GROWTH PERFORMANCE, HAEMATOLOGY AND HISTOLOGY OF GUINEA FOWL FED DIFFERENT DIETARY PROTEIN LEVELS

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DECLARATION

I, CYRIL ABANG, a (Master degree) student in the Department of Animal Science, Landmark University, Omu-Aran, hereby declare that this dissertation entitled “Growth Performance, Haematology and Histology of guinea fowl fed different dietary protein levels”, submitted by me is based on my original work. Any material(s) obtained from other sources or work done by any other persons or institutions have been duly acknowledged.

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CERTIFICATION

This is to certify that this thesis has been read and approved as meeting the requirements of the Department of Animal Science, Landmark University, Omu-Aran, Nigeria, for the Award of (Master Degree in Animal Nutrition).

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ABSTRACT

Guinea fowl (*Numida meleagris*) output in Africa is still in its early stages, and there is a paucity of data on these birds' crude protein requirements. The goal of this research was to investigate the effect of different dietary protein levels on the growth, hematological, and histological parameters of these birds. One hundred unsexed indigenous guinea keets were assigned randomly into three treatments, each of which was reproduced three times in a Completely Randomize Design (CRD) with twelve birds in each replicate. The birds were administered experimental diets that contained T1 (22 percent), T2 (24 percent) and T3 (26 percent crude protein) respectively. This study took place over the course of 13 weeks. All data collated were analyzed using GENSTAT Release 8.1 software program. The results showed that birds fed 24 percent crude protein gained the most body weight (619.83) and had the highest significant FCR (3.45). The crude protein level in the treatments recorded a significant ($P<0.05$) impact on most prime cut and carcass trait. However, the crude protein, had no statistically significant ($P>0.05$) impact on GIT WT, head weight, dress percentage and organ yield. Furthermore, it was discovered that the quantity of crude protein in the diet had no influence ($P>0.05$) on the organs weight at all treatments in the results for organs weight evaluation. All the parameters (Ash, CP, EE and CF) for apparent digestibility were significant ($P<0.05$). Packet cell volume, haemoglobin, MCV, MCH, Platelet, Lymphocytes and Eosiniphils were significantly ($P<0.05$) influence by crude protein levels. The varied levels of crude protein however, had no significant ($P>0.05$) effect on red blood cells, white blood cells, or neutrophils. The crop, gizzard, heart, and proventriculus exhibited no abnormalities in all treatments, demonstrating that the crude proteins had no negative impact on the birds' health. The intestine and lungs showed no abnormalities in T3, whereas T1 and T2 displayed epithelial desquamation and mild pulmonary edema. The research discovered that optimum crude protein boosted body weight gain and carcass yield in these birds. Farmers can feed meals containing 24 percent crude protein and manage their flocks efficiently for maximum yield.

Key words: Guinea fowl, crude protein, haematology, histology.

DEDICATION

This research is dedicated to Almighty God and to my parents; Mr & Mrs Cyril and Charity Abang Bikom for all the love they have given me, their dedicated partnership in the success of my life and for their prayers and support.

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CHAPTER ONE

1.1 INTRODUCTION

Guinea fowl (*Numida meleagris*) yield is still in its infancy (Oke *et al*., 2020) regardless of the certainty that these birds evolved in Africa and have a ready market on the continent. The guinea fowl gets its name from the Guinean coast, where it is thought to have emerged (Chiroque *et al*., 2018). In Nigeria, this bird are second only to domestic chicken in terms of number and protein supply (Ebegbulem, 2018). The northern guinea savanna zone contains a big population of guinea fowl, but the forest-dwelling crested guinea fowl can also be found in the southern region. The number of semi-domesticated guineas in Nigeria is estimated to be over 50 million and is widely scattered throughout the country's savanna areas (Victoria and Bassey, 2017). These birds make about 25% of Nigeria's total poultry population, making them a socially acceptable source of animal protein. Baruwa and Sofoluwe (2016).

The production of guinea fowl as a meat bird has the potential of being a successful industry in numerous parts of the globe, mainly in developing countries like Nigeria. According to Oke *et al*. (2020), these birds have a high socioeconomic importance in rural communities, where they are primarily raised to provide egg and meat as well as a means of income for these farmers. In Nigeria, majority of guinea fowl farmers raise their birds widely in their backyards, and just a few farmers engage in intensive guinea fowl rearing. Guinea fowls are left to rummage for scraps, worms, insects, seeds, leaves, fruits, and other items throughout farmsteads, open fields, and compounds under the vast system, and as a result, their productivity is low (Korankye, 2018). Guinea fowls in Nigeria are distinguished by their color differences in plumage. Pearl, white, lavender, and black are the most prevalent kinds (Victoria and Bassey, 2017). These birds have retained their traits to this day: (such as being resistant to diseases under different ambient temperatures). Guinea fowl are said to be sturdy, resistant to most poultry diseases, and tolerant of bad husbandry (Amoah *et al*., 2018).

These birds possess a higher protein content, lower carcass fat, and more iron (Fe++) and Vitamin E than domestic fowls (Singh *et al*., 2017). Guinea fowl offers some advantages over chicken, including higher disease resilience, greater capacity to rummage for feed, and an elevated ratio of meat-to-bone (Igwebuike and Anagor, 2013). These birds have thicker eggshells, which gives them a clear benefit in terms of storage and handling, as well as reduced breaking (Amoah *et al*., 2018). The increasing demand for the production of these birds in order to raise household protein supply, mitigate rural protein/energy deficiency, and elevate income necessitates a rise in the birds' productivity, which is critical because the species cannot attain its full potential naturally (Korankye *et al*., 2018). There is a scarcity of data on the farming of these birds, which slows the industry's growth (Okyere *et al*., 2020). It has being proven that guinea fowl performance is influenced by access to high-quality feed. Understanding the degree of food protein need of these birds is necessary in order to efficiently utilize current local poultry resources to boost poultry output. As a result, the goal of this research is to investigate different protein levels in guinea fowl diets in order to provide farmers and other stakeholders with a standardized protein requirement for guinea fowl farming.

1.2 Problem of Statement

There is currently no commercially prepared guinea fowl feed available in Nigeria (Ebegbulem, 2018). Farmers in the free-range method let the birds scavenge for the majority of their food around the community, supplementing it with modest amounts of supplementary feed such as sorghum and millet for keets and whole grains for growers and breeders. Guinea fowl performance has been shown to be influenced by access to high-quality feed (Okyere *et al.*, 2020). Guinea fowl should be fed a diet with high crude protein content for rapid growth and maximum productivity. Understanding the degree of food protein need of the birds is necessary in order to efficiently use current local poultry resources to boost poultry output.

1.3 Justification

The most significant topic on the development strategy agenda for underdeveloped countries is global food security. In order to feed two billion people by 2050, a 50 to 70 percent increment in food yield is anticipated to be required (Alabi *et al*., 2021). Obviously, as the global population grows, so does the demand for animal products in the future (Alabi *et al*., 2021). Poultry production is crucial to battle against poverty and improving living circumstances in rural African families (Koné *et al*., 2019). Consumer demand for guinea fowl meat and eggs is rising, but supply is falling behind (Koné *et al*., 2019) due to poor nutrition, a lack of documented dietary requirements for different periods of life, and other issues. The rising cost of feed materials like maize and soybean promotes research into methods that will allow for the long-term and efficient use of alternative protein and energy resources in guinea fowl production, allowing Nigerian farmers to expand their bird output.

1.4 Objectives of the study

1.4.1 General Objective

The generic goal of this research was to investigate varied dietary protein levels effect on the growth performance, hematology and histological indices of guinea fowls.

1.4.2 Specific Objectives are to;

- Determine the effect of dietary protein levels on the growth of guinea;
- Determine the effect of dietary protein levels on the haematological profile of the guinea fowls,
- Examine the effect of dietary protein levels on the organ histological indices of the crop, heart, gizzard, lungs, small intestine and proventriculus of the experimental guinea fowls.

CHAPTER TWO

2.1 REVIEW OF LITERATURE

2.2 History and Origin of Guinea Fowl

Guinea fowl are Galliform birds (Brown, 2021). These birds originated in Africa and have been developed via years of cross-breeding. Domesticated guinea fowls originated in Africa's savanna region and have been hunted and kept for food in various nations for hundreds of years; depictions of them can even be seen on the walls of pyramids (Armitage, 2021). Over time, cross breeding has resulted in a wide range of colors. Naturalists have identified eight distinct varieties of these birds, all of which are native to Africa.

2.3 Scientific Classification

Kingdom:	Animalia
Phylum:	Chordata
Class:	Aves
Order:	Galliformes
Family:	Numididae
Genus:	*Numida*

Species: *N. meleagris* (Riddles, 2015)

2.4 Morphology and Description of Guinea fowl (*Numida meleagris*)

Guinea fowl belong to the Galliformes order of birds and are roughly the size of a large chicken. For their size, they have a spherical body and a small head (Brown, 2021). Their beak is brilliant red and has a crest on top. Its plumage is dark grey or black with noticeable white patches. The guineas' helmet is a whitish, waxy protrusion from the top of the head that is rigid and bends away from the body. It is blackish in young keets and brown in adults. Wattles are fleshy coral red appendages that hang from either side of the head, flat, firm, and wrinkle-free. The lower edge of the wattles curves away from the beak and appears cupped (Brown, 2021). The wedge-shaped head is short and taper towards the beak. A line of very fine hair-like feathers runs down the back of the head, sticking out and growing upward. Its eyes are alert, huge, round, and dark brown; its neck is rounded with down-like feathers; and its shanks are bright orange in keets, changing to mottled orange with brown as they age. Furthermore, the beaks are small, strong, and curve, the back is broad, curves from the neck down to the tail feathers, and the body is carried low to the ground and quite short, with strong and straight toes. Unlike other avian species, guinea fowls have heavier females than males. The growth weight of male and female is similar until 12 weeks of age, thereafter females gain roughly 20% more weight as a result of sexual maturity, giving rise to more fat deposition and genitalia development (Houndonougbo *et al*., 2017). At 8 weeks of age, the most reliable test for sexing is a cloaca inspection.

2.5 Distribution of Guinea fowl

Guinea fowls are found throughout Africa and are divided to numerous guinea variations, as opposed to chicken breeds. The helmeted guinea fowl (*Numida melagris*) is a famous African breed. It is docile and hence readily tamed (Musundire, 2016). It is a common domesticated breed found in most African rural households since it can lay eggs at very low input settings. Its natural habitat in Africa, south of the Sahara, is grassland and scrubland. The enormous backward-curving bony "helmet" on top of this bird's cranium stands out. Other guinea fowl species are found all over Africa. Upper Guinea, Nigeria, Ivory Coast, Sierra Leon and Ghana are some of the countries that are home to the white-breasted guinea bird (*Agelastes meleagrides*), It is distinct in color thus, one of the many indigenous species of the region (Musundire *et al*., 2017).

2.6 Guinea fowl production systems

Village chickens have well-defined production methods, but guineas production systems are less well defined, albeit the free range system is the most popular in rural areas. Guinea fowls are often raised in semi-intensive or intensive methods. Similar management approaches are used in the intensive guinea fowl production system as they are in poultry (Yamak *et al*., 2016).

2.6.1 Intensive system

The guineas in this method are not allowed to go scavenge outside. In order to manage day-length and maximize output, poultry should be raised in confinement. This is in response to the expanding urban population in most emerging countries, which has a strong demand for animal protein. Huge-scale production units of these birds are defined by large investments, intense management, mechanization, and specialization (Raphulu *et al*., 2015). These constraints limit the broad-scale system to a few corporations or affluent investors. This system is characterized by a high input and high output. Efficient bird management methods, such as proper feeding, housing, and health/vaccination programs, are followed. This technique is mostly utilized in industrialized Nations, where specialized strains of guinea fowl have been developed and output is money oriented for eggs and meat. Breeding flocks of are kept in battery cages or on clay floors. In earthen floors with perches supplied in the homes, a stocking density of 3 to 5 birds/m^2 is employed Musundire (2016). Artificial insemination and battery cage system are two features of present breeding facilities of these birds.

Plate 1: Guinea fowl in the woods

Source: Brown, (2021).

2.6.2 Semi-intensive system

This method is widely used in urban, peri-urban, and rural settings. Because it includes raising specific breeds, it is akin to the intense production system. Permanent home amidst access to the surrounding ambient or a yard is available with minute space (Yamak, *et al*., 2016). Farmers frequently supply perches, and a 1.5-2 m high wire fence encloses the enclosure. The pen in the enclosed area is designed to give refuge during the day and at night. Protection from predators and thieves is provided by the house and fencing. Farmers supply fresh green food and water in troughs for the birds, as well as additional feed. Pinning keets that are expected to be breeders prevents them from flying. Stocking densities of up to 500 birds per acre have been reported (Yamak *et al*., 2016). According to Musundire (2016), 1000 keets require 24 m^2 in a starting house for the first three weeks of their lives before being transferred to a rearing pen with a 40m^2 and a 200m^2 aviary. The semi-intensive system is labor demanding and has a moderate management level. Most farmers in this system have turned to feeding homemade rations to save money on feed (Musundire *et al*., 2017). Disease control is carried out, particularly immunizations against economically important illnesses including Marek disease, fowl pox, Newcastle disease (ND) and infectious bursal disease. However, when compared to the intensive production system, the yield of this system is lower.

