by reduction of packed cell volume (Akinmutimi, 2004). The findings of Agbabiaka*etal*. (2013) indicated a reduction in the haemoglobin and red blood cell counts when birds were fed tiger nut based diets beyond 50%.

They attributed this situation to the presence of high fibre content and antinutritional factors in the tigre nut based diets. Tewe (2006) attributed changes in haematological indices to the presence of high cyanide levels when growing pigs were fed sun-dried cassava based rations.

2.6.5 Disorders and death

Anti-nutrient factors like hydrogen cyanide contained in plants can cause a malfunction of the central nervous system, respiratory failure and cardiac arrest (D'Mello, 2000) when fed to animals. The effect of tannins is observed to include intestinal damage, interference with iron absorption and can also have a carcinogenic effect (Butler, 1989) in animals.

It is reported that *Napoleona imperalis* seed meal contains oxalate which decreases the availability of dietary calcium at high concentration and eventually death due to its corrosive effects (Kumar and D'Mello, 1991). Douglas *et al*. (1993) reported that tannins found in sorghum, can cause death to poultry with inclusion level of about 30-70g/kg in their diets (Salunke and Chavan, 1990; Farrel *et al*., 1999; Iji *et al*., 2004). Hydrocyanic acid, a highly poisonous substance, in cassava impairs cellular respiration which can lead to death (Salkowski and Penny, 1994) when the material is used as a feed ingredient in poultry diets.

2.7.0 Processing of false yam

The chemistry of Icacina reveals that it contains 0.08% icacinone and 0.03% icacinol including 3-0-β-D glucosides of β-sitoster and stigmaterol (Neuwinger, 1996). As reported by Antai and Nkwelang (1999), the false yam contain bitter compound such as hydrocyanic acid, phytic acid as well as oxalic acid akin to the bitter principle in cassava, which makes the false yam unpalatable to both human and animals especially poultry.

However, with better treatments or processing the bitter or anti nutritional components can be reduced to promote better utilization of the false yam by either human beings or other animals especially poultry. This is buttressed by the findings of Fagbemi *et al*. (2005), that processing reduces significantly the anti-nutritional factors in foods. Processing of the tuber, which is a potential feed ingredient, can reduce the toxic substances (gum resins) according to Dei *et al*. (2011).

Researchers have tried various processing techniques for the false yam (seeds and tubers) for better utilization by animals and these include the following: soaking, boiling, fermentation and addition of additives.

2.7.1 Soaking

Soaking refers to making a substance totally wet by submerging it in a liquid for a period. In this instance, it involves processing of the false yam (especially tubers) in water (Mohammed and Dei, 2013). This is process involves sliced false yam tubers that are put in clean water for several days to leach out toxic and bitter compounds (NRI, 1987).

Dei *et al*. (2012) recommended that false yam seed should preferably be soaked for 12 days for use as a feed ingredient in broiler diets after studying the effects of soaking duration (9,12,and 15 days respectively) on the nutritive value of the seed for broiler chickens. Moreover it is reported that soaking false yam tuber in water for12 days can replace maize up to 10% in Ashanti black weaner pig's diet with no detrimental effect on their growth performance (Dei *et al*., 2013).

Dei *et al*. (2013) also reported that soaking false yam tuber in water before drying improves its nutritional value for broiler chicken when such processed material is fed up to 90g/kg in the grower diet. This confirmed the results of an earlier study by Dei *et al*. (2011), when false yam tuber was soaked in water. A further study revealed that false yam (especially tubers) can be soaked in saltpetre solution (Dei *et al*., 2015) to reduce the effects of the anti-nutritional factors. From this investigation, soaking false yam tuber in saltpetre solution improved its utilization by broilers and could be fed up to 120g/kg without any detrimental effects on growth performance. This is because, as an oxidizer, saltpetre (potassium nitrate) reacts to remove carbon – carbon double bonds in the structure of terpenes because its (terpenes) ability to react with oxidizing agents (Pommer, 2003).

2.7.2 Boiling

Boiling is the rapid vaporization of a liquid which occurs when a liquid is heated to its boiling point, the temperature at which the vapor pressure of the liquid is equal to pressure exerted on the liquid by the surrounding atmosphere (https: //en m. Wikipedia.org/wiki/Boiling).

According to Dei *et al.* (2011), boiling of *Icacina olivoformis* tubers for 2 hours has been demonstrated to improve its nutritive value for broilers when included in their diet at 90g/kg. Boiling of the false yam seed for 1-3hrs improved growth performance of broiler chicken (Dei *et al*., 2013).

2.7.3 Fermentation

Fermentation is the process of treatment of raw materials by using microbes (such as bacteria, mold and yeast) to form new and better products than the initial one (Frazier and Washoff, 1988).

Fermentation procedures have been found to reduce anti-nutritional factors in feedstuffs and ensure better performance when those feeds are fed to animals. Kim (2004) observed a reduction in trypsin inhibitors when soybean meal was treated by fermentation. Also, weaned pigs were observed to exhibit higher growth performance and nutrient digestibility when they were fed fermented soy protein (FSP) meal than those fed soy protein of untreated soybean meal diets (Min *et al*. 2004).

Antai and Nkwelang (1999) reported that fermentation of the *Icacina manii* paste for six (6) days resulted to a reduction in the level of anti-nutritional factors, giving a reduction in the range of 178 mg/kg to 170mg/kg for hydrochloric acid, 638mg/kg to 463mg/kg for oxalic acid and 49mg/kg to 21mg/kg for phytic acid.

Teog (2010) also noted that aerobic fermented false yam tuber meal (FFYTM) had negative effect on the growth performance of broiler chickens, but had no adverse effect on carcass dressing percentage of broiler chicken.

2.7.4 Treatment with charcoal

Agyeman *et al.* (2012) reported that charcoal is commonly produced in earth mounds using wood from natural vegetation. Charcoal is a carbonaceous crop residue of wood and black, which in its very fine nature, is odorless, tasteless, can absorb toxins, gases, drugs, fat and fat soluble substances without any specific action (Kutlu, *et al*.

2000).Charcoal is regarded as a universal antidote to toxic substances (Kanzler, 1995) and is found to attenuate toxins such as aflatoxins, fumonisins, ochratoxin A, trichothenes and zearalenone (Dalvi and Ademoyero, 1983; Rotter *et al*., 1989; Kubena *et al*., 1990; Edrington *et al*., 1997; Huwig *et al*., 2001).

Natural toxins are also removed or attenuated by activated charcoal treatment or supplementation (Pass and Stewart, 1984; McLennan and Amos, 1989; Poage *et al*., 2000; Banner *et al*., 2000; Bisson *et al*., 2001). Studies have shown that charcoal is important in the control of pathogenic bacteria (Almagambetov *et al*., 1992; Nikolaeva *et al*., 1994) and form complexes with phenols in the gastrointestinal tract in order to prevent hydrosable tannins interference with enzyme function and protein digestion (Murdiati *et al*., 1991). Previous studies by Mohammed *et al*., (2017) indicated that charcoal has the potential of aiding the utilization of false yam seed meal up to 140g/kg in the diet of broiler chicken. This was seen to be attributed to the fact that charcoal has the ability to bind with the toxic substances in the gut of poultry. Edrington *et al*., (1997), Kutlu and Unsal, (1998), Shareef *et al*., (1998), and Majewska and Siwik, (2006) reported improvement or increase in body weight, survival and feed utilization when broiler chickens were fed diets containing charcoal. Gerlach and Schmidt (2012) stated that biochar as feed supplement in animals promotes digestion, improves feed efficiency and in particular energy absorption via the feed. This is because toxins such as dioxin, glyphosate, mycotoxins, pesticides and PAHs are efficiently bound by the biochar, hence obviating any adverse effects on the digestive system and intestinal flora. Teleb *et al*. (2004) found a diet supplemented with 0.5% biochar made from locally available wood overcame the adverse effects of feeding broilers 30ppb aflatoxin. This reduced mortality rates and improved growth rates when compared to those fed 30ppb aflatoxin. Kutlu *et al.* (2000), Jiya *et al*. (2013) and Prasai (2013) have all noticed significant increased growth rates and higher final body weights for broilers fed diets supplemented with 0.2% - 0.6% biochar made from oak, maize cob, seed of Canarium, coconut shell and locally available wood. But other studies have reported that too much of biochar in the diet can be deleterious.

In this regard Odunsi *et al*. (2007), Kana*et al*. (2010) and Jiya *et al*. (2013) all found depressed growth rates and final body weights for broilers fed diets supplemented with 2% or more biochar.

2.8.0 Chemical composition of the false yam plant

Table 2 shows the chemical composition of the false yam (seed or tuber) which have been reported by different researchers.

Table 2: Chemical composition of the false yam plant (%)

Source	**(Kay,1973)**	**Dei *et al.* *(2012)***	**(Fay, 1991)**	**Dei *et al.* (2011)**	**Dei *et al.* (2011)**	**NRI (1987)**
	Seed	**Seed (soaked and dried)**	**Tuber(fresh)**	**Tuber(dried)**	**Tuber (soaked- g/kg "as fed basis)**	**Tuber (dried)**
	13	14.1	59.0	13.5	-	11.7
	8	7.4	4.4	5.4	30.0	10.3
	-	0.4	1.6	1.6	9.1	0.7
s	72	65.6 (starch)	84.5	53.1(Starch)	581.2 (starch)	74.5
	0.1	1.7	-	-	72.0	-
	0.5	0.5	-	-	14.0	2.8mg/g
	-	-	-	-	-	150mg/g
	-	-	-	-	-	7mg/g
	-	-	-	-	-	0.04mg/g
	-	-	-	-	-	0.18mg/g
	-	-	-	-	-	1.4mg/g

The above table indicates that both the false yam seed and tuber are high in carbohydrate (starch).the fresh false yam tuber from the table is higher than the processed tuber. From the table, it can be observed that the false yam tuber and seed have small crude proteins, fat and ash values.

The reported crude protein concentration in the seed is higher than in the tuber except what is reported by NRI (1987). However, the fat and ash values in the false yam tuber are higher than in the seed. The high carbohydrate content of both the seed and tuber suggests that they preferably can be used as feed ingredients in the diets of monogastrics (poultry, pigs, etc). The differences in the nutrient compositions in both the tuber and seed may be due to differences in processing methods and geographical locations of the plant.

2.8.1 Nutritional evaluation of false yam in mongastric animals

The false yam is a potential plant that could serve as an alternative source of dietary energy in poultry rations (Dei *et al.*, 2010). But its utilization is limited by the presence of toxic compounds identified as terpenes (Vanhaelen *et al.*, 1986). Terpenes are known to be toxins, growth inhibitors or deterrents to animals (Gershenzon and Dudareva, 2007), and therefore in the false yam (seed or tuber) they need to be removed to enhance the utilization of this material as a dietary ingredient. Processing by cooking, soaking, fermentation and others are reported to serve as effective means of removing the anti-nutritive properties found in other root or tuber crops used in diets of monogastric animals (Feng*et al.*, 2003).

Studies have shown that, these recommended practices can be used to improve the nutritional values of false yam (seed and tuber meals) for monogastrics.

Processing of the tuber traditionally involves peeling and chopping it into pieces (about 2cm long) with a knife. The chopped tuber can be soaked in water, boiled in water or soaked water containing additives (such as saltpetre and sodium chloride). The seeds on the other hand, is processed by cracking the fruits using stones to remove the seeds and then soaked or boiled in water. These products are dried and milled before being used in the ration of monogastric animals.

2.8.1.1 Broiler chickens

Preliminary work by Dei *et al*. (2011a) was done to study the nutritive value of untreated false yam tuber meal for broiler chickens. In this experiment the tubers were peeled, cut into pieces with a knife and sun-dried for five (5) days. The findings of this experiment showed a decreasing trend of feed intake, live weight gain and feed conversion efficiency of broiler chickens when they were fed increasing levels of the raw tuber meal-based diet beyond 3%. Dei *et al*. (2013) observed that processing the tuber by soaking in water for 9 days improved the nutritional value. This processed product can be fed up to 90g/kg broiler grower diet without any detrimental effects on performance (Table 3).

Table 3: Effect of soaked (9 days) false yam tuber meal on mean feed intake, weight gain and gain/feed of broilers (3-8 weeks of age)

Parameter	Control(0)	30	60	90	±SED
Feed intake (g/bird/day)	120.0	122.3	123.0	119.0	6.39ns
Weight gain (g/bird/day)	56.7	51.4	51.2	46.2	4.74ns
Gain: Feed Ratio	0.473	0.420	0.416	0.388	0.037ns

SED-standard error difference, ns-not significant, (P>0.05)

Source: Dei *et al*. (2013)

A similar experiment was conducted to study the effect of varying levels of soaked false yam tuber meal on the diets beyond 9% on the growth performance of broiler chickens (Dei *et al*., 2015a).

In this experiment, there was a decline in feed intake and mean weight of the birds when the birds were fed diets containing 120g/kg and 150g/kg soaked false yam tuber (Table 4). This was attributed high residual concentration of gum resins (terpenes) in the soaked false yam tuber meal that was fed to the birds. This is because, McDonald *et al*. (2002) reported that terpenes actually antagonize the availability of nutrients and reduce performance in animals.

Table 4: Effect of soaked false yam tuber meal fed to broilers on feed intake, weight gain and gain/feed of broilers (d 21-56)

Parameter	Control (0)	120	150	SED	P
Feed intake (g/bird/day)	111.1[a]	86.1[b]	72.0[b]	7.13	0.004
Weight gain (g/bird/day)	43.1[a]	26.3[b]	19.9[b]	2.74	<0.001
Gain: Feed Ratio	0.39[a]	0.30[b]	0.28[b]	0.012	<0.001

SED-standard error of difference, P-probability, Means with the same superscripts in a row are not significantly different (P>0.05)

Source: Dei *et al.* (2015a)

The findings of this study therefore suggest that soaked false yam tuber cannot be used as a feed ingredient in the diets of broiler chickens beyond 90g/kg (Table 4).

Dei *et al*. (2015b) conducted another experiment to determine the effect of soaking of false yam tuber meal in saltpetre solution on the growth performance of broiler chicken.

In this experiment, the tubers were soaked in 0.1% saltpetre solution, which was changed every 3 days for 12 days. The saltpetre was used because it is reported to have the ability to react with many different compounds including terpenes (Pommer, 2003) and therefore can remove the anti-nutritional factors in the false yam tuber. After the processing, the tuber was used to replace maize (w/w basis) in a maize-fish meal diet at 80, 100 and 120g/kg in diets of broiler chickens (Table 5).

The findings of the experiment showed that soaking the tuber in salt petre (potassium nitrate) solution improved its utilization by broilers and could be fed up to 120g/kg without any adverse effect on their performance (Table 5). In an earlier experiment, Dei *et al*. 2013 used sodium chloride solution (NaCl). The result in this experiment however, showed a depressed growth performance when broilers were fed the SFYTM based-diets (Table 6).

Table 5: Effect of false yam tuber soaked (12 days) in salt petre on feed intake, weight gain and gain to feed ratio of broiler chickens (23-56 d of age)

Variable	Control (0)	80	100	120	SED	P
Feed intake (g/bird/day)	119.4	120.9	117.6	115.5	3.37	0.461
Weight gain (g/bird/day)	40.58	37.40	37.15	37.15	1.306	0.078
Gain: Feed Ratio (g/bird/day)	0.34	0.31	0.32	0.31	0.016	0.307

SED-standard error of difference, P-probability, Means with different superscripts are significantly different (P<0.05)

Source: Dei *et al*., (2015b)

Table 6: Effect of false yam tuber treated with sodium chloride on feed intake, weight gain and gain to feed ratio of broiler chickens (23-56 d of age)

Variable	Control (0)	80	100	120	SED	P
Feed intake (g/bird/day)	98.7	95.1	97.5	100.6	3.59	0.519
Weight gain (g/bird/day)	42.4[a]	33.4[b]	35.0[b]	33.0[b]	2.759	0.030
Gain: Feed Ratio	0.43[a]	0.35[b]	0.36[b]	.033[b]	0.021	0.005

SED-standard error of difference, P-probability, Means with different superscripts are significantly different ($P<0.05$)

Source: Dei *et al*., (2013)

A study was conducted by Dei *et al*., (2011) to evaluate the effect of boiling false yam tuber in water on the growth performance of broiler chickens. In this instance, the chopped tubers were boiled in fresh water for 2 hours, sun-dried and milled into flour before feeding to the birds. The BFYTM diets were replaced for maize (w/w basis) at 30, 60 and 90g/kg and which were then fed to broiler chickens between 21 days and 56 days. It was observed that boiling the tuber resulted to a reduction of the level of resins in the tuber by 39% of the recorded 37.5g total resins in SDFYTM (Dei *et al*., 2011). The results of the experiment also showed that broiler chickens can be fed diets containing boiled false yam tuber meal up to 90g/kg without any effect on their growth performance (Table 7).

Table 7: Effect of boiled false yam tuber meal (BFYTM) from 21 to 56 d on broiler feed intake, weight gain and gain to feed ratio

Variable	Control (0)	30	60	90	SEM	P-value
Feed intake (g/bird/day)	114.8	116.5	119.8	117.3	3.41	NS
Weight gain (g/bird/day)	50.8	52.4	52.9	51.5	3.70	NS
Gain: Feed Ratio	0.44	0.45	0.44	0.44	0.020	NS

SEM-standard error of means, NS-not significant (P>0.05)

Source: Dei *et al*., (2011)

The findings of Osei *et al*., (2013) indicated that feeding broilers at 5% level of BFYTM had a negative effect on their growth performance (Table 8). The disparity to the observation of Dei *et al*. (2011), could be due to factors such as false yam varietal differences and strains of broiler used.

