AKENTEN APPIAH-MENKA UNIVERSITY OF SKILLS TRAINING AND
ENTREPRENEURIAL DEVELOPMENT

EFFECTS OF TWO LEVELS OF DIETARY FAT AND FIBRE ON THE GROWTH, HAEMATOLOGY, SERUM BIOCHEMISTRY AND ORGAN HISTOLOGY IN MALE ALBINO RATS

MICHAEL ADDO BOAKYE

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BY

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A thesis submitted to the School of Graduate Studies, Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development in partial fulfillment of the requirements for the award of a Master of Philosophy degree in Biology

DECEMBER, 2023

DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original work and that no part of it has been presented for another degree in this university or elsewhere.

Michael Addo Boakye

Signature: ……………………………… Date…………………………….

Supervisor's Declaration

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development.

Dr. Holy Kwabla Zanu

Signature: ………………………………….. Date: …………………………….

ABSTRACT

The intake of high levels of saturated fat poses health risks in humans. However, intake of high levels of fibre, such as those in corn cob, might reduce these risks. Thus, the present study was conducted with the hypothesis that high fibre intake might reduce the risks posed to body weight (BW), haematology, serum biochemistry and organ health from the intake of high levels of saturated fat in Albino rats. Twenty-four (24) male Albino rats were randomly assigned to four treatments in a 2 × 2 factorial arrangement in a completely randomized design (CRD). The factors were dietary fat (low or high) and fibre (low or high). Data collected included feed intake, BW, organ weight (%), blood glucose, haematology, serum biochemistry and histology of the heart, liver and kidney. The results indicated that high fibre consistently reduced ($P < 0.05$) the BW of Albino rats throughout the study period (d 0 -56), while high fat reduced BW only on d 56. The MID count was higher in the group fed high fat ($P < 0.05$). In the group fed high fat, high fibre reduced PLT ($P = 0.05$) and PCT ($P < 0.05$) levels. In the group fed a high fat, high fibre increased ($P < 0.05$) TGA and VLDL. In the group fed low fibre, low fat reduced the LDL ($P < 0.05$), TGA ($P = 0.05$), and VLDL ($P = 0.05$). High fibre increased ($P < 0.05$), Total Bilirubin ($P = 0.05$. Dietary fat did not influence the liver function test after day 56 of the study. Low levels of dietary fat and fibre were ideal for organ health, however increasing the level of fibre improved health and mitigated some of the adverse effects imposed by dietary fat. Thus, the findings from this study indicate that increasing the level of fibre in the diet mitigated some of the adverse effects of taking in high levels of saturated fats in male Albino rats.

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DEDICATION

This work is dedicated to Almighty God, my parents, Rev. and Mrs. Peterkin Boakye, my senior brother, Daniel Boakye, my sister, Christabel Frimpomaa Boakye and Mr. Joseph Appiah.

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LIST OF ACRONYMS

ALBU.	Albumin
CV	Central vein
Fa x Fb	Fat and fibre interaction
G	Glomerulus
GLOB.	Globulin
H&E	Haematoxylin and Eosin
HDL	High-density lipoprotein
HFa-HFb	High fat & High fibre diet
HFa-LFb	High fat & Low fibre diet
IND. BIL	Indirect Bilirubin
LDL	Low-density lipoprotein
LFa-HFb	Low fat & High fibre diet
LFa-LFb	Low fat & Low fibre diet
MID	Minimum inhibitory dilution
NAFLD	Non-Alcoholic Fatty Liver disease
PT	Portal Tract
T. Cholesterol	Total cholesterol
T. Pro	Total protein
T.BIL	Total Bilirubin
T2DM	Type 2 Diabetes Mellitus
TGA	Triglycerides
VCO	Virgin coconut oil
VLDL	Very low-density lipoprotein

w/BW %	organ weight per body weight expressed as a percentage (relative organ weight)

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Metabolic syndrome is a set of interconnected health complications that simultaneously increase the risk of heart disease, type 2 diabetes and stroke. It typically includes several health issues such as hypertension, hyperglycemia, and abnormal cholesterol levels (Bovolini *et al.*, 2021). These conditions synergistically heighten the risk of cardiovascular complications and diabetes (American Heart Association, 2017; Ranasinghe *et al*., 2017).

The pervasive occurrence of metabolic syndrome has surged globally (Saeedi *et al*., 2019; Jatoi *et al*., 2022). According to Grundy (2008), approximately 20 % to 30 % of adults exhibit signs of metabolic syndrome with notable prevalence rates reported in specific locations. For instance, in Ghana, Nsiah *et al*. (2015) reported the prevalence rate of metabolic syndrome (MetS) as 58 %. Osei-Yeboah *et al.* (2017) reported the prevalence range of MetS in Ghanaian diabetic patients to be 43.3 % to 78.8 %. The aetiology of metabolic syndrome spans from overweight or obesity, sedentary lifestyle, insulin resistance and genetic predisposition with factors such as old age, diabetes and stress increasing one’s risk (Swarup *et al*., 2022). Diet significantly influences the development and treatment of metabolic diseases. Consuming saturated and trans fats increases the risk of adverse health conditions like dyslipidemia, non-alcoholic fatty liver disease (NAFLD), insulin insensitivity and heart diseases, (Maki *et al.*, 2021).