2.6.3 Extensive system

Broad guinea flocks are allowed to roam freely across an enormous region of land in this system. These birds hunt for food and water on a regular basis in rangelands and crop fields, making them vulnerable to disease and predators. Local poultry birds, which are not designated as breeds and have been crossed with improved breeds to some extent, dominate extensive system, this is regarded as chaotic, making the concept of breed erroneous (Yamak *et al*., 2016). In Africa, where farmers use little inputs in production and reap modest profits, the extensive production system is popular. Birds are given either some or no housing, in which case they sleep on trees near buildings. For millennia, small farms all across the poor world have used this low input/output approach, and it is likely to continue in the future. Standard poultry management techniques, are not been followed by the farmers in this system. This technique is defined by low resource, with birds rummaging for feed; little or zero inputs beside the startup stock, a fistful of feed daily, and unsophisticated nocturnal cages (Yamak *et al*., 2016). During the dry season, the scavenged resource base for free-range birds is low in nutrition thus insufficient. Due to economic and socio-cultural importance of guinea fowls, practically most farmers rear them in the traditional wide manner (Musundire, 2016). Farmers may be denied the full advantage of the birds if they use feed resources that do not fulfill the birds' nutritional needs, restricting their output.

2.7 Housing

Guinea fowl production strategies include Intensive, semi intensive and extensive. The birds in extensive systems are given with the bare minimum of shelter and habitation (Jajere *et al.*, 2018). However, housing is necessary to shield them from strong winds, rain, cold, sun, and predators. A minimum of 2–3 square feet per bird is required (Mulenga, 2019). Paddy husk, wood shavings, chopped hay or straw should be use to cover the pen's floor. It's important to keep the litter dry. Hence, because guinea birds love to roost, perches must be provided. guinea fowls can fly from an early stage and develop into strong fliers capable of flying 400 to 500 feet at a time. Guineas are also excellent runners and prefer to travel on foot, especially when fleeing predators.

2.7.1 Brooding and Rearing

Keets are brooded in the same brooder houses as chicks and poults utilize. Ambient temperatures are kept at 35^0 Celsius for the first 2weeks after hatching, thereafter reduced by 10^0 Celsius every 7days after that. The bottoms of the lamps should be 18 to 24 inches above the litter if they are to be used (Mulenga, 2019). The temperature of the lamps can be adjusted by raising or lowering them. It is advisable to use multiple heat sources, especially during cold weather, so that the keets are not left without heat if one of the bulbs burns out.

2.8 Feeds and Feeding

In the fields and villages, grains, herbaceous plants, and insects scavenged form the basis of smallholders' feeding systems. The birds supplemented their diet by gleaning from various concessions and receiving grain supplements from the traditional breeder on occasion. Despite qualitative assessments, the amount of feed consumed in the wild during rummage has yet to be accurately evaluated. The scavenging bird's diet is primarily made up of ingredients that are high in energy (rice, corn, millet, sorghum, bran and domestic waste), vitamins (fruits, sprouting grains and green fodder), minerals (shells and common salt), and protein-rich (legumes, soybeans and insects) according to (Ikani and Dafwang 2014). The farmers' supplements vary depending on the young chicks that are commonly supplemented with termites and mashed cereals; feathered keet and adults supplemented with grains (sorghum, millet and maize) depending on the availability of feed ingredients.

The birds are fed in the evenings to encourage them to return to the chicken coop. (Houndonougbo *et al*., 2017).

2.9 Health management

Guineas that have been tamed are renowned to be sturdy and resilient of most diseases that affect poultry birds. Guineas reared in the village system in difficult conditions with little or no access to basic health care, vulnerable to disease attacks. Furthermore, because they are raised in the system where they rummage and mingled with wild species, there is a considerable risk of infection and disease transmission (Yamak *et al*., 2016). Guinea fowls in poor nations have not yet been totally domesticated, thus they retain the toughness of their wild ancestors. Newcastle disease (ND) and fowl pox are more tolerable to them (Musundire *et al*., 2017). Bulk of the diseases that affect poultry are likely to affect these birds. Ascariasis and fleas have been documented as leech that harm guineas, as well as coccidiosis diseases (Musundire, 2016). Insecticides, anthelminthics, and antibiotics would be required for their treatment. Guinea fowls are also harmed when disease epidemics in chickens occur.

2.9.1 Causes of mortality

According to a survey conducted on the guinea fowl breeding system, 28 percent of the deaths were caused by various causes, including 19% fleeing to the bush, 17% mishaps, 5% feed poisoning, 5% predators, 7% drowning in run-off during heavy rain, and 18% other causes (Houndonougbo *et al*., 2017). Undiagnosed diseases (72%) were found to be the leading cause of death, followed by poor shelter (13%), predation (8%), and a lack of food (7%). The infestation of parasitic such as ascariasis and capillariasis, are the most common pathology in free range systems. Although guineas can function under low hygienic conditions, these parasites are responsible for significant growth retardation, weight loss, and diarrhea in birds raised in free range (Houndonougbo *et al.*, 2017).

2.10 Nutritional Requirements of guinea fowl (*Numida melagris*)

Guinea fowls eat a variety of insects in the wild, as well as mice, rats, and snakes. To aid their digestive processes, they will eat grass and weeds. Grit must be accessible for guinea inhabitants, just as it is for chickens and turkeys (Barnes, 2020). Guinea fowls, like chickens, like scratching on the ground, albeit they scratch less than chickens do. They may overlook full corn kernels and prefer wheat, sorghum, or millet grain. Guinea fowls require a higher protein diet than chickens, but can perform fine on standard poultry diets. As a starting feed, keets have been reported to require higher protein ration Barnes (2020). Guineas should not be fed pelleted food. Supplemental greens, such as leafy alfalfa, can also be offered for the guineas to peck at. To avoid a mold problem, leftovers can be eliminate on a daily basis. Feed conversion rates are exceptionally high - each bird is predicted to use roughly 6.5kg of feed to achieve a slaughter weight of 1.85kg – owing to the reality that they gallop around during the daylight frequently taking to the air and burning up energy (Ndakeva, 2019).

2.11 Light duration/photoperiod required

The second significant factor affecting guinea fowl productivity is lighting duration, or photoperiod. The length of time guinea fowls are exposed to light is generally determined by their age and the type of housing system utilized (Kyere *et al*., 2021). Natural daylight is widely regarded as the greatest and ideal illumination for guinea fowls. They require a 14hours daily period of light, which is essential for optimal egg yield, while a day duration of more than 17 hours is detrimental to egg production (Kyere *et al*., 2021).

Guinea fowls, on the other hand, require six hours of sleep during the beginning of their lives, but may require more at different stages of their development (Kyere *et al*., 2021). Guinea fowls synchronize their internal circadian and circannual clocks by stimulating photoreceptors with daylight, which synchronizes their actions to the right time of day and year.

2.11.1 Light intensity required for Guinea fowls:

In all lighting programs, one of the most crucial variables to consider is light intensity. Guinea fowl egg production is affected by low light intensity. A lux meter can be utilize to regulate light intensity in a laying pen in order to reduce incident light intensity in chicken production. A general formula (Light intensity) can be used to calculate light intensity inside a specific region in the absence of a lux meter. The distance between the light sources and the place of interest determines the intensity of light at that location. In dark houses for guinea fowl layers, the lowest light intensity necessary for optimum egg output is 5.38 lux (Kyere *et al*., 2020). According to Kyere, *et al.* (2021), 10 lux is required in open ended houses to give sufficient light intensity to promote egg production. The visible spectrum ranges from 664 to 740 nm, hence lightening lamps should emit within this range in pens.

2.11.2 Constant light for Guinea fowls

Guinea fowls that are availed to full spectrum light (UVB) daily are healthier, look better, and may behave better. The synthesis of vitamin D, which is essential for normal control of phosphorous and calcium levels, requires sunlight or full spectrum lighting, according to Han, *et al*. (2017). Birds, like humans, are sophisticated creatures who rely on light to regulate and signal a variety of biological processes (Kyere *et al*., 2021). Guinea fowls in captivity are frequently exposed to insufficient or incorrect lighting, which is harmful to their health. The majority of artificial lighting is designed by profit-driven companies that attempt to provide as much apparent brightness as possible while consuming as little electricity and manufacturing cost as possible. As a result, light quality, whether determined by spectrum analysis or otherwise, is nearly never a top focus. Constant lighting should be viewed as more than just a tool to aid human eyesight; it is a crucial component and building element for avian health (Han *et al*., 2017).

2.11.3 Darkness requirement

Guinea fowl comes from tropical regions. They normally get 12 hours of daylight and darkness there. Birds require more sleep than humans, and most require at least 10 hours of sleep every day (Kyere *et al*., 2021). Because a bird's tendency is to stay awake during this time when predators may be present, lights and movement will keep it awake. When the bird may sleep while there is noise, movement will keep it awake (Kyere *et al*., 2021). Guinea fowls raised in extended durations of light have been found to be healthier than those raised in long periods of darkness.

2.11.4 Effect of Lighting in Guinea Fowl (*Numida meleagris*) production

Although lighting is essential in guinea fowl development and poultry production in general, it has its own impact on the general yield and well-being of this birds. Lightening has the following consequences on guinea fowl production:

2.11.4.1 Effect of light on fertility and hatchability:

Guinea fowl begin laying at the start of the rainy season and continue to lay throughout it. Artificial illumination can help to prolong the egg-laying cycle and increase early fertility. Infertility in guinea fowl cocks is caused by a decrease in day length, which affects testicular development (Kyere *et al*., 2021). Sexual activity in pheasants, quail and chickens is mostly induced by light. In guinea fowls, increasing light boosts gonadal development, which boosts fertility and hatchability. Early maturity is influenced by the lighten duration, more so insufficient lighting causes guinea fowls to delay maturation, which affects fertility, hatchability, and subsequent growth (Kyere *et al*., 2017). The production of progesterone and testosterone in male guinea fowls is affected by a lack of light. Ovulation in guinea fowls is influenced by external stimuli such as artificial light, diet, and water supply. Increases in day length or enough light regimes ensure proper production of hormones like luteinizing hormones (LH) and follicle stimulating hormone (FSH), according to Kyere *et al*. (2021). Ovulation can happen on a regular basis when these hormones are present (Hesham, 2016). Between 11 and 15 hours after turning on the light, the layers are most receptive to it. These hormones trigger ovulation regulate reproductive activities during this photosensitivity stage. Increased day duration from 15 to 18 hours boosts fecundity and hatchability. Increases in photoperiod improve chicken fertility and hatchability (Hesham, 2016).

2.11.4.2 Effect of light on growth parameters

Guinea fowls' health, growth and reproduction are all affected by light. Lack of light causes newly born keets to have difficulty finding water and feeding through the night, which can result in an increase in mortality due to malnutrition. Light energy affects growth and reproduction in both poultry and mammalian species (Utshav, 2019). In poultry birds, short day lengths and feed restrictions during production times delay sexual maturity and lower growth and body weight. Light has an impact on feed and water intake in chicken production, according to (kyere *et al*., 2021). In guinea fowl production, a longer daily light time enhances feed and water consumption, resulting in increased growth and body weight.

If daily light exposure is fewer than twelve hours, feed and water intake may be reduced, affecting development and reproduction.

2.11.4.3 Light's influence on Haematological and Biochemical parameters

The blood includes various compounds that provide useful information about an individual's nutritional condition and clinical research, the World Health Organization (WHO) has advocated the use of blood parameters for medical and nutritional assessment Kyere, *et al.* (2021). To determine normalcy and identify disease and physiological changes, serum biochemical and haematological reference values are used (Hesham, 2016). Veterinary laboratories in Europe and the United States generally base their reference intervals on animals kept in favorable conditions. The significance of haematological and biochemical markers in birds as diagnostic tools and physiological indicators has been established. As physiological indicators and illness diagnostic tools, haematological measures were widely used in avian medicine. The discrepancies in haematological values among local chickens raised in different places make it more difficult to diagnose the birds' health. The information collected through investigating haematological values, disease diagnostics, and managerial aspects are the primary tools for creating new lines of birds that are genetically resistant to various diseases (Han *et al*., 2017). Avian hematology is largely influenced by sex, age, and nutrition.

2.12 Reproductive performance of Guinea fowl

Strain, climate, and feed quantity all have a significant impact on reproductive performance. Female sexual maturity can theoretically be reached at 24 weeks, however in the Nigerian traditional systems, it takes 32, 36, or 37 weeks (Kyere *et al*., 2021). The guinea hen will lay her eggs in an isolated ground nest. They may lay one egg per day during the breeding season until they produce a clutch of 20 to 30 eggs in a deep, tapering nest (Brown, 2021). The fact that the brief laying cycle coincides with the rainy season is an economic constraint. Artificial lightening, on the other hand, can lengthen the laying circle and boost early fertility. When given enough additional feeds and ad libitum water, females are capable of laying viable eggs all year round with 40% daily laying rate. Studies has shown that, hatchability in October and November was 69 percent and 66 percent, respectively (Houndonougbo *et al*., 2017). As a result, in addition to the seasonal implication of feed accessibility on laying performance, the hot dry season's environmental changes appear to be deleterious to egg hatchability due to semen quality or issues during brooding and activities of mating. More so, the weight of the testicles regulated by environmental elements like as illumination, temperature, and nutrition, determines the quantity and quality of sperm. Male virility may be particularly difficult in guineas, as the monogamous nature of the species necessitates a larger sex ratio for good fertility than in other chicken species.