Table 8: Effect of boiled false yam tuber meal on broiler feed intake, weight gain and gain to feed ratio

Parameters	Control (0)	5%	10%	LSD
Feed intake (g/bird/day)	129.1	121.9	118.1	0.011
Weight gain (g/bird/day)	52.0[a]	41.3[bc]	40.1[c]	0.004
Feed: Gain Ratio	2.48[b]	2.95[a]	2.94[a]	0.498

LSD-Least significant difference at 5% level, [a,b,c]Means within rows with the same superscripts are not significantly different (P>0.05) . Source: Osei *et al*., (2013)

There is a lack of knowledge on the duration with which boiling of the tuber can impact on the nutritive value of false yam tuber for the growth of broiler chickens.

For this reason, Tibieb (2011) conducted an investigation to ascertain the effect of varying boiling time (1-3 hours) on the nutritive value of false yam tuber for broiler chickens (Table 9). In this experiment, the tubers were chopped into pieces and boiled in water (one part of fresh tuber to one part of water) for 1, 2 and 3 hours respectively and sun-dried and milled into gritty flour. The processed tubers were each then replaced for maize on (w/w) at 100g/kg in grower broiler diet fed from 3-8 weeks of age. The result of the study revealed that the different boiling times of the tuber had similar effect on its feeding value for broiler chickens. Also, it was observed that birds can be fed the material boiled for 1hour. Inadvertently, the feeding of the boiled tuber at 100g/kg had poor effect on broiler performance therefore agreeing to the findings of Osei *et al*. (2013).

Table 9: Effect of boiling duration of false yam tuber on feed intake, weight gain and gain to feed ratio of broiler chickens (3-8 weeks of age)

Parameters	Control (0)	1HR	2HR	3HR	±SED	P
Feed intake (g/bird/day)	121.3[a]	102.9[b]	103.8[b]	104.1[b]	5.23	*
Weight gain (g/bird/day)	55.5[a]	42.5[b]	42.1[b]	45.2[b]	3.00	**
Gain: Feed Ratio (g/bird/day)	0.46	0.41	0.41	0.43	0.026	Ns

SED-standard error difference, Means with the same superscripts in a row are not significantly different (P>0.05), ns-non significant

Source: Tibieb, (2011)

From the above discussion it is realized that separate processing procedures by either soaking or boiling apparently show promise of improving the nutritional value of the tuber for broiler chicken. Hence the need to combine these methods on the tuber is not known.

In light of this, Dei *et al*., (2013) carried out an experiment to evaluate the effect of soaked/boiled false yam tuber on the performance of broiler chickens (Table 10). In this experiment the tubers were chopped into pieces, soaked for 12 days with the water changed every 3 days, and then boiled in water (1 part of tuber to 2 parts of water) for 2 hours, sun-dried for 5 days and milled into a gritty meal.

There were four dietary treatments comprising of the control and diets containing the soaked/boiled (SBFYTM) false yam tuber substituted for maize at 80, 100 and 120g/kg in maize-fishmeal based diets.

The results of this experiment indicated that processing of the false yam tuber by soaking and boiling improved its nutritional value and therefore can be included in diets up to 120g/kg without any adverse effects on broiler chicken performance (Table 10).

Table 10: Effect of SBFYTM on feed intake, weight gain and gain to feed ratio of broiler chickens (4-8 weeks of age)

Parameters	Control	80	100	120	±SED	P
Feed intake (g/bird/day)	133.5[a]	131[a]	118.9[b]	119.1[b]	3.57	0.005
Weight gain (g/bird/day)	62.9	62.6	58.1	50.7	5.10	0.134
Gain: Feed Ratio	0.47	0.48	0.49	0.43	0.33	0.336

SED-standard error difference, P-probability, [a,b]Means with the same superscript in a row are not significantly different (P>0.05)

Source: Dei *et al*., (2013)

The false yam seed is another aspect which many have researched into, to unearth its nutritive value as feed ingredient in monogastric animal diets. In this instance, Dei *et al*., (2011b) observed that processing the seed by soaking improves its nutritional value.

In this experiment, the seeds were soaked in water (1 part of seeds to 2 parts of water) for 3 days and were changed every 24 hours, sun-dried for 7 days and milled into gritty meal and labeled SFYSM. The experiment was conducted at four dietary levels (0. 50, 75,100 g/kg) of the false yam seed meals prepared and replaced for maize (w/w) in diets of broiler grower aged between 3 and 8 weeks (Table 11).

The findings of the experiment showed that soaking of the false yam seed improved its nutritive value and therefore can be fed to broiler chickens up to 100g/kg without any adverse effects on their growth performance.

Table 11: Effect of soaked (3 days) false yam seed meal on feed intake, weight gain and gain to feed ratio of broiler chickens (3-8 weeks of age)

Parameter	Control (0)	50	75	100	±SED	P
Feed intake (g/bird/day)	105.8	104.8	96.5	94.7	4.35	0.075
Weight gain (g/bird/day)	60.6	57.3	55.8	56.2	3.80	0.598
Gain: Feed Ratio	0.47	0.45	0.46	0.48	0.015	0.375

SED-standard error difference, P-probability

Source: Dei *et al*. (2011b)

Also, Dei *et al*., (2012) carried out an experiment to ascertain the effect of soaking duration (9, 12 and 15 days) on the nutritional value of false yam seed meal for broiler chickens. After the processing the soaked false yam seed meal were labeled 9SFYSM, 12SFYSM and 15SFYSM, and each was replaced for maize (w/w) at 100g/kg in grower diet. The result of the nutrient composition of the experiment showed that carbohydrate content in the SFYSM is comparable to the control diet and therefore can replace maize as an energy source in broiler chicken diet (Table 12). The results of the feeding trial showed that soaking of the false yam seed meal for 12days improved its feeding value for broiler chickens (Table 13).

Table 12: Nutrient composition of SFYSM compared with maize (%DM basis)

Nutrient component	9SFYSM	12SFYSM	15SFYSM	Maize
Dry matter	85.90	85.52	86.12	86.95
Crude protein	8.57	8.11	8.40	10.20
Ether Extract	0.48	0.82	0.56	4.80
Neutral Detergent Fibre	7.41	7.12	9.85	[1](2)
Ash	0.56	0.75	0.63	(2.1)
Starch	76.34	76.65	77.65	(79.5)
Gross energy (MJ/kg)	15.34	15.25	15.38	-

Source :[1]Value and bracket adopted from NRI, (1994)

Table 13: Effect of SFYSM (for 9, 12 and 15d) on feed intake, weight gain and gain to feed ratio of broiler chickens (3-8 weeks of age)

Parameters	Control (0)	9d	12d	15d	±SED	P
Feed intake (g/bird/day)	111.1[a]	99.4[b]	107.4[ab]	108.0[a]	2.23	0.004
Weight gain (g/bird/day)	43.1[a]	35.4[b]	39.0[ab]	38.5[b]	1.53	0.004
Gain: Feed Ratio	0.39	0.36	0.36	0.36	0.016	0.096

SED-standard error difference,[a,b]Means with the same superscripts in a row are not significantly different (P>0.05)

Source: Dei *et al*., (2012)

A study was conducted by Dei *et al*., (2011b) to determine the effect of boiling on the nutritive value of seeds. The seeds were cracked by a stone and boiled in water (1 part of seed to 1 part of water) for 30 minutes, sun-dried for 7 days, milled into gritty meal and labeled BFYSM. In this trial, four dietary treatments used to replace maize (w/w) at 0, 50, 75, and 100g/kg were tested in a broiler grower diet from 3 to 8 weeks of age. The results of the experiment showed that BFYSM when incorporated in the diet of broiler chicken at 50g/kg or more had no detrimental effects on feed intake but affected negatively growth performance of broiler chickens (Table 14).

Table 14: Effect of BFYSM on feed intake, weight gain and gain to feed ratio of broiler chickens (3-8 weeks of age)

Parameter	Control (0)	50	75	100	±SED	P
Feed intake (g/bird/day)	105.8	97.5	105.5	88.0	6.52	0.08
Weight gain (g/bird/day)	49.41[a]	42.65[b]	40.43[b]	39.43[b]	2.35	0.01
Gain: Feed Ratio	0.47[a]	0.44[a]	0.39[b]	0.45[a]	0.02	0.03

SED-standard error difference, P-probability, [a, b]Means with the same superscripts in a row are not significantly different (P>0.05)

Source: Dei *et al*. (2011b)

In another experiment (Table 15), Dei *et al*., (2013) evaluated the effect of boiling time on the nutritive value of the false yam seeds. In this experiment the seeds were cracked with stones and boiled with water for 1, 2 and 3 hours with the ratio 1 part of seeds to 2 parts of water. The boiled seed samples were then sun-dried for 3 days and each were milled into gritty meal and labeled BFYSM-1h, BFYSM-2h AND BFYSM-3h to represent boiling durations of 1, 2 and 3 h, and replaced for maize (w/w) at 100g/kg of broiler diets. The result of the experiment show that birds showed no significant improvement in feed intake, live weight gain and feed conversion efficiency when they were fed the BFYSM diets. Also, the performance of the birds fed the BFYSM based-diets were similar, suggesting that boiling the seed beyond 1 hour provided no nutritional advantage.

Table 15: Effect of BFYSM (for 1h, 2h and 3h) on feed intake, weight gain and gain to feed ratio of broiler chickens (4-8 weeks of age)

Variable	Control (0)	1h	2h	3h	±SED	P
Feed intake (g/bird/day)	161.5[a]	133.3[b]	123.6[b]	123.4[b]	5.72	<0.001
Weight gain(g/bird/day)	64.9[a]	43.5[b]	37.1[b]	38.7[b]	2.76	<0.001
Gain: Feed Ratio	0.40[a]	0.33[b]	0.30[b]	0.31[b]	0.016	<0.001

SED-standard error difference, P-probability, [a, b]Means with different superscripts are significantly different (P<0.05)

Source: Dei *et al*. (2013)

A combine processing involving soaking (for 12 days) boiling (for 2 hours)of the false yam seed (SBFYSM) was conducted to determine its feeding value to broiler chickens (Mensah, 2013). The experiment had the false yam seed meal replacing maize (w/w) at 80, 100, and 120 g/kg in maize-fish meal based grower diets. The results of the experiment indicated that birds tended to exhibit poor growth performance when they were fed the test diets (Table 16).

Also, some particles of the boiled seed meal were seen in the droppings of the birds therefore suggesting a poor digestibility due to hardness of the seed after boiling.

Table 16: Effect of SBFYSM (at 80, 100 and120g/kg) on feed intake, weight gain and gain to feed ratio of broiler chickens (4-8 weeks of age)

Parameters	Control(0)	80	100	120	±SED	P
Feed intake (g/bird/day)	161.46[a]	129.72[a]	127.05[b]	120.95[c]	2.140	<0.001
Weight gain (g/bird/day)	64.87[a]	52.81[b]	52.62[b]	48.66[c]	1.848	<0.001
Gain: Feed Ratio	0.40	0.41	0.42	0.40	0.009	0.356

SED-standard error difference, P-probability,[a,b,c]Means with same superscript in a row are not significantly different (P>0.05)

Source: Mensah (2013)

2.8.1.2Layer chickens

Many studies have been conducted on the effect of processed tuber and seed meals on layer chicken performance. Dei *et al*. (2012b) evaluated the effect of boiling false yam tuber (for 2hours) on growth of growing pullets (Table 17). The findings of this study showed that BFYTM can be fed to pullets at 25g/kg without any adverse effects on their growth performance (Table 17). It was observed that egg production of pullets fed diets containing BFYTM up to 100g/kg was not compromised (Dei *et al*., 2012b). In a soaked seed experiment, Dei *et al*. (2012) observed no detrimental effect on growth of pullets when they were fed false yam seed-based diets up to 100g/kg (Table 17). The findings of Mohammed and Dei (2012) recommended that SFYSM can be included in diets of layer chickens up to 100g/kg without any adverse effect on their egg production.

Table 17: Effects of processed false yam products on feed intake, weight gain and gain to feed ratio of pullets (9-19 weeks of age)

Processed product	Treatments (g/kg)	Feed intake (g/bird/day)	Weight gain (g/bird/day)	Gain: Feed Ratio (g/bird/day)	Source
Diets containing SFYTM	Control(0)	72.4[a]	13.3[a]	0.18	Niayale, (2013)
	50	75.7[a]	11.7[ab]	0.15	
	75	64.0[b]	11.1[b]	0.17	
	100	62.5[b]	10.2[b]	0.16	
	SED	*2.01*	*0.67*	*0.01*	
	P-value	*<0.001*	*0.011*	*0.143*	
Diets containing BFYTM	Control(0)	64.1[a]	11.0[a]	0.17	Dei *et al.*, (2012b)
	25	61.8[b]	10.5[ab]	0.16	
	50	65.4[a]	10.0[b]	0.15	
	75	65.1[a]	9.8[b]	0.15	
	100	65.4[a]	9.7[b]	0.14	
	SED	*1.27*	*0.41*	*0.01*	
	P-value	*0.022*	*0.04*	*0.063*	
Diets containing SBFYTM	Control(0)	73.08[a]	13.25[a]	0.18[a]	Gyawu, (2013)
	50	74.50[a]	11.74[b]	0.16[b]	
	75	64.68[b]	11.79[b]	0.19[a]	
	100	63.10[b]	11.36[b]	0.18[a]	
	SED	*2.21*	*0.45*	*0.01*	
	P-value	*0.002*	*0.014*	*0.011*	
Diets containing SFYSM	Control(0)	76.07	13.57	0.18	Dei *et al.*, (2012)
	50	73.39	13.89	0.19	
	75	73.75	14.14	0.19	
	100	75.36	13.18	0.18	
	SED	*2.67*	*1.09*	*0.02*	
	P-value	*0.713*	*0.831*	*0.730*	
Diets containing BFYSM	Control(0)	72.4	13.25[a]	0.18[a]	Owusu, (2013)
	50	70.8	10.13[b]	0.14[b]	
	75	63.1	10.45[b]	0.17[b]	
	100	69.8	9.93[b]	0.14[b]	
	SED	*3.49*	*0.55*	*0.01*	
	P-value	*0.113*	*<0.001*	*0.002*	

SED-standard error of difference, [a,b]Means with the same superscripts within a column for each experiment are not significantly different (P>0.05), SFYTM-Soaked false yam tuber meal, BFYTM-Boiled false yam tuber meal, SBFYTM-Soaked and boiled false yam tuber meal, SFYSM-Soaked false yam seed meal, BFYSM-Boiled false yam seed meal.

According to Opoku-Addae (2013) and Owusu (2013) BFYSM included in the diets of pullets up to 50g/kg had no adverse effect on their growth performance and subsequent egg production (Table 18). In contrast, SFYTM can be put in the diets of pullets up to 5% without any adverse effect on growth and subsequent egg production (Niayale, 2013 and Effah, 2013).

Another experiment carried out by Ofori (2013) to evaluate the effect of soaking of the false yam tuber combined with boiling on growth and subsequent egg production of pullets reported that pullets' growth and subsequent egg production were adversely affected when they were fed the SBFYTM-based diets up to 50g/kg (Table 18).

Table 18: Performance of layer chickens fed processed false yam tuber meal during grower phase on subsequent egg production

Treated products	Treatments (g/kg)	Feed intake (g/bird/day)	Hen-day production (%)	Egg weight (g)	Feed conversion efficiency	Source
Diets containing SFYTM	Control(0)	90.94	68.9[a]	49.21	0.54	Effah, (2013)
	50	88.54	60.9[a]	48.93	0.55	
	75	86.38	52.1[b]	49.95	0.58	
	100	87.55	47.6b[c]	49.43	0.57	
	SED	*2.79*	*6.28*	*0.88*	*0.02*	
	P-value	*0.54*	*0.038*	*0.709*	*0.36*	
Diets containing BFYTM	Control(0)	93.5	79.1	51.3	1.84	Dei *et al*., (2012b)
	25	95.2	77.0	53.6	1.78	
	50	96.2	78.3	53.8	1.79	
	75	94.4	80.3	53.2	1.77	
	100	93.5	82.9	52.9	1.77	
	SED	*3.24*	*4.57*	1.28	*0.67*	
	P-value	*0.937*	*0.746*	0.381	*0.793*	
Diets containing SBFYTM	Control(0)	90.5	68.9[a]	49.2	0.54	Ofori, (2013)
	50	101.8	60.2[b]	49.6	0.50	
	75	90.7	52.4[c]	49.2	0.55	
	100	83.2	51.3[c]	49.4	0.59	
	SED	*8.65*	*3.36*	*0.91*	*0.05*	
	P-value	*0.273*	*0.003*	*0.966*	*0.310*	
Diets containing BFYSM	Control(0)	90.5	70.3[a]	49.25	0.55	Opoku-Addae, (2013)
	50	91.2	53.5[b]	50.56	0.56	
	75	81.5	51.9[b]	50.23	0.62	
	100	95.3	48.6[b]	50.20	0.37	
	SED	*6.84*	*4.87*	*0.82*	*0.11*	
	P-value	*0.304*	*0.009*	*0.461*	*0.219*	

SED-Standard error of difference, [a,b,c]Means with the same superscripts within a column in each experiment are not significantly different (P>0.05), SFYTM-Soaked false yam tuber meal, BFYTM-Boiled false yam tuber meal, SBFYTM-Soaked and boiled false yam tuber meal, BFYSM-Boiled false yam seed meal.

Further study was carried out to determine digestibility of false yam tuber meal by layer chickens. In this regard, Mohammed and Dei (2013) carried out an experiment to ascertain the effect of soaked false yam tuber meal on egg performance of layer chickens. Tubers were chopped into pieces and soaked in water (1 part of tubers to 2 parts of water) for 12 days with the water changed every 3 days. The tubers were then sun-dried for 7days and milled into gritty meal were then used to replace maize (w/w) at 0, 50, 75, 100g/kg layer chicken diets for 19-35 weeks.

The result of the apparent nutrient digestibility of the experimental diets showed that crude protein and crude fat digestibilities were decreased when layer chickens were fed the SFYTM based diets (Table 19). Also feeding the soaked material at 5% depressed egg production (Table 20).

Residual concentrations of anti-nutritional factors in the tuber were attributed to this situation; since terpenes can actually impair the availability of nutrients and reduce performance in animals (McDonald *et al*, 2002).

