QUALITY ATTRIBUTES OF BROILER CHICKEN MEAT AND PATTIES AS INFLUENCED BY WALNUT (*Plukenetia conophora* MULL.ARG.) AND MELON (*Citrullus colocynthis* (L) SCHRAD.) SEED MEAL

BY

Sherifat Omowunmi **OLUFEKO**

Matriculation Number: 104909

B. Agric. (Ibadan), M.Sc. Animal Science (Bayero University, Kano)

A THESIS IN THE DEPARTMENT OF ANIMAL SCIENCE SUBMITTED TO THE FACULTY OF AGRICULTURE IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

of the

UNIVERSITY OF IBADAN

February, 2023

CERTIFICATION

We certify that this work was carried out by Sherifat Omowunmi OLUFEKO with matriculation number 104909 in the Department of Animal Science, Faculty of Agriculture, University of Ibadan, Ibadan, Nigeria.

……

Supervisor

Professor. A. B. Omojola

BSc. Hons. M.Sc. Ph.D. (Ibadan) RAS, FCASN

Professor of Meat Science and Food Safety

Department of Animal Science,

University of Ibadan, Ibadan,

Oyo state, Nigeria.

….....

Supervisor

Professor O. A. Ogunwole

BSc. Hons. M.Sc, Ph.D, (Ibadan) RAS, JP. FCASN

Professor of Vitamin and Amino Acid Metabolism,

Department of Animal Science,

University of Ibadan, Ibadan,

Oyo State, Nigeria.

DEDICATION

To almighty Allah, I dedicate this work in the memory of my late father Mr. Taoheed Ishola Omotosho

ACKNOWLEDGEMENTS

All admiration and appreciation be to Almighty Allah, the most Benevolent, the most Merciful that granted me strength, wisdom and indulgent throughout this research. The lord of mankind and all that exists. You alone we worship and ask for help.

My earnest appreciation goes to my research fathers and ingenious supervisors, Professors A. B. Omojola and O. A. Ogunwole for their guidance, support and encouragement during this program. They have both inculcated in me the symbol of productiveness and prayerfulness throughout the course of this study. I am grateful to the most high God for providing me with such conscientious supervisors.

I am much obliged to the Head of Department, Professor D. O. Adejumo, for his support in the pursuit of my Ph. D. May you continue to be relevant in all arears and God's blessing for your life. I also appreciate Prof. Olubunmi O. Olusola for her motherly care and concern. I am obligated to all lecturers in the department: Professors O. J. Babayemi, M. K Adewumi, Oyebiodun G. Longe, T.O. Ososanya, O. A. Olorunnisomo, O. A. Abu, Drs. Ngozi F. Anurudu, Oluwafunmilayo O. Adeleye, Funmilayo G. Adebiyi, Modupe O. Ajayi, Adebisi F. Agboola, A. Adebiyi, O. Odu, O. H. Osaiyuwu, E. O. Ewuola, O. A. Sokunbi and O. Alaba. You all have added immensely to the victory of this research. I really appreciate everyone for your assistance.

To Dr B. R. Omdiwura, our amiable Postgraduate Coordinator, your support and assistance towards the completion of my program was highly cherished. Really appreciate you sir. I appreciate Dr Olayemi R. Awodoyin for your guidance, encouraging words and assistance during my analytical procedures in Meat Science laboratory. Thank you ma.

My sincere appreciation to all Laboratory Technologists in the departments: Messrs S. A. Adelani, A. A. Fabowale, E.O. Joel, H. O. Ngere, T. T. Lawal, T. A. Salau and A. Ayo ,for their assistance and teaching of handling equipments while working in the laboratory. You all made my period in the laboratory worthwhile. Thank you all wonderful people.

Sincere appreciation to my research colleague in animal products and processing Department, Kehinde Tella, Tayo Akinsehinde, Drs O. Abiala, O. Jegede, Blessing Fadeyibi, Okere and Ayobami Adeshola. You all are the best. My love and appreciation goes to my adorable vitamin – mineral research group members both Ph,D and MSc. Colleagues. You all were always ready to assist whenever need be: Ireti Oludoyi, O. Asebiode, A. Aluko and Faith Adenigba. A big thank you for all you have done, am sincerely grateful. Also, I wish to offer my heartfelt thanks to Drs Oshibanjo, Mosuro, Bamidele Samuel Adedeji, Omowumi, Folashade Jemiseye, Ayodeji Adeyemi, Sabur Oladimeji and Titilope, Victoria Abokede. I really appreciate you all. I sincerely appreciate my friends and colleague for their encouragement and assistance towards the completion of my program: Drs Chika Ozumba, Musiliu Ewuola, Bisi Bolarinwa, Mrs Priscillia Komolafe, Mr Oso Yusuf and Bukky. May your lives be elongated enough to reap the fruit of your labour.

With all sense of humbleness and appreciation, I sincerely appreciate my dear mother Mrs Olanrewaju Omotosho for all your prayers on me since birth. You sacrificed all you can for me and my siblings. Dear Mummy, you have been a great pillar to us your children and I am most grateful for taking care of your grandchildren during my program. May you live long to reap your labour mum. Great appreciation to my siblings: Kudirat Kareem, Azeez Omotosho and Aminat Sanusi. Really appreciate your assistance and support during this journey. May you all continue to see the favour of almighty Allah in all your endeavours in life (Amin).

I deeply appreciate my husband, Babatunde Olufeko, for encouraging me to embark on this expedition. Despite all the challenges surrounding the completion of my programme, you still supported me to the fullest and encourage me the more. Thank you for your support in all ways imaginable dear. To my darling children Jamaal and Meenat, Mummy appreciate your patience dearly sweetie pies. Finally, mummy is responding to the academic Doctor you always address her by. For this and constantly, I appreciate you both. I sincerely appreciate my in-laws. My Dad-in-law, Late Alhaji M. O. Olufeko, He was always encouraging and praying for me. Thank you sir and may your soul rest in peace. To my Mum-in-law, Alhaja S.O. Olufeko, really appreciate you ma for all your prayers and care ma. Thank you ma.

In conclusion, I am glad for the constant supports and words of encouragement from Prof. R. O. Awodoyin and Dr M. K. Kareem. Your career journey is a source of motivation to me which has kept me in tune during my program. Thank you sirs.

ABSTRACT

Chicken meat and its products are prone to Lipid Peroxidation (LP) during storage. Synthetic Antioxidants-SA which could be harmful to consumers are often added to broiler chicken diets or to meat to mitigate LP. Natural antioxidants from plant sources such as Walnut Seed-WS and Melon seed- MS could replace SA. Information on the use of WS and MS as sources of antioxidant for broiler chicken meat and patties is scanty. Therefore, WS and MS as antioxidant sources in broiler chicken meat and patties were investigated.

Precisely, 1kg each of WS and MS was boiled for one hour and oven-dried for 12 hours to obtain Treated WS-(TWS) and Treated MS -(TMS), respectively. Milled samples of Raw -WS and MS, TWS and TMS were assayed for flavonoids (mg/100g) and Total Tocopherol-TT (mg/kg) using standard procedures. Arbor Acres Plus chicken (n=336, r=6) aged 21 days, weighing 452±0.21g were randomly allotted to a basal diet supplemented with TWS (g/kg) at 0.0 (T1), 2.0 (T2), 4.0 (T3), 6.0 (T4), TMS (g/kg) at 2.0 (T5), 4.0 (T6) and 6.0 (T7) in a completely randomised design with eight birds/replicate. At day 42, four chickens were randomly selected from each replicate, slaughtered and meat samples assayed for LP (mg MDA/100g), and lightness (colour) parameter determined using standard procedures. Breast meat samples from T1 were processed into patties with TWS included at 0.0 (S1), 2.0 (S2), 4.0 (S3) and 6.0 (S4) and TMS at 2.0 (S5), 4.0 (S6) and 6.0% (S7). Patties were cooked for 7 minutes (72^{o}C) and stored (-18^{o}C). Patties Overall Acceptability (OA) was assessed by panellists (n=20) immediately after cooking, LP and lightness were assessed at seven-day intervals for 28 days using standard methods. Data were analysed using descriptive statistics, regression and ANOVA at $\alpha_{0.05}$.

Flavonoids of MS (20.59±0.01), TWS (21.13±0.02) and TMS (21.15±0.02) were significantly higher than WS 12.51±0.01. Also, TT of raw WS (69.40±0.10) and TWS (58.65±0.24) were significantly higher than those of raw MS (3.07±0.01) and TMS (3.06±0.02) showing that cooking increased the flavonoids but reduced TT compositions. The LP of 0.006±0.002 and 0.006±0.001 were least in T3 and T4, respectively and highest in T5 (0.008±0.02). The OA values of T1 (6.85±0.04), T4 (6.75±0.03), T5 (6.75±0.05), T7 (6.70±0.03), T6 (6.60±0.05) and T2 (6.60±0.06), were similar but significantly lower than T3 (7.50±0.02). Also, the OA of S3 (7.55±0.02) was significantly higher than in other treatments, while S7 (5.90±0.04) had the least. The LP was significantly higher in T6 (0.10±0.01), T4 (0.11±0.12) and T7 (0.15±0.01) than T3 (0.05±0.02). The LP of S3 (0.11±0.01), S5 (0.11±0.02), S6 (0.11±0.04) and S7 (0.11±0.03) were similar but higher than S4 (0.04±0.02). Lightness was higher in T1 (59.39±0.10) than T7 (54.67±0.09). The lightness of 59.39±0.10 in S1 was significantly higher than 46.00±0.11 in S4. Lightness of patties (T1-T7 and S1-S7) decreased linearly (R^2=0.99) with days of storage.

Cooking enhanced the flavonoid concentration of walnut seed meal. Patties developed from chickens fed walnut and melon seed meal were of lower quality but more acceptable.

Keywords: Flavonoids, Lipid peroxidation, Broiler chicken, Patties lightness, Total tocopherol

Word count: 493

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURE

LIST OF ABBREVIATION

ALB	Albumin
ALT	Alanine aminotransferase
ANOVA	Analysis of variance
AOAC	Association of Official Analytical Chemist
AST	Aspartate aminotransferase
BASO	Basophil
BW	Bled weight
CL	Cooking loss
DFW	Defeathered Weight
DPPH	Diphenylpicrylhydrazyl
EE	Ether extracts
EOS	Eosinophils
EVW	Evicerated weight
GLU	Glucose
Hb	Haemoglobin
LW	Live weight
LYM	Lymphocytes
MCH	Mean corpuscular haemoglobin
MCHC	Mean corpuscular haemoglobin concentration
MCV	Mean corpuscular volume
MONO	Monophil
MSM	Melon seed meal
NEUT	Neutrophil
NS	Not significant
PCV	Packed cell volume
RBC	Red blood cell
RCD	Randomised completely design
SEM	Standard error of mean
TBARS	Thiobarbituric acid reactive substances

WBC	White blood cell
TCC	Total coliform count
T CHOL	Total cholesterol
THC	Total heterotrophic count
TSC	Total staphylococcus count
TP	Total protein
UR	Urea
WHC	Water holding capacity
WSM	Walnut seed meal

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

The muscle tissue of animal is meat which is composed of protein, minerals, fat and oils and little carbohydrate. It is highly perishable due to this rich nutritional profile and deteriorates rapidly (Devatkal *et al*., 2012). Poultry meat is an exceptional quality protein, which retains stable expanse of polyunsaturated fatty acid (PUFA) with addition of vitamin as well as minerals. These extreme levels of PUFA are liable to lipid oxidation, leading to reduction in meat quality and its products (Luna *et al*., 2007).

Peroxidation involves the loss of electrons through molecule, atom or ion which is the predominant reasons for the deterioration of products of meat and its quality. The main reason for declination of food for human ingestion is oxidative rancidity, which produce unpleasant odour, loss in flavour, reduced texture, stability and nutritional attributes as well as reduced shelf life of meat. Development of reactive species in oxidation process can cause impairment to vital components in biological system (Halliwell *et al.*, 1995). Oxidation is a universal process which obstructs fats and oil, pigments, protein, DNA, carbohydrates and vitamin. Oxidation resistance after slaughtering determines the stability of meat and its product (Stronskyi *et al*., 2020).

The main problem of keeping fatty food from dreadful condition in meat aside lipid oxidation is microbial spoilage, which embroils creation of volatile oxygen species and free radicals which results in rancid odour, bad flavour and surface discolouration of meat and its product thereby, generating a toxic compounds (Olorunsanya *et al*., 2009). Extensive stability of meat and safety from oxidative decline and microbial spoilage is necessary. It has been reported that use of antioxidant in controlling and lessening lipid oxidation has been effective (Karre *et al*., 2013). Antioxidants could either be synthetic or natural, but usage of natural antioxidant has elicited favourable

response from consumers due to its perceived safety than synthetic antioxidants (Faluyi *et al*., 2020).

Human health is endangered by the carcinogenicity of synthetic antioxidants such as propyl gallate (PG), butylated hydroxytoluene (BHT), tert-butylhydroquinone (TBHQ), and butylated hydroxyanisole (BHA). Thus, their replacement with natural antioxidants due to their safe use (Karre *et al*., 2013). There have been increased requests for natural antioxidant from various products due to perceived healthiness, deferment in oxidative degradation of lipids, development of quality and nutritive foods (Faluyi *et al*., 2020).

In this perspective, here are technical tactics which encompass the introduction of natural antioxidants into the diets of animals, meat products or using the antioxidant extracts to cover packaging materials so as to improve oxidative reliability of the products. Studies by (Camo *et al.*, 2008; Faluyi *et al.*, 2020) indicated that shelf life of meat, lipid stability, palatability and quality could be improved by these natural antioxidants which can be added pre and post slaughter stages by incorporating them in diets, onto meat surfaces or active packaging. Natural antioxidant could be from herbs, spices fruits legumes nuts and vegetables. They are highly acceptable by consumer and are safe to use (Karre *et al*., 2013). Natural antioxidants have better potential for improving the pertinence, delectability, and meat shelf life and its products for consumers (Faluyi *et al*., 2020).

In various parts of plant, natural antioxidants are found. Plant parts such as fruits (date, grape, citrus,), vegetables (pumpkin, broccoli, cabbage, lettuce), herbs and spices (oregano,tea,rosemary, cinnamon, curry,mint, thyme, ginger) are natural antioxidants. They decrease lipid oxidation in meat as well as preserve and prevent the growth of antimicrobial and microbiological activity (Camo *et al.*, 2008). Plants provide vitamins, protein, fats and oils, carbohydrates, minerals, and water, all of which remain necessary for change and evolution both in human and animal. More than that, researchers have discovered that several plant compounds formerly thought to be antinutritional and antinutrients may be useful in reducing disease frequency in humans (Agte *et al*., 2000). Phytochemicals which are found natural in fruits, grains, vegetables, nuts, legume, have been reported to improve human health and prevent

disease in humans (Liu and Boyer, 2004). Such invaluable substances abounds in the seeds of walnut (Igara *et al*., 2017) and melon (Uzami *et al*., 2015).

Walnut *(Plukenetia conophora*) seed, named ukpa in Eastern Nigeria, conophor in English, awusa in Western Nigeria. It belongs to the Euphorbiaceae family and also a perennial climbing shrub that grows to a height of 3 to 6 meters (Igile, 1996). The crop is well-known and frequently consumed. Walnut is rich in micronutrients and secondary metabolites such as tocopherol, flavones and polyphenols. Secondary metabolites are compounds found in seeds that have been shown to have biological activity (Igara *et al*., 2017). Some secondary metabolites cause extremely detrimental biological responses, whereas others act as an active pharmaceutical drugs and are often used in food. The nut is rich in fat, protein, minerals and vitamins. The minerals content and percentage oil content of the nut varies depending on its cultivar, soil parameters and climatic conditions of where it is grown (Ogunsua, 1993).
Melon (*Citrullus colocynthis*) which is cucurbitaceous crop is commonly grown in tropical Africa for its seed (Uzami *et al*., 2015). It is a crawling crop named ‘‘egusi’’ in West Africa. This plant family has an extensive range of eco-diversity and adaptation, allowing it to develop well in hot and subtropical climate, dry deserts and cold weather (Oluba *et al*., 2008).

Enhanced docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) levels, on the other hand, may contribute to increased oxidative degradation and lipid oxidation, which can negatively impact product sensory qualities such as odour and flavours, over storage (Abbasi *et al*., 2019). Essential oils and plant extracts in poultry feed brought about minimized lipid peroxidation in the past (Abbasi *et al*., 2019).

1.2 Problem statement

Food industry continually research in developing new formulations designed to improve meat and its products quality, shelf life and food safety. Nutritional composition of walnut seeds have been documented (Akpoghelie *et al*., 2019. Futhermore, the chemical component of melon seed have been determined (Jacob *et al*., 2015). There is, however, need to improve on the knowledge of whole seed meal as an antioxidants. This research is aimed at assessing the antioxidant activity of

walnut and melon seed meal in broiler chicken meat and chicken patties, for their quality and attributes.

1.3 General objective

To assess the effect of walnut and melon seed meal based diets as well the treatment with seed meal on meat quality attributes of finisher broiler chickens and patties

1.3.1 The Specific objectives

To assess the;

a. Walnut and melon seeds meal phytochemical profiles

b. Antioxidant compositions of walnut and melon seeds meal

c. Meat quality characteristics of broiler finishers chicken fed walnut and melon seeds meal

d. Quality attributes of chicken patties with walnut and melon seed smeal inclusion

Statements of hypothesis are:

H_0: There is no significant ($p < 0.05$) difference in the chemical profile of walnut and melon seeds

H_A: There is significant ($p > 0.05$) difference in the chemical profile of walnut and melon seeds

H_0: Increasing dietary supplementation of walnut and melon seeds meal in broiler chickens diet will have no significant effect on meat quality characteristics of broiler chicken

H_A: Increasing dietary supplementation of walnut and melon seeds meal in broiler chickens diet will have significant effect on meat quality characteristics of broiler chicken

H_0: Quality of patties from broiler chicken fed walnut and melon seed meal will not be significantly affected during storage

H_A: Quality of patties from broiler chicken fed walnut and melon seed meal will be significantly affected during storage

H_0: Increasing levels of walnut and melon seed meal in patties will have no effect on quality of chicken patties

H_A: Increasing levels of walnut and melon seed meal in patties will have effect on quality of chicken patties

1.4 Justification

Meat quality deterioration from oxidative rancidity occurs more in the tropics due to high ambient temperature because meat in other climates are also very perishable in nature. This could be at different stages of processing, handling and storage. Hence, there is concern for shelf life extension. Antioxidants prevent, control and reduce lipid oxidation. These antioxidants could be natural or synthetic. Synthetic antioxidants like propyl gallate (PG), butylated hydroxyanisole (BHA), tert-butylhydroquinone (TBHQ), and butylated hydroxytoluene (BHT) may pose a risk to consumers' health. Therefore, awareness and search for natural antioxidants have increased intensely through the last decade. For this reason, there have been approaches involving the use of antioxidants from different plants, herbs, spices extracts directly into meat and its products for the improvement in stable oxidation and extending its quality during storage, after processing and packaging. Moreover, there are technical strategies involved in the admininistration of antioxidants either straight into the products of meat and meat or cladding containers with natural extracts to enhance the products from oxidative stability. In addition to reducing or eliminating lipid oxidation, these study involved the use of walnut and melon seed meal in broiler chicken meat thereby extending its shelf life and increase the quality of patties.

CHAPTER TWO

LITERATURE REVIEW

2.1 Nutrient Requirements of Broiler Chickens

Poultry must be fed feed that has all of the elements indispensable for optimum growth and output. Therefore, it is essential that poultry be fed on diet that is a mixture of economically available ingredients so as to provide all the nutritional needs in quantities necessary for their well-being. Formulation of broiler ration should be correctly done to provide the necessary equilibrium of energy, amino acids, mineral, protein,vitamins and vital fatty acids for optimal development and performance (Idahor and Adua, 2011).

The feed of broilers are usually formulated to promote rapid growth while the feeds comprise proportionally high energy (3000 kcal) and ample protein (22 – 24 %) for the first 5 - 6 weeks to obtain early rapid growth and fewer protein of 19 – 20 % and substantial energy of 2800 kcal per kg of feed for fattening (Banerjee, 2005). Idahor (2013), reported that growing poultry are normally fed to appetite and feeding standards which are expressed not as amounts of nutrients but as the nutrient proportions of the diet. The nutritional value of chicken feed ingredients is determined by different factors which includes variety, source, storing and processing conditions, specie, season and the type of birds being fed.

In broiler production, source of feed materials, especially sources of protein feed in animal, has been deficient and costly. Feed costs are substantial, accounting for 70 to 80 percent of total production expenses, resulting in high prices for poultry meat. Currently, special importance is inclined to sourcing high-quality protein feedstuffs which are reasonably cheap and indigeneously available for use in place of imported feed additives. By way of their high protein content and favorable amino acid profile, protein-rich foods such as fish meal and soyabean meal are key components of broiler chicken diets. Their high cost militates against their use for economic broiler production (Idahor, 2013).

Due to exorbitant prices of protein source ingredient for animals and the scarcity of locally produced protein supplement for animal diets, there is need for continuous search for new and less costly dietary protein ingredients. In this quest, researchers (Idahor *et al*., 2010) identified the nutritional potential of many non-conventional animal feed ingredients and their inclusion levels that will ensure satisfactory performance. These new protein sources are especially important since they are abundantly available in the tropics, high in protein and minerals, and of high quality.

2.2 Phytochemicals

Plant compounds are simply referred to as phytochemical. They are found naturally in vegetables, legumes, fruits, and grains. They are responsible for flavor, colour, and scent as well as serving as component of plant's natural defense mechanism (disease resistance). Liu (2003) reported that plant-derived phytochemicals are favourable to human well being and assist in preventing diseases. In plants, phytochemicals attract useful and repel detrimental organisms. They also serves as photo protectants, and react to environmental variations. For instance, anthocyanin, flavonoids and isoflavones, do function as phytoalexins, which are helpful in resisting pathogens in plant (Agte *et al*., 2000).

Tannins are water-soluble phenol derivatives that higher plants naturally make and store as secondary metabolic products. Tannins are polyphenols with molecular weights ranging from 500 to 3000 Da that form complexes with saccharides, alkaloids, and protein with its molecular weight increasings up to 20000 Da. Tannic acid's chemical structure is determined by the plant species that produces the substance. Tannins can be classified into:

A Hydrolysable tannins

1. Gallotannin
2. Ellagitannins
3. Complex tannins (Sugar derivatives e.g ellagic derivatives, glucose and gallic acid)

B Procyanidins are non-hydrolyzable condensed tannins with a condensed carbon chain, similar to flavonoids (Khanbabaee and Van Ree, 2001). Condensed tannins are

substantially more resistant to microbial destruction than hydrolysable tannins, and they have higher antibacterial, antiviral, and antifungal activity.

Polyphenols are group concerning phytochemicals which is abundant in food and it is classified in the direction of various groups in respect toward the structure of the chemicals which are: flavonoids, lignans, phenolic acids, and stilbenes. Plants contain phenolic chemicals both free and covalently coupled with macromolecules or cell wall components (Kumar *et al*., 2014). During food preparation, polyphenols which are highly reactive substances undergo a variety of transformations. Cooking might cause phenolic compounds to incur physical and chemical changes, as well as oxidation, release from bound forms, polymerization and degradation. Polyphenols and other food phenolics have interested many researchers due to their health benefits to human. Their presence in plant foods varies in type and quantity among plants, ecological conditions and inherited factors. The largest group of polyphenols are Flavonoids which consists of substances with two substituted benzene rings. They are connected by three carbon atoms chain and an oxygen bridge. The abundant flavonoids in foods are Kaempfrol and Quercetin. It has been established that plants with pharmacological and anti oxidative properties are correlated to the existence of flavonoids and phenolic acids.

In nature, carotenoids are isoprenoids that appear in fruits and flowers.They aid in collection of light constrained by low light environment or help to release unabsorbed energy as heat when exposed to high intensity of sun. The conjugated double carbon-carbon bonds of carotenoids are sensitive to oxygen, light, heat, and damage by acid. However, the decrease in carotenoids concentration due to burning is related to exposure by degrading agents. Cooking can also be due to the isomerization of the natural all- trans-form to its cis- isomers. Plants synthesize phytonutrients molecules, but they do not play any role for their development and growth (Liu, 2003).Instead, they have variety of roles in plant processes such as safety against environmental stresses such as ultra violent damage,defense against phytophage and pathogen attack, and as attractants for pollinators (Agte *et al*., 2000). Unlike vitamins and minerals, phytonutrients are not classified as essential, but they appear to have many benefits. Polyphenols, for example, are known to contribute to plant defense mechanisms in the case of disease or pest attack (Kumar *et al*., 2014) as evidenced by reports of induced

fungal disease on plantain leaves and immediate plant response with highest concentration around the zone of attack and by increasing caffeic acid concentration (a phenolic compound) in the leaves (Igile *et al*., 2019).

Plants are essential for the development and growth of both human and animal as a result of high carbohydrate, mineral, protein, vitamins, fat and oil, and water content. More than that, researchers have discovered that several plant compounds classified as anti-nutrients or anti-nutritional have the potential of reducing various diseases in humans (Agte *et al*., 2000). Reports showed that these phytochemicals reduces LDL (Low-density lipoprotein) that is the cholesterol that has a role in artery fat accumulation (Sheng *et al*,. 2018), lowering the threat of heart attack or stroke, and prevents blood clotting. Sulphur compounds, which are phytochemicals, are also known to lower cholesterol production in the body and as a result, lower blood pressure. This is accomplished either alone or in the conjuction with vitamins and other nutrients found in foods (Liu and Boyer, 2004). Biologically active components are found in abundance in the plant kingdom, predominantly in plants used for animal feed and in human food (Igile, 1996). These compounds elicit both noxious and beneficial biological reaction prompting a number of new investigations into their potential physiological consequences in various biological systems (Igile *et al*., 2019). Secondary metabolites as some of these compounds are known, have been demonstrated to be active biologically. Some of these secondary metabolites are extensively used in nutrion and as active pharmacological substances, while others induce very detrimental biological responses. When consumed in an unprocessed food, they could be toxic.

Vitamins are found from seed, fruits and food which are needed in minute quantity. They are hydrogen carbon that are essential nutrients that cannot be produced. They are required for basic physiological activities such as sustenance, growth and development (Mohammed and Ifat, 2016).

2.3 Haematological Data and their Relevance in Animal Studies

Haematological indicators serve as a guide and reference to indicate how nutritional treatments affect animals through the amount,kind and quality of feed consumed, as well as its availability for metabolic, physiological, and biochemical requirements

(Ewuola *et al*., 2004). Haemoglobin analysis is performed as an investigative tool to evaluate the health condition of humans along with animals. Any haematological changes observed through the analysis are used to establish the health condition, metabolic profile, production patterns and to determine the effect of ecological, nutritional and pathological stresses on the animal. Haematological measurements provide vital information about an animal's immunological health as well as an indicators of physiological state of poultry (Strydom *et al.,* 2008). Apart from being valuable for diagnosis and management, such information might also be included in breeding programs. Conducting haematological studies helps to determine the usual biological values for feeding, suitable care, breeding, illness, treatments and prevention under local conditions.

Studies about haematological parameters in birds show that they are subject to some factors such as season, nutrition, age and sex. Pavlak *et al*. (2005) observed that haemoglobin (Hb) and packed cell volume (PCV) values in male tend to be greater than in female turkeys and pigeons. Chickens' Red blood cell (RBC), PCVand Hb have all been found to increase as they become older (Mahmud *et al*., 2016). Pavlak *et al*. (2005) reported that many factors influence the composition of blood drawn from animals namely: time, gene (breed or strain), length of life, sex, nutrient, geographical conditions, physiological status, capillary or heart blood, type of anaesthetics and the animal's state of excitement. Diurnal oscillations or changes in metabolic and daily physical activity have an impact on haematological spectrum (Piccione *et al*., 2005). The average haematological values of Hb, erythrocyte sedimentation rate (ESR) and RBC of poultry differ amid the various strain and further factors which include strain, sex and the diet of the chicken also affects the RBC counts (Sarica *et al*., 2020).

2.4 Melon seed

Melon (*Citrullus colocynthis*) is a cucurbitaceous plant otherwise called bitter apple, colosynth and vine- of- sodom (Uzami *et al*., 2015). It is a thronged crop grown extensively in tropical Africa for its seeds, which are de-shelled, shrivelled, and blended into paste that are put into vegetable soup to provide aroma, enhance taste, and thickening of soup (Oluba *et al*., 2008). This plant family, named egusi in West Africa, is known for its tremendous genetic variety and adaptability, which spans sub-tropical and tropical climates, dry deserts and temperate regions (Oluba *et al*., 2008).

It has a big, thick sturdy base from which slender, tough, pointed, vine like stems sprout. The leaves are irregular, measuring about 5-10 cm long, with 3-7 nodes.The flowers are single yellow pale blooms with a rough and angular stems. Each plant produces 15-30 spherical fruits that are green with rippled yellow stripes and when dried, turns yellow. The seeds are small (6 mm long), unwrinkled, and brownish when ripe (Abbah *et al*., 2014).They are mostly grown for their seeds which is found in gourds that are neither edible nor delicious.Egusi seeds are tiny and flat. The seed has one rounded end and brisle end. It is a yearly herbaceous, monoecious plant that creeps but does not climb. Insects fertilise the egusi melon fruits, which are indehiscent, levelled berries that are generally huge and seedy and ready for harvest 3-4 months after sowing (Abbah *et al*., 2014).The seeds are separated from the soft mass, cleaned, and dried in the open air.

Citrullus lanatus is a spreading yearly plant and an intercropping plant that flourishes on rich light soil in Africa's hot climate. It has, however, been observed to endure minimal rainfall (Jacob *et al.*, 2015)

In this part of Nigeria, *egusi,* grow best after the earliest rains of the year (Ogbonna and Obi, 2000).Around thirteen weeks after planting, the first fruits are picked.

2.4.1 Composition and Nutritive Value of Melon

Melon is a member of the Cucurbitaceae family, which is extensively farmed and consumed as an oil seed crop in West Africa. Chemical composition of melon seed have been reported: 50 % oil and 35 % protein (Jacob *et al*., 2015); 28 % protein,53 % oil, with some essential nutrients and substitute, Oluba *et al*. (2008); Ojieh *et al.*, (2008) publicised a ether extract of 45.7 %, crude protein 23.4 %, also reviewed that *egusi* melon is nutritious, medicinal and could perhaps be a rich supply of vital amino acids, including arginine,protein,leucine, lipids, isoleucine, and calcium. Hunt *et al*. (1980) stated that the seed contains ascorbic acid and riboflavin**,** minerals, fat, biological compound and organic molecule. The oil expelled from the seed is used for edible purpose, while the remanent cake is fried and eaten as a snack, it is also devoured in form of *egusi* soup, melon ball snacks and brewed condiments (Oyenuga

and Fetuga, 1975).The oil is majorly composed of quality, nutritious and .non-saturated fatty acid.

Some cucurbitaceae oils have considerable levels of conjugated fatty acids, making their use as drying oils flawless (i.e. they combine readily with oxygen to form a water proof stretchy film). Despite the deficiency of lysine and critical amino acid in melon seed, when utilized as the primary source of protein in a balanced diet, it is easily digested, and its biological value and utilization efficiency are only secondary to those of animal protein (Oyenuga and Fetuga, 1975). In a research on the seed, Braide *et al.* (2012) demonstrated that heating and fermentation of melon seeds made the protein in melon seed more accessible to broiler chicks while also extracting some or all of the anti-nutritional elements in raw melon seed. The oil content of the seeds is reported (Pariza *et al.*, 2001) to be 17-19 %, including 9-12 percent palmitic acid, 67-73 percent linoleic acid,5-8 % stearic acid and 10-16 percent oleic acid. This is similar to safflower oil composition with unsaturated fatty acids of 80-85 percent and estimated oil output value of 250-400 L/hectare. The oil's percentage constitution by weight is as follows: palmitic, 13.45 percent; stearic, 13.71 percent; myristic, 0.78 percent; linolenic, 0.46 percent; oleic, 14.50 percent; linoleic, 56.94 percent and lauric. 0.21 percent according to Oluba *et al*. (2008). This composition is composed of around 72 percent of unsaturated fatty acids by weight, with polyunsaturated fatty acids representing the remaining 57.4 percent (PUFA). Vital fatty acids, in which the body cannot produce and they must thus be obtained through diet is polyunsaturated fatty acids (PUFAs). In facts, an essential fatty acid shortage has been linked to dermatitis similar to zinc or biotin deficits (Pariza *et al.*, 2001).

2.5 Walnut seed

Walnut, the fruit of the walnut tree (*Pukenetia conophora* MULL. ARG.), has along history as occasional natural fruits. Its an implausible plant which initiated from the tropical West African nations of Sierra Leone to Angola, Nigeria and different nations in West Africa (Janick and Paul, 2008). Its range in Nigeria includes Uyo, Lagos, Akure, Ibadan, Ogbomoso, Kogi, Ajaawa (Obianime and Uche, 2010). It is magnanimous in all cocoa-producing states in Nigeria and Southern part of Nigeria.

Shortage of storage facilities has fraught the market value of walnut therefore, the walnut are mostly consumed within 1-2 days when boiled or will be unpleasant with a foul smell (Kanu *et al*., 2015). The seeds are consumed as snacks and refreshments. It is a non-timber forest resource secure on farmland and economically nurtured for its oil- rich fruits which serves as a good source of income for the rural areas. The fruit is chewed raw as a medicine against snake bite and as thickener in soup. The fruit is a capsule with 1-4 chambered which is as a result of the number of cells in the ovary. One seed unit inhabits a chamber which is secluded from other seed units. The seed unit which is also the planting unit is made of an outer stony testa and when matured, it is black in colour. At immature stage, the testa is cream white. The testa (0.2mm thick) is enclosed in a large mass of cream white fleshy endosperm (kernel). The inner surface of the testa is lined by a thin white covering. The plant undergoes active vegetative growth in September- November, flowers in November/ December which are set fruits in February/ March. Fruits are available for harvesting in April through July (Awodoyin *et al*., 2000). African Walnut is a blooming plant, a woody perennial climber of around 6 – 18 m long at conceptive stage.It produces stems of 3-15 m long, though they can be up to 30 m long. The seed takes 4- 6 months to develop. The leaves are edible.

2.5.1 Composition and Nutritive Value of Walnut

Walnut (*Pukenatia conophora)* seed is a member from Euphorbiaceae family and otherwise known as asala (Western Nigeria), Ukpa (Eastern Nigeria), and conophor (English). It is reported to have high lipid content (Tchiegang *et al*., 2001) carbohydrate, ether extract, moisture, crude fibre,ash, and protein,which are similar to that of soyabean which make it to be used instead of soyabean by farmers (Oladiji *et al*., 2007a). Chemical constituents of walnut seed was on the report of Oladiji *et al*. (2007b) to have crude protein 23.20, lipid 8.20, crude fibre 3.90, carbohydrate 59.10 and moisture 10.80 %. Walnuts are edible seeds of the conophor genus of plants. The walnut tree produces spherical, single-seeded fruits. The walnut's fruit and seeds are encased in a thick, inedible husk.The fruit's hard shell, which encases the kernel, is divided in half.

The walnut fruit's seed contains considerable amounts of nutrients such as carbohydrate, EFAs, vitamins, proteins, and required minerals. The minerals found in

walnuts include Cu, Na, Se,Mg, Ca, Ph, Fe, K, Mn, and Zn. Vitamins include ascorbic acid, pantothenic acid, niacin, thiamin, riboflavin, pyridine, folate, cobalamin, tocopherol, antihemorrhagic vitamin, and provitamin A. Beta-carotene, lutein, and zeaxanthin are some of the carotenoids contained in walnuts. The fatty portion of nuts includes non-cholesterol which are sterols from plant sterols or physterols, group of chemicals also the nuts are cholesterol -free. They are membranes structures that have an important role as non- nutritive component of plants and assist to stabilize phospholipid bilayers similar to the way cholesterols maintain it in animal cell membranes (Sheng *et al*., 2018).

Nuts help to maintain body weight since fats aren't fully absorbed; therefore, they control food intake and aid in energy burn. Nut consumption has been linked to body weight loss. Low risk of chronic disease (diabetes and heart disease) could be as a result of reduced abdominal fat. The body does not properly digest and absorb the fats in nuts. Fat absorption is reduced, which means less energy from nuts is absorbed. Nuts help to reduce food consumptiom by suppressing appetite. The protein, fat, and fiber levels of nuts provide this effect (Tchiegang *et al*., 2001).

