GROWTH PERFORMANCE OF WEANED RABBIT FED DIET CONTAINING *Tectona grandis* AND OXIDIZED OIL

BY

ALEMEDE WILLIAMS OLUWASEGUN HND/23/AGT/FT/0051

A PROJECT SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL TECHNOLOGY, INSTITUTE OF APPLIED SCIENCES.

IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF HIGHER NATIONAL DIPLOMA, KWARA STATE POLYTECHNIC, ILORIN.

SUPERVISED BY: MR. AHMED, S.A

JUNE, 2025

CERTIFICATION

The is to certify that this project has been read and approved as meeting the requirement of the Department of Agricultural Technology, Institute of Applied Sciences, Kwara State Polytechnic, Ilorin for award of Higher National Diploma in Agricultural technology.

MR. AHMED S.A	DATE
Project supervisor	
Mr. Muhammed S. B	DATE
Project coordinator	
MR. BANJOKO I. K	DATE
Head of Department	
External Examiner	DATE

DEDICATION

This project is dedicated to Almighty God, the beginning and end, the one who is, who was and is to come, the master and shepherd of my soul.

He had been my provider, protector and my all in all. Also, I dedicate this to my late father Mr. Matthew Biodun Alemede, daddy I love you and may your soul continue to rest on in the bosom of the Lord (Amen).

ACKNOWLEDGEMENT

I Thank Almighty God for sparing my life to this moment and for bestowing on me grace, all honour, praise and adoration to the Almighty God.

I also give a lot of appreciation to my able and understanding supervisor. Mr. Ahmed S.A. for his time and guidance throughout this project work. I am very grateful sir for the fatherly love you showed up to us during and even after the project work.

My appreciation is extended the Head of Department of Agricultural Technology Mr. Banjoko I. K. and all departmental lecturers.

I give great and undiluted appreciation to my parents for their support; morally, spiritually and financially, and all those who had in one way or the other assisted me and see me through this programme.

I will like to congratulate and thank the entire student of agricultural technology department, Kwara state polytechnic Ilorin, and that i will miss you all.

Abstract

The experiment was carried out to determine the growth performance of weaned rabbit fed diet containing Tectona grandis and oxidized oil. Twenty four homogenous sex rabbit kits at four weeks old was randomly allocated to four dietary treatments D1, D2, D3 and D4, non-oxidized oil, oxidized oil, oxidized oil plus BHA and oxidized oil plus 10% TGLM respectively, replicated three times. The rabbit were fed and managed for eight weeks. The following growth performance traits were measured; initial body weight, weight gain, average weight gain, feed intake, average feed intake and feed conversion ratio. The result shows that initial body weight, feed intake and average feed intake were not significantly (P>0.05) affected while final body weight, weight gain, average body weight and feed conversion ratio were positively influenced by addition of 10% TGLM. Feed containing 3% oxidized oil and 10% TGLM had better performance on the rabbits and thereby recommended.

TABLE OF CONTENTS

CHAPTER ONE

1.0.INTRODUCTION

1.1.INTRODUCTION

Rabbit meat is commonly consumed in Europe and Africa countries playing a crucial role in their national economic (Ebeid *et al*., 2013). Rabbit meat is highly nutritive and healthy because it is low in cholesterol and rich in protein of high biological values and polyunsaturated fatty acids constituting up to 35-40% of total fatty acids (Mattioli *et al*., 2017) and mainly contributing to human health (Abdel-Hamid *et al.*, 2020). Additionally rabbit meat is considered a unique function food that possesses various important elements (eg minerals, vitamins, amino acids e.t.c) which can be further enriched by intelligent feeding approaches (Pla, M. and Dalle Zotte, 2000). Oxidative stress is a disturbance in cellular redox reactive oxygen species, ROS at rates that exceed the cellular production of internal antioxidant (Osman *and Salama, 2021*). Abdel-Hamid *et al*. (2020) oxidative stress has deleterious effects on farm animals health, performance and production, subsequently affecting the domestic animal industry economic efficiency (Hendary *et al*., 2019). Reactive oxygen species naturally emit as by-products of normal oxygen metabolism in aerobic organisms. Free radicals significantly trigger lipid oxidation of sub cellular membrane in animals muscle (Ashore *et al*., 2022) which remarkably accelerates meat products postmortem oxidative rancidity (Morrissey *et al*., 1998). Because of its high content of polyunsaturated fatty acids, rabbit meat is susceptible to lipid oxidation indicated by rancidity and color determination, which reduce its shelf life (Dalle zotte and Endro 2011). Therefore, natural and synthetic antioxidant are used to combat free radicals internal pro-diction and improve meat quality (Ashore *et al*., 2022).

Several plants have proven to have an antioxidant effect on growth performance of weaner rabbit by which the demand for antioxidants of plant origin capable of replacing synthetic antioxidants in feeds and foods has increased considerably in recent tears. Many herbs and spices contain active components capable of exerting antioxidant action such as phenolic substance (Flavonoids, Tannins, Phenolic Acids and phenolic determine) and vitamins E, C and A. These plants feed against oxidative deterioration during storage, and enhancing the oxidative stability of meat and meat products during storage or ripening for the latter purpose. Herbs and spices (oregano, rosemary, sage, thyme, cinnamon, mint, ginger, clove etc.) or their extracts (prepared from the plant material). Can be also directly added to the meat products during processing. Pla, M. and Dalle Zotte, (2000) reviewed the antioxidant effects of the herbs and spices that had been tested.

Rabbit growth and feed conversion ratio were also enhance through dietary supplementation (150 mg/kg feed) of Siberian ginseng (*Eleutherococcu senticosus*) extract (Chrastinova et al., 2009) or 150 mg/kg feed of commercial phytogenic feed additive (Cuxarom spice master) composed of a mixture of brown algae, basil, funnel garlic, cinnamon and essential oil from aniseed and thyme (Chrastinova et al., 2009) one example of a typical antioxidant plant is *Tectona grandis*.

Tectona grandis commonly known as teak, is a tropical tree species native to Southeast Asia, research has shown that T. grandis extract possess an antioxidant and phytochemical, and other essential biological value that can suppress oxidative stress in livestock.

Butylated hydroxyl anisole (BHA) is a synthetic phenolic antioxidant, comprising two isomers: 85% of 2 tert-buty 1.4methoxyphenole and 15% of 3-fert-buty-4-methoxyphenole (Wu *et al*., 2022) it is used mainly as a food preservative because of its chain breaking function in lipid peroxidation (Wu *et al*., 2022). Animal studies demonstrated a wide range of biological behaviors towards this compound. Dietary administration of BHA was reported to protect rats against acute radiation exposed and multiple xenobiotic (Kahl, 1984). It was also reported to inhibit chemically induced tumor (Kahl, 1984). The defensive activities of BHA are attributed to its potential capacity to stimulate phase 2 detoxifying enzymes such as epoxide hydrolases, glutathione s-transferases, uredines 5 - diphosphos- glucuronosy transferases and quinone reducetase. It also modulates cytochrome - p450 mono oxygenase activity, which is involved in pathways of detoxification and carcinogenase. Antioxidant activities are usually associated with better metabolism and vital organs functionality, according to Wu *et al*. (2022).

1.2. JUSTIFICATION

Over the years the performance of rabbits and other livestock spices have been faced with a challenges of feeding and feed availability, often use oxidized oil provide excellent source of energy but still exposed livestock to oxidative stress. The use of *Tectona grandis* leaf meal may serve as antioxidants to combat the effect of oxidized oil on oxidative stress and growth performance in weaner rabbits. Improve growth performance aims to investigative whether *Tectona grandis* leaf meal can improve growth performance in weaner rabbit fed oxidized oil.

1.3. OBJECTIVE

General objective

To evaluate the influence of antioxidant level of *Tectona grandis* on performance of rabbit fed oxidized oil.

Specific objective

- To determine the weight gain and feed intake of rabbit fed *Tectona grandis* and oxidized oil.
- To evaluate the feed conversion ratio of rabbit fed *Tectona grandis* and oxidized oil.