Table 19: Effect of SFYTM on apparent nutrient digestibility of layers (19-35 weeks of age)

Parameter	Control (0)	50	75	100	±SED	P-value
Dry matter (%)	69.5	72.9	68.7	68.7	2.60	0.324
Protein (%)	67.7[a]	53.5[b]	56.2[b]	53.9[b]	4.41	0.033
Crude fat (%)	81.3[a]	84.6[a]	72.9[b]	71.5[b]	2.63	<0.001
Ash (%)	75.5	66.8	66.4	73.2	4.49	0.052

SED-Standard error of difference, P-probability,[a,b]Means with the same superscripts in a row are not significantly different (P>0.05)

Source: Mohammed and Dei (2013)

Table 20: Effect of SFYTM on performance of layers (19-35 weeks of age)

Parameter	Control (0)	50	75	100	±SED	P-value
Feed intake (g/bird/day)	89.6	94.2	93.3	92.1	2.33	0.203
Hen-day egg production (%)	60.3[a]	51.2[b]	44.1[c]	39.9[c]	3.23	<0.001
Egg weight (g)	48.5	48.3	49.3	47.9	0.68	0.246
Egg mass output (g)	29.5[a]	24.4[b]	21.5[b]	18.9[b]	1.47	<0.001
Feed/egg mass	3.04[a]	3.88[b]	4.34[b]	4.96[c]	0.298	<0.001
Mortality (dead/total)	0/60	2/60	4/60	4/60	-	-

SED-Standard error of difference, P-probability, Means with the same superscripts in a row are not significantly different (P>0.05)

Source: Mohammed and Dei, (2013)

2.8.1 3 Guinea fowl

Another area that has been explored is the feeding of guinea fowl with the false yam.

Dei *et al*. (2015) carried out an experiment to evaluate the effect of processed false yam seed meal in diets of guinea fowls (Table 21). The experiment was in two: experiment 1involved guinea fowls at age 9-19 weeks and experiment 2 was with 5-15 weeks old guinea fowls. In these studies, false yam fruits, after sun-drying, were cracked with stones to obtain the seeds and afterwards the seeds were crushed and divided into two lots.

One lot was boiled for 2 hours (1 part of seed to 1 part of water), sun- dried for 8 days and milled into gritty meal and labeled BFYSM and used for Experiment 1(Table 21).

The other was soaked in water for 12 days (1 part of seed to 2 parts of water) and water changed every 3 days, sun-dried for 8 days and milled into gritty meal and labeled SFYSM and this was used for Experiment 2 (Table 22). Four dietary treatments (at 0, 5, 10 and 15%) containing the SFYSM were used in diets of pearl guinea fowls. The findings of the experiments (1 and 2) showed that processing the false yam seed by either boiling or soaking improved its feeding value and can be fed to growing guinea fowls at up to 15% of the diet (Table 21, 22).

Table 21: Effect of boiled false yam seed meal on feed intake, weight gain and gain to feed ratio of guinea fowls (10-19 weeks of age)

Parameter	Control (0)	5%BFYSM	10%BFYSM	15%BFYSM	±SED	P-value
Feed intake (g/bird/day)	65.2	66.4	62.0	65.1	2.79	0.489
Weight gain (g/bird/day)	9.0	7.8	6.4	5.9	1.15	0.097
Gain: Feed Ratio	0.14	0.12	0.11	0.09	0.015	0.062

SED-Standard error of difference, P-probability, means with no superscripts in the same row are not significantly different (P>0.05)

Source: Dei *et al*., (2015)

Table 22: Effect of soaked false yam seed meal on feed intake, weight gain and gain to feed ratio of guinea fowls (5-15 weeks of age)

Parameter	Control (0)	5%SFYSM	10%SFYSM	15%SFYSM	±SED	P-value
Feed intake (g/bird/day)	44.8	41.6	40.2	39.2	4.52	0.642
Weight gain (g/bird/day)	8.7	8.3	8.3	6.3	0.99	0.155
Gain: Feed Ratio	0.19	0.20	0.21	0.16	0.022	0.171

SED-Standard error of difference, P-probability, Means with no same superscripts in the same row are not significantly different (P>0.05)

Source: Dei *et al*., (2015)

2.8.1.4 Pigs

A study conducted by Mbimadong (2013) reported that feeding pigs with raw false yam tuber meal diet had adverse effects on their growth performance and therefore it should not be used (Table 23). In contrast, processed (soaked) (Amewonye, 2013) of the false yam tuber meal can be fed to Ashanti Black weaner pigs up to 100g/kg diet without any adverse effect on their growth performance and it is cost effective to use as a replacement for maize (Table 23).

In another experiment (Getsey, 2013), boiled false yam tuber meal gave a good result, which indicated that this material can be fed to Ashanti Black pigs at 50g/kg without any adverse effect on their growth performance and is economical to feed (Table 23).

Table 23: Effect of processed false yam tuber meals on feed intake, weight gain and gain to feed ratio of Ashanti black weaner pigs (12-20 weeks of age)

Processed products	Treatments (g/kg)	Initial weight (kg)	Weight gain (g)	Feed intake (g)	Feed/gain ratio	Source
Diets containing SDFYTM	Control (0)	6.19	306^{a}	803^{a}	2.62^{a}	Mbimadong, (2013)
	50	5.21	217^{b}	548^{b}	2.53^{a}	
	100	5.18	135^{c}	440^{c}	3.43^{b}	
	150	5.29	93^{c}	390^{c}	4.49^{b}	
	SED	*0.78*	*22.9*	*41.4*	*0.61*	
	P-value	*0.538*	*<0.001*	*<0.001*	*0.40*	
Diets containing SFYTM	Control (0)	6.19	306^{a}	803	2.62	Amewonye, (2013)
	50	5.31	261^{a}	689	2.48	
	100	5.43	263^{a}	721	2.62	
	150	4.63	213^{b}	601	2.60	
	SED	*0.63*	*23.4*	*64.4*	*0.08*	
	P-value	*0.186*	*0.027*	*0.075*	*0.256*	
Diets containing BFYTM	Control (0)	6.19	307^{a}	803^{a}	2.62^{a}	Getsey, (2013)
	50	5.34	284^{a}	680^{a}	2.38^{b}	
	100	5.10	203^{b}	553^{b}	2.76^{a}	
	150	5.09	83^{c}	440^{b}	5.16^{a}	
	SED	*0.58*	*23.1*	*84.1*	*0.64*	
	P-value	*0.261*	*<0.001*	*0.013*	*0.008*	

SED-Standard error of difference, ^{ab,c}Means with the same superscripts within a column for each experiment are not significantly different (P>0.05), SDFYTM-Sun-dried false yam tuber meal, SFYTM-Soaked false yam tuber meal, BFYTM-Boiled false yam tuber meal.

2.8.1.5 Rabbits

Ansah *et al*.,(2012) reported that feeding rabbits with false yam leaf meal improved feed intake, nutrient digestibility and weight gain (Table 24). However, the author recommended feeding rabbits with only up to 5% of the leaf meal.

Table 24: Performance of rabbits fed increasing levels of *Icacina oliviformis* leaf meal (IOL)

Parameter	Control (0)	5%	10%	SED
Feed intake (g/day)	125.11^{b}	128.65^{a}	129.27^{a}	0.72
Weight gain (g/day)	17.65^{a}	13.33^{ab}	10.83^{b}	2.32
Gain: Feed Ratio	0.14^{a}	0.10^{ab}	0.08^{b}	0.02

SED: Standard error of difference, ^{a,b,c}Mean values in a row with uncommon letters are significantly different at P<0.05

Source: Ansah et al., (2012)

2.8.2 Effect of false yam on heamatological profile on some animals

2.8.2.1 Chickens

A study by Dei *et al*. (2011) to determine the nutritive value of false yam tuber meal for broiler chickens indicated that the inclusion of sun-dried and boiled false yam tuber meals in diets of broiler chickens had no adverse effects on haematological profile of the birds. There were no observable changes in hemoglobin, haematocrits and white blood cells values (Table 25).

The findings of Agyemang, (2010) who reported no negative effects on blood characteristics in broiler chickens fed processed (soaking and cooking) false yam tuber meal (Table 25) is worth mentioning. In another experiment, Dei *et al*. (2013) reported no variability in haematological parameters of broilers when they were fed SFYTM (Table 25).

Studies on the effect of raw and processed false yam seeds on haematological parameters show that raw and processed false yam seed meals can replace maize in diets of broiler chickens up 50g/kg and 100g/kg respectively without any adverse effects on their haematology (Table 26).

Table 25: Blood constituents of broiler chickens fed varying levels (0, 30, 60 and 90g/kg) of SDFYTM, SFYTM, BFYTM and SBFYTM (21-56 days of age)

Processed product	Treatments (g/kg)	RBC count (10^6µl)	WBC count (10^3/µl)	Hb (g/dl)	Haematocrit (%)	Source
Diets containing SDFYTM	Control (0)	3.97	4.80	9.93	29.67	Dei *et al.* (2011)
	30	3.90	4.33	10.10	30.17	
	60	3.70	5.20	10.00	30.08	
	90	3.87	5.23	9.40	28.50	
	SEM	0.144	0.377	0.353	1.037	
	P	NS	NS	NS	NS	
Diets containing SFYTM	Control (0)	4.30	5.13	10.90	32.69	Dei *et al.* (2013)
	30	4.10	4.77	10.47	31.17	
	60	3.90	5.47	10.13	29.83	
	90	3.93	4.83	10.20	30.00	
	SEM	0.262	0.978	0.706	1.425	
	P	NS	NS	NS	NS	
Diets containing BFYTM	Control (0)	3.88	4.76	9.97	30.00	Dei *et al.* (2011)
	30	3.97	4.80	10.20	30.33	
	60	3.78	5.60	9.77	29.17	
	90	4.02	4.80	10.23	30.50	
	SEM	0.134	0.330	0.300	0.886	
	P	NS	NS	NS	NS	
Diets containing SBFYTM	Control (0)	3.77	4.81	9.67	29.00	Agyemang (2010)
	30	4.13	4.32	10.57	31.67	
	60	3.92	5.20	10.05	30.17	
	90	3.78	5.23	9.72	29.17	
	SEM	0.288	0.377	0.712	2.122	
	P	NS	NS	NS	NS	

SDFYTM-Sun-dried false yam tuber meal, SFYTM-Soaked false yam tuber meal, BFYTM-Boiled false yam tuber meal, SBFYTM-Soaked and boiled false yam tuber meal, RBC-Red blood cell, WBC-White blood cell, Hb-Haemoglobin, NS-Not significant (P>0.05), P-probability, SEM-Standard error of means.

Table 26: Blood components of broiler chickens fed varying levels (0, 50, 75, and 100g/kg) of SDFYSM, SFYSM, and BFYSM (21-56 days of age)

Processed products	Treatments (g/kg)	RBC count (10^6µl)	WBC count (10^3 / µl)	Hb (g/dl)	Haematocrit (%)	Source
Diets containing SDFYSM	Control (0)	4.67	-	11.87	35.3	Okyere (2011)
	50	4.47	-	11.37	34.0	
	75	4.60	-	11.70	35.0	
	100	4.50	-	11.47	34.3	
	SEM	0.240	-	0.606	1.840	
	P	NS	-	NS	NS	
Diets containing SFYSM	Control (0)	4.67	-	11.87	35.5	Okyere (2011)
	50	4.37	-	10.73	32.17	
	75	4.87	-	12.43	36.83	
	100	4.80	-	11.77	35.17	
	SEM	0.392	-	1.034	3.266	
	P	NS	-	NS	NS	
Diets containing BFYSM	Control (0)	4.67	-	11.87	35.50	Okyere (2011)
	50	4.30	-	10.97	32.83	
	75	4.20	-	10.70	36.00	
	100	4.67	-	11.90	35.67	
	SEM	0.438	-	1.092	3.282	
	P	NS	-	NS	NS	

SDFYSM-Sun-dried false yam seed meal, SFYSM-Soaked false yam seed meal, BFYSM-Boiled false yam seed meal, RBC-Red blood cells, WBC-White blood cells, Hb-Haemoglobin, NS-Not significant (P>0.05), P-probability, SEM-Standard error of means

In another experiment, Mohammed and Dei (2013) observed no significant difference in all haematological parameters of laying chickens measured when they were fed soaked false yam tuber meal diets (at 0, 50g/kg, 75g/kg and 100g/kg) (Table 27).

Table 27: Effect of soaked false yam tuber meal on haematological parameters of laying chickens (19-35 weeks of age) (Mohammed and Dei, 2013)

Parameter	Control (0)	50	75	100	±SED	P-value
Packed cell volume (%)	27.50	26.00	28.75	28.75	1.479	0.250
Haemoglobin (g/dl)	9.18	8.65	9.57	9.57	0.499	0.254
Red blood cells (10^6µl)	3.58	3.35	3.73	3.73	0.203	0.260
Mean corpuscular volume (fl)	76.90	77.60	77.17	77.25	0.388	0.386
Mean corpuscular Haemoglobin (Pg)	25.65	25.80	25.68	25.70	0.081	0.314
Mean corpuscular Haemoglobin concentration (g/dl)	33.33	33.25	33.25	33.30	0.073	0.671
White blood cells differentials						
Neutrophils (%)	48.5	47.2	48.0	44.2	4.07	0.731
Lymphocytes (%)	50.5	52.0	51.2	54.5	4.07	0.780
Eosinophils (%)	0.75	0.25	0.25	0.75	0.540	0.644
Monocytes (%)	0.00	0.25	0.50	0.50	0.445	0.640
Basophils (%)	0.25	0.25	0.00	0.00	0.250	0.588

SED-Standard error of difference, P-probability

2.8.2.2 Rabbits

An experiment to evaluate the effect of false yam leaf meal as an ingredient in the diets of weaner rabbits show no variability in haemoglobin (Hb) concentrations, packed cell volume (PCV) and red blood cells but erythrocyte values were increased from initial low values to higher values as they were fed false yam leaf meal at 5 and 10% (Ansah and Aboagye, 2011). They reported however that, the values for all the parameters measured were within the normal range for rabbits (Table 28).

Table 28: Blood constituents of rabbits fed increasing levels (0, 50 and 100g/kg) of false yam leaf meal (8-16 weeks of age)

False yam product	Treatments (g/kg)	RBC count (10^6µl)	WBC count (10^3 / µl)	Hb (g/dl)	Haematiocrit (%)
Diets containing FYLM	Control (0)	4.99	8.93	12.80	38.40
	50	4.56	7.44	11.62	34.80
	100	4.28	9.84	10.92	32.80
	SEM	*0.82*	*3.46*	*2.04*	*6.12*
	P	*NS*	*NS*	*NS*	*NS*

RBC-Red blood cell, WBC-White blood cell, Hb-Haemoglobin, FYLM-False yam leaf meal, NS-Not significant (P>0.05), P-probability, SEM-Standard error of means.

Source: Ansah and Aboagye (2011)

2.9 Inferences from the literature review

Poultry farming refers to the rearing of birds including chicken, turkeys, ducks, and geese basically for their meat, eggs and feathers (Ray and Roy, 1991) and which is operated in various systems of rearing such as the battery cage or intensive, semi-intensive and free range.

The poultry industry in present years has been playing a very significant role in several parts of the world. Bell and Weaver (2002) reported that poultry production makes a substantial degree of the global total meat output and it is the second most popular meat consumed in the world after pork. The industry is however faced with several problems including difficulty in obtaining good quality day-old chicks (Oluyemi and Robert, 1988), feed scarcity and high cost, poor hygienic conditions at hatcheries (Appiah, 1993), and many others.

To ensure a continuous supply of meat and eggs all year round, poultry need to be adequately nourished or fed with good quality feed. Feed alone as a component in production cost takes 70-75% (Ademola and Farinu, 2006). Maize is the most preferred energy source in broiler chicken diets due to its high energy and low fibre content, the presence of pigments and essential fatty acids (Panda *et al.*, 2010). Buamah (1992) reported that occasional shortage of maize scare many people from going into the production of poultry meat and eggs. Koney (1992) reported that it will be very important that the level of grain in standard poultry ration be reduce without adversely hampering the production of the poultry birds.

Due to this, certain programs have been put in place to reduce the high cost of feeding poultry including the use of Agricultural by-products, ingredients substitution and the use of new feed resources. But one plant of interest that can be exploited for use is the false yam (Dei *et al*., 2011a).

The false yam (*Icacina oliviformis*) is a Savannah shrub indigenous to West and Central Africa (Styslinger, 2011). False yam is mostly found growing wild in the Savannah areas of Senegal, the Gambia, Guinea, Northern Ghana and parts of Sudan (Fay, 1987).

A number of the benefits derived from the false yam plant include its use as a feed resource for animals and for medicinal purposes. The seeds and tubers are products which are high in carbohydrate, hence can serve as alternative dietary source of energy for broilers (Dei *et al*., 2011a).

The false yam, despite its importance, however, contain bitter substances (called gum resins) which limits its use. There is therefore the need to properly process the false yam (seeds and tubers) to reduce the adverse effects the toxic compounds can pose to life during the usage of these products. Many processing techniques have been evaluated including soaking in water (Dei *et al*., 2010), boiling in water (Dei *et al.*, 2011a), soaking in saltpetre solution (Dei *et al*., 2013c). These methods have been reported to improve the nutritional value for broiler and growing layer chickens.

A new method is the inclusion of charcoal into false yam based diets as an additive to help reduce these toxins. Hence the importance of this study which sought to determine the effects of varying levels of charcoal containing(3 or 6%) false yam tuber meal diets on broiler chicken performance.