1.2 Statement of the Problem

While previous studies (Jiménez-Moreno *et al.*, 2009; Kieffer *et al.*, 2016; De Moura e Dias *et al.*, 2018; Morrison *et al.*, 2020; He *et al.*, 2022; Ioniță-Mîndrican *et al.*, 2022; Barreto *et al.*, 2023; Pappan & Rehman, 2023) have investigated the individual effects of dietary fat or fibre on metabolic health markers and physiological parameters in humans and animal models, there remains a notable gap in understanding the interactive effects of different levels of dietary fat and fibre on the physiology of organisms. Specifically, few research focused on the impact of these dietary components on growth, haematological parameters, serum biochemistry, and organ histology.

The interrelation between dietary fat and fibre and their influence on physiological parameters, particularly in Albino rats, remains an underexplored domain in current research. Very few literature works (Hollenbeck & Coulston,1991; Jackson *et al.*, 1996; Jiménez-Moreno *et al.*, 2009; and Morrison *et al.*, 2020) delved into the interactive effects of fat and fibre. However, none of these works comprehensively checked the impact of variable levels of dietary fat and fibre to examine their interactive effects on growth, haematology, serum biochemistry, and organ histology in their research models.

A recent work by Noye Tuplin *et al.* (2022) focused on the combinations of dietary fibre to alleviate metabolic, microbial, and cognitive disturbances in obese rats. Ndou *et al.* (2019) also researched the interactive effects of dietary fibre and lipids to regulate gastrointestinal processes and the digestion of fatty acids in piglets. By meticulously examining growth performance haematological parameters, serum biochemistry, and organ histology, this study aims to understand the complex mechanisms underlying the physiological adaptations induced by varying levels of dietary fat and fibre.

1.3 Research Hypothesis

In this study, it was hypothesized that the intake of high dietary fibre would mitigate the adverse effects of high-fat consumption on body weight, haematological parameters, blood glucose levels, serum biochemistry, and histological features of the liver, heart and kidney in the male Albino rats.

1.4 Aim and Objectives

1.4.1 Main Objective

Investigate the effect of two levels of dietary fat and fibre on body weight, biochemical and organ indices of male Albino rats.

1.4.2 Specific Objectives

The specific objectives were to:

1. assess the effect of two levels of dietary fat and fibre on feed intake and body weight in Albino rats.
2. analyze how the two levels of dietary fat and fibre affect the haematology and blood sugar in Albino rats.
3. analyze how the two dietary fat and fibre levels impact the serum biochemistry in Albino rats.
4. examine histological changes in the kidney, liver, and heart of Albino rats due to the variable levels of dietary fat and fibre.

CHAPTER TWO

LITERATURE REVIEW

2.1 Relationship between Diet and Health

The connections between diet and health have been of keen interest to researchers and dieticians, especially to understand the effects of specific dietary components on haematological parameters, serum biochemistry and the health and function of vital organs. It has been emphasised by Baik & Bird (2023), that the kind of diet an individual consumes especially regularly has an impact on the development and general well-being of the individual. The effect of diet on an individual's health could be either negative or positive depending on the nature and composition of the diet; whether it is balanced or unbalanced (healthy or unhealthy) (Baik & Bird, 2023).

It has been established that a balanced diet lowers the development of chronic diseases and promotes healthy growth and development in children (CDC, 2022). Whereas in adults a healthy diet reduces the risk of type 2 diabetes, heart disease and several diseases thus enabling them to live longer (CDC, 2022). The consistent intake of a balanced diet nourishes the body with all the essential nutrients and optimum energy required to function effectively to sustain good health and a healthy lifestyle. Essential nutrients provided by a balanced diet are required to maintain good health and the prevention of nutrient deficiency diseases which can cause a wide range of health problems. A balanced diet that is enriched with nutrients from varying sources reduces the risk of getting sick (Neuhouser, 2019). The consumption of an unhealthy diet affects the optimum functioning and health of the body. Globally, poor nutrition is considered a major cause of morbidity (Ng *et al*., 2014).

As reported by the USA Centre for Disease Control (CDC, 2022), poor nutrition can cause overweight, heart disease, type 2 diabetes, and some cancers. It has been reported that an unhealthy diet coupled with inadequate physical activity are the leading risk factors for health worldwide (World Health Organization., 2019). Consuming foods deficient in one or more important elements or eating unhealthy foods in excess have numerous negative consequences on general health and well-being.

2.1.1 The Western Diet

The Western diet is notable as a modern diet that encompasses convenience foods, processed grains, deep-fried foods, fatty dairy products, animal products and sweets. The high consumption of saturated fats and processed foods often leads to obesity and overweight (Odermatt, 2011). The Western diet usually contains high-fat and low-fibre intake, which increases the risk of various diet-related disorders since these processed foods tend to be high in fats and refined sugars.

According to López-Taboada *et al.* (2020), this modern-day diet has been linked to the increased occurrence of metabolic disorders. Processed foods such as fast foods or ready meals, baked products, and processed meats can harm one’s health. Consistent consumption of either excessively or heavily processed foods might cause weight gain, making people susceptible to type 2 diabetes, and other metabolic syndromes and diseases (Jamie, 2020).

2.1.2 Dietary Recommendations for Good Health

A well-balanced diet for healthy living should include foods from all the seven major food nutrients namely; carbohydrates, fats and oil, vitamins, fibre, proteins, mineral salts, and water (Centre for Health Protection - Nutrient Classifications, 2017).