Since walnut can be processed (boiled or roasted), eaten raw or added to sauces, confectionaries, and pastries, they are termed important crop of food division. Its sensory qualities, health and nutritional benefits, made it to be well- known all over the world. Kernels are nutrient-dense food due to their high vitamin, fat, protein, and mineral profiles. Walnut kernels also include a range of related polyphenols, flavonoids and phenolic acids (Martinez *et al*., 2010). This secondary metabolites could be blame for variety of therapeutic outcomes. Natural antioxidants, such as phenolic chemicals found in walnuts, have a significant impact on human health because they inhibit macromolecule oxidation and lower the risk of degenerative illness through oxidative stress reduction (Sousa *et al*., 2008). Walnut kernels contain approximately 50-70 % unsaturated fatty acid oil, with linoleic acid (49-63 %) being the most abundant (Ecocrop, 2012).

2.6 Meaning and Chemistry of Antioxidant and Antimicrobial

Compounds in plant with a variety of chemical properties are natural antioxidants. Antioxidants work by preventing the beginning or propagation of oxidative chain reactions, which slows or stops the oxidation of other molecules (Kulistic *et al*.,

2004).Cellular component that are biologically important are protected by natural antioxidant from induced oxidative reactions of reactive oxygen species (ROS) (Velasco and Williams, 2011). Vitamin C, alpha-tocopherol, beta-carotene, different flavonoids, and other phenolic components all contribute to fruit and vegetables extracts antioxidant activity. Studies (Kulistic *et al*., 2004; Velasco and Williams, 2011) observed tocopherol and ascorbic acid activity, as well as their significant radical scavenging capacities. The presence of antioxidants were expressed as reduction of purple- coloured stable free DPPH to yellow- coloured diphenylpicryl hydrazine by donating an electron.

There have been some reports of synergistic benefits between ascorbic acid, tocopherol, and beta-carotene in the fight for reducing or deterring oxidation (Velasco and Williams, 2011). Futhermore, there are three mechanism for antioxidant activity of phenolic compounds which are: singlet-oxygen quenching capacity, free-radical scavenging activity and transition-metal-chelating activity (Zheng *et al*., 2009). Presence of high natural antioxidant such as carvacrol, catechin, quercetin, thymol, cyanidin and gallic acid which are determined via various method in vitamins and phenolic compounds to proposes their antioxidant capacity. Trolox equivalent are used in measuring the foremost phenolic compounds in plant extracts which are: volatile oils (e.g aromatic compounds), phenolic acids (e.g caffeic acid, gallic acid, rosmarinsic acid, and coumaric acid) flavonoids (e.g., catechin and kaempferol), and phenolic ditrepenes (e.g carsonic acid and epirosmanol) (Kumar *et al*., 2014).

Plant extracts have antibacterial effect which could be utilize to extend refridgerated meat shelf life (Chouliara *et al.*, 2007). Application of eugenol, thyme, oregano and clove extracts in higher doses and directly on meat prevent the growth of autochthonous, *L. monocytogenes* and *A. hydrophila* spoilage bacteria than when fed to the animals (Chouliara *et al*,, 2007).*Salmonella typhimurium* and *Escherichia coli* 0157:H7, *Pseudomonas aeruginosa* and *Staphylococcus aureus* (Elgayyar *et al*., 2001) were tested in the laboratory for antibacterial activity using natural antioxidants. Substituting antibiotics as a result of their antibacterial abilities against extensive range of pathogens in livestock, plants essential oils have been utilized (Chao *et al*., 2000). As a result, essential oils show promise as feed additives for improving feed efficiency and preventing disease spread in animals (Chao *et al*., 2000).

2.7 Other Sources of Natural Antioxidants and their uses in Meat and Meat Products

Plants are persistently the generous source to supply man with valuable bioactive substances (Tayel and El-Tras, 2012) and thus different plant products are being evaluated as natural antioxidants to preserve and improve the overall quality of meat and its products. Different parts of the plant material have been used for the extraction of antioxidants like leaves, roots, stems, fruits, seed and bark. Some of these natural antioxidants are also available commercially and several studies have been carried out by different authors applying commercially available natural antioxidants of plant origin to meat. Shad *et al.* (2009) found that clove was most effective in retarding lipid oxidation and presented the highest antioxidant activities on raw pork. Feeding broiler chicken natural antioxidant from different sources have been efficient in enhancing growth, microbiological and immunological parameters of the broiler. Beet roots extracts in the feed of broilers enhanced overall body weight but tomato puree and ginger root extract group reduced the feed conversion ratio of the broilers. The antioxidants in beet root also depressed the bacterial count of the meat products (Selim *et al*., 2013).

There have been effective treatment of meat and its product with grape seed extract to delay lipid oxidation and formation of volatile compounds during storage (Selani *et al*., 2011). Also, pomegranate extract has active constituents which belong to tannins and alkaloids groups that possess strong antimicrobial and antioxidant potentialities (Seeram *et al*., 2006). Chicory (*Cichorium intybus* L.) has tannins, saponnins, flavonoids, terpenoids, cardiac glycosides and anthocyanins in all its parts and also a good source of antioxidants. It has been reported to have a protective role in plants against micro-organisms, insects, unfavourable climatic conditions and damage by animals (Shad *et al*., 2013).

2.8 Meat Quality

The various features in meat is termed meat quality (Maltin *et al*., 2003). Meat compositional quality (lean to fat ratio) are characterized by its palatability factors such as firmness, texture, scent, tenderness, visual appearance, juiciness and colour (Camo *et al*., 2008).The form, flavor,juiciness and tenderness of meat are the most important factors to consider while evaluating its quality (Lawrie and Ledward, 2006).

Spices and cooking methods can improve the scent and juiciness of the meat. Tenderness and flavor, on the other hand, are determined by textural qualities such as meat species composition, age, and so on and so forth (Nasir *et al*., 2017). The ideal level of meat quality combines the ability to keep a high nutritional value when cooked with the ability to fulfill a variety of functional tasks in the processed product.

Natural antioxidants can be added to animal diets, or can be applied on the flesh surface, or active packaging can be used to enhance quality of meat. Lipid oxidation reduction is one of the favourable impacts of natural antioxidants on meat quality (Camo *et al*., 2008), growth of microbial and colour loss (Elgayyar *et al*., 2001). Chaves *et al*. (2008), reported that sensory characterics of sirloins had no effect when essential oil components (carvacrol and cinnamaldehyde) were added to the diet of developing lambs. Similar thing happened when other essential oils were added to diets of pigs'. Coating active packaging with natural antioxidants' as the ability to prevent the creation of off-odours and discoloration in meat (Camo *et al*., 2008).

Some plant extracts have been shown to reduce the production of 2-thibarbituric acid (TBA) or malondialdehyde (MDA mg/kg) in several types of meats during refrigeration storage, hence lowering lipid oxidation. In the study by Tanabe *et al*. (2002), he observed that sage, sansho (*Zanthoxylum piperitum* L.) and ginger (*Zingiber officinale* Rosc.) extract had the highest effect when added to pork flesh thereby reducing lipid oxidation among all the 22 herbs and spices methanolic extracts used. Also, Al-Hijazeen *et al*. (2016) reported the use of oregano and sage essential oils on beef and pork flesh while Govaris *et al*. (2010) observed the use of rosemary and ascorbic acid solution sprayed on meat surface. It was deduced that both researchers observed reduced oxidation during refrigeration. Furthermore, Simitzis *et al*. (2008) reported that during refridgeration and frozen stage of meat that sage, oregano and rosemary essential oils were added to their diet, malondialdehyde production was prevented. In Botsoglou *et al*. (2003) research, prolonging lipid stability of chicken meat in frozen storage was found to be more efficient in supplementation of α-tocopheryl acetate than dietary incorporation of oregano essential oil.

Sensory attributes and stability increase of meat products for better consumer acceptance has recently gained popularity through partial replacement of meat with

extenders, binders, and fillets (Kyriakopoulou *et al*., 2021). Processed meat products offer a variety of flavours and textures to consumers, as well as allow for the effective use of less attractive meat pieces. Augmenting the products of meat with fruits, fibres, seed and vegetables might enhance the nutritional quality of the products as consumers have become more health- concerned (Botsoglou *et al*., 2003).

Quality of meat is mostly recognized by its color. However, consumer associate colour with freshness.Colour, on the other hand, has nothing to do with variances in consumption to satisfaction (Carpenter *et al*., 2001).Changes in meat colour to brown which is unappealing is as a result of red oxymyoglobin oxidation to metmyoglobin (Nerín *et al*., 2006). Extending and delaying the colour of meat from developing into metmyoglobin have been shown in several studies with the use of natural antioxidant. The increased colour characteristics on meat of lambs fed oregano essential oil supplementation (1 mL oregano essential oil /kg) are an example of dietary natural antioxidants altering meat colour (Simitzis *et al.*, 2008).

Some researchers have shown that some vitamins have antioxidant properties that help to prevent colour loss in meat during preservation. Simitzis *et al*. (2008) observed that the enhancement of fresh beef myoglobin stability during storage was best by supplementing Vitamin E (tocopherol) in animal diets at 1300 IU/d while Eikelenbloom *et al*. (2000) reported 2025 mg per day. Injecting sodium ascorbate into beef (4 percent sodium ascorbate into 20 g cut weight) extended the shelf life of meat and improve stability of the meat colour (Mitsumoto *et al*., 2006).

Slaughter weight (Martínez-Cerezo *et al*., 2005), pH, production system and breed (Ekiz *et al*., 2010) are all factors that influence meat colour (Ekiz *et al*., 2010). Consumer approval of poultry meat is influenced by colour, which is an important quality factor. Meat discolouration is induced by oxidation processes and enzyme reducing systems, according to Camo *et al*. (2008). Meat colour could be assayed either visually or reflectance colorimeter. Visual assessment is relatively inaccurate which could not reflect meat colour on an objective level while use of colorimeter are objective (Amano *et al*., 2020). There has been some evidence of a link between colour and pH (Ekiz *et al*., 2010). The lightness, redness and yellowness of the flesh are determined by Commission International de l Eclairage (CIE) L* a* b* system

data (Amano *et al*., 2020) on different regions of the muscular surface are used to determine meat colour with colorimeter.

2.9 Sensory Assessment of Meat and Texture

The scientific approach of measuring, analysing, and interpreting results of products as observed via taste, touch, smell, and the senses of sight is known as sensory evaluation. This help to evaluate appearance, colour, texture, juiciness, tenderness, aroma and flavor. All these tools are measured subjectively (Omojola *et al*., 2004). This functional manifestation and sensory evaluation of a food; the surface properties, structural, and mechanical of foods is known as texture. Assessing texture of meat visually can relate to the mouth feel characteristics by consumer indicating how tender the meat are. However, tenderness only describe a part of texture. Other texture attributes are hardness, chewiness, springiness, cohesiveness and gumminess which can be analyse by a Texture Profile Analysis (TPA) (Lyon and Lyon, 2001). TPA mimicks the human biting action. TPA affects connective tissues and muscle fibres by many histological and chemical alterations.

2.9.1 Appearance

Attraction of products to consumer is by appearance which assist in purchase of meat. Appearance features are used to identify freshness and flavor quality of meat by consumer when purchasing (Lawrie and Ledward, 2006). Some consumer preferred lean meat to fatty meat while some would choose marble meat. Unfavourable effects can be identified by filthy flesh surface, excessive wetness or dryness, or unsightly blood splashes on muscle tissue. Aside colour, other factors of appearance are: Shape, pattern, size, gloss, wholeness, consistency and presence of defects. Measurement can be done for factors of appearance e.g. size can be measured either by dimension, volume, or weight with a fair correlation between weight and size (Wenther, 2003).

2.9.2 Colour

Consumers' initial impression which is of crucial significance is the colour of meat product. There is variation in colour of freshly cut beef from deep purplish red to light grey of faded cured pork. Unprocessed and marinated meat colour depends on myoglobin but enormously differ from each other as a result of their development and overall firmness (Carpenter *et al*., 2001).

Age, sex, meat moisture level, species, processing variables food, intramuscular fat and, preslaughter cicumstances all affect meat colour (Ekiz *et al*., 2010). Red pigment of meat due to myoglobin of muscle pigment determines meat colour. This gives meat its distinctive colour, comparable to the blood pigment haemoglobin.

After ripening, drying, and intensive heat treatment, the colour of fresh meat cured with ingredients such as sodium nitrite, sodium chloride, and others remains red for longer storage periods. Sodium nitrate can combine with red meat pigment to produce a heat- resistant red curing colour (Nasir *et al*., 2017). In view of the fact of preserving effect of the curing salt, cured meat has a longer shelf life than fresh meat. However, cured products, like cooked cured food, decay faster in unfavourable conditions than raw cured products. Cured items will also degrade in quality with time, which can be seen when the red colour fades or changes to grey or green.

2.9.3 Flavour and Aroma

When meat is cooked, it develops flavor. The Maillard reaction, which is subjective to temperature, pH, and texture influences the flavour of meat by the amount of fat in it (Li *et al*., 2021). Brining and marinating can also be used to add flavor to meat. When the denatured protein on the meat surface recombines with the sugar present, the Maillard reactions occur. The mixed results in a beefy flavor and a different colour. When meat is cooked at temperatures between 300 and 500 degress Fahrenheit, the outside of the meat achieves a greater tempersture than the inside, trigerring the Maillard reaction and producing the strongest flavor on the surface. This is also called brownning reaction which is when sugars and amino acids are heated together, then slowly turn to brown (Baek *et al*., 2008).

Oxidative changes in the pork during storage results in undesirable flavour. Rancidity of fat will occur when the fatty acid chains are broken to the points of unsaturation (double bond) by the chemical addition of oxygen. Arshad *et al*. (2017), states that the formulation of carbonyls particularly low molecular weight volatile aldehydes is responsible for the rancid flavour and sharp aroma.

2.9.4 Meat pH

Meat quality is highly determined by pH. The interplay of pH and temperature after slaughter has an influence on meat softness by varying the enzymes activities of

proteolytic (Pouliot *et al*., 2014). The suitable pH for quality meat ranges from 5.4 to 5.7. The point at which pH drops after termination is interrelated to the extent of glycogen present in the muscle before slaughtering. Higher pH (>5.8) results in tougher meat which indicates overstretched animals during pre-slaughter handling and malnourishment (Hannula and Puolanne, 2004). The pH has influence on meat in terms of holding water. An increase in water movement from free to immobilized state, increases the amount of water retained in the meat which is as a result of increase in pH towards the neutral thereby allowing an increase in ionic charges between the muscle fibres. Hence, the higher the water holding capacity of meat with better flavor, juiciness and texture, the higher the pH (Owens *et al*., 2010)

2.10 Lipid Oxidation

Oxidative degradation of polyunsaturated fatty acids that results in an off-odour, off-colour, warmed-over flavor or rancid taste, in broiler meat, decreasing its quality is known as lipid oxidation (Velasco and Williams, 2011). Although oxidative breakdown of PUFAs is the primary cause of lipid oxidation, alterations can occur in tissues as a result of protein reactions with oxidative products (Onyeneho and Heittiarachchy, 1991). Lipases and phospholipases are examples of lipolytic enzymes that cause changes in oxidative of fatty acids. Light and temperature have an impact on the rate of lipid oxidation. During storage, lipid oxidation develops intensely which is influenced by composition of poultry tissue and lipid content (Korzeniowska *et al*., 2018). Also, age, breed and sex of animal influence lipid oxidation rate.

At the onset of slaughtering and during storage, rancidity occurs which is caused by lipid oxidation. Reduction of rancidity is observed in an oxygen –free container and during storage of meat at low temperature. Lipids, on the other hand, may continue to oxidise even when frozen. Off-flavours and lipid oxidation production susceptibility are particular in processed meats (minced and cooked meat). It disrupts inactivating antioxidant enzymes, muscle cell structure and other antioxidant chemicals which releases heme pigments in iron, volatile generation in meat and speeding up lipid oxidation.At the nutritional level, lipid oxidation causes wholesomeness food loss due to loss of aroma and flavour, likewise nutritional deterioration and safety of food properties (Falowo, 2015).

The most widely used approach for detecting oxidative degradation of fat- containing foods is Malondialdehyde (MDA) (Gutierrez-del-Rio *et al*., 2021). Malonaldehyde (MA), is a small component with three or more double bonds for fatty acids, is generated during lipid oxidation due to the destruction of fatty acids polyunsaturated. Its made up of PUFAs that have been broken down, It is commonly utilised as a lipid oxidation process indicator, both for its early presence during oxidation and for the analytical method's sensitivity. It's worth noting that while the oxidation of pure fatty acids is very well understood, a new ways to examine and control oxidative stability in more complex food systems, such as some meat products, are still needed (Van Dyck *et al*., 2005).

2.10.1 Mechanism of Lipid Oxidation

The three-step free radical chain reaction for lipid oxidation includes initiation, propagation, and termination. Wagner *et al.* (2008) found that lipid oxidation sensitivity and susceptibility are determines by number of bisallylic carbons in molecules of lipid the number of bis-allylic. Despite the fact that there was no effect on radical generation rate for the lengthy lipid, lipid oxidation rate rose exponentially with the number of bis-allylic carbons.Direct connection of dissociation energy of carbon-hydrogen (C-H) bonds in fatty acid chains initiate rate of lipid oxidation. C-H weakest bond is bis-allylic bond which has a bond energy of 75-80 kcal/mol while 101 and 80 kcal/mol C-H bond energies were for alkyl and allylic, respectively (Min, 2006). As a result, the bis-allylic position of C-H bond is the most reactive location for hydrogen abstraction. The hydroxyl radicals an example of reactive oxygen species (ROS) are well known species capable of abstracting hydrogen atoms (OH). At neutral pH, the possible reduction for PUFA couple/ PUFA radical was estimated to be +0.60 V, implying that PUFA might be easily reduced by hydroxyl radical (+ 2.31 V) and other reactive oxygen species.

2.10.2 Reactive Oxygen Species (ROS) In Lipid Oxidation

As much as oxygen destroys various cells, they are also important for life. The reason for poisoining by oxygen, leads to an increased generation of reactive oxygen species (ROS) (Velasco and Williams, 2011). Superoxide, nitric oxide, hydrogen peroxide and hydroxyl radical, are all members of the ROS family of oxygen derivatives (Linzner *et al*., 2021). They can be created in the body under normal physiological settings, but

not in quantities that overwhelm the body's natural defense systems. Hydrogen peroxide, hydroxyl radical, superoxide anion, iron-oxygen complexes (perferryl and ferryl), and hydroperoxyl radical are highly reactive oxygen products but short-lived produced through one-electron reduction processes. They all indirectly or direcly participate in lipid oxidation developments in products of meat and meat (Min and Ahn, 2005).

2.10.3 Factors Affecting Lipid Oxidation in Products of Meat and Meat

Directly after slaughtering, lipid oxidation begins and continues during post-slaughtering measures. Through the conversion of muscle to meat, postmortem aging that occur through biochemical changes allows the equilibrium of antioxidant and prooxidant factors disruption (Herrera, 2020). The actions that occur before slaughtering for example physical damage and stress, after slaughtering such as pH, shortening, early post mortem, carcass temperature and tenderizing techniques such as electrical stimulation are the grade of damage on muscle tissue. All these actions influence the extent and rate of lipid peroxidation in tissue of muscle (Min and Ahn, 2005).

Factors that have effect on lipid peroxidation rate in meat and its products are Flaking, deboning (mechanical deboning), grinding, prolonged storage, oxygen,mis-handling temperature, aging time,cooking,composition of raw meat,addittives (antioxidant,spices, nitrites and salt) and distribution (Min, 2006). The fatty acid and lipid content of meat varies depending on location of the anatomical muscle, animal species and muscle type.

Sarraga *et al*. (2002) have reported the importantance of phospholipids in raw and cooked meat that produced lipid oxidation. According to Kakhki (2021), the phospholipid fraction in chicken meat account for about 90 % malonaldehyde in their total fat. Commencement of rancidity associates with phospholipids of PUFA (Kurt, 1999). According to Haak (2007), the oxidative stability of membrane components has a greater impact on lipid oxidation than that of cytosolic components. Early stage of storage is connected to oxidation of phospholipid in lipid peroxidation level (Calhoon, 2016).The quality, quantity and composition of dietary fat in feed and tendency of animal species in storing fatty acids in phospholipids membrane occur due to fatty

acid composition of memebranes and their proneness to lipid peroxidation (Kakhkai, 2021).

Meat's lipid oxidation susceptibility varies by anatomical location, animal species and muscle type (Burnett *et al*., 2020). They found that frozen pork muscle and raw beef increased TBARS values and iron heme value than frozen raw meat of chicken, whereas cooked meat of chicken was more prone to lipid oxidation than cooked pork and beef. Lipid oxidation in cooked meats is the main determination of PUFA level also, by heme pigment content and catalase activity. The breast meat of turkey was less vulnerable to oxidation in thigh meat of turkey (Al- Hijazeen *et al*., 2016).

Also, according to Yim *et al*. (2015) beef is highly prone to lipid oxidation than pork and turkey breast muscles. Oxygen availability is a major variables for lipid oxidation production in cooked and raw meat. Distruptions of membrane operations leading to size reduction (mincing, flaking, grinding etc), frying and deboning, exposes the phospholipids to oxygen which speeds up the development of oxidative rancidity (Min, 2006). Lipid oxidation rate was comparative to oxygen amount in the modified environment and vacuum packaged raw and cooked beef (Minelli *et al*., 2020). According to Santos *et al*. (2016), reduced TBARS was developed during storage for cooked meat that was vacuum- packed while still hot than chilled vacuum packed meat. This implies that 3-hour chilling gave enough time for oxygen to inspire lipid oxidation in cooked meat. Prooxidants like fat content, haemoglobin, NaCl, fatty acid composition and ionic iron, had no influence on the oxidation of cooked beef in the absence of oxygen and during storage.

Further more, addition of antioxidants like free radicals terminators and reducing agents with the combination of hot packaging protects cooked patties from turkey for a better lipid oxidation than using only one treatment. This is as a result of exposing the meat to air and protecting the meat from oxidation with the use of antioxidants (Karre *et al*., 2013).

2.11 Effects of Processing and Preservation methods on Rancidity

Meat processing is a treatment on meat which could be by mechanical, enzymatic, or chemical to improve the form from which it was at a start or it occurs originally. The processing of meat is associated with the removal of dullness that could be associated

with eating it uncooked. Meat processing involve different stages ranging from slaughtering of the animal to cutting into different pieces, probing it to see if its fi for consumption and finally processing or conversion into different products. It has been in practice to preserve meat with various processes such as smoking, salting, drying, heating and cooling to achieve various products with organoleptic characteristics (Lee *et al*., 2020). Predominantly, processing meat is a better way of preserving it and also increases its significance. Conversly, different processing steps, can have an adverse impact on quality of meat and change lipid quality traits. Hot smoking, for example, can damage cell membranes and accelerate lipid oxidation by heating meat and meat products (Braiek and Smaoui, 2021). This have effects on sensory properties and nutritional components of meat produce. Hence, alternative methods of processing and use of antioxidants during processing can reduce these adverse influences.

2.12 Measurement of Degree of Oxidative Rancidity

The degree of oxidation in meat and muscle are measured by several methods. The following are the most prevalent methods:

1. **Thiobarbituric acid reactive substances** (TBARS): Malondialdehyde a product from PUFA is a secondary oxidation. The PUFA has three or more double bonds that interacts with thiobarbituric acid to generate a molecule of pink complex and can be noticed at 532 nm. This method has a disadvantage of forming coloured complexes with other chemicals and TBARS which potentially leads to inaccurate oxidation status estimation (Abeyrathne *et al*., 2021).

2. **Iodine value**: It is unsaturated fatty acid value measurement to indicate its drying capacity and oxidation affluence. It is stated in grams of iodine per 100 grams of sample, indicating unsaturation content in fatty acids. The unsaturation are highly reactive with iodine compounds and are shown in the form of double or triple bonds.The higher the number of iodine, the more reactive and susceptible to oxidation resulting to an increased unsaturated fatty acid linkages in lipid (Gupta and Kanwar, 1994).

3. **The peroxide value**: The principal product of hydroperoxides is measured by peroxide value. Due to the unstability and reaction of peroxides, the results

must be determined carefully. For example, with ongoing oxidation, peroxides increased to a maximum level, after which the speed of the reaction shifts to secondary oxidation products, that are faster, and decrease the peroxide value (Jacobsen *et al*., 2021).

4. **Free fatty acids**: The amount of free fatty acids (FFA) is used in measuring Lipolysis content. However, faster oxidation of free fatty acids than bound fatty acids, can be a measuring guage for muscle's or product's heightened oxidative sensitivity (Abeyrathne *et al*., 2021).

2.13 Health Implication of Rancid Meat and Meat Products

Lipid oxidation has an aspect of organoleptic that were once thought to be the most significant to both producers and consumers. Health hazards associated with lipid oxidation are now receiving a lot of attention. In the body, rancid oil produces damaging free radicals, which can lead to premature aging, high cholesterol levels, obesity, and weight gain. Degenerative disorders such as diabetes, Alzheimer's disease, antherosclerosis and cancer, due to increase daily use of fatty materials and depletion of vitamin B and E in the body thereby hardening the artery walls (Mitu *et al*., 2020).

Peroxides and aldehydes are chemicals that can harm cells and lead to atherosclerosis. Rancid oil produces free radicals, which can damage DNA in cells. Also, the toxic free radicals, as well as those created by normal biological processes, can behave as carcinogens, or cancer-causing compounds (Olorunsanya *et al*., 2009).

A significant health danger may exist if oxidative rancidity is present in large amounts. Rancid meals include high quantities of malonaldehyde. Malonaldehyde is a polyunsaturated fatty acid breakdown product. This substance has been found to be carcinogenic, posing a risk to human health (Racanicci *et al*., 2008).

2.14 Ways of Inhibiting Oxidative Rancidy in Meat and its Products

The increased use of meat that are prepackaged raw and precooked has improved reduction and importance in oxidation. As a result, an extensive variety of substances and conditions are established, ranging from the usage of antioxidants to physical conditions and packing materials, all of which are discussed below.

i. Use of antioxidant

Lipids are kept from oxidizing by using antioxidants (Onyeneho and Heittiarachchy, 1991).There are two types of antioxidants based on their sources: synthetic and natural antioxidants (Karre *et al*., 2013). The synthetic antioxidants are well recognized for their effectiveness and are sourced from inorganic compounds and chemical.Butylated Hydroxyl Toluene (BHT), Tertiary Butyl Hydroxyl Quinone (TBHQ), and Butylated Hydroxyl Anisole (BHA) are examples. Antioxidant can be of naturally occurring origin like tocopherol, spices, ascorbic acid, and herbs like rosemary, ginger, turmeric etc. However, the use of natural antioxidant is becoming more popular recently due to its safety in consumption and additional medicinal advantage in contrast to the synthetic that has been found to have deleterious health effects ranging from carcinogen to mutagen in human body system.

ii. Tocopherol

Animals could be fed diets enriched with a naturally occurring antioxidant (tocopherol) to minimize lipid oxidation (Eikelenbloom *et al*., 2000). This has been shown to have a positive impact on oxidative stability as well as meat sensory qualities. Proteins oxidise during beef preservation, as indicated by the increase in carbonyl value. Lipid oxidation is intrinsically linked to protein oxidation. There is less volatile oxidation products in the meat of animals fed diets supplemented with α-tocopherol.This resulted in a meat with a desirable sensory attribute, such as softness and juiciness (Omojola *et al*., 2014). Tocopherols must be present in the membranes for the meat to be stable. Vitamin E supplementation in the diet is far more beneficial than adding tocopherols to meat after it has been cooked. Protection of membrane lipids against oxidative attack are by naturally occurring antioxidants, such as α-tocopherol.

iii. Ascorbic acid

To obtain an excellent results, it is important to fortify the feed with a stabiliser like vitamin C. The synergistic effect assists in increasing the amount of α-tocopherol that eventually gets to the muscle which would otherwise been neutralised in the Gastro intestinal tract by free radicals, phenols and other oxygen

reactive elements in the feed. The fortified stabilizer takes care of that thus maximising the amount of Vitamin E targeted towards tissues (Lauridsen *et al*., 1995).

iv. Use of spices and herbs

The antioxidative potential of phenolic compounds found in spices and herbs is as a result of their capabilities to act as radical desiccant. Use of various spices have been examined on various products such as meatballs, fish oil, sausages and fish fillet (Tanabe *et al*., 2002). According to Gunes *et al*. (2012), in minimizing unfavourable variation in composition and reducing oxidation, one and half percent of sage was added to meatballs. Spices and herbs have the advantage of being all- natural. Natural antioxidants are preferred by consumers over synthetic antioxidants in their products. A problem could occur when the flavor of the herb or spice offers an intense aftertaste or hinder the product. Ucak *et al*. (2011) reported that incorporating 0.4% rosemary resulted to an enhanced shelf life of meat patties with a goal of achieving an optimal taste, whereas 80 percent of rosemary provided an intense flavour. Tanabe *et al*. (2002), evaluated the antioxidative activities of 22 regularly used herbs and spices added to npork meat in various doses and found that ginger and sage has the highest antioxidant activity.

v. Packaging

Packing should be close and compressed to prevent lipid oxidation by reducing surface area and oxygen access. Nevertheless, this may not fulfill the expectations of consumers in terms of product production, thus compromises will have to be made. During the previous few decades, packaging systems and technologies have advanced at a fast pace. Antimicrobials predominantly prevent the growth and spoilage of bacteria in meat and its products. The maintenance of a deep red colour in red meat is critical since it serves as a consumer indicator of freshness (Simitzis *et al*., 2008). This can be accomplished by maintaining oxygen at high percentage in a modified atmosphere packaging (MAP) also simultaneously inhibiting a higher CO_2 content with bacteria.Park *et al*. (2010) observed that enhanced lipid and colour stability was achieved in a mixture of rosemary and ascorbic acid with modified atmosphere packaging. Also, Eneji *et al*. (2011) researched on the

influence of oxidation in storing differently for rabbit meat patties, they discovered that vacuum packing reduced oxidation.

There are two major types of packaging namely:-

(i) Vacuum packaging which involves depriving air completely from aproduct in a package. This is aimed at decreasing aerobic bacteria growth

(ii) Modified atmospheric packaging which involves replacing air in a pack completely with a single gas or mixture of gasses

CHAPTER THREE

MATERIALS AND METHODS

3.1 STUDY ONE

3.1.1 Chemical Profile of Walnut and Melon seed meal

3.1.2 Location of the study

The study was conducted at the Agricultural Biochemistry and Nutrition Laboratory, Department of Animal Science and the Teaching and Research Farm, University of Ibadan, Ibadan, Nigeria. It is stationed at derived savanna vegetation belt on (latitude 7º22'28.l9" N and longitude 3º58'59.99"E) and above sea level of 273m. Temperature ranges from 21-26^{0}c with a mean annual rainfall of around 1420.06 millimeters and a relative humidity of 74.55 %. The soils are well- drained and are classified as alfisols (Rhodic Kandiustalf) Ajayi *et al*. (2017).

3.1.3 Sample Collection

The seeds of walnut and melon were bought from Oje market in Ibadan Oyo state. The walnut was thoroughly washed and de-kernelled while melon seeds was thoroughly washed and de-hulled, before dividing both seeds into two parts. A part of both walnut and melon were cooked in boiling water at 100 ºC for one hour, then oven dried at 60 ºC for 12 hours till a constant weight was attained. The processed seeds were ground separately while the other half were dried, ground raw and kept for analysis. The seeds were transferred to Central Nutrition Laboratory in the Department of Animal Science for analyses.

3.1.4 Chemical Analysis

3.1.4.1 Proximate composition

The ground seed samples were subjected to a proximate analysis (dry matter, crude protein, ether extract, ash and crude fibre) according to AOAC, (1990). Dry matter of the seeds were determined by thermal treatment at 110 ºC over 48 hours till steady weight was attained. Triplicate (100 mg) samples' for crude protein of walnut and

melon seeds were determined by Kjeldahl method. Ether extract and crude fibre were determined using AOAC (1990) standard techniques. Briefly, after heating 10 g samples in a furnace at 500^{o}C for six hours, the ash content of both samples were determined (in triplicate). The mineral contents were evaluated by the procedures outlined by AOAC (1990). The Nitrogen Free Extract (NFE) was calculated as shown in equation 1 below:

Nitrogen Free Extract (NFE) = 100 – (% ether extract + % crude protein + % crude fibre + % ash + % moisture).……(1)

3.1.4.2 Determination of Phytonutrients in walnut and melon seed meal

Saponin determination was done on dried samples of walnut and melon seed meal with Sofowora, (1996) in which 0.5 g of milled sample was added 5 mL of distilled water in a test tube. The solution was shaken vigorously and observed for a stable persistent froth. Precisely 4 g of each samples were dispersed in 40 mL of 20% ethanol. The suspension was heated over a hot water bath for four hours with continuous stirring at about 55^{o}C. The mixture was filtered and the residue re-extracted with another 40 mL of 20% ethanol. The combined extract were reduced to 40 mL over water bath at 90 ^{o}C. The concentrate was transferred into a 250 mL separator funnel and 20 mL of diethyl ether was added and shaken vigorously. The aqueous layer was recovered while the ether layer was discarded. The purification process was repeated. 60 mL of n-butanol was added. The combined n-butanol extracts were washed twice with 10 mL of 5% aqueous sodium chloride. The remaining solution was heated in a water bath. After evaporating, the samples were dried in the oven to a constant weight in a pre-weighed evaporating dish. The calculation was done on the purified sample as described by Dosumu and Akinnuoye, (2014) as shown in equation 2 below:

$$\% \text{ Saponins} = \frac{W2 - W1}{\text{Weight of sample}} \times \frac{100}{1} \quad \ldots\ldots(2)$$

Where W1 = Weight of evaporating dish;

W2 = Weight of dish + sample

Tannins was determined using the method of Sofowora, (1996) in which a few drop of 0.1 % iron chloride was added and observed for brownish- green or blue- black colouration while colour was determined using tannic acid and measured in a

spectrophotometer at 120 nm wavelength within 10 mins. A blank sample was prepared and the colour also developed and read at the same wavelength. A standard was prepared using tannin acid to get 100 ppm and measured (Emeribe, 2018).

Flavonoids was determined with an indication of red or orange colour using Sofowora, (1996) procedures. About 0.5 g of sample was dissolved in 1.5 mL of 50% methanol and warmed on steam bath. Metallic magnesium and five drops of concentrated hydrochloric acid were added. A red or orange colour indicates the presence of flavonoids.

Terpenoid presence was determined as described by Harbone, (1988). Accurately, 0.2 g of the sample was mixed with 2 mL of chloroform and concentrated hydrogen sulphate H_2SO_4 (3 mL) was carefully added to form a layer. A reddish brown colouration of the interface was formed to indicate positive result for the presence of terpenoids while the total terpenoids was extracted from dried ether extract (Franco and Vazquez, 2020).

Steroids was determined using the method of Harbone, (1973) there, accurately, 1 mL of sample was dissolved in 10 mL of chloroform and equal volume of concentrated sulphuric acid was added by sides of test tube. The upper layer turns red and sulphuric acid layer showed yellow with green fluorescence which indicated the presence of steroids.