CHAPTER TWO

2.0. LITERATURE REVIEW

2.1 livestock production and militating factors

Livestock systems occupy about 30 percent of the planet's ice-free terrestrial surface area and are a significant global asset and plays a key role in global food system as one of the main sources of animal protein (milk, meat and egg), contribute to crop productivity through provision of draught power and manure, and to the livelihood in low and middle income countries. The livestock sector is increasingly organized in long market chains that employ at least 1.3 billion people globally and directly support the livelihoods of about 600 million poor smallholder farmers in the developing world (Robinson, 2011).

Livestock are important in supporting the livelihoods of poor farmers, consumers, traders, and labours throughout the developing world. The greatest impact of livestock in sustainable development is designed to help the poor in enhancement of livestock-production systems, during the past decade, it contributed to total Nigerian livestock cash income (Adams, 2016).

In Nigeria, presently, there has been incidence of extreme poverty and malnutrition in the country, livestock contribute directly to the economy through employment generation, increase in savings and investment, foreign exchange earnings, contribution to human food and nutrition. Livestock also contribute indirectly to food security by increasing crop output through providing manure, and serve as a buffer to mitigate the impact of fluctuations in crop production on the availability of food for human consumption, thereby, stabilizing food supply (Adams, 2016). Despite its smaller output compared with that of staple crops, productivity and income growth in the livestock sector have strong income multiplier and poverty reduction impacts (Adams, 2016).

2.2. Problems Militating Against Sustainable Livestock Production

Livestock sector worldwide focus numerous daunting challenges that will require innovations, new technologies and new ways of approaching agriculture if the food, feed and fibre needs of global population are to be met. Animal population trends are said to be influenced by strong demand driven factors such as population growth, urbanization, income growth, high cost of animal feed, animal diseases, access to veterinary services, vaccines and drugs, level of education of famers, role of government in policies making, market structure, storage facilities, adequate extension services, insufficient supplies of man power, transportation insufficient and poor transportation channel, inadequate basic animal husbandry infrastructure, climatic and environmental factors, animal welfare, attitude to animal production system (Etuk *et al*., 2014).

2.2.1. Effects high cost of conventional feed and the need for exploring novel feedstuffs

Nutritious animal feeds are essential for full development and productivity of animals. Animal feeds are not readily available and where they are they are not easily affordable for an average farmer. Since farmers go into animal production for profit they need to obtain feed at a price where they do not only break-even: but also make reasonable profit. Perhaps the livestock industry of ruminants does not feel the impact as much as the poultry industry which is mostly intensive in nature requiring constant supply of feeds for maximum productivity unlike the livestock which can still be fed on pastures and forage or allowed to scavenge for food. Due to the high cost of feeds, various research alternatives have sought for other means of providing animal feeds to ameliorate the effects of cost of feed such as the use of activated sludges (Etuk *et al*., 2014). Many livestock and poultry farmers compound their own feed themselves for their farm animals but they face the challenges of raw materials for compounding the feed which may be very expensive or unavailable (Etuk *et al*., 2014).

Attempt has recently been taken to reduce the cost of feed, including the incorporation of agro-industrial by-products in broiler diets as an energy source (Sugiharto *et al.*, 2018a). However, some limitations may exist when using agro-industrial by-products as ingredients in broiler rations. The high and low contents of fibre and protein in the by-products may limit the digestibility and thus inclusion level of such by-products (Sugiharto *et al.*, 2018a). In addition to the agro-industrial by-products, the application of leaf meal as the ingredient in broiler feeds has also been conducted (Mustafa, 2019). Compared to agro-industrial by-products, the content of crude protein in leaf meal is much higher (Sugiharto *et al*., 2018a). This may be beneficial in reducing the proportion of the conventional expensive protein-rich feed ingredients in broiler rations.

It has been known that some particular foliage contain a number of bioactive compounds that are beneficial for the health of chickens. These compounds include vitamins, phenolic acids, flavonoids, isothiocyanates, tannins as well as saponins (Vergara-Jimenez *et al*., 2017). In this regard, the use of leaf meal in rations may not only reduce the cost of feeds, but also elicit the health-promoting effect on broiler chickens. Apart from their benefits, the use of leaf meals in broiler diets may be limited by their high content of crude fibre. In general, broiler chickens showed low tolerance to dietary fibre, and therefore feeding diets containing high levels of leaf meal may improve nutrient digestibility and thus alleviated growth performance of broilers (Rama Rao *et al*., 2019).

2.3.TECTONA GRANDIS Linn

2.3.1. Morphology

Teak is a large tree, which can attain a height more than 30 m. It has a simple root system. Colour of the bark varies from pale brown to grey. Leaves have some distinct features by which it can easily be identified. It bears a pair of leaves that stands at right angle to the next upper or lower pair and in each pairs; two leaves are situated at a node on the opposite side. Young leaves are red in colour but become dark green at maturity. Leaves are broad towards apex, oval in outline, widest at the centre and bear small star shaped hairs. Inflorescence large, flowers are white in colour and become inflated at maturity. Fruit is fleshy and bears 1-4 seeds which are enclosed in a stony covering. Teak sheds leaves from November to January. The flowers appear from June to September and fruits ripen from November to January (ICFRE.2009).

2.3.2. Taxonomy of *T. grandis* Linn

Kingdom	Plantae
Super division	Angiosperms
Division	Eudicots
Class	Asterids
Order	Lamiales
Family	Verbenaceae

Genus	*Tectona*	
Species	Grandis	(ICFRE.2009).

2.3.3. Utilization

Teak is recognized as the best timber for the manufacture of door, window frames and shutters, wagon and carriage, furniture, cabinets, ships, agricultural implements, decorative flooring and wall paneling because of its moderate weight, appropriate strength, dimensional stability and durability, easy workability and finishing qualities and most appealing grain, texture, colour and figure (ICFRE, 2009).

Teak is also used in a variety of ways apart from its use as timber. Various parts of the tree, including the wood are credited with medicinal properties. Kernels yield fatty oil (about 2 per cent). Flowers are considered useful against a number of diseases such as biliousness, bronchitis and urinary discharges. Both flowers and seeds are considered diuretic. Leaves are used in indigenous medicine and their extract indicates complete inhibition of Mycobacterium tuberculosis. The leaves also contain yellow and red dyes, which have been recommended for dyeing of silk, wool and cotton. The leaves are occasionally used as plates for dining purposes, for making cheap umbrellas and for thatching temporary huts in some places. The bark is regarded as an astringent and considered useful in bronchitis. Various valuable compounds have been isolated and identified from the wood, bark, root and leaves of the tree. Activated charcoal can be prepared from its saw dust (ICFRE, 2009).

2.3.4. Distribution

Natural distribution of teak ranges from the Indian sub-continent through Myanmar and Thailand. It is common in deciduous forests and well-drained alluvial soils. India has one-third of the natural distribution. It is discontinuously distributed throughout Peninsular India below the latitude of 24°N, in the states of Madhya Pradesh, Maharashtra, Tamilnadu, Karnataka and Kerala. In Myanmar, the species is distributed throughout the country up to latitude 25°N. In Thailand, it occurs naturally up to 17.5°N and from 97° to 101°E in the watershed areas of Mae Khong, Salween and Chao Phya rivers. Teak has been introduced as a plantation species in as many as 36 tropical countries across tropical Asia, Africa and South and Central America (Indira and Mohanadas, 2002).

2.3.5. Use in Traditional Medicines

Apart from its wide spread application as timber plant, teak is also considered as a major constituent in many traditional medicines. The extracts prepared from various parts of teak are found to be effective against biliousness, bronchitis, diabetes, leprosy, anthelmintic etc. and thus shows expectorant, anti-inflammatory, anthelmintic properties. The plant extracts are also well known for analgesic, diuretic activity, gastroprotective activity, anti-haemolytic anaemia activity, Hair growth activity, Antioxidant activity etc. They are also used for treating inflammatory swelling (Neamatallah *et al*., 2005).