Carbohydrates: Carbohydrates are the main energy food to the body, hence are classified as energy-giving foods. Sources of carbohydrates include tubers, corms, grains, fruits, and, high-fibre breads and cereals. It is recommended to take 3 - 6 servings of carbohydrates a day (CDC, 2021). For maximum health benefits, refined or processed carbohydrates should be effectively reduced or replaced with whole grains in one's diet.

Proteins**:** Proteins are essential food nutrients needed to build up the body and are referred to as body-building foods. Proteins are needed to form new cells, repair worn-out ones, and form hormones, blood, and other body parts. Protein is obtained from sources like fish, poultry, meat, legumes, whole grains, nuts, seeds, etc. It is highly recommended by dieticians to include proteins like eggs, lean meats, beans, nuts, and seafood, in the diet. It is also recommended to eat white meat more often than red meat and consume low-fat protein and dairy products (DietaryGuidelines.gov, 2020).

Vitamins: Vitamins are chemical substances needed by the body in small amounts to function well. They are classified into fat-soluble or water-soluble. The vitamins A, D, E, and K are soluble in fat and can be stored in the body. Water-soluble vitamins, which include vitamin C and the B-complex, cannot be stored in the body so excess are mostly excreted in the urine. According to McDonell (2023), It is recommended to eat enough fruits and vegetables from different sources.

Fats and oils: Fats and oils make up the majority of naturally occurring lipids. They fuel living things, protect internal organs, and help in the transportation of fat-soluble vitamins through the blood. The use of vegetable oils such as olive and sunflower oil is very healthy than trans or saturated fats.

Dietary fibre: Dietary fibre is the indigestible part of a plant or plant product that is found in food. One has to aim to consume sufficient dietary fibre from both soluble and insoluble fibre sources. Sources of fibre include whole grains, fruits, nuts and vegetables. The inclusion of adequate fibre in one's diet is highly recommended and beneficial. Fibre lowers the risk of chronic diseases, supports a healthy weight, and improves digestive health. (Neuhouser, 2019). According to Fayet-Moore *et al*. (2018), the daily recommendations for fibre for adults and children vary depending on the sex and age range. For adults, it is recommended that men consume 30 g of fibre per day, while women should aim for 25 g. In children aged 4-8 years, the recommendation is 18 g of daily fibre intake. Girls aged 9 to 13 years are advised to have 20 g, and boys in the same age group should aim for 24 g. For girls aged 14 to 18 years, the daily fibre intake recommendation is 22 g, and boys aged 14 to 18 years should consume 28 g of fibre daily (Fayet-Moore *et al.*, 2018).

Minerals: Minerals are inorganic elements which are absorbed by plants (National Library of Medicine, 2016), and consumed by animals and humans as they feed on plants and other animals. Minerals can be grouped into macro-minerals and microminerals depending on the amounts needed by the body. Different food sources comprise variable amounts of macro and trace minerals. Therefore, to provide the body with a variety of essential minerals, a healthy diet derived from different plant and animal sources should be taken. (Gharibzahedi & Jafari, 2017).

Minerals perform a lot of beneficial functions and processes in our bodies, helping us stay healthy and balanced. Not having enough of these important elements can lead to common health problems. Knowing how to keep the right amount of minerals in our food can help our bodies absorb and utilize them in metabolic activities. According to Gharibzahedi & Jafari (2017), the roles of minerals include bone and teeth health, hormone synthesis and regulation, improving enzyme structure and function, nerve cell transmission and signalling, erythrocyte formation, blood glucose regulation, antioxidant activation and blood pressure regulation, immune system support and brain health.

2.2 Dietary Fibre

Dietary fibre also known as roughage comprises the indigestible parts of plants such as cereals, grains vegetables and fruits (Mayo Clinic, 2022). Unlike carbohydrates, which are digested and assimilated by the gut, fibre remains relatively undigested and hence egested. Different fibre types can have different effects on our health (Guan *et al.*, 2021). The human gut approximately host about 100 trillion microorganisms known as gut microbiota, with a majority being bacteria. Within this ecosystem, various species of gut bacteria exist, and their impact on health can range from beneficial to harmful (Thursby & Juge, 2017; Rinninella *et al.*, 2019). The equilibrium of these bacteria in the gut microbiota is affected by numerous factors, such as dietary choices and lifestyle.

2.2.1 Benefits of Fibre

Dietary fibre has a lot of health benefits to the body warranting its inclusion in diet. Below are some of the known importance of fibre.

1. Regulates bowel movements: Dietary fibre softens stools and also increases the amount of faeces egested. The easier egestion of a bulky stool helps in the prevention of constipation. However, in the instance of loose or watery stools, fibre may help to harden the stool since it can absorb excess water and make the faeces bulky (Soliman, 2019; Ioniță-Mîndrican *et al.*, 2022; Ziani *et al.*, 2022).
2. Improve bowel health: A diet high in fibre may lower the risk of haemorrhoids and diverticular disease. Kunzmann *et al.* (2015) reported that a high-fibre diet lowers the risk of colorectal cancer. Some fibre is fermented in the colon by some commensal bacteria (Williams *et al.*, 2017; Mansoorian *et al.*, 2019). In light of that, the potential of fibre to prevent colon disorders is being studied by researchers.
3. Lowers cholesterol levels: Soluble fibre may help lower total blood cholesterol levels by lowering low-density lipoprotein (LDD), or "bad," cholesterol levels (Mayo Clinic, 2022). Studies also have shown that high-fibre foods may have other heart-health benefits, such as reducing blood pressure and inflammation (Shivakoti *et al.*, 2022).
4. Regulate blood sugar levels: Soluble fibre can slow down the absorption of sugar to improve blood sugar levels as earlier reported by Riccardi & Rivellese (1991) and confirmed by the work of Goff *et al.*, (2018) among several others. A healthy diet with insoluble fibre may also reduce the risk of developing type 2 diabetes.