CHAPTER THREE

3.0 Materials and Methods

3.1 Location and duration of experiments

The experiments were conducted at the Poultry Unit of the Department of Animal Science, University for Development Studies (UDS), Nyankpala Campus, Tamale. The location lies on latitude 9^0 25’ 41” and longitude 0^0 58’ 42” W and at an altitude of 183m above sea level (SARI, 2001). The location is generally described as a hot dry Savannah zone. The rainfall pattern is unimodal and occurs between April and October with the dry season beginning from November to March. Averagely it has an annual rainfall of 1200mm with fluctuating temperatures between 19^0C and 42^0 C for minimum and maximum respectively (SARI, 2001). Two feeding experiments were ran concurrently (Experiment 1 using sun-dried false yam tuber meal and Experiment 2 using soaked false yam tuber meal). Each experiment lasted for five weeks (16th February, 2016 to 22nd March, 2016).The third experiment was conducted to determine the digestibility of the experimental diets and the digestibility trial lasted for fourteen days.

3.2.0 Sources and processing of the false yam tuber meal and the charcoal

3.2.1 Sun-dried false yam tuber meal (SDFYTM)

Tubers of wild growing false yam (*Icacina oliviformis*) at Nyankpala regardless of their ages were obtained by harvesting them manually using a hoe. The tubers were peeled and chopped into small pieces of about 2cmusing a knife.

The sliced tubers were sun-dried on a concrete floor to a moisture content of about 10%.

The dried tubers were then milled into gritty flour and labeled SDFYTM and used for experiment one (1).

3.2.2 Soaked false yam tuber meal (SFYTM)

The false yam tubers were peeled and chopped into small pieces of about 2cm using knife. The sliced pieces were then soaked in water for 12 days in the ratio of 1kg tuber:2L water. That is, one (1) part of fresh false yam tuber to two (2) parts of water, the water was changed every three (3) days. The sliced tubers after the twelve (12) days of soaking were sun-dried on a concrete floor to a moisture content of about 10%. The dried tubers were then milled into gritty flour and labeled SFYTMand this was used for Experiment two (2).

3.2.3 Wood charcoal (WC)

Wood charcoal (WC) was purchased from the Tamale Wood and Charcoal Market. This was subsequently taken to the grinding mill where it was milled into flour to be included in the false yam diets (at 3 and 6%) for the experiments.

3.3.0 Chemical analysis of the false yam tuber meals.

The chemical analysis of the false yam tuber meals (SDFYTM and SFYTM) were not done before the formulation of the experimental diets due to financial constraints. However, reports on the aforementioned meals were obtained from Dei *et al*. (2011) and Dei *et al*. (2012) for the SDFYTM and the SFYTM respectively. The level of terpenes in the tuber meals could not be determined due to the difficulty in locating a laboratory that can determine the level of terpenes in the false yam tubers in Ghana.

Table 29: Percentage composition of the SDFYTM and SFYTM samples (dry matter basis)

Component	SDFYTM(Dei *et al*., 2011)	SFYTM(Dei *et al*., 2012)
DM	86.46	82.79
CP	5.41	3.63
Ether extract	1.60	1.10
Neutral detergent fiber	28.61	23.14
Starch	48.63	58.12
Ash	2.19	14.00
Gross energy (kcal/kg of DM)	4,067	14.3
Essential and non-essential amino		
Arginine	0.792	0.08
Glycine	0.094	0.08
Histidine	0115	0.16
Isoleucine	0.079	0.08
Leucine	0.124	0.13
Lysine	0.192	0.24
Phenylalanine	0.042	0.07
Methionine	0.003	0.01
Threonine	0.077	0.07
Tryptophan	0.021	0.05
valine	0.102	0.13

3.4.0 Experimental diets

The experimental diets were formulated using a commercial broiler finisher feed as control in both feeding and digestibility trials, procured from Agricare LTD. The false yam tuber meals were substituted for the commercial feed on weight by weight basis (5% for the sun-dried tuber and 15% for the soaked tuber). The wood charcoal (WC) was incorporated into the false yam tuber-based diets as add-on. The experimental diets were formulated as follows:

Experiment 1 involved 4 dietary treatments with increasing levels of charcoal at 0, 3, and 6% respectively in 5%SDFYTM-based finisher broiler diets.

Experiment 2 involved 4 dietary treatments with increasing levels of charcoal at 0, 3, and 6% respectively in 15%SFYTM-based finisher broiler diets. The dietary compositions for the two experiments are illustrated in the table 30 below.

Table 30: Composition of experimental diets (%)

	Experiment 1				Experiment 2			
	5%SDFYTM Containing Diets				15%SFYTM Containing Diets			
Ingredients	Control	+0%WC	+3%WC	+6%WC	Control	+0%WC	+3%WC	+6%WC
Commercial feed	100	95	95	95	100	85	85	85
SDFYTM	0	5	5	5	-	-	-	-
SFYTM	-	-	-	-	-	15	15	15
WC	-	-	3	6	-	-	3	6
Total	100	100	103	106	100	100	103	106

3.5.0 Experimental Design

3.5.1 Experiment I

At 28 days of age, 96 healthy female broiler chickens were randomly selected with similar average weights into 16 groups (n=6) in a Completely Randomized Design (CRD). Each treatment was replicated four (4) times. The birds were housed in deep litter cages (1.8mx0.9m=0.27m^2/bird) and were fed and watered *ad libitum* up to 63 days of age. Light was provided 24 hours/day.

3.5.2 Experiment II

The experimental procedure or design used in this experiment was similar to what was applied in experiment I (above).

3.5.3 Digestibility trial

Sixteen Cobb broilers at six weeks of age were used in the digestibility trial for each of the diets used in the two experiments. The birds were randomly assigned to 16 cages with one bird per cage (0.4mx0.3m=0.12m^2). Each bird received one of the dietary treatments which were replicated four times in a Completely Randomized Design. Birds were fed the experimental diets for 14 days. Feed and water were given *ad* libitum. Light was also provided twenty-four (24) hours daily.

3.6.0 Data collection procedures

3.6.1 Experiments 1and 2

3.6.1.1 Feed intake

Feed intake was obtained by subtracting the left –over feed at the end of the week from the feed supplied for the week. Mean feed intake per bird per day was then calculated by dividing the feed consumed by the number of birds in the replicate and the number of the days in the week.

3.6.1.2 Weight gain by birds

Individual weights of the birds were taken once every week during the experimental period. Birds were tagged with coloured rings on their shanks for identification. The birds per replicate were put in a plastic basket and were weighed using Kern electronic balance- Model PCB 3500-2. The recorded weights obtained at the end of every week was divided by the number of days in a week (7days) to get the average daily weight gain. This was further divided by the number of birds to get the average daily weight gain per bird.

3.6.1.3 Feed to gain ratio

This was determined as a unit of feed consumed daily per unit of daily body weight gain.

3.6.1.4 Haematology and serological profiles of birds

Two (2) birds from each replicate were randomly selected for blood sample collection at the end of the experimental period for each experiment.

The birds selected were restrained and the bloods were drawn (2ml) from their wing veins using a syringe and a needle. The collected blood from each bird was emptied into test tubes and labeled.

The test tubes contained ethylene diaminetetra acetic acid (EDTA), an anticoagulant which was mixed gently with the blood to prevent it from clotting. This was used for haematological analysis such as packed cell volume (PCV, %), red blood cell counts(RBC,$\times 10^6$/µl), haemoglobin (Hb, g/dL), mean corpuscular haemoglobin (MCH, pg), mean corpuscular haemoglobin concentration (MCHC, gl/dL), mean corpuscular volume (MCV, fl), white blood cell counts (WBC, $\times 10^3$/µl), Platelets ($\times 10^3$/µl), Neutrophil (%), Lymphocytes (%), Eosinophils(%) and Monocytes(%).

These parameters were measured using the SYSMEX XS-500i hematology analyser (SYSMEX Europe GmbH, Norderstedt, Germany) for blood haematological profiles.

Another quantity was collected from the same birds and emptied into test tubes without EDTA. The blood was allowed to coagulate and serum collected for serological analysis (that is, Albumin, Globulin, Alkaline phosphatase, Aspartate transferase and Alanine transferase) using spectrophotometry.

3.6.1.5 Carcass characteristics of birds

The whole carcass and organ characteristics (weights) of the birds whose blood were drawn were taken using the Kern electronic balance- PCB 3500-2.

3.6.2 Digestibility trial

Weighed quantities of the diets were provided and faeces were collected on plastic sheets placed under the wire mesh floor of the cages using the Total Collection Method. Faeces were collected every 24 hours, weighed and oven-dried at a temperature of 60^0C overnight.

At the end of the trial, daily samples collected from chickens in each replicate cage were pooled into one sample per treatment, weighed, ground and stored in airtight plastic containers.

Samples of the diets and dried faeces were analyzed for proximate components in triplicates in accordance with standard methods described by the Association of Official Analytical Chemists (AOAC), (2000).

The values were used to compute for apparent nutrient digestibility as follows:

$$\text{Apparent digestibility} = \frac{\text{Nutrient consumed} - \text{Nutrient in faeces}}{\text{Nutrient consumed}} \times 100$$

3.7.0 Data analysis

The parameters measured in the 3 experiments were subjected to analysis of variance (ANOVA) for Completely Randomized Design (CRD) using GenStat 3 version statistical software (8th edition, Lawes Agricultural Trust, 2005). Significant differences among treatment means were separated using least significant difference (LSD) and values were considered significant at ($P < 0.05$).

CHAPTER FOUR

4.0 Results

4.1 Nutrient compositions and amino acid profiles of experimental diets

Table 31shows the calculated nutritional compositions of the control diet and the false yam based-diets.

Table 31: Calculated Nutrient composition and AA profile of experimental diets (g/kg)

	Experiment 1				Experiment 2			
		5%SDFYTM containing diets				15%SFYTM Containing Diets		
Nutrient	control	+0%WC	+3%WC	+6%WC	Control	+0%WC	+3%WC	+6%WC
DM	964	967	962	968	964	956	965	966
OM	898	902	908	912	898	917	918	917
Crude protein	201	197	190	176	201	171	175	168
NDF	63.2	62.7	61.8	63.9	63.2	61.8	62.3	63.5
ADF	58.0	57.4	57.3	59.3	58.0	57.2	58.1	58.9
ME (kcal kg^{1})	3000	Nd	Nd	Nd	3000	Nd	Nd	Nd
Arginine	12.2	12.2	11.8	11.5	12.2	10.8	10.5	10.2
Histidine	6.1	6.1	5.9	5.7	6.1	5.8	5.6	5.5
Isoleucine	8.6	8.2	8.0	7.7	8.6	7.5	7.3	7.1
Leucine	19.7	18.3	17.8	17.2	19.7	16.9	16.4	15.9
Lysine	12.1	12.2	11.8	11.5	12.1	11.3	11.0	10.6
Methionine	3.9	3.7	3.6	3.5	3.9	3.4	3.3	3.2
Phenyl alanine	10.5	10.1	9.8	9.5	10.5	9.1	8.8	8.6
Threonine	7.6	7.2	7.0	6.8	7.6	6.7	6.5	6.3
Valine	10.0	9.3	9.0	8.7	10.0	8.7	8.4	8.2
Tryptophan	1.9	1.9	1.8	1.8	1.9	1.7	1.6	1.6

Calculated: Nitrogen×6.25. SDFYTM: 5% Sun-dried false yam tuber meal, SFYTM: Soaked false yam tuber meal, C: 3and 6% charcoal, DM: Dry matter, OM: Oganic matter, NDF: Neutral Detergent Fibre,ADF: Acid Detergent Fibre, ME: Metabolisable Energy. Nd- not determined.

From table 31, it is shown that the nutrient composition of the 5%SDFYTM based diets are comparable to the control diet and contain large values for DM, OM, NDF, and ADF in Experiment1. The calculated crude protein concentrations of the tuber however is shown to be reducing gradually (from197g/kg to 176g/kg) as more levels of charcoal is included in the false yam tuber based diets.

In experiment 2 (Table 31) the calculated nutrient compositions of the 15%SFYTM are also shown to contain large and similar values for DM, OM, NDF, and NDF concentrations compared to the control diet. The crude protein concentrations of the 15%SFYTM diets were also shown to contain smaller values as more levels of charcoal were added into the diets.

4.2 Apparent digestibility of broiler chickens fed the SDFYTM and SFYTM with increasing levels of charcoal

The result of the effect of the increasing levels of charcoal in SDFYTM and SFYTM on digestibility of broiler chickens is represented in Table 32.

Table 32: Effect of SDFYTM and SFYTM with increasing level of charcoal on nutrient digestibility of broiler chickens (4-9 weeks of age)

	Experiment 1					Experiment 2					
Parameter (	5%SDFYTM Containing Diets						15% SFYTM Containing Diets				
	+0%WC	+ 3%WC	+6%WC	SED	P	Control	+0%WC	+3%WC	+6%WC	SED	P
DM	74.3[a]	72.7[a]	68.3[b]	2.31	0.027	76.3[a]	67.5[b]	59.7[c]	61.1[c]	3.30	0.001
OM	71.2	70.1	64.6	4.84	0.553	67.7	65.1	56.9	58.2	5.11	0.150
CP	79.5[a]	75.7[b]	72.3[c]	2.70	0.046	80.1[a]	73.6[b]	63.5[c]	61.8[c]	4.83	0.008

DM- D ic matter, CP- Crude protein, SED- Standard error of difference, P-probability, Means with different superscripts on the same row are significantly different (P<0.05

4.2.1 Dry matter

From Table 32, it can be seen that there was no significant (P>0.05) difference in the dry matter digestibility between the control birds and birds fed with diets containing 0 and 3% WC in the 5%SDFYTM diets. However, there was a significant (P<0.05) reduction in dry matter digestibility of birds fed the diet containing 6% WC in the 5%SDFYTM diet. On the other hand, dry matter digestibility was significantly (P<0.05) higher in the control birds than those fed diets containing 15%SFYTM. Among the test diets the inclusion of 3 and 6% WC in the 15%SFYTM further showed a significant (P<0.05) decline in the dry matter digestibility than the same diet with 0% WC.

4.2.2 Crude protein

The result in Table 32 showed that there was no significant (P>0.05) difference in crude protein digestibility between birds in the control group and birds fed the 0%WC in the 5%SDFYTM based diet. However, there was a significant (P<0.05) reduction in crude protein digestibility when charcoal was introduced at 3% in the SDFYTM. A further significant (P<0.05) reduction was observed when charcoal was increased from 3% to 6% in the same diet.

In contrast, there was a significant (P<0.05) difference in crude protein digestibility between birds fed the control diet and those fed all the 15%SFYTM based-diets with all without charcoal.

4.3 Growth performance of broiler chickens fed the 5%SDFYTM and 15%SFYTM with increasing levels of charcoal

The result of the effect of varied levels of charcoal in 5%SDFYTM and 15%SFYTM based diets on broiler growth performance is represented in Table 33**.**

Table 33: Effect of 5%SDFYTM and 15%SFYTM with increasing levels of charcoal on growth performance of broiler chickens (4-9weeks of age)

	Experiment 1					Experiment 2					
	%SDFYTM Containing Diets						15%SFYTM Containing Diets				
Param	0%WC	+ 3%WC	+6%WC	SED	P	Control	+ 0%WC	+ 3%WC	+6%WC	SED	P
F I (g/l	132.5	134.8	136.5	9.57	0.855	128.6	133.4	136.7	115.4	8.54	0.118
WG (g/b/d)	43.4	44.5	39.4	2.94	0.369	43.38[a]	31.50[b]	28.11[b]	26.82[c]	2.185	0.001
F:G	3.11	3.06	3.47	0.337	0.486	2.97[b]	4.31[a]	4.87[a]	4.35[a]	0.422	0.005
Mortal (%)	1.25	1.00	0.00	0.629	0.271	0.75	0.25	0.25	0.00	0.421	0.380

VG-Weight gain, F:G- Feed to gain ratio, SED-Standard error of difference, P-Probability, [a,b,c] means with the same superscripts on the same row are

different (P<0.05

4.3.1 Feed intake

There was no significant (P>0.05) variability in feed intake between birds in the control group and birds fed all the various levels of charcoal in 5%SDFYTM based diets. However, numerically birds fed the diets containing the 5%SDFYTM slightly ate more feed than birds in the control group (Table 33).

In experiment 2, daily feed intake by the birds was shown to be similar as was observed in experiment 1 when birds were fed the 15%SFYTM based-diets.

4.3.2 Weight gain

The result in Table 33 showed that daily weight gain by birds was not significantly (P>0.05) different between birds fed the control diet and birds fed the varied levels of charcoal in 5%SDFYTM based-diets.

It can be observed from the same Table 33 however, that there was a significant (P<0.05) difference in the weight gains of birds fed the control diet and birds fed the diets containing the 15% SFYTM. Among the diets tested, birds fed the 3 and 6% charcoal 15SFYTM diets significantly (P<0.05) reduced more than birds fed 0% charcoal in the same diet.

4.3.3 Feed to gain ratio

From Table 33, feed to gain ratio by birds was not significantly (P>0.05) different between birds in the control group and birds fed the different levels of charcoal in the 5%SDFYTM diets. But birds fed the different levels of charcoal in 5%SDFYTM diets numerically had higher feed to gain ratios than those fed the control diet.

However, feed to gain ratios were observed to be significantly (P<0.05) higher among birds fed the 15%SFYTM diets than those fed the control diet. The addition of charcoal at 3 and 6% in15%SFYTM diets led to higher feed to gain ratios.

4.3.4 Mortality

Mortality was very low and did not show any significant (P>0.05) difference in all groups of birds fed the control diet and the 5%SDFYTM diets tested (Table 33). Similar results were noticed when the 15%SFYTM diets were tested among the birds.

4.4 Haematological profile of broilers fed the 5%SDFYTM and 15%SFYTM diets with increasing levels of charcoal

The result of the effect of various levels of charcoal in 5%SDFYTM and 15%SFYTM on haematological parameters of broiler chickens is shown in Table 34.