2.4. Phytochemical Constituents of *Tectona grandis*

Several classes of phytochemicals like alkaloids, glycosides, saponins, steroids, flavonoids, proteins and carbohydrates have been reported in *Tectona grandis* (Rodney *et* *al*., 2012). Secondary metabolites such as tectoquinone, 5-hydroxylapachol, tectol, betulinic acid, betulinic aldehyde, squalene, lapachol were also extracted from the plant (Rodney *et al*., 2012). Acetovanillone, E-isofuraldehyde, Evofolin, syringaresinol, medioresinol, balaphonin, lariciresinol, zhebeiresinol, 1- hydroxypinoresinol together with two new compounds Tectonoelin A and Tectonoelin B were extracted from the leaves of *Tectona grandis.* 9,10 dimethoxy-2 methyl-anthra-1,4-quinone ,5-Hydroxylapachol along with tecomaquinone,methylquinizarin, lapachol, dehydroxy-α-lapachone were isolated from the heartwood of *Tectona grandis* (Rodney *et al*., 2012). Teak wood contains naphthoquinone (lapachol, deoxylapachol, 5-hydroxylapachol), naphthoquinone derivatives (α- dehydrolapachone, β-dehydrolapachone, tectol, dehydrotectol), anthraquinones (tectoquinone,1-hydroxy-2-methylanthraquinone, 2-methyl quinizarin, pachybasin), and also obtusifolin, betulinic acid, trichione, β-sitosterol and sqaulene.Roots are rich in lapachol,tectol, tectoquinone, β-sitosterol, and diterpenes, tectograndinol (Goswami *et al*., 2009).

2.4.1. Pharmacological activities of *Tectona grandis*

Teak is considered as one of the major constituent in folklore medicines. Medicinally, it has various pharmacological activities like antibacterial, antioxidant, antifungal, anti-inflammatory, anti-pyretic, analgesic, anti-diuretic and hypoglycemic activities (Neha and Sangeeta, 2013).

Traditionally; **the bark**: is used as astringent, constipation, anthelmintic and depurative, also used in bronchitis, hyperacidity, dysentery, verminosis, burning sensation, diabetes, difficult labour, leprosy and skin diseases. **The leaves**: are used in haemostatic, depurative, anti-inflammatory and vulnerary. They are useful in inflammations, leprosy, skin diseases, pruritus, stomatitis, indolent ulcers, haemorrhages and haemoptysis. **The wood**: is used as Acrid, cooling, laxative, sedative to gravid uterus, useful in treatment of piles, leucoderma and dysentery. Oil extracted from the wood is best for headache, biliousness, burning pains particularly over a region of liver (Rodney *et al*., 2012). **The roots**: are useful in anuria and retention of urine (Rodney *et al*., 2012). While **the flowers**: are acrid, bitter dry and cures bronchitis, biliousness, urinary discharge (Varier, 1996). According to Unani system of medicine, oil extracted from the flowers is useful in scabies, and promotes the hair growth (Ragasa *et al*., 2008).

- **Antibacterial activity**

Antibacterial activity of *T. grandis* bark extracts towards *S. aureus* and other bacterial strains was reported by Rafullah and Suleiman (1999). The leaf extracts of *Tectona grandis* was found to contain two quinones: naphthotectone and anthratectone that were mainly responsible for the antibacterial activity and good antiradical properties (Neamatallah *et al*., 2005). The other active ingredient that contribute to antibacterial activity was found to be 5-hydroxy-1,4- naphthalenedione (Juglone). Mahesh and Jayakumaran (2010), showed the antibacterial activity of leaf, bark and wood extracts of *T. grandis* against *Staphylococcus aureus* (ATCC 25923), *Klebsiella pneumoniae* (ATCC 700603), hospital strains of *Salmonella paratyphi* and *Proteus mirabilis* by disc diffusion assay. They also found that methanol extract of leaf and ethyl acetate extract of wood was also able to show fairly good activity against gram positive and negative species. Teak extract present good antibacterial activity against both Gram positive (*S. aureus, B. subtilis)* and Gram-negative (*P. aeruginosa)* bacteria.

- **Antifungal activity**

The available literature reveals that tectoquinone and anthraquinone from teak sawdust, possess antifungal activity. Other phytochemicals reported from teak viz., juglone, lapachol and deoxylapachol (Naphthoquinones) also possess antimicrobial activity (Sumthong *et al*., 2006).

The leaf and bark extracts of *Tectona grandis* prepared in solvents (ethanol, methanol, ethyl acetate and water) were tested for the antifungal activity against test fungi. The antifungal activity of the extract was assessed by the presence or absence of zone of inhibition which shows a clear zone of inhibition measured (in mm) around the discs. Antifungal and antibacterial activity of wood and bark of teak has been reported earlier by Sumthong *et al*. (2006).

Suseela and Parimala (2017) reported that both leaf and bark extracts of *Tectona grandis* prepared using ethanol, methanol, ethyl acetate and water were found to be efficient in inhibiting the growth of pathogenic bacteria and fungi. Among different extracts prepared using leaf and bark of teak plants, ethanolic extracts showed significant antibacterial and antifungal activity.

- **Antioxidant activity**

Sumthong *et al*. (2006) examined the antioxidant activity of *T. grandis* Linn. Leaf extracts employing four *in vitro* assay systems, i.e., Total phenolic content, reducing power, Super oxide radical scavenging activity, Inhibition of H_2O_2 induced erythrocyte haemolysis method, in order to understand the usefulness of this plant as a foodstuff as well as in medicine. The plant extracts of 17 commonly used Indian medicinal plants were examined for their possible regulatory effect on nitric oxide (NO) levels using sodium nitroprusside as an NO donor *in vitro*. *T. grandis* Linn shows potential scavenging activity among all other plant extracts. Antioxidant activity of leaf, bark and wood of Hexane, chloroform, ethyl acetate and methanol extracts was checked with 1, 2-diphenyl 1-picryl hydrazil (DPPH) and ABTS+ free radical. Ethyl acetate extract of wood showed very high activity with 98.6 % inhibition against DPPH and ABTS+ free radicals (Sumthong *et al*., 2006).

- **Anti-haemolytic anaemia activity**

Traditional oral report indicates that *T. grandis* Linn, is used in the treatment of anemia in Togo (Aboudoulatif *et al*., 2008). The ethanol extract of leaves of *T. grandis* Linn was evaluated on anemia model of rat induced by intraperitoneal injection of phenylhydrazine at 40 mg/kg for 2 days. This anemia which resulted from the early lysis of the RBCS was naturally reversed 7 days later by the regeneration of these blood cells due to the increase of the reticulocytes. Oral administration of leaves ethanol extract of 1 mg/kg/day and 2 mg/kg/day, to the rats previously treated with phenylhydrazine, significant increased the concentration of Hb, RBCs number, haematocrit and reticulocytes rate mainly 7 days after phenylhydrazine administration. So the study suggested that, the extract could stimulate erythropoiesis process and which may increase the number of young RBCs (reticulocytes) (Aboudoulatif *et al*., 2008).

- **Anti-inflammatory Activity**

Denaturation of proteins is a well-documented cause of inflammation. As part of the investigation on the mechanism of the anti-inflammation activity, ability of different solvent plant extract protein denaturation was studied. It was effective in inhibiting heat induced albumin denaturation. Maximum inhibition 89.61% was observed from methanol extract followed byethanol 86.81% and water 51.14%. All the solvent extracts inhibited the albumin denaturation, the methanol extract stood first compared to ethanol and water extracts. Aspirin, a standard anti-inflammation drug showed the maximum inhibition 75.89% at the concentration of 200μg/ml (Shruthi *et al.*, 2012).

- **Anti-ulcer Activity**

Lapachol, a naphthaquinone isolated from the roots of *Tectona grandis* given at a dose of 5 mg/ kg twice daily for 3 days was found to have an anti-ulcerogenic effect on subsequently induced experimental gastric and duodenal ulcers in rats and guinea-pigs. Its action appears to be associated with an effect on the protein content of gastric juice, and it reversed aspirin-induced changes in peptic activity, protein and sialic acid (Shruthi *et al*., 2012).

2.5. Rabbit Production

Rabbits (*Oryctolagus cuniculus*) are small herbivorous mammals widely used in research, as pets, and for meat and fur production. Their efficient feed conversion, high reproductive rates, and adaptability make them an excellent model for studying dietary interventions and nutritional strategies. The increasing competition between rabbit for available gains and feed coupled with Nigeria's neglect of Agriculture, has led to high cost of available feed resources.