5. Reduces the caloric content of food and promotes satiety: Fibre reduces the amount of calories in a meal and promotes long-lasting satiety (Ioniță-Mîndrican *et al.*, 2022). Dietary fibre enhances the clearance of cholesterol from the body, reduces intestinal cholesterol absorption, and increases bile acid excretion (Jesch & Carr, 2017).
6. Aids in losing weight or gaining a healthy weight: When compared to low-fibre diets, high-fibre foods promote satiety, causing one to eat less and feel fuller for longer. Increased soluble fibre intake can help people lose weight (Leech, 2017), especially when the caloric content of the diet is lower. High-fibre foods reduce obesity (Ioniță-Mîndrican *et al.*, 2022).
7. Dietary fibre promotes longevity: Hydes *et al.* (2020) reported that increasing dietary fibre intake can help one to live relatively longer since fibre reduces the risk of death caused by cancer or heart disease.

2.2.2 Types of Fibre

Fibre is commonly classified into two types; namely soluble or insoluble, (Soliman, 2019; Poulson, 2023;). The amount of soluble and insoluble fibre varies from plant diet. Eating a wide variety of high-fibre plants incorporates adequate amounts of both soluble and insoluble fibre to ensure the greatest health benefit (Soliman, 2019). Fibre can also be classified as either viscous or non-viscous; fermentable or non-fermentable. Viscous fibres form a colloid that influences how quickly the body absorbs certain nutrients like sugar (McRorie & McKeown, 2017; Guan *et al.*, 2021;). Fibres that ferment affect the number and type of bacteria in the gut.

Foods that contain dietary fibre usually have variable types and quantities. Hence, it is very beneficial to include a variety of plant foods to provide the body with all the benefits of dietary fibre. According to the British Nutrition Foundation (2021) fermentable fibres, like inulins and galacto-oligosaccharides, serve as a nourishing food for beneficial gut bacteria. These fibres contribute to the proliferation of bacterial species like *Bifidobacterium* and *Lactobacillus*. Through fermentation by these bacteria, fibres produce short-chain fatty acids which act as an energy source for gut cells and might also trigger hormones responsible for regulating appetite and glucose levels.

Soluble Fibre

Soluble fibre forms a gel-like substance in water which tends to slow down digestion and absorption (Phillips & Dugdale, 2022). Sources of soluble fibre include oats, bananas, peas, beans, citrus fruits, Brussels sprouts etc. Soluble dietary fibre regulates blood glucose levels by slowing down the digestion and absorption of carbohydrates thereby releasing glucose gradually into the bloodstream. This process reduces the likelihood of a rapid increase in blood glucose levels, hence maintaining constant blood sugar levels and insulin sensitivity (Balaceanu *et al*., 2017; Goff *et al.*, 2018). To enhance steady blood glucose regulation, it is recommended to eat foods such as whole grains, legumes, fruits, and vegetables.

Insoluble Fibre

Insoluble fibre is a form of dietary fibre predominantly present in the cell walls of plants. It is distinguished by its resistance to dissolving in water and hence remains relatively unchanged as it travels through the digestive system. This fibre type enhances the free transit of food through the digestive system and contributes to bulk of faeces. It also aids in preventing constipation and supports regular bowel movements by swiftly passing through the digestive tract (Phillips & Dugdale, 2022; Poulson, 2023). By preventing constipation, insoluble fibre prevents haemorrhoids and diverticulosis by maintaining optimal bowel regularity (Mahmood *et al*., 2019). Additionally, insoluble fibre supports overall gut health by promoting a diverse and healthy gut microbiota, contributing to a balanced and efficient digestive process (Thursby & Juge, 2017; Rinninella *et al*., 2019). Sources of insoluble fibre include whole-wheat flour, avocado wheat bran, nuts, beans, peas, berries, etc.

2.2.3 Corncob as a source of Fibre

Corncob is the cylindrical core or central part of a corn's ear around which the kernels or grains are attached in rows. Corncobs are a highly fibrous by-product from maize processing. Corncob is usually treated as a waste product from corn and it is mostly used as fuel (Bede *et al*., 2020). True to that, corncob is mostly used in Ghana as a source of fuel and has not been put to very good use. In agriculture, it is used as litter for animals, such as chickens, as a mulch and soil conditioner, and as fodder for ruminants.

Corncobs primarily contain about 36 % cellulose, 26 % hemicelluloses, and 17 % lignin (Thangavelu *et al*., 2018). Bede *et al*. (2020) stated that "Corn cob is a lignocelluloses biomass containing a total dietary fibre content of 90 g /100 g dry matter composed of 45 % - 55 % cellulose, 25 % - 35 % hemicelluloses, and 20 % - 30 % lignin.". Similar to wheat bran, maize cobs have similar effects on feed intake, digestion, intestinal viscosity, gut fermentation and metabolism, and visceral organs. (Bede *et al.*, 2020).