Alkaloids determination was by gravimetric technique using alkaline precipitation and precisely, 5 g of each sample was soaked in 100 mL of 10% acetic acid solution of ethanol. The mixture was allowed to stand at room temperature for four hours before it was filtered through Whatman filter paper. The filtrate was reduced to its original volume by evaporation over a steam bath. Alkaloid in the extract was precipitated by drop wise addition of concentrated NH_4OH until full turbidity was obtained. The precipitate was recovered by filtration using a previously weighed filter paper. The precipitate was then washed with 1% NH_4OH solution, dried in the oven at 100 ^oC for an hour. It was cooled in a dessicator and reweighed. By difference, the weight of alkaloid was determined and expressed as a percentage of the sample analysed. (Franco and Vazquez, 2020). This is as shown in equation 3 below:

$$\% \text{ Alkaloid} = \frac{W2 - W1}{\text{Weight of sample}} \times \frac{100}{1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where W1 = Weight of empty filter paper;

W2 = Weight of paper + alkaloid precipitate

Phenol determination was by titration using ammonium hydroxide solution and concentrated amyl alcohol (Okwu and Orji, 2007). Precisely 5 mL of the boiled sample was pipetted into a 50 mL flask, then 10 mL of distilled water was added also, 2 mL of ammonium hydroxide solution and 5 mL of concentrated amyl alcohol were added. The samples were made up to mark and left to react for 30 mins for colour development. The absorbance of the solution was read using a spectrophotometer at 505 nm wavelengths. The phenol content was calculated as shown in equation 4 below:

$$\% \text{ Phenol} = \frac{100}{W} \times \frac{Au}{As} \times C \times \frac{Vf}{1000} \times \frac{D}{Va} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(4)$$

Where W = weight of sample analysed;

Au = Absorbance of the test sample;

As = Absorbance of standard solution

C = Concentration of standard in mg/mL;

Vf = Total filtrate volume;

Va = Volume of filtrate analysed
D = Dilution factor where applicable

Phytate was determined using phytic acid measurement described by Eke *et al*. (2016). Accurately, 2 g of the sample was weighed into 250 mL conical flask, 100 mL of 2% concentrated HCl was to soak the samples in the conical flask for 3hrs and then filtered through a double layer filter paper. Precisely, 50 mL of each sample filtrate were placed in a 250 mL beaker and 107 mL of distilled water was added to improve the acidity. Accurately, 10 mL of 0.3% ammonium thiocynate solution was added to each sample solution as indicator and titrated with standard iron chloride solution

which contained 0.00195 giron/mL and the end point was signified by brownish/yellow colouration that persisted for 5 minute. The percentage phytate was calculated which is as shown in equation 5 below:

Phytate = titre value x 0.000195 x 1.19 x 100 ……(5)

3.1.5 Vitamin Determination

Ascorbic acid was determined by titration method with a standard solution of 2,6 dichlorophenol-di-phenol (Ikewuchi and Ikewuchi, 2011). Tocopherol was determined from a spectrophotomer at 296nm wavelength and Ergocalcipherol was determined using Pyragallol solution and measured in a spectrophotometer at 265 nm wavelength as described (Jakobsen *et al*., 2004) while beta carotene was determined by diffusion and spectrophotometer was used to measure at 328 nm (Parrish, 1977).

3.1.6 Mineral

The samples were ashed for the determination of sodium, potassium and calcium and readings were taken using mineral element specific filter (Rowe, 1973). To the ashed sample, 5 mL 2MHCL was added in the crucible and heated to dryness on a heating mantle. Again, 5 mL of 2MHCL was added to the ash, heated to boil and filtered through Whatman filter paper into a 100 mL volumetric flask. With distilled water, the filtrate was made up to a mark and reading was taken on the Jenway Digital Flame Photometer (PFP7 Model) by using the filter corresponding to each mineral element.

Phosphorus determination was by ashing the sample and measured in an absorbance at 470 nm (Kim and Choi, 2013). Mg, Fe, Zn, Se and Cu were determined using a Buck 200 Atomic absortion spectrophotometer at 202.6, 248.3, 213.9, 196.1, 217.9, respectively (Kim and Choi, 2013).

3.1.7 Diphenylpicrylhydrazyl (DPPH) Analysis

A radical di-phenylpicrylhydrazyl (DPPH) is used as a reagent in the spectrophotometric analysis (Harmanescu *et al*., 2006). Fifty microliters of various concentrations of the extracts in methanol were added to 5 mL of a 0.004% (w/v)

methanol solution of DPPH. After a 30 minutes incubation period at room temperature (in the dark) the absorbance was read against a blank at 517 nm.

3.1.8 Statistical Analysis

Data were subjected to descriptive statistics and analysis of variance (SAS, 2002). Duncan's Multiple Range Test at α- $_{0.05}$ was used to differentiate the means of the treatments.

3.2 STUDY TWO

3.2.1 Characteristics of Meat quality attributes of broiler chickens fed diet supplemented with walnut and melon seed meal

3.2.2 Experimental Site

The experiment was done at Poultry Unit of the Teaching and Research Farm, Department of Animal Science, Faculty of Agriculture, University of Ibadan, Ibadan. University of Ibadan is located on Latitude 7º22'28.l9" N and Longitude 3º58'59.99"E.

3.2.3 Animal Management and Experimental design

Three hundred and thirty-six unsexed one-day old Arbor Acres plus broiler chickens were obtained from a reputed hatchery and reared in the Poultry Unit of the Teaching and Research Farm, University of Ibadan, Ibadan.

The pen was dirt free and formalin fumigated before the arrival of the chicks.To get rid of the odour, the brooder house was left for two days. Wood shavings were used as bedding on the floor. Vaccination and other routine medications were carried out as and when due. During the brooding stage, 100 watt electric lights were installed to offer constant light and heat. A broiler chicken finisher diet with 190 g crude protein kg^{-1} diet and metabolisable energy (ME) of 2931.5 kcal kg^{-1} were fed to the birds. At day 28, to the start of the feeding trial, three hundred and thirty six birds were randomised and divided into seven group,each group comprising of a treatment and replicated six times with eight birds per treatment in a Completely Randomised Design (CRD). An aggregate of 48 birds (both unsexed) were used in each treatment and kept in a deep litter pen. The feed comprised of 3 levels of walnut and melon seed (2, 4, 6 g/kg) each. Feed and fresh cool water were provided *ad-libitum* for two weeks. Table 3.1 shows the gross composition of the experimental broiler feeds. Vaccination, medicine administration and maintaining cleanliness inside and outside the broiler chicken pens were all done on a regular basis.

3.2.4 Experimental diet

- Treatment 1 - Control diet (no walnut / melon meal)

- Treatment 2 – Control diet + 2 g walnut seed meal / kg
- Treatment 3 – Control diet + 4 g walnut seed meal /kg
- Treatment 4 – Control diet + 6 g walnut seed meal/kg
- Treatment 5 – Control diet + 2 g melon seed meal /kg
- Treatment 6 - Control diet + 4 g melon seed meal / kg
- Treatment 7 – Control diet + 6g melon seed meal / kg

3.2.5 Proximate Determinations

Proximate analyses of walnut and melon seed samples were undertaken according to standard methods (AOAC, 1990).

3.2.6 Carcass Yield and Organs Weight

At the end of week six, four chicks were randomly selected from each replicate. The broiler chickens were individually weighed, slaughtered via the jugular vein, and the carcass properly bled. The feathers of the carcass were plucked manually. The carcass were then eviscerated by cutting through the vent while the viscera was removed. The percentage of carcass dressing was estimated using the eviscerated and live weights. Individual weights of the organs namely, the gizzard, heart, liver, intestine, and proventriculus were measured. Also, the shank, head, neck, drumstick, thigh, wings, back, abdominal fat and breast weight were cut out and measured using an electronic scale with a high sensitivity.

3.2.7 Blood collection and analysis

Blood collection from the birds was carried out at week 6. Four birds each were selected randomly and bled through their wing veins with the use of sterile gauge 48 needles and syringes. About 2 mL of blood was collected into a labelled sterile vacutainer tube containing ethylene- diamine-tetra-acetic acid (EDTA). Red Blood Cell (RBC) haemoglobin (Hb), White Blood Cell (WBC) and Packed Cell Volume (PCV) were determined using haemocytometer as described by Ewuola and Egbunike, (2008). Blood indices and corpuscular constants were calculated using appropriate formulae (Van Beekvelt *et al.*, 2001).

Table 3.1 Gross composition (g/100g) of finisher diets fed to broiler chickens (Basal diet)

Ingredients /kg	**%**
Maize	59.10
Soybean meal	30.00
Wheat offal	5.00
Lysine	0.10
Bone meal	2.00
Oyster shell	2.00
Dicalcuim phosphate	1.00
Vit/Mineral premix*	0.50
Salt	0.30
Total	100
Calculated Nutrients	
Crude protein	19.00
Crude fibre	3.24
ME (Kcal/kg	2931.5

Premix supplied (kg -1 diet); 10,000 IU Vit A; 2000 IU Vit D3; 10 IU Vit E; 3mg Vit K; 2.5mg Riboflvin; 0.05mg Cobalamin; 5mg Panthothenic acid; 12.5mg Niacin; 175mg Choline; 0.5mg Folic acid; 2.8mg Manganese; 0.5mg Iron; 2.5mg Zinc; 625mg Cobolt

For serum biochemical indices, 3-4 mL of blood was taken into labelled sterile sample bottles without anticoagulant. The total protein concentration in the serum was determined using Buiret method determined by Wariboko *et al*. (2020). The Bromcresol Green (BCG) method was used to determine albumin, which binds to each other to produce a green component (Keay and Doxey, 1984).

By using an enzymatic colorimetric technique, Alanine aminotransferase (ALT) and Aspartate aminotransferase (AST) were determined (Babson, 1962). The determination of total protein was by burette method (Doumas *et al*., 1975). Urea was determined (Doumas and Biggs, 1972).

3.2.8 Meat Parameters

3.2.8.1 Colour determination

Akonica Minolta Chroma Meter CR- 400 was used to assess the sample's colour (L*, a*,b*values)(Sensing, Japan). L* is known as the lightness and extends from 0 (black) to 100(white) while a* and b* represent redness (+a) to greenness (-a) and yellowness (+b) to blueness (-b) respectively. All measurements were in triplicates for each sample (Tolga and Sukran, 2010).

3.2.8.2 pH

The pH of the meat 24 hours after it was slaughtered was determined with a pH digital meter (model H18424 Micro-Computer, Havanna Instruments, Romania). Accurately, 1g of meat from each treatment was homogenized for 5 minutes with 20mL distilled water using a kitchen blender (Model 242, Nakai, Japan). The pH meter was placed in a buffer solution of 4.0 and 7.0 in order to allow equilibrium for two minutes before inserting into each of the homogenate sample. For each pH value, an average of three readings were used.

3.2.8.3 Shear force value

The meat samples of about 10g each were weighed in thermo-resistant polyethylene bags and cooked to an internal temperature of 72 ^{o}C in a pre-heated pressure cooking pot on an adjustable Pifco Japan Electric hot plate Model (NO ECP 202) as described by Kassim, (2013). The meat samples were removed from the pot and cooled at room temperature (approx. 25 ^{o}C) for 10 minutes. A core sample were taken from each sample parallel to the direction of the muscle fibres with a device called Warner –

Bratzler V- notch blade shear device (Qiaofen and Da- Wan, 62005). The average shear values represented the force values in kilograms/meters^2 (kg/m^2).

3.2.8.4 Water holding capacity

The press method was slightly modified (Apata *et al.,* 2016) was used to assess the water holding capacity (WHC) of meat samples. Briefly, 1g of meat sample was placed between two 9 cm Whatman filter papers (Model C, Caver Inc, Wabash, USA). The meat sample was then pressed between two 10.2 x 10.2 cm^2 plexi glasses at about 35.2 kg/ cm^3 absolute pressure for 1 minute using a table device. The amount of juice released from the sample was measured indirectly by measuring the area of the filter paper wetted relative to the area of pressed sample. A pencil was used to trace out the covered area by the compressed meat sample and the area covered by the let out water onto a piece of tracing paper, and then transferred onto a graph sheet. The areas calculated was used to determine the water holding capacity which was calculated as shown in equation 6 below:

$$\text{Water holding capacity WHC} = \frac{100-(Ar-Am\times 9.47)}{(Wm-Mo)} \text{----------(6)}$$

Where: Aw = Area of water released from meat samples (cm^2)

Am = Area of meat samples (cm^2)

Ar = Area of the meat covered (cm^2)

Wm = Weight of meat samples (g)

Mo = Moisture content of meat samples (%)

9.47= a constant factor

3.2.8.5 Cooking loss

Cooking loss was determined from the meat samples. The uncooked meat was placed in pre-heated water and further boiled on a gas oven till the core temperature of 72^{0}C was reached. Meat samples were then removed and allowed to cool to room temperature. Cooked meat sample were weighed and recorded. Cooking loss was measured after re-weighing the cooked meat samples (Omojola and Adesehinwa, 2007). Cooking loss was calculated as shown in equation 7 below:

Cooking loss (%) =

$$\frac{(\text{Initial weight of sausage} - \text{Final weight of sausage})}{\text{Initial weight of sausage}} \times 100 \quad \ldots\ldots\ldots (7)$$

3.2.8.6 Thermal shortening

Thermal shortening measurement was determined following the modified approach of Panea and Ripoll, (2020). It was calculated as shown in equation 8 below:

$$\text{Thermal shortening \%} = \frac{\text{Length of meat before cooking} - \text{Length of meat after cooking}}{\text{Length of meat before cooking}} \times 100 \quad \ldots \quad (8)$$

3.2.8.7 Proximate Analyses

Official procedures were used to determine the proximate analyses of beef samples (AOAC, 2000). Moisture content, ether extract, crude protein, and ash were all analysed. Kjeldahl assay was used to determine crude protein content. The ether extract was determined by soxhlet device. Moisture was measured by oven drying while ash was measured by burning in a furnace.

3.2.8.8 Analysis of oxidative rancidity

Thiobarbituric acid reactive substances (TBARS) assay technique was used to measure the degree of lipid oxidation for each meat sample per treatment (Cheng and Ockerman, 2013). Precisely, 5 g of each sample was weighed into a conical flask, 10 mL of distilled water was added and homogenised for 2 minutes. Accurately 2mL of 10% trichloroacetic acid (TCA) was added and each was filtered through Whatman No 1 filter paper. Freshly prepared thiobarbituric acid (TBA) was added to each sample filtrate on ratio 1:1. A blank 10mL distilled water, 2 mL of 10% TCA and freshly prepared TBA were prepared in another conical flask. The solutions of each sample and the blank were stirred for 4-5 seconds and stored in the dark for 1hour to develop the colour (slightly reddish colour). Absorbance wavelength was measured using an UV- vis Spectrophotometric (CE1020 model, Cecil-UK) at 530nm.

The results were expressed as mg malonaldehyde (MDA)/kg products using the formulae in equation 9 below:

$$TBA = \frac{OD \times V \times 1000}{A \times v \times I \times Y} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

O.D = Absorbance of test at 530nm

V = Total volume of the reaction mixture

A = Molar extinction coefficient of the product which is 1.56×10^5

I = Length of light path which is 1cm

Y = mg of tissue in the volume of the sample used

v = volume of tissue extract used which is 0.6ml

3.2.8.9 Sensory Evaluation

Twenty trained participants were utilised to examine the cooked meat's sensory evaluation. Colour, flavor, tenderness, texture, juiciness and overall acceptability were assessed with a 9- point hedonic scale (Mavimbela *et al*., 2000). The scale had a minimum score of 1, while the highest score of 9 was for the best condition.

3.2.8.10 Statistical Analysis

The data were subjected to analysis of variance using the procedures of SAS (1999) and means were separated using Duncan multiple range test $\alpha_{0.05}$

3.3 STUDY THREE

Quality of chicken patties treated with walnut and melon seed meal

Experiment One: Quality of chicken patties from broiler chickens fed diets with varying inclusion levels of walnut and melon seed meal

3.3.1 Experimental site

The preparation of patties was conducted at the Animal Products and Processing (Meat Science) Laboratory of the Department of Animal Science, Faculty of Agriculture, University of Ibadan, Ibadan. The location is as described in study two.

3.3.2 Meat and Meat Preparation

Meat from broiler chickens raised and fed dietary inclusion of walnut and melon seed meal in study two were used for the preparation of patties. A total of 8 kg of breast meat were washed from each treatment, divided into five replicate per treatment, trimmed of all visible dirt, fats, skin, bones and homogenised. They were cut into chunks for easy grinding in a meat grinder.

3.3.3 Preparation and packaging of chicken patties

The spices (curry, thyme and pepper) were bought from Bodija market in Ibadan, Oyo state and sorted to remove extraneous matters before being ground and kept in an air-tight container. The ground meat were thoroughly mixed with measured level of seasonings with a mixer for 10 minutes for a better communition. The minced meat was divided into seven equal portions and randomly allotted to each treatment in a randomized completely design with six replicates per treatment. The patties were made using a patty moulder. Data were taken on raw patties for pH, proximate composition, shrinkage, yield and colour. The remaining patties were cooked for 6 - 7 minutes on a pre- heated griller which was on for 10 minutes to achieve a uniform temperature. The patties were turned every minute for even cooking (Dreeling *et al*., 2000). Table 3.2 shows the ingredients for the chicken patties, while Table 3.3 shows the ingredients for the spices.

The treatments were:

- Treatment 1: Meat from broiler fed without walnut and melon (Control)
- Treatment 2: Meat from broiler chickens fed 2g/kg walnut
- Treatment 3: Meat from broiler chickens fed 4g/kg walnut
- Treatment 4: Meat from broiler chickens fed 6g/kg walnut
- Treatment 5: Meat from broiler chickens fed 2g/kg melon
- Treatment 6: Meat from broiler chickens fed 4g/kg melon
- Treatment 7: Meat from broiler chickens fed 6g/kg melon

3.3.4 Parameters measured on meat patties

The parameters measured were cooking loss, pH, colour, proximate composition and oxidative rancidity as determined in study two. Others were: microbiological status, shrinkage, texture profile analysis, sensory evaluation and product yield**.**

3.3.4.1 Product yield

Yield of patties which is the yield of the final product was determined by weighing the patty before and after producing it (Omojola and Adesehinwa, 2007) as described below:

$$\text{Product Yield} = \frac{\text{Weight of product}}{\text{Initial weight of sample}} \times 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

3.3.4.2 Shrinkage

Dreeling *et al*. (2000) procedure was used to determine shrinkage of the patties, which is the reduction in size after cooking. The shrinkage was calculated as summation of difference between thickness of raw and cooked patties and diameter of raw and cooked patties, divided by difference between raw thickness and diameter of patties. The equation is as shown in equation 11 below:

$$\text{Shrinkage (\%)} = \frac{(\text{Raw thickness} - \text{Cooked thickness}) + (\text{Raw diameter} - \text{Cooked diameter})}{\text{Raw thickness} - \text{Raw diameter}} \quad \ldots\ldots (11)$$

3.3.4.3 Texture Profile Analysis

A texture analyser (TA-XT2i, Stable Micro Systems, England) was used to measure the texture profile of newly cooked patties from each treatment. Each patty had a sample collected from the core area, which was allowed to equilibrate to room temperature before being cut into uniform size of 2 cm (wide) x 2 cm (thick). Each was compressed twice with a compression plate (TA11/1000, 20mm) to 80% of its original height at a crosshead speed of 2 mm/ sec through two cycle sequence with a 50 kg load cell and 75 mm compression platen probe (P75) at a pre-tested speed of 2 mm/ sec, a post- test speed of 2 mm /sec, distance 8.5 mm and a trigger of 0.15 N as described by Santhi and Kalaikannan (2014). The following texture profile analysis parameters were determined:

Hardness (N /cm): Resistance to deformation of the sample during maximal compression of the first bite

Springiness or elasticity (cm): The distance between the first and second compressions that the sample recovered its height

Cohesiveness: It is the positive force ratio of the second compression area to the first compression area (A_2/A_1)

Gumminess (N /cm^2): The Force required to breakdown a semi-solid sample for swallowing, it is calculated by multiplying the hardness and cohesiveness of the sample

Chewiness (N /cm): It was measured as the amount of effort required to masticate the sample for swallowing. It is a combination of hardness, cohesiveness and springiness multiplied.

Table 3.2 Composition (%) of patties from broiler chickens fed diets with graded levels of walnut and melon seed meal

Ingredients (%)	Control	Walnut(g/kg)			Melon(g/kg)		
		2	4	6	2	4	6
Breast Meat	70.00	70.00	70.00	70.00	70.00	70.00	70.00
Fat	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Ice	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Binder	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Spices	4.95	4.95	4.95	4.95	4.95	4.95	4.95
Total	100	100	100	100	100	100	100

Table 3.3 Component of Spices for Patties

Spice	Inclusion level (%)
Curry powder	35
Thyme	20
Red pepper	10
Monosodium glutamate	20
Salt	15
Total	100

3.3.4.4 Sensory Determination

Sensory evaluation was conducted on cooked patties using 9- point hedonic descriptive scale, where 9 denotes extremely like, 5 denotes neither like nor dislike and 1 denotes extremely dislike. Colour, taste, overall acceptability juiciness, tenderness, appearance and flavour were judged by a panel of twenty students from the University of Ibadan. The chicken patties were cut into 2 cm^2 bite-size pieces. Patties were coded with alphabets and served randomly. Cracker biscuit and water were served to eat and rinse mouth respectively in- between tasting. Panellist sat independently all through the evaluation period.

3.3.4.5 Microbial count

Bacterial analysis of patties was carried out using three different culture mediums. The MacConkey agar (MA) were used for coliform bacteria, Manitol salt agar (MSA), and nutrient agar (NA) was used for general microbial analysis and for staphylococcus species (Downes and Ito, 2001). One gramme each of sausage samples were weighed into 10ml series peptone water to serve as a stock and diluted serially. The selected dilution factor was plated on the appropriate media using the pour plate technique. The sausage samples were analyzed for Total *E.coli* count (TEC), Total Heterotrophic Count (THC), and Total coliform count (TCC). The set up was incubated at 35 ± 2^0C for 24 – 48 hours (bacteria), at room temperature. Observations were made after the incubation period.

Experiment Two: Quality of chicken patties developed from different inclusion level of walnut and melon seed meal

3.3.5 Experimental site

The preparation of patties was at the Animal Product and Processing (Meat Science) Laboratory of the Department of Animal Science, Faculty of Agriculture, University of Ibadan, Ibadan, Nigeria.

3.3.6 Meat and Meat Preparation

Meat from broiler chickens raised without dietary inclusion of walnut and melon seed meal in Study Two (Control) were used for the preparation. A total of 8kg of breast

meat from each treatment were trimmed of all visible dirt, fats, skin, bones washed, divided into five replicate per treatment and homogenised. They were cut into chunks for easy grinding.

3.3.7 Preparation and packaging of chicken patties

The spices (curry, thyme, pepper, monosodium glutamate and salt) were bought from Bodija market in Ibadan, Oyo state and sorted to remove extraneous matters before being ground into powdery form and stored in an air-tight container. The ground meat were thoroughly mixed with measured level of walnut and melon seed meal and other composition as shown in Table 3.4. The treatments were

- Treatment 1: Patties without walnut and melon (Control)
- Treatment 2: Patties with 2% walnut
- Treatment 3: Patties with 4% walnut
- Treatment 4: Patties with 6% walnut
- Treatment 5: Patties with 2% melon
- Treatment 6: Patties with 4% melon
- Treatment 7: Patties with 6% melon

3.3.8 Parameters measured on meat patties

The parameters measured were Cooking loss, pH, colour, proximate composition and oxidative rancidity as determined in study two. Others were: microbiological status, shrinkage, texture profile analysis, sensory evaluation and product yield as determined in study three experiment one.

Table 3.4 Composition (%) of patties developed with varying inclusion levels of walnut and melon seed meal

Ingredients(%	Control	Walnut			Melon		
		2	4	6	2	4	6
Breast Meat	70.00	70.00	70.00	70.00	70.00	70.00	70.00
Fat	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Ice	15.00	13.00	11.00	9.00	13.00	11.00	9.00
Binder	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Spices	4.95	4.95	4.95	4.95	4.95	4.95	4.95
Walnut (g/kg)	-	2	4	6	-	-	-
Melon (g/kg)	-	-	-	-	2	4	6
Total	100	100	100	100	100	100	100

Experiment Three: Keeping quality and shelf life assessment of patties

3.3.9 Method

Preparation of patties was as in Study 3 Experiments 1 and 2. The cooked patties were kept in freezer and analysed for colour, oxidative stability, microbial count and proximate composition as earlier described in Study 3 Experiments 1 and 2 but for a period of one month at 7 days interval (0, 7, 14, 21, 28).

3.3.10 Statistical Analysis

Data were subjected to descriptive statistics, polynomial regression and one-way analysis of variance (SAS, 2002) while treatment means were separated using Duncan's multiple range test option of the same software at $\alpha_{0.05}$.

CHAPTER FOUR

RESULTS

4.1 Study one

Chemical profile of walnut and melon seed meal

4.1.1 Phytochemical composition of raw and cooked walnut seed meal

Table 4.1 shows the phytochemical composition of raw and cooked walnut seed meal. All evaluated parameters yielded statistically different results ($p < 0.05$) except for saponin which ranged from 24.91 in the raw to 24.62 mg/100 g in the cooked walnut seed meal. The measured parameters reduced in value after cooking except for phytate and flavonoids which increased from 0.49 in the raw to 0.81 mg/ 100 g and 12.51 to 21.13 mg/ 100 g in the cooked walnut, respectively. After cooking, saponin value (24.62 mg/100g) was highest among the phytochemicals while phytate (0.81mg/100g) was the least. Tannins, steroid, terpenoid, alkaloids and phenol (mg/100g) ranged from 20.82 – 16.92; 16.95- 14.90; 32.91- 23.94; 13.06- 9.32 and 1.73- 0.91, respectively.

4.1.2 Phytochemical composition of raw and cooked melon seed meal

Presented in Table 4.2 is the phytochemical composition of raw and cooked melon seed meal. Except for phytate that was not affected significantly by cooking, other measured parameters were different significantly ($p < 0.05$) as a result of cooking for melon seed meal. Flavonoids levels after cooking increased from 20.59 in raw MS to 21.13 mg/ 100 g. Other parameters reduced after cooking from 22.92-17.46 (tannins), 16.26-13.53 (steroids), 23.22-19.22 (saponins), 37.02-22.44 (terpenoids), 5.23 -1.07 (alkaloids) and 1.56 -0.46 mg/100g (phenols).

Table 4.1. Phytochemical composition of raw and cooked walnut seed meal

Parameters(mg/100g)	Raw Walnut	Cooked Walnut
Tannins	20.82 ± 0.58^{a}	16.92 ± 0.42^{b}
Steroid	16.95 ± 0.62^{a}	14.90 ± 0.32^{b}
Saponin	24.91 ± 0.02	24.62 ± 0.01
Terpenoid	32.91 ± 0.01^{a}	23.94 ± 0.02^{b}
Phytate	0.49 ± 0.002^{b}	0.81 ± 0.002^{a}
Alkaloids	13.06 ± 0.02^{a}	9.32 ± 0.02^{b}
Flavonoids	12.51 ± 0.01^{b}	21.13 ± 0.02^{a}
Phenol	1.73 ± 0.002^{a}	0.91 ± 0.001^{b}

[ab-] Means with same superscripts on each row are not significantly different ($p < 0.05$)

Table 4.2: Phytochemical composition of raw and cooked melon seed meal

Parameters(mg/100g)	Raw Melon	Cooked Melon
Tannin	22.92 ± 0.20[a]	17.46 ± 1.09[b]
Steroid	16.26 ± 0.31[a]	13.53 ± 0.92[b]
Saponin	23.22 ± 0.01[a]	19.22 ± 0.02[b]
Terpenoid	37.02 ± 0.02[a]	22.44 ± 0.02[b]
Phytate	0.70 ± 0.002	0.73 ± 0.001
Alkaloids	5.23 ± 0.01[a]	1.07 ± 0.02[b]
Flavonoids	20.59 ± 0.01[b]	21.13 ± 0.02[a]
Phenol	1.56 ± 0.01[a]	0.46 ± 0.03[b]

[ab-] Means with same superscripts on each row are not significantly different ($p < 0.05$)

4.1.3 Proximate composition of raw and cooked walnut seed meal

The proximate composition of raw and cooked walnut seed meal are shown in Table 4.3. Cooking reduced crude protein and crude fiber from 32.24 to 23.78 and 5.39 to 4.10%, respectively. There were increased ether extracts and moisture after cooking from 26.78 to 44.59 (crude protein) and 8.78 to 11.50% (crude fibre), while the ash content reduced insignificantly ($p > 0.05$) from 5.38 to 5.30 %.

4.1.4 Proximate composition of raw and cooked melon seed meal

Presented in Table 4.4 is proximate composition of raw and cooked melon seed meal. The crude protein is different significantly ($p < 0.05$) and ranged from 30.78 % in the raw to 27.63 % in the cooked melon seed meal. The ether extracts of 59.88 to 61.10% the highest while both values in raw and cooked MS, increased after cooking. Crude fibre and ash reduced due to cooking ranging from 0.02 SD in the raw to 0.01 SD in MS. Moisture content increased significantly ($p < 0.05$) from 9.68 to 10.20% after cooking.

Table 4.3: Proximate composition of raw and cooked walnut seed meal

Parameters(%)	Raw walnut	Cooked walnut
Crude protein	32.24±0.01[a]	23.78±0.02[b]
Ether extract	26.78±0.01[b]	44.59±0.01[a]
Crude fibre	5.39±0.01[a]	4.10±0.02[b]
Ash	5.38 ±0.02	5.30±0.02
Moisture	8.78±0.02[b]	11.50±0.01[a]

[ab-] Means with different superscripts on each row are significantly different ($p < 0.05$)

Table 4.4: Proximate composition of raw and cooked melon seed meal

Parameters(%)	Raw melon	Cooked melon
Crude protein	30.78 ±0.02[a]	27.63±0.02[b]
Ether extract	59.88 ±0.02[b]	61.10±0.02[a]
Crude fibre	3.50±0.02[a]	3.10±0.01[b]
Ash	3.50 ±0.01[a]	3.10±0.01[b]
Moisture	9.68±0.02[b]	10.20±0.01[a]

[ab-] Means with different superscripts on each row are significantly different ($p < 0.05$)

4.1.5 Vitamin and Provitamin content of raw and cooked walnut seed meal

The vitamin and provitamin compositions of raw and cooked walnut seed meal are presented in Table 4.5. The tocopherol and ascorbic acid for the raw and cooked walnut seed meal differed significantly ($p < 0.05$). Tocopherol (mg/kg) in the raw walnut seed meal samples (69.40) was significantly higher ($p < 0.05$) than 58.65 in the cooked seed meal while ergocalcipherol in the raw and cooked walnut seed meal which ranged from 0.51 to 0.55 mg/ kg were similar ($p > 0.05$). The provitamin levels before and afterwards ranged from 2.67 to 2.48 mg/kg were also similar ($p>0.05$). Cooking had no influence on the ergocalcipherol concentration of the walnut seed meal, which ranged from 0.51 to 0.55mg/kg ($p > 0.05$).

4.1.6 Vitamin and provitamin content of raw and cooked melon seed meal

The vitamin and provitamin content of the raw and cooked melon seed meal are shown in Table 4.6. Reported values differed significantly ($p < 0.05$) for β carotene and ergocalcipherol which reduced after cooking from 0.16 to 0.13mg/kg and 0.57 to 0.25mg/kg, respectively. Tocopherol and ascorbic acid melon seed meal were not affected by cooking significantly ($p > 0.05$), which ranged from 3.07 to 3.06 mg/kg and 1.56 to 1.47 mg/kg for raw and cooked melon seed meal, respectively.

Table 4.5: Vitamin and provitamin content of raw and cooked walnut seed meal (mg/kg)

Parameters (mg/kg)	Raw Walnut	Cooked Walnut
β carotene	2.67± 0.17	2.48±0.15
Ergocalcipherol	0.51±0.11	0.55±0.05
Tocopherol	69.40±0.10[a]	58.65±0.24[b]
Ascorbic acid	4.41±0.10[a]	3.95±0.26[b]

[ab-] Means with different superscripts on each row are significantly different ($p < 0.05$)

Table 4.6: Vitamin and provitamin content of raw and cooked melon seed meal (mg/kg)

Parameters (mg/ kg)	Raw melon seed	Cooked melon seed
β carotene	0.16±0.01[a]	0.13±0.01[b]
Ergocalcipherol	0.57±0.06[a]	0.25±0.05[b]
Tocopherol	3.07±0.01	3.06±0.02
Ascorbic acid	1.56±0.07	1.47±0.16

[ab-] Means with different superscripts on each row are significantly different ($p < 0.05$)

4.1.7 Mineral composition of raw and cooked walnut seed meal

Presented in Table 4.7 is the mineral composition of raw and cooked walnut seed meal. All measured minerals in walnut seed meal, were significantly lowered ($p<0.05$) after cooking. The Fe reduced significantly ($p < 0.05$) from 51.80 to 48.27 mg/ kg, Zn from 33.59 to 31.60 mg/kg, Cu from 8.10 to 6.13 mg/kg, K from 0.83 to 0.72%, P from 0.44 to 0.34 %, Mg from 0.34 to 0.25 %, Ca from 0.34 to 0.23 %, Na from 0.22 to 0.13 % and Se from 0.11 to 0.06 mg/kg due to the effect of cooking.

4.1.8 Mineral composition of raw and cooked melon seed meal

The mineral composition of raw and cooked melon seed meal are shown in Table 4.8. Cooking had no difference significantly ($p > 0.05$) on Na (0.12 to 0.10 %) and Se (0.05 to 0.04 mg/kg) composition of melon seed meal. Other minerals K (0.63 to 0.47), Ca (0.21 to 0.12), P (0.32 to 0.22), Mg (0.24 to 0.18) %, Fe(45.77 to 41.10), Zn(29.85 to 22.88) and Cu(5.10 to 4.09) mg/kg, reduced significantly ($p < 0.05$) as a result of cooking.

4.1.9 Di-phenyl picryl hydrazil radical scavenging activities of raw and cooked walnut and melon seed meal

The Di-phenyl picryl hydrazil (DPPH) of raw and cooked walnut and melon seed meal are presented in Figure 1. Walnut had a higher antioxidant level compared to melon seed meal. There antioxidant levels which ranged from 88.33 to 85.33 % and 37.67 to 33.67 % in the raw and cooked walnut and melon seed meal, respectively were not unaffected ($p > 0.05$) by cooking.