2.12.1 Egg Characteristics

Guinea fowl eggs are lesser in size than hen eggs, but they are more resistant to shattering. They are 47 mm in length on average, 36.5 mm wide at the widest point, and weigh between 25 and 50 grams. In Nigeria, for example, Ikani and Dafwang (2014) discovered that Guinea fowl eggs weigh 35 to 40 g compared to 45 to 55 g for chicken eggs. Guinea fowl eggs have different external and interior properties depending on the geographical variation. More specifically, both thick eggshells and firm interiors are considered above average, giving way to a rise in egg weight, which leads to a more effective embryo hatching from heavier eggs. According to research, eggs weigh between

25 and 50 grams, fertility rate averages 84.4 percent but varies depending on the egg weight. The embryonal mortality rates ranged from 11.2percent to 17.3percent. Houndonougbo, *et al*. (2017) found a favorable correlation between hatching rate and egg weight (r= 0.85, p0.05). The one-day chicks weighed an average of 25.21.1.9g, and their weight was favorably linked with egg weight (r= 0.96, p0.05). Furthermore, guinea fowl eggs demonstrate the general propensity for minimal hatchability to be a property of eggs with forms beyond the typical range. Furthermore, these researchers discovered that eggs with rounded ends were less likely to hatch than those with pointed edges. External and interior egg quality could be utilized as selection criterion between types and as factors for improving egg weight and fertility. Hatchability may also be affected by the incubation conditions.

2.13 Competitive advantages of raising Guinea fowl

Guinea fowls can live up to 15 years (Ndakeva, 2019). Unlike regular chicken birds, guinea fowls are less susceptible to poultry diseases and they are resilient and require less capital. Guineas make a lot of noise, which most farmers may employ to safeguard their farm. Ticks, insects, snakes, termites, and rats are all controllable with them. They can withstand transportation because of their capacity to tolerate high temperatures (Ndakeva, 2019). Because they are quite gregarious and prefer to stay in flocks, you may rest assured that if one goes missing, the others will discover it. The flesh is extremely lean, high in essential fatty acids, low in calories, vitamin-rich, and high in protein, with a breast meat yield of roughly 25% of live weight and an outstanding meat-to-bone ratio. Their meat, however, is darker than that of chickens. More so, guineas have tender and juicy flesh that imparts more flavor. Guineas can lay up to 100 eggs each year if adequately cared for, and if maintained in a limited space, they can gather them all. Their eggs are smaller than chicken eggs and have extremely hard shells that prevent them from breaking (Ebegbulem, 2018). The egg and meat of the guinea chicken are nutritious and profitable. Because of their gamey flavor, eggs and meat fetch high rates. Their eggs store better than chicken eggs and do not fracture as quickly because of their thicker shells. The protein composition of guinea fowl flesh is comparably higher than domestic chicken. In the life of numerous tribes, guinea fowl play a vital socio-cultural function; they are utilize to perform religious sacrifices and some burial rites (Ebegbulem, 2016). Local artisans use their bright feathers to create artwork and decorative items.

2.14 Challenges to guinea fowl production

Large cost of production, high feed bills and minimal profit margins, characterize Nigeria's chicken sector. Despite the abundance of guineas in Nigeria and their multiple benefits, guinea fowl production is still at a primitive stage. Guinea fowl production, unlike domestic chicken production, faces various hurdles. Poor housing, according to Ebegbulem (2018), poses a severe obstacle to guinea fowl rearing. Predation rates are high due to substandard housing. The lack of designed rations for these birds in Nigeria, have made producers resort to feeding birds with commercial layer and broiler chicken diets and supplementing with green vegetables and grains (Ebegbulem, 2018). Early keet mortality was attributed to a paucity of knowledge about feed composition resulting to a substantial majority of producers being forced to raise birds on the scavenging system due to a lack of knowledge about guinea fowl nutritional requirements. However, Dahouda *et al*. (2017) found that additional feed is available for birds following harvesting, from December to February, but was insufficient to meet the birds' nutritional needs. Low growth rates, limited egg output, and elevated mortalities result from insufficient nutrition availability. In Nigeria, full-scale taming of these birds have not been tried because it appears that little or no attention is been paid to its economic production, with small flocks kept in the village system. The majority of the food that birds eat comes from scavenging around the village (Dahouda *et al*., 2017).

2.14.1 Sexing

One of the problems to guinea fowl production has been highlighted as sexing difficulty. According to Moreki and Radikara (2013), determining sex is near impossible, especially in keets, because males and females seem quite alike, making it challenging to distinguish between them. Farmers' failure to distinguish the sexes makes raising breeder and layers challenging. A full stock meant for breeding has been reported to turn up as all males with a few females. From about 8 weeks of age, the voice call of the birds can be used to determine sex. The males make sounds like "wheat" which is distinct from the females sound '"buck-wheat, buck-wheat" or "put-rock, put-rock,". At around 12-15 weeks of age, the male's wattles develop thicker edges (Ikani and Dafwang, 2014). The males wattles are cupped, concaved and carried at a sharp angle to the side of the head (Ebegbulem, 2018).

2.15 Prospects of guinea fowl production

Although these birds are native to tropical West Africa, it can adapt to a variety of climates and often raised in temperate countries. They are raise in the traditional free-range way throughout Nigeria and most of Africa. Guineas raised in the wild is a valuable resource for rural populations in developing Nations. The native breeds do not need sophisticated, costly pen-house. Foraging and rummaging are prevalent actions in the free-range technique (Ebegbulem, 2018). They ingest a vast variety of fauna and vegetation, scouring a large region of land for food. Guinea birds eat a wide variety of non-traditional feeds not found in chicken feed. This attribute has made it the impoverished preferred poultry. It is also a good fit for a crop-livestock agricultural combination. Guinea fowl eggs and meat are nutritious and profitable. Guinea fowl eggs and meat fetch premium pricing in Nigeria, according to Ikani and Dafwang (2014), due to their gamey flavor. Guineas' eggs store better than of chicken because their shells are thicker and do not crack readily hence, being highly priced in most African countries Moreki and Radikara (2013). Guinea fowl meat has minimal fat and rich in protein, making it better appealing than chicken flesh (Ndakeva, 2019). Guinea fowl can be seen as the future of poultry production in Africa compared to the chicken bird due to its potential.

2.16 Haematology of Avian species

The study of the constituents of the blood and their application in the detection and monitoring of disease is known as haematology (Etim, 2014). Many disorders can be diagnosed with haemtological examinations, as well as the level of blood damage can be determined. Haematological research is of pathological and physiological interest because it aids in the comprehension of the correlation between blood features and the ambient, which might be pertinent in the choice of animals that are genetically resilience to certain ailment and prevailing climate (Isaac *et al*., 2013). Haematological indices are those that are affiliated to the blood and blood-comprising organs. They are adequate indicators of an animal's physiological wellbeing. The haemoglobin is carried by red blood cells (erythrocytes). During breathing, this haemoglobin combines with oxygen in the bloodstream to generate oxyhaemoglobin. The movement of carbon dioxide and oxygen in the body is facilitated by red blood cells (Etim, 2014). Hence, a minimal red blood cell count means minimal oxygen is carried to the tissues and more carbon dioxide is returned to the lungs (Isaac *et al*., 2013).

The main obligations of the white blood cell and its variability are to fight infections, guard the body through phagocytosis of alien organism intrusion, and generate or at least transport and distribute antibodies in the immune response. Thus, animals with minute white blood cell counts are more prone to infection, whereas those with high numbers can produce antibodies and hence have a higher level of disease resilient (Soetan *et al*., 2013), as well as enhance adaptability to local climate and disease-prevalent conditions (Adedibu *et al*., 2014). Platelets aid the clotting of blood however, low platelet concentration means the clotting process will take longer, resulting in increased blood loss in the case of an injury. The percentage of red blood cells in blood is known as packed cell volume (PCV), haematocrit (Hct), or erythrocyte volume fraction (EVF). PCV plays a role in distribution of oxygen and ingested nutrients (Isaac *et al.*, 2013). All vertebrates' red blood cells include haemoglobin, which is an iron-containing oxygen-transport metalloprotein.

2.16.1 Factors Influencing Haematological parameters of Farm Animals:

Haematological indices of farm animals are influenced by both hereditary and non-genetic causes (Xie *et al*., 2013). Environmental conditions, fasting, age, medicine administration, anti-aflatoxin treatment, and continuous vitamin supplementation all influence the blood profile of healthy animals. Age, nutrition, animal health, sex, level of physical activity and ambient elements affects blood values of the animal (Etim, 2014). Aside from physiological and environmental aspects such as the animal's age, animal breeds, breeding techniques, genetics, oestrus cycle, pregnancy, and parturition, housing, fasting, stress, exercise, food, castration, diseases, transport and extreme climatic conditions have also been implicated alter the blood.

CHAPTER THREE

3.0 Materials and Methods

3.1 Experimental Site

The Poultry Unit of Landmark University's Teaching and Research Farm in Omu-Aran was used for this study. The Teaching and Research Farm is located In the tropical plain agro-ecological region of Southern Guinea Savannah Nigeria. Omu-Aran is located at 8° 8.00 N, 5° 6.00 E, and is 564 meters above sea level (Rapheal *et al*., 2019). The climate in the area is moderate, with annual daily average temperatures ranging from 16°C to 32°C, with yearly variations of 10°C to 20°C, over 6–8 months an average annual rainfall of 500– 1500mm per annum is spread, susceptible to slight seasonal variations of hot and cold (Rapheal *et al*., 2019). It is located in Kwara State, Nigeria's North Central (Middle Belt), surrounded by derived savanna. The map of the study location is show in (Figure 1).

3.2 Experimental birds and Management

One hundred and eight unsexed indigenous day-old keets hatched in Landmark University's Animal Science lab were assigned randomly to three treatments after brooding for 2 weeks, each of which was duplicated three times in a Completely Randomize Design (CRD) with twelve birds in each replicate. Over the course of 13 weeks, the experiment was conducted. The birds were raised in a deep litter system using brooding and rearing techniques. At a depth of 2 cm, wood shaving were used as litter materials. Oke *et al*. (2020) described the provision of feeder and drinker space.

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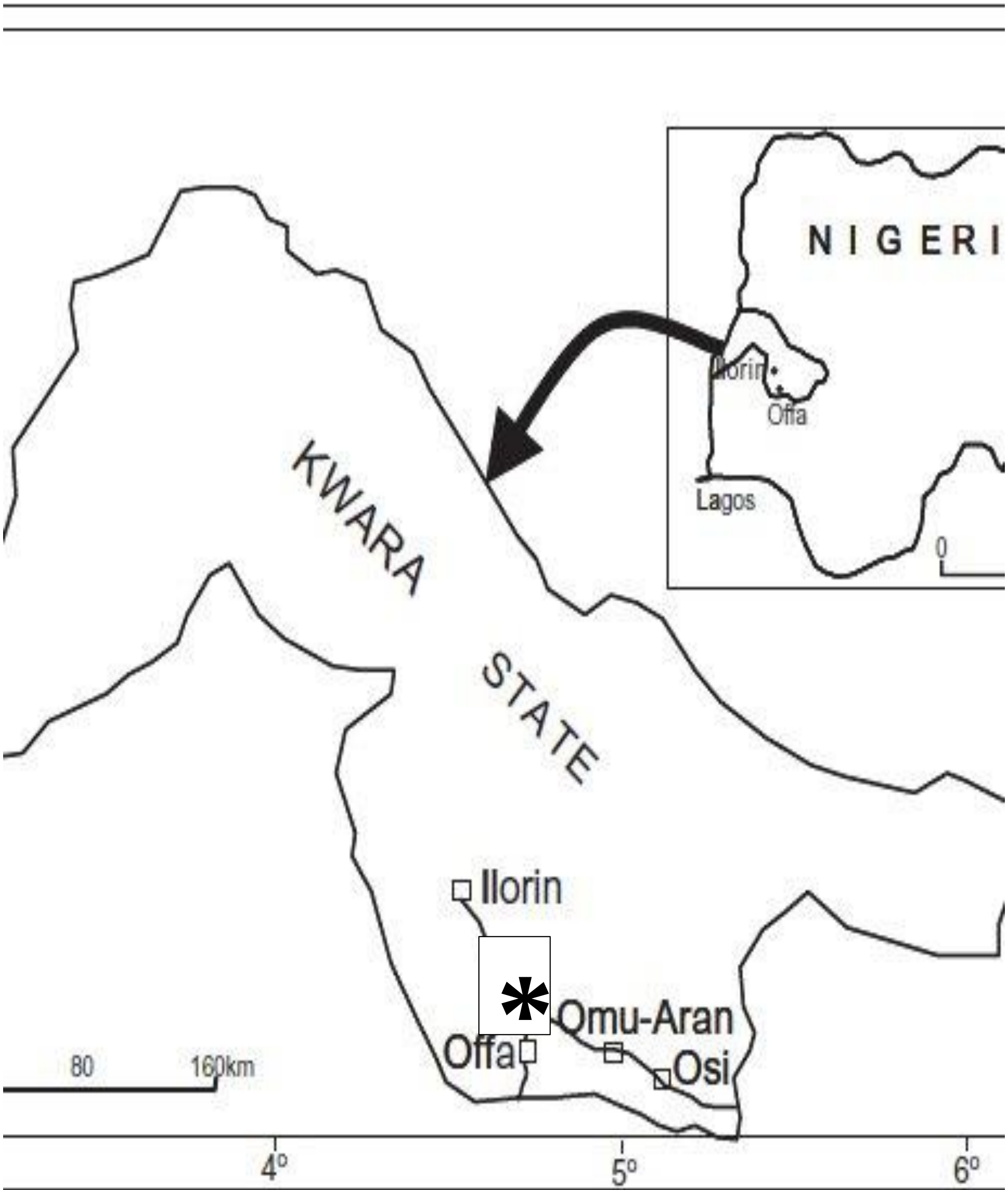


Figure 1: Map of Kwara state showing the study area.