2.3 Dietary Fat

Fat is an essential fatty acid hence needs to be included in our diet as dietary fat. Like excess proteins and carbohydrates, excess dietary fat that is not metabolized by the body's cells or used as fuel is stored as body fat. The body also stores excess carbohydrates and proteins as fat. Fat contains a lot of energy compared to other dietary components. Both saturated and unsaturated fats give 9 kcal (37 kJ) of energy per gram, compared to 4 kcal (17 kJ) for carbohydrates and proteins.

2.3.1 Types of Dietary Fat

Dietary fat could be mainly grouped into two; these are saturated and unsaturated fats. Different diets have different compositions of saturated and unsaturated fats. Saturated fats and trans fats are known as “unhealthy fats” since they elevate low-density lipoprotein (LDL) levels which can increase the risk of stroke and heart disease (Hewlings, 2020). Unsaturated fats are considered “healthy fats” since they maintain healthy cholesterol levels, (American Heart Association, 2017).

Saturated fats

Saturated fats are fats in which all the fatty acid chains are singly bonded, thus they are fully bonded and “saturated” with hydrogen bonds. They are usually solid at room temperature and are predominantly from animal sources. Sources of saturated fats are meat and dairy products such as butter, cream and cheese palm kernel oil, palm oil and coconut oil etc.

Three categories of saturated fatty acids (SFAs) exist; short-chain SFAs (C2-C6), medium-chain SFAs (C6-C12), and long-chain SFAs (C14-C24). Short-chain SFAs are those with 2 to 6 carbon atoms. Medium-chain SFAs are those with 6 to 12 carbon molecules (Hewlings, 2020). Listed below are examples of saturated fatty acids:

i. Lauric acid: Lauric acid is composed of 12 carbon atoms that are bonded with hydrogen atoms. It is commonly found in coconut oil, palm kernel oil, and milk.
ii. Myristic acid: Myristic acid has 14 carbon atoms and it is found in milk and dairy products.
iii. Palmitic acid: Palmitic acid comprises 16 carbon atoms and it is contained in palm oil.
iv. Stearic acid: Stearic acid has 18 carbon atoms and can be found in meat and cocoa butter.

To reduce cholesterol in the body, it has been recommended by the American Heart Association (2017), to consume about 6 % or less of total calories from saturated fats. Comparably this is just about 11-13 g saturated fat for every 2,000 calories.

Trans Fats

Trans fatty acids are fats that are usually synthesized through the hydrogenation of liquid vegetable oils into solids. Due to the process of its synthesis, trans fats are called partially hydrogenated fats making them stable and less prone to rancidity. Due to their resistance to repeated heating and rancidity, they are ideally used as margarine and shortening to baked foods and frying of fast foods. Naturally, small amounts of trans fats could be found in beef fat and dairy fat. Just as saturated fats, trans fats also reduce the levels of HDL and increase the level of LDL which increases the occurrence of heart disease.(American Heart Association, 2017). Food sources that usually have trans fats include fried and baked foods such as pastries, pizza, cookies etc.

Unsaturated fats (Mono and polyunsaturated fats)

Unsaturated fats are fats that have one or more Carbon-Carbon (C-C) double bonds in their chain. Unsaturated fats are often liquid at room temperature and are generally obtained from plant sources such as vegetable oils, olives, walnuts and avocados. Animal sources include fish such as salmon, trout and herring. Monounsaturated fats are fatty acids that have only one C-C double bond in their chain. Usually, they are liquid at room temperature but turn to solidify upon cooling. Common examples are palmitoleic and oleic acids which are found in palm oil and vegetable oils respectfully. Monounsaturated fats can be found in foods like olive, peanut, and canola oils.

Polyunsaturated fats are fats that have more than one C-C double bond in their fatty acid chain. Sources of foods that contain high amounts of polyunsaturated fats are corn sunflower, soybean, flaxseed oils, fish etc. Polyunsaturated fat is a rich source of essential Omega-3 fats which cannot be synthesized by the body. Hence the need to include them in the diet. Consuming fish is a very good way of including omega-3 fatty acids in the body. Higher levels of omega-3 fats in the blood are associated with a lower risk of premature death from heart disease among the aged (Harvard School of Public Health, 2021).

2.3.2 Importance of Dietary Fat

Dietary fat as a food nutrient has a lot of benefits to the body and its physiology. Consuming healthy types and amounts of fat unleashes its benefits to the body for proper functioning. Below are some of the known benefits of dietary fat according to Callahan *et al*. (2023).

1. Fats are a very good source of energy and storage for the body.
2. Fats serve as protection for internal organs. Visceral fats protect vital internal organs such as the heart, liver and kidney.
3. Fats stored under the skin provide insulation and heat generation in the body.
4. Fats help the body absorb and utilize the fat-soluble vitamins.
5. Fats enable the body to produce and regulate hormones.
6. Fats provide the body with essential fatty acids such as linolenic and linoleic acid.
7. Fats are essential for building cell membranes and ensuring the proper function of cells.
8. Fats, particularly omega-3 fatty acids, are vital for brain development and cognitive function.