Table 4.7: Mineral composition of raw and cooked walnut seed meal

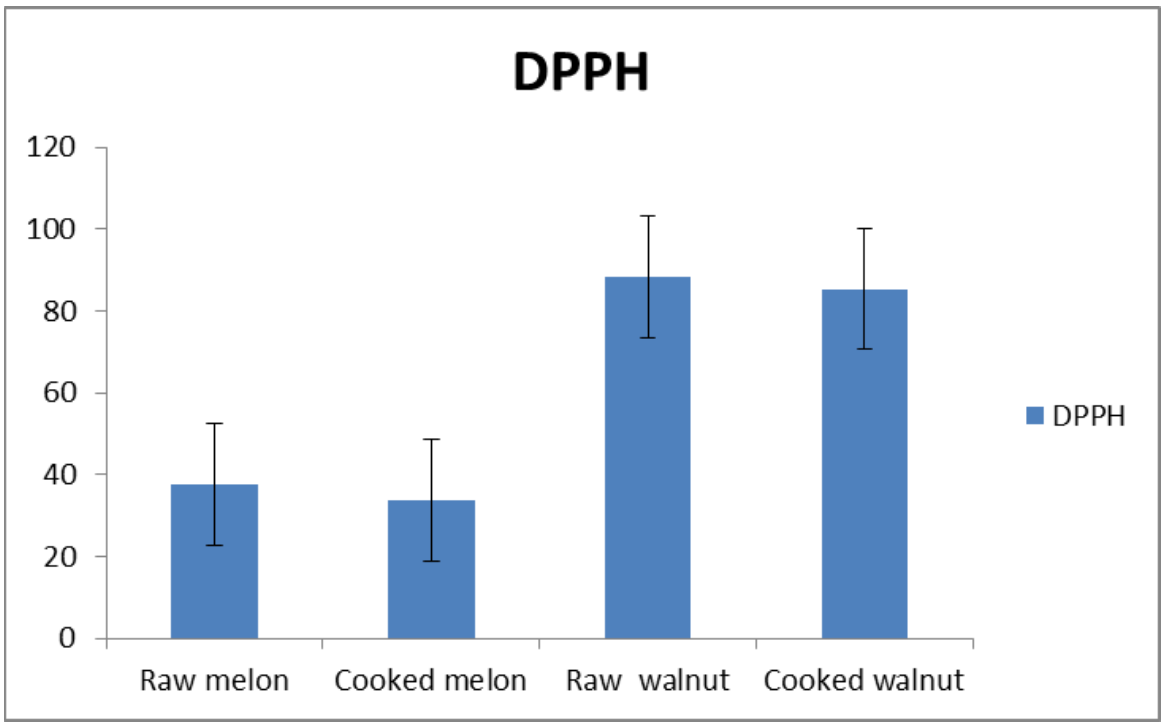
Parameters	Raw Walnut	Cooked walnut
K (%)	0.83±0.02[a]	0.72±0.003[b]
Na (%)	0.22±0.01[a]	0.13±0.003[b]
Ca (%)	0.34±0.004[a]	0.23±0.004[b]
P (%)	0.44±0.01[a]	0.34±0.004[b]
Mg (%)	0.34±0.01[a]	0.25±0.003[b]
Fe (mg/kg)	51.80±0.56[a]	48.27±0.45[b]
Zn (mg/kg)	33.59±0.45[a]	31.60±0.16[b]
Se (mg/kg)	0.11±0.01[a]	0.06±0.005[b]
Cu (mg/kg)	8.10±0.46[a]	6.13±0.25[b]

[ab-] Means with same superscripts on each row are not significantly different ($p < 0.05$)

Table 4.8: Mineral composition of raw and cooked melon seed

Parameters	Raw melon	Cooked melon
K (%)	0.63±0.007[a]	0.47±0.05[b]
Na (%)	0.12±0.003	0.10±0.004
Ca (%)	0.21±0.004[a]	0.12±0.01[b]
P (%)	0.32±0.003[a]	0.22±0.01[b]
Mg (%)	0.24±0.004[a]	0.18±0.01[b]
Fe (mg/kg)	45.77±0.55[a]	41.10±0.26[b]
Zn (mg/kg)	29.85±0.07[a]	22.88±0.32[b]
Se (mg/kg)	0.05±0.004	0.04±0.004
Cu (mg/kg)	5.10±0.26[a]	4.09±0.52[b]

[ab-] Means with different superscripts on each row are significantly different ($p < 0.05$)



Figs 4.1: DPPH Radical scavenging activities of raw and cooked walnut and melon seed meal

DPPH-Di-phenyl picryl hydrazil

4.2 Meat quality characteristics of broiler chickens fed diet supplemented with walnut and melon seed meal

4.2.1 Proximate composition of diets with varying inclusion levels of cooked walnut and melon seed meal

The proximate compositions of diets supplemented with varying inclusion levels of cooked walnut and melon seed meals are presented in Table 4.9. Increased inclusions of walnut and melon seed meal significantly increased ($p < 0.05$) the proximate concentration of the diets. Dry matter of 92.19 % for the control diet and 91.82 (walnut at 2 %), 91.72 (walnut at 4 %), 92.31 (walnut at 6 %) as well as 92.06 (melon seed inclusion at 2 %) 92.52 (melon seed inclusion at 4 %) and 92.10 (melon seed inclusion at 6 %) were significantly different ($p < 0.05$). Cooked walnut seed meal dietary inclusions at 2, 4 and 6 g/ kg resulted in progressive increased crude protein (%) 19.23, 19.38 and 19.61, the ash (%) 9.15, 9.18 and 9.18, ether extracts (%) 3.43, 3.48 and 3.57, and crude fiber (%) 3.59, 3.70 and 3.82, respectively. Cooked melon seed meal inclusion in the diets also resulted in progressive increases proximate crude protein (19.35, 19.57 and 19.80 %), ether extract (3.71, 3.79 and 3.83 %) and crude fibre % (3.56, 3.74 and 3.91), respectively for diets with 2, 4 and 6 % inclusion levels. The diet with no walnut or melon had significantly lower ($p < 0.05$) crude protein (18.80 %), crude fiber (3.53 %), ether extracts (3.38 %) and ash (9.11 %) than other experimental diet.

4.2.2 Processed weights of broiler chickens fed diets with varying inclusion levels of cooked walnut and melon seed meal

The weight of the processed broiler chickens fed with varying dietary supplement of cooked walnut and melon seed meal are shown in Table 4.10. The live weights, body weights, defeathered weights, eviscerated weights, and the dressed weights of chickens on graded dietary cooked walnut seed meal were higher significantly ($p < 0.05$) at inclusion 6 % level equated to those on control and other levels. Also, only the dressed weights of the chickens on melon seed meal diets at 6 % dietary inclusions were significantly higher ($p < 0.05$) equated to those on control, other dietary inclusion levels of cooked melon seed meal as well as those on cooked walnut seed meal.

Table 4.9: Proximate composition of experimental diets supplemented with cooked walnut and melon seed meals fed to broiler chickens

Parameters(%)	Control	Walnut(g/kg)			Melon(g/kg)			SEM
		2	4	6	2	4	6	
Crude Protein	18.80^{c}	19.23^{d}	19.38^{cd}	19.61^{ab}	19.35^{d}	19.57^{bc}	19.80^{a}	0.07
Ash	9.11^{d}	9.15^{c}	9.18^{ab}	9.18^{a}	9.15^{c}	9.15^{c}	9.17^{b}	0.01
Ether extract	3.38^{g}	3.43^{f}	3.48^{e}	3.57^{d}	3.71^{c}	3.79^{b}	3.83^{a}	0.04
Crude Fibre	3.53^{f}	3.59^{e}	3.70^{d}	3.82^{b}	3.56^{c}	3.74^{c}	3.91^{a}	0.03
Dry matter	92.19^{c}	91.82^{f}	91.72^{g}	92.31^{b}	92.06^{c}	92.52^{a}	92.10^{d}	0.06

^{abcdefg}-Means with the same superscripts along each row are not significantly different ($p > 0.05$), SEM-Standard Error of Means

Table 4.10: Processed weights of broiler chickens fed diets with varying inclusion levels of cooked walnut and melon seed meal

Parameters	Control	Walnut(g/kg)			Melon(g/kg)			SEM
		2	4	6	2	4	6	
LW (g)	1340.50^{b}	1357.50^{b}	1372.33^{b}	1628.83^{a}	1343.67^{b}	1357.17^{b}	1416.17^{b}	22.67
BW (g)	1275.50^{b}	1306.17^{b}	1317.17^{b}	1485.17^{a}	1269.17^{b}	1289.00^{b}	1361.50^{b}	17.50
DFW (g)	1166.00^{b}	1214.67^{ab}	1219.50^{ab}	1323.00^{a}	1199.33^{ab}	1214.17^{ab}	1242.67^{ab}	16.15
EVW (g)	1012.50^{ab}	1071.83^{ab}	1064.67^{ab}	1099.00^{a}	955.00^{b}	1083.17^{a}	1019.67^{ab}	15.60
DRW (%)	56.31^{c}	62.53^{a}	64.61^{a}	64.62^{a}	58.13^{bc}	61.22^{ab}	63.21^{a}	0.68

^{abc}-Means with different superscripts on each row are significantly different ($p < 0.05$),LW-Live Weight, BW-Bled Weight, DFW-Defeathered Weight ,EVW-Eviscerated Weight, DRW- Dressed weight SEM-Standard Error of Means

4.2.3 Relative weights of internal organs of broiler chickens fed increased dietary supplememtation levels of cooked walnut and melon seed meal

The internal organs relative weights for broiler chickens fed varying dietary inclusion levels of cooked walnut and melon seed meal are shown in Table 4.11. The varying dietary inclusion levels of walnut and melon seed meal significantly ($p < 0.05$) increased the relative weights of internal organs of broiler chickens except for the liver weights which were similar ($p > 0.05$). Dietary cooked walnut and melon seed meal at 6 g/kg (2.09 and 2.07 g/kg) and 4 g/kg (2.01 and 2.09 g/kg), respectively, were comparable ($p > 0.05$) but significantly higher than obtained at 2 g/kg (1.94 and 1.97 g/kg).

Spleen (%) had the lowest value at control (0.09), followed by inclusion level of walnut at 4 and 6 g/kg which were similar (0.10) while the highest was melon inclusion at 4 g/kg (0.25). Walnut inclusion at 6 g/kg had the lowest value for intestine (5.77 %) while melon at 4 g/kg had the highest value of 7.63 %. The weight of gizzard fed control was highest for 4.77 %, those fed walnut at 2 (4.75%), 4 (4.04%) and 6 (3.7%) reduced. Has inclusion of melon increased at 2, 4, 6 g/kg, gizzard weight increased 4.26, 4.70, 4.61 %, respectively.

Proventriculus was significantly highest (0.79) for broilers fed 4 g/kg WSM while control was significantly lowest (0.52 %). Abdominal fat of broilers fed 6g/kg inclusion level of melon was the highest (1.56) ($p < 0.05$) as related to control having the least (0.61) ($p < 0.05$) abdominal fat.

4.2.4 Relative weight of primal cut of broiler chicken fed dietary inclusion levels of cooked walnut and melon seed meal

Presented in Table 4.12 is relative weight of primal cut of broiler chicken fed increased diet supplementation of cooked walnut and melon seed meal. Walnut and melon seed meal inclusion increased significantly for all parameters of primal cut except thigh and breast.

Broiler fed cooked melon seed meal at 4 g/kg had significantly ($p < 0.05$) higher drum stick (10.28 %), wings (8.36 %) and back (13.11 %) while the least were for control 7.73, 6.79 and 8.93 %, respectively for those on control. There was a steady increase in the relative weights of primal cut with increased inclusion level of walnut and melon till 4 g/kg which fells or lowered at 6 g/kg inclusion for all parameters except breast weights of broiler chicken on dietary melon seed at 2 (16.89), 4 (16.41) and 6 (16.84) g/kg.

Table 4.11: Relative weights of internal organs of broiler chicken fed varying dietary levels of cooked walnut and melon seed meal

Parameters (%)	Control	Walnut (g/kg)			Melon (g/kg)			SEM
		2	4	6	2	4	6	
Liver	2.04	1.94	2.01	2.09	1.97	2.09	2.07	0.32
Spleen	0.09^{b}	0.15^{ab}	0.10^{b}	0.10^{b}	0.22^{a}	0.25^{a}	0.22^{a}	0.02
Intestine	6.69^{ab}	6.41^{b}	6.64^{ab}	5.77^{b}	6.75^{ab}	7.63^{a}	6.78^{ab}	0.14
Gizzard	4.75^{a}	4.77^{a}	4.04^{ab}	3.79^{b}	4.26^{ab}	4.70^{a}	4.61^{a}	0.10
Proventriculus	0.52^{d}	0.54^{cd}	0.79^{a}	0.55^{cd}	0.70^{abc}	0.75^{ab}	0.61^{bcd}	0.02
Abdominal fat	0.61^{c}	0.89^{bc}	1.08^{abc}	1.24^{ab}	1.13^{ab}	1.42^{ab}	1.56^{a}	0.08

abcd-Means with different superscripts on each row are significantly different ($p < 0.05$), SEM-Standard error of means

Table 4.12: Relative weights of primal cut of broiler chicken fed varying dietary inclusion levels of cooked walnut and melon seed meal

Parameters(%)	Control	Walnut(g/kg)			Melon(g/kg)			SEM
		2	4	6	2	4	6	
Drumstick	7.73[b]	9.46[a]	9.97[a]	9.53[a]	9.98[a]	10.28[a]	10.27[a]	0.18
Thigh	8.13	9.06	9.10	8.49	8.90	9.18	9.03	0.13
Wings	6.79[c]	7.67[abc]	7.99[ab]	7.03[bc]	7.94[ab]	8.36[a]	7.90[ab]	0.14
Back	8.93[c]	10.27[bc]	10.53[b]	10.88[b]	11.75[ab]	13.11[a]	12.69[a]	0.27
Breast	16.51	16.39	18.72	16.82	16.89	16.41	16.84	0.32

[abc]-Means with same superscripts along each row are not significantly different ($p < 0.05$), SEM-Standard Error of Means

4.2.5 Haematological indices of broiler chickens fed varying dietary inclusion levels of cooked walnut and melon seed meal

Haematological indices of broiler chickens fed diet supplemented with cooked walnut and melon seed meal is presented in Table 4.13. Significant difference ($p < 0.05$) were observed in all the haematological indices except lymphocytes and MCHC with similar values ($p > 0.05$).

The WBC was significantly at 6 g/kg walnut inclusion (17.32 µl) while least was at 2 g/kg walnut inclusion (12.21 µl). Inclusion level of melon at 6 g/kg to broiler chicken diet had highest packed cell volume (31.72 %) while control had the least (24.31 %).

Haemoglobin value increased steadily as walnut seed meal inclusion level increased in broiler chickens diet (9.61, 10, 10.21 g/dL) while inclusion level of melon seed at 2, 4 and 6 g/kg were 10.30, 9.11 and 10.40 g/dL, respectively and control was 7.90 g/dL. Red blood cell increased in value as inclusion level increased for walnut (2.42, 3.54 and 3.62 µl) as compared to control (2.11 µl) but inclusion of melon seed at 2, 4 and 6 g/kg were 3.42, 3.01 and 3.61 µl, respectively.

There was no difference significantly ($p > 0.05$) for the platelet of broilers fed cooked varying inclusion level of melon seed meal 2 (1.38), 4 (1.46) and 6 g/kg (1.44 µl) but for walnut inclusion, highest was at 4 g/kg inclusion (1.66 µl) and least was at 2 g/kg (1.27 µl). Neutrophil was highest at 4 g/kg inclusion level of melon seed for 33.31 mL while the least was inclusion of walnut at 6 g/kg.

Monophil reduced significantly as inclusion level of walnut increases (2.71, 2.02, 4.71 mL) as compared to control (3.02 mL) while as inclusion of melon increases (2, 4 and 6 g/kg) monophil level increased (3.72, 3.73 and 4.33 mL). Eosinophils was highest ($p < 0.05$) at 4 g/kg walnut inclusion (5.02 mL) and least at 2 g/kg walnut inclusion (3.02 mL). Basophil was significantly highest at 6 g/kg melon (1.03 mL) and 2 g/kg walnut (1.00 mL) while it was significantly least at 6 g/kg walnut, 4 g/kg melon and control which were all similar (0.02 mL).

The MCV of broilers fed 2 g/kg WSM (127.50 fL), 4 g/kg MSM (106.04 fL) and control were significantly ($p < 0.05$) similar and higher than broiler chickens fed 4 g/kg WSM (89.72 fL), 6 g/kg WSM (87.98 fL), 2 g/kg MSM (79.22 fL), 4 g/kg MSM (106.04 fL) and 6 g/kg MSM (88.14 fL). The MCH (pg) of broiler chicken fed 2 g/kg WSM (46.22), control (39.41) and 4 g/kg MSM (35.05) were similar but higher than

those fed 4 g/kg WSM (28.32), 6 g/kg WSM (28.50), 2 g/kg MSM (27.10), and 6 g/kg MSM (28.87).

4.2.6 Serum biochemical indices of broiler chickens fed dietary inclusion level of walnut and melon seed meal

Table 4.14 shows the serum biochemical indices of broiler chickens fed increasing dietary supplement of walnut and melon seed meal. Glucose (mg/dl) increased steadily from control (145) to increase in inclusion level of walnut 2 (146.61), 4 (197.92) and 6 (131.30) g/kg and melon 2 (154.22), 4 (171.10) and 6 (185.50) g/kg. AST (i.u /L) had the highest significant difference ($p < 0.05$) at 6 g/kg MSM (70.90) than other treatments. ALT (i.u /L) increased significantly as inclusion level of WSM (3.80, 4.41, and 5.30) and MSM (5.90, 6.22 and 7.32) increases when compared to control (3.60).

Total cholesterol increased steadily as inclusion level of walnut and melon increases. Broiler chicken fed 6g/kg waln had the highest significant value (155.21mg/dL), while control had the lowest significant value (67.81 mg/dL). Albumin varied significantly among treatment with inclusion level of 4 and 6 g/kg WSM having same value (2.31 g/dL) while there was reduction significantly as inclusion level of MSM increases (2.12, 2.0 and 1.90 g/dL). Urea (mg/dL) increased significantly as inclusion level of WSM (5.13, 7.50, 11.01) and MSM (4.40, 8.50 and 10.60) increased.

Table 4.13: Haematological indices of broiler chickens fed dietary inclusion levels of cooked walnut and melon seed meal

		Walnut(g/kg)			Melon(g/kg)			
Parameters	Control	2	4	6	2	4	6	SEM
PCV(%)	24.31^{b}	27.32^{ab}	31.70^{a}	31.32^{a}	32.02^{a}	26.70^{ab}	31.72^{a}	0.87
Hb(g/dl)	7.90^{b}	9.61^{ab}	10.00^{a}	10.21^{a}	10.30^{a}	9.11^{ab}	10.40^{a}	0.27
RBC(10^{6}µl)	2.11^{c}	2.42^{bc}	3.54^{a}	3.62^{a}	3.42^{ab}	3.01^{abc}	3.61^{a}	0.16
WBC(10^{9}µl)	12.21^{c}	14.20^{ab}	17.21^{b}	17.32^{a}	17.00^{ab}	12.21^{c}	15.41^{b}	5.95
Platelet(10^{9}µl	1.42^{b}	1.27^{b}	1.66^{a}	1.41^{b}	1.38^{b}	1.46^{b}	1.44^{b}	0.003
LYM(/mL)	67.71	65.02	66.71	63.02	66.71	61.72	64.31	0.77
NEUT(/mL)	25.70^{ab}	29.00^{ab}	26.32^{ab}	25.31^{a}	26.02^{ab}	33.31^{a}	27.70^{ab}	0.94
MONO(/mL)	3.02^{bc}	2.71^{c}	2.02^{c}	4.71^{a}	3.72^{abc}	3.73^{ab}	4.33^{ab}	0.22
EOS(/mL)	3.30^{ab}	3.02^{b}	5.02	3.33^{ab}	3.31^{ab}	4.31^{ab}	3.72^{ab}	0.22
BASO(/mL)	0.02^{b}	1.00^{a}	0.00^{b}	0.02^{b}	0.71^{a}	0.02^{b}	1.03^{a}	0.11
MCV(fL)	122.70^{a}	127.50^{a}	89.72^{b}	87.98^{b}	79.22^{b}	106.04^{ab}	88.14^{b}	5.07
MCH(pg)	39.41^{ab}	46.22^{a}	28.32^{b}	28.50^{b}	27.10^{b}	35.05^{ab}	28.87^{b}	1.91
MCHC	33.21	33.52	33.20	33.30	33.42	33.23	33.28	0.50

[abc]Means with different superscripts on each row are significantly different ($p < 0.05$); SEM- Standard Error of Means: PCV; Pack cell volume: Hb; haemoglobin: RBC; Red blood cell: WBC: white blood cell: MCV; mean corpuscular volume: MCHC; mean corpuscular haemoglobin concentration: MCH: mean corpuscular haemoglobin LYM-Lymphocytes,NEUT-Neutrophil,Monophil,EOS-Eosinophils,BASO-Basophils

Table 4.14: Serum biochemical indices of broiler chickens fed dietary inclusion levels of cooked walnut and melon seed meal

Parameters	Control	Walnut(g/kg)			Melon(g/kg)			SEM
		2	4	6	2	4	6	
Glu(mg/dL)	145.00^{c}	146.61^{c}	197.92^{a}	131.30^{d}	154.22^{c}	171.10^{b}	185.50^{a}	5.14
AST(i.u/L)	45.01^{b}	45.41^{b}	48.82^{b}	53.31^{b}	51.92^{b}	53.50^{b}	70.90^{a}	2.42
ALT(i.u/L)	3.60^{b}	3.80^{b}	4.41^{ab}	5.30^{ab}	5.90^{ab}	6.22^{ab}	7.32^{a}	0.42
T.CHOL.(mg/dL)	67.81^{d}	107.92^{bc}	115.21^{b}	155.21^{a}	101.81^{c}	112.30^{bc}	119.90^{b}	5.50
ALB(g/dL)	1.70^{c}	1.82^{bc}	2.31^{a}	2.31^{a}	2.12^{ab}	2.10^{abc}	1.90^{bc}	0.06
T.P(g/dL)	4.40^{c}	5.91^{b}	6.01^{ab}	7.32^{a}	6.21^{ab}	6.62^{ab}	5.20^{bc}	0.23
UR(mg/dL)	4.71^{c}	5.13^{c}	7.50^{bc}	11.01^{a}	4.40^{c}	8.50^{ab}	10.60^{a}	0.65

^{abc}Means with different superscripts on each row are significantly different ($p < 0.05$); SEM- Standard Error of Means: Glu-Glucose; AST- Aspartate Amino Transferase; ALT- Alanine Amino Transferase; T.CHOL- Total Cholesterol; ALB- Albumin; T.P- Total Protein; UR- Urea.

4.2.7 Colour of raw meat of broiler chickens fed varying dietary inclusion of walnut and melon seed meal

The colour parameters of raw meat of broiler chickens fed varying dietary inclusion of WSM and MSM is shown in Table 4.15. Broiler meat from chicks fed the control diet (60.93) and 2 g/kg WSM (59.17) were significantly higher ($p < 0.05$) than other treatments while meat of broiler chickens fed 2 g/kg MSM had the lowest significant difference ($p < 0.05$) of 53.33.

The redness (a*) was not influenced ($p < 0.05$) by MSM inclusion and ranged from 1.21 to 1.23, while the highest value for the raw meat was obtained in broiler chicken on control diet (1.27) and least in 6 g/kg WSM inclusion (1.08). The yellowness (b*) of raw broiler chickens on control diet (12.20) and 2 g/kg WSM (12.02) were higher ($p < 0.05$) than other treatments.

4.2.8 Proximate composition of meat of broiler chickens fed varying dietary inclusion levels of cooked walnut and melon seed meal

Proximate composition of meat of broiler chickens fed varying dietary inclusion levels of cooked walnut and melon seed meal was shown in Table 4.16. Except for ether extract, the values obtained for all of the parameters examined were significantly different ($p < 0.05$). Moisture of meat of broiler chicken fed melon at 2 g/kg had highest significant value of 71.56 % while 2 g/kg WSM inclusion had the least significant of 70.76 %.

There was steady increase in crude protein as inclusion level of WSM and MSM increased in diet of broiler chickens, with MSM supplemented at 6 g/kg having highest significant value of 21.74 % when compared to 4 g/kg MSM having least significant value of 21.21 %. Ash (%) increased as inclusion level of WSM increased at 2 (1.53), 4 (1.72) and 6 g/kg (1.83). Also, melon inclusions increased steadily (0.61, 0.90 and 1.30 %) but lower when compared to control (1.47 %).

Table 4.15: Colour of raw meat of broiler chickens fed varying dietary inclusion levels of cooked walnut and melon seed meal

		Walnut(g/kg)			Melon(g/kg)			
Parameter	Control	2	4	6	2	4	6	SEM
L*	60.93[a]	59.17[ab]	58.30[bc]	57.93[bc]	53.33[d]	57.00 [c]	56.67[c]	0.53
a*	1.27 [a]	1.16[c]	1.12[d]	1.08 [e]	1.21[b]	1.21[b]	1.23[b]	0.01
b*	12.20 [a]	12.02[a]	11.43[b]	11.40[b]	11.43[b]	11.63[b]	11.53[b]	0.01

[abc]-Means with different superscripts on each row are different significantly ($p < 0.05$), SEM-Standard Error of Means. L*- Lightness, a*- redness and b*- Yellowness

Table 4.16: Proximate composition of meat of broiler chicken fed varying dietary inclusion levels of cooked walnut and melon seed meal

Parameters(%)	Control	Walnut(g/kg)			Melon(g/kg)			SEM
		2	4	6	2	4	6	
Moisture	71.17[a]	70.76[b]	71.32[a]	70.51[b]	71.56[a]	71.20[a]	71.44[a]	0.08
Crude protein	21.27[b]	21.52[ab]	21.42[ab]	21.61[a]	21.52[ab]	21.21[b]	21.74[a]	0.05
Ether extract	6.10	6.20	6.33	6.25	6.15	6.31	6.25	0.03
Ash	1.47[ab]	1.53[ab]	1.72[a]	1.83[bc]	0.61[c]	0.9[bc]	1.3[ab]	0.10

[abc]-Means with the same superscripts along each row are not significantly different ($p > 0.05$), SEM-Standard Error of Means

4.2.9: Physico-chemical properties of broiler chicken meat fed dietary inclusion level of cooked walnut and melon seed meal

Summary presented in Table 4.17 gives physico-chemical properties of broiler chicken meat fed dietary inclusion level of cooked walnut and melon seed meal. The values obtained for all the parameters measured were significantly ($p < 0.05$) different.

Cooking loss (%) in broiler chicken meat increased as dietary inclusion level of WSM increases. Cooking loss was highest ($p < 0.05$) in broiler chickens fed 6 g/kg WSM (43.51) compared to broiler chicken meat from other treatments. Thermal shortening was highest at inclusion level of WSM at 4 g/kg (46.27 %) while the least was at 6 g/kg MSM inclusion (24.36 %). Water holding capacity (WHC %) of broiler chicken meat fed 6 g/kg MSM (74.15) was higher significantly ($p < 0.05$), than MSM at 2 g/kg (64.71), 4 g/kg (71.16), WSM at 2 g/kg (56.64), 4 g/kg (54.70), 6 g/kg (51.94) and control diet (65.87). Shear force (kg/ m^2) increased significantly as inclusion level of walnut increased (1.04, 1.05 and 1.09) as compared to control (1.00), while inclusion of MSM was significantly similar in value which ranged from 1.06 to 1.081.

pH was significantly highest and same for control (5.54), at 2 g/kg (5.51) and 4 g/kg (5.44) WSM inclusion while the least was at 6 g/kg MSM (5.26).

Table 4.17: Physico-chemical properties of broiler chicken meat fed varying dietary inclusion level of cooked walnut and melon seed meal

Parameter	Control	Walnut(g/kg)			Melon(g/kg)			SEM
		2	4	6	2	4	6	
Cooking loss(%)	31.97^{b}	35.51^{b}	35.98^{b}	43.51^{a}	32.30^{b}	27.38^{c}	24.43^{c}	1.37
Thermal shortening(%	45.43^{ab}	32.77^{c}	46.27^{a}	40.61^{b}	45.39^{ab}	25.78^{d}	24.36^{d}	2.03
WHC (%)	65.87^{c}	56.64^{d}	54.70^{b}	51.94^{d}	64.71^{c}	71.16^{b}	74.15^{a}	2.13
Shear force(kg/m^2)	1.00^{d}	1.04^{cd}	1.05^{bc}	1.09^{a}	1.06^{abc}	1.08^{ab}	1.08^{ab}	0.01
pH	5.54^{a}	5.51^{a}	5.44^{a}	5.36^{c}	5.30^{c}	5.43^{b}	5.26^{d}	0.02

^{abcd}-Means with different superscripts on each row are significantly different ($p < 0.05$), WHC-Water Holding Capacity, SEM-Standard Error of Means

4.2.10: Organoleptic traits of broiler chicken meat fed varying dietary inclusion level of walnut and melon seed meal.

Organoleptic traits of meat of broiler chickens fed increased dietary supplement of walnut and melon seed meal is shown in Table 4.18. The organoleptic traits of the broiler chicken meats increased significantly ($p < 0.05$) as inclusions of walnut and melon seed meal in the diets increased. Dietary cooked WSM inclusion at 4 g/kg (4.30), 6 g/kg (4.20), MSM inclusion at 2 g/kg (3.90) and 6 g/kg (3.80) were similar significantly in colour but significantly higher than those obtained at 2 g/kg WSM and control diet (3.10). The flavour of broiler chicken meat at 4 g/kg WSM inclusion (4.50), 6 g/kg (4.30) and MSM inclusion at 4 g/kg (4.00) were similar and higher significantly ($p < 0.05$), compared to control with least significant difference ($p < 0.05$) of 3.00. Broiler chicken fed 6 g/kg MSM (6.00) was the best in terms of tenderness while those fed WSM at 2 g/kg (5.60) was the least. Texture of the broiler chicken meat of 6.20 (melon seed inclusion at 6 g/kg) had highest significant value compared to 5.70 for control diet, 6.00 (walnut at 2 g/kg), 5.50 (walnut 4 g/kg) 4.80 (walnut 6 g/kg) also 5.90 (melon seed inclusion at 2 g/kg) and 5.40 (melon at 4 g/kg).

Juiciness was highest ($p < 0.05$) for broiler chicken fed 6 g/kg of melon (6.00), broiler chicken fed 4 g/kg walnut (5.90) while 6 g/kg walnut and 2 g/kg melon had similar value of 5.80.

Meat from broiler chicken fed melon at 6 g/kg had the highest overall acceptability (7.10) with control having the least (6.00) while others were 6.50 (2 g/kg WSM), 6.80 (4 g/kg WSM), 6.90 (6 g/kg WSM), 6.10 (2 g/kg MSM) and 7.00 (4 g/kg MSM).

Table 4.18: Organoleptic trait of meat of broiler chicken fed varying dietary inclusion level of walnut and melon seed meal

		Walnut(g/kg)			Melon(g/kg)			
Parameter	Control	2	4	6	2	4	6	SEM
Colour	3.10^{d}	3.40^{d}	4.30^{ab}	4.20^{ab}	3.90^{abc}	3.70^{bc}	3.80^{abc}	0.08
Flavour	3.00 ^{d}	3.80^{bc}	4.50^{a}	4.30^{ab}	3.40^{c}	4.00^{ab}	3.80^{bc}	0.08
Tenderness	5.90^{ab}	5.60^{b}	5.90^{ab}	5.80^{ab}	5.80^{ab}	5.80^{ab}	6.00^{a}	0.05
Texture	5.70^{ab}	6.00^{ab}	5.50^{ab}	4.80^{b}	5.90^{ab}	5.40^{ab}	6.20^{a}	0.60
Juiciness	4.10 ^{c}	5.10^{b}	5.90^{a}	5.80^{a}	5.80^{a}	5.20^{b}	6.00^{a}	0.09
Overall acceptability	6.00^{c}	6.50^{b}	6.80^{a}	6.90^{a}	6.10^{c}	7.00^{ab}	7.10^{a}	0.06

^{abc}-Means with different superscripts on each row are significantly different ($p < 0.05$), SEM-Standard Error of Means

4.3 Quality of chicken patties treated with walnut and melon seed meal

4.3.1: Physico-chemical properties of patties developed from broiler chickens fed varying dietary inclusion of cooked walnut and melon seed meal

Table 4.19 shows the physico-chemical parameters of patties from broiler chickens fed varied levels of cooked walnut and melon seed in their diet. Inclusion of cooked WSM dietary at 2, 4 and 6 g/kg gave rise to progressive increased yield (%) 70.50, 71.27 and 71.53 of patties from broiler chicken meat, the pH of cooked patties 5.74, 5.77 and 5.77 and shrinkage (%) 18.55, 18.73 and 18.65, respectively. Cooked MSM inclusion in the diets also resulted in progressive increase in yield of patties (70.23, 71.53 and 72.23 %), pH of cooked patties (5.73, 5.71 and 5.71) and shrinkage (18.45, 18.56 and 18.53 %), respectively for diets with 2, 4 and 6 g/kg inclusion levels. The control diet had significantly lowest ($p < 0.05$) yield (64.23 %) also shrinkage (17.94 %) while highest significant difference ($p < 0.05$) was obtained in pH of cooked patties (5.82).

Increased ($p < 0.05$) cooking loss (%) was recorded in patties of broiler chicken meat on control diet (35.70) compared to other varying dietary inclusion levels of WSM at 2 g/kg (29.50), 4 g/kg (28.73), 6 g/kg (28.47), MSM at 2 g/kg (29.77), 4 g/kg (28.47) and 6 g/kg (27.77).

Increased inclusions of walnut seed meal in the diets of broiler chicken meat patties were similar significantly ($p < 0.05$) at 2 g/kg (5.54), 4 g/kg (5.52) and 6 g/kg (5.52), MSM inclusion at 2, 4 and 6 g/ kg were 5.50, 5.40 and 5.34 while the control diet (5.63) of the raw pH of the patties had the highest significant difference ($p < 0.05$).

Table 4.19: Physico-chemical properties of patties developed from broiler chickens fed varying dietary inclusion of cooked walnut and melon seed meal

	Control	Walnut			Melon			
Parameters	0	2	4	6	2	4	6	SEM
Yield(%)	64.23^{d}	70.50^{bc}	71.27^{abc}	71.53^{ab}	70.23^{c}	71.53^{ab}	72.23^{a}	0.57
Cooking loss(%)	35.70^{a}	29.50^{bc}	28.73^{bcd}	28.47^{cd}	29.77^{b}	28.47^{cd}	27.77^{d}	0.57
pH raw	5.63^{a}	5.54^{b}	5.52^{b}	5.52^{b}	5.50^{b}	5.40^{c}	5.34^{c}	0.02
pH cooked	5.82^{a}	5.74^{bc}	5.77^{ab}	5.77^{ab}	5.73^{bc}	5.71^{c}	5.71^{c}	0.01
Shrinkage(%)	17.94^{d}	18.55^{b}	18.73^{a}	18.65^{b}	18.45^{c}	18.56^{b}	18.53^{bc}	0.05

^{abcd} –Means with same superscript along each row are significantly ($p < 0.05$) different, SEM- Standard Error of Means

4.3.2 Proximate composition of raw patties developed from broiler chickens fed dietary inclusion of walnut and melon seed meal

Table 4.20 shows the proximate composition of raw patties developed from broiler chicken fed varying inclusion of walnut and melon seed meal in their diet. It was observed that varying dietary inclusion levels of WSM and MSM had insignificant difference ($p > 0.05$) for moisture ranged from 76.83 to 76.33 % and 75.90 to 76.13 %, respectively.

The crude protein of raw patties developed from broiler chickens fed 6 and 4 g/kg MSM had similar and highest significant difference ($p < 0.05$) of 32.43 and 32.23 %, respectively while broiler chicken on control diets and those fed 2g/kg melon had similar crude protein value which was however, the least and significantly different from others. The ether extract (%) was least in the control however, there was no significant different

between the control and the walnut inclusion levels at 2 g/kg and 4 g/kg. The highest EE was obtained from the treatment with 2 g/kg melon. All EE values obtained from treatments with melon inclusion were statistically similar while those from walnut and control were statistically lower except for the treatment with 6 g/kg walnut inclusion that was similar ($p > 0.05$) to those of melon included treatments.

Raw patties for WSM fed at 4 g/kg inclusion level had higher ($p<0.05$) ash content compared to other dietary inclusion level. However, the control diet (2.00 %) had the least ($p < 0.05$) ash content in raw patties.

Table 4.20: Proximate composition of raw patties developed from broiler chickens fed varying dietary inclusion of walnut and melon seed meal

Parameter(%)	Control	Walnut(g/kg)			Melon(g/kg)			SEM
		2	4	6	2	4	6	
Moisture	75.50	76.83	76.57	76.33	75.90	76.17	76.13	0.16
Crude Protein	30.33^{e}	30.83^{d}	30.93^{c}	32.13^{b}	30.30^{e}	32.23^{ab}	32.43^{a}	0.21
Ether Extract	10.07^{c}	10.23^{bc}	10.25^{bc}	10.33^{ab}	10.57^{a}	10.33^{ab}	10.33^{ab}	0.41
Ash	2.00^{e}	2.40^{ab}	2.47^{a}	2.27^{cd}	2.33^{bc}	2.17^{de}	2.33^{bc}	0.04

^{abcde} –Means with same superscript along each row are not significantly ($p < 0.05$) different, SEM- Standard Error of Mean

4.3.3 Proximate composition of cooked patties developed from broiler chickens fed different levels of walnut and melon seed meal

Table 4.21 shows the proximate compositions of cooked patties developed from broiler chicken fed different levels of walnut and melon seed meal. It was observed that moisture was significantly highest at 4 g/kg (51.59 %) WSM and least at 4 g/kg (49.38 %) MSM. Dietary inclusion of MSM at 2 % (20.58 %) had highest ($p < 0.05$) crude protein in cooked patties than other treatments. Ether extract of cooked patties had no effect ($p > 0.05$) by varying inclusion level of MSM in the diet. Though, varying inclusion levels of WSM increased ($p < 0.05$) ether extract in cooked patties. Cooked patties from broiler chicken on control diets had the least (10.99) significant difference ($p < 0.05$) of ether extract. Dietary inclusion level of MSM in broiler chicken of cooked patties had no influence ($p > 0.05$) in ash concentration and ranged from 4.55 to 4.43 %. Nevertheless, it was observed that broiler chicken of cooked patties on 6 % (4.59 %) WSM had significantly higher ($p < 0.05$) ash whereas those on control diet had the lowest 3.53%) significant difference ($p < 0.05$).