Source: (Rapheal *et al*., 2019).

The birds were fed ad libitum, a strict immunization schedule (Lasota, gumboro and fowl pox) was implemented, and medications (multivitamins, antibiotics and dewormers) were given out on time. Mortality was dutifully noted and discarded appropriately.

3.3 Feed formulation and Experimental diets

3.3.1 Sources of Ingredients:

The majority of the feed materials, as well as other necessary feed additives, were purchased in omua-aran town.

3.3.2 Experimental diets:

Diets were designed to provide the necessary protein for optimal performance and progress. Treatments 1, 2, and 3 have protein content of 22%, 24%, and 26%, indicating a lower, medium, and upper threshold, respectively.

3.3.3 Proximate analyses of formulated feeds:

The Association of Official Analytical Chemists (AOAC) (2011) methodologies were utilized for this study. Furthermore, at the conclusion of the experiment, nutrient digestibility was assessed, and weighed amounts of feed were provided, with feaces collected over a 72-hour period. The collected feces samples were weighed and oven dried at 70 degrees Celsius. The nutrient digestibility using the formula below:

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

The metabolizable energy (ME) was also calculated. Composition of the experimental diets is shown in Table 1.

Table 1: Feed Composition for Experimental Diets

Ingredients	T1	T2	T3
Maize	41	41	38
SBM	25	30	37
GNC	13.5	14	14
Corn bran	7.5	2	1
Wheat offal	9	9	6
Bone meal	2	2	2
Limestone	0.8	0.8	0.8
Salt	0.25	0.25	0.25
Lysine	0.25	0.25	0.25
Methionine	0.25	0.25	0.25
Premix	0.25	0.25	0.25
Enzyme	0.1	0.1	0.1
Vitamin E	0.1	0.1	0,1
Total	100	100	100
Calculated			
Metabolizeable energy (Kcal/kg)	2650	2650	2650
Crude protein (%)	22	24	26

SBM = Soya bean meal; GNC = Groundnut cake;

3.4 Data Collection

3.4.1 Growth Performance Measurement

The guinea fowls' body weights were measured weekly on a digital scale (Ohaus; model PA512). The disparity between the feed delivered and feed left over at the conclusion of each session will be used to calculate the birds' feed intake (FI). Throughout the trial, the birds' initial body weights was recorded, followed by weekly recordings of live body weight (BW) and feed intake (FI). The feed conversion ratio (FCR) of the birds was calculated by dividing the weekly feed intake per replicate by the weight gain of the birds.

3.4.2 Estimation of carcass Traits:

Two birds from each replicate in the experimental treatment were chosen at 13 weeks. These birds were slaughtered after being starved overnight. The birds chosen had live weights that were closer to the group's average. The birds' jugular veins were cut and they were bled, then their feathers were softened by soaking them in hot water for around 2 minutes before being hand-picked. After removing the shanks, head, neck, and viscera, the dressed weight was taken. The following characteristics of carcasses are assessed:

- Live weight – at point of slaughter
- Hot carcass weight – after bleeding
- Dressed weight
- Dressing percentage- dressed weight/ live weight X 100

3.4.3 Samples Collection

At the conclusion of the feeding trial, two guinea fowl birds were randomly selected per replicate for haematological and histological features. Blood samples from each bird were collected via brachial (wing) vein to check haematological blood indicators, while organs (crop, proventiculous, gizzard, small intestine, heart, and lungs) were collected and fixed in 10% neutral buffered formalin solution to check histological features for laboratory for analysis.

3.4.4 Analysis of Haematological Blood Indicators

Blood samples were obtained in K3 EDTA tubes (BD Vacutainer®, Franklin Lakes, NJ, USA) for haematological blood indicator assays. Blood haematology characteristics were examined, including red blood cell (RBC) and white blood cell (WBC) counts, haemoglobin (Hb), packed cell volume (PCV), mean corpuscular volume (MCV), and mean corpuscular haemoglobin (MCH) concentrations (MCHC). Within 2 hours of blood collection, erythrocyte indices were calculated, and other parameters were examined using a haematology analyser (ABC Vet, ABX Diagnostics, Montpellier, France).

3.5 Statistical analyses

All data collected were subjected to a one-way (ANOVA) in a completely randomized design. Internal organs and carcass were expressed as a percentage of live weight. Duncans New Multiple Range Test of GENSTAT Release 8.1 (GENSTAT, 2011) software program was used to distinguish means when they were statistically significant.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION OF FINDINGS

4.1 RESULTS

4.1.1 Growth Performance of guinea fowl

Table 2 shows the growth performance of indigenous guinea fowl (*Numida meleagris*). The different levels of crude protein had no statistically effects (P>0.05) on the parameters measured. Treatments 1, 2, and 3, however, exhibit numerical significance. Treatment 2 (24 percent crude protein) had a higher value (564.67) for total weight gain than the values (530.08 and 516.91g) of treatment 1 (22 percent) and treatment 3 (26 percent) crude protein, respectively. Treatment 2 also has the highest daily weight gain (6.20g) numerical value. Furthermore, treatment 3 has the highest numerical value (1953.12g) for total feed intake , while treatment 2 and 1 have practical closely identical figures (1933.13 and 1929.52g) respectively. For daily feed intake T1 and T2 had slightly similar values (21.20 and 21.24g), while treatment 3 has the higest value of (21.46g). The feed conversion ratio in all three treatments was not significant (P>0.05), but was numerically significant, with treatment 2 having the best feed conversion ratio of (3.45), while treatments 1 and 3 had (3.67 and 3.79) correspondingly. With a percentage of 0.31, mortality was only reported in treatment 3.

Table 2: Growth performance of guinea fowl (*Numida meleagris*)

	Treatments			
Parameters (g)	**T_1 (22%)**	**T_2 (24%)**	**T_3 (26%)**	**SEM**
Initial weight	56.7	55.16	49.52	1.87
Final weight	586.80	619.83	566.43	16.49
Total weight gain	530.08	564.67	516.91	16.02
Daily weight gain	5.82	6.20	5.68	0.18
Total Feed intake	1929.52	1933.13	1953.12	5.72
Daily Feed intake	21.20	21.24	21.46	0.06
FCR	3.67	3.45	3.79	0.11
Mortality	0.00	0.00	0.31	0.10

FCR: Feed conversion ration

4.1.2 Carcass traits of guinea fowl fed different protein levels

The crude protein level in the experimental groups had a significant ($P<0.05$) influence on some of the carcass trait of guinea fowls (*Numida meleagris*), as indicated in Table 3. The crude protein amount in the diets, more so, had no statistically significant effect on GIT WT, head weight, or dress percentage ($P>0.05$). Treatment 2 (24 percent) and treatment 1 with (22 percent) crude protein both showed statistical similarity. Furthermore, in treatment 2 (24 percent crude protein), greater values for carcass metrics were obtained. More so, it was discovered that the quantity of crude protein in the diet had no statistical impact ($P>0.05$) on the organs weight at all crude protein levels in the results for organs weight evaluation. Treatment 3 had the highest numerical values for gizzard weight (22.46), lung weight (7.51), proventriculus (2.37), and small intestine weight (17.60), whereas Treatment 2 attained the highest numerical values for heart weight (3.24), and crop weight (4.02).

Table 3: Carcass traits of guinea fowl (*Numida meleagris*)

Parameters (g)	Treatments			
	T_1 (22%)	T_2 (24%)	T_3 (26%)	SEM
Live weight	637.83^{a}	654.50^{a}	519.33^{b}	16.82
Hot carcass weight	628.83^{a}	647.83^{a}	511.83^{b}	16.79
Feather weight	55.83^{a}	56.50^{a}	32.33^{b}	3.10
De-feather weight	573.00^{a}	591.33^{a}	479.50^{b}	14.09
GIT WT	57.08	57.36	51.84	1.23
Eviscerated weight	515.93^{a}	533.98^{a}	427.67^{b}	13.47
Breast weight	113.45^{a}	119.24^{a}	98.28^{b}	3.04
Wing weight	73.61^{a}	77.40^{a}	63.01^{b}	2.11
Drumstick weight	61.20^{a}	62.08^{a}	48.91^{b}	1.71
Shank weight	20.80^{a}	21.31^{a}	11.82^{b}	1.32
Thigh weight	76.18^{a}	79.81^{a}	63.90^{b}	2.41
Head weight	30.84	31.32	30.65	0.50
Neck weight	32.77^{a}	34.89^{a}	28.11^{b}	0.92
Dress weight	431.52^{a}	446.46^{a}	357.08^{b}	11.45
Dress weight%	68.15	68.24	68.77	0.32
Organs yield				
Heart weight	3.00	3.24	2.78	0.10
Gizzard weight	22.46	21.74	20.25	0.49
Proventriculus weight	2.37	1.97	2.13	0.14
Crop weight	3.49	4.02	3.59	0.16
Lung weight	7.52	7.36	7.22	0.14
Small intestine weight	17.60	17.51	16.27	0.39

^{a,b,c} : Means with different superscripts on the same row differ significantly (P<0.05)

SEM: Standard error of mean, GIT WT: Gastro intestinal tract weight

4.1.3 Apparent Digestibility of guinea fowl fed varying protein levels

Table 4 shows the results for apparent nutritional digestibility of guinea fowl fed varying quantities of dietary protein. For all criteria, significant ($P<0.05$) changes in the birds' nutritional digestibility was recorded. The results attained showed a peculiar trend, as Treatment 1 revealed the greatest value of (50.00%) in the digestibility of Ash and 53.82% in the digestibility of crude fibre. However Treatment 2 had the highest values of 63.16 and 53.65% in the digestibility results of and ether extract and crude protein respectively.

4.1.4 Haematological indices of guinea fowl fed different protein levels

The results of haematological parameters of the native guinea fowl (*Numida meleagris*) in response to varied crude protein concentrations are demonstrated in Table 5. The amount of crude protein used in each treatment had a significant ($P<0.05$) impact on packed cell volume, haemoglobin, MCV, MCH, platelets, lymphocytes, and Eosiniphils. On red blood cells, white blood cells, and neutrophils, different quantities of the dietary protein exhibited no statistically significant effect ($P>0.05$). However, Treatment 2 also has the highest Eosiniphils value (2.00), followed by treatment 3 with a value of (1.50). More so, Treatment 3 had the highest hemoglobin level (10.66), whereas treatment 1 has the lowest value (9.66). Packet cell volume, MCV and MCH is largest in Treatment 3.

Table 4: Apparent Digestibility

	Treatments			
Parameters (%)	**T_1 (22%)**	**T_2 (24%)**	**T_3 (26%)**	**SEM**
Ash	50.00^a	45.45^a	36.46^b	2.17
CP	60.39^b	63.16^a	58.57^b	0.73
EE	51.58^a	53.65^a	48.40^b	0.87
CF	53.82^a	37.55^b	52.66^a	2.64

CP; crude protein, EE; ether extract, CF; crude fibre. SEM: Standard error of mean ^{a,b,c} : Means with different superscripts on the same row differ significantly ($P<0.05$)

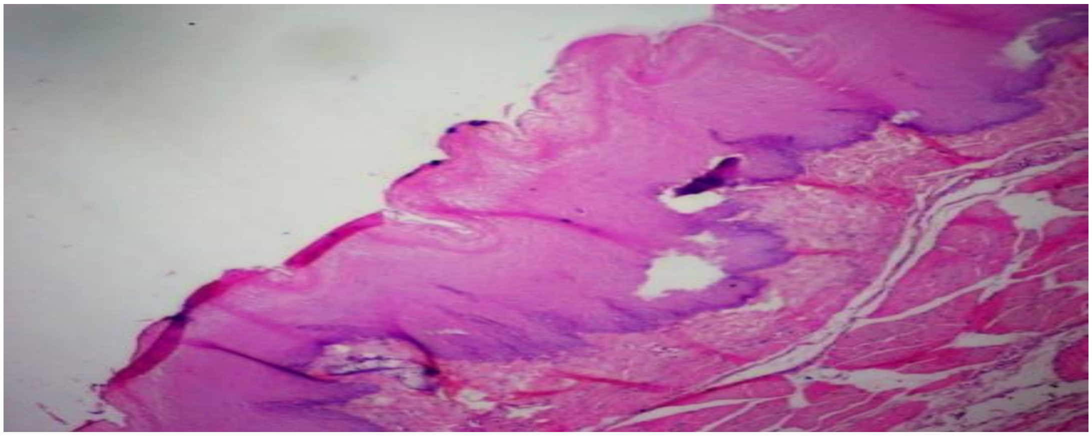
Table 5: Haematological indices of guinea fowl (*Numida meleagris*)