Rabbit meat is lean meat of high nutritive value, because it is rich in essential amino acids, polyunsaturated fatty acids (PUFA), vitamins, minerals, low in cholesterol contents, and does not contain uric acid compared with other meats. The profitability of rabbit farms is partly depending on the effectiveness of weaned rabbits to grow healthy and to protect them from high mortality rates during the fattening period. Antibiotics are frequently used in the diets of growing rabbits because digestive disturbances are the main reason for morbidity and mortality in the rabbit industry.

The aim of livestock farmer is to produce the animal protein in the shortest possible time to meet the demand for animal protein. To achieve this aim, the use of antibiotic growth promoter in livestock production to promote growth by enhancing feed utilization and inhibition of pathogens activities are being considered by the farmers. However, the awareness of possible microbial resistances in farm animals and the eventual antibiotic residue in animal products later formed a major discouragement for the use of antibiotic growth promoter for animal production (Ayodele, 2016). This thereafter fuelled the search for and the use of the alternative to antibiotic growth promoters or complementary medicines to enhance performance, immunomodulation, and general health maintenance in animal production. Herbs of medicinal values are currently in increasing demand as they are being found suitable for the animal with the benefits of low cost and total safety. Medicinal plant parts, when incorporated in the rabbit diets, could serve as protein source suitable for replacing in full or part the conventional and expensive protein feedstuff and also as a phytobiotic growth promoter (Oloruntola *et al*. 2016). Herbs in monogastric diets are known for impacting the metabolism by combating microbial activities and stress (Dhama *et al*. 2015) through the prevention of pathogens colonization and enhancement of the digestive enzymes production and activities by the phytogenic components of the plants' parts (Dhama *et al*. 2015). Numerous plants possess anti-microbial traits which are synthesized during secondary metabolism of the plant (Ayodele, 2016).

2.5.1 Importance of Rabbits in Livestock Production

- Meat Production: Rabbit meat is a lean, high-protein source with low cholesterol levels, making it ideal for health-conscious consumers.
- Reproductive Efficiency: Rabbits have short gestation periods (28–31 days), high litter sizes, and the ability to breed throughout the year, ensuring steady production.
- Adaptability: Rabbits can thrive in diverse environments and utilize forages, agricultural by-products, and unconventional feed resources such as leaves.

2.5.2. Rabbit Nutrition

Rabbits feed on fresh and dry legumes and grasses, and occasionally on roots and tubers, straw and stem. They are one of the few animals that do not compete with humans for available limited conventional feed. Unlike the poultry farmer, the small-scale rabbit fanner should not face problems with food supplies at any time of the year. Even when the grasses have withered, the leaves from tall trees and shrubs are available for food. However, care must be taken as to what is given to young rabbits and pregnant and nursing does, as they are particularly sensitive to some plants (Fawzia *et al*., 2020).

Rabbit have the ability to utilize forages and fibrous agricultural by-products are attributes in favor of rabbit production. Though there are two types of nutrition programs are used for raising rabbits: hay and grain diets or commercial balanced pellet rations. Pellets meet all of a rabbit's nutritional requirements and are more convenient than formulating a hay and grain ration. Pregnant does and those with litters should fed ad-libitum. Bucks and does without litters need 6 to 8 ounces of pellets a day. When raising

Angora rabbits, you should avoid feeding hay because the dust will contaminate the wool and lower its quality. Rabbits require fresh, clean water every day (Iyeghe-Erakpotobor *et al*., 2002). Automatic watering systems offer a continuous water supply while reducing waste and contamination. A doe and her litter need 1 gallon of water a day in warm weather. Rabbits also enjoy receiving small amounts of greens as a treat. In spite of these apparent advantages, rabbit production has not yet achieved its potential in the tropics. Productivity is 50% or less of what is typical in temperate areas (a characteristic not unique to rabbits). While heat stress is a major factor accounting for the low productivity, inadequate nutrition is also very important. The limiting nutritional factor is probably digestible energy. Feeding programs that incorporate cull bananas, plantains, cassava, and various tropical fruits, sugar cane products, and agricultural byproducts such as rice bran and other grain-milling by-products, should be developed. These materials are excellent sources of digestible energy, and can be used to supplement legume forages (e.g. tree legumes) which are good sources of protein (Shi-yi *et al*., 2019).

Rabbit have been reported to perform better on different feed ration ranging from fodder, forage, grains and forage combination and compounded feed (Heba *et al*., 2021). Heba *et al*. (2021) reported that while digestibility of protein, fibre and energy of tropical grasses is very low in rabbits, many of the tropical legumes are as digestible as temperate forages. High digestibility of dry matter, crude protein, crude fibre and nitrogen free extract was reported by Iyeghe-Erakpotobor**,** (2006) indicating that the rabbits were able to utilize nutrients in the high forage and low concentrate combinations. Iyeghe-Erakpotobor**,** (2006) reported that combinations of concentrate, grass and forage would be adequate for grower rabbits. Though soybean forage treatments gave the lowest rate of gain, the difference was not significant. In the rural areas where soybean cheese waste meal, groundnut haulms, sweet potato vines and soybean forage are available, these could be efficiently utilized for feeding grower rabbits.

In general, rabbits will eat about 80 percent of available plants. However, they have their favourites, including the leaves below the crown of cabbages (*Brassica aleracea*), groundnut leaves, juice plant (*Euphorbia heterophylla*), *Centrosema pubescens* and wild marigold (M*elanthera scandens*). They eat all types of grass. Although freshly cut and dried greens, together with food waste from the house, are suitable for small-scale enterprises (FAO, 2005). Fortunately, the availability of pellets in West Africa has increase the development of rabbit farming on a commercial scale. It is possible, however, for rabbit farmers to mix their own feeds which will meet the requirements of a balanced diet and ensure fast growth, good milk production and good health. Although the rabbit is regarded as herbivorous animal, many rabbit farmers feed their animals with poultry feed, which often contains dried fish. Rabbits will consume dried but not fresh fish (De-Blas and Mateos, 2010).

Nutritional Composition of Tectona grandis Leaves

Crude Protein: The leaves contain 15–18% crude protein, which meets a significant

portion of the protein requirement for rabbits (Oloruntola *et al*., 2018).

Fiber Content: The high fiber content (30–40%) supports gut health and enhances nutrient absorption in rabbits, which are hindgut fermenters (Akinwande & Akinola,

2018).

Antioxidants: The leaves are rich in phytochemicals such as flavonoids, polyphenols, and tannins, which act as natural antioxidants to combat oxidative stress (Ebenebe *et al*., 2013).

Benefits of Tectona grandis Leaves in Rabbit Diets.

Growth and Weight Gain: Rabbits fed diets containing Tectona grandis leaves achieved comparable or superior growth performance to those fed conventional feeds, likely due to the leaves' high protein and antioxidant content (Oloruntola *et al*., 2018)

Digestibility: The fiber in Tectona grandis leaves supports healthy digestion, reducing incidences of enteritis and diarrhea in rabbits.

The anti-nutritional factors (Soetan and Oyewole, 2009). The adverse effect of some anti-nutrients in feed can be overcome by repeated washing with water which makes the feed more palatable by reducing its bitterness. Though by washing, little quantity of the dry matter is lost (Joshi et al., 2012). According to Togun and Oseni, (2005), haematological profile; red blood cells, white blood cells, packed cell volume and haemoglobin have been found useful for disease prognosis and for therapeutic and feed stress monitoring. Therefore the aim of this study was to investigate the effect of feeding raw and boiled rosella (Hibiscus sabdariffa L.) seed meal based diets on blood profile of growing rabbit. Theanti-nutritional factors (Soetanand Oyewole, 2009). The adverse effect of some anti-nutrientsin feed can be overcome by repeated wash in with water which makes the feed more palatable by reducing its bitterness. Though by washing, little quantity of the dry matter is lost (Joshi *et al*., 2012). According to Togun and Oseni (2005), haematological profile; red blood cells, white blood cells, packed cell volume and haemoglobin have been found useful for disease prognosis and for therapeutic and feed stress monitoring.