4.3.4 Linear regression coefficient of proximate composition of patties from bird fed different inclusion level of walnut and melon seed meal over storage days

The linear regression coefficient of proximate composition of patties from bird fed varying inclusion level of walnut and melon seed meal is shown in Table 4.22. There exist significant ($p < 0.05$) difference in the proximate composition of patties stored at 7 days storage day intervals except Ether extract. Moisture content of patties reduced significantly ($p < 0.05$) has storage days increased at the rate of approximately 9 % with the regression model fit of 98 % . This means that with 98 % level of propbability, the patties will truly lost 9 % moisture between the observed storage days. Then, the moisture was regarded as losing water because the slope is negative if not, it will be regarded that the water is increasing. Also, the CP and Ash were significantly increasing at the rate of 3% and 0.6 %, respectively while EE was at the rate of 0.7 % and not significant

Table 4.21: Proximate composition of cooked patties developed from broiler chickens fed different levels of walnut and melon seed meal

Parameters(%)	Control	Walnut(%)			Melon(%)			SEM
		2	4	6	2	4	6	
Moisture	49.95^{d}	50.45^{c}	51.59^{a}	50.59^{c}	49.69^{e}	49.38^{f}	50.84^{b}	0.24
Crude protein	17.01^{f}	20.00^{b}	18.53^{e}	19.87^{b}	19.57^{c}	20.58^{a}	18.87^{d}	0.23
EE	10.99^{d}	13.08^{c}	13.47^{d}	13.18^{c}	13.57^{ab}	13.74^{a}	13.71^{a}	0.19
Ash	3.53^{d}	3.87^{c}	4.11^{b}	4.59^{a}	4.55^{a}	4.50^{a}	4.43^{a}	0.17

^{abcd}- Means with the same superscripts along each row are not significantly different ($p > 0.05$), EE- Ether extract, SEM-Standard Error of Means

Table 4.22 . Linear coefficient of proximate composition of patties from broiler chicken fed different levels of walnut and melon seed meal over storage days

Proximate parameters	Regression coefficients			Regression P-value
	R^2	slope	intercept	
Moisture	0.98	-0.093	51.67	0.001**
Crude Protein	0.92	0.035	18.72	0.009**
Ether extract	0.75	0.007	13.01	0.58^{NS}
Ash	0.82	0.006	4.142	0.035*

NS- Not significant

4.3.5 Organoleptic traits of patties developed from broiler chickens fed varying dietary inclusion of walnut and melon seed

Summary of panellist score for organoleptic traits of patties produced from broiler chickens fed varied dietary amount of walnut and melon seed meal in their diet are presented in Table 4.23. Varying dietary inclusion of WSM and MSM significantly ($p < 0.05$) influenced organoleptic traits of patties. It was observed that patties from control sample had highest value (7.50) ($p < 0.05$) for colour. The 2 % dietary inclusion of MSM gave the highest value (4.25) for flavour and roppiness (7.90) compared to other dietary inclusion. Lower ($p < 0.05$) tenderness score was recorded for patties developed from broiler chicken fed dietary inclusion of MSM at 2 % (6.25) compared to other treatments.

The texture ranged from 7.40 (2 % MSM) to 7.55 (6 % MSM). The texture of patties on control diet (7.75) and 4 % WSM (7.75) had the highest and similar values. Juiciness of patties developed from broiler chickens fed dietary inclusion of WSM at 2 % (6.00) and 4 % (5.95) had the least value ($p < 0.05$) compared to other treatments. The overall acceptability of patties from broiler chicken on control diet (7.50) was higher significantly ($p < 0.05$) than those on other diet.

4.3.6 Texture profile analysis of patties from broiler chickens fed varying dietary inclusion of walnut and melon seed meal

The texture profile analysis of patties from broiler chickens fed varying dietary inclusion of walnut and melon seed meal is presented in Table 4.24. The springiness were higher significantly ($p<0.05$) in patties of 6 % WSM (0.83), 2 % MSM (0.84), 4 % MSM (0.87) and 6 % MSM (0.88) than other experimental rations. However, patties from broiler chicken had ($p < 0.05$) increased gumminess which ranged from 27.70 to 30.00.

Hardness value observed in patties of broiler chicken fed no WSM or MSM (23.00) had lowest ($p < 0.05$) value. Chewiness value in control diet (15.19) for patties was lower ($p < 0.05$) than other treatment. Nevertheless, varying inclusion of MSM had no effect ($p > 0.05$) on patties chewiness values and ranged from 23.13 to 25.45. There exist significant ($p < 0.05$) influence of varying dietary inclusion of MSM and WSM on patties cohesiveness. The MSM dietary level of 6 % was significantly ($p < 0.05$) the highest (1.23) value for cohesiveness and was significantly ($p < 0.05$) different from patties from broiler chicken fed control diet (1.11) while 2 % WSM inclusion had significantly ($p < 0.05$) the lowest (1.07) cohesiveness.

Table 4.23: Organoleptic traits of patties developed from broiler chickens fed dietary inclusion of walnut and melon seed meal

Parameters	Control	Walnut(g/kg)			Melon(g/kg)			SEM
		2	4	6	2	4	6	
Colour	7.50 ^{a}	6.60^{bc}	6.30^{d}	6.20^{d}	6.40^{bcd}	6.40^{cd}	6.85^{b}	0.08
Flavour	3.55 ^{c}	4.25^{a}	3.85^{bc}	3.95^{ab}	4.05 ^{ab}	3.15^{d}	3.70^{bc}	0.05
Tenderness	6.55^{abc}	6.50^{bc}	6.85^{a}	6.45^{bc}	6.25^{d}	6.65^{ab}	6.50^{bc}	0.04
Texture	7.75^{a}	7.70 ^{ab}	7.75^{a}	7.40^{b}	7.40^{b}	7.65^{ab}	7.55^{ab}	0.04
Juiciness	7.80 ^{a}	6.00^{d}	5.95^{d}	6.80^{c}	6.80^{c}	7.00^{bc}	7.15^{b}	0.06
Roppiness	7.00 ^{d}	7.90^{a}	7.25^{c}	7.75 ^{ab}	7.30^{c}	7.30^{c}	7.60^{b}	0.04
Overall acceptability	7.50 ^{a}	6.60 ^{b}	6.85^{b}	6.75^{b}	6.75 ^{b}	6.60^{b}	6.70^{b}	0.05

^{abcd}-Means with the same superscripts along each row are not significantly different ($p > 0.05$), SEM-Standard Error of Means

Table 4.24: Texture Profile Analysis of patties from broiler chickens fed dietary inclusion of walnut and melon seed meal

		Walnut(g/kg)			Melon(g/kg)			
Parameter	Control	2	4	6	2	4	6	SEM
Springiness(mm)	0.66^{c}	0.74^{b}	0.77^{b}	0.83 ^{a}	0.84 ^{a}	0.87^{a}	0.88^{a}	0.02
Gumminess(kg)	27.70^{b}	28.93^{ab}	28.67^{ab}	30.00^{a}	28.00^{b}	28.37^{b}	28.67^{ab}	0.22
Hardness(kg)	23.00^{c}	27.33^{b}	28.93^{ab}	29.27 ^{a}	27.53^{b}	28.47^{ab}	28.93 ^{ab}	0.48
Chewiness(kg)	15.19^{c}	20.35^{b}	19.91^{b}	24.41^{a}	23.13^{ab}	24.67^{a}	25.45^{a}	0.83
Cohesiveness	1.11^{de}	1.07^{e}	1.10^{de}	1.12^{cd}	1.16^{bc}	1.20^{ab}	1.23^{a}	0.01

^{abcde}-Means with the same superscripts along each row are not significantly different ($p > 0.05$), SEM-Standard Error of Means

4.3.7 Keeping quality of patties developed from broiler chickens fed different levels of walnut and melon seed meal

The keeping quality of patties produced from broiler chickens fed varied levels of walnut and melon seed meal in their diet is shown in Table 4.25. It was observed that patties from broiler chicken fed 6 g/kg MSM had higher ($p < 0.05$) THC (log10cfu/g) 0.91 log10cfu/g than other treatments. Inclusion of MSM had influence ($p < 0.05$) on TSC of patties. However, similar TSC values were obtained in patties from broiler chicken fed 2 % (0.11 log10cfu/g), 4 % (0.15 log10cfu/g) and 6 % (0.15 log10cfu/g). At 6 %, broiler chicken patties had greater TCC value of 0.75 log10cfu/g. The lipid stability at varying inclusion level of WSM at 2 %, 4 % and MSM at 6 % were similar (0.11 mg/100g) and also higher ($p < 0.05$) than other treatments.

4.3.8 Linear Regression coefficient for keeping quality of patties from broiler chicken fed different levels of walnut and melon seed meal over storage days

Presented in Table 4.26 is the linear regression for keeping quality of patties from broiler chickens fed different levels of walnut and melon seed meal over storage days. It was observed that THC had no significant ($p > 0.05$) difference over the storage days at an interval of 7 days. The THC was reducing at the rate of 0.5 % .All other parameters were significantly ($p < 0.05$) difference. The TSC, TCC and Lipid stability of the patties increased significantly over storage days at the rate of approximately 0.5, 0.2 and 0.4 % with regression model fit of 78, 87 and 96 %, respectively.

Table 4.25: Keeping quality of patties developed from broiler chickens fed different levels of walnut and melon seed meal

Parameters	Control	Walnut(g/kg)			Melon(g/kg)			SEM
		2	4	6	2	4	6	
THC(log10cfu/g)	0.20^{c}	0.31^{b}	0.26^{bc}	0.21^{c}	0.20^{c}	0.21^{c}	0.91^{a}	0.06
TSC(log10cfu/g)	0.01^{c}	0.11^{b}	0.15^{b}	0.15^{b}	0.11^{b}	0.14^{b}	1.41^{a}	0.05
TCC (log10cfu/g)	0.00	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{b}	0.75^{a}	0.07
Lipid Stability (mg/100g)	0.10^{b}	0.10^{b}	0.11^{a}	0.11^{a}	0.10^{b}	0.10^{b}	0.11^{a}	0.00

[abc]-Means with different superscripts on each row are significantly different ($p < 0.05$),THC-Total heterotrophic count, TCC- Total Coliform Count, TSC-Total Staphylococcus count, ,SEM-Standard Error of Mean

Table 4.26. Linear coefficient of keeping qualities of patties from broiler chicken fed different levels of walnut and melon seed meal over storage days

Microbial parameters	Regression coefficients			Regression P-value
	R^2	slope	intercept	
THC (log10cfu/g)	0.382011	-0.00543	0.406	0.267^{NS}
TSC (log10cfu/g)	0.784504	0.005143	0.222	0.046*
TCC (log10cfu/g)	0.870482	0.002429	0.07	0.021*
Lipid(mg/100g)	0.961	0.004429	0.038	0.003**

THC-Total heterotrophic count, TCC- Total Coliform Count, TSC-Total Staphylococcus count, ,SEM-Standard Error of Mean NS- Not significant

4.3.9 Colour of patties from broiler chickens fed different levels of walnut and melon seed meal.

The colour of patties from broiler chickens fed different levels of walnut and melon seed meals is shown in Table 4.27. The colour of patties was significantly ($p < 0.05$) influenced by walnut and melon seed meal in the diet. It was observed that patties from broiler chicken fed no walnut or melon seed meal in diet had the highest value for lightness (59.39). All values for redness (a*) differed significantly ($p < 0.05$) with walnut at 6 g/kg having highest value of 4.43 and least with control (3.31). The yellowness of patties was highest in the control treatment (23.88) but least for 21.35 at 6 g/kg walnut inclusion.

4.3.10 Liner regression coefficient of colour stability of patties from broiler chicken fed different level of walnut and melon seed meal over storage days

The linear regression coefficient of colour stability of patties from broiler chicken fed different level of walnut and melon seed meal is presented in Table 4.28. There was significant difference ($p < 0.05$) observed for all parameters of colour stability over storage days that were stored at intervals of 7 days. The lightness of the patties was significantly ($p < 0.05$) reducing over storage days at rate of approximately 40% with regression model fit of 99%. This means at 99% level of probability, the patties lightness (L*) will truly lost its lightness between the observed storage days. The a* and b* were significantly increasing at the rate of 6 and 3 %, respectively.

4.3.11 Physico-chemical attributes of patties developed with graded levels of walnut and melon seed meal

Table 4.29 shows the physico-chemical attributes of patties developed with graded levels of walnut and melon seed meal. Walnut inclusion at 6 % had the highest significant ($p < 0.05$) difference of 85.03 % of yield while control was least of 64.23 %. Cooking loss was least at 6 % walnut inclusion (14.97 %) and highest at no inclusion for 35.70 %. There was no significant difference ($p > 0.05$) in raw pH of patties with melon inclusion at 2 (5.37), 4 (5.37) and 6 % (5.39) while for walnut inclusion at 2, 4 and 6 % were 5.48, 5.39 and 5.53, respectively but control was the least (5.63). The cooked pH of patties had highest significant of 5.82 in control and least of 5.64 at 6 % walnut inclusion. Patties developed with 6 % walnut had the highest shrinkage of 34.29 % and least of 17.94 % for control.

Table 4.27: Colour of patties from broiler chickens fed different levels of walnut and melon seed meal

Parameters	Control	Walnut(g/kg)			Melon(g/kg)			SEM
		2	4	6	2	4	6	
L*	59.39^{a}	58.00^{b}	54.93^{d}	55.20^{d}	56.87^{c}	56.33^{c}	54.67^{d}	0.85
a*	3.31^{d}	4.09^{c}	4.09^{c}	4.43^{a}	4.19^{bc}	4.25^{abc}	4.31^{ab}	0.19
b*	23.88^{a}	21.77^{c}	22.41^{b}	21.35^{d}	21.76^{c}	22.39^{b}	22.67^{b}	0.31

abc-Means with different superscripts on each row are significantly different ($p < 0.05$), SEM-Standard Error of Means. L*- Lightness, a*- redness and b*- Yellowness

Table 4.28. Linear coeffiecent of colour stability of patties from broiler chicken fed different level of walnut and melon seed meal over storage days

Colour parameters	Regression coefficients			Regression P-value
	R^2	slope	intercept	
L*	0.995259	-0.408	62.194	0.000**
a*	0.993712	0.059857	3.256	0.000**
b*	0.976677	0.034429	21.836	0.002**

L*- Lighness, a*- redness and b*- Yellowness

Table 4.29: Physico- chemical attributes of patties developed with graded levels of walnut and melon seed meal

Parameters	Control	Walnut (%)			Melon(%)			SEM
		2	4	6	2	4	6	
Yield (%)	64.23^{e}	75.00^{c}	78.83^{b}	85.03^{a}	73.13^{d}	76.30^{c}	78.30^{b}	1.33
Cooking loss	35.70^{a}	25.00^{c}	21.17^{d}	14.97^{e}	26.87^{b}	23.70^{c}	21.70^{d}	1.32
pH raw	5.63^{a}	5.48^{b}	5.39 ^{c}	5.53^{b}	5.37^{c}	5.37^{c}	5.39^{c}	0.02
pH cooked	5.82^{a}	5.72^{b}	5.72^{b}	5.64^{c}	5.66^{bc}	5.67^{bc}	5.73^{b}	0.01
Shrinkage (%)	17.94^{f}	23.22^{c}	31.45 ^{b}	34.29^{a}	21.92^{e}	22.54^{cd}	30.86^{b}	1.27

^{abcd} –Means with same superscript along each row are not significantly ($p > 0.05$) different, SEM- Standard Error of Means

4.3.12 Proximate composition of cooked patties developed with different levels of walnut and melon seed meal.

Table 4.30 shows the proximate composition of cooked patties developed with varied quantities of walnut and melon seed meal. Control moisture content showed the lowest significant difference ($p < 0.05$) of 49.95 % whereas melon inclusion at 6 % was the highest (51.45 %). The crude protein was significantly highest at 6 % walnut inclusion and least at 0 and 6 % melon inclusion (17.01 and 17.17 %). Ether extract for cooked patties were: 10.99, 12.54, 13.46, 13.54, 14.30, 13.33 and 13.32 at 0, 2, 4, 6 % walnut and 2, 4 and 6 % melon, respectively. The cooked patties ash were significantly highest at 4 melon and 6 % walnut inclusion of 4.28 and 4.27 %, respectively.

4.3.13 Linear Coefficient of proximate composition of cooked patties developed with different levels of walnut and melon seed meal

There was no significant effect of storage period observed for proximate composition of cood patties developed with different levels of walnut and melon seed (Table 4.31). The moisture content reduced over storage days at the rate of 11% with a regression model fit of 98 %. The Crude protein and ether extract increased at the rate of 0.01 and 0.003 %. Ash and Crude fibre also increased at a rate of 0.006 and 0.0004 %.

4.3.14 Organoleptic traits of patties developed with graded level of walnut and melon seed meal

Summary of panellist scores for organoleptic traits of patties developed with graded level of walnut and melon seed meal are shown in Table 4.32. Control had the highest colour rating (7.50), while melon inclusion at 4 and 6 % received the lowest score 3.55 and 3.70, respectively, with the same significant difference. Higher significant difference ($p < 0.05$) was recorded for flavour at 6 % walnut inclusion (7.70) while control had the least score of 3.55. The tenderness of the patties were: 6.55, 6.45, 5.65, 4.45, 5.20, 4.80 and 4.15 for 0, 2, 4, 6 % walnut and 2, 4 and 6 % melon inclusion, respectively. The texture of the patties was least at 6 % melon inclusion (3.30) but highest for control at 7.75. The panellist rated control highest for juiciness (7.80), followed by 5.80, 5.80, 5.55, 5.40, 4.40 for 2, 6 % walnut, 2 % melon, 4 % walnut ,4 % melon, respectively and 6 % melon the lowest (4.20). The roppiness was highest at 6 % walnut inclusion (8.00) and least for control (7.00). Consumer's overall acceptability was highest (7.55) at 4 % walnut inclusion and least at 6 % melon inclusion.

Table 4.30: Proximate composition of cooked patties developed with different levels of walnut and melon seed meal

Parameters(%)		Walnut(%)			Melon(%)			
	Control	2	4	6	2	4	6	SEM
Moisture	49.95^{e}	50.25^{cd}	50.54^{b}	49.02^{f}	50.43^{bc}	50.10^{de}	51.45^{a}	0.24
Crude Protein	17.01^{e}	18.64^{c}	19.47^{b}	20.01^{a}	18.59^{c}	18.05^{d}	17.17^{e}	0.25
Ether extract	10.99^{e}	12.54^{d}	13.46^{bc}	13.54^{b}	14.30^{a}	13.33^{c}	13.32^{c}	0.20
Ash	3.53^{d}	4.09^{b}	3.89^{c}	4.27^{a}	3.89^{d}	4.28^{a}	4.06^{b}	0.16

^{abcdef} –Means with same superscript along each row are significantly ($p < 0.05$) different, SEM- Standard Error of Means

Table 4.31. Linear Coefficient of proximate composition of cooked patties developed with different levels of walnut and melon seed meal over storage days

Proximate parameters	Regression coefficients			Regression P-value
	R^2	slope	intercept	
Moisture	0.983644	-0.11243	51.822	0.001
Crude Protein	0.449335	0.011143	18.264	0.216
Ether extract	0.336022	0.003571	13.02	0.306
Ash	0.379756	0.006571	3.912	0.268
Crude Fibre	0.0225	0.000429	0.524	0.81

Table 4.32: Organoleptic trait of patties developed with graded level of walnut and melon seed meal

Parameters	Control	Walnut(%)			Melon(%)			SEM
		2	4	6	2	4	6	
Colour	7.50 [a]	6.70 [b]	5.85 [c]	5.85 [c]	5.15[d]	3.55[e]	3.70 [e]	0.11
Flavour	3.55 [d]	5.85 [c]	6.90 [b]	7.70 [a]	5.85 [c]	6.85[b]	6.95[b]	0.11
Tenderness	6.55[a]	6.45[a]	5.65 [b]	4.45[e]	5.20 [c]	4.80 [d]	4.15[e]	0.08
Texture	7.75[a]	6.15 [b]	4.65 [c]	3.35 [de]	3.60[de]	3.65[d]	3.30 [e]	0.14
Juiciness	7.80 [a]	5.80 [b]	5.40 [c]	5.80 [b]	5.55[bc]	4.40 [d]	4.20 [d]	0.10
Roppiness	7.00 [e]	7.05[de]	7.80[ab]	8.00 [a]	7.75[b]	7.25[d]	7.55[c]	0.04
Overall acceptability	7.50[ab]	6.90 [cd]	7.55[a]	6.65 [d]	7.15[bc]	7.45[b]	5.90[e]	0.06

[abcde] Means with the same superscripts along each row are not significantly different ($p > 0.05$), SEM-Standard Error of Means

4.3.15 Texture profile of patties developed with graded level of walnut and melon seed meal

Table 4.33 shows the texture profile analysis of patties developed with graded level of walnut and melon seed meal. The patties springiness was significantly highest at 6 % melon inclusion (1.94) and lowest at 0 % inclusion (0.66). Highest significant value of 42.67 at 6 % melon inclusion was obtained for gumminess and least (27.70) at 0 % inclusion. Hardness was significantly highest at 6% walnut and melon inclusion at 34.47 and 35.47, respectively while control was least with a value of 23.00. The chewiness was significantly highest at 6% melon inclusion (68.93), followed by 6 % walnut (65.49), 4 % melon (56.34), 4 % walnut (55.71), 2 % melon (49.83), 2 % walnut (49.14) and least at 0 % inclusion (16.22). The cohesiveness increased as inclusion level of walnut and melon increased.

4.3.16 Keeping quality of patties developed from different levels of walnut and melon seed meal

The keeping quality of patties developed with different levels of walnut and melon seed meal is presented in Table 4.34. The total heterotrophic count (log10cfu/g) was significantly highest at 6 % melon inclusion (0.35) and least at 4 % walnut inclusion (0.08). Highest significant difference ($p < 0.05$) of 0.13 (logcfu/g) at 6 % melon inclusion was obtained for total staphylococcus count while there was no significant difference at 0 ,2, 4, 6 % walnut and 2, 4 % melon inclusion (0.01, 0.02, 0.03, 0.05, 0.03 and 0.02, respectively). The total coliform count was not detected in all treatment. Lowest significant different ($p < 0.05$) for lipid stability (mg/100g) was at 6 % walnut inclusion (0.04) while highest significant were at 2 and 4 % melon inclusion (0.11).

4.3.17 Linear regression coefficient for keeping quality of patties developed from different levels of walnut and melon seed meal over storage days

Presented in Table 4.35 is keeping quality of patties developed from different levels of walnut and melon seed meal over storage days at 7 days storage days interval. There exist no significant ($p > 0.05$) difference for the keeping quality parameters of the patties. The total heterotrophic count and total staphylococcus count reduced over storage days at a rate of 0.008 and 0.004 %, with regression model fit of 95 and 60 %, respectively. Total coiform count was not detected over the storage days. Lipid stability increased over storage days at a rate of 0.004 % and regression model fit of 92 %.

Table 4.33: Texture Profile of patties developed with graded level of walnut and melon seed meal

		Walnut(%)			Melon(%)			
Parameter	Control	2	4	6	2	4	6	SEM
Springiness	0.66 ^{f}	1.62^{d}	1.73^{c}	1.90^{b}	1.56 ^{e}	1.69 ^{c}	1.94^{a}	0.09
Gumminess	27.70^{e}	34.20^{d}	40.67 ^{b}	42.00^{ab}	37.33^{c}	41.33^{ab}	42.67^{a}	1.14
Hardness	23.00 ^{e}	30.33^{d}	32.20^{c}	34.47^{a}	31.87 ^{c}	33.33^{b}	35.47^{a}	0.86
Chewiness	16.22^{e}	49.14 ^{d}	55.71^{c}	65.49^{b}	49.83^{d}	56.34^{c}	68.93^{a}	3.59
Cohesiveness	1.11^{c}	1.16^{c}	1.15^{c}	1.21^{b}	1.24^{ab}	1.25^{ab}	1.27 ^{a}	0.01

^{abcdef} Means with the same superscripts along each row are not significantly different ($p > 0.05$), SEM-Standard Error of Means

Table 4.34: Keeping quality of patties developed from different levels of walnut and melon seed meal

Parameters	Control	Walnut(%)			Melon(%)			SEM
		2	4	6	2	4	6	
THC (log10cfu/g)	0.20^{b}	0.16^{bc}	0.08^{d}	0.11^{cd}	0.16^{bc}	0.12^{cd}	0.35^{a}	0.06
TSC (log10cfu/g)	0.01^{b}	0.02^{b}	0.03^{b}	0.05^{b}	0.03^{b}	0.02^{b}	0.13^{a}	0.05
TCC(log10cfu/g)	ND	ND	ND	ND	ND	ND	ND	ND
Lipid (mg/100g)	0.10^{c}	0.10^{c}	0.11^{b}	0.04^{d}	0.11^{a}	0.11^{a}	0.11^{b}	0.00

^{abcd}-Means with different superscripts on each row are significantly different ($p < 0.05$),THC-Total heterotrophic count, TCC- Total Coliform Count, TSC-Total Staphylococcus count, TBARS- Thiobarbituric acid reactive substances ,SEM-Standard Error of Mean

Table 4.35 Linear coefficient of keeping quality of patties developed from different levels of walnut and melon seed meal over storage days

Microbial parameters	Regression coefficients			Regression P-value
	R^2	slope	intercept	
THC(log10cfu/g)	0.955682	-0.00829	0.286	0.004
TSC(log10cfu/g)	0.600962	-0.00357	0.09	0.124
TCC(log10cfu/g)	ND	ND	ND	0
Lipid Stability(mg/100g)	0.926211	0.004143	0.04	0.009

,THC-Total heterotrophic count, TCC- Total Coliform Count, TSC-Total Staphylococcus count, TBARS- Thiobarbituric acid reactive substances ,SEM-Standard Error of Mean, ND-Not detected

4.3.18 Colour of patties from broiler chickens fed different levels of walnut and melon seed meal

Presented in Table 4.36 is the colour of patties developed with walnut and melon seed meal at different levels. The L* reduced significantly for 0, 2, 4 and 6 % walnut seed meal inclusion as 59.39, 52.15, 49.33 and 46.00, respectively. Also, 2 (50.40), 4 (49.87) and 6 % (46.60) melon inclusion reduced significantly. Redness (a*) increased significantly ($p < 0.05$) with melon inclusion at 6 % recording the highest score of 6.41 compared to no seed meal inclusion having the least score of 3.30. Yellowness (b*) had highest ($p < 0.05$) score of 25.32 in walnut seed meal inclusion of 2 % while melon seed inclusion at 2 % had the lowest score of 22.55.

4.3.19 Linear regression on colour of patties developed from different levels of walnut and melon seed meal over storage days

There was no significant ($p<0.05$) difference observed for colour properties of patties developed from different levels of walnut and melon seed meal over storage days as presented in Table 4.37. The lightness reduced over 7 days interval stirage days at a rate of 0.35 % and regression fit of 99 % while redness and yellowness increased over storage days at a rate of 0.07 and 0.1 %. Their regression model fit was at 99 %(a*) and 98 % (b*).

Table 4.36: Colour of patties developed with different levels of walnut and melon seed meal

Parameters	Control	Walnut(%)			Melon(%)			SEM
		2	4	6	2	4	6	
L*	59.39^{a}	52.15^{b}	49.33^{d}	46.00^{e}	50.40^{c}	49.87^{cd}	46.60^{e}	0.67
a*	3.30^{g}	3.97^{f}	5.11^{d}	5.68^{c}	4.82^{e}	5.95^{b}	6.41^{a}	0.21
b*	23.88^{b}	25.32^{a}	22.93^{cd}	23.08^{c}	22.55^{d}	22.87^{cd}	23.96^{b}	0.46

abc-Means with different superscripts on each row are significantly different ($p < 0.05$), SEM-Standard Error of Means. L*- Lighness, a*- redness and b*- Yellowness

Table 4.37. Linear coefficient of colour of patties developed with different levels of walnut and melon seed meal over storage days

Colour parameters	Regression coefficients			Regression P-value
	R^2	slope	intercept	
L*	0.998806	-0.35129	55.452	0
a*	0.99589	0.070429	4.05	0
b*	0.98852	0.101571	22.092	0.001

L*- Lightness, a*- redness and b*- Yellowness

CHAPTER FIVE

DISCUSSION

5.1 Phyto-chemical and proximate compositions of walnut and melon seed meal

Phytochemicals are toxins that may affect bioactive components in seeds by limiting protein and mineral digestibility. The phytochemicals which are also heat labile (Ammar *et al*., 2017) can be reduced or eliminated by processing using heat and could be medicinal for human and livestock. Tannins combination with proline which is a rich protein can also impede protein synthesis through hydrogen bonding and hydrophobic interactions causing reduction in their nutritional quality. Tannins are caustic in nature, they also cause discoloration of the seeds. They are used to treat digestive diseases like diarrhoea and dysentery (Chikezie, 2017).

Alkaloids which is responsible for the bitter taste upon drinking water after consumption of walnut and have been reported (Adam and Carmen, 2000) for their analgesic, antibacterial and antihypertensive properties. Walnut seeds feeding assists the body to fight microorganism hence, boosting the immune system (Nwaoguikpe *et al*., 2012).

Saponin reduced from 24.91 in raw walnut to 24.62 mg/ 100g in cooked walnut seeds. Anyalogbu and Ezejiofor (2017), reported lower saponin of 1.00 in raw to 1.90 mg/100g in roasted walnut seed. This discrepancy could be the result of different processing methods. Cooking will result in leaching into the cooking water whereas roasting will lead to removal of water and increased the concentration of other nutrients.

The observed reduction in the levels of phenols (mg/ 100g) from 1.73 to 0.90 after cooking was adduced to thermal degradation which reduced their concentrations. In contrast, Udedi *et al*. (2013) reported 4.4 in raw walnut to 7.04 mg/100mg in cooked walnut. Both edible and non-edible plants contain phenols, which have antioxidant properties (Aberoumand, 2011). Phenols are specifically connected to their respective proteins in both non- edible and edible plants. The binding may have been sequestered by heating and then subsequently destroyed in solution by further heating.

Phytate (mg/100g) increased from 0.49 to 0.81 in walnut seed due to cooking. Ogbe and John (2011), similarly observed increment in the concentration of phytate from 1.02 in raw to 2.57 (mg/100g) in boiled moringa leaf due to cooking. Conversely, Ojediran *et al*. (2014) observed that phytate concentration reduced in *Jatopha curcas* from 8.63 in raw to 2.46 when cooked. Phytates are naturally bound form of phosphorous in plants. The P exists in myoinositol structure as polydentate ligand (Keerthana and Sukhita, 2018) alongside important minerals in digestive tract thereby ensuing mineral shortage (Bello *et al*., 2008). Phytate concentration in WSM and MSM in this study were within 4 to 9 mg/100mg tolerable level for poultry birds (Penuel *et al*., 2012).

There was reduced steroid concentration of walnut due to cooking. The level of 16.95 in raw seed reduced to 14.90 mg/100g after cooking. This was higher than 1.44 mg/100g reported for raw walnut seeds (Igara *et al*., 2017). Steroids are essential in pharmacology, particularly in drugs which assist in labour in women and milk let down (Okwu and Okwu, 2004).

Flavonoids' concentration increased from 12.51 in raw seeds to 21.13 mg/100mg in cooked walnut seed. The observed effect of cooking on flavonoids in walnut seed was contrary to the reported level of 3.5 in raw to 1.66 mg/100mg in cooked walnut seeds (Udedi *et al*., 2013). The variance might be ascribed to soil differences and climatic conditions of where it was grown (Kamran *et al*., 2011). There have been recent attention on both phenols and flavonoids of plants due to their antioxidant activity (Liu, 2003). These active compound was observed to display increased anti-carcinogenic and antioxidant activities *in vitro* and *in vivo* (Lachance *et al*., 2019) also prevent chronic diseases (Hunt and Papathomas, 2019). Flavonoids have a nonlinear and bell-shaped dosage effect on the production of acrylamide levels, which is related to their antioxidant characteristics, which prevent lipid oxidation and the buildup of carbonyls.

Melon contained high levels of saponins (mg/100g) which varied from 23.22 and 19.22. Saponins have detergent properties due to the presence of water and fat soluble components in them (Manika *et al*., 2015). Cooking reduced the level of saponin in melon, this reduction could be adduced to thermal degradation as observed by earlier reports in which the level of 3.20 reduced after boiling to 0.04 in water melon (Manika

et al., 2015). Another possible explanation for the differences in decrease in saponin of melon upon cooking is the duration of heating and the heat intensity. The observed higher value of saponins could be because of differences in varieties which was *Citrullus colocynthis* in this study and *Citrullus lanatus* in the earlier report.

Tannins concentration also reduced from 22.92 in raw to 17.46 mg/100g in cooked melon seed. Uche *et al*. (2014), documented reduction in tannin level of 18.09 in raw to 3.65 mg/100mg in cooked African yam bean due to thermal reduction. The reduction might be due to tannin leaching into the water for cooking. The range are within permissible limit of 20 mg/g while excess consumption prevent absorption of iron and calcium that could cause anaemia (Betty *et al.*, 2016).

Phytate concentration improved from 0.70 in raw melon seed to 0.73mg/100g in cooked melon seed. Raman *et al*. (2019) reported a similar result for phytate concentration from 0.18 in raw to 0.23 in defatted guna seed.

There was reduced alkaloid concentration from 5.23 in raw melon seed to 1.07 mg/100g after boiling. According to Braide *et al.* (2012), alkaloids concentration in watermelon seed was reduced from 7.28 in raw seed to 4.28 mg/100g in roasted watermelon seed. The differences could be due to different processing method and varieties of melon seed.

Proximate composition of food crop is a guide for nutrients in crops. The amount of moisture in feed samples affects their shelf life in which high level of moisture might lead to spoilage while low moisture will imply better shelf life. Moisture content increased due to cooking from 8.78 in raw walnut to 11.50 % in cooked walnut. On the contrary, Eugene *et al*. (2015) observed reduced moisture content of 3.01 in raw walnut to 1.62 % in cooked walnut seed. The variance could be attributed to difference in temperature ($99\pm1^{O}C$) of processing. The high moisture might cause deterioration of seed since water is necessary for microbiological development and biochemical responses. Instead, the seeds were oven dried and ground to flour. Furthermore, rise in moisture content in walnut seed might be due to water absorption by the seed through diffusion (Davidson and Mbah, 2016).

Crude protein level reduced from 32.24 in raw walnut to 23.78 % in cooked walnut. The observed effect of cooking imply that there was nutrient loss into the cooking water and might cause denatured of protein (Adeniyan *et al*., 2013). Protein vibrates as

a result of the heat provided while cooking. This breaks the weak connections that hold proteins together in their complicated form. The protein stands that have been unraveled then adhere together to produce an aggregation. The reduced low crude protein could also be attributed to solubility of nitrogen.

There was increased ether extract contents in walnut seed due to thermal hydration. The level of 26.79 in raw seed reduced to 44.59 % in cooked walnut. There might have been hydrolyses of some organic bonds in the seed thereby releasing more oils.

The crude fibre content of walnut seed reduced from 5.39 in raw to 4.10 % after cooking. The observed effect of cooking on crude fibre in walnut was similar to the reported levels of 5.85 to 5.21 % (Eugene *et al*., 2015). The decreased crude fibre could be due to solubilisation since high temperature destroy weak connections between polysaccharide chains and glycosidic links in dietary fibre polysaccharides (Caprita *et al*., 2011).

The amount non- combustible inorganic minerals in plants is measured by the ash component. Audu and Aremu (2011) observed that ash content reduced from 3.04 in raw to 2.70 % in cooked groundnut. Similar reduction was observed in raw walnut seed from 5.38 to 5.30% after cooking of this study. The ash content of food, which is the filtrate after water filtration, is an indicator of mineral content.

Crude protein in raw melon seed ranged from 30.78 to 27.63 % in cooked seed. Cooking and oven drying as processing techniques brought about reduction in the content of crude protein of melon seeds. Proteins are a substrate for non-enzymatic browning, hence the reduction in crude protein could be attributed to the maillard reaction (Xiang *et al*., 2021). Reduction of protein after cooking makes it more digestible than in raw. Cooking improves food digestion and increases absorption of many nutrient. There was increased concentration of ether extract in the raw melon seed from 59.88 to 61.10 % after cooking. The increased might be ascribed to processing method which could result in disruption of the structure of the seed's cell and partition of the membrane due to heating thereby enabling the fat to melt and be easily extracted. However, ether extract for this study increased than those reported for *Citrullus lanatus* seeds (57.26 %) and *Colocynthis citrullus* seeds which was 53.85 % (Braide *et al*., 2012). The disparity could be due to the different species and method of processing (Jacob *et al*., 2015).