Parameters	Treatments			
	T_1 (22%)	**T_2 (24%)**	**T_3 (26%)**	**SEM**
Haemoglobin (g/dL)	9.66^{b}	10.16^{ab}	10.66^{a}	0.72
Red blood cell (10^{12}/L)	2.70	2.80	2.90	0.04
Packet cell volume (%)	29.00^{b}	30.50^{ab}	32.00^{a}	0.55
White blood cell (l0^{9}/L)	11.90	11.45	12.00	0.15
Platelet (xl0^{3}/mm^{3})	209.40^{a}	202.45^{b}	199.85^{b}	1.65
MCV(fl)	107.76^{b}	108.89^{ab}	110.04^{a}	0.05
MCH (pg/cell)	35.59^{a}	34.50^{ab}	33.05^{b}	0.11
MCHC (g/dL)	31.22	31.47	31.40	0.06
Lymphocytes (%)	33.50^{ab}	31.50^{b}	35.00^{a}	0.60
Neutrophils (%)	66.50	66.50	68.50	0.80
Eosinophils (%)	0.00^{b}	2.00^{a}	1.50^{a}	0.35

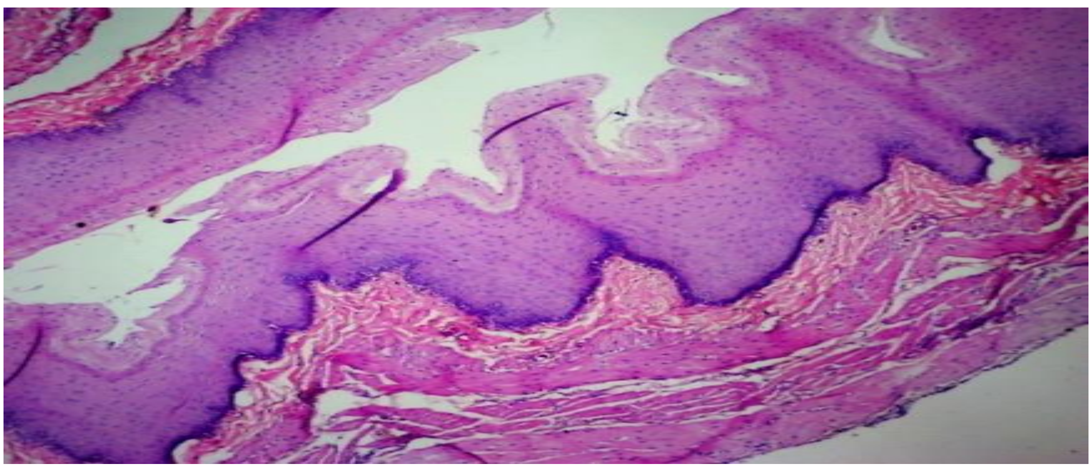
MCV: Mean Corpuscular Volume; MCH: Mean corpuscular hemoglobin; MCHC: Mean corpuscular hemoglobin concentration, SEM: Standard error of mean ^{a,b,c} : Means with different superscripts on the same row differ significantly ($P<0.05$).

4.1.5 Histological parameters of guinea fowl fed varying protein

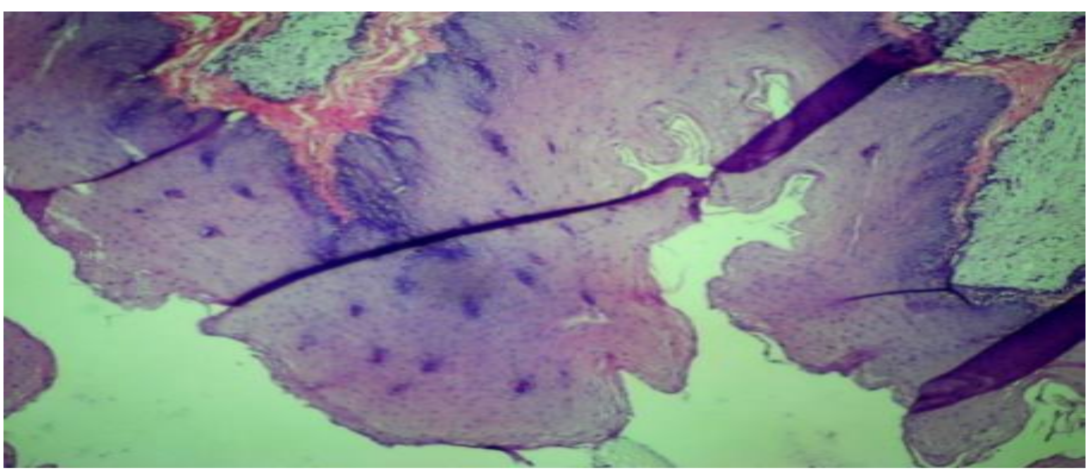
The results of the histological representation of guineas fed different protein levels is shown in Plate 2, 3, 4, 5, 6 and 7 below. The treatment of birds with protein inclusions at varying percentages observed an effect and histological changes in the organs: Crop, Gizzard, Heart, Lung, Intestine and Proventriculus respectively. More so, the histological results showed a peculiar trend with the T1, T2 and T3 showing no detrimental impacts on the crude protein utilized in the diets, as displayed on the H&E X40 photomicrograph of the crop, gizzard, heart and proventriculus. However, T1 and T2 revealed abnormalities in the intestine and Lungs while T3 showed no detrimental effects on the intestine and lungs respectively.



T1 (22%CP)

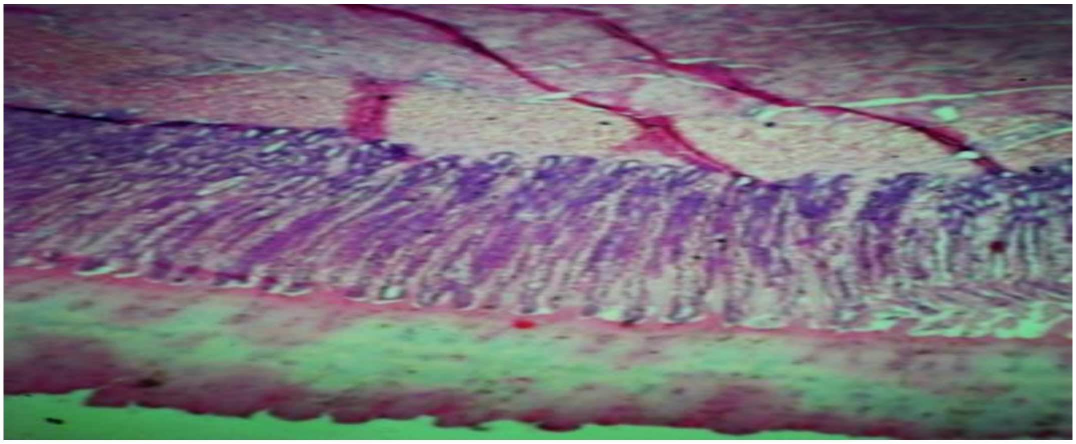


T2 (24%CP)

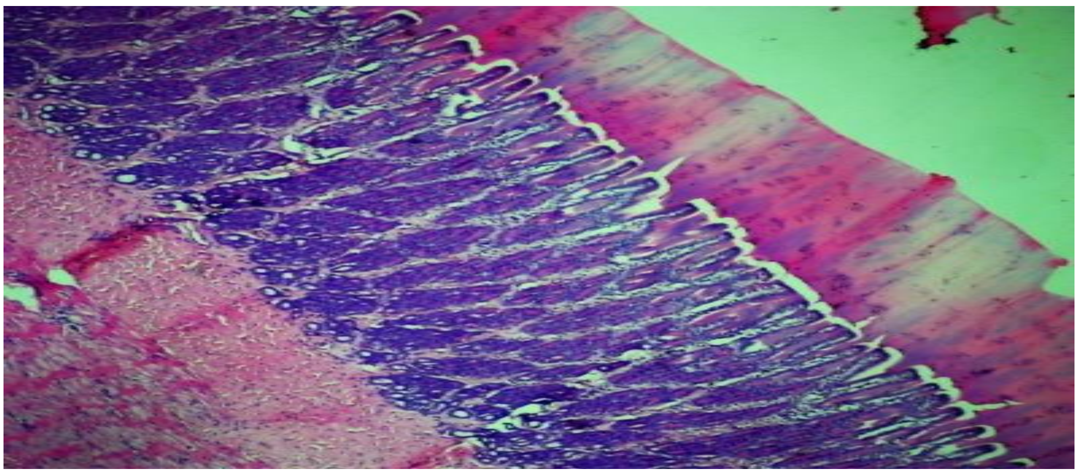


T3 (22% CP)

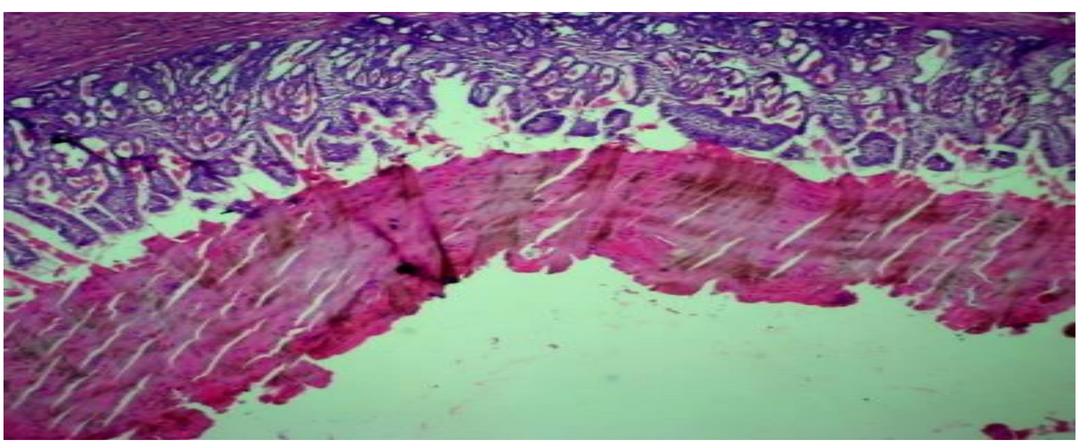
Plate 2: Showing the Crop photomicrograph H&E X40



T1 (22% CP)

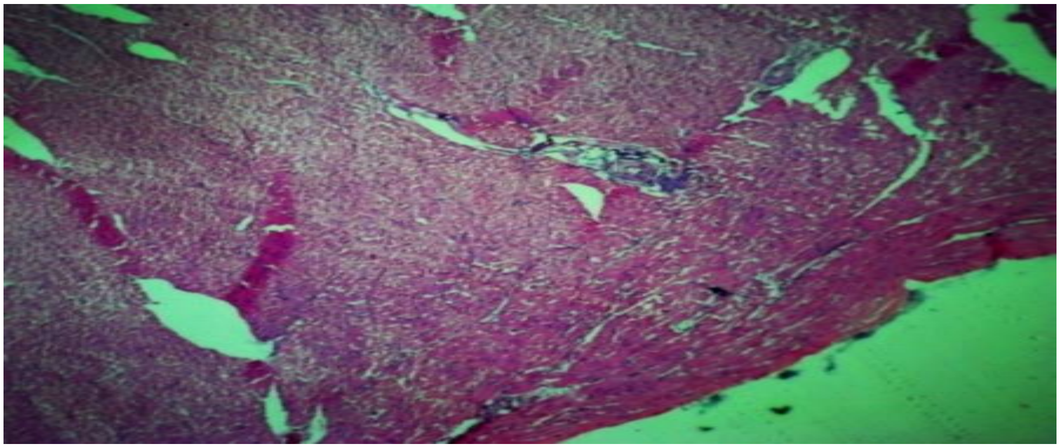


T2 (24% CP)

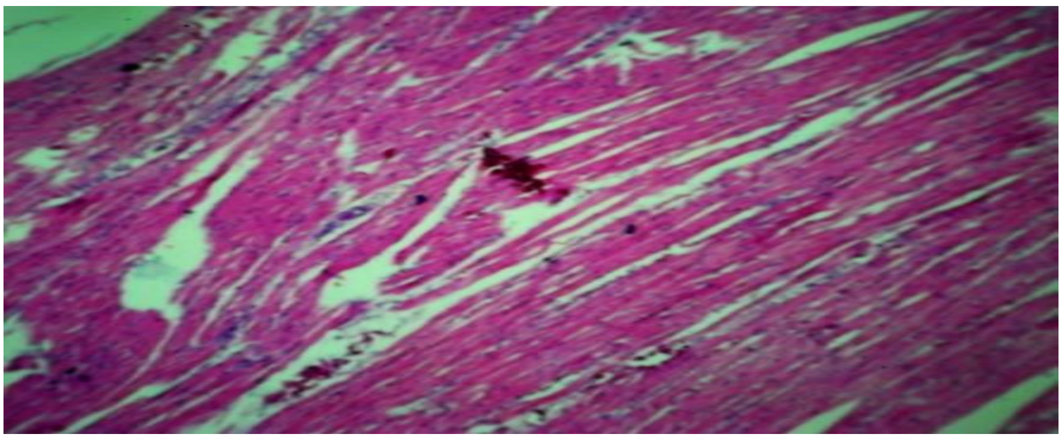


T3 (26% CP)