Table 34: Effect of 5%SDFYTM and 15%SFYTM diets with increasing levels of charcoal on hematological profile of broilers (4-9 weeks of age)

Parame		Experiment1					Experiment 2					
		5%SDFYTM Containing Diets						15%SFYTM Containing Diets				
		+0%WC	+ 3%WC	+6%WC	SED	P	Control	+ 0%WC	+ 3%WC	+6%WC	SED	P
PCV (%		32.93	34.33	34.17	0.693	0.112	32.77	32.87	33.23	33.40	2.138	0.989
RBC ($x10^{6}$/μ		2.67^{a}	2.73^{a}	2.57^{a}	0.111	0.047	2.37	2.77	2.60	2.60	0.194	0.304
Hb (g/		7.93	8.43	8.13	0.361	0.321	7.73	8.23	7.93	8.30	0.788	0.876
MCH (		29.93	30.93	31.77	0.88	0.076	32.60	29.70	30.40	32.23	1.039	0.063
MCHC (gl/dL)		24.10	24.57	23.80	1.074	0.820	23.60	25.03	23.83	24.70	1.154	0.576
MCV (		124.1^{b}	126.1^{b}	133.5^{c}	4.74	0.051	138.6^{a}	118.4^{b}	127.4^{b}	130.5^{b}	4.49	0.013
WBC ($x10^{3}$/μ		13.3	7.2	6.1	3.38	0.230	8.1	11.03	7.40	6.37	1.712	0.113
Platelet ($x10^{3}$/μ		10.3	10.0	9.7	4.18	0.980	11.3	11.3	13.3	9.3	3.82	0.779
Neutro (%)		50.67	50.33	46.67	2.082	0.211	51.00	50.00	51.67	50.33	2.571	0.917
Lymph (%)		48.67	49.67	52.67	2.095	0.257	48.67	48.00	48.67	49.67	2.236	0.901
Eosino (%)		0.00	0.00	0.33	0.236	0.441	0.00	0.33	0.00	0.00	0.236	0.441
Monocytes (%)	0.33	0.67	0.00	0.33	0.577	0.728	0.33	1.00	0.33	0.00	0.527	0.349

The above result showed that birds fed the 5%SDFYTM-based diets had significantly (P<0.05) higher RBC values than the control group of birds. However, there was no significant (P>0.05) difference within the group of birds fed the 5%SDFYTM-based diets. On the other hand, birds fed the control diet were significantly (P<0.05) higher than birds fed diets containing the 5%SDFYTM in the MCV values. Birds fed the 5%SDFYTM plus the 6% charcoal diet however, were observed to have significantly (P<0.05) higher MCV values than birds fed 0% and 3% charcoal diets. The PCV, Hb, MCH, MCHC, WBC, platelets, neutrophils, lymphocytes, eosinophyl and monocytes values, however, did not show significant (P>0.05) differences in all groups of birds fed the control diet and diets containing the 5%SDFYTM (Table 34).

In Experiment 2which involved 15%SFYTM based-diets, there was a significant (P<0.05) difference in the mean corpuscular volume (MCV) values between birds fed with the control diet and birds fed the 15%SFYTM based-diets (Table 34). Within the groups of birds fed the tests diets, however, the MCV values were similar (P>0.05).However, there was no significant (P>0.05) difference in all other haematological parameters measured between birds in the control group and birds in the groups fed the test diets.

4.5 Serology of broilers fed the5%SDFYTM and 15%SFYTM with increasing levels of charcoal

The effect of varying levels of charcoal in the 5%SDFYTM and 15%SFYTM on serum biochemistry of broiler chickens is shown in Table 35.

Table 35: Effect of 5%SDFYTM and 15%SFYTM with increasing levels of charcoal on serology of broilers (4-9 weeks of age)

Param	Experiment 1						Experiment 2					
	5%SDFYTM Containing Diets						15%SFYTM Containing Diets					
	l	+0%WC	+3%WC	+6%WC	SED	P	Control	+ 0%WC	+ 3%WC	+6%WC	SED	P
Total protei	[illegible]	32.80	36.33	32.27	1.626	0.098	35.40	31.60	26.20	26.90	3.350	0.079
Albun (%)	[illegible]	13.77[b]	15.97[b]	14.33[b]	0.806	0.042	16.17[a]	13.40[b]	11.80[b]	11.77[b]	1.452	0.050
Globu (%)	[illegible]	19.07	20.37	17.93	1.628	0.554	19.20	18.20	14.40	15.17	2.691	0.291
Alkali Phosp (%)	[illegible]	154.3	177.2	182.6	20.36	0.423	155.1	168.3	186.6	161.2	24.16	0.612
Aspar Transf (%)	[illegible]	92.0	76.0	52.0	46.7	0.485	126.0	142.0	107.0	173.0	37.90	0.415
Alanin Transf (%)	[illegible]	7.9	13.1	8.3	3.6	0.476	11.0	8.40	9.070	7.770	1.310	0.162

d error of difference, P: Probability, [a,b]Means with the same superscripts on the same roware not significantly (P>0.05) different

Serum albumin was significantly (P<0.05) higher among the control birds than birds fed the 5%SDFYTM diets. However, there were no significant (P>0.05) differences between birds fed the 5%SDFYTM based diets and the control diet in the globulin, ASP, AST and ALT values.

Similar results were observed in the other experiment involving the diets containing 15%SFYTM.

4.6.0 Carcass and organ characteristics of broiler chickens fed the 5%SDFYTM and the 15%SFYTM diets with increasing levels of charcoal

Table 36 shows the effect of various levels of charcoal in the 5%SDFYTM and 15%SFYTM containing diets on the carcass and organ characteristics of broiler chickens.

Table 36: Effect of 5%SDFYTM and 15%SFYTM with increasing levels of charcoal on carcass and organ characteristics of broilers (4-9 weeks of age)

Param	Experiment 1						Experiment 2					
		5%SDFYTM Containing Diets						15%SFYTM Containing Diets				
	l	+0%WC	+ 3%WC	+6%WC	SED	P	Control	+ 0%WC	+3%WC	+6%WC	SED	P
Dress weight		2.06	1.92	1.90	0.176	0.766	2.02^{a}	1.37^{b}	1.52^{b}	1.48^{b}	0.16	0.015
Dressi percen (%)		77.57	76.40	77.14	1.116	0.717	76.58^{a}	70.03^{c}	73.87^{b}	73.13^{b}	1.157	0.003
Liver (		40.6	35.2	28.0	5.83	0.128	42.8	37.6	36.9	31.6	5.59	0.329
Heart (		10.34	8.57	8.59	1.919	0.483	11.13	8.69	7.22	7.33	1.565	0.117
Spleen		2.59	2.91	1.87	0.966	0.751	2.55	2.66	2.07	1.28	0.9	0.454
Gizzar		41.0	41.1	38.6	9.48	0.985	42.0	44.9	36.5	31.7	9.62	0.553
Full intesti		105.0	99.4	103.5	10.87	0.636	91.7	125.0	98.5	110.9	20.53	0.433

SED-Standard error of difference, P-Probability, Means with the same superscripts on the same rows in each experiment are not significantly (P>0.05) different

4.6.1 Carcass dress weight

The results in Table 36 show that there were no significant (P>0.05) differences in the carcass weights of birds fed the control diet and birds fed the 5%SDFYTM diets tested.

The result from the same table, however, shows that there were significant (P<0.05) difference in carcass dress weight between birds in the control group and birds fed the 15%SFYTM-based diets. Within the 15%SFYTM diets tested, carcass dress weights were similar (P>0.05).

4.6.2 Carcass dressing percentage

Carcass dressing percentage did not show a significant (P>0.05) difference between birds fed the control diet and birds fed diets containing 5%SDFYTM. Plus charcoal and the carcass dressing percentages were also similar within the group of birds fed 5%SDFYTM-based diets (Table 34).

On the other hand, carcass dressing percentage showed a significant difference between the birds in the control group and birds fed diets containing the 15%SFYTM. Dressing percentage was significantly (P<0.05) higher when charcoal was introduced at 3and 6% in the SFYTM diet than when there was no charcoal in the diet.

4.6.3 Organ characteristics

The weights of organs such as liver, heart, spleen, gizzard and full intestines all did not show significant (P>0.05) differences between the control birds and birds fed the diets containing the 5%SDFYTMplus charcoal diets (Table 36) and similar results were observed in all the groups of birds fed diets containing the 15%SFYTM plus the charcoal.

CHAPTER FIVE

5.0 Discussion

5.1.0 Nutrient composition and amino acid profiles of experimental diets

In Experiment 1, the calculated crude protein concentration for the 5%SDFYTM based diets from the result showed to be slightly lower than the 200g/kg requirements for 4wks old broiler chickens but were higher than the 180g/kg of their requirements when they are above 6wks old (NRC, 1994). The crude protein concentrations were particularly highest (197g/kg)in the diet containing 0% wood charcoal in the 5%SDFYTM and the least in the 5%SDFYTM containing 6% wood charcoal. This could account for the similar performance of all birds fed those diets. This confirms that the SDFYTM meal can be substituted for maize in the diets of broiler chickens at 5% (Dei *et al*.2011).

In Experiment 2 involving the 15%SFYTM diets, the calculated nutrient composition showed that the crude protein levels were below the 200g/kg and 180g/kg recommended for4wks old and above broiler chickens (NRC, 1994).This accounted for poor performance of birds fed the SFYTM based diets. This suggests that there is need to incorporate ingredients with high protein to compensate the protein concentrations when using SFYTM at 15% in broiler diets. This is because protein is the critical ingredient of poultry diets combined with other nutrients is essential for life (Cheeke, 2005).

5.2.0 Apparent digestibility of broilers fed the 5%SDFYTM and 15%SFYTM diets with increasing levels of charcoal

The inclusion of 5%SDFYTM with no wood charcoal in the diets of broiler chickens had no significant (P>0.05) effect on crude protein digestibility (Table 32) compared to the control diet. False yam is reported to contain bitter compounds (Vanhaelen *et al*., 1986) with 3.75% gum resins (Dei *et al.*, 2011b) react with proteins and enzymes in the digestive tract of animals and as a result affect protein and carbohydrate digestibility (Jansman *et al*., 1995). The similarity could be due to the low dietary inclusion level of the tuber meal. The charcoal isa toxin binder(Gerlach and Schmidt, 2012) but its inclusion at 3 and 6% in the SDFYTM diet could not improve on protein digestibility.This suggests that the toxins in the false yam tuber could not be actually the type that the charcoal can bind with, hence, the charcoal could only dilute the feed without improving on protein digestibility.

In contrast,the inclusion of 15%SFYTM with no wood charcoal in broiler chicken diet affected crude protein digestibility. This may be due to the presence of the residual concentration of the resins (terpenes) reported in the tuber (Fay, 1991; and Dei *et al*., 2011). According to Gershenzon and Dudareva (2007) terpenes have cytotoxic effects which antagonise the availability of nutrients and hence reduce performance of animals (McDonalds *et al*., 2002). Previous study by Mohammed and Dei (2013) reported a reduction in protein digestibility by layer chicken when soaked false yam tuber meal was added to their diets. This was attributed to the poor digestibility of the material by the birds.

When wood charcoal was added (at 3% and 6%) in the SFYTM meal diets to remove these natural toxins (Pass and Stewart, 1984; McLennan and Amos, 1989; Poage *et al*., 2000; Banner *et al*., 2000; Bisson *et al*., 2001) could not improved protein digestibility.

This again maybe the reason that the toxins in the false yam tuber meal could not be the type that the charcoal can bind with therefore, only be present to dilute the diet.

5.3.0 Growth performance of broiler chickens fed the 5%SDFYTM and 15%SFYTM with increasing levels of charcoal

Table 33 shows that birds tended to feed more even with the inclusion of the 5%SDFYTM diet with no wood charcoal. This may be due to the smaller percentage of the false yam tuber meal included their diets and as a result the smaller concentrations of the toxins (NRI, 1987) reported in the tuber could not affect the palatability of the diet. A report by Burrit and Provenza (2000) indicated that the amount of toxins in a food sets a limit on the amount of a particular food an animal can eat.

In Experiment 2, higher inclusion level (15%SFYTM diet with no charcoal) in the diets of broiler chickens showed a similar observation (Table 33). This may have been due to the leaching out of the toxins in the tuber and hence improving intake as a result of the soaking (Dei *et al*. 2011a). From the same table it can be seen that the addition of the charcoal in the false yam tuber meals in both experiments could not significantly improve feed intake therefore could only be serving to dilute the feed without any positive impact.

Daily weights gain by broiler chickens were comparable among birds fed the 0% wood charcoal in the 5%SDFYTM to those fed the control diet (Table 33).

This may be accounted for by the high protein (more than 180g/kg) levels (Table 31) recommended for 6-8wks old broiler chickens fed to the birds. Also, the similarities in crude protein digestibility by the birds (Table 32) fed the same diet could account for this observation.

Previous study by Osei *et al*., (2013) observed depressed weight gain when broiler chickens were fed 5%SDFYTM. This may be due to differences in experimental location and species composition of birds.

In Experiment 2, there was a significant decline in daily weight gain of the birds when they were fed 15%SFYTM with 0%wood charcoal diet (Table 33). This may be due to the low crude protein content of the SFYTM based diets which did not meet their requirement (Table 31).A study by Bregendahl *et al*. (2002), showed poor growth performance, higher feed intake and thus poorer feed conversion rate of broiler chickens fed low-protein diets. As a result, more feed and feed additives might be needed to provide a good balance of the low protein content of false yam meals in order to promote efficiency. Also, the presence of higher residual concentration of the toxins in the tuber affecting protein digestibility (Table32) may account for this observation. This agrees with a report by Dei *et al*. (2015) when broiler chickens were fed false yam tuber diets beyond 120g/kg. Even though charcoal is regarded as a universal antidote to toxic substances (Kanzler, 1995) and enhances growth performance (Kutlu *et al*., 2000; Teleb *et al*., 2004; Jiya *et al*., 2013 and Prasai, 2013), the addition of the charcoal at 3 and 6% in the SFYTM broiler diets did not serve that purpose of binding toxins in the false yam tuber and therefore tended to dilute the diet without any positive improvement in performance.

Generally mortality among birds in all the groups fed the 5%SDFYTM-based diets was low. This means that the false yam tuber diet could not adversely affected the health of the birds and therefore agrees with earlier report of Dei *et al*., (2011a). Similar observation was made by Osei *et al*., (2013) who indicated that false yam tuber either sun-dried or boiled had no detrimental problems to the health of broiler chickens when added to their diets up to a 10% concentration.

In experiment 2 which involved diets containing the 15%SFYTM indicated similar mortality as was observed in experiment 1. The low mortality could also not probably be affected by the SDFYTM-based diets.

Similar observations were recorded in the other experiment when birds were fed diets containing 15%SFYTM.

5.4.0 Haematological profile of broilers fed the 5%SDFYTM and the 15%SFYTM diets with increasing levels of charcoal

Blood haematological constituents are important in monitoring feed toxicity particularly with feed ingredients that affect blood as well as the health condition of farm animals (Oyawoye and Ogunkunle, 2004). Feeding broiler chickens with diets containing 5%SDFYTM plus wood charcoal showed no adverse effect on most heamatoligical parameters measured except an increasing trend in RBC values and decreasing MCV values (Table 34). Dei *et al.* (2011) found no effect of SDFYTM based diets fed to broiler chickens on their haematological parameters measured. This disagrees with the findings of this study especially on the RBC and MCV counts.

Similar observations in the haematological parameters measured were recorded except a decreasing trend in MCV values as the level of wood charcoal increases in the 15%SFYTM broiler diets.

However, all the haematological parameters measured were observed to be within the range reported by Jain (1993). This suggests that the health of the birds were not negatively affected when they were fed the 5%SDFYTM in experiment 1 and the 15%SFYTM based diets in experiment 2.

5.5.0 Serology of broilers fed the 5%SDFYTMand 15%SFYTM diets with increasing levels of charcoal

The feeding of broiler chickens with 5%SDFYTM-based diets had no adverse effect on most of their serum biochemical parameters measured except a decreasing albumin values (Table 35).

Delde (1994) reported that albumin represent the commonest blood plasma protein. This may be explained by the low crude protein concentrations as well as amino acid components in the SDFYTM based diets required for better performance. A decrease in blood proteins reflect decreased protein synthesis due to malnutrition or lack of essential amino acids that are required for protein synthesis (Shikora, 2002).

Similar observations have been made in the other experiment when broiler chickens were fed 15%SFYTM based diets.

5.6.0 Carcass and organ characteristics of broilers fed the increasing levels of charcoal in the SDFYTM and SFYTM

The inclusion of 0% wood charcoal in the 5%SDFYTM broiler chickens diet had no effect in their dress weight, dressing percentage and organ characteristics (Table 36).

The resins indicated earlier (Dei *et al*. 2011) may not have been transported into these organs to cause detrimental effects. The observation may also be due to the small percentage inclusion of the false yam tuber meal in the diet. Osei *et al*. (2013) observed similar carcass properties except for depressed dress weight and full intestines when birds were fed the same diet. Maybe the experimental locations and species of birds used for the experiment may account for these differences.

The inclusion of wood charcoal at 3 and 6% in the 5%SDFYTM broiler could not improve dress weight, dressing percentage and organ characteristics. Wood charcoal as feed supplement in animals is a toxin binder (Gerlach and Schmidt,2012) but does not actually add any nutrient or bind any toxins in the material for positive effect.

In Experiment 2 theinclusion of 0%wood charcoal in 15%SFYTM broiler chicken diet did not significantly affected carcass organ characteristics but carcass dress weight and dressing percentage were depressed. This may be due to the poor crude protein concentration content of the diet. The depression may also be attributed to the high residual concentrations of toxic compounds (resins) beyond tolerable levels when the birds were fed soaked false yam tuber meal at 15%.

This agree with previous study by Dei *et al*. (2015) who observed decline carcass dressing percentage when broiler chickens were feda 15%SFYTM diet.

Teguia *et al*. (2003) cited by Teguia and Beynen (2005) reported that feeding diets containing anti-nutritional factors resulted to a depression in carcass traits of broiler chickens.

Although charcoal is found to attenuate toxins such as aflatoxin, fumonisins, ochratoxin A, trichothenes and zearalenone (Dalvi and Ademoyero, 1983; Rotter *et al*., 1989; Kubena *et al*., 1990; Edrington *et al*., 1997; Huwig *et al*., 2001) the addition of the charcoal at 3 and 6% in the SFYTM broiler diets did not serve that purpose of binding toxins in the false yam tuber.