2.3.3 Coconut Oil

Coconut oil is produced from the kernels, flesh, and milk of the coconut fruit. At lower temperatures below 25 °C, coconut oil appears as white solid fat, and as a clear thin oil at temperatures above 25 °C. Aside from using coconut oil as food, it is also used in industrial applications to produce cosmetics and detergents (Harvard School of Public Health, 2021). Coconut oil has become a good oil preference due to its saturation and stability (Deen *et al*., 2021), hence its ability to maintain its taste and properties over a relatively long time. Due to the high level of saturated fatty acids (SFA) in coconut oil, it is usually linked with palm oil, butter and animal fats. Also, because of its high saturation level, coconut oil is not closely related to vegetable oils like olive, soybean, etc. even though it does not contain cholesterol as animal fat does.

Composition of Coconut oil

According to Deen *et al*. (2021), coconut oil contains 92 % saturated fat similar to the 90 % they cited from the report of Boemeke *et al*. (2015). Lekshmi Sheela *et al.* (2016) also reported it to have 91 % SFA of which about 72 % are medium chain fatty acids (MCFA) like lauric and myristic acid. Coconut oil consists of about 92 % saturated fats and 8 % unsaturated fats (Hewlings, 2020). The saturated fat content of coconut oil is about 90 % of which 65 % are medium-chain fatty acids with lauric acid being predominant at about 48 % (Dayrit, 2014). Coconut oil contains other minor components such as sterols phospholipids, tocopherols and volatile substances which influence the chemical and physical characteristics of coconut oil (Deen *et al*., 2021).

Table 2.1: Fatty acid composition of Coconut oil

Fatty acid	% Composition
Caprylic acid	9.6
Capric acid	6.4
Lauric acid	51.5
Myristic acid	19.1
Palmitic acid	6.9
Stearic acid	1.1
Linoleic acid	4.3
Linolenic acid	1.1

(Lekshmi Sheela *et al*., 2016)

Benefits of coconut oil

Coconut oil unlike other saturated fats is becoming an increasingly popular cooking oil due to the range of health benefits associated with its consumption and usage. Coconut oil is now used in industries to make packaged goods such as fried dishes, chocolates, shampoos, coffee, smoothies, etc. (Brazier, 2019). Aside from its preference as cooking oil, it has been known for other benefits such as reducing oxidative stress, inflammation, antimicrobial property, weight loss etc. (Cunnane *et al*., 2016). Below are some of the importance of coconut oil.

1. Coconut oil has been associated with fat burn and weight loss: The effect of medium-chain triglycerides (MCT) reveals a close association with fat burn as a result of increasing the number of calories the body burns leading to a relative loss of weight (Bueno *et al.*, 2015; Kappally *et al.*, 2016; Mumme & Stonehouse, 2015).

In light of this, coconut oil is also believed to contribute to weight loss since it consists of about 65 % of MCT. However, consuming it in higher amounts can lead to weight gain due to its high caloric value. However, there is currently little information and evidence to conclude that the consumption of coconut oil will increase calories the body oxidizes and an apparent loss in weight. Premise on this, an objective of this present study is dedicated to checking the effect of coconut oil on the growth (body weight) of the Albino rats.

2. Coconut oil serves as a quick source of energy for the body due to the higher percentage of MCT (~48-52 %).

MCTs are known to be a fast source of energy that the liver may use in the same way that it uses proteins and carbohydrates. MCTs are an efficient energy source that the body can use since it is easily oxidized by the liver and absorbed by cells, unlike long-chain triglycerides (LCT), which must be delivered to the muscles and fat tissues that use them (Watanabe & Tsujino, 2022).

3. Coconut oil boosts cardiovascular health: Coconut oil is known to increase levels of HDL in the blood causing a reduction in LDL.

Chinwong *et al.*, (2017) concluded from their research that, MCTs found in coconut oil, may help boost levels of “good cholesterol” (HDL). Conversely, another study by Eyres *et al*. (2016) discovered no conclusive proof that coconut oil raises or lowers cholesterol levels significantly. Although coconut oil was comparably improving cholesterol levels than butter and other saturated fats it was not significantly different.

4. Coconut oil helps to control blood sugar levels: Coconut oil helps to regulate blood sugar levels (Kappally *et al.*, 2016).

MCTs predominantly found in coconut oil are known to improve blood sugar levels by preserving insulin sensitivity. Malaeb & Spoke (2020), concluded from their study that incorporating coconut oil as a supplement might influence glycemic control, which could be potentially attributed to phenolic compounds and anti-inflammatory properties in coconut oil (Malaeb & Spoke, 2020).

Conversely, a systematic literature review concerning the glycemic control effect of coconut oil was conducted by Dhanasekara *et al*. (2022). They concluded by disproving the claim that coconut oil can improve glycemic control. It was found in their study that the intake of coconut fat over a long period can increase insulin resistance, however, this does not amount to an improvement in long-term glycemic control (Dhanasekara *et al*., 2022). However, further research is required to ascertain the potential of coconut oil in controlling blood sugar.

5. Coconut oil also prevents liver disease: Narayanankutty *et al*. (2018) reported that Wistar rats that were given virgin coconut oil for four weeks showed improved liver health than those that were not given the coconut oil. It was also known from their work that, the administration of virgin coconut oil improved the levels of HDL cholesterol level by 53.5 % and a reduction in hepatic and serum triacylglycerol by 78.0 % and 51.7 % respectively (Narayanankutty *et al*., 2018).