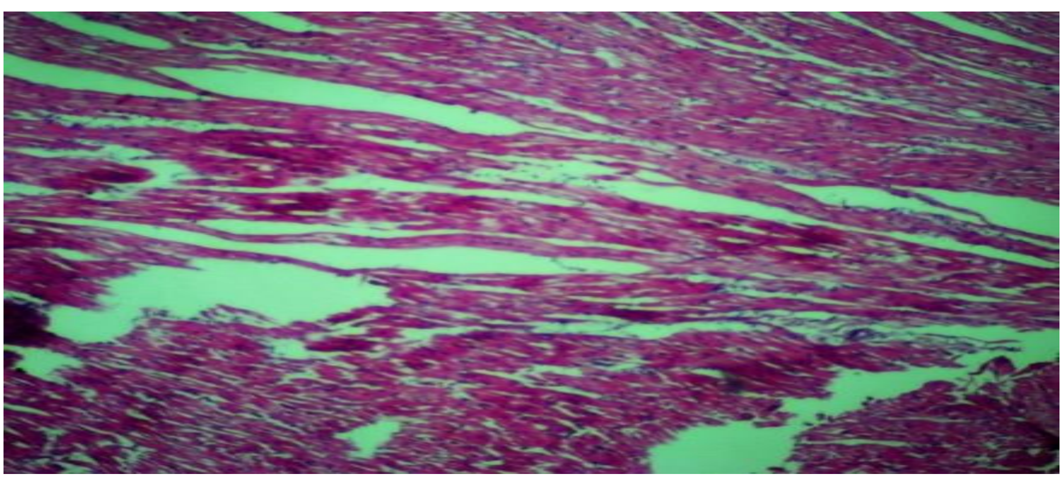
Plate 3: Showing Gizzard photomicrograph H&E X40



T1 (22% CP)

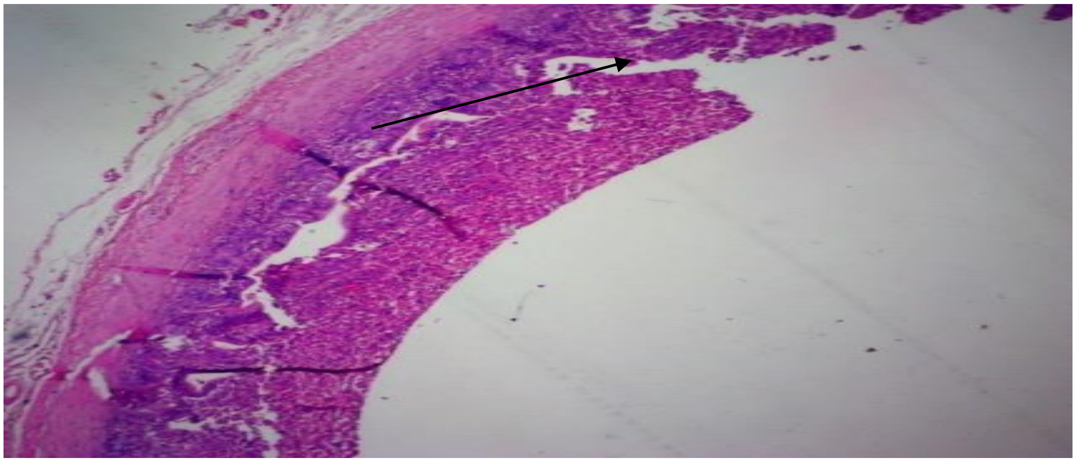


T2 (24% CP)

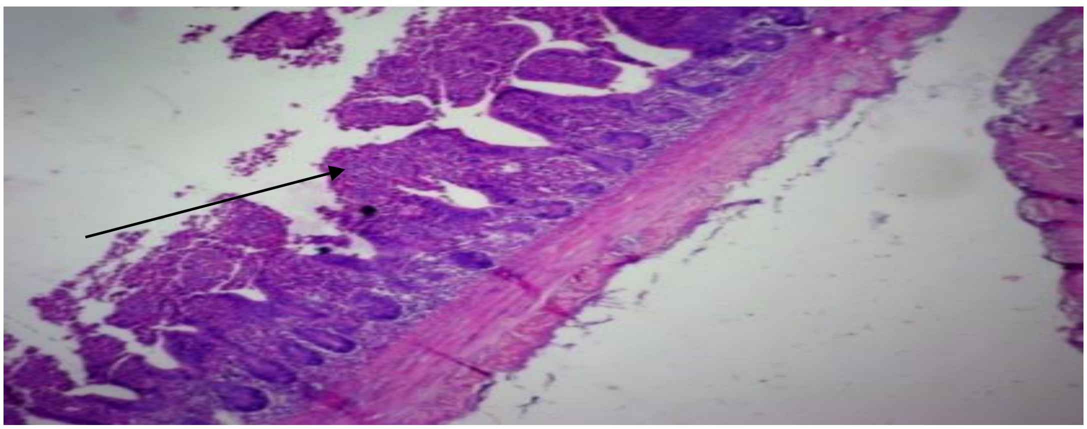


T3 (26% CP)

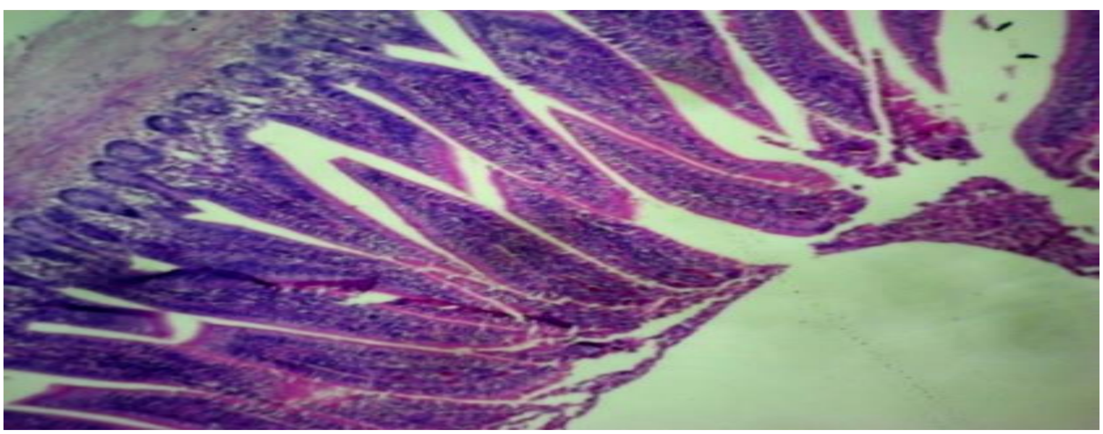
Plate 4: Showing Heart photomicrograph H&E X40



T1 (22% CP) Epithelial desquamation

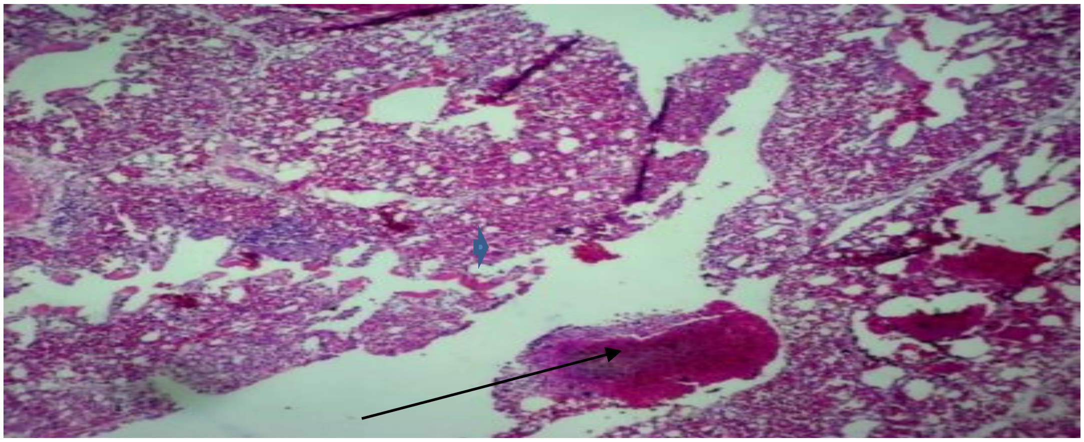


T2 (24% CP) Epithelial desquamation

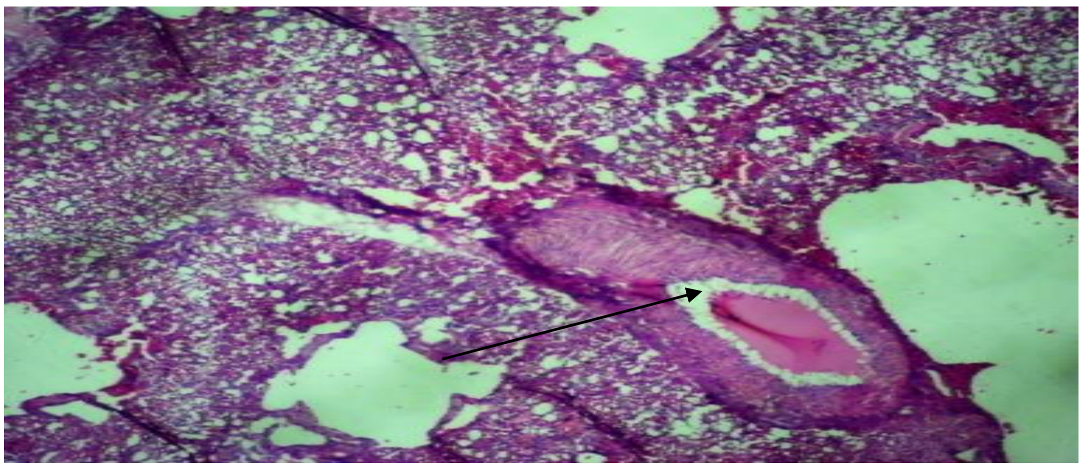


T3 (26% CP)

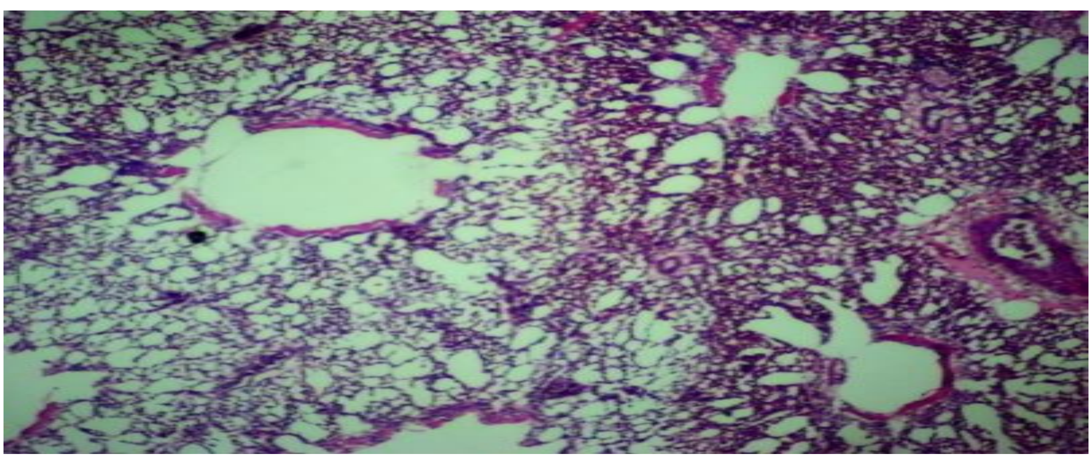
Plate 5: Showing photomicrograph of the intestine. H&E X40



T1 (22% CP) Mild pulmonary edema

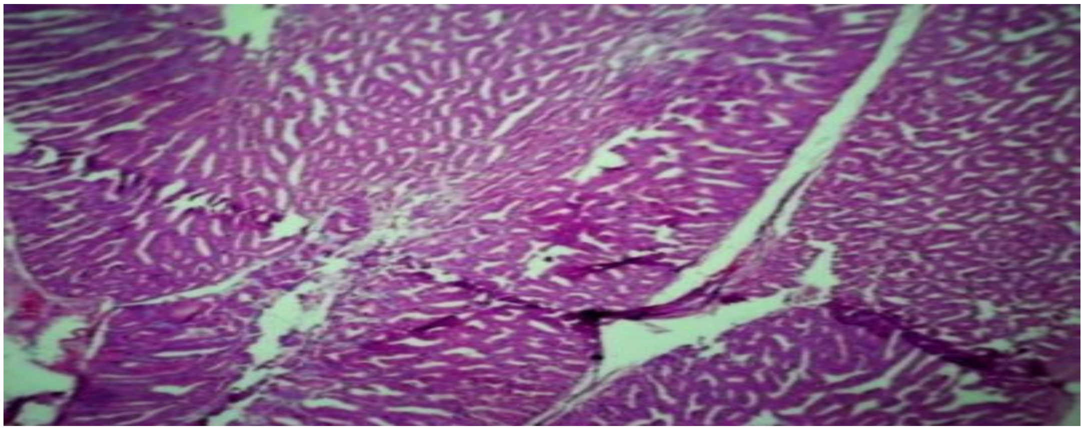


T2 (24% CP) Mild pulmonary edema

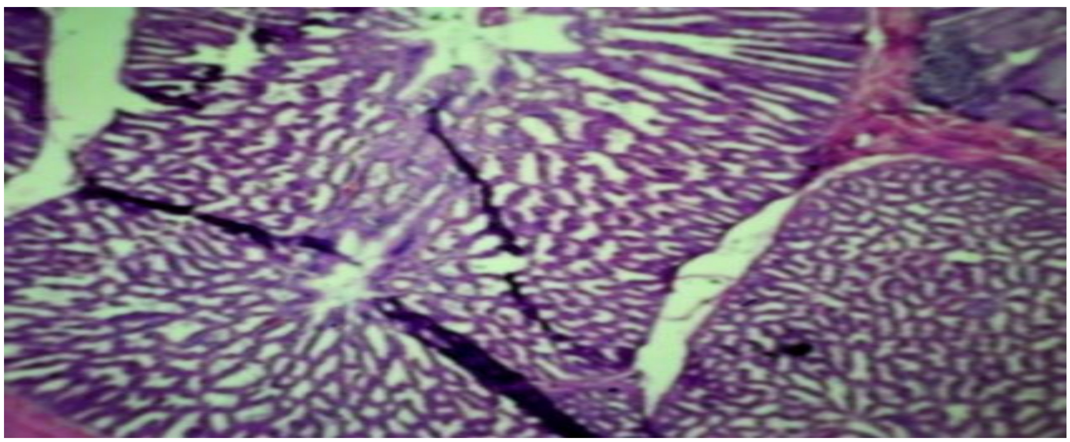


T3 (26% CP)