There was reduced crude fibre content in raw melon seed from 3.50 to 3.10 % after cooking. Uzama *et al*. (2015) reported 3.51 % after processing. Crude fibre in food shows the level of non- digestible carbohydrate and lignin which improves digestibility. Ash content reduced from 3.50 in raw to 3.10 % in cooked melon seed. Kiin- Kabari and Akusu (2014) reported similar reduction of 4.20 in raw to 4.01 % in cooked melon seed.

Vitamins and Mineral content of walnut and melon seed meal

Water soluble vitamins like vitamin C and B are rapidly damaged when immersed in water (Virginia, 1995) while cooking has no effect on fat-soluble vitamins (D,E, K). Cooking or heat treatments, conversely may have impacted significantly on vitamin content, resulting in inaccurate estimation of nutrient consumption (Lee *et al*., 2017). Cooking quickly degrades ascorbic acid, which is a temperature- sensitive and water-soluble vitamin. Significant ascorbic loss has been associated to high heat and long cooking durations (Hailemariam and Wudinch, 2019). The vitamins and pro-vitamin of walnut had highest level of tocopherol which increased to 58.65 mg/kg after cooking compared to 96.42 mg/100g after roasting as reported by Hejtmankova *et al*. (2018). It was higher for roasting and this differences could be attributed to different ways of processing. Tocopherol are potent fat- soluble antioxidants which helps in fighting cancer and heart diseases (Mohammed and Iffat, 2016). The high amount of tocopherol may account for the inhibition of lipid oxidation and strong activity of antioxidant. They are found in seed in two forms as alpha- tocopherol and gamma-tocopherol which provide substantial protection against health problem.

Ascorbic acid content for raw walnut seed was 4.41 mg/kg,which reduced to 3.95 mg/kg in processed walnut seed. The ascorbic acid of 3.95 mg/kg was lower than 6.98 mg/kg earlier documented (Igara *et al*., 2017). The reduction was adduced to the high temperature of cooking and the method of processing. Ascorbic acids and tocopherol have antiaging and powerful antioxidant, which helps in preventing or reducing formation of carcinogenic constituents from food thereby preventing several cancers (Pallazo and Krinzy, 1992).They protect cells from lipid oxidation. Ascorbic acid aids in the wound healing, enhancement of the immune system and absorption of iron (Chijoke *et al*., 2015). Ergocalcipherol are fat soluble vitamin and hormone precursor. They mediate calcium and phosphorus absorption, bone health metabolism, reducing cancer risk, preventing cardiovascular diseases and insulin resistance (Chiu *et al*.,

2004). Pure vitamin D is liabile to degradation and easily decomposed by heat (Saghafi *et al*., 2018). However, cooking had no effect on ergocalcipherol with values between 0.51 (cooked) and 0.55 mg/kg (raw). Conversely, earlier documentation (Dewanto *et al*., 2002) showed ascorbic acid when cooked in the fruit would be liberated from cellular membranes into cooked food. The provitamin A values reported in this study was slightly higher from 3.59 mg/100g in raw walnut to 3.16 mg/100g of cooked walnut compared to 2.67 mg/kg and 2.48 mg/kg in the literature for raw and processed walnut, respectively (Okonkwo and Ozounde, 2014). This might be as a result of variation in the processing method employed. Provitamin A from which the active vitamin A is formed in vivo is important for growth, vision and maintenance of soft mucous tissue (FAO, 2001).

Ascorbic acid is considered as a dietary antioxidant because it helps protect biological components from free radical damage (Hunt *et al*., 1980). Ascorbic acid of melon seeds numerically decreased due to processing ranging from 1.56 in the raw seed to 1.47 mg/kg in processed seed. Cooking and oven drying as processing methods brought a reduction in the concentration of ascorbic acid. Khalid *et al*. (2018), reported a higher ascorbic acid level of 12.5 mg/100g for honey dew melon seed, and the variation linked to the different varieties considered as well as the different processing techniques. The honey dew melon seeds were air dried.

Vitamins have a varied array of biochemical roles; ergocalcipherol, for example has hormonal effects as a mineral metabolism regulators or a cell and tissue growth regulator. Cooking and oven drying did not have any effect on tocopherol concentration (3.07 to 3.06 mg/kg) in melon seed. However, Ejeh and Ketiku (2013), reported a significant reduction in tocopherol concentration after raw melon seeds were roasted (16.1), fermented (3.9) and defatted (12.0 mg/100g) seeds. Tocopherol guards against oxidation of fatty acids and prevents in vivo cell damaging tendencies of the free radicals (Besong *et al*., 2011). Vitamins are necessary for energy production, break down of fat and protein likewise protecting the mucus membrane healthy.

Minerals are vital for digestion, optimum production, and are of several of health benefits to human body. Ash content indicates the levels of minerals in a feedstuff. Macro minerals like Ca, Mg, P are necessary for the formation of bones while K, Na

assists in the maintenance of normal blood pressure hence, required by the animals in relatively large quantity. The mineral composition of walnut seeds was most affected by thermal processing as shown in Table 4.7. Potassium was noted to be most predominant in Nigerian agricultural products (Enenwa *et al*., 2020). Highest contents of phosphorus were 0.83 % in raw and 0.72 % in processed seeds of walnut. Taleat *et al*. (2013) however, reported higher levels of phosphorus concentration ranging from 200.00 mg/100g (raw) and 215.61mg/100g (cooked) in walnut seeds. This discrepancy could be related to changes in processing methods and species differences. The sodium component of walnut (0.22 %) in this study was lower than 4830.00 mg/kg documented by Ayoola *et al*. (2011) and 3480.00 mg/kg according to Akpoghelie *et al*. (2016). The disparity in sodium composition would be due to processing procedure, soil composition and rates of uptakes of the mineral by the plant.

Potassium maintain cell membrane potential which allows nerve cells to transmit electrical impulses and smooth cardiac with skeletal muscle contraction. Too low poatassium and too high sodium can lead to heart diseases and chronic condition. Regulation of the electrochemical balance is important to allow muscle contraction and neurons to transmit impulses (James, 2000). Both sodium and potassium have low concentration in seeds. This could be indicative of their importance as sodium is related to aetiology of coronary heart disease and hypertension in humans (Dahl, 1972). The Fe, Zn, Se and Cu are micro- nutrients of animals. Copper is vital for formation of haemoglobin from iron also cellular defence of mucous membrane (Chikezie, 2017). There was reduction in mineral content of raw melon seed from 0.63 to 0.47 % after cooking. High potassium concentration upsurge the iron used in the body (Adeyeye, 2010). Sodium and potassium assist in normalising high blood pressure. Sodium to potassium ratio obtained in this study were 0.19 for raw seed and 0.21 for processed seed of melon which were less than one. This is comparable to the findings of Jacob *et al.* (2015) who observed a sodium-to-potassium ratio of 0.12 to 0.23 for sodium in *Citrullus lanatus* seed. The variation in values obtained could be due to varietal difference. This may be suggestive that melon seed based diets would assist in the prevention of hypertension and reduce blood pressure in hypertensive patients, in line with earlier report (Aremu *et al*., 2006) that diets based on Nigerian underutilised legumes were invaluable for reducing blood pressure.

The presence of copper in the seed would assist in the proper usage of dietary iron, sugar, growth of bone, nerve functions, and prevention of anaemia and weak bones (Aliyu *et al*., 2008). Calcium has medicinal effect which is prevention and control of diseases (Amadi *et al*., 2018). The standard calcium to phosphorus ratio was 0.5 (Jacob *et al*., 2015) which is lower than 0.65 in raw seed but similar to 0.54 obtained for the processed seed of melon in this study. This is an indication that that the innate of calcium of melon would be absorbed in the body when ingested (Farhan *et al*., 2018).This was low in *Citrullus lanatus* (0.02) as reported by Jacob *et al*. (2015). Boiling and oven drying may have accounted for the significant reductions in the values of all the analysed minerals. This would be due to nutrients seeping into the water for cooking as had been earlier posited (Adeniyan *et al*., 2013).

Antioxidant activities of walnut and melon seed meal

The recent attentions albeit substantial use of natural antioxidant from plants motivated the analysis of antioxidant activities in walnut and melon. This antioxidant properties could improve shelf life by delaying lipid oxidation and reducing deteriorating diseases related with aging (Chouliara *et al*., 2007). Also, measurement of antioxidant ability of plant materials assists in health benefits (Olorunsanya *et al*., 2009), enhanced shelf life and appearance of food (Tanwar *et al*., 2016). Similar study (Sousa *et al*., 2008) on DPPH to test free radical scavenging activity of purified chemicals and plants have been undertaken. The antioxidant activities of walnut and melon seed meal, as shown in Figure 1, were lowered in the current study. The antioxidative effect of walnut seed decreased from 87 % in raw to 85 % in the processed walnuts seed due to cooking and oven drying. Similarly, processed melon seed meal had 35 % free scavenging potential compared with 39 % recorded for the raw melon seed.

The walnut seeds exhibited a higher antioxidant activity level compared to melon seed meal. The reduction would likely be adduced to the neutralisation of free radical activities by reduction in cellular destruction sequel to neutralisation of reactive oxygen species in the seed (Wu and Ng, 2008).

5.2 Meat quality characteristics of broiler chickens fed diet supplemented with walnut and melon seed meal

Proximate composition of experimental diets fed to broiler chicken

The crude protein levels in the diets compared favourably with 19-20 % level reported by Banerjee (2005) for broiler chicken finisher diets. The protein level increased with higher inclusion levels of walnut and melon seed meal in the diets. Both seeds had high levels of crude protein which was 27.63 % in melon and 23.78 % in walnut seed meal. Both seed meal however, had similar proximate nutrient profile.

Effect of varying levels of walnut and melon seed meal on processed, internal organ weight and primal cut of broiler chicken

Carcass yield is a vital index of chicken performance in meat production. The carcass characteristics of the broiler chicken showed by positive effect of the dietary treatment in this study. The broiler chickens fed 6g/kg which was the highest inclusion level of walnut had higher weights.

Similar effect was observed for the carcass of broiler chickens fed similar inclusion of melon seed meal. Opoola *et al*. (2016) reported similar higher final weight,feed conversion ratio and feed intake of broilers on nutritional formular. Increased carcass weight indicated more nutrient bioavailability in muscle development (Bangu *et al*., 2015). The values obtained for the carcass of broiler chickens with the higher inclusion of walnut and melon seed meals compared favourably with the control. The dressed weight percentage (56.31 – 64.61 %) were influenced by the dietary treatment when compared to control. This may be as a result of crude protein level of walnut and melon seed and their utilization in the diets. Feed with lower protein and amino acid had an impact on performance and weight gain (Omerovic *et al*., 2016). Conversely, were the lower weights of internal organs except for liver which indicated good performance (Bangu, 2015). Liver is an organ of detoxification which would have been swollen if stressed. The lower weights of liver could probably be an indication that it was not stressed. Alternatively, Paul *et al*. (2020) observed substantial variation in the weights of internal organs of the chickens fed treated diets compared to this study. The increased weight of proventriculus of broiler chickens fed WSM and MSM indicated increased secretory functions of the organ. This may also be a reflection of higher solubility and tranquil flow of the feed in aqueous milieu of the gastro-intestinal tract as reported (Okosun and Eguaoje, 2017). The large gizzard

size was a pointer to the level of crude fibre in the diet, both MSM and WSM contained appreciable crude fibre content. The broiler chicken diets supplemented with melon seed meal had higher weights of abdominal fat which increased with the levels of dietary inclusion. Melon seed was noted to be higher in ether extracts component. Conversely, broiler chickens on walnut seed meal at 2 g/kg had low abdominal fat, suggesting that walnut was carefully related with lipid deposition and transportation in the birds. Junshu *et al*. (2013) confirmed that herbs, plant and seeds could regulate lipometabolism.

Drumstick, wing, and back weights were highest in 4 g/kg melon seed meal diet fed to broiler chickens which was indicative that appropriate tissue synthesis for those parts were enhanced at that level. The breast and thigh weights of broiler chickens on supplemental walnut and melon seed meals were comparable with those on control. This also was indicative that inclusion level of walnut and melon seed promoted proper muscle deposition and accretion. Broiler chickens fed highest walnut seed meal (WSM) had the lowest thigh weight and wings compared with thigh weights of broiler chicken fed other treatments. This implies that inclusion of WSM at that level hindered or failed to support the growth of some broiler chicken body parts. Also, bird with lowest weight may have a limited feed intake thus reducing the conversion of feed to meat (Abu et *al*., 2015).

Haematological Blood Indicators

Biochemical evaluations of the blood copious are indications of the nutritional value and utilisation of a diet by the animal (Ewuola *et al*., 2004) and a reflection of the animal state of health (Strydom *et al*., 2008). Cooking and oven drying as they affects the innate antinutritional factors of MSM and WSM reflected in the values attained for the haematological parameters of broiler chickens fed diets with varying inclusion of processed melon and walnut seed meal which were relative to those on control (without walnut or melon seed meal).

The PCV increased as walnut and melon seed meal were included in the diets. However, PCV of broiler chickens given MSM supplemented diets were higher than those on WSM and control with a clear reduction in the PCV levels at 6 g/kg WSM and 4 g/kg MSM supplementations. This could be indicative of enhanced positive haemopoietic systems by the dietary supplement of MSM. The same trend was

observed for the increased PCV and Hb of the broiler chickens fed diets supplemented with WSM and MSM indicated improvement health status and better utilization of the source of nutrients in feed.

The PCV ranged from 25 to 45 % PCV while Hb was between 7 and 13 g/dL for healthy birds (Mahmud *et al*., 2016). This WSM and MSM antioxidant capacity would have improved the iron absorption from the gut for blood formation (Mustapha *et al*., 2017). The values obtained for the haemoglobin indicated that the broiler chicken diets had good protein quality and better utilisation of the dietary nutrients in this research. It was also detected that walnut and melon seed meals supplementation in broiler chicken diets did not result to anaemia, therefore, either meals would be suitable for feeding broiler chickens and considered as safe immunostimulants.

Similar increased RBC and WBC were observed as dietary supplementation of WSM and MSM increased for the broiler chickens. The WBC was within the range 9.20 – 31.0 x $10^{12/}$ dL reported by Afolabi *et al*. (2011). The WBC of broiler chicken fed WSM and MSM were higher than the control which reflected that broiler chicken fed WSM and MSM were able to build immunity against pathogens. The higher WBC (17.32 µl) in WSM at 6 g/kg inclusion could be an indication of better immune capability and resistance against pathogens than for other diets. The WBC are lymphocytes, neutrophils, monocytes, eosinophils and basophils that destroy infected cells, enhance antibody production and stop antigens from entering the body.

The movement of oxygen and carbondioxide in the blood is aided by red blood cells. The higher levels in the blood will indicate a healthy state of health (Aguihe *et al*, 2017). Banerjee (2005) reported normal reference for RBC as 2.0 - 4.00 (10^6µl), which were within the range of RBC of broiler chickens in this study. The relatively lower RBC levels observed in control chickens would be due to lower dietary protein quality as earlier reported (Sarica *et al*., 2020). The WSM and MSM contained some innate antinutrients (alkaloids, flavonoids and tannin) which all contributed to acquired immunity and blood cell formation of the broiler chicken. Also, Elbashier and Ahmed (2016) reported an enhancement in RBC and Hb value could be as a result of protein and mineral increased level in Moringa leaf meal fed to broilers as inclusion level increased.

The observed MCH and MCV of broiler chickens were found to be within the usual ranges of 16-53pg and 90-140fl, respectively, in this study (Muhammad *et al*., 2015). The blood of bird fed 2 g/kg WSM had the highest MCH (46.22 pg) which was indicative of more efficiency of the bird than other in respiratory functions. MCH is an indicative of the ability to convey blood of RBC, which could be that the broiler chickens supplemented with WSM and MSM diets were efficient in respiratory purpose (Abdulazeez *et al*., 2016). The dietary treatment had no influence on MCHC.

The lymphocyte, monocyte and eosinophil counts observed for healthy broiler chicken were all within normal range (Pavlak *et al*.,2005). This indicates the resistance of broiler chicken to disease conditions, in which high lymphocytes and monocytes values occur when there is a bacterial infection and injury to body tissues, respectively. In this study, all the blood parameters measured were within the normal limits, but were greater in broiler chicken fed WSM-supplemented diets. Thus, WSM and MSM emboldened glycolysis, protein synthesis and haemopoesis. The normal range of the haematology values indicated the tolerability of the feed and improved immune status of the broiler chicken finisher when fed diet supplemented with WSM and MSM. The increased crude fibre observed across the dietary treatment could be the reason for variations observed in the blood parameters (Eromosele,1993).

Serum Biochemistry Indices of Broiler Chickens

Serum proteins have been linked to the replacement of damaged tissues, the maintenance of acid-base balance, and the movement of blood elements such as iron,vitamins, hormones, copper, enzymes and lipids (Amao and Siyanbola, 2013). The broiler chickens on the control diets had the lowest total sera proteins, which was probably an indication of reduction in the protein biosynthesis in the broilers on this diet.

Ewuola and Egbunike (2008), reported normal range for urea in broiler chickens serum as 1.90- 12.5 (mg/dL) in which adequate urea were excreted from the kidney. The urea concentration of broiler chicken diets supplemented with 2g/kg MSM had the lowest value. This therefore reflects more efficient metabolism with appropriate renal and hepatic function (Onunkwo *et al*., 2018). The urea concentration of broiler chicken diets supplemented with 6 g/kg WSM and MSM were similar thereby reflecting similarities in the protein quality of WSM and MSM supplemented diets.

Serum enzymes activities measurements are deployed for the monitoring of protein quality indices, especially, the toxicity of the fed condiments (Yusuf and Aliyu-Paiko, 2020).The broiler chickens' AST and ALT levels were within normal range of 2.00-10.00 i.u/L and 35-70 i.u/L, respectively (Fathi *et al*., 2011). Hence, the liver, heart and kidney functionalities of the broiler chickens on various diets were also not adversely affected by the dietary supplement of WSM and MSM and those diets were absorbed and optimally utilised. The increase in AST and ALT concentration identifies changed membrane permeability and tissue impairment (Erukainure *et al*., 2015). Nonetheless, the differences observed significantly among the treatments implies that the inclusion of WSM and MSM did not induce hepatic damage in the broiler chicken which therefore showed favourable levels of the phytochemical contents of WSM and MSM.

Aderinola *et al*. (2013) earlier reported similar levels of 17.00 – 28.00 g/L serum albumin for broiler chicken which accorded with the report in this study. This also was a reflection of appropriate processing of the MSM as well as the WSM used in the supplementation which therefore left insignificant levels of residual antinutritional factors that could affect the organ functioning in the broiler chickens. The higher the albumin value, the better the blood clotting ability, and hence the lower the risk of haemorrhage (Roberts *et al*., 2003). The range of 1.70- 2.31 g/dL serum albumin earlier reported, were similar (Daramola *et al*., 2005).

Serum glucose levels are gauge of carbohydrate metabolism in high-energy diets, and when they are below or over the normal range, hypoglycaemia and hyperglycaemia, respectively, occur (Olorunnisomo and Fayomi, 2012). The glucose values were within the usual range for chickens, which is 130-270 mg/ dL (Bolu and Adelakun, 2013). Therefore, dietary carbohydrates were effectively metabolised by the broiler chickens fed the supplemental WSM and MSM diets.

The total cholesterol of broiler chicken on diets supplemented with WSM and MSM compared to control were within the recommended range of 100 to 260 mg/dL for the broiler chickens (Ugwuene, 2011). The polyphenols in WSM and MSM, could have contributed to the improved excretion of cholesterol in the biliary tract (Karen *et al*., 2019). Also, saponins were noted for the binding of cholesterol (Chaudhary *et al*.,

2014) making it unavailable for absorption in animals thereby, causing hypocholesterolemia.

Colour properties of broiler chicken fed dietary inclusion of walnut and melon seed meal

Muscle colour is an important features in chicken production since it determines consumer acceptance (Carpenter *et al*., 2001). The concentraton of haem pigments in the muscle, particularly myoglobin, is related to the color of the meat. Purchase by consumers and meat freshness highly is dependent on its colour (Nadja *et al*., 2019). The feeding treatment influenced the colour of the broiler chicken meat in this study compared to control. Lightness (L*) and yellowness (b*) values in meat of broiler chicken on supplemental reduced for those on WSM but increased for the MSM groups, with increased inclusion levels. When associated to the control group, the WSM and MSM had a substantial impact on breast meat lightness. The decreased meat lightness divulges would be due to white muscle fibres (low in myoglobin) of breast meat in the treated broiler chickens (Nadja *et al*., 2019).

The observed colour alterations were most likely caused by the antioxidant activities of innate phenols, which had an impact on colour (Mainente *et al*., 2018), this is present in WSM and MSM. Meat with greater pH had reduced L, a and b indicating a darker meat but in this study, the pH were moderate, thereby making the colour of meat light and also affecting the redness and yellowness making them lesser. Hence, consumers will consider the broiler meat of this study acceptable due to its colour.

Physico-chemical and Organoleptic properties of meat from broiler chickens fed varying dietary inclusion levels of cooked walnut and melon seed meal

Muscle composition, ageing before cooking, heat coagulation, fibre proteins and partial hydrolysis of the connective tissues are all dependent on internal temperature, and period of heating (Abu *et al*., 2015). The fraction of bound water matained in the muscle is measured by water holding capacity (WHC). Broiler chickens fed supplemental MSM at 6 g/kg had the lowest cooking loss, therefore, highest WHC. This is an indication of better meat quality. In line with earlier documentation, (Park and Kim, 2021) the higher the WHC, the better the meat quality. Cooking loss (%) reflects the most important physical characteristics, such as moistness which affects both the economic and palatability values of processed meats (Omojola *et al*., 2004).

The comparatively reduced loss of protein into the water after cooking broilers fed 6 g/kg supplementary MSM could be related to the meat's ability to retain water. Proteins were usually lost into the water due to proteolysis (Zeng *et al*., 2017). Proteolysis is minimal in tougher meats with lower fat content. Result here corroborates the assertion of Gomez *et al*. (2020) that meat with low cooking loss has higher quality and protein content. As the MSM inclusion increased, the WHC decreased in the meat.

The reduced cooking loss observed in the meat of broiler chicken fed supplemental MSM is an indicative of the antioxidative effect of MSM which also affected the eating quality by consumers. Conversely, high cooking loss in control may perhaps be related to pH of meat which showed low ability of meat to imbibe water through shear force value. The hardness of meat or its products is determined by measuring shear force. Shear force is defined as achange in the elastic properties of the connective tissue of various muscles with varying mechanical qualities (Adebiyi *et al*., 2011). Perhaps, heat would have weakened the connective tissues which toughened the meat thereby increasing the shear force values, measured by the total cutting force and showed the changes in texture of meat products. The changes could be due to many intrinsic and attained factors of meat. The dietary supplement of both WSM and MSM influenced in the shear force of the broiler chickens meat.

The tenderness, colour,and water holding capacity of meat are all affected by its pH (Owens et al., 2010). Higher lightness was connected with decreased pH and water holding capacity in broiler chicken breast meat of broiler chicken according to a previous investigation (Augustynska-Prejsnar *et al*., 2018)

Organoleptic trait of meat from broiler chickens fed varying dietary inclusion levels of walnut and melon seed meal

Meat quality depends on colour, texture, flavour and juiciness and also related to breed, sex, age and type of muscle (Ekiz *et al*., 2010). The dietary supplementations with WSM and MSM had effect on sensory attributes on the breast meat. Colour, flavor, tenderness, and juiciness were the critical factors of meat eating quality, according to Lawrie and Ledward (2006). The panellist rated the meat from broiler chickens on 6 g/kg supplemental MSM highest, having scored higher value in tenderness, texture, juiciness and overall acceptability. Juiciness is determined by the

quality of the raw meat and cooking process used, which specifies overall impression of palatability to the consumer (Margit, 2003). This attribute also depends on WHC and cooking loss as reported (Fakolade *et al*., 2016). The high juiciness was adduced to the fat deposition as melon supplementation increased in the diet. Dietary supplementation of WSM and MSM improved meat tenderness of broilers in this study which could also be as due to high level of flavonoids in the seeds. Flavonoids are antioxidants that may improve the antioxidative state of broilers chicken meat (Mazur-Kusnirek *et al*., 2019).

Flavour is observed in the process of ingestion in the mouth during chewing and swallowing. Other organoleptic characteristics of the meat, especially, juiciness and texture are influenced by the flavour and also the overall acceptance by consumers. The increased dietary lipid content of MSM at 6g /kg supplemental level would enhance the tenderness of the meat, thereby ensuring its choice by consumers. Muller *et al*. (2012) reported that shear force and WHC values highly associated with breast meat tenderness when subjected to heat thereby, conserving water inside intramuscular fibres. Therefore, increased dietary MSM improved meat tenderness in this study.

Quality of chicken patties from broiler chicken fed varying dietary inclusion levels of walnut and melon seed meal

Nutritional approach involving in feed of supplemental additives when deployed for the improvement of meat stability proved to be more effective than using the condiment directly on meat products (Arshad *et al*., 2017). This method is often used to preserve meat and regulate the oxidation process so that meat products can last longer (Brenes *et al*., 2016). When supplemented to diets, the inherent phenols in WSM and MSM were active, distributed and absorbed influencing antioxidant activity in muscle tissues, according to Sayago- Ayerdi *et al*. (2009).

Cooking yield and cooking loss

The mixture of soluble materials and liquid that is lost from the meat while cooking is cooking loss (Tibin and Mustafa, 2017). Remarkable differences in the cooking loss were observed among broiler chicken meat from the control, the WSM and MSM treated chicken patties in their increasing order, for cooking yield. Lower yields were also reported when textured soy protein was used to prolong beef and ground turkey during cooking, according to a review by Yousef and Barbut (2011).

Water holding and fat binding abilities of WSM and MSM could be the reason for the water loss (El- Magoli *et al*.,1996).

Proximate composition and pH of patties from broiler chicken fed dietary inclusion levels of walnut and melon seed meal

Dietary supplementation with WSM and MSM had varying impacts on proximate composition of raw and cooked patties of meat of broiler chickens. The moisture content was reduced in cooked patties. This decrease could be due to loss of water during processing. Cooking causes structural changes which decreased WHC. Results here corroborated the study of Lopez- Vargas *et al*. (2014) where all cooked samples had lower moisture content. There was a linear trend for the crude protein of the raw patties compared to cooked patties similar to moisture content.

The meat of broiler chickens treated with MSM had the highest ether extract (EE), which might be related to the high quantities of oil in MSM , whereas the meat of control birds had the lowest. This result showed that WSM and MSM had varying EE content and were lost during cooking. It was observed that pH value reduced in the treated broiler chickens meat samples compared to those from control samples of raw patties. The ingredients used were acidic in nature which may have also reflected in the increased in the acidity of the cooked patties. Selani *et al*. (2015) discovered that when fruit by-products and canola oil were used in raw and cooked burgers, the results were similar. As a result, acidity and alkalinity of WSM and MSM integrated in meat products would be critical for pH value hence, the functional features of the resulting meat products.

Sensory quality of patties from broiler chicken fed dietary inclusion of WSM and MSM

Sensory assessment of meat products is an indicative of consumer acceptability. The panellist were able to differentiate the colour, tenderness and overall acceptability among the treatments. Incorporating non- meat substances into patty recipes may result in unfavourable sensory changes as a result of excessive use or intense odour of the ingredient used/ added. Addition of WSM and MSM significantly influenced all the sensory scores. Therefore, both the WSM and MSM had limitation as to levels which they could be used/ applied to meat. The use of canola meal in broiler chicken patties has an effect on the sensory qualities of the meat balls, according to Mikulski *et*

al. (2012). A significant differences was observed in the sensory quality fillet when Black soldier fly was supplemented to the diets Borgogno *et al*. (2017).

Physico-chemical attributes of patties developed with graded application of walnut and melon seed meal.

Cooking yield and cooking loss

Significant increase in yield values was observed for all treatments. This rise may be related to fat and water retention. Lopez- Vargas *et al*. (2014) observed that grinding of meat for burger processing results in a tender product due to myofibrils and connective tissue that are broken down and promoting weight loss throughout the cooking process. The maximum yield was obtained for meat treated with WSM at 6g/kg compared to other levels WSM and MSM. The WSM was noted to have lower capability to hold excess water. Sam *et al*. (2021) contrarily, observed no significant differences between the control and carrot included into sausage in terms of cooking yields. This variation could be due to the non-meat ingredient's water absorption levels. The results here are consistent with Lopez- Vargas *et al*. (2014) findings on fat retention in pork patties prepared with highest value (30 %) of yellow passion fruit, which had the best yield. In this study, the broiler chickens with meat WSM applied at 6g / kg had the highest fat retention.

Cooking loss is a measurement of how much water and drippings were lost during cooking. The lower the percentage, the better the product, and juicier as well as tender would be the product, due to retained moisture in it (Alakali *et al*., 2010). WSM and MSM at higher levels in patties reduced meat cooking loss in different ways.There were lower cooking loss in extended patties treated with WSM and MSM than the control which could be due to the capabilities of the seed meals to imbibe more water therefore less fluid loss during cooking. The cooking loss was higher for WSM treated meat at 6 g/ kg than MSM in agreement with the report of Ngala (1995) for sausages containing 20 and 40 % chickpea, faba bean and pigeon pea. This observation was attributed to the lower content of fat in WSM. In conjunction with the WSM and MSM treatments, the heat treatment used (grilling) could also have increase on the rate of moisture loss in the patties.

Proximate composition and the pH of raw and cooked patties treated with varying inclusion levels of WSM and MSM.

The inclusion levels of WSM and MSM in raw and cooked patties had an impact on the moisture content of the meat.. Moisture content of treated patties with varying inclusion levels of WSM and MSM were lower than those made with meat from broiler chickens fed varying dietary supplemental levels. This showed the binding ability of the treatment being more effective when directly applied to the meat than in nutritional approach. Also, the fat content was higher at varying direct inclusion levels than the corresponding nutritional dietary supplementation. This difference could be due to other feed ingredients in the fed diet to the broiler chicken which may have diluted the capability of the supplemental WSM and MSM.

The quality of meat is mostly affected by pH. In maintaining colour, WHC and tenderness, high pH is important (Aberle *et al*., 2001). With higher cooking and drip loss, meat with an acidic pH has a lower WHC. The control meat sample had the lowest pH which attributed to the acid nature of the ingredients. Ruusunen *et al.* (2003) observed a similar reduction in pH for sausages with different levels of salt incorporation.

Storage Study

The keeping quality (microbial and TBARS) were affected significantly during storage for patties developed from broiler fed walnut and melon seed meal. The THC, TSC and TCC of patties from broilers chickens fed varying dietary inclusion levels of WSM and MSM, increased slightly over the storage days. All of the minor increases in bacteria counts were below the maximum allowable levels of 7 $\log_{10}$ cfu/g for micro-organisms in meat products (Rajkumar *et al*.,2004). Heat treatment during cooking might have destroyed microbial population in the patties. Comparable result was observed for patties at varying inclusion levels of WSM and MSM. The effect of WSM and MSM in reducing microbial load in the patties was evident with their varying inclusions leading to lower count of bacteria count during storage.

The preservation of food through heat is vital when natural antioxidants are added. This will increase their oxidative stability as well as their microbiological shelf life. Lipid oxidation of stored meat products ensue due to oxidative changes during storage. There was an increase in Lipid stability over the storage days which was more in

nutritional approach compared to direct application on meat. The production of volatile metabolites might have caused the increase over storage days (Gadekar *et al*., 2017). Nonetheless, regardless of the storage status, the values observed were low and this can be due to the antioxidant activity of the WSM and MSM used (either supplemented in feed or applied on meat). This can be due to its ability to quench free radicals, scavenge oxygen, reduce globin denaturation or function as a reducing agent (Lawrie, 1979).

Physical parameters of meat is highly characterized by its colour, and it is the means through which consumers assess its freshness and quality (Carpenter *et al*., 2001). Maintaining the colour parameters of meat during storage is therefore desirable. It was observed that the patties lightness and redness decreased over storage days. The observed changes in lightness and redness could be attributed to progressive myoglobin oxidation and metmyoglobin accumulation (Mancini and Hunt, 2005). Muhlisin *et al*. (2013) observed an increase in lightness of patties while redness slightly reduced for pre-cooked hamburger patties while kept. The increased yellowness of patties during storage in this study could be due to changes in meat pigmentation. Conversely, Ammar *et al*. (2014) showed significant increases in the yellowness of poultry meat. This upsurge was due to the continuing process of meat spoilage and oxidative damage occurring in poultry meat irrespective storage conditions.

Sensory quality of patties with varying inclusion levels of WSM and MSM

Direct addition of WSM and MSM significantly affected the sensory quality.In contrast to the findings of Ammar *et al*. (2014) who posited that using pumpkin flour had no effect on the sensory qualities of meatballs. Wedyan Mahgob *et al*. (2020) observed that pumpkin flour had no effect on appearance, colour and flavour scores of beef sausages. The noted difference in this report could be as result of aroma and flavour of WSM and MSM.

Textural Properties of Chicken Patties

The textural properties of cooked broiler chicken patties supplemented with varyied amount of WSM and MSM in the diet improved significantly. Similar effect was observed for the patties developed with the application of WSM and MSM. The values obtained for the patties with WSM and MSM were highly significant as compared to control. The hardness and gumminess of patties were more influenced by the

application of WSM and MSM. This could be attributed to different range (80-100ºC) of heat applied on the meat which denatured the myofibrillar proteins, intramuscular collagen shrinkage, and acomyosin shrinking and dehydration of the meat (Baitley and Light 1980). This may be a reflection of the hard texture of cooked patties.

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Summary

Walnut and melon seed meal were utilised as natural antioxidants to extend the shelf life of broiler chicken meat and patties. There were three studies employed in this research. The first study elaborated on the chemical profile of walnut and melon seed. The seeds were divided into two parts. A part was cooked, oven dried and milled while the other were left raw. Cooking reduced mostly all the phytochemicals, vitamins, mineral, proximate chemicals and antioxidants levels in walnut and melon seeds. The second study involved the use of cooked WSM and MSM. They were fed to broiler chickens finisher at three inclusion levels of 2 g/kg, 4 g/kg and 6 g/kg each to give seven dietary treatments. The meat quality characteristics of the broiler chickens fed WSM and MSM were determined. The results obtained showed that:

i. Broiler chicken diet supplemented with 6 g/kg WSM had the highest live weight (1628.83 g) while other treatment were significantly similar.

ii The varying dietary inclusion levels of WSM and MSM had no impact on the broiler chicken liver.

iii Diets supplemented with WSM and MSM significantly improve abdominal fat with the best result in 6 g/kg supplemented MSM (1.56 %).

iv Supplementing broiler chicken diets with WSM and MSM significantly improved drumstick ,wings and back of the birds

v. Broiler chicken fed 6 g/kg WSM (43.51) increased ($p<0.05$) of cooking loss than broiler chicken meat of other treatments while water holding capacity of broiler chicken meat fed 6 g/kg MSM (74.15) was significantly higher ($p<0.05$).

vi. Meat of broiler chicken supplemented with 6 g/kg MSM had the lowest pH (5.26) compared to other treatment

vii. Meat of broiler chicken fed dietary inclusion level of MSM at 6 g/kg was significantly highest ($p<0.05$) for tenderness (6.00), juiciness (6.00) and overall acceptability (7.10).

In study three, quality of chicken patties was determined from broiler chicken supplemented with varying inclusion level of WSM and MSM also by direct application of varying level of WSM and MSM. The results obtained indicated the following:

i. Yield and cooking loss of patties was higher in direct application of WSM and MSM than in nutritional approach

ii. Supplementing WSM and MSM in feed of broiler chicken made into raw patties had higher moisture compared to direct application of WSM and MSM on raw patties.

iii Patties colour was best at supplementing MSM (6 g/kg) while at direct application it was more attractive at 2 g/kg WSM.

iv. Total coliform count was not detected in patties from direct application of WSM and MSM over storage days

v Lightness was higher at day 28 (50.76) in patties from broiler chicken supplemented with feed compared to direct application (45.76)

6.2 Conclusion

Processing walnut and melon seed affected their chemical profile which were safe for broiler chicken and human consumption

Antioxidant level was higher in walnut than melon seed meal

Supplementing diet with 4 g/kg melon seed meal had the best carcass performance

The inclusion of processed walnut and melon seed in broiler feed had no deleterious effects on their haematology parameters

It was possible to improve the quality of patties made using meat from broiler chickens fed diets containing 4 g/kg walnut seed meal and 6 g/kg melon seed meal

The addition of walnut seed meal to patties directly had no significant effect on colour and keeping quality of patties

Patties developed from chickens fed walnut and melon seed meal had lower peroxidation and were more acceptable.