6. Consumption of Coconut oil has been linked with satiety.

However, a study by Kinsella *et al*. (2017) confirmed that MCT oil has considerable effects on satiety and not coconut oil. It could be inferred from their research finding that coconut oil will have a level of satiety effect due to its higher content of MCT though not as much as MCT would impose. A systematic literature review by Maher & Clegg (2021) concluded based on evidence gathered that "MCT decreases subsequent energy intake, but does not appear to affect appetite".

7. It reduces stress: Virgin coconut oil is believed to have some antioxidant properties.

In a study to check the anti-stress effect of coconut oil on mice Yeap *et al*. (2015), grouped the mice for their study into three; the control only took normal saline while the positive control group took 2 mg/kg body weight of diazepam and the treatment group took 10 mL/kg of body weight for 7 days. After seven days, the mice were made to swim for 6 minutes after which they were euthanized. The stress levels of the mice treated with diazepam and virgin coconut oil (VCO) showed a notable improvement. It appeared that the VCO reduce stress (Yeap *et al*., 2015). They claimed that virgin coconut oil may be beneficial in reducing certain types of depression.

8. It has antimicrobial activity: Because of its high MCT content, coconut oil is thought to possess antibacterial and antifungal qualities., specifically its high level of lauric acid (Hewlings, 2020).

Lauric acid makes up about 50 % of the MCTs in coconut oil. Research claims that it may have antimicrobial effects against pathogens such as *Staphylococcus aureus, Streptococcus mutans,* and *Helicobacter pylori* (Hewlings, 2020; Liang *et al*., 2021). Lauric acid could be a bacteriostatic agent or bactericidal agent (Widianingrum *et al.*, 2019; Hewlings, 2020). Liang *et al*., (2021) reported that lauric acid may also impede the development of microbes that damage plants.

2.4 Effect of Coconut Oil on Growth, Haematology, Serum Biochemistry and Histology of Organs

2.4.1 Effect of Coconut oil on Feed Intake and Body Weight

Consumption of coconut oil is believed to cause satiety which can cause a relatively lower feed intake. An earlier work by Wang *et al*. (2015) submitted that coconut oil insignificantly affected feed intake, feeding conversion and weight gain of broilers fed 42 days with a variable percentage (25, 50, 75 and 100) replacement of coconut oil with soybean oil. De Moura e Dias *et al.* (2018) concluded from their study that coconut oil have no considerable effect on feed intake and body weight. They found no difference in body measurements between the groups (P > 0.05) after 10 weeks.

Adelusi *et al.* (2020) in their study to find the "*Effects of coconut oil on the weight and blood status of grazing cattle fed concentrate as supplementary feed*" reported no significant difference in the final weight and feed intake of the cattle ($P > 0.05$). However, cattle that received coconut oil recorded significantly lower average weight gain; 9.82 kg for those on 50 g/day compared to the 24.67 kg increase in weight in the control group which did not take in coconut oil. Additionally, it was discovered that weight gain increased when coconut oil levels increased (Adelusi *et al.*, 2020). This finding proves that coconut oil does not have a significant effect on feed intake but rather causes a reduction in body weight.

Swarnamali *et al.* (2021) confirmed that intake of coconut oil for more than a month can significantly increase weight. A very recent research published by Gomes *et al*. (2023) also confirmed that coconut oil supplementation aids in weight loss but failed to report on the effect of coconut oil supplementation on feed intake. One may argue that it led to weight loss due to a relatively lower feed intake. This makes it very important to find out how coconut oil influences feed intake to ascertain if it causes weight loss by reducing feed intake.

2.4.2 Effect of Coconut Oil on Blood Glucose

Dietary fat and dietary fibre impact blood glucose levels differently. Diets that have high saturated fat and calories are linked to insulin resistance and impaired glucose metabolism. However, healthy fats like monounsaturated and polyunsaturated fats may have neutral or beneficial effects on blood glucose regulation (Imamura *et al*., 2016; Telle-Hansen *et al.*, 2019).

Adelusi *et al*. (2020) reported in their study that coconut oil had no significant effect on the blood glucose of cattle (P = 0.88). Contrary to that, Vogel *et al.* (2020) reported from their study in which 29 obese men were given 12 mL of coconut oil and soybean oil for 45 days that, coconut oil significantly decreased blood glucose, insulin level and insulin resistance but increased insulin sensitivity as compared to soybean oil and their baseline levels. De Moura e Dias *et al*. (2018) also reported that coconut oil did not have any significant effect on the blood glucose levels among the various groups of Wistar rats fed with variable levels and a combination of soybean oil and virgin coconut oil after 10 weeks of treatment.

Dhanasekara *et al*. (2022) concluded from their study that the fat in coconut oil could reduce postprandial insulin response and slightly elevate glycemic response, however long-term consumption increases insulin resistance (Dhanasekara *et al.*, 2022). Their results disproved the fact that long-term intake of coconut fat improves blood sugar control. Gomes *et al*. (2023) in their study observed that coconut oil supplementation improves glucose homeostasis in Wistar rats induced with metabolic syndrome (MetS) with 20 % fructose. Although it was concluded that coconut oil improved the glucose regulation in the blood they could not report if there were differences between the experimental groups.

2.4.3 Effect of Coconut Oil on Haematology

Nandakumaran *et al*. (2011) conducted a study on the effect of coconut oil on the haematology of pregnant rats given either 1, 2 or 4 mL oral dose of coconut oil twice a day for 20 days. Their treatments did not affect the haematological parameters studied as compared to the control group.