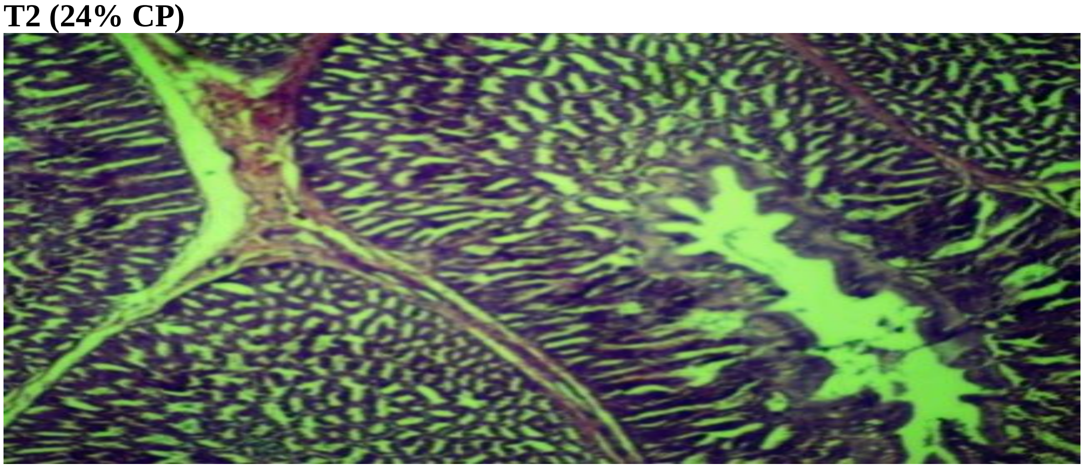
Plate 6: Showing photomicrograph of the Lungs H&E X40



T1 (22%CP)



T2 (24% CP)



T3 (26% CP)

Plate 7: Showing the photomocraphy of the proventriculus H&E X40

4.2. DISCUSSIONS AND FINDINGS

4.2.1 Effect of the different protein on growth performance

The weight gains, daily feed intake, feed conversion ratio, and mortality rate of guinea fowl fed varied quantities of dietary protein are shown in table 4.1. The treatments recorded no statistically significant (P>0.05) on the weight gains, daily feed intake, and feed conversion ratio, respectively. However, birds fed 24 percent CP had the highest final mean weight, (619.83g), which is greater than (429.0g) of Singh *et al*. (2015) followed by birds fed 22 percent (586.80g), while birds fed 26 percent CP had the lowest final mean weight (566.43g). These outcomes are in accordance with that of Amoah *et al*. (2018) and Rafiu *et al*. (2021), who found that feeding guinea fowl an excessive amount of dietary protein did not result in enhanced weight gain. The highest weight is lower than what (Khairunnesa *et al*., 2016) reported in week 13, which could be due to environmental factors. Seabo *et al*. (2011) found a substantial variation in weight increase between birds fed different protein content. The genetic make-up of the birds, hormones, tissue-specific regulatory factors, nutrition and other environmental features can all influence animal growth.

Feed consumption

The crude protein level had no statistically significant impact on feed intake levels (P>0.05), but there were numerical differences. Feed intake was highest in birds on 26 percent (1953.12g) protein feed, followed by 24 percent (1933.13g) protein feed, and finally the 22 percent (1929.52g) protein feed, according to the trend of (Avornyo *et al*., 2013). Gous (2010) stated that birds tends to take more feeds in order to meet their need for a limited nutrient in the feed, and if the feed was low in energy, they would consume more of it. The 26 percent protein feed was probably energy limiting, and the birds devoured more of it than the 22 percent protein feed due to its lower protein content than the 24 percent protein meal. Given that the diet contains isocaloric energy, Avornyo *et al.* (2016) believe that a corresponding rise in energy tends to match the 26 percent protein level of the feed should be made to boost growth performance. 26 percent CP (21.46) and 22 percent CP (21.46) had the highest and lowest daily feed intake of 21.20g respectively. The variation in feed intake obtained accords with Rafiu *et al.* (2021) reports when compared to other treatments. According to Avornyo, *et al*. (2016), birds would consume excessive amounts of energy in order to meet their protein requirements. According to this study, birds fed a 22 percent CP diet were more likely to achieve their protein requirements. The best feed conversion efficiency was reported at 24 percent CP (3.45), which was comparable to 22 percent CP (3.67) and 26 percent CP (3.79) but less than Batkowska, *et al*. (2021) values (5.28). This could be attributable to nutrition and the research area's environmental conditions. Crude protein is one of numerous nutritional elements that has a substantial impact on guinea fowl growth and health; in the study, the bigger body weight of guinea fowl fed 24 percent CP may be the claim for nutrient need of these birds. The increase in overall weight gain might be responsible for the greater feed conversion ratio (Rafiu *et al*., 2021).

4.2.2 Effect of crude protein on Carcass Traits

Table 4.2 reveals the impact of crude protein on the carcass traits of these birds at the three treatments:

Live weight: The mean live weight value was statistically significant ($P<0.05$) due to crude protein inclusion, with T2 having the highest value of (654.50g), which is closely similar to the values (637.83) of T1, but is higher than 554.80.81 and 572.54 recorded by

Fajemilehin, (2010) at 14 weeks. However, at week 14, Victoria and Bassey (2017) and Chiroque, *et al.* (2018) reported (950.0, 916.67, 975.0g) and (1029.96 1127.78 1141.82g) respectively. The discrepancies could be attributable to the scavenging guinea fowls' age and the environment.

Hot carcass weight: The crude protein levels had a significant (P<0.05) impact on the hot carcass weight mean value, with treatment 2 (24%) having the greatest value of 511.83g and T3 (26%) having the lowest value of 647.83g, respectively. This is higher than the findings of Musundire, (2016). The differences could be the effect of the birds' feeding and management techniques.

Feather weight: The different crude protein treatments influenced the mean feather weight value in this study statistically (P<0.05), with T2 recording the greatest value of 56.50g and T3 recording the lowest value of 32.33g. These figures are lower than those found by Kgakole *et al.* (2016), who found 93.14g for royal blue guinea fowl at 20 weeks, which could be due to age differences and the birds' genetic make-up.

De-feather weight: The de-feather weight mean value was significant (P<0.05) in this study and was influenced by dietary protein. T2 attained the greatest mean value of 591.33g, accompanied by T1 with a value of 573.00g, and T3 with the lowest value of 479.50g. These disparities could be attributable to dietary variances.

Gastro intestinal tract weight (GIT WT): The GIT mean weight had no statistically significant (P>0.05) in this research, hence the different dietary protein of the treatments had no effect. T2 had the highest numerical value of 57.36g, whereas T1 and T3 had 57.08g and 51.84g, respectively. The variances could be due to differences in nutrition and feed composition.

Eviscerated weight: The difference in protein levels in each treatment influences the mean value for eviscerated weight, which is significant (P<0.05). T2 had the greatest mean value of 533.98g, while T3 has the lowest value of 427.67g. This could be due to the management structure in place.

Breast weight: This study's mean breast weight value was significant (P<0.05). Thus, T2 had the greatest value of 119.24g and T3 had the lowest value of 98.28g. More so, these values are lesser than those reported by Chiroque, *et al.* (2018), Kerketta and Mishra, (2016), who recorded 272±21.07g and 259.33±17.49g for Pearl and levander guinea fowl at 14 weeks. This could be due to the birds' age and genetic makeup.

Wing weight: The difference in protein levels influences the mean value for wing weight, statistically (P<0.05). T2 recorded the greatest mean weight of 77.40g and T3 had the lowest value of 63.01g; these values are greater than those reported by Musundire (2016), which were 53.5g and 55.4g, respectively. This variance could be due to adequate nutrition.

Drumstick weight: The dietary protein influenced the mean value of drumsticks, which was significant (P<0.05). T2 had the greatest value of 62.08g, however, similar to T1 had the lowest value of 61.20g, both of which are greater than Musundire, (2016) findings of 53.6g. It is possible that this could be due to poor management.

Shank weight: The mean shank weight for this study was statistically significant (P0.05), with T2 having the highest value of 21.31g, T1 had the least value of 11.82g, and T3 having the highest figure of 20.80g. These figures are higher than Kagakole *et al.* (2016) findings. These variations could be due to managerial practices.

Thigh weight: The dietary protein levels influenced the mean value of thigh weight, statistically (P<0.05). T2 has the greatest mean value of 79.8g, followed by T1 with 76.18g, and T3 with 63.90g. These values are higher than (17.19g, 17.63g), (18.60g), recorded by Batkowska *et al.* (2021) and Ahaotu *et al*. (2019). This could be as a result of the certainty that inadequate dietary protein levels cause the birds to produce less than optimal yields.

Head weight: The protein levels had no significant (P>0.05) implication on head weight mean value in this study. T2 has the greatest numerical value of 31.32g, followed by T1 and T3 with relatively similar numerical values of 30.84g and 30.65g. These numbers are greater than Musundire (2016) findings for adult male and female guinea fowls (26.3g, 27.3g). This could be the outcome of good management.

Dress weight: The dietary protein influenced the mean value of dress weight statistically (P<0.05). T2 attained the greatest value of 446.46g, accompanied by T1 with 431.52g and T3 with 436.46g (357.08g). These values are lower than those found by Victoria and Bassey (2017) at week 14 (736.67g, 700g, and 708.33g). It's possible that this disparity is due to age.

Dress percentage: The protein inclusion had no significant (P>0.05) impact on the dress percentage in this study. T1 had the greatest value of 68.77 percent, while T3 had the lowest value of 68.15 percent. The results of this study are identical to Chiroque, *et al.* (2018); 69.68 and 68.98 percent. This similar trend could be due to nutrition.

Organs yield:

Internal organ indices in this experiment were not statistically significant (P>0.05) and hence not impacted by dietary protein. The heart weight mean values were 3.24g in T2, 3.00 in T1, and 2.78g in T3. The results of Seabo *et al*. (2011) for different dietary protein levels in guineas (3.89g, 3.86g, 3.85g) are similar to that of this study. However, these are greater than the values of (Batkowska *et al*., 2021) at week 14 (0.64g, 0.64g).

This could be due to poor nutrition. The greatest numerical value for gizzard weight mean values was 22.46g in T1, while the least value was 20.25g in T3. These values are greater than the results of Houndonougbo *et al.* (2017) for guineas at week 16, but lower than the results of Musundire (2016) for grower male and female guinea fowl at week 16. It might be possible that this is due to age differences. Furthermore, T1 had the highest mean value of 2.37g for Proventriculus weight, whereas T2 (1.97g) had the lowest, possibly because to feed composition absorption. T2 had the greatest crop weight mean values of 4.02g, whereas T1 had the lowest at 3.49g in this study. This could be as a result of nutrition. Furthermore, T3 had the greatest value of 7.52g, T2 recorded the second highest value of 7.36g, and T1 had the lowest value of 7.22g in this study. These findings are lower than (Seabo *et al*., 2011) values of 22.13g, 22.21g, and 2.20g for 14 percent, 16 percent, and 18 percent dietary protein, respectively. This could be due to the management practice. T1 had the greatest mean weight value of 17.60g, followed by T2 with 17.51 and T3 with 16.27g. This number is lower than (Musundire, 2016) reported values of 48.3g and 47.6g for grower guinea fowl at week 16. The contrast in age could be to blame for this variation.

4.2.3 Effect of crude protein on Apparent digestibility

The length in which feed nutrients are ingested as they move through the digestive tract of the bird is known as nutrient digestibility. For all measures, there was significant ($P<0.05$) variations in nutritional digestibility throughout the experimental group.T3 had the greatest ash content (50.00g), T2 had a value of (45.45g), and T1 had the lowest values of (36.46). T2 had the highest crude protein digestibility value (63.16g), while T1 had the lowest value (58.57g). The maximum crude fibre value (53.82g) was recorded for T3, and the minimal value (37.55g) was attained in birds fed 24 percent dietary protein. There was a significant disparity in ether extract digestibility amidst the treatments ($P<0.05$). The lowest value (48.40g) was obtained from birds fed 22 percent dietary protein, while the greatest value (53.65g) was obtained from birds fed 24 percent dietary protein and was statistically ($P<0.05$) significant equivalent to the figures (51.58g) attained from birds fed 26 percent dietary protein. This result's trends match those of (Rafiu *et al*., (2021). The findings simply indicated that dietary crude protein variation is responsible for varying levels of digestibility of other nutrients in this study.