6.3 Recommendations

Nutrient requirement of walnut and melon seed meals were determined after processing and incorporated into feed and meat products, it is therefore recommended that other processing method should be look into and standardized to achieve optimum production of maet and its products.

The patties in this study had a shelf life of 21 days while kept in a freezer. Hence, further studies could be carried out to determine if walnut and melon could be added and kept on the shelf without refrigerator or freezer.

Further studies can be carried for higher inclusion level of walnut and melon seed meal in patties. This is to confirm if the patties will still be acceptable by consumers.

Additional studies on the use of seed that have antioxidant in it should be work on to determine their effect on meat products (sausage, burger).

6.4 Contributions to Knowledge

Cooking reduced phytonutrients and improved nutritional profile of walnut and melon seed meals.

Increasing levels of walnut or melon seed meals in broiler chicken diets resulted in improved haematological and serum biochemical indices. There was also increased processing weight of carcass.

Improved quality of patties prepared from meat of broiler chickens fed diets containing 4 g/kg walnut seed meal and 6 g/kg of melon seed meal were best achieved.

Patties developed from chicken fed walnut and melon seed meal had lower peroxidation and were more acceptable.

Shelf life of patties was improved with inclusion of walnut and melon seed meal.

REFERENCES

Abbah, O. C., Sanni, M. and Ejembi, D. O. 2014. Nutritional aspects of melon (*Citrullus colocynthis* L.). *Asian Journal of Science and Technology* 5(3):176-180.

Abbas, R.J., Ali, N.A., Alkassar, A.M. and Jameel, Y.J. 2018. Haematological and Biochemical Indices of Broiler Chicks fed at different levels of *Moringa Oleifera* leaf meal. *Biochemical Cellular Archeology Journal* 18(2):1931-1936.

Abbasi, M.A., Ghazanfari, S., Sharifi, S.D., and Gavlighi, H.A. 2019. Influence of dietary plant fats and antioxidant supplementations on performance, apparent metabolizable energy and protein digestibility, lipid oxidation and fatty acid composition of meat in broiler chicken. *Vetrinary Medicine and Science* 6(1):54-68.

Aberle, E. D., Forrest, J.C., Gerrard, D. E. Mills, E. W., Hedrick, H. B., Judge, M. D. and Merkel, R. A. 2001.Principle of Meat Science. 4th edition Kendall Hunt Publishing Company, Dubuque Iowa.

Abdulazeez, H., Adamu, S. B., Igwebuike, J.U., Gwayo, G.J. and Muhammad, A. I. 2016. Haematology and Serum Biochemistry of Broiler Chickens fed Graded levels of Baobab (*Adansonia digita* L.) seed meal. *Journal of Agricultural and Veterinary Science* 9(10): 48-53.

Aberoumand, A. 2011. Screening of plants phenols compounds commonly consumed in Iran. *Journal of Microbiology, Biotechnology and Food Sciences* 1(2): 164-172.

Abeyrathne, E. D. N.S., Nam. K. and Ahn, D.U. 2021. Analytical methods for lipid oxidation and antioxidant capacity in food systems. *Antioxidants* (*Basel*) 10(10):1587

Abu, O.A., Olaleru, I. F. and Omojola, A.B. 2015. Carcass characteristics and meat quality of broilers fed cassava peel and leaf meals as replacements for maize

and soyabean meal.*IOSR-Journal of Agricultural and Veterinary Science* 8(3):41-46.

Adam, D. and Carmen, G. 2000. Bitter taste, phytonutrients and the consumer: a review. *The American Journal of Clinical Nutrition* 72(6): 1424-1435.

Adebiyi, O. A., Adu, O. A. and Olumide, M. D. 2011. Performance characteristics and carcass quality of broiler chicks under high stocking density fed vitamin E supplemented diet. *Agriculture and Biology Journal of North America* 2(8):1160-1165.

Aderinola, O. A., Rufiu, T. A., Akinwunmi, A.O., Alabi, T. A. and Adeagbo, O. A. 2013. Utilization of Moringa oleifera lef as feed supplement in broiler diets. *International Journal of Food, Agricultural and Veterinary Sciences* 3(3):94-102.

Adeniyi, B.A., Odelola, H.A. and Oso, B.A. 1996. Antimicrobial potentials of *Diospyros mespiliformis* (Ebenaceae). *African Journal of Medicinal Science* 25(4): 221-224.

Adeniyan, O.O.,Ibunkun, E. O., Ogunbolude, Y. and Eseigbe, M.I. 2013. Effect of boiling on the nutritional composition and antioxidant properties of Beni seed sesame (*Sesamum indicum* L). *Food Science and Quality Management Journal* 11(3):39-48.

Adeyeye, E.I. 2010. Effect of cooking and roasting on the amino acid compostion of raw groundnut (*Arachis hypogea*) seeds. *Acta Scientiarum Polonorum Technologia Alimentaria* 9(2):201-216.

Adi, D.D., Oduro, I. N. and Tortoe, C.2021. Effect of flour types concentrations on the physicochemical and sensory characteristics of an indigenous senescent plantain cake (ofam). *African Journal of Food Science* 15(5):190-202

Afolabi, K.D., Akinsoyinu, A.O., Abdullah, A.R.O., Olajide, R. and Akinleye, S. B. 2011.Haematological Parameters of the Nigeian local grower chickens fed varying dietary levels of palm kernel cake. *POLJOPRIVREDA*.17(1):74-78.

Aguirrezabal, M., Mateo, J., Dominguez, C. and Zumalacarregui, J.M. 2000. The effect of paparika, garlic and salt on rancidity in dry sausages. *Meat Science* 54(4):77-81.

Agte, V. V., Tarwadi, K.V., Mengale, S. and Chiplonkar, S. A. 2000. Potential of Traditionally cooked green leafy vegetables as natural sources for supplementation of eight micronutrients in vegetarian diets. *Journal of Food Composition and Analysis* 13(6):885-891.

Aguihe, P.C., Kehinde, A.S., Ospina-Rojas, I.C., Murakami, A.E. 2017. Comparative effect of different detoxified rubber seed meal on haematological and serum biochemical indices of broilers. *Journal of Animal Health Production* 5(2):50-57.

Ajayi, M. O., Osowe, C.O, and Babayemi, O. J. 2017. Assessment of conventional and non-conventional estimation of live weight, carcass characteristics and dressing percentage of Nigerian breeds of goats as panacea for livestock. *Nigerian Journal of Animal Production* 44(2): 173-178.

Akpoghelie, J.O., Esemedafe, J.U., Okoh, R. and Ugochukwu, G.C.2016. The nutritional assessment of the seed of walnut (*Plukenetia conophora*) seed purchased in an open market in Warri, Delta State. *Nigeria Journal of Chemical Society* 41(1):125-129.

Alakali, J. S., Irtwange, S.V. and Mzer, M. T. 2010. Quality evaluation of beef patties formulated with Bambara groundnut (*Vigna subterranean* L.) seed flour. *Journal of Meat Science* 85(2):215-223.

Al- Hijazeen, M., Lee, E.J., Mendonca, A. and Ahn, D. U. 2016. Effect of oregano essential oil (*Origanum vulgare* subsp. hirtum) on the storage stability and quality parameters of ground chicken breast meat. *Antioxidants* (*Basel*) 5(2):18-24

Aliyu, A.B., Musa, A. M. and Oshaniyi, J.A. 2008. Phytochemical Analysis and Mineral Composition Analysis of Some Medicinal Plants of Northern Nigeria. *Nigerian Journal of Pharmaceutical Sciences* 7(1):119-120.

Al-Owaimer, A. N., Suliman, G.M., Alyemni, A.H and Abudabos, A.M. 2014. Effect of different probiotics on breast quality characteristics of broilers under *Salmonella* challenge. *Italian Journal of Animal Science* 13(9): 450-454.

Amano, K., Xiao, K., Wuerger, S., and Meyer, G. 2020. A colorimetric comparison of sunless with natural skin tan. *Journal Pone* 15(12):25-45

Amao, E. A. and Siyanbola, M.F. 2013. Carcass and physiological response of broilers fed dry heat treated mango (*Magnifera indica*) kernel based diet. *International Journal of Livestock Production*4(3):30-34. https://doi.org/10.5897/IJLP12.011.

Ammar, A.S.M., El-Hady, E.S.A.A., and El-Razak, M.M.A. 2014. Quality characteristics of low-fat meat balls as affected by date seed powder, wheat germ and pumpkin flour addition. *Pakistan Journal Food Science* 24(2):175-185

Ammar A.,Naoufal, L., Azam, B., Dennis, G. W and David, A. L. 2017. Phytochemicals: Extraction, Isolation and Identification of Bioactive Compounds from Plant Extracts. *Multidisciplinary Digital Publishing Institute Journal* 6 (42): 1-23.

Andrews, W. 1992. Manual of food quality control. 4.1. Microbiological Analysis. Food and Agriculture Organization of the United Nations, Rome.

Anyalogbu, E.A.A and Ezejiofor, T. I.N. 2017. Effect of Processing on Antinutrients contents of African Elemi (*Canarium schweinfurthii*) and African walnut (*Plukenetia conophora*) consumed as traditional snacks in Nigeria. *International Journal of Scientific and Technology Research* 6(7):383-391.

Anyanwu, G.A. and Adikuru, C.O. 1993. Biometric Measurement of the local chicken and the effect of release age on the extensively managed exotic cockerels.The Book of Abstracts Nigeria Society for Animal Production.18th Annual Conference.Owerri

Apata, E. S., Omojola, A.B., Eniolorunda, O.O., Apata, O.C. and Okubanjo, A. O. 2016. Effects of breeds and spices on water holding capacity and consumers

acceptability of goat meat (Chevon). *Nigerian Journal of Animal Science* 1:275-282.

Aremu, M.O., Olaofe, O. and Akintayo, T.E. 2006.A comparative study on the chemical and amino acid composition of some Nigerian underutilized legumes flours. *Pakistan Journal of Nutrition* 7(4):381-384.

Arshad, M. S., Imran, A., Nadeem, M.T.. Sohaib, M., Saeed, F., Anjum, F.M., Kwon, J. and Hussain, S. 2017. Enhancing the quality and lipid stability of chicken nuggets using natural antioxidants. Lipids in Health and Disease. 16:108-116.

Association of Official Analytical Chemists (AOAC). 1990. Fat in eggs: Acid hydrolysis method. 13th edition. Washington: Official Methods of Analysis 925.32.

Association of Official Analytical Chemists (AOAC).1995. Official Methods of Analysis method 14th edition. Wasington DC.

Audu, S. S. and Aremu, M. O. 2011. Effect of processing on chemical composition of Red Kidney Bean (*Phaseolus vulgaris*. L) flour. *Pakistan Journal of Nutrition* 10(11): 1069-1075. DOI: 10.3923/pjn.2011.1069.1075.

Augustynska-Prejsnar, A., Ormian, M., and Sokolowicz, Z. 2018. Physicochemical and sensory properties of broiler chicken breast meat stored frozen and thawed using various methods. *Journal of Food Quality* 10(1):1-9.

Audu, S. S. and Aremu, M. O. 2011. Effect of processing on chemical composition of Red Kidney Bean (*Phaseolus vulgaris*. L) flour. *Pakistan Journal of Nutrition* 10(11): 1069-1075. DOI: 10.3923/pjn.2011.1069.1075.

Ayodeji, A. E. and Aliyu, N. 2018. Tetracarpidium conophorum (African walnut) Hutch. And Dalziel: Ethnomedicinal uses and its therapeutic activies. *Journal of Medicinal plants for Economic Development* 2(1): 47

Ayoola, P.B., Adeyeye, A., Onawunmi, O. O. and Faboya, O.O.P.2011. Chemical evaluation and nutritive value of *Tetracarpidium conophorum* (Nigeria walnut) seeds. *Journal of Pharmaceutical of Biomedical Science* 11(15):1-5.

Babson, A. L., Shapiro, P. O., Williams, P. A. R., Phillips, G. E. 1962. The use of a diazonium salt for the determination of glutamic-oxalacetic transaminase in serum. *Clinical Chimica Acta* 7(2): 199-205.

Baek, H. S., Kwon, S. Y., Lee, H.G. and Baek, H.H. 2008. Maillard browning reaction of D-Psicose as affected by reaction factors. *Food Science and Biotechnology* 17(6):1349-1351

Bali, A., Sudip, K. D., Anupam, K., Dipenwita, P. B. and Bhattacharyya, D. 2011. A Comparative Study on the antioxidant and antimicrobial properties of garlic and Coriander on chicken sausage. *International Journal of Meat Science* 1 (2): 108 - 116.

Bangu, B., Aberra, M., Mohammed, B. and Kefyalew, B. 2015. The effect of feeding stinging nettle (*Urtica simensis* S.) leaf meal on feed intake, growth performance and carcass characteristics of hubbard broiler chickens. *Global Journal of Science Frontier Research*:*The Agriculture and Veterinary* 15(3):1-20.

Barbut, S., Zhang, L., and Marcone, M. 2005. Effects of pale, normal, and dark chicken breast meat on microstructure, extractable proteins and cooking of marinated fillets. *Poultry Science*.84:797-802.

Barcelo, P.M. and J.R. Barcelo. 2012. The potential of *Samanea saman*(JACK) *MERR*. Pods as Feeds for Goats. *International Journal of Zoology Research* 1(2):40-43.

Banerjee, G.C.2005. Animal Husbandry textbook. Oxford and IBH Publishing Company Pivot Limited,New Delhi.8th Edition.896-921.

Bello, M.O., Falade, O.S., Adewusi, S.R.A. and Olawore, N.O. 2008. Studies on the chemical compositions and antinutrients of some lesser known Nigeria fruits. *African Journal of Biotechnology* 7(21):3972-3979.

Besong, S. A., Ezekwe, M.O., Fosung, C.N. and Senwo, Z.N. 2011. Evaluation of nutrient composition of African melon oilseed (*Cucumeropsis mannii*

Naudin) for human nutrition. *International Journal Nutrition Metabolism* 3(8): 103-108.

Betty, T., Jacob, K. A., Faustina, D. W. and Elsa, I. O. 2016. Watermelon seeds as food: Nutrient composition. phytochemicals and antioxidant activity. *International Journal of Nutrition and Food Sciences* 5(2): 139-144. DOI: 10.11648/j.ijnfs.20160502.18 ISSN: 2327-2694.

Bolu, S.A and Adelakun, M. A. 2013. Effects of alphamune G on the performance, serum and haematological parameters of *Escherichia coli* challenged turkey poults. *Nigerian Journal of Animal Production* 40(2):2013

Borgogno, M., Dinnnella, C., Iaconisi, V., Fusi, R., Scarpaleggia, C., Schiavone, A., Monteleone, E., Gasco, L. and Parisi, G. 2017. Inclusion of *Hermetia illucens* larvae meal on rainbow trout (*Oncorhynchus mykiss*) feed:effect on sensory profile according to static and dynamic evaluations. *Journal of the Science of Food and Agriculture* 97(21): 3402-3411.

Botsoglou, N.A., Fletouris, D. J., Florou-Paneri, P., Christaki, E. and Spais, A.B. 2003. Inhibition of lipid oxidation in long-term frozen stored chicken meat by dietary oregano essential oil and α- tocopheryl acetate supplementation. *Food Research International* 36:207-213.

Braide, W., Odiong, I.J. and Oranusi, S. 2012. Phytochemical and Antibacterial properties of the seed of watermelon (*Citrullus lanatus*). *Prime Journal of Microbiology Research* 2(3):99-104.

Braiek, B. O. and Smaoui, S. 2021. Chemistry, safety and challenges of the use of organic acids and their derivative salts in meat preservation. *Journal of Food Quality* 2021(3):1-20

Brenes, A. Viveros, A., Chamorro, S. and Arija, I. 2016. Use of polyphenol rich grape by-products in monogastric nutrition. A review. *Animal Feed Science Technology* 2(11):1-17.

Calhoon, E. A. 2016. Lipid class and phospholipid species composition associated with life history variation in north temperate and neotropical birds. Dissertation in The Ohio State University.190.

Camo, J., J.A. Beltrán, and P. Roncalés. 2008. Extension of the display life of lamb with an antioxidant active packaging. *Meat Science Journal* 80(3):1086-1091.

Caprita, A.,Caprita, A., Simulescu, V.O., and Drehe, M.R. 2011. The effect of temperature on soluble dietary fiber fraction in cereals. *Journal of Agro-alimentary Processes and Technologies* 17(3):214-217.

Carpenter, C. E., Cornforth, D.P. and Whittier, D. 2001. Consumer preferences for beef colour and packaging as did not affect eating satisfaction. *Meat Science* 57(2):359-363

Carpenter, R., O'Grady, M. N, O'Callaghan,Y. C, O'Brien, N.M and Kerry J,P. 2007. Evaluation of the antioxidant potential of grape seed and bearberry extracts in raw and cooked pork. *Meat Science Journal* 76:604-610.

Chao, S. C., Young, D.G. and Oberg, C.J. 2000. Screening for inhibitory activity of essential oils on selected bacteria, fungi and viruses. *Journal of Essential Oil Research* 12:639-649.

Chaudhary, N., Bhardwaj, J., Seo, H. J., Kim, M. Y., Shin, T.S. and Kim, J.D. 2014. *Camellia sinensis* fruit peel extract inhibits angiogenesis and ameliorates obesity induced by high-fat diet in rats. *Journal of Functional Foods* 7:479-486.

Chaves, A. V., Stanford, K., Gibson, L. L. McAllister, T. A. and Benchaar, C. 2008. Effects of carvacrol and cinnamaldehyde on intake, rumen fermentation, growth performance, and carcass characteristics of growing lambs. *Animal Feed Science and Technology* 145:396-408

Chen, P., Wang, A. Q., and Shan, A.S. 2009. Effect of *Ligustrum lucidum* fruits on growth performance, antioxidant and meat quality in arbor acres broilers. *Asian- Australisan Journal Animal Science* 22(5):700-705.

Cheng, J. H. and Ockerman. H. 2013. Effects of electrical stimulation on lipid oxidation and warmed –over flavor of pre-cooked roast beef. *Asian-Australisian Journal of Animal Sciences* 26(2):282-286.

Chijoke, O. C., Anosike, C. A. and Ani, C. C. 2015. Studies on the phytochemical and nutritional properties of *Tetracarpidium Conophorum* (Black walnut) seeds. *Journal of Global Biosciences* 4(2):1366-1372.

Chikezie, U. N. 2017. Phytochemical and proximate compositions of *Plukenetia conophora* (African Walnut) seeds. *International Journal of Research Studies in Biosciences* 5(10):25-31.

Chiu, K. C., Chu, A., Go, V. L. W. and Saad, M. F. 2004. Hypovitaminosis D is associated with insulin resistance and β cell dysfunction. *American Journal of Clinical Nutrition* 79(5):820-825.

Chouliara, E., Karatapanis, A, Savvaidis, I. N., Kontominas. M. 2007. Combined effect of oregano essential oil and modified atmosphere packaging on shelf-life extension of fresh chicken breast meat, stored at 4 °C. *Food Microbiology Journal* 24:607–617.

Cosmolescu, S., Trandafir,I., Achim, G., Botu, M., Baciu, A. and Gruia, M. 2010. Phenolics of green husk in mature walnut fruits. *Notulae Botanicae Horti Agrobotanici Cluj- Napoca* 38(1):53-56

Dacia, J. V. and Lewis, S. M. 1991. Practical haematology 8th edition, Longman Group Ltd. London. 21-68.

Dahl, L.K.1972. Salt and hypertension. *America Journal Clinical Nutrition*. 25(2):231-244.

Daramola, J., Adeloye, A., Fatoba, T. A. and Soladoye, A. O. 2005. Haemtological and biochemical parameters of West African Dwarf goats. *Livestock Research for Rural Development.* 17(8): 89-92.

Davidson, G. I. and Mbah, O. B. 2016. Effect of cooking methods on the nutrient, phytochemical and anti-nutrient composition of raw bread fruit (Artocarpus communis) pulp. *Pakistan Journal of Nutrition* 15(2):99-103

Devatkal, S.K., Throat, P.R. and Manjunatha, M. 2012. Effect of vacuum packaging and pomegranate peel extract on quality aspects of round goat meat and nuggets. *Journal of Food Science and Technology* 51(10):2685-2691.

Dewanto, V., Wu, X., Adom, K.K and Liu, R.H. 2002. Thermal processing enhances the nutritional value of tomatoes by increasing total antioxidant activity. *Journal of Agricultural and Food Chemistry*50(10):3010-3014.

De Winnie, A. and Dirinck, P. 1996. Studies on vitamin E and meat quality. Effect of feeding high vitamin E levels on chicken meat quality. *Journal Agriculture of Food Chemistry*4 4(2):1691-1696

Dhia, H. and Kharma, A. 2006. Antimicrobial activity of some medicinal plants against *Candida albicans*. *Journal of Biological Sciences* 6(1):109-114.

Djikeng, F. T., Selle, E., Morfor, A.T., Tiencheu, B., Touko, B. A. H., Boungo, G. T., Houketchang, S.N., Karuna, M. S.L, Linder. M., Ngoufack, F. Z. and Womeni, H.M. 2017. Effect of boiling and roasting on lipid quality, proximate composition, and mineral content of walnut seeds (Tetracarpidium conophorum) produced and commercialized in Kumba, South- West region Cameroon. *Food Science Nutrition* 6(2):417-423.

Dreeling, N., Allen, P. and Butler, F. 2000. Effect of cooking method on sensory and instrumental texture attributes of low-fat beef burgers. Lebensmittel-Wissenchaft und-Technologie. 33(3):234-238

Dosumu, O.O. and Akinnuoye, G.A. 2014. Effect of steaming of beans pudding on the phytochemical composition of *Thaumatococcus Danielli* wrapper. *Nigerian Food Journal* 32(1):110-116.

Doumas, B.T., Bayse, D. D., Carter, R. J., Peters, T. Jr., Schaffer, R. 1981. A candidate reference method for determination of total protein in serum. I. Development and validation. Clinical Chemistry. 27(10):1642-1650.

Doumas, B. T. and Biggs, H. H. 1972. Determination of serum albumin. In: Standard methods in Clinical Chemistry (ed. Copper, G.R). Academic Press Incorporation. New York.

Downes, F. P. and Ito, K. E. 2001. Compendium of methods for the microbiological examination of foods. Fourth edition American Public Health Association. Washington DC.

Duh, P. D., Tu, Y. Y. and Yen, G. C. 1999. Antioxidant activity of water extract of Harng Jyur (Chrysanthemum moifolium Ramat),” Lebensm–Wiss Technol,; 32: 269 - 277.

Ecocrop, 2012. Crop Ecological Requirements Database (ECOCROP).

Eikelenboom, G., Hoving, B. A. H., Kluitman, I., Houben, J.H. and Klont, R.E. 2000. Effect of dietary vitamin E supplementation on beef colour stability. *Meat Science*. 54(1):17-22.

Ejeh,S.I and Ketiku, O. A. 2013. Vitamin E content of traditionally processed products of two commonly consumed oil seeds- Groundnut (*Arachis hypogea*) and Melon seed (*Citrillus vulgaris*) in Nigeria. *Journal Nutritional Food Science.* 3(9): 185-187.

Ekiz, B. , Ozcan, M., Yilmaz, A., Tolu, C. and Savas, T. 2010. Carcass measurements and meat quality characteristics of dairy suckling kids compared to an indigenous genotype. *Meat Science*. 85(2):245-249

Elbashier, O.M and Ahmed, H.E. 2016. The effect of feeding different levels of Moringa Oleifera leaf meal on the performance and some blood parameters of broilers. *International Journal of Science and Research* 5(3):632-635.

Elgayyar, M., Draughon, F.A. Golden, D. A. and Mount J.R. 2001. Antimicrobial activity of essential oils from plants against selected pathogenic and saprophytic microrganisms. *Journal of Food Protection* 64:1019-1024.

El-Magoli, S. B., Laroia, S. and Hansen, P. Y. M. 1996. Flavour and texture characteristics of low fat ground beef patties formulated with whey protein concentrate. *Journal of Meat Science* 42(6):179-193

El- Syiad, S.I and El-Ghazali, M.N. 1992. Effect of frozen storage on lipid, phospholipid fractions and fatty acid composition of Cobb chicken tissues. *Journal of Applied Animal Research* 2(1):47-56.

Emeribe, E.O. 2018. Phytochemicals and organic compounds of two Nigerian insecticidal plants. *Journal of Agricultural and Food Sciences* 16(1):1-12

Eneji, C. A., Ikpeme, C.A. E., Anya, M.I. and Oko, O.O.K. 2011. Shelf life quality of rabbit meat under different storage conditions. *Journal of Food, Agriculture and Environment* 9(3-4):134-138

Enenwa, N. E., Onwuka, K. E and Osigwe, C. E. 2020. A review on the composition, proximate and elemental analysis of the Nigerian walnut (*Tetracarpidium conophorum*). *Chemistry Research Journal* 5(4):161-175.

Eromosele, I.C. 1993. Studies on the chemical composition and physiochemical properties of seeds of some wild plant. *Plant Food for Human Nutrition Journal*. 43:251-258.

Erukainure, O.I., Ebuehi, O. A. Adeboyejo, F. O., Oladunmoye, O. O., Aliyu, M., Obode, O.C., Olasehinde, T. and Elemo, G.N. 2015. Short-term feeding of fibre- enriched biscuits: protective effect against hepatotoxicity in diabetic rats. *Biochemistry Research Institute*15:1-6

Eugene, N. O., Ernest, A. A. and Micheal, O.M. 2015. Effect of heat processing on the proximate composition and energy values of African walnut (*Plukenetia conophora*) and *Canarium schweinfurthii. International Journal of Scientific and Technology Research* 4(8):38-45. ISSN 2277-8616.

Evans, W. C. 2000. Trease and Evans Pharmacognosy (15th edn), Elsevier Science limited, New York, 156 - 200.

Ewuola, E.O., Folayan, O.A., Gbore, F.A., Adebunmi, A. I., Akanji, R. A., Ogunlade, J.T. and Adeneye, J.A. 2004. Physiological response of growing West African dwarf goats fed ground nut shell-based diet as the concentrate supplement. *Bowen Journal of Agriculture* 1:61-69.

Ewuola, E. O. and Egbunike, G. N. 2008. Haematological and serum biochemical response of growing rabbit bucks fed dietary fumonisin B1. *African Journal of Biotechnology*7(23):4304-4309.

Fakolade,P.O.,Akinduro,V.O. and Ogungbade,K. O. 2016. Proximate, physicochemical and palatability analysis of grilled and boiled meat from broilers fed varying levels of honey in their diet during dry season. *Journal of B iology, Agriculture and Healthcare* 6(9): 88-93.

Falowo, A.B. 2015. Effectof natural antioxidants and thermal treatment on quality of meat from Bonsmara and non-descripts cattle. A thesis from Department of Livestock and Pasture Science, University of Fort Hare, South Africa.

Faluyi, O.B., Akintomide, A. A. and Onibi, G. 2020. Antimicrobial and antioxidant effects of red onion (Allium cepa) on unrefridgerated broiler chicken meat. *Animal Research International*17(2):3665-3673

FAO, 1990. Food and Agriculture Organisation. The state of food and agriculture, Rome. pp 242

FAO, 1991. Food and Agriculture Organisation Production Year book, Volume 44, Rome

FAO, 2001. Human vitamin and mineral requirements. Report of joint Food and Agriculture Organization of the United Nations and World Health Organization expert consultation Bangkok, Thailand. Chapter 7:87-102.

Farhan, S., Muhammad, A., Bushra, N., Muhammad, U. A., Tabussam, T., Muhammad, B.H and Ahsan, J.2018. Bitter melon (*Momordica charantia*) : a natural healthy vegetables. *International Jounal of food* properties 21(1): 1270-1290.

Fathi, M., Kambiz, N., Yahya, E. N., Habib, A. S., Mohsen, D. and Taimor, T. 2011. The role of oxidative stress in the development of congestive heart failure (CHF) in broilers with pulmonary hypertension syndrome (PHS). *Journal of Cell and Animal Biology*5(8):176-181.

Ferreira, I.C.F.R., Barros, L. Soares, M.E., Bastod, M.L., Pereira,J. A. 2007.Antioxidant activity and total phenolic contents of Olea europaea L. leaves sprayed with different copper formulations.*Food Chemistry Toxicology*103:188-195.

Fetuga, B. L, Babatunde, G M, Oyenuga, V. A. 1975. The feeding stuff potential of cashew nut scraps kernel meal. Proceedings of the 1974 Conference on Animal Feeds of Tropical and Subtropical origin, Ibadan, Nigeria. 201-201.

Franco, C.M. and Vazquez, B.I. 2020. Natural compounds as antimicrobial agents. *Antibiotics*9: 217-227.

Friedewald, W. T, Levy, R. I, Fredrickson, D.S. 1972. Estimation of the concentration of low-density lipo protein cholesterol in plasma, without use of the preparative ultracentrifuge. *Clinical Chemistry Journal* 18:499-502.

Gadekar, Y., Sharma, B. D., Shinde, A. K., Das, A. K.and Mendiratta, S.K. 2017. Effect of incorporation of functional ingredients on quality of low fat restructured goat meat product. *Nutrition and Food Science* 47(5):151-160.

Gregor, A., Kostrzewska, E., Godorowska, W. 1977. Determination of serum proteins in the presence of dextran by means of the biuret reaction. Infusionsther Klin Ernahr 4(1):48-50

Gomez, I., Janardhanan, R., Ibanez, F.C. and Beriain, M.J. 2020. The effects of processing and preservation technologies on meat quality: Sensory and nutritional aspects. *Food Science and Technology* 9(4):1416-1446

Govaris, A., Botsoglou, E., Moulas, A. and Botsoglou, N. 2010. Effects of dietary olive leaves and rosemary on microbial growth and lipid oxidation of turkey breast during refrigerated storage. *South African Journal of Animal Science* 40(2):145-155.

Gowenlock, A. H., McMurray, J. R. and McLauchlan, D. M. 1988. Varley's Practical clinical biochemistry. 6th edition New Delhi: CAS Publishers and Distributors. 477-549.

Gul, S., Rashid, Z. and Sarwer, G. 2014. *Citrullus lanatus* (watermelon) as Diuretic agent: An in vivo investigation on mice. *American Journal of Drug Delivery and Therapeutics*1(4):89-92.

Gunes, G.,Yilmaz, N., and Ozturk, A. 2012. Effects of Irradiation dose and O_2 and CO_2 concentrations in packages on foodborne pathogenic bacteria and quality of ready- to- cook seasoned ground beef product (meatball) during refrigerated storage. *The Scientific World Journal*12(10):1-7.

Gupta, R.C. and Gulab, K. 1994. Determination of Iodine number of edible oils.*Biochemical Education* 22(1):1

Gutierrez-del-Rio, I., Lopez-Ibanez, S., Magadan-Corpas, P., Frnandez- Calleja, L., Perez- Valero, A., Tunon- Granda, M., Miguelez, E.M., Villar, C. J.and Lombo, F. 2021. Terpenoids and Polyphenols as natural antioxidant agents in food preservation. *Antioxidant*10(8):1264

Haak, L. 2007. Impact of animal diet and meat preparation on fatty acid composition and oxidative stability of pork. PhD dissertation, Ghent University, Ghent.228.

Halliwell, B., Aeschbach, R., Loliger, J. and Aruoma, O. I. 1995.The characterization of antioxidants. *Food Chemical Toxicology* 33(7):601-617.

Hannula, T., and Poulanne, E. 2004. The effect of cooling rate on beef tenderness: The significance of pH at 7^{o}C. *Meat Science* 67(2): 403-408.

Hailemariam, G.A. and Wudineh, T. A. 2020. Effect of cooking methods on ascorbic acid destruction of green leafy vegetables. *Journal of Food Quality* 10(1):1-5

Harbone, J. B. 1973. Phytochemical methods, Chapman and Hall, London. 113.

Harborne, J. B. 1988. Phytochemical Methods-A Guide to Modern Techniques of Plant Analysis. Chapman and Hall, London. 182 – 190.

Harmanescu, M., Gergen, I., and Isengard, H.D. 2006. Polyphenols content, total antioxidant and radical scavenging capacities for different tomatoes and apples juices. *Journal of Agroalimentary Processes and Technologies* 12(1):83-88.

Hejtmankova, A., Taborsky, J., Kudelova, V., and Kratochvilova, K. 2018. Contents of tocols in different types of dry shell fruits. *Agronomy Research* 16(2):1373-1382.

Herrera, N. J. 2020. The impact of oxidative stress on post-mortem meat quality. Thesis and Dissertations in Animal Science. University of Nebraska. 195.

Hunt,S., Goff, J.L. and Holbrook, J.1980. Nutrition Principles and Chemical Practices. John Wiley and Sons. New York. 49-52.

Hunt, E.R. and Ppathomas, A. 2019. Being physically active through chronic illness: life experiences of people with arthritis. *Qualitative Research in Sport, Exercise and health* 12(2):242-255.

Idahor, K. O., Yakubu, A. and Aya, V. E. 2010. Performance response of broiler finishers fed graded levels of sundried cassava peels. *Proceedings of the 35th Annual Nigerian Society for Animal Production Conference,* Ibadan, Nigeria. 344-346.

Idahor, K. O. and Adua, M. M. 2011. Chemical evaluation of the nutritional quality of some commercial poultry feeds sold within Guine Savannah region of Nigeria. *Nigeria Poultry Science Journal World's Poultry Science Journal* 8:51-57

Idahor, K. O. 2013. Alternative feedstuffs utilisation in Nigeria Poultry Industry: potentials problems and prospects. *World's Poultry Science Journal* 69(3):666-675

Igile, G. O. 1996. Phytochemical and Biological studies on some constituents of *Vernonia amygdalina* (composite) leaves. Ph.D thesis, Department of Biochemistry,University of Ibadan.

Igile, G.O., Iwara, I. A., Mbeje, B. I. A., Uboh, F. E. and Ebong, P. E. 2019. Phytochemical, proximate and nutrient composition of Vernonia calvaona Hook (Asterecea): A green-leafy vegetable in Nigeria. *Journal of Food Research* 2(6):1-12.

Ilodibia, C. V., Ugwu, R. U., Okeke, C.U., Ezeabara, C. A., Okeke, N. F., Akachukwu, E. E. and Aziagba, B.O. 2014. Determination of Proximate Composition of Various parts of Two *Dracaena specie. International Journal of Botany*10(1):37-41.

Igara, C. E., Omoboyowa, R. I., Uchegbu, R. I. and Ahuchaogu, A .A. 2017. Phytochemical composition, proximate analysis and vitamin content of (*Plukenetia conophora*) walnut seed. *Chemistry Research Journal* 2(5):1-8.

Igene, J. O., Yamauchi, K., Pearson, A. M., Gray, J. I. and Aust, S.D. 1985. Evaluation of 2- thiobarbituric acid reactive substances (TBARS) in relation to warmed-over flavour (WOF) development in cooked meat. *Journal Agricultural Food Chemistry* 27(4):838-842.

Ikewuchi, C.J. and Ikewuchi, C.C. 2010. Iodometric determination of the ascorbic acid (Vitamin C) content of some fruits consumed in a university community in Nigeria. *Global Journal of Pure and Applied Sciences* 17(1): 47-49.

Jacob, A.G., Etong, D.I. and Tijanni, A. 2015.Proximate, Mineral and Anti-nutritional composition of Melon (*Citrullus lanatus*) seeds. *British Journal of Research.* 2(5):142-151.

Jacobsen, C., Garcia-Moreno, P.J., Yesiltas, B., and Sorensen, A. M. 2021. Lipid oxidation and traditional methods for evaluation. In book: Omega-3 Delivery Systems.183-200.