2.6. Oils and Oxidized Oil in Livestock Feeding

Carbohydrates and lipids (fats and oils) are the main energy sources in poultry ration. Lipids provide about 2.25 times greater energy compared with carbohydrates and proteins, and are obtained from both vegetable and animal sources. The building blocks of lipids are fatty acids that form bonds with various compounds to make corresponding lipids. These fatty acids are further categorized based on their chain length, number and configuration of double bonds. Fatty acids, because of the presence of double bond, are divided into saturated (without double bond), unsaturated (with double bond), monounsaturated (with one double bond) and polyunsaturated fatty acids (PUFAs) (with two or more double bonds) (Orsavova *et al*., 2015). Vegetable oils, rich in PUFAs, are used in broiler ration to enhance their growth performance because of their high digestibility (Shafqat *et al*., 2021). Fats with longer chain length and a higher degree of saturation result in a lower fat absorption leading to a lower nitrogen corrected apparent metabolizable energy. Fats with greater proportion of short- and mid-chain fatty acids (C4:0–C14:0) are well absorbed compared to long-chain animal fats (Shafqat *et al*., 2021). Inclusion of oil in poultry diets helps birds to overcome growth depression and manage heat stress (Wang et al., 2016). Lipids increase the energy content of the diet, decrease feed dustiness (Varady et al., 2012), enhance feed palatability (Cleland et al., 2005), consistency and fat soluble vitamins absorption, and supply of essential fatty acids leading to an improved zootechnical performance of the birds (Shafqat *et al*., 2021).

2.6.1. Lipid oxidation

Lipid oxidation is a procedure where oxidants including free radicals or non-radical species invade lipids having carbon-carbon double bond(s) that involve hydrogen abstraction from a carbon with oxygen insertion, particularly in PUFAs, leading to production of hydroperoxides and lipid peroxyl radicals (Yin *et al*., 2011). The process of lipid oxidation is divided into three phases including initiation, propagation and termination with each phase consuming and producing primary, secondary and tertiary complexes, respectively (Belitz *et al*., 2009). Lipid oxidation consists of a chain reaction that yields and utilizes substances including peroxides, aldehydes and polar compounds by weakening the oil antioxidant capability. The level of oxidation varies and depends upon oil composition, temperature and extent of thermal processing. Since there is no single measure to evaluate the oxidation status of oil, it is biologically more descriptive to test different markers of oxidation. (Lindblom *et al*., 2019). Many peroxidation compounds including acids, aldehydes, and polymerized fatty acids formed during lipid peroxidation process can be assessed to evaluate the severity of lipid peroxidation (Kerr *et al*., 2015). The peroxide value (PV) measures primary products including lipid peroxides and hydroperoxides contents that are produced in the initiation phase. The PV is expressed as milliequivalents per kilogram (meq kg-1) and tends to be highest in the initiation phase and decreases in the propagation and termination phases (Lindblom *et al*., 2019). The propagation phase produces secondary oxidation products including aldehydes, ketones and acids which are commonly estimated by thiobarbituric acid reactive substances and p-anisidine value. P-anisidine value measures the total molecular weight of saturated and unsaturated aldehydes. Thiobarbituric acid reactive substances are indirect measure of malondialdehyde, formed in lipid peroxidation, whereas there are other aldehydes contributing to the thiobarbituric acid reactive substances value not specific to lipid peroxidation (Kerr et al., 2015). The termination phase follows the propagation phase and is supposed to yield the most harmful products of lipid peroxidation relative to DNA, protein or lipid damage.

2.6.2. **Global frying of food**

Global frying of food in heated oil/fat is a popular method of food preparation to develop desirable flavour, aroma, golden brown and crispy texture. The repeated heating, however, of oils and fats at deep frying temperature (150 to 190°C), particularly for extended period, predisposes the unsaturated fatty acids to thermal oxidation and polymerization leading to a partial transformation of unsaturated fatty acids into saturated and trans-fatty acid. As a result of oxidation, free radicals, peroxides and secondary oxidation products including ketones and aldehydes are formed (Frankel, 1991). Oils retrieved from frying industry can be a convenient energy source for animal feed (Tres *et al*., 2013). Provision of feed, containing oxidized oil, to broilers and turkeys resulted in a decreased growth performance and feed efficiency (Jankowski *et al*., 2000) possibly due to a decreased feed intake because of off flavour, reduced palatability and digestibility of the feed. Oxidized fat in diets has a significant effect on the production of lipid rancidity in meat products that leads to an increased drip loss and a decrease in its shelf life (Delles *et al*., 2015). The contribution of oxidized fats to overall energy consumption has been distinctly expanded in developed countries mainly because of increased fast food consumption comprised of heated and processed dietary fats, including frying oil. The current review highlights the response of modern poultry to supplementation of oxidized oil on growth performance, nutrients digestibility, gut health, carcass characteristics, meat quality, blood chemistry and tissue oxidative status.

2.6.3. Influence of dietary oxidized oil in livestock

Effects on growth performance

Growth performance is measured in terms of feed intake (FI), body weight gain (BWG) and feed conversion ratio (FCR) and, in general, reflects the nutritional quality of the diet. Development of rancid odour and off flavour due to secondary oxidation products including aldehydes can influence palatability and feed intake in poultry (Dibner *et al.*, 1996). These oxidation products reduced fat retention to 1.4% and energy value of the diet by 1%, resulting in a lower BWG in broilers. Tavarez *et al*. (2011) performed a study to examine the influence of oil quality (PV: 180 meq kg–1 of oil) and antioxidant inclusion (blend of ethoxyquin and propyl gallate at two levels; 0 or 135 mg/kg) in broilers and observed that antioxidant supplemented diets increased FI by 2.4% and BWG by 4%, whereas FCR remained unaffected compared to the birds in control group (PV: 1 meq kg–1).

Effects on nutrients digestibility

Acikgoz *et al*. (2011) investigated the nutrients digestibility in broilers by supplementing the oxidized (PV: 148 meq kg–1) oil with or without vitamin E and did not observe any significant effect on digestibility coefficients of crude protein and fat in male broilers during the grower phase (22–42 days). The apparent crude-fat digestibility was, however, decreased from 95% (fresh fish oil) to 91% (PV: 200 meq kg–1) and 74% (PV: 400 meq kg–1) in mink (Borsting *et al.*, 1994). The digestibility response of broilers fed oxidized oil based diets (PV: 156 meq kg–1) and reported no significant difference in the retention of DM and nitrogen, whereas about 1.6% reduction in energy and fat retention was observed compared with the birds fed fresh oil based diets.

Effects on gut health

Gastrointestinal tract is an organ system that mediates uptake of nutrients. Healthy gut is, therefore, the foundation for optimum performance of the birds. Gut health includes effective digestion and absorption of nutrients and operative immune response. Intestinal villi is a basic site for the nutrients absorption and its surface area mainly controls absorption efficiency of nutrients. High digestive and absorptive functions of the intestine is directly related to increased villus height and surface area of intestine (Da Rocha *et al*., 2012). Da Rocha *et al*. (2012) conducted a study on turkeys to evaluate gut health in response to feeding of oxidized soybean oil (PV: 250 meq kg–1). The study showed that birds fed diets containing oxidized soybean oil had 14% decrease in villus height, which the authors related to the effects of primary and secondary oxidation products on intestinal epithelium. Some of the oxidation products including aldehydes, acids, ketones and esters were assumed to have deleterious effects that led to destruction of the brush border membrane (Kimura *et al*., 1984).

Effects on carcass characteristics and meat quality

Heating of oil may lead to decreased capability of the broilers to metabolize and utilize energy as a result of increased primary, secondary and tertiary oxidation products that may enhance the oxidative stress in the birds (Ehr *et al*., 2015). Lin et al. (1989) concluded that the oxidative products destroy the fat-soluble vitamins (A, D, E and K) and reported 25% decreased concentration of α-tocopherol in white and dark muscles of broilers fed diets supplemented with 5.5% thermally oxidized (PV: 400 meq kg–1) sunflower oil compared with birds fed fresh (PV: 1 meq kg–1) oil based diets. This reduced concentration of α-tocopherol may be due to the damage of some α-tocopherol contents in the diets by the dietary oxidized oil before offered to the broilers. A part of the α-tocopherol present in tissue may protect the tissue lipids from oxidation. Engberg *et al*. (1996) examined the effects of oxidized oil (PV: 156 meq kg–1) based diets on tocopherol (vitamin E) levels and observed reduced concentrations of α and γ-tocopherol in all tissues of broilers.