CHAPTER SIX

6.0: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The results of the study showed that anti-nutritional factors in the 5%SDFYTM had not negatively affected protein digestibility, growth performance, haematological profile, serum biochemistry and carcass and organ characteristics of broiler chickens when the material was included into their diets.

On the other hand, the anti-nutritional factors in the 15% SFYTM negatively affected protein digestibility, growth performance, carcass dress weights and dressing percentage of broiler chickens when it was included into their diets.

The charcoal inclusion into the false yam tuber meals diets in both cases for broiler chicken had no positive impacts on their performance

6.2 Recommendations

In both experiments, it is clear that treating the false yam tuber with charcoal as a feed material in broiler chicken does not give any significant effects to their performance, probably due to the short production process.

Similar experimental procedure can be tested on layer production since their production is more extended than in broiler production.

REFERENCES

Adei, D. and Asante, B. K. (2012). The challenges and prospects of the poultry industry in Dormaa District., Department of Planning, KNUST, Kumasi, Ghana. *Journal of Science and Technology*,**32,** (1):104-116

Ademola, S.G. and Farinu, G.O. (2006). Performance of laying birds fed diets containing forage meal of *Tithonia diversifolia* (Hemsl AG) and antibiotics. *Niger .J. Anim. Prod*.**33** (1).58-68.

Adene, D.F. (1996). International poultry health problems: Perspective from the poultry industry in Africa. *Proceedings of the 20th World Poultry Congress*. 1-5 September, 1996. New Delhi, India. **Vol.2**:401-414.

Afful E. N (1971). Poultry Marketing, Mystery? Proceedings of Ghana Animal Science Association Symposium pp.6 – 8.

Agyemang, K. (2010). Effect of Processing (soaking/cooking) False Yam Tuber on the Performance of Broiler Chickens. *B.Sc. Dissertation.* University for Development Studies, Tamale.

Akande, K.E., Doma U.D., Agu H.O., and Adamu, H.M. (2010). Major Anti-nutrient found in plant protein sources: Their effect on Nutrition. *Pakistan Journal of Nutrition*,**9**(8): 827-832, 2010, ISSN 1680-5194.

Akinmutimi, A.H. (2004). Evaluation of sword bean (*Canavalia gladiata*) as an alternative feed resources for broiler chickens. PhD Thesis. Department of Non-ruminant Animal Production, Michael Okpara University of Agriculture, Umudike, Nigeria. Pp 4-17

Akinmutimi, A.H., Oke, U.K. and Basiekong, S.F.A (2004). Observation on blood constituents of broiler finisher birds fed toasted lima bean (*Phaseolus lunatus*). *Proceedings of the 9th Annual Conference* (ASAN). 13-16 September, 2004. Eboyi State University, Abakaliki., P. 60-67.

Akinwuni J, Adegeye A. J., Ikpi AE, and Olayide, S. O (1979). Economic Analysis of Nigerian Poultry Industry. Study Commissioned by the Federal Livestock Department, Lagos – Nigeria.

Aletor, V. A. (1993). Allelochemicals in plant foods and feeding stuffs. Part 1. Nutritional, Biochemical and Physiopathological aspects in animal production. Vet. Human toxicology. **35** (1): 57-67.

Aletor, V.A. (1991). Anti-nutritional factors in some Nigerian feedstuffs, herbage by-products, crop residues and browse plants. A monograph prepared for the Presidential Task Force on Alternative formulation of livestock feeds; Production Development, Quality Evaluation and Health Implications.

Allan, W,H., Lancaster, J.E. and Toth, B. (1978). Newcastle diseases vaccines: their production and use. FAO, *Animal Production and Health Series*, No. 10,P .1. Italy.

Almagambetov, K. Bonderenko, V.M. Gorskaia, E.M. and Pavlova, L. A. (1992). The prevention of the translocation of intestinal microflora after the rescue of an organism from a terminal state. Mikrobiol. Epidemiol. Immunobiol. 5-6: 11-14.

Amaefule, K.U. (2002). Evaluation of pigeon pea seeds (*Cajanus cajan*) as protein source for pullets. Ph*D* Thesis. Department of Animal Science, University of Nigeria, Nsukka, Nigeria.

Amewonye, M.K. (2013). Effect of replacing maize with soaked false yam tuber meal on growth performance of local pigs (Ashanti black). *B.Sc. Dissertation*. University for Development Studies, Tamale.

Ansah .T., Emelia, A.A, Deku G., and Karikari, P.K. (2012). Evaluation of false yam *(Icacina oliviformis*) leaves on the growth performance of weaner rabbits (*Oryctolagus cuniculus*). *Online J. Anim. Feed Res.,* 2(1): 76-79. http:www-science-line.com/index/;http://wwwojafr.ir.

Ansah T, and Aboagye C. (2011). False yam (*Icacin aliviformis*) leaf meal as an ingredient in the diet of weaner rabbits (*Oryctolagus cuniculus*) to improve blood profile. Online *Journal of Animal and Feed Research.* **1**:135-138.

Antai, S.P and Nkwelang, G (1999). Reduction of some toxicants in *Icacinamannii* by fermentation with *Saccharomyces cerevisae*. Plant Foods for Human Nutrition **53**(2): 103 – 111.

Appiah, S. N. (1993). Poultry Health.CITA Press, Kumasi, Ghana.p 45-53.

Aryee, A. K, Obuobi, E. and Kutume, K. (1989). Project Paper of Ghana National Livestock Development, Project report submitted to the Government of Ghana, Ministry of Agriculture and the World Bank. Accra.

Ashitey, E. and Flake, L. (2008).Ghana Poultry and Products, annual. USDA Foreign Agricultural Services. Global Agriculture Information Network. Gain Report Number GH8006. Pp 3-9.

Association of Official Analytical Chemists (AOAC), (2000). Official Methods of Analysis. (17thed). Association of Official Analytical Chemists, Washington, D.C.

Asuzu I.U., Sosa, S., and Della, L.R. (1999). Screening of *Icacina trichantha* tuber. Phytomedicine **6**:267 – 272.

Asuzu, I.U. and Abubakar, I.I. (1995). The effect of *Icacina trichantha* Tuber extract on the Nervous system. Phototherapy Res. **28**: 21-25.

Asuzu, I.U. and Egqu, O.K. (1998). Search for the centrally active component of *Icancina trichantha* tuber. Phytomedicine **5**: 35 – 39.

Atuahene, C.C., Attoh-Kotoku, V., and Mensah, J.J. (2010). Poultry production in Ghana: Prospects and challenges. Department of Animal Science, Kwame Nkrumah University of Science and Technology, Kumasi. Ghana Journal of Animal Science, **5** (2): 93-99

Atuahene, C.C., Donkoh, A. and Asante, F. (1998). Value of sheanut cake as a dietary ingredient for broiler chickens. *Animal Feed Science and Technology*, **83**: 185-193.

Awoniyi, T. A., Aletor, I. A., and Oyekunle, B. O. (2000). Observations on some Erythrocyte indices of broiler chicken raised on maggot meal based diets. NSAP Proc. Umudike. Pp 225-228.

Ayivor, V.F.K., and Hellins, E.K. (1986). Poultry Keeping in the Tropics. (3rd ed). University Press Ltd, Ibadan, Nigeria. 34pp.

Banner, R.E., J. Rogosic, E.A Burritt, and F.D. Provenza. (2000). Supplemental barley and charcoal increase uptake of sagebrush by lambs. *Journal of Range Management***53**: 215-420.

Bell, D.D. and Weaver, W.D.Jr (2002).*Commercial Meat and Chicken Production*. Kluwer Academic Publishers, Massachusetts, USA. P 243.

Belmar, R. R., Nava-montero, Sandoval-Castro C., and McNab, J.M. (1999). Jack bean (*Canavalia ensiformis* L. DC) in poultry diets: Anti-nutritional factors and detoxification studies- A review. *World Poult. Sci J.*, **55**: 37-59.

Bisson, M.G., C.B. Scott, and C.A. Taylor, Jr. (2001). Activated charcoal and experience affect intake of juniper by goats. *Journal of Range Management***54**: 274-278.

Bollengier-Lee, S., Williams, P.E.V. and Whitehead, C.C. (1999). Optimal dietary concentration of vitamin E for alleviating the effect of heat stress on egg production in laying hens. British Poultry Science, **40**: 102-107.

Bonnet S. Geraert P. A Lessive M. Carre B. and Guillaumin S. (1997). Effect of high ambient temperature of feed digestibility in broilers. *Poult. Sci***76**: 857 – 863

Bouraoui, R., Lahmar, M., Majdoub, A., Djemali, M. and Belyea, R. (2002). The relationship of temperature-humidity index with milk production of dairy cows in a Mediterranean climate, *Animal Research*, 51:479-491.

Bregendahl, K., Sell, J. and Zimmerman, D. (2002). Effect of low-protein diets on growth performance and body composition of broiler chicks. Poult. Sci. 81: 1156-1167

Buamah, F.T. (1992). Feeding Chicken for egg production. Ghana Publishing Corporation. 108pp.

Burkhill, H.M. (1985). The Useful Plants of West Tropical Africa.2nd edition.Volume1, Families A-D.Royal Botanic Gardens, Kew, Richard, United Kingdom. 960pp.

Burrit, E.A., and Provenza.F.D. (2000). Role of toxins in intake of varied diets by sheep.*J. Chem. Ecolo.* 26: 1991-2005.

Butcher, G.D., Jacob, J.P. and Mather, F.B. (2012).Common Poultry Diseases. Dairy and Poultry Science Department, Cooperative Extension Services, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, 32611.

Butler, L.G. (1989). Effects of Condensed Tannins on Animal Nutrition. In: Chemistry and Significance of Condensed Tannins. (Editors: Hemingway, R.W. and J.J.Karchey). Plenum Press, New York, PP:391-402.

Carew, L.E. Hardy, D., Weis, J., Alsters, F., Mischter, S.A., Gernat, A and Zarkrzewska, F.I (2003). Heating raw velvet beans *(Mucuna pruriens)* reverses some anti-nutritional effects on organ growth, blood chemistry, and organ histology in growing chickens. *Tropical and Subtropical Agroecosystems*,1:267-275.

Chadd, S. (2008).Future trends and developments in poultry nutrition. Proceedings of the International Conference Poultry in the 21st Century Avian Influenza and Beyond, November 5-7, 2007, FAO, Bangkok.

Chauyarong, N., Elangovan, A.V. and Iji, P.A (2009). The potential of cassava products in diets of poultry. *World Poultry Science Journal*, **65**: 23-35.

Cheeke, P. R. (2005). Livestock feeds and feeding (3rd ed.), Pearson Prentice Hall, Upper Saddle River, New Jersey, 2005.

Cheeke, P.R. (1971). Nutritional and physiological implications of saponins: a review. *Canadian Journal of Animal Science*,**51**: 621-632.

Chunmei, G., P. Hongbins, S. Zewei and Q. Guixin.(2010). Effect of soybean variety on Anti-Nutritional Factors content, and Growth Performance and Nutrients Metabolism in Rat.*Int. J. Mol. Sci*, 2010, 11, 1048-1056; doi: 10.3390/ijms11031048. ISSN 1422-0067.

Clarke, E.G.C. and Clarke, M.L. (1979).Veterinary Toxicology. Bailliere Tindale, London. 438pp.

Corn Refiners Association (1982). Corn wet-milled feed products, 2nd edition. Corn Refiners Association, Washington D. C.

D'Mello, J.P.F., (2000). Anti-nutritional factors and mycotoxins. In: Farm Animals Metabolism and Nutrition. CAB International, Wallingford, UK, pp 383-403.

Dado, R.G. (1999). Nutritional benefits of Specialty corn grain hybrids in dairy diets. *Journal of Animal Science***77**: (197 – 207)

Daghir, N. J. (1995). Poultry Production in Hot Climates. A. B International Wallingford 2 – 110 UK.

Dalvi, R.R. and A.A. Ademoyero. (1983). Toxic effects of aflatoxins B_1 in chicken given feed contaminated with *Aspergillus flavus* and reduction of the toxicity by activated charcoaland some chemical agents. 28: 61-69.

Darko K. (2010). Ghana's Poultry Industry Still Faces Challenges. Ghana – The Government has been urged to revive the Poultry industry. Poultry Site News. Available at www.thepoultrysitelatestnews.com/Ghana's Poultry Industry Still Faces Challenges).

David Yarrow, (2016). Biochar in Poultry Farming. Unexpected uses for bicarbons.www.dyarrow.org/carbonsmart

Dei, .G, W., Yaro, D.and Mohammed, A. (2013).Nutritional value of soaked false yam tuber and seed meals in chicken diets. *Ghanaian Journal of Animal Science,* **7**(1): 87-92.

Dei, H. K, Adeti, J., Bacho, A. and Rose S. P. (2011a) Nutritive value of false yam (*Icancina oliviforms*) tuber meal for broiler chickens. *Poultry Science* **90**: 1239 – 1244

Dei, H.K, Adjokatse, R.A, Abdulai, S, Amoako, G.K, Mohammed, A. and Teye, G.A. (2011b). Evaluation of nutritive value of (*Icacina oliviformis*) seed meal in broiler chicken diets.*British Poultry Abstracts* **7**: 26-27.

Dei, H.K. and Bumbie, G.Z. (2011). Effect of wet feeding on growth performance of broiler chickens in a hot climate.*British Poultry Science*.**52** (1): 82-85.

Dei, H.K., Wallah, T.A. and Mohammed, A. (2012). Effect of soaking duration on nutritional value of false yam (*Icacina oliviformis*) seed meal for broiler chickens.*Proceedings of Crop Livestock Integration Wokshop. GILLBT,* Tamale. 27-28th August, 2012. P. 124-129.

Dei, H.K., Adeti, J., Bacho, A. and Rose S.P. (2011). Nutritive value of false yam (*Icacina oliviformis)* tuber meal for broiler chickens. *Poultry Science*, **90**:1239-1244.

Dei, H.K., Ajigepungu, W.T., and Mohammed, A. (2015a). Growth performance of broilers fed varying levels of soaked false yam (*Icacina oliviformis*) tuber meal. *Ghana Journal of Science, Technology and Development,* Vol 3(1): 72-76.

Dei, H.K., Alagma, A.H. and Mohammed, A. (2012a).growth response of broilers fed moderate levels of soaked false yam (*Icacina oliviformis*) tuber meal. *Proceedings of 24th World's Poultry Congress*. 5-9 August, 2012. Salvador, Brazil (Suppl. 1). P. 1-4.

Dei, H.K., Amewonye, M., Getse, F., Mbimadong, J., Alenyorege, B., Sarpong P., Avornyo, F., and Karbo, N. (2013).Effect of replacing maize with false yam tuber meals on growth performance of local pig (Ashanti black).Proceedings of 18th Biennial Conference of Ghana Society of Animal Production. Accra. Pp 308. 24-26, July, 2013.

Dei, H.K., Antchey-Boniku, M. and Appiah, I.K. (2012b). Effect of boiled false yam (*Icacina oloviformis*) tuber meal fed to layers during laying on subsequent egg production. *Proceedings of the 24th World's Poultry Congress,* 5-9 August, 2012. Salvador, Brazil. (Suppl. 1) P.1-4.

Dei, H.K., Asare, A.I., Mohammed, A. (2015b). Growth response of broiler chickens fed false yam tuber soaked in saltpeter solution. *Proceedings of the 19th Europian Symposium on Poultry Nutrition.* 26-29 August, 201. Potsdam, Germany, 3: 44-46

Dei, H.K., Bosoma ,J., andTumbultoR..(2015). Partial replacement of maize with processed false yam (*Icacina oliviformis*) seed meals in guinea fowl diets. *UDS International Journal of Development (UDSIJD)*, 1, January, 2015. 1(1): 36-41.

Dei, H.K., Gborkey, W., Mohammed, A. and Teye, G.A. (2010). Effect of soaked false yam (Icacina oliviformis) tuber meal on growth performance of broiler chickens. *Proceedings of the 30th Biennial Conference of the Ghana Animal Science Association* held at the Animal Research Institute, Accra 26-27 August, 2010. Kantamanso-Accra.

Dei, H.K., Is-haq, N. and Mohammed, A. (2013). Effect of varying boiling time (1-3h) on nutritive value of false yam seed meal in broiler chicken diets.*Proceedings of* *the 19th European Symposium on Poultry Nutrition*. 26-29 August, 2013. Potsdam, Germany. P. 1-3.

Dei, H.K., Owusu, M. and Mohammed, A. (2013). Growth response of broiler chickens fed false yam tuber soaked in sodium chloride solution. *Proceedings of the 19th Europian Symposium on Poultry Nutrition*. 26-29 August, 2013. Potsdam, Germany. P. 1-8.

Dei, H.K., Yaro, D. and Mohammed, A. (2012). Effect of soaked false yam (*Icacina oliviformis*) tuber meal on growth performance of layer chickens. *Proceedings of the 31st Biennial Conference of the Ghana Animal Science Association held at the Animal Research Institute*, 23-24th August, 2012, Katamanso-Accra.

Delde, A. (1994). Blood and Bone marrow.In: Veterinary Histology 5th Edition. HD Dellmann and J Eurell (eds) Williams and Wilkins. A Wavely Company, **4**: 62-79.

Dirian, O.C.P and Waldroup, P.W. (2002). Evaluation of lysine, methionine and threonine needs of broilers three to six week of age under moderate temperature stress. *International Journal of Poultry Science*, **1** (1): 16-21.

Donkoh, A. (1989). Ambient temperature: a factor affecting performance and physiological response of broiler chickens. *International Journal of Biometeorology*, **33**:259-265.

Donkoh, A., Atuahene, C.C. and Offori, S.K. (1998). Effects of solar dried blood meal on growth performance of broiler chickens. *Proceedings of the 24th Ghana*

Animal Science Symposium 26th-29th August 1998, KNUST, Kumasi, Ghana.**Vol. 2**:108.