Jakobsen, J., Clausen, I., Leth, T. and Ovese, L. 2004. A new method for the determination of vitamin D_3 and 25-hydroxyvitamin D_3 in meat. *Journal of Food Composition and Analysis* 17(6): 777-787.

James, R.G., 1992. Modern livestock and poultry production (4thed). Delmer publishers Incoporation.

James, N. R. 2000. Volatile components of green walnuts husks. *Journal of Agricultural and Food Chemistry* 48(7): 2858-2861.

Junshu, Y., Anshan, S., Huanyu, W., Deying, M. and Changjiang, Y. 2013. Influence of supercritical carbondioxide extraction of *Schisandra chinensis* on antioxidant status, carcass and meat quality of Arbor acres broilers. *Japan Poultry Science Association* 50(3):219-227.

Kamran, G., Yousef, G, Abdollah, E., Seyed, M. N., Seyed, F.N., Mohammed, A.E. and Fereshteh, P. 2011. Influence of environmental factors on antioxidant activity, phenol and flavonoids contents of walnut (*Juglans regia* L.) green husks. *Journal of Medicinal plants Research* 5(7):1128-1133.

Kakhkai, R.A.M. 2021. Investigating the role of N-3 fatty acids on embryonic and rearing skeletal development and the subsequent impact on egg production, bone and eggshell quality in ISA brown and shaver white hens. A thesis to the University of Guelph. 168.

Karen, F. C., Priscilla, E. D, Hassan, T.A. and Paul, A.K. 2019. A review. Cholesterol metabolism via bile acid biosynthesis, CYP7A1. Multidisciplinary Digital Publishing Institute.

Karre, L., Lopez, K., and Getty, J. K. 2013. Natural antioxidants in meat and poultry products. *Meat Science Journal* 24(4):220–7.

Kassim, O. R. 2013. Development and quality evaluation of meat floss from beef, chevon and pork. A thesis in the Department of Animal Science Submitted to the Faculty of Agriculture and Forestry in partial Fulfillment of the requirements for the degree of Doctor of Philosophy of the University of Ibadan.

Keay, G. and Doxey, D.L. 1984. Astudy of the interaction between bromocresol green dye and bovine, ovine and equine serum globulins. *Veterinary Resources Communication* 8(1):25-32

Keerthana, S. and Sukitha, K. 2018.An overview of the analytical methods for food phytates. *International Journal of Chemical studies* 6(1):2016-2020.

Khalid, W., Ikram, A., Rehan, M. Afzal, F. A. Ambreen, S., Ahmad, M. Aziz, A. and Sadiq, A. 2021. Chemical composition and health benefits. *Pakistan Journal of Agricultural Research* 34(2):309-317.

Khanbabaee, K. and Van Ree, T. 2001. Tannins classification and definition. *Journal of Natural Product Reports* 18(6):641-649

Khayat, A. and Schwall, D. 1983. Lipid Oxidation in sea food. Food Technology. 7(1):130-140.

Kiin-Kabari, D.B. and Akusu, O.M. 2014.Effect of processing on the proximate composition, functional properties and storage stability of watermelon (*Citrullus lanatus*) seed flour. *International Journal of Biotechnology and Food Science*. 2(7):143-146.

Kim, J. H. et al. 2004. Oral administration of pravastatin reduces egg cholesterol but not plasma cholesterol in laying hens. *Poultry Science Journal* 83(9):1539-1543. PMid:15384905.

Kim, M. H. and Choi, M. K. 2013. Seven dietary minerals (Ca, P, Mg, Fe, Zn, Cu, and Mn) and their relationship with blood pressure and blood lipids in healthy adults with self-selected diet. *Biological Trace Elements Research* 153(1-3).

Knecht, K., Sandfuchs, K., Kulling, S.E. and Bunzel, D. 2015. Tocopherol and tocotrienol analysis in raw and cooked vegetables: a validated method with emphasis on sample preparation. *Food Chemistry*169(5): 20-27.

Koppenol, W. H.1990. Oxyradical reactions from bond-dissociation energies to reduction potentials. *Food Science Biotechnology*264(2):165-167

Korzeniowska, M., Kroliczewska, B, and Kopec, W. 2018. Effect of dietary selenium on protein and lipid oxidation and the antioxidative potential of selected chicken culinary parts during frozen stage. *Journal of Chemistry* ID 3492456, 12-24.

Kulistic, T., Radonic, A., Katalinic, V. and Milos, M. 2004. Use of different methods for testing antioxidative activity of oregano essential oil. *Food Chemistry Journal* 85:633-640.

Kumar, H., Choudhary, N., Varsh, N.K., Suma, K. and Raman, S. 2014.Phenolic compounds and their health benefits. *Journal of Food Research and Technology* 2(2):46-59

Kurt, E. 1999. Association between lipid composition shelf life and sensory quality in ruminant meats. A dissertation submitted to the University of Bristol. 323

Kyriakopoulou, K., Keppler, J.K. and Van der Goot, A. J. 2021. Functionality of ingredients and addiives in plant-based meat analogues. *Food Journal* 10(2): 600-629.

Lachance, J.C., Radhakrishnan, S., Madiwale, G., Guerrier, S., Vanamala, J.K.P. 2019. Targeting hallmarks of cancer with a food system based approach. *Nutrition Journal* 69(10):1-23.

Lauridsen, C., Jakobsen, K., and Hansen, T. K. 1995. The influence of dietary ethoxyquin on the vitamin E status in broilers. Archiv fur Tierernahrung. 47(3): 245-254.

Lawrie, R. A. 1979. Meat Science. Pergamon Press, London rd Edition, 241-299

Lawrie, R. A. and Ledward, D. A. 2006. Lawrie's Meat Science. 6th Edition, Woodhead, Cambridge. 11-30.

Lee, T. C. and Ho, C. T. 2002. Bioactive compounds in foods: Effects of processing and storage . American Chemical Society, Washington, D.C. USA. 34-43.534.

Lee, S., Choi, Y., Jeong, H. S., Lee, J. and Sung, J. 2017. Effect of different cooking methods on the content of vitamins and true retention in selected vegetables. *Food Science Biotechnology* 27(2):333-342

Lee, S.Y., Lee, D.Y., Kim, O.Y., Kang, H.J., Kim, H.S and Hur, S.J. 2020. Overview of studies on the use of natural antioxidative materials in meat products. *Food Science Animal Resources* 40(6):863-880

Li, L., Belloch, C. and Flores, M. 2021. The maillard reaction as source of meat flavor compounds in dry cured meat model systems under mild temperature conditions. *Molecules*26(1):223

Linzner, N., Loi, V.V., Fritsch, V.N., and Antelmann, H. 2021. Thiol redox switches in the major pathogen *Staphylococcus aureus.Biological Chemistry* 402(3):333-361.

Liu, R. H. 2003. Health benefits of fruits and vegetables are from additive and synergistic combinations of phytochemicals. *The American Journal of Clinical Nutrition* 78(3):517-520.

Liu, R. H. and Boyer, J. 2004. Apple phytochemicals and their health benefits. *Nutritional Journal* 3(5): 61-76.

Lopez- Vargas, J.H., Fernandez- Lopez, J., Perez-Alvarez, J.A. and Viuda-Martos, M. 2014. Quality Characteristics of pork burger added with albedo- fiber powder obtained from yellow passion fruit (*Passiflora edulis* varieties F.) co-products. *Journal of Meat Science* 97(3):54-61

Luna A, Labaque M.C, Zygadlo J.A, Marin R.H.2007. Effects of thymol and carvacrol feed supplementation on lipid oxidation in broiler meat. *Poultry Science Journal* 89(2):366–370.

Lyon, B. G., and Lyon, C.E. 2001. Meat quality: Sensory and instrumental evaluations.Pp 97-120 in Poultry Meat Processing. A.R. Sams ed. CRC Press. Boca Raton, Florida.

Mahmud, M., Maidala, A., Dantata, I.J. and Turaki, H. 2016. Blood profile and serum biochemical parameters of broiler chickens fed three local sorghum varieties grown in Bauchi state. *International Journal of Chemistry and Chemical Processes* 2(1):35-40

Mainente, F., Menin, A., Alberton, A.,Zoccatelli, G.and Rizzi, C. 2018. Evaluation of the sensory and physical properties of meat and fish derivatives containing grape pomace powders. *International Journal of Food Science and Technology* 54(4):952-958

Makrides M, Hawkes J. S, Newmann M. A. and Gibson R. A. 2002. Nutritional effect of including egg yolk in the weaning diet of breast-fed and formula-fed infants: a randomized controlled trial. *American Journal of Clinical Nutrition*75:1084–1092.

Malgorzata, S., Kazimierz, L., Henry, K.K., Jerry, W., Leszek, G., Joanna, Z., Arkadiusz, Z., Marek, K., Piotr, S., and Edyta, R. 2005. The effect of cattle genotype on texture of selected muscles during post-mortem ageing. *Food Science and Technology Electronic Journal of Polish Agricultural Universities* 8(3):1-9.

Maltin, C., Balcerzak, D., Tilley, R. and Delday, M. 2003. Determinants of meat quality:tenderness. Proceedings of Nutrition Society. 62(2):337-347

Manach, C., Scalbert, A., Morand, C, Remesy, C. and Jimenez, L. 2004. Polyphenols. Food sources and bioavailability. *American Journal of Clinical Nutrition*79(2):727-747

Mancini, R. A. and Hunt, M.C. 2005. Current Research in Meat Colour. *Journal of Meat Science*71(10):100-121.

Manika, M., Vani, P. and Rajinder, K. G.2015. Estimation of nutritional, phytochemical and antioxidant activity of seeds of musk melon (*Cucumis melo*) and water melon (*Citrullus lanatus*) and nutritional analysis of their respective oils. *Journal of Pharmacognosy and Phytochemistry*3(6):98-102.

Margit, D. A., Camilla, B. P., Hanne, C. B., and Henrik, J.A. 2003. Cooking loss and juiciness of pork in relation to raw meat quality and cooking procedure. *Food quality and preference* 14: 227-288.

Martinez, M. L. Labuckas, D. O., Lamarque, A.L. and Maestri, D. M. 2010. Walnut (*Pukenetia conophora* MULL.ARG) genetic resources, chemistry and by-products. *Journal Science Food Agriculture* 90(12): 1959-1967.

Martinez- Cerezo, S., Sanudo, C., Panea, B., Medel, I., Delfa, R., Sierra, I., Beltran, J. A., Cepero, R., and Olleta, J. L. 2005. Breed, slaughter weight and ageing time effects on physico-chemical characteristics of lamb meat. *Meat Science* 69(2):325-333

Mavimbela, D. T., Webb, E. C., Van Rysesen, J. B. J. and Bosman, M. J. C. 2000. Sensory characteristics of meat and composition of carcass fat from sheep fed diets containing various levels of broiler litter. *South African Journal of Animal Science*30(1): 26- 32.

Mazur-Kusnirek, M., Antoszkiewicz, Z., Lipinski, K., Kaliniewicz, J., and Kotlarczyk, S. 2019. The effect of polyphenols and vitamin E on the antioxidant status and meat quality of broiler chickens fed low-quality oil. *Arch Animal Breed.* 62(1):287-296.

Mikulski, D., Jankowski, J. Zdunczyk, Z. Z., Juskiewicz, J. and Slominski, B. A. 2012. The effect of different dietary levels of rapeseed meal on growth performance, carcass traits and meat quality in turkeys. *Poultry Science* 91(3):215-223.

Min, B. and Ahn, D. U. 2005. Mechanism of lipid peroxidation in meat and meat products. A review. *Food Science Biotechnology* 14(1):152-163.

Min, B. R., Attwood, G.T., McNabb, W.C., Molan, A.L. and Bary, T. N. 2005. The effect of condensed tannins from *Lotus corniculatus* on the proteolytic activities and growth of rumen bacteria. *Animal Feed Science Technology* 121(1-2):45-58

Min, B. 2006. Mechanism of lipid peroxidation in meats from different animal species. Thesis from Iowa State University, USA.

Minelli, G., Macchioni, P. Belmonte, A.M., Mezetti, F., Scutaru, C., Volpelli, L.A., Fava, P. and Lo Fiego, D.P. 2020. Effects of dietary linseed and synthetic or

natural antioxidants on shelf-life of porks. *Italian Journal of Food Science*32:151-167

Mitsumoto, M., Arnold, R. N., Schaefer, D. M. and Cassens, R. G. 1993. Dietary versus postmortem supplementation of vitamin E on pigment and lipid stability in ground beef. *Journal of Animal Science*71(7):1812-1816.

Mitsumoto, M., Cassens, R. G., Schaefer, D.M. and Arnold, R.N. 2006. Improvement of colour and lipid stability in beef longissimus with dietary vitamin E and C dip treatment. *Journal of Food Science*56(6): 1489-1492

Mitu, O., Cirneala, I.A., Lupsan, A.I., Iurciuc, M., Mitu, I., Dimitriu, D.C., Costache, A.D., Petris, A.O. and Costache, I.I. 2020. The effect of vitamin supplementation on subclinical athrosclerosis in patients without manifest cardiovascular disease: Never-ending hope or underestimated effect? *Molecule*25:1717-1738

Mohammed, A.K and Iffat, H. 2016.Vitamin E in dermatology. *Indian Journal of Dermatology*7(4): 311-315.

Morrissey, P.A., Sheehy, P. J.A., Galvin, K., Kerry, J. P. and Buckley, D.J. 2008.Lipid stability in meat and meat products. *Meat Science* 49(1): 73-86.

Muchenje V., Dzama, K., Chimonyo, M. Raats, J. G. and Strydom, P.E. 2008. Meat quality of Nguni, Bonsmara and Angus steers raised on natural pasture in the Eastern Cape, South Africa. *Meat Science Journal*79:20-28.

Muller, A. T., Paschoal, E. C., Santos, J.M.G. 2012. Impact of Pre- slaughter Management on the quality of chicken meat. Magazine on Agriculture business and Environment Brazil. 5(1):61-80.

Munyaka, A.W., Makule, E.E., Oey, I., Van, L. A. and Henderrickx, M.2010. Thermal stability of L-ascorbic and ascorbic acid oxidase in broccoli (*Brassica oleracea*). *Journal of Food Science*75(4):336-340.

Mustapha, U. I., Shenshen, Z., Jifei, M., Hao, W. and Fudi, W. 2017. Antioxidants mediate both iron homeostasis and oxidative stress. Multidisciplinary Digital Publishing Institute. 9(7):671

Nadja, N. P. F., Ednardo, R. F., Herbenson, M. G., Davyd, H. S., Edibergue, O. S., Germana, C. A., DanilO, R.F., Lina, R. S. A. and Pedro, H. W. 2019 Ethanolic extract of mango seed used in the feeding of broilers: effects on phenolic compounds, antioxidant activity, and meat quality. *Canadian Journal of Animal Science* 100(2):299-307.

Naeem, E. N., Ahmad, T., and Behzahani, M. 1995. Rapid and simple method for determination of cholesterol in processed food. *Journal Association of Analytical Chemistry International* 78: 1522-1525.

Nagla, K. A. 1995. Utilization of Chick pea, Faba bean and Pigeon pea in Sausages. M. Sc. Thesis, Faculty of Animal Production. University of Khartoum, Sudan.

Nanbol, D. L., Duru, B.N., Nanbol, H. D., Abiliu, C. A., Anueyegu, D. M., Kumbish, P. R and Solomon, M. 2016. Establishment of Reference Value for some Biochemical and Haematological Parameters for Broilers and Layers in Plateau State Nigeria. *Vom Journal of Veterinary Science* 11:30-35.

Nasir, A.M., Aasima, R., Faneshwar, K., Vijay, S. and Vivek, S.2017. Determinants of broiler chicken meat quality and factors affecting them: a review. *Journal of Food Science and Technology* 54(10): 2997-3009.

Nerin, C., Tovar, L., Djenane, D., Camo, J., Salafranca, J., Beltran, J. A. and Roncales, P. 2006. Stabilisation of beef meat by a new active packaging containing natural antioxidants. *Journal of Agricultural and Food Chemistry*54(20):7840-7846.

Nwaoguikpe, R.N., Ujowundu, C.O. and Wesley, B. 2012. Phytochemical and Biochemical Compositions of African walnut (*Tetracapidium conophorum*). *Journal of Pharmaceutical and Biomedical Sciences* 20(9):1-4.

Nworgu, F. C. 2006. Prospect and Pitfalls of Agricultural Production in Nigeria. 1st Edition. Blessed Publication Ibadan. Nigeria, 79 – 96.

Obadoni, B. O. and Ochuko, P. 2001. Phytochemical studies and efficacy of crude extracts of some homeostatic plants in Edo and Delta State of Nigeria. *Global Journal of Pure and Applied Science* 8:203-208.

Obasi N. L., Egbuonu, A. C. C., Ukoha, P. O. and Ejikeme, P. M. 2010. Comparative phytochemical and antimicrobial screening of some solvent extracts of *Samanea saman* (fabaceae or mimosaceae) pods. *African Journal of Pure and Applied Chemistry* 4(9): 206-212.

Ogbe, A. O and John, P. A. 2011. Proximate study, mineral and anti-nutrient composition of *Moringa oleifera* leaves harvested from Lafia, Nigeria: Potential benefits in poultry nutrition and health. *Journal of Microbiology, Biotechnology and Food Sciences* 1(3):296-308.

Ogbonna, P. E. and Obi, I.U. 2000. The influence of poultry manure application and plant density on the growth and yield of melon (*Colocynthis citrullus*) on the Nsukka plains of South Eastern Nigeria. *Agro-Science Journal of Tropic Agriculture Food Environment Extension* 1(1):122-129.

Ogunsua, A.O. and Adegbona, M. B. 1993. Chemical composition of Tetracarpidium conophor. *Food Chemistry Journal* 10:173-177.

Ojediran, T.K., Adisa, Y.A., Yusuf, S.A. and Emiola, L.A.2014. Nutritional evaluation of processed *Jatropha curcas* kernel meals effect on growth performance of broiler chicks. *Journal of Animal Science Advances* 4(11):1110-1121.

Ojieh, G.C., Oluba, 0.M., Ogunlowo, Y.R., Adebisi, K.E., Eidangbe, G.O. and Orole, R.T. 2008. Compositional studies of *Citrullus lanatus*(Egusi melon) seed: *Internet Journal of Nutrition and Wellness* 6: 1-6.

Okonkwo, C.O. and Ozounde, U. J. 2014. The impact of processing on nutrient content, vitamin and mineral composition of walnut (*Tetracapidium conophorum*).*International Journal of Novel Research in Life Sciences*1(2):10-16.

Okosun, S. E. and Eguaoje, S. A.2017. Growth performance, carcass response and cost benefit analysis of cockerel fed graded levels of cassava (*Manihot esculenta*) grit supplemented with moringa (*Moringa oleifera*) leaf meal. *Animal Research International* 14(1):2619-2628.

Okwu, D.E. and Okwu, M.E.2004. Chemical composition of *Spondias mombia* L. plant parts. *Journal sustainability Agricultural Environment* 6(2):140-147.

Okwu, D. E. and Orji, B.O. 2007. Phytochemical composition and nutritional quality of selected tropical edible grains of Northern Nigeria. *Food* 1(2):347-353

Oladiji, A.T., Abodunrin, T.P., Yakubu, M.T., 2007a. Some physicochemical characteristics of the oil from *Tetracarpidium conophorum* (Mull. Arg.) Hutch. Dalz nut. *Nigerian Journal Biochemistry Molecules Biology* 22 (2): 93–98.

Oladiji, A.T., Jacob, T.O., Yakubu, M.T., 2007b. Anti-anaemic potentials of aqueous extract of Sorghum bicolor (L.) Moench stem bark in rats. *Journal of Ethnopharmacology* 111: 651–656.

Olorunnisomo, O.A. and Fayomi, O. H. 2012. Quality and preference of Zebu heifers for legume or elephant grass silages with cassava peel. *Livestock Research for Rural Development* 24(9):24-38.

Olorunsanya, O. A., Olorunsanya, E. O., Aliu, O. T. and Kayode, R. M. O. 2009**.** Effects of different species of pepper on the oxidative Stability of raw and cooked Pork patties*. Pakistan Journal Nutrition* 8 (10)*:* 1588 - 5194.

Oluba, M. O., Ogunlowo, Y. R., Ojieh, G. C. Adebisi, K. E., Eidangbe, G.O. and Isiosio, I. O. 2008. Physicochemical properties and fatty acid composition of *Citrullus lanatus* (melon) seed oil. *Journal of Biological Science* 8(9):814-817.

Olugbemi, T.S., Mutayoba, S.K. and Lekule, F. P.2010.Effet of Moringa (*Moringa oleifera*) inclusion in Cassava Based Diets fed to Broiler Chickens. *International Journal of Poultry Science* 9(4):363-367.

Omerovic, I., Milosevic, B.,Ciric, S., Spasic, Z., Lalic, N. and Samardzic, S.2016. Effect of prebiotic on performance and slaughter traits of broiler chicken fed lower protein diets. *Journal of Livestock Science*7:168-171.

Omojola, A. B. and Adesehinwa, A.O.K. 2007.Performance and carcass characteristics of broiler chickens fed diets supplemented with graded levels of Roxazyme G. *International Journal of Poultry Science* 6(5):335-339.

Omojola, A.B., Isah, O. A., Adewunmi, M., Ogunsola, O.O., and Attah, S. 2004. Evaluation of the effects of various additives on the acceptability of Kilishi. *Tropical Journal of Animal Science* 6(2):230-235

Onyeneho, S. N. and Heittiarachchy, N.S. 1991. Effect of navy bean hull extract on the oxidative stability of Soy and sunflower oils. *Journal of Agricultural Food Chemistry* 39(2):1701-1704.

Owens, C.M., Alvarado, M.Z., and Sams, A.R. 2010. Poultry meat processing Second Edition CRC, Press, Boca Raton, Florida.

Oyenuga, V.A. and Fetuga, B.L. 1975. Some aspects of the biochemistry and nutritive value of the melon seed.

Pallazo, P. and Krinsky, N. I. 1992. Beta-carotene and alpha-tocopherol are synergistic antioxidants. *Archive Biochemistry Biophysics* 297:184-187.

Park, S.H., Chung, S.H., Lee, S.K., and Lee, T. K. 2010. Effect of organic acid salts and chitosan on case-reaady packed ground beef and pork patties. *Korean Journal of Food Science Animal Resources* 30(4):674-684.

Park, S.Y. and Kim, H. Y. 2011. Quality properties of Bulgogi sauce with crust derived from dry aged beef loin. *Food Science Animal Resources* 41(2):247-260.

Paul, T.K., Hasan, M.M., Haque, M.A, Talukder, S., Sarker, Y. A., Silder, M.H.,Ali Khan, M.A.N., Sakib, M.N., and Kumar, A. 2020. Dietary supplementation of Neem (*Azadirachta indica*) leaf extracts improved growth performance and

reduced production cost in broilers. *Veterinary World Journal* 13(6):1050-1055.

Pavlak, M. K., Vlahovic, J. Jarcic, A. D. and Zupancic, Z. 2005. Age, sexual and seasonal differences of haematological values and antibody status to *Chlamydophila specie* in feral and racing pigeons (*Columba livia forma* Domestica) from an urban environment (Zagreb Croatia). *European Journal Wildlife Research* 51:271-276.

Peter, T., Biamonte, G. T. and Doumas, B.T. 1982. Protein (Total protein) in serum, urine and cerebrospinal fluids. Albumin in serum. In : selected method of clinical chemistry, (Faulkner, WRS, Meites Edition). *American Association for Clinical Chemistry*. 9(1):10-15

Piccione, G. F., Fazio, E., Grasso, G. F. and Morgante, M. 2005. Nycthermal change of some haematological parameters in horses. *Journal Applied Biomedicinal* 3: 123-128

Pouliot, E., Gariepy, C., Theriault, M., and Castonguay, F.W. 2014. Use of electrical stimulation and chilling to enhance meat tenderness of heavy lambs. *Canadian Journal of Animal Science* 94(4):76-85

Qiaofen, C. and Da- Wen, S. 2005. Application of PLSR in correlating physical and chemical properties of pork ham with different cooking methods. *Meat Science Journal* 70:691-698.

Racannici, A.M.C., Menten, J. F. M., Regitone, M. A. B., Torres, E. A. F. S., Pino, L. M. and Pedroso, A. A. 2008. Effects of dietary oxidized poultry offal fat on the performance and oxidative stability of dark chicken meat during chilled storage. *Brazilian Journal of Poultry Science* 10(2):29-35.

Raman, S., Abdullah, N., Boo, L.J., Azizi, S.,and Mohammed, R. 2019. Improvement of phytase biosynthesis by new bacterial isolate, pediococcupentosaceusC4/1A via continuous cultivation.*Journal of Microbiology, Biotechnology and Food Sciences* 8(5):1118-1124.

Reddy, N.R and Pierson, M. D. 1994. Reduction in antinutritional and toxic components in plant foods by fermentation. *Food Research International Journal* 27: 281-290.

Rhee, K.S., Anderson, L. M. and Sams, A. R. 1996. Lipid oxidation potential of beef chicken and pork. *Journal Food Science* 61(2): 8-12.

Rowe, C. J. 1973. Food analysis by Atomic Absorption Spectrum, Varien Techron Springvale

Ruusunen, M., Vainionpaa, J., Puolanne,E., Lyly, M., Lahteenmaki, L., Niemisto, M. and Ahnvenainen, R. 2003. Physical and sensory properties of low-salt phosphate- free frankfurters composed with various ingredients. *Meat Science* 63(1):9-16

Sadik, N. 1991. Population growth and the food crisis: food, nutrition and agriculture/alimentation. *Nutrition and Agriculture* 1: 3 – 6.

Salih, A.M., Price, J. F., Smith, D.M. and Dawson, L. E. 1989. Lipid peroxidation in turkey meat as influenced by salt metal cations and antioxidants. *Journal of Food Quality* 12(2):71-83.

Santhi, D. and Kalaikannan, A. 2014. The effect of the addition of oat flour in low-fat chicken nuggets. *Journal of Nutrition and Food Sciences* 4(1):260-263.

Santos, P. R., Contreras-Castillo, C.J. and Venturini, A.C. 2016. Color stability of Bos indicus bull steaks in modified atmosphere packaging (MAP). *Scientia Agropecuaria.* 7(4):401-408

Sarraga, C., Carreras, I. and Garcia-Regueiro, J. A. 2002. Influence of meat quality and NaCl percentage on glutathione peroxidase activity and values for acid-reactive substances of raw and dry-cured Longissimus dorsi. *Meat Science* 62(4): 503-507.

Sarica, S., Yurtseven, S. and Polat, I. 2020. Supplementing diets for broilers that are low in crude protein and amino acids with protease. *South African Journal of Animal Science* 50(4):521-528.

Sayago- Ayerdi, S.G., Brenes, A., Viiveros, A. and Goni, I. 2009. Antioxidative effect of dietary grape pomace concentrate on lipid oxidation of chilled and long term frozen stored chicken patties. *Journal of Meat Science* 83(2):397-403

Selani, M.M., Margiotta, G.B., Piedade, S. M., Contreras-Castilo, C.J. and Canniatti-Brazaca, S.G. 2015.Physicochemical, sensory and cooking properties of low fat beef burgers with addition of fruit byproducts and canola oil. *International Conference on Biomedical Enginerring and Technology* 81(11):1-8

Sheldon, B. W., Curtis, P.A. Dawson, P. L. and Ferrket, P.R. 1997. Effect of dietary vitamin E on the oxidative stability, flavor, colour and volatile profiles of refrigerated and frozen turkey breast meat. *Poultry Science* 76(2):634-641

Sheng, S., Tong, Li, and Liu, R. 2018. Corn phytochemicals and their health benefits. *Food Science and Human Wellness* 7(3):185-195.

Shin, J.Y., Xun, P., Nakamura, Y. and He, K. 2013. Egg Consumption in Relation to Risk of Cardiovascular Disease and Diabetes: A Systematic Review and Meta-Analysis. *American Journal of Clinical Nutrition* 98:146-159.

Simitzis, P. E., Deligeorgis, S.G., Bizelis, J.A., Dardamani, A., Theodosiou, I. and Fegeros, K. 2008. Effect of dietary oregano oil supplementation on lamb meat characteristics. *Meat Science* 79(2): 217-223.

Smiddy, M., Papkovskaia, N., Papkovskaia, D.B. and Kerry, J. P. 2002. Use of oxygen sensors for the non destructive measurement of the oxygen content in modified atmosphere and vacuum packs of cooked chicken patties, impact of oxygen content on lipid oxidation. *Food Research International* 35: 577-584.

Sofowora, A. 1996. Medicinal plants and traditional medicine in Africa. Spectrum Books limited, Ibadan. 100-107

Solomon, D., 2008. Poultry sector country review: from the report; HPAI prevention and control strategies in Eastern Africa. The structure, marketing and importance of the commercial and village poultry industry: An analysis of the

poultry sector in Ethiopia. Food and agriculture organization of the United Nations 2007, Re-edited September.

Song, J. H., and Miyazawa, T. 2001. Enhanced level of n-3 fatty acid in membrane phospholipids induces lipid peroxidation in rats fed dietary docosahexaenoic acid oil. Antherosclerosis. 155(1):9-18

Sousa, A., Ferreira, I.C.F.R., Barros, L., Bento, A., Pereira, J.A. 2008. Effect of solvent and extraction temperatures on the antioxidant potential of traditional stoned table olives alcaparras. LWT-Food Science Technology.41:739-745.

Statistical Analysis Software (SAS) 1999. user's guide; Statistics version. 8th Edn. SAS Institute Inc. Cary NC.

Statistics Analysis Software (SAS), 2002. SAS users Guide version 9. SAS Institute, Incorporation, Cary, New York City, USA.

Stronskyi, I., Simonov, M., and Stronskyi, Y. 2020. Content of lipid of lipid peroxidation products in pig meat at industrial and domestic slaughter. *Scientific Messenger of Lviv National University of Veterinary Medicine and Biotechnologies* 22(99):69-74.

Strydom, S., Agenas, S., Hearth, M.F., Phillips, C.J.C., Rautenbach, G.H. and Thompson, P.N. 2008. Evaluation of biochemical and ultrasonographic measurements as indicators of undernutrition in cattle. *Onderstepoort Journal Veterinary Research* 75(3):207-213.

Taleat, A. A., Ajewole, K., and Abibu, M.A. 2013. Proximate analysis of the edible part of the African walnut (*Juglans spiecie*). *Natural Products an Indian Journal* 9(2):51-54.

Tanabe, H., Yoshida, M. and Tomita, N. 2002. Comparison of the antioxidant activities of 22 commonly used culinary herbs and spices on the lipid oxidation of pork meat. *Animal Science Journal* 73(5):389-393.

Tanwar, T., Kumar, A., and Pankaj, N.K. 2016. Oxidative stability and storage quality analysis of *Ocimum sanctum* L. extracts incorporated chicken nuggets. *Journal of Applied and Natural Science* 8(4): 2182-2188

Tchiégang, C., Kapseu, C. and Parmentier, M., 2001. Chemical composition of oil from (*Tetracarpidium conophorum* Müll Arg.) walnuts. *Journal of Food Lipids* 8(8): 95–102.

Tibin, I. M. and Mustafa, M. A. 2011. Quality attributes of burger patties extended with soybean flour and water melon seed cakes. University of Khartoum. *Journal of Veterinary Medicine and Animal Production* 8(1): 60-68.

Tolga, D. and Sukran, C. 2010. Textural and sensory properties of fish sausage from rainbow trout. *Journal of Aquatic Food Product Technology* 19(3): 238-248

Ucak, I., Ozogul, Y. and Durmus, M. 2011. The effect of rosemary extract combination with vacuum packing on the changes of Atlantic mackerel fish burgers. *International Journal of Food Science and Technology* 46(6):1157-1163.

Uche, S., Ndidi, C., Unekwuojo, N., Abbass, O., Aliyu, M., Francis, G.B. and Oche, O. 2014. Proximate, antinutrients and mineral composition of raw and processed (boiled and roasted) *Spenostylis stenocarpa* seeds from Southern Kaduna, Northwest Nigeria. *International Scholarly Research Notices* (ISRN)ID280837:1-9 https://doi.org/10.1155/2014/280837

Udedi, S. C., Ani, O. N., Anajekwu, B. N., Igwilo, I. O., Ononamadu, C. J., Adindu, C. S. and Okafor, U. M. 2013 Comparative proximate analysis of raw and cooked *Tetracarpidium conophorum* (African walnut) found in Awka, Anambra State,Nigeria.*TheBioscientistJournal*1(2):114-118. http://www.bioscientistjourmal.com.

Ugwene, M. C.2011.Effect of Dietary Palm Kernel Meal for maize on the Haematological and Serum Chemistry of Broiler Turkey. *Nigerian Journal of Animal Science* 13:93-103

Uzami, D., Gbubele, J. D., Bwai, M. D. and Kabir, M. G. 2015. Phytochemical, Nutritional and Antimicrobial screening of hexane, ethyl acetate and ethanolic extracts of *Boswellia dalzielii* leave and bark. *American Journal of Bioscience and Bioengineering* 3(5): 76-79. DOI: 10.11648/j.bio.20150305.19

Van Beekvelt, M.C.P., Colier, W.N.J.M., Wevers, R.A. and Van Engelen, B. G.M. 2001. Performance of near-infrared spectroscopy in measuring local oxygen consumption and blood flow in skeletal muscle. *Journal of Applied Physiology* 90(4):511-519.

Van-Burden, T.P. and Robinson, W.C. 1981. Formation of complexes between protein and Tannic acid. *Journal of Agricultural Food Chemistry* 1: 77.

Van Dyck, S.M.O., Verleyen, T., Dooghe, W., Teunckens, A. and Adams, C.A. 2005. Free radical generation assays: New methodology for accelerated oxidation studies at low temperature in complex food matrices. *Journal of Agricultural Food Chemistry* 53(2):887-892

Velasco, V. and Williams, P. 2011. Improving meat quality through natural antioxidants. *Chilean Journal of Agricultural Research* 71 (2): 313 - 322.

Verkerk, R., Schreiner, M., Krumbein, A., Ciska, E., Holst, B., and Rowland, I. 2009. Glucosinolates in Brassica vegetables: The influence of the food supply chain on intake bioavailability and human health. *Molecular Nutrition and Food Research* 53(2):219-265.

Wagner, K., Plasser, E. , Proell, C. and Kanzler, S. 2008 Comprehensive studies on the trans fatty acid content of Australian foods: Convenience products, fast food and fats. *Food Chemistry* 108(2):1054-1060.

Wariboko, O.N. Christina, M. and Onunkwo, D.N. 2020. Haematological indices and serum chemistry of Red Chinchilla weaner rabbit fed diet containing Gmelina fruit meal. *International Journal of Agriculture and Biosciences* 9(2):66-69

Wenther, J. B. 2013. The effect of various protein ingredients utilized as a lean meat replacement in a model emulsion system and frankfurters.Retrospective Thesis and dissertations.1-326

Wu,S.J. and Ng, L.T. 2008. Antioxidant and free radical scavenging activities of wild bitter melon(*Momordica charantia* Linn. Varities S)in Taiwan. LWT-*Food Science Technology* 41:323-330.

Xiang, J., Fenglin, L., Wang, B., Chen, L., Liu, W., and Tan, S. 2021. A Literature review on maillard reaction based on milk proteins and carbohydrates in food and pharmaceutical products: Advantages, Disadvantages, and Avoidance Strategies. *Foods* 10(9):1-18.

Youssef, M. K. and Barbut, S. 2011. Effects of two types of soy protein isolates, native and preheated whey protein isolates on emulsified meat batters prepared at different protein levels. *Journal of Meat Sciences* 87(4): 54-60.

Yusuf, H.U. and Aliyu-Paiko, M. 2020. Evaluation of cashew nut meal as phytobiotics in diet of broiler chickens and effects on feed efficiency, growth performance, blood metabolic and antioxidant profiles. *International Journal of Veterinary Sciences and Animal Husbandry* 5(1):108-114.

Zeng, Z., Li, C. and Ertbjerg, P. 2017. Relationship between proteolysis and water-holding of myofibrils. *Journal of Meat Science* 131: 448-461.

Zheng, G., Xu, L., Wua, P., Xie, H., Jiang, Y., Chen, F. and Wei, X. 2009. Polyphenols from longan seeds and their radical- scavenging activity. *Food Chemistry Journal* 116:433-436.