Effects on blood chemistry and tissue oxidative status.

The influence of dietary oxidized oil on biochemical indices in the blood of poultry is presented in Table 4. Blood chemistry is a biochemical profile that is a reliable indicator of health and provides valuable information for evaluation of health status (Abdi-Hachesoo *et al.*, 2011). Jankowski *et al*., (2000) evaluated the influence of fat (combination of rapeseed oil and poultry fat) with varied degrees of oxidation.

2.6.4. Antioxidant Role of Leaves in Mitigating Oxidative Stress

Tectona grandis are rich in natural antioxidants, including flavonoids, tannins, and polyphenols, which can help neutralize ROS and protect cellular components.

- Reduction in Lipid Peroxidation: Antioxidants in leaves reduce the levels of MDA, a biomarker for oxidative damage to lipids (Oloruntola *et al*., 2018).
- Boosting Antioxidant Enzymes: Dietary leaves have been shown to increase the activity of SOD, catalase (CAT), and GPx in rabbits, enhancing their ability to combat oxidative stress (Akinwande & Akinola, 2018).

- Improved Immunity: The antioxidant properties of leaves improve immune response, reducing the inflammatory effects caused by oxidized oil (Ebenebe *et al*., 2013).

CHAPTER THREE

3.0. MATERIALS AND METHODS

3.1. Study Area

The experiment was carried out at the Department of Agricultural Technology Garden, Institute of Applied Sciences, Kwara State Polytechnic, Ilorin, Kwara State.

3.2. Construction of rabbit hutch

Four tiers rabbit hutch with four units per tier was constructed using galvanized iron mesh, the hutch was housed in a pen well ventilated and conducive for rabbit rearing.

3.3. Sample collection and processing

Tectona grandis*:* - *Tectona grandis* leaf was harvested from Kwara State Polytechnic School Farm. The leaves was identified at the Department of Biology, Kwara State Polytechnic, Ilorin, Nigeria. The leaves were air-dried at 35 ± 2^0C for 4 days and milled using locally fabricated attrition milling machine into semi-powder to pass through a 3.0 mm sieve. The ***Tectona grandis* leaf meal** (TGML) was packaged in polythene plastic bags, sealed, and kept at $34 \pm 3\ ^0$C for further use.

Rabbits*:* - - rabbit kittens to be used for the experiment was purchased form a reputable rabbit farm within Ilorin, the pureness of the breed was ascertained at Botany Unit University of Ilorin, Ilorin, Kwara State, Nigeria.

Preparation of Oxidize oil

Soya bean oil was obtained from a reputable groceries store. Soybean oil was heated at 180^0C for 10 min stir in the open with access to air. The oil was heated five times with cooling interval of 5 h per heating as described by Jaarin and Kamisal (2012) and Leong *et al*. (2012).

3.4. Experimental design

Twenty four homogenous sex rabbit kits at four weeks old was randomly allocated to four dietary treatments D1, D2, D3 and D4 as highlighted below, with four replicates and 2 rabbit kits per replicate, the distribution was in such a way that each group was homogenous in weight. Diet D2, D3 and D4 was supplemented with oxidize oil at 3.0%.

D1……… Treatment one (Control diet + normal oil)

D2………Treatment two (Control diet + oxidized oil).

D3.. Treatment three (Control diet + oxidized oil + Butylated hydroxyl anisole (BHA).

D4……… Treatment four (best diet with TGLM + oxidized oil).

3.5. Animal feeding and management

The homogeneous sex kits rabbits at 6 weeks of age was purchased from reputable rabbit farm in Ilorin, was acclimatized for two weeks while feeding them on control diet with 0% TGLM (Table 1 experiment 2) before randomly assigning them to treatments. The kits was fed on experimental diets *ad-libitum* with adequate supply of cool clean water. The rabbit was given adequate management. The pen was kept clean and other precautions taken into consideration as the need may require. The kits was dewormed for ectoparasite and endoparasite, and was given broad spectrum antibiotics against infections.

3.6. Experimental diets

Table 3: - Ingredient and calculated chemical composition of experimental diets

Ingredient	TGLM %replacement for wheat offal			
	TGML 0% +3% N.O	TGML 0% +3% O.O	TGML 0% + BHA 150g/kg + 3% O.O	TGML10% + 3% O.O
Maize	16	16	16	16
Corn bran	10	10	10	10
Wheat offal	30	30	30	20
TGLM	0	0	0	10
Palm kernel cake	30	30	30	30
Groundnut cake	5	5	5	5
Bone meal	5	5	5	5
Salt	0.25	0.25	0.25	0.25
Vit./Min. Premixes	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Oil	3 N. O.	3 O.O	3 O.O.+BHA	3 O.O
Total	100kg	100kg	100kg	100kg

TGML. *Tectona grandis* leaf meal

N.O. Normal Oil

O.O. Oxidized Oil

BHA. Butylated hydroxyl anisole

Calculated Nutritional Value				
Digestible Energy (Kcal/kg)	2364.98	2364.98	2364.98	2390.15
Crude protein (%)	15.19	15.19	15.19	15.04
Crude fat (%)	5.12	5.12	5.12	4.90
Ash (%)	3.85	3.85	3.85	3.80
Crude fibre (%)	7.65	7.65	7.65	7.40
Calcium (%)	1.71	1.71	1.71	1.71
Phosphorus (%)	1.12	1.12	1.12	1.12

3.7. Experimentation

The following parameters was analyzed and data was collected

Growth performance

Weight gain: - The rabbits was weighed prior to feeding on the first day and at weekly interval for 8 weeks.

Feed intake: - The rabbits was feed ad-libitum; with adequate supply of cool-clean water. Weight of feed given and left-over feed was taken daily. Accumulated feed intake per week and overall was determined.

Feed intake was calculated as: - feed offered – left over feed

Feed Conversion Ratio: - this was calculated by dividing feed intake by weight gain

$$\text{FCR} = \frac{Feed\ intake}{Weight\ gain}$$

4.8. Statistical Analysis

All data generated was subjected to analysis of variance (ANOVA) in a completely randomized design (CRD) using SAS, (2005). The statistical significance was considered at $P<0.05$, data was subjected to a repeated measured analysis.

CHAPTER FOUR

4.0. RESULT AND DISCUSSION

4.1. Results

Growth performance

The result of growth performance of rabbits fed diet supplemented with oxidized oil with or without 10% TGLM is presented in table 5**.**2**.,** TGLM 0% + 3% N.O, diet containing 0% *Tectona grandis* leaf meal (TGLM) plus 3% non-oxidized oil; TGLM 0% + 3% O.O, diet containing 0% *Tectona grandis* leaf meal (TGLM) plus 3% oxidized oil; TGLM 0% + BHA 150mg/kg + 3% O.O, diet containing 0% *Tectona grandis* leaf meal (TGLM) plus 150mg/kg butylated hydroxyl anisole plus 3% oxidized oil; TGLM 10% + 3% O.O, diet containing 10% *Tectona grandis* leaf meal (TGLM) plus 3% oxidized oil. SEM, standard error of mean. Final body weight (FBW), body weight gain (BWG), feed conversion ratio (FCR) and average body weight (ABW) gain were significantly affected by dietary treatment. Rabbits in the TGML10%+3% O.O groups had higher FBW, BWG and ABW compared to those in the TGML 0%+3% N.O, TGML 0%+3% O.O and TGML 0%+BHA 150mg/kg+3% O.O ($P < 0.05$). FCR was better in TGML10%+3% O.O, TGML 0%+3% N.O and TGML 0%+BHA 150mg/kg+3% O.O compared to TGML 0%+3% O.O ($P < 0.05$). Initial body weight (IBW), Feed intake and average feed intake were similar in all the treatment groups ($P > 0.05$). Among all groups, TGML 0%+3% O.O rabbits exhibited the lowest FBW, BWG, FCR and ABW ($P < 0.05$).