Douglas, J.H., Sullivan, T.W., Gewemter, N.J. and Beck, M.M (1993). Differential age response of turkeys to protein and sorghum tannin levels.*Poultry science*,**72**: 1944-1951.

Edrington, T.S., KUbena, L.F., Harvey, R.B., and Rottinghaus, G.E.. (1997). Influence of superactivated charcoal on the toxic effects of aflatoxin or T-2 toxin in growing broilers. *Poultry Science* **76**: 1205-1211.

Effah, K.J. (2013). Effect of soaked false yam tuber on pullets on subsequent egg laying performance .*B.Sc. Dissertation*. University for Development Studies, Tamale.

Endale, .Y., Abule, .E., Lemno, .F., and Getnet, .A. (2015). Livestock Feed Production and Feed balance in Meta – Robi District, West Shewa zone, Oromiya Regional State, Ethiopia, *Acad. Res. J. Of Agric Sci. and Res*. Vol. 4(2), PP: 45 – 54

Erdman, J.W., (1979). Oilseed phytates: nutritional implications. *J. Am. Oil Chemist Soc*., **56**: 736-741.

Etukudo, I. (2003). Ethnobotany: Conventional and Traditional Uses of Plants. Vol 1.The Verdict Press, Uyo, Nigeria. p 65.

Ewuola, E.O., Folayan O.A., Gbore F.A., Adebunmi A.I., Akanji R. A., Ogunlade J.T., and Adeneye, J.A. (2004). Physiological response of growing West African Dwarf goats fed groundnut shell-based diets as the concentrate supplements. *Bowen Journal of Agriculture*, **1** (1): 61-69.

Ezeigbo, I.I. (2010). Antidiabetic potential of methanolic leaf extracts of *Icacina trichantha* in alloxan induced diabetic mice. *International Journal of Diabetes in Developing Countries,* **30**:150-152.

Fagbemi, T.N., Oshodi, A.A and Pinmoroti, K.O. (2005). Processing effects on some Anti-nutritional Factors and in vitro multi-enzyme protein digestibility of three Tropical seeds. Bread nut (*Artocarpus attilis*), cashew nut (*Anacardium occidentale*) and Fluted pumpkin (*Telferia occidentalis*), *Pal J. Nutrition*. **48**: 250 – 256.

FAO, (2014). Poultry Nutrition and Feed. Agriculture and Consumer Production Department. Animal Production and Health.www. Fao.org>poultry>AP.nutrition

Farrell, D.J. (1997). Where in the world will we find the ingredients to feed our livestock by the year 2007? In: Corbett, J.L., Choct, M., Nolan, J.V. and Rowe, J.B. (Eds.), *Recent Advances in Animal Nutrition in Australia.* University of New England, Armidale. P. 136-145.

Farrell, D.J., Perez-Maldonado, R.A. and Mannion, P.F. (1999). Optimum inclusion of field peas, chick peas and sweet lupins in poultry diets II. Broiler experiments.*British Poultry Science*, **40**:674-680.

Fay, J. M. (1991). *Icacina oliviforms* (Icacinaceae).A close look at an under exploited food plant.II.Analysis of Food Products. Economic Botany **45 (1)**: 16 – 26

Fay, J. M. (1993). *Icacina oliviforms* (Icacinaceae) : A close look at an under exploited food plant. III. Ecology and Production Economic Botany **47 (2)**: 163 – 170

Fay, J.M. (1987). *Icacina oliviformis* (*Icacinaceae*): A Close Look at Unexploited Crop. Plant. 1. Overview and Ethnobotany. The New York Botanical Garden, Bronx, NY 10458. *Economic Botany*, **41** (4): 512-522.

Feng, D., Shen, Y. and Chavez, E.R.(2003). Effectiveness of different processing methods in reducing hydrogen cyanide content of flaxseed. *Journal of the Science of Food and Agriculture*, **83**: 836-841.

Flake, L. and Ashitey, E. (2008) Ghana's Poultry and Products Annual Report.USDA Foreign Agriculture Services GAIN Report.(www.the poultrysite.com/articles Accessed on February3, 2010).

Food and Agriculture Organizations (FAO-STAT) (2014). Sources of world meat.Animal Production and Health. Agriculture and Consumer Protection Department. www.fao.org./meat/bacgr_sources

Franco-Jimenez, D.J. and Beck, M.M (2007). Physiological changes to transient exposure to heat stress observed in laying hens. *Poultry Science*,**86**:538-544.

Freizier, W.C. and Westhoff, D.C. (1988). Food Microbiology.4th edition.McGraw Hill, Book Company, New York. 540pp.

Gerlach, H., and Schmidt, H.P. (2012). Biochar in poultry farming.*Ithaka -Journal*. 1/2012: 262–264.

Gershenzon, J., **and Dudareva, N. (2007)**.The function of terpenes natural products in the natural world. Nature Chemical Biology, **3**: 408-414.

Getsey, F. (2013). Effects of replacing maize with boiled false yam tuber meal on growth performance of local pigs (Ashanti Black). *B.Sc. Dissertation*. University for Development Studies, Tamale.

Gillespie, J. R. (1983).*Livestock and Poultry Production*.2nd Ed. Delmar Publishers lnc, Columbus P 516

Gillespie, J. R. (1992). Modern Livestock and Poultry Production.4th edition. Delmar Publishers Inc., New York. PP. 595 – 598

Gyawu, J.B. (2013). Effect of soaked/boiled false yam tuber meal on growth performance of layer chickens. *B.Sc. Dissertation*. University for Development Studies, Tamale..

Hathcoock, J. N. and J. I. Rader.(1994). Food Additives, Contraminants and Natural Toxins. In: Modern Nutrition in Health and Disease. M. E. Shils, J. A. Olson and M. Shike, (Eds.) 8th Edition, 2: 477-483.

Hurwitz, S., Weiselberg, M., Eisner, U., Bartov, L., Reisenfeld, G., Sharvit, M., Niv, A. and Bornstein, S. (1980). The energy requirements and performance on growing chickens and turkeys as affected by environmental temperature. *Poultry Science,* 59:2290-2299.

Huwig, A., Freimund, S., Kappeli, O., and Dutler, H. (2001). Mycotoxin detoxification of animal feed by different adsorbents.*Toxicology Letters*. **122**:179-188.

Iji, P.A., Khumalo, K., Slippers, S. and Gous, R.M. (2004). Intestinal function and body growth of broiler chickens on maize-based diets supplemented with mimosa tannins and microbial enzyme. *Journal of the Science of Food and Agriculture*, **84**:1451-1458.

Jain, N.C. (1993). Essential of Veterinary Hematology, Lead and Febiger, Philadelphia.

Jansman, A .J., Verstegen, M.W.A., Huisman J., and Van den Berg, J. W. (1995). Effects of hulls of faba beans (*Vicia faba L.*) with low or high content of condensed tannins on the apparent ileal and fecal digestibility of nutrients and the excretion of endogenous protein in ileal digesta and feaces of pigs. *J. Anim. Sci.***73**: 118-127.

Jenkins, K.J. and Atwal, A.S. (1994). Effects of dietary saponins on faecal bile acids and neutral sterols and availability of vitamins A and E in the chick.*Journal of Nutritional Biochemistry*, **5**: 134-138.

Jiya, E. Z., Ayanwale, B. A., Ijaiya, A. T., Ugochukwu, A. and Tsado, D. (2013). Effect of activated coconut shell charcoal meal on growth performance and nutrient digestibility of broiler chickens. *British Journal of Applied Science and Technology*, **3**(2): 268-276.

Johnson, I.T, Gee, J.M, Price, K., Curl, C., (1986). Part 1. Nutritional, biochemical and physiopathological aspects in animal production. Vet. Human Toxicol. **35** (1): 57-67.

Jones, T. C. and Hunt, R. D. (1982).Veterinary Pathology 5th edition. Layer and Febiger. Pp 1294-1296.

Jordan, F.T.W., and Pattinson, M. (1996). Poultry Diseases. Sounders, W.B Company Ltd, London. 571 pp .

Kana, J.R., Teguia, A., Mungfu, B.M., and Tchoumboue, J. (2010). Growth performance and carcass characteristics of broiler chickens fed diets supplemented with graded levels of charcoal from maize cob or seed of *Canarium schweinfurthii Engl*. Tropical Animal Health and Production **43** (1): 51-56

Kanzler, K. (ed.). (1995). Veterinary pharmaceuticals and biologics (9th ed.). Lenexa, KS: Veterinary Medicine.

Kasei, C.N. (1988). The Physical Environment of Semi-arid Ghana: Inger, P.W. (Eds). Challenges in Dry Land Agriculture- A Global Peerrspective. Texas Agricultural Experimental Station, Texas, USA.P.350-354.

Kay, D.E., (1973). TPI crop and product Digest No.2, Root crops. Overseas Development Administration, London.

Kekeocha, C.C (1984). Poultry Production Hand Book. Macmilian , U.K. 166pp.

Khare, S.K., (2000). Application of immobilized enzymes in soybean processing. The Third International Soybean Processing and Utilization Conference (ISPCRC) III: 2000 of the Inovation Era for Soybeans. 15-20, October, 2000. Tsukuba, Ibaraka, Japan, pp: 381-382.

Killebrew K. and Plotnick R. (2010). Poultry Marketing in West Africa. Ghana EPAR Brief No. 83 – Prepared for the Market Assess Team of the Bill and Melinda Gates foundation. May 28, 2010. Retrieved December 10,2012,fromhttp://evans.washington.edu/files/evens%20UW – Request % 2083 – Poultry % 20 Analysis % 20Ghana – May – 28 – 2010. Pdf

Kim, Y. C. (2004). Evaluation of Availability for Fermented Soybean Meal in Weaning Pigs. PhD Thesis, Department of Animal Sources and Science, Seoul, The Republic of Korea.

Koney E. B. M. (1993). Poultry Health and Production.Advent Press. Accra. PP. 28 – 35

Koney, E. B. M. (1993). Poultry Health and Production.33pp.

Koney, E.B. (1992). Poultry Health and Production, It-Neck Art Limited, Accra, Ghana pp.1-2185

Koney, E.B.M (2004). Poultry health and production.2nd edition. Advent Pess, Accra, Ghanan. 182 pp

Kubena, L.F., Harvey, R.B., Phillips, T.D., Corrier, D.E. , and W.E. Huff. (1990). Diminution of aflatoxicosis in growing chickens by the dietary addition of hydrated, sodium calcium aluminosilicate. *Poultry Science***69**: 727-733.

Kumar, R. and D'Mello, J.P.F. (1991). Anti-nutritional Factors in Forage Legumes. In: D'Mello, J.P.F. and Devendra, C. (Eds.). Tropical Legumes in Animal Nutrition, CABI Publishing. P. 95-133.

Kutlu, H.R. Unsal, I.M. and Gorgulu, J. (2000).Effects of providing wood (oak) charcoal to broiler chicks and laying hens. Animal Feed Science and Tech. **90**: 213-239.

Kutlu, H.R., and Unsal I. (1998). Effects of dietary wood charcoal on performance and fatness of broiler chicks. *Brit. Poult. Sci*. T. 76. P. 1205-1211.

Larbier Z. Chagneau M., Geraert, A. M., P. A (1993). Influence of ambient temperature on true digestibility of protein and amino acids of rape seed and soybean meals in broilers. Poultry science **72**:289 – 295

Lawes Agricultural Trust (2005). GenStat 8th ed. Rothamsted Experimental Station, Harpenden, UK.

Lawes Agriculture Trust (2005). Gentstat 8th ed. Rothamsted Experimental Station, Harpenden, UK.

Lin, H., Jiao, H.C., Buyse, J., and Decuypere, F. (2006). Strategies for preventing heat stress in poultry. World's Poultry Journal 2006; 62:71-85

Lin, H., Mertens, K., Kemps, B., Govaerts, T., Deketelaere, B., Debaerdemaeker, J., Decuypere, E. and Buyse, J. (2004). New approach of testing the effect of heat stress on egg quality: mechanical and material properties of eggshell and membrane. *British Poultry Science*,**45**: 476-482.

Majewska T., and Siwik T. (2006). Silica grit **Lucindo. J.Q.J., Jacksen, R.G.S.A., Julianel:, T.L., Xirley, P.N., Jully and S.S., Leander, E.G.O, Reinaldo, N.A., Petronio. F.A.F. and Jose, M.B.F. (2008).**Plants with anticonvulsant properties a review of *Brazilian Journal of pharmacogriosy* **18**, 798-819.MAFF. Undated egg Quality Guide http://www.defra.gov.uk/foodrin/poultry/pdfs /eggqual.pdf

Marsden, A., Morris, T.R. and Cronarty, A.S. (1987). Effects of constant environmental temperature on the performance of laying pullets. *British Poultry Science*, **28**: 361-380.

Mbimadong, J.K. (2013). Effect of raw false yam tuber (*Icacina oliviformis*) meal as a substitute for maize in the diet of Ashanti black pig. *B.Sc. Dissertation*. University for Development Studies, Tamale.

McDonald P., Edwards R.A. and Greenhalgh, J.F. D. (1995). Annual Nutrition 4th Edition, Longman Group Ltd., Essex, England pp.405-491.

McDonald, P., Edwards, R.R., Greenhalgh, J.F.D. and Morgan, C.A. (2002). Animal Nutrition. 6th edition, Pearson Education Ltd, Essex, U.K. P.201-312.

McLennan, M.W. and M.L. (1989). Treatment of lantana poisoning in cattle. *Australian Veterinary Journal* **66**: 93-94.

Mehri, M., Adibmoradi, M., Samie, A. and Shivazad, M. (2010). Effects of B-mannanase on broiler performance, gut morphology and immune system. *African Journal of Biotechnology*, **9**:6221-6228.

Mengesha, M., (2011). Climate change and the preference of rearing poultry for the demands of protein foods. *Asian J. Poult. Sci*., **5**:135-143

Mengesha, M., B. Tamit and T. Dessie, (2011) Village chicken constraints and traditional management practices in Jamma District, South Wollo, *Ethiopia, J. Livestock Res. Rural Dev.*, Vol.**23**, No.2.

Mensah, J. (2013). Effects of soaked/boiled false yam seed meal on growth performance of broiler chickens. *B.Science Dissertation*.University for Development Studies, Tamale. 33(2)

Min, B. J., J. W. Hong, O.S. Kwon, W.B. Lee, Y.C. Kim, I.H. Kim, W.T. Cho and J.H. Kim. (2004). The effect of feeding processed soy protein on the growth performance and apparent ileal digestibility in weaning pigs. *Asian-Aust. J. Anim. Sci*. **17**: 1271

Mohammed, A. Aborchei, C. and Dei, H.K. (2017). Charcoal in false yam seed meal-based diet: effect on broiler growth, carcass and organ characteristics. Journal of Veterinary Science and Technology. **6** (1):22-25p.

Mohammed, A. and Dei, H.K (2010). Effects of water temperature and alcohol addition to water on growth performance of broiler chickens in a hot climate.*Ghana Journal of Animal Science*,**5**(2): 73-79.

Mohammed, A. and Dei, H.K. (2012).Effect of soaked false yam (*Icacina oliviformis*) seed meal on laying performance of chicken.*Proceedings of the 31st biennial conference of the Ghana Animal Science Association held at the Animal Research Institute.* 23-24 August, 2012. Katamanso-Accra.

Mohammed, A. and Dei, H.K. (2013). Effects of soaked false yam (*Icacina oliviformis*) tuber meal on feed digestibility, performance and haematological characteristics of layer chickens. *Ghanaian Journal of Animal Science*, 7(20): 105-116.

Murdiati, T.B., McSweeney, C., and Lowry J.B. (1991). Complexing of the toxihydrolasable tanins of yellow wood (*Terminalia oblongata*) and harendong (*Climedia hirta*) with reactive substances: an approach to preventing toxicity. J. Appl. Toxicol. 11: 333-338.

Nakayoma, J. and Yamada, M. (1995). Suppression of active oxygen-induced cytotoxicity by flavonoids. Biochemical Pharmacology, 45:265-267.

National Research Council (2008). Lost Crops of Africa; Volume III: Fruits. 281 – 289. Available at http://www.nap.edu/catalog/11879.Html, (20/11) 2011.

National Research Council (NRC), (1994). Nutrient Requirements of Poultry.9TH Rev. ed. National Academy Press, Washington, DC, US. http://www.nap.edu/catalog/2114.html

National Research Council (NRC).(1998). Nutrient Requirements of Swine.10th Edition, National Academy Press, Washington DC.

National Research Institute (NRI), (1987). Crops and Product Digest, 2nd ed. Tropical Development and Research Institute, London. 308pp.

Nelson, F. S. (1998). Growth performance and economics of broiler production using diets containing oil and palm oil slurry. *Proceedings*, *6th Animal Science*

Conference, Ghana Society of Animal Production. UCC, Cape Coast, Ghana. Pp69

Neuwinger, H.D. (1996). African Ethnobotany: Poisons and Drugs, Chemistry, Pharmacology and Toxicology. P 542.Chapman and Hall. London, New York.

Niayele, R. (2013). Effect of varying levels of soaked false yam tuber meal on the growth performance of layer chicken. *B.Sc. Dissertation*. University for Development Studies, Tamale.

Nikolaeva, L., Grigor'ev, A.V., Znamenskii, V., and Kuval'chuc, V.K. (1994). An experimental study of the efficacy of entersorbents in salmonellosis. Zh. Mikrobiol. Epidemiol.Immunobiol.**2**: 7-11.

Nordblom, T.L., and Shomo, F. (1995). Food and Feed Prospects to 2020 in the West Asia-North Africa region, ICARDA 2 Social Science papers, Aleppo, Syria, pp 55.

North, M.O. and Bell, D.D. (1990). Commercial Chicken Production Manual, 4th edition.An AVI Book Publication by Van Nostrand Reinhold, New York, USA. 42pp.

Nweze, B. O., A. E. Nwankwegu and O. O Ekwe, (2011). The performance of broiler chiCkens on African porridge fruit (*Tetrapleuratetraptera*) pod under different feeding regimes. *Asian J. Poult Sci*.**5**: 144 – 149.