4.2.4 Effect of crude protein on the Haematological parameters

Haemoglobin: The protein levels revealed a statistically significant ($P<0.05$) effect on the mean haemoglobin values in this study. T3 had the greatest score of 10.66g/dL, while T1 had the lowest value of 9.66g/dL. These values are lower than Rafiu *et al*. (2021) findings of 11.90, 13.05, 12.15 and 11.60g/dL for 16 percent CP, 18 percent CP, 20 percent CP, and 22 percent CP. However, the change in Haemoglobin between treatments suggests that treatment diets are unlikely to cause anemia, as the values obtained between treatments were within the reference range for physiological normal guinea fowl (8.00-17.5g/100ml) Kokore *et al.* (2021).

Red blood cell (RBC): In this study, dietary protein had no significant ($P>0.05$) impact on red blood cell mean values. T1, T2 and T3, on the other hand, have numerical disparities with values of 2.70, 2.80, and 2.90 (10^{12}/L), respectively. These results are comparable to Kokore *et al*. (2021) findings of 2.99 and 3.03 (10^{12}/L) respectively. RBC transports O_2 from the lungs to the tissues and carbon dioxide from the tissues to the lungs throughout the physique via haemoglobin. More so, a low red blood cell count shows a decrease in the quantity of O_2 transported to the tissues as well as the proportion of carbon dioxide returned to the lungs. The protein diets, may not cause anemia because they lie between observed range of 2.5-4.5 millions of cells per cubic millimeter reported by Miesle (2020).

Packet cell volume: The fed protein has a highly significant ($P<0.05$) influence on the packet cell volume mean value in this study. T3 got the highest value 32.00%, followed by T2 with 30.50, and T1 with 29.00%. This number is lower than Rafiu *et al*. (2021) findings of 36.00, 31.00, 36.50 and 34.50 percent for guinea fowl fed various protein diets of 16, 18, 20 and 22 percent CP. Furthermore, the changes in PCV seen between treatments suggest that treatment diets are unlikely to cause anemia, given the values obtained between treatments were within the reference range for physiological normal guinea fowl (30.00-50.00 percent) as described by Kokore *et al.* (2021).

White blood cell (WBC): The protein levels had no impactt on the mean values of white blood cells in this study ($P>0.05$). The figures in this research are close to those found by Oke *et al*. (2020) on tropical guinea fowls (11.85, 12.00, 11.60, and 11.28xl0^{9}/L). The WBC are largely in charge of combating diseases and safeguarding the body against invading alien pathogens, and producing antibodies in the immune response. Hence, animals with minute WBC counts maybe at a greater risk of disease infestation, however those with higher counts are able to create antibodies, having an enormous level of disease resilient and have greater resistance to native environs and disease-prevalent conditions. The results found in this study are within the recommended range of 12-30 x 10^{3} for bird white blood cell count (Odunitan-Wayas *et al*., 2018).

Platelet: The mean value recorded for this study is significantly ($P<0.05$) affected by the protein inclusion, T2 had the greatest score of 202.45 xl0^{3}/mm^{3}, while T3 had the lowest value of 199.85 xl0^{3}/mm^{3}. These figures are lesser than thoes reported by Rafiu, *et al*.

(2021) for guineas on a varied protein diet (122.00, 111.00, 185.00, and 152.00 $xl0^3/mm^3$). However, when compared to other treatments, the highest platelet value observed could be link to greater nutritional utilization in the diet, which may have resulted in the production of more platelets, according to the report of Rafiu, *et al*. (2021). Platelets are pertinent in repairing blood vessels that have been destroyed, as well as aid healing and repair (Odunitan-Wayas *et al*. 2018). A low platelet count means the coagulation (blood clotting) procedure will be protracted; in case of an injury, this could result in considerable blood loss.

Mean Corpuscular Volume (MCV): MCV mean for this study is significantly (P<0.05) impacted by the crude protein. T1, T2, T3 recorded the following values 110.04, 108.89 and 107.76fl respectively. These values are lesser than the findings 155.4 and 161.8fl of Nalubamba *et al.* (2014) for helmented guinea fowl. Mean Corpuscular Volume are utilize in computing the average erythrocyte size, normal ranges are MCV: 90-140fl (Odunitan-Wayas *et al.* 2018). This result could be as a result of the feed composition.

Mean corpuscular hemoglobin (MCH): There was a significant (P<0.05) impact on the MCH readings in this investigation. T1, T2, and T3 have recorded mean values of 33.05, 34.50, and 35.59 pg/cell, respectively. These values are lower than Nalubamba *et al*. (2014) findings of 52.3 and 51.1 pg/cell for helmented guinea fowl. The MCH is used to determine the amount of haemoglobin per blood cell, and its typical range is 33-47 pg/cell (Odunitan-Wayas *et al*., 2018). The dietary composition in this study may not cause the birds anemia.

Mean corpuscular hemoglobin concentration (MCHC): The dietary protein has no effect on MCHC mean values (P>0.05). The following values were reported for T1, T2 and T3 respectively: 31.22, 31.47, and 31.40g/dL. These results are lower than the findings

(3.34, 32.4 g/dL) of Nalubamba *et al* (2014). The MCHC is a helpful a measure of the bone marrow's ability to generate RBC and can be used as a diagnostic sign for anemia. The MCHC method is used to determine the quantity of haemoglobin per blood cell and the amount of haemoglobin per red blood cell in relation to the cell size. The usual range for MCHC is 26-35 g/dL (Odunitan-Wayas *et al.* 2018). The reults of MCHC in this research indicate that the dietary protein did not influence the birds health.

Lymphocytes: The protein inclusion recorded a substantial (P<0.05) impact on the mean value of lymphocytes reported in this study. T3 attained the topmost value of 35.00%, while T2 had the minimal value of 31.50%. This is lower than (Rafiu, *et al*., 2021) values of 65.50, 66.00, 63.50 and 66.00% with varied protein; 16, 18, 20 and 22 percent diet of guinea fowl. The typical amount of lymphocytes is 20-50 percent, but persistent infections and lymphoid leukemia show an increase in numbers Miesle (2020). The results of this investigation are within acceptable limits.

Neutrophils: Neutrophils mean values for this study was not affected by the crude protein significantly (P>0.05). T1, T2, recorded the following values 66.50, 66.50 while T3 had 68.50 respectively.

Eosinophils: A substantial statistical (P<0.05) impact on the mean value of Eosinophils measured in this study. T2 had the greatest value of 2.00%, while T1 had the smallest value of 0.00%. This experiment's mean values are greater than Oke *et al*. (2020) findings for guinea fowls in a tropical climate. Eosinophils are a type of disease-fighting white blood cell. However, the usual percentage of Eosinophils is 0-2 percent (Miesle, 2020). As a result, the birds in this study are in good health and are within a safe range**.**

4.2.5 Effect of crude protein on the Histological parameters

The effects of the protein inclusions at varying percentages (T1=26% CP, T2= 24%, T3=22% CP) in each treatment of birds observed and its histological changes in the organs: Crop, Gizzard, Heart, Lungs, Intestine and Proventriculus are discussed thus;

Crop: The crop's histological structures are comparable to those of the esophagus (Akter *et al.*, 2018). T1 crop photomicrograph revealed normal epithelial lining of crop (Plate 2) X 40 H&E. The T2 photomicrograph also shows that the epithelial lining of the crop is normal. More so, T3 photomicrograph H&E X40 photomirograph of the crop, indicates normal epithelial lining, respectively. This is comparable to what (Akter *et al*., 2018) discovered with broiler chickens. Furthermore, the outcome of this study suggest that protein level in the diet has a positive impact on the birds' health.

Gizzard: This is a powerful pouch that travels caudally to the proventriculus and is the avian stomach's second component. This is where the food particles are mechanically ground to a finer composition, allowing for better nutritional extraction. Plate 3 depicts an H&E X40 photomicrograph of the gizzard, with the T1 photomicrograph indicating no abnormalities in the gizzard lining. T2 photomicrographs of the gizzard lining show no abnormalities, and T3 photomicrographs of the gizzard lining show no abnormalities: H&E X40, respectively. This study's findings are homogenous to those reported by (Matias *et al*., 2021) on Japanese quail and (Saran and Meshram 2021) on guinea fowl gizzard (*Numida meleagris*). Hence, the protein's influence in this study has no detrimental implications for gizzard health.

Heart: The plate 4 depicts T1: No abnormalities in the heart photomicrograph, T2: No abnormalities in the heart photomicrograph, T3: No abnormalities in the heart photomicrograph: X 40 H&E. The findings of Wankhede *et al.* (2017), who found modest degenerative changes in the cardiac muscles fibres of Japanese quails exposed to imidacloprid with *B. monosperma*, are in disparity to the findings of this study. Thus, the outcome of this study show that the protein in the feed has no detrimental impact on heart function.

Intestine: The gizzard transports ground food particles to the intestinal tract, where they are further digested and nutrients extracted. Photomicrograph of the gizzard is shown on Plate 5. T3 intestinal photomicrograph revealed no abnormalities. T1 intestinal photomicrograph revealed epithelial desquamation. T2: H&E x 40 photomicrograph of the colon with epithelium desquamation. This is related to the findings of Wankhede *et al.* (2017), who discovered that the intestine of Japanese quails is distorted and desquamated. The findings of this investigation show that the protein in T3 has no effect on intestinal health. However, the intestinal health of T1 and T2 was affected, which could be attributed to the meal composition.

Lung: Photomicrograph of the lungs is shown on Plate 6 H&E x 40. T3: lung photomicrograph revealed no abnormalities. T1: lungs photomicrograph demonstrating moderate pulmonary edema. T2: lung photomicrograph demonstrated moderate pulmonary edema as well. These findings match those of Wankhede *et al*. (2017), who found substantial blood vessel congestion and haemorrhages in the lungs of Japanese quails. Pulmonary edema is an abnormality that arises when there is a lot of fluid in the lungs. This fluid accumulates in the lungs' many air sacs, causing difficulty in breathing.

The level of protein in the lungs may be jeopardizing the function of the lungs, according to the findings. This could be related to a slaughter practice.

Proventriculus: Photomicrograph HJ&E x 40 of the proventriculus on Plate 7 shows no abnormalities. T1: The proventriculus photomicrograph of the proventicus revealed no abnormalities; T2: The proventriculus photomicrograph of the proventricus revealed no abnormalities. T3: The proventriculus photomicrograph revealed no abnormalities. This research on Japanese quail is comparable to that of (Wilkinson *et al*., 2018). The proventriculus is the glandular section of the avian stomach, where digestion begins. To initiate the digestion of food particles, this organ releases hydrochloric acid, mucus and enzymes (Wilkinson *et al*., 2018). According to the study report, the crude protein in the meal does not interfere with the proventriculus birds' healthy behaviors.

CHAPTER FIVE

5.1 Conclusion

Increased dietary protein inclusion levels improved growth performance and carcass attributes without affecting the histological characteristics of the numerous internal organs tested (crop, heart, gizzard, lungs, small intestine, and proventriculus). The protein inclusions of 26 percent, 24 percent, and 22 percent showed no deleterious effect on the birds, according to the haematological blood indicators utilized in this experiment. Guinea fowl (*Numida meleagris*) fed a 24 percent dietary protein inclusion had the best growth performance, with a final mean weight of (619.83g); however, birds fed 22 percent dietary protein had a similar final mean weight (586.80g), while those fed 26 percent had the least final mean weight (566.43g). Furthermore, birds fed 24 percent dietary protein had a greater mean weight throughout the treatments in terms of carcass features. Despite the fact that the energy was isocaloric, the birds appeared to react to the meal's protein content. As this study shows, guinea fowls are unable to utilize excessively high crude protein levels in their diet.

5.2 Recommendations

- Farmers can feed their birds diet containing 24 percent crude protein at the early stage of development, thus it has been proven to be the best for optimum performance and production in this study.
- Guinea fowls (*Numida meleagris*) are known to be flighty and wild in nature, hence chicks should be brooded in cages to avoid mortality due to stampede. When cages aren't readily available, the stocking density on the floor should be considered.
- Additional researches should be undertaken to improve carcass output.

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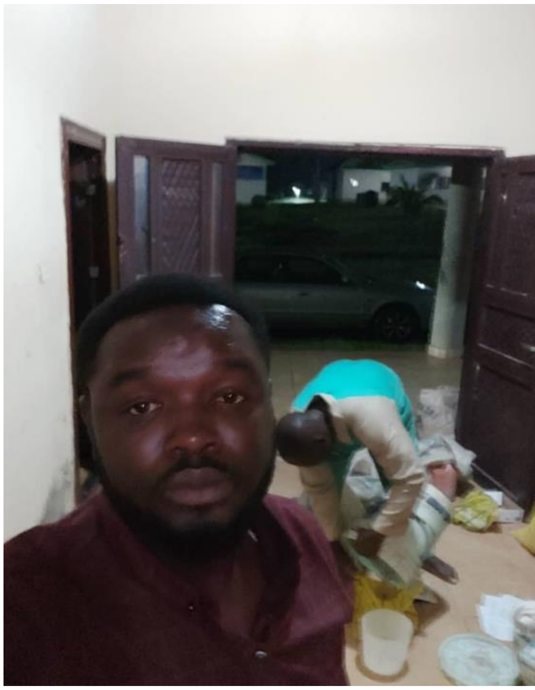
APPENDIX

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