Table 3. Growth performance of rabbits fed diet supplemented with oxidized and oil with or without 10% TGLM

	Dietary treatment[1]					
Item	TGML 0% +3% N.O	TGML 0% +3% O.O	TGML 0% +BHA 150mg/kg + 3% O.O	TGML10% + 3% O.O	SEM	*P* value
Initial body weight (g)	897.67	1018.33	900.00	1026.67	615.25	0.078
Final body weight (g)	1891.00^{b}	1724.33^{b}	1727.67^{b}	2006.00^{a}	860.22	0.007
Body weight gain (g)	893.33^{ab}	706.00^{b}	828.00^{ab}	979.33^{a}	616.17	0.069
Feed intake (g)	3921.33	4064.33	4055.67	4346.33	864.33	0.160
Feed conversion ratio	4.58^{b}	5.88^{a}	5.00^{b}	4.86^{b}	0.54	0.015
Average body weight gain (g)	15.95^{ab}	12.61^{b}	14.79^{ab}	17.49^{a}	3.38	0.060
Average feed intake (g)	70.02	72.28	72.42	77.79	14.31	0.160

[a, b, c] Means in a row with no common superscript differ significantly ($P < 0.05$). Values are means of three replicates.

Discussion

Growth Performance and Nutrient Digestibility

Studies have reported the in-vitro beneficial impacts of TGML and it possible positive implication in livestock feed (Somayya *et al*., 2021; Pooja *et al* 2021; Syed *et al.*, 2022; Mei *et al*., 2023; Mosad *et al*., 2024). However, to the authors' knowledge, little information is available on the effect of dietary supplementation of TGML on the growth performance, nutrient digestibility, oxidative stability, cholesterol contents and blood profile of rabbit subjected to oxidative stress. In the present study involving feeding oxidized oil with or without TGML or BHA indicate that the feed intake and average feed intake were not affected. The weight gain, feed conversion ratio and average body weight gain were favoured by feeding 10% TGML and oxidized oil. The dry matter and ether extract digestibility were unaffected while protein digestibility was favoured by feeding 10% TGML and oxidized oil. This revealed that the TGML was able to mitigate the oxidative effect of the oil fed to the rabbit. Syed *et al.* (2022); Mei *et al*., (2023); Mosad *et al*., (2024) reported that *T. grandis* leaf and it extracts possess a powerful antioxidant and cytotoxic activities, having the potential to suppress the activities of free radical. Thousands of diverse natural products are produced by plants and many of these are involved in plant defense (Pooja *et al.*, 2021). Mosad *et al*. (2024) report phenolic compounds containing free hydrogen are largely responsible for antioxidant activity in *T. grandis* leaf. Thus contributing to the growth performance of rabbit fed 10% TGML and oxidized oil in this study. He also reported significant correlation between total phenolic content and the DPPH antioxidant activity of the defatted 90% methanolic extract of TGML as well as its derived fractions. This might confer on *T. grandis* the ability to impact positively on rabbit performance.

CHAPTER FIVE

5.0. CONCLUSION AND RECOMMENDATION

5.1. CONCLUSION

The result of the above experiment shows that the inclusion of oxidized oil and non-oxidized did not have effects on the initial body weight, feed intake and average feed intake. However, final body, average body weight, feed conversion ratio and average body weight gain were positively influenced by addition of 10% TGLM.

5.2. RECOMMENDATION

From the study the feed containing 3% oxidized oil and 10% TGLM had better performance on the rabbits and hereby recommended.

Further research is recommended to look into the digestibility and carcass characteristics of rabbit weaner fed feed containing 3% oxidized oil and 10% TGLM.

REFERENCES

Acikgoz Z., Bayraktar H., Altan O., Akhisaroglu S.T., Kirkpinar F., Altun Z. (2011). The effects of moderately oxidized dietary oil with or without vitamin E supplementation on performance, nutrient digestibility, some blood traits, lipid peroxidation and antioxidant defence of male broilers. J. Sci. Food Agri., 91: 1277–1282.

Abou-Elkhair, R.; Selim, S.; Hussein, E. (2018). Effect of supplementing layer hen diet with phytogenic feed additives on laying performance, egg quality, egg lipid peroxidation and blood biochemical constituents. Anim. Nutr. 2018, 4, 394 400.

Adams O. K. (2016). Economic Impact of Livestock Production on The Society: A Case Study of Ikare Akoko Ondo State. *Journal of Agriculture and Veterinary Science (IOSR-JAVS).* Volume 9, Issue 12 Ver. I (Dec. 2016), PP 77-80 www.iosrjournals.org.

Ayodele, S. O., Oloruntola, O. D., & Agbede, J. O. (2016). Effect of Alchornea cordifolia leaf meal inclusion and enzyme supplementation on performance and digestibility of rabbits. World Rabbit Science, 24, 201–206. https://doi.org/ 10.4995/wrs.2016.3933.

Belitz H.D., Grosch W., Schieberle P. (2009). Food Chemistry. Springer-Verlag. Berlin, pp. 158–247.

Bamishaye F.A., Odutuga A.A. and Minari J.B. (2019). Phytochemical Constituents and antidiarrhoeal effects the aqeous extract of Terminalia leave on Wiastar Rat. African Journal of Pharmacy. 7 (16), 848-851, 2019.

Burnett, N., Mathura, K., Metivier, K. S., Holder, R. B., Brown, G., & Campbell, M. (2008). An investigation into haematological and serum chemistry parameters of rabbits in Trinidad. World Rabbit Science, 14, 175–187.

Cleland L.G., James M.J., Proudman S.M. (2005). Fish oil: what the prescriber needs to know. Arthritis Res. Ther., 8: 1–9.

Da Rocha C., Maiorka A., De PaulaValle F.L., Gonsales Schramm V., Ange - li A.L., Fischer D.S.A.V. (2012). The effect of soybean oil quality and vitamin E supplementation on turkey diet nutrition. J. Appl. Poult. Res., 21: 318–324.

Delles R.M., Xiong Y.L., True A.D., Ao T., Dawson K.A. (2015). Augmentation of waterholding and textural properties of breast meat from oxidatively stressed broilers by dietary antioxidant regimens. Br. Poult. Sci., 56: 304–314.

De Blas C. and Mateos G. G. (2010). Chapter 12 - Feed formulation De Blas C. and Wisemann J., Nutrition of the rabbit , 2nd edition, CAB International,Wallingford, UK. 222-233.

Ebeid T.A., Zeweil H.S, Basyony M.M. and Dosoky W.M. (2013). Fortification of rabbit diet with vitamin E os selenium affects growth performance, lipid peroxidation, oxidative status and immune response in growing rabbits. Livestock science 155 (2-3), 323-331.

Etuk R., Grace R. E. and Baghebo M. (2014). Small and Medium Scale Enterprises (SMEs) and Nigeria’s Economic Development. Med.j.soc.sci. 5(7):656-662.

Fawzia A., Ibrahim M., and Sohair A. (2020). Effect of using pricklypiar and it by-products as alternative feed sources on performance of growing rabbit. Egyptian journal of rabbit science. 29(1), 99-124.

Frankel E.N. (1991). Recent advances in lipid oxidation. J. Sci. Food Agric., 54: 495–511.

Heba S. A., Salama A. M S., Osama H E. and Ahmed M. (2021). Agronomic and In Vitro Quality Evaluation of Dual-Purpose Cereals Clipped at Variable Ages and Their Utilization in Rabbit Feeding. *Agronomy* 11 (6), 1147, 2021.

Iyeghe-Erakpotobor G. T., Aliyu R and Uguru, J. (2006). Evaluation of concentrate, grass and legume combinations on performance and nutrient digestibility of grower rabbits under tropical conditions. *African Journal of Biotechnology* Vol. 4 (20), pp. 2004-2008.

J a n k o w s k i J., Z d u n c z y k Z., K o n c i c k i A., J u s k i e w i c z J., F a r u g a A. (2000). The response of turkeys to diets containing oxidized fat of differing degree of oxidation. J. Anim. Feed Sci., 9: 363–370.

K e r r B.J., K e l l n e r T.A., S h u r s o n G.C. (2015). Characteristics of lipids and their feeding value in swine diets. J. Anim. Sci. Biotechnol., 6: 1–30.