Obi, O. O., and Sonaiya, E. B. (1995). Gross Margin estimation of rural poultry production in Ogun State, Nigeria, *Nigeria Journal of Production*. **22**:89.

Obidinma, V.N. (2009). Brewer's spent grain as energy source in finisher broiler birds and laying hen production. *Doctor of Phylosophy* Thesis. Imo State University, Owerrri, Nigeria.

Odukoye, O.A., Jenkins., M.O., Llori, M.O.O, and Sufidiya, M.O (2005). The use of selected Nigerian natural product in management of environmentally induced skin damage, *Pakistan Journal of Biological Sciences* **8:** 1074-1077.

Odukoye, O.A., Sofidiya, M.O., Familoni, O.B, and Inya-Agha, S.I. (2006). Free radical scavenging activity of some Nigerian medicinal plant extracts. *Pakistan Journal of Biological Sciences***9**, 1438-1441.

Odunsi, A.A., Oladele, T.O., Olaiya, A.O. and Onifade, O.S. (2007). Response of broiler chickens to wood charcoal and vegetable oil based-diets. *World Journal of Agricultural Sciences* **3**(5):572-575.

Ofori, C. (2013). Effect of soaked/boiled false yam tuber meal on subsequent egg production in layer chickens. *B.Sc. Dissertation*. University for Development Studies, Tamale.

Okai, D. B and Boateng M. (2007). Pig nutrition research in Ghana – some achievements, prospects and challenges. *Ghanaian Journal of Animal Science* **23**(1): 9 – 25

Oke, J.M. and Hamburger, M.O. (2002).Screening of some Nigerian medicinal plants for antioxidant activity using 2, 2, diphenyl-picrylhydrazyl radical. *African Journal of Biomedical Research***5**: 77-79.

Okeke, J.E., Agbakoba, A.M. and Otil, A. (1992). Cassava Utilization in the Poultry Industry. The Nigeria Perspective. Proc. 5th Trennial sym. ISTRC-AB Kampala, Uganda 22-23rd November 1992. pp 89.

Okyere, E.J. (2011). Effect of raw and processed false yam seed meals on the haematology of broilers. *B.Sc. Dissertation*. University for Development Studies, Tamale.

Olomu, J.M. (1995). Monogastric Animal Nutrition, Pinciples and Practice. Jachem Publication. 320pp.

Olorode , B.R., Adeiniran R.A., and Abiola J.O. (2007). Effect of graded levels of *Moringa oleifera* seed meal on haematological values and organ weight of broiler chickens. Tropical *Journal of Animal Sciences*, **10**:63-67.

Oluyemi, J. A and Roberts, F. A. (1979). Poultry Production in Warm Wet Climates. The Macmillan, Basingstoke, London. Pp 125-130.

Oluyemi, J.A. and Roberts, F.A (1988). Manure parameters: Poultry Production in Warm Wet Climate. The Machillan, Besingstoke, London. pp 125-130.

Oluyemi, J.A. and Roberts, F.A. (1979). *Manure parameters: Poultry Production in Warm Wet Climates.* The Macmillan, Basingstoke, London. Pp 172.

Omage, J. J, Agubosi, O. C. P, Bawa G. S and Onimisi, P. A. (2009). Evaluation of the nutritive value of quality maize on the growth performance and carcass characteristics of weaner rabbits.*Pakistan Journal of Nutrition*, **8(**2) : 106 – 111

Opoku-Addae, E. (2013). Effect of boiled false yam seed meal fed to pullets on subsequent egg production. *B.Sc. Dissertation*. University for Development Studies, Tamale.

Osei, S. A. (1990). Poultry Feeding Strategies: Feed Formulation and Feed management in the Tropical Climate. Proceedings from Ghana Society of Animal Production (GSAP) Conf. 3:57. UST, Kumasi

Osei, S. A. (1990). The nutritionist and the extension agent as partners in evolving feeding strategies for poultry in Ghana.Journal of Agricultural Science.**24:** p.35.

Osei, S.A., Atuahene, C.C., Donkoh, A., Kwateng, K., and Afriyie, S (1994). Further Studies on the use of QPM as feed ingredient for broiler chickens, Proc. of Symposium of Ghana Animal Science Association **22**:51-55.

Osei, S.A., Korsah-Gyapong, M. and Danso, S.A. (2013). False yam (*Icacina oliviformis*) tuber meal as a feed ingredient in broiler chickens diets. *Ghanaian Journal of Animal Science* 7(1): 15-21.

Osho, S.M., (1993). Developed soybean technologies for small – scale and industrial level. A manual workshop on small scale and industrial level processing of soybean, July, 1993, Ibadan, Nigeria.

Osthuysen, P. (2013). Opportunities and Challenges for Poultry Production in Sub-Saharan Africa.WATTAGNet.com.

Otoo, J. (2009). Crisis in Ghana's Poultry Industry. Ghana Business News, www.modernghana.com/crisis in Ghana's Poultry Industry.

Owusu, F.E. (2013). Effect of boiled false yam (*Icacina oliviformis*) seed meal on the growth performance of pullets. *B.Sc. Dissertation*.University for Development Studies, Tamale.

Owusu-Domfeh, K. (1972). The future of cocoa and its by-products in feeding livestock. *Ghanaian Journal of Agricultural Science,* **5**:57-63.

Oyawoye, B.M., and Ogunkunle, H.N. (2004). Biochemical and haematological reference values in normal experimental animals (P. 212-218). New York: Masson..

Panda, A. K. Raju, M. V. L. N., Rama S. V. R., Lavanya, G., Reddy, E. P. K. and Sunder, G. S. (2010). Replacement of normal maize with Quality Protein Maize on performance, immune response and carcass characteristics of broiler chickens. *Journal of Animal Science,* **23**(12): 1626 – 1631

Parkhurst, C.R. and Mountney, G.J. (1988). Poultry Meat and Egg Production by Van Nostrand Reinhold, New York.P. 5.

Pass, M.A. and C. Stewart. (1984). Administration of activated charcoal for the treatment of lantana poisoning of sheep and cattle.*Journal of Applied Toxicology***4:** 267-269.

Peckham, M.C. (1984). Poison and Toxins. In: Hofstad, M.S., Barnes, H.J., Calnek B.W., Reid, W.M. and Yoder, H.W. (Eds). Diseases of Poultry. 8th edition, Iowa State University Press, Iowa, USA. P. 789-818.

Poage, G.W., III, C.B.Scott, M.G.Bisson, and F.S.Hartmann.(2000). Activated charcoal attenuates bittersweet toxicosis in sheep. *Journal of Range Management* **53**: 73-78.

Pomer, L. (2003). Oxidation of terpenes in indoor environment: A study of influencing factors. VMC, Umea, Sweden. P. 1-96.

Potter, N.N and Hotchkiss, J. H. (1995). Food Science 5th Edition. Chapman and Hall, New York. P. 381 – 394

Prasai (2013). Double Green Chickens Produce Carbon-Smart Poo. Sustainability Matters **6**(4): 34. http://issuu.com/westwick-farrowmedia/docs/sm_febmar13 issuu.

Prince Appiah, P. (2016). Poultry Industry in Ghana.www.modernghana.com

Qin, G.X. (2003). The anti-nutritional factors in the feed and their eliminating methods.*Pig Poultry*, **23**: 10-13.

Qureshi, A.W. (1987). Current trends and possibilities of increasing small ruminant production in the near east. In: small Ruminants in the Near East. F.A.O Animal Production and Health Paper No. 54, F.A.O, Rome, Italy, pp. 21-22.

Qureshi, A.W. (1993). Issues related to sustainable development of livestock production. In: Strategies for sustainable animal agriculture in developing countries. F.A.O Animal Production and Health Paper, No. 107, F.A.O. Rome, Italy, pp. 1-5.

Ravindran, V. and Blair, R. (1991). Feed resources for poultry production in asia and the pacific. II. Plant protein sources. *World's Poultry Science Journal*, **49**:205-231.

Ravindran, V. and Blair, R. (1992). Feed resources for Poultry Production in Asia and the Pacific II. Plant Protein Sources. *World's Poultry Science Journal*, **48** : 219 – 235

Ray, V. H and Roy L. D. (1991). The Agriculture Dictionary (Second Edition).Published by Delmar Publishers Inc. Albany, New York.

Reddy, C. V. and Qudratullah, S. (2004). Strategic feed Supplementation through locally available resources. In proceedings of XX 20th World Poultry Congress, New Delhi, India.

Rejendran K. and Mohanty S. (2003). Comparative Economic Analysis and Constraints in Eggs Production Under Cage VS Deep litter System of rearing in India.

Retrieved December 10, 2012, from http://docsdrive.com/pdfs/ansinet/ijps/2003/153-158.pdf

Retrieved from http://eds.ifas.ufl.edu. (14/05/2014)

Roeder, E. (1995). Medicinal plants in Europe containing pyrrolizidine alkaloids. Pharmazie, **50 (2)**: 83-98.

Rosenzweig; C., Parry, M.L., Fisher, G., and Frohberg, K. (1993). Climate change and world food supply. Research Report No. 3, University of Oxford, Environmental Change Unit, Oxford, UK., PP.133-138. http://www.ciesin.org/docs/004-046/004-046.htm.

Rotter, R.G., Frohlich, A.A., and Marquardt, R.R.. (1989). Influence of dietary charcoal on ochratoxin A toxicity in leghorn chicks. *Canadian Journal of Veterinary Research* **53**: 449-453.

Rufus, M.U. (2010). Ethnobotany and Biodiversity Conservation in the Niger Delta, Nigeria. *International Journal of Botany*, **6**: 310-322.

Russ, N., and Elmasoeur, Z. A. (2013). 2013 Ghana Poultry Report Annual. GAIN Report:1304. Pp5-8

Sahin, K., Sahin, N., Kucuk, O., Hayirli, A. and Prasad, A.S. (2009). Role of dietary zinc in heat-stressed poultry: A review. *Poultry Science*, **88**: 2176-2183

Saito, K. Horie M, Hoshino Y., Nose N, and Nakazawa J. (1990). High performance liquid chromatographic determination of glycoalkaloids in potato products. *J. Chromatograph*. **508**: 141-147.

Salkowski, A.A. and Penney, D.G. (1994). Cyanide poisoning in animals and humans: a review. *Veterinary Human Toxicology*, **36**: 455-466.

Salunke, D.K. and Chavan, J.K. (1990). Dietary tannins: Consequences and remedies. CRC Press, USA.

Sarr, S.O, Sylvie, P., Ibrahima, F., Said, E., Minjie, Z., Yerim, M, and Ermanne, C. (2011). *Icacina senegalensis* (Icacinaceae), traditionally used for the treatment of malaria inhibits in vitro plasmodium falciparum growth without host cell toxicity. *Malaria Journal*, **10:** 85.

Savannah Agricultural Research Institute (SARI), (2001). Meteorological Department.Council for Scientiific and Industrial Research, Nyankpala, Tamale, Ghana.

Science, **58**:674-680.

Shahidi, F. (1997). Beneficial health effects and drawbacks of anti-nutrients and phytochemicals in foods. An overview. In: Anti-nutrients and phytochemicals in foods. ACS Symposium Series 662. American Chemical Society, Washington DC, pp: 1-9.

Shareef, A.M., AL-Jubory K.M.T., and Hassan, M.G. (1998). Effect of activated charcoal in reducing dietary aflatoxin-induced stress in broiler chicks.*Iraqi J. Vet. Sci*. 1998 .T. 11. P. 23-29.

Shikora, S.A. (2002). Nutritional considerations in the intensive care unit: Science, rationale and practice, Kendall/Hunt, Dubuque, Iowa, US.

Sienso, G., Asumin – Brempong, S., and Amegashie, D. P. K. (2013). Estimating the efficiency of maize farmers in Ghana.In 4th International Conference of the AAAE. Cape Town, Hammamet, Tunisia

Smith, A.J. (1990). Poultry.*The Tropical Agriculturalist*, Macmillan. Basingstoke.Pp 3-195.

Spinelli, J., Houle, C.R., and Wakell, J.C. (1983). The effect of phytates on the growth of rainbow trout (*Salmo gairdneri*) feed purified diets containing varying quantities of calcium and magnesium. Aquaculture, 30: 71-83.

SRID/Veterinary Services Directorate (2013). Agriculture in Ghana (Livestock subsector) Facts and Figures (2012), Ministry of Food and Agricuture. Pp1-64

Sterling, K.G. Bell, D.D. Pesti, G.M. and Aggrey, S.E. (2003). Relationships among strain, performance, and environmental, temperature in commercial laying hens.*Journal of Applied Poultry Research*,**12**: 85-91.

St-Pierre, N.R. Cobanov, B. and Schnitkey, G. (2003). Economic losses from heat stress by US livestock industries. *Journal of Dairy Science*, **86**:52-77.

Sturkie, P.D. (1976). Avian Physiology. Springen-Verlag, New YORK. 657 PP.

Styslinger, M. (2011). False yam: A famine prevention Trifecta. Nourishing the planet.http://blogs. worldwatch.org/nourishing the planet/false-yam-a-famine-prevention-trifecta-false-yam-west0africa-central-africa-indigenous-crop-food-store-fruit-seed-famine-food-hunger-prevention. Accessed (20/01/2014).

Tachie – Menson, C. K. M. (1991). Steps in Rearing Chicken. Asempa Publishers Ghana. 87pp.

Teguia, A. and Beynan, A.C. (2005).Alternative feedstuff for broilers in Cameroon. Livest. Res. Rural Dev. **17**(3).

Teleb, H.M., Hegazy. A.A., and Hussein, Y.A. (2004). Efficiency of Kaolin and Activated Charcoal to Reduce the Toxicity of Low Level of Aflatoxin in Broilers. *Scientific Journal of King Faisal University*, **5**(1): 1425.

Teog, A. (2010). Effect of Fermented False Yam (*Icacina oliviformis*) Tuber meal on Growth Performance of Broiler Chicken. BSc. (Agric. Tech.) Dissertation. University for Development Studies, Tamale.

Tewe, O.O. (2006). Cassava products for animal feeding. In: Integrated cassava project. P. 1-3. http://www.cassavabiz.org/postharvest/lvstock-1.htm10Nov.2006.

Thompson, H.E,L. Berrang –Ford and J.D Ford, (2010). Climate change and food security in Sub-Saharan Africa: A Systematic Literature Review. Sustainability, **2**:2719-2733.

Tibieb, D.A. (2011). Effect of boiling time of false yam tuber meal on growth performance of broiler chickens. *B.Sc. Dissertation.* University for Development Studies, Tamale.

Timothy, O. and Idu, M. (2011). Preliminary phytochemistry and in vitro antimicrobial properties of aqueous and methanol extracts of *Icacina trichantha* Oliv Leaf. *International Journal of Medicinal Aromatic Plants*. 1, 1-5.

Tuleum, C.D., Patrick, J.P. and Tiamiyu, L.O. (2009). Evaluation of raw and boiled velvet bean (*Mucuna utilis*) as feed ingredient for broiler chickens.*Pakistan Journal of Nutrition*, **8** (5): 601-606.

Udeh, N.E. and Nwaehujor, C.O. (2011). Antioxidant and hepatoprotective activities of ethyl acetate leaf extract of *Icacina trichantha* on paracetamol induced liver damage in rats. *Continental J. Animal and Veterinary Research,* **3:** 11 – 15.

USDA Foreign Agriculture Services GAIN Report. (www.thepoultrysite.com/Articles Accessed on February 3, 2016).USDA GAIN Report Number: 1304Aglogos@usda.gov or http://www.fas.usda.gov

USDAFAS GAIN (2008). Poultry and Poultry Product Annual Reports, No. E48090. Pp 3-11

Van der Berg, T. P (2000). Acute Infectious bursal disease in poultry. Avian Pathol.**29**: 175 – 194.

Van, D.T.T., Mui, N.T. and Ledin, I. (2006). Effect of method of processing foliage of *Acacia mangium* and inclusion of bamboo charcoal in the diet on performance of growing goats. Animal *Feed Science and Technology,* **130**: 242-256.

Vanhaelen, M., Planchon, C., Vanhaelen-Fastre, R. and On'Okoko, P. (1986). Terpenic constituents from *Icacina senegalensis. Journal of Natural Products,***50** (Suppl.2): 312.

Vohra, P., WILSON, W.O. and Siopes, T.D. (1979). Egg production, feed consumption and maintenance of energy requirements of leghorn hens as influenced by dietary energy at temperatures 15.6 and 26.7^{0}C Poultry Science 58:674-680.

Weingartner, K.E., (1987). Processing nutrition and utilization of soybeans. In: Soybean for the Tropics, research, production, and utilization, edited by S.R. Singh, K.O. Rachie, and Dahiel. John Wiley and Sons Ltd, Chichester, U.K PP149-178.

Williamson G. and W. J.A Payne (1978). An Introduction to Animal Husbandry in the Tropics. Longman Publication, London. PP. 24

World Watch Institute (2016). Vision for Sustainable World. Global Meat Production and Consumption continue to rise. www.worldwatch.org, global-meat production.

Yahav , S., Shinder, D., Tanny, J., and Cohen, S. (2005). Sensible heat loss: the broiler's paradox. World's Poultry Science Journal 2005; 61:419-434.

Yelioglu, Y.S, Mazza, 6., L. and Oomah, B.D. (1998). Antioxidant activity and total phenolics in selected fruits, vegetables grain products. *Journal of Agricultural Food Chemistry* **46:** 4113-4117.

Yotopoulas, P.A., (1987). The new food feed competition. Proceedings of the FAO Expert Consultation on the substitution of Imported Concentrate Feeds in Animal Production Systems in Developing Countries, September 9-13, 1985, FAO, Bangkok.

Younas, M., and Yaqoob, M. (2005). Feed resources of livestock in the Punjab, Pakistan, Livestock Res. Rural Dev., 17(2).

APPENDICES

Appendix 1: Taking weights of experimental birds

Appendix 2: Experimental birds in digestibility cages