L i n d b l o m S.C., G a b l e r N.K., B o b e c k E.A., K e r r B.J. (2019). Oil source and peroxidation status interactively affect growth performance and oxidative status in broilers from 4 to 25 d of age. Poultry Sci., 98: 1749–1761.

Mattioli S., Cardinali R., Balzano M. .. (2017). Influence of dietary supplementation with prebiotic, oregano extract and vitamin E on fatty acid profile and oxidative status of rabbit meat. journal of food quality 2017 (1), 3015120.

Mustafa M. A. G. (2019). Effect of eucalyptus leaf and its supplementation with diet on broiler performance, microbial and physiological statues to alleviate cold stress. *Iraqi Journal of Agricultural Science*, 50, 953-963.

Mutsami C. and Karl S. (2020). Commercial Rabbit Farming and Poverty In Urban and Peri urban Kenya. *Frontier in Veterinary Science*. 7, 353, 2020.

Neamatallah A., Yan L., Dewar S.J. and Austin B. (2005). An Extract From Teak (*Tectona grandis*) Bark Inhibited *Listeria monocytogenes* and Methicillin Resistant *Staphylococcus aureus*. *Lett in Applied Microbio*, 2005; 41: 94–96.

Ogbunugafor, H.A.; Eeneh, F.U.; Ozumba, A.N.; Igwoezikpe, M.N.; Okpuzor, J.; Igwilo, I.O.; Adenekan, S.O.; Onyekwelu, O.A. (2011). Physico-chemical and anti oxidant properties of Moringa oleifera seed oil. Pak. J. Nutr. 2011, 10, 40 414.

Oloruntola, O. D., Ayodele, S. O., Agbede, J. O., Oloruntola, D. A., Ogunsipe, M. H., & Omoniyi, I. S. (2016). Effect of Alchornea cordifolia leaf meal and enzyme supplementation on growth, haematological, immunostimulatory and serum biochemical response of rabbits. Asian Journal of Biological and Life Sciences, 5(2), 190–195.

Orsavova J., Misurcova L., Ambrozova V.J., Vicha R., Mlcek J. (2015). Fatty acids composition of vegetable oils and its contribution to dietary energy intake and dependence of cardiovascular mortality on dietary intake of fatty acids. Int. J. Mol. Sci., 16: 12871–12890.

Pla, M. and Dalle Zotte, A. (2000). Harmonisation of criteria and methods used in rabbit meat research. in *Proc 7th World Rabbit Congr*., Valencia, Spain. pp 539-545.

Rafullah, M.K. and Suleiman M.M. (1999). 5-Hydroxylapachol: a cytotoxic agent from *Tectona grandis*, Phytochem, 1999; 50: 439-442.

Ragasa C.Y., Lapina M.C., Lee J.J., Mandia E.H. and Rideout J.A. (2008). Secondary Metabolites From Tectona philippinensis, *Nat Prod Res*. 2008, 22 Suppl 9, 820-824.

Rama Rao S V., Raju M V L N., Prakash B., Rajkumar U. and Reddy E P K. (2019). Effect of supplementing moringa (*Moringa oleifera*) leaf meal and pomegranate (*Punica granatum*) peel meal on performance, carcass attributes, immune and antioxidant responses in broiler chickens. *Animal Production Science*, 59, 288-294. https://doi.org/10.1071/AN17390

Razali N., Razab R., Mat Junit S. and Abdulaziz A. (2008). Radical Scavenging and Reducing Properties of Extracts of Cashew Shoots (Anacardium occidentale). *Food Chem*. 111:38-44.

Robinson T. (2011). Global Livestock Production System 152pp.

Rodney L., Rosa M.V., Jose M.G.M., Clara N. and Francisco A.M. (2012). Tectonoelins, New Norlignans From Bioactive Extract of *Tectona grandis*. *Phytochem Lett*. 2012; 5: 382-386.

Shafqat N. Q., Muhammad R., , Ghulam Y., , Fehmeeda B., , Muhammad A. S., Nazir A. K., Saima N. and Talat N. P. (2012). Effects of dietary oxidized oil on growth performa meat quality and biochemical indices in poultry-a review. Ann. Anim. Sci., Vol. 21, No. 1 (2021) 29–46.

Shi-yi C., Feilong D., Xianbo J., Hanzhong L., Gong W. Z. and Song-Jia L. (2019). Gut microbiota with differential tolerance against the reduced dietary fibre level in rabbit. *Scientific reports* 9(1), 288-294.

Shruthi D.P., Sunith K.E., Haritha K.E., Govindappa M. and Siddalingeshwera K.G. (2012). Phytochemical Screening, Antioxidant and Anti-inflammatory Activity of Different Extract From Leaf, Bark and Stem of *Tectona grandis*. *Int J Res Pharmacol Pharmacotherapeutics*. 2012; 1 Suppl 2: 140-146.

Su, B. and Chen, X. (2020). Current Status and Potential of Moringa oleifera Leaf as an Alternative Protein Source for Animal Feeds. Front. Vet. Sci. 2020, 26, 53.

Sugiharto S., Yudiarti T., Isroli I. and Widiastuti E. (2018). The potential of tropical agro industrial by-products as a functional feed for poultry. *Iranian Journal of Applied Animal Science*, 8, 375-385.

Sumthong, P., Damveld, R.A., Choi, Y.H., Arentshorst, M., Ram, A.F., Vanden, (2006). Activity of Quinines From Teak (*Tectona grandis*) on Fungal Wall Stess. *Planta Medica*, 72(10): 943-944.

Suseela L. and Parimala (2017). Antimicrobial Activities of Tectona Grandis Leaf And Bark Extracts. *European Journal of Pharmaceutical And Medical Research*. *2017,4(12), 245-248.*

Va r a d y J., G e s s n e r D.K., M o s t E., E d e r K., R i n g s e i s R. (2012). Dietary moderately oxidized oil activates the Nrf2 signaling pathway in the liver of pigs. Lipids Health Dis., 11: 1–9.

Wa n g L., Z h a n g J., G a o J., Q i a n Y., L i n g Y. (2016). The effect of fish oil-based lipid emulsion and soybean oil-based lipid emulsion on cholestasis associated with long-term parenteral nutrition in premature infants. Gastroent. Res. Pract., 2016: 1–4.

Y i n H., X u L., P o r t e r N.A. (2011). Free radical lipid peroxidation: mechanisms and analysis. Chem. Rev., 111: 5944–5972.

Zotte, A.D.; Celia, C. and Szendr˝o, Z. (2016). Herbs and spices inclusion as feedstuff or additive in growing rabbit diets and as additive in rabbit meat: A review. Livest. Sci. 2016, 189, 82–90.

Abdel-Hamid., Romelh E., Huang Z., and Enomoto T. (2020). Bioactive properties of probiotic set yoghurt supplemented with Siraitia grosvenorii fruit extract. Food chemistry 303, 125400, 2020.

Osman A. and Salama A. (2021). Alleviation of carbon tetrachloride induced hepatocellular damage and oxidative stress in rats. Journal of Food Biochemistry 45(1), e13562, 2021.

Hendry L.C., Stevenson M., MacBryde J. and Ball P. (2019). Local food supply chain resilience to constitutional change: the Brexit effect. International journal of operations and production management 39(3), 429-453.

Ashore A., Gholipoor M., Gholami A and Abbasdokht H. (2022). Evaluation of some morphological and physiological characteristicsof cumin by using magnetic water and superabsorbent under a low irrigation regime. Jci.ut.ac.ir.

Christinova L., Simonova M.P., and Laukova A. (2009). Enterococcus faecium CCM7420, bacteriocin PPB and their effects in the digestive tract of rabbits. Czech J Anim Sci. 54(8), 376-386,2009.

Wu L., Zhang C., Long Y and Chen Q. (2022). Food additives: from functions to analytical methods. *Critical review in food science and nutrition*. 62(30), 8497-8517, 2022.

Kahl R. (1984). Synthetic antioxidants: biochemical actions and interference with radiation, toxic compounds, chemical mutagens and chemical carcinogens. *Toxicology* 33 (3-4), 185-228, 1984.