Adelusi *et al*. (2020) reported that coconut oil did not affect packed cell volume (PCV), haemoglobin and mean corpuscular haemoglobin concentration (MCHC) of cattle. They noticed an increase in red blood cells (RBC) and platelet count ($P < 0.05$) with increasing levels of coconut oil from 0 g/day to 200 g/day. A study was conducted by Oghenemaro *et al.* (2022) using 10 rats that were grouped into 2 ($n = 5$) in which the treatment group received 0.5 mL/kg body weight of coconut oil. They reported a decrease in haemoglobin, red blood cell count, white blood cell, platelet count, mean corpuscular haemoglobin concentration (MCHC), granulocyte and mean platelet volume when compared to the control group. Comparing this finding to that of Adelusi *et al.* (2020) it could be said that coconut oil have a contrasting effect on the haematological parameters.

2.4.4 Effect of Coconut Oil on Lipid Profile

Recently there have been some claims that coconut oil is good for heart health since some studies suggest it may lower LDL “bad” cholesterol and increase HDL ‘good’ cholesterol levels. However, there has been some conflicting report on the effects of coconut oil on blood cholesterol. Earlier work by Wang *et al*. (2015) reported that higher coconut oil levels led to a decrease in total cholesterol and an increase in lipoprotein lipase, hepatic lipase, and total lipase activities. Chinwong *et al.* (2017) concluded from their research that coconut oil, may help boost levels of HDL. In contrast to Chinwong *et al.*, (2017) findings, De Moura e Dias *et al*. (2018) in their study observed a similarity in the HDL, LDL and total cholesterol among the experimental groups ($P > 0.05$). Later on, some research findings reported that coconut oil may increase LDL levels, therefore, increasing the risk of heart complications (Sankararaman & Sferra, 2018; Hewlings, 2020; Neelakantan *et al.*, 2020). Eyres *et al.*

(2016) reported from their work that the consumption of coconut oil improves lipid profile compared to the consumption of butter.

Adelusi *et al*. (2020) submitted from their research that increasing levels of coconut oil (0, 50, 100, 150 g/day) had a significant increase in total cholesterol, LDL and HDL ($P < 0.05$). However, increasing the level of coconut oil from 150 g/day to 200 g/day reduced HDL and LDL values. Signifying from their research that the optimum level of coconut oil for a better lipid profile is 150 g/day given to cattle with an approximate weight of 140 kg. Vogel *et al*. (2020) concluded from their study that coconut oil improved HDL cholesterol.

Gomes *et al.* (2023) concluded from their research that coconut supplementation in Wistar rats induced with metabolic syndrome decreased the levels of triglycerides (TG). Similarly, Oghenemaro *et al.* (2022) also reported a decrease in HDL, LDL and total cholesterol in Wistar rats that were fed with 0.5 mL/kg daily as compared to the control. The different findings on the impact of coconut oil on the lipid profile call for more investigations and studies to help ascertain its impact. Whether the quantity or administration of coconut oil can influence the contrasting effects from the various kinds of research.

2.4.5 Effect of Coconut Oil on the Liver, Heart and Kidney

The liver and kidneys are the vital organs that perform metabolic activities and detoxification processes in the body, making them crucial for healthy living and effective body function. Fat is linked with NAFLD which is characterized by hepatic lipid accumulation, inflammation, and oxidative stress (Perdomo *et al*., 2019). Sun *et* *al.* (2020) submitted from their research study that, diets high in fats are associated with kidney dysfunction, including renal injury and increased risk of kidney diseases.

Several claims have it that coconut oil increases the HDL in the blood causing a reduction of LDL. Chinwong *et al.* (2017) concluded that MCTs found in coconut oil may help boost levels of "good cholesterol" (HDL). This finding indicates that coconut oil can help improve cardiovascular health. Although coconut oil was comparably improving cholesterol levels than butter and other saturated fats, the improvement was not significantly different.

Otuechere *et al.* (2014) concluded from their study that coconut oil had hepatoprotective properties against the harmful effects of trimethoprim-sulfamethoxazole. AbdEl-Fattah & Barakat (2011) submitted that olive and coconut prevent the liver from damage and oxidative stress (AbdEl-Fattah & Barakat, 2011). Another research by Zakaria *et al*. (2011) also confirmed the hepatoprotective activity of Virgin coconut oil (VCO) in rats that were induced with a 3 g/bodyweight paracetamol dose to damage the liver. They submitted from their study that VCO has a hepatoprotective effect despite the method of preparation (dried or fermented) due to its antioxidant feature (Zakaria *et al*., 2011). On the contrary, Sacks (2020) reported in his study "*Coconut Oil and Heart Health: A Fact or Fiction*" that coconut oil causes an increase in cholesterol and the risk of cardiovascular disease.

2.4.6 Effect of Coconut Oil on Metabolic Health and the Development of Metabolic Syndromes

Nikooei *et al.* (2021) studied the effect of virgin coconut oil (VCO) on metabolic syndrome components. Results from the analysis indicated VCO reduced fasting blood glucose, triglyceride and very low density lipoprotein while it increased HDL, LDL and total cholesterol when compared to the control group (Nikooei *et al.*, 2021). To find out the effect of coconut oil supplementation in Wistar rats induced with MetS with 20 % fructose, Gomes *et al*. (2023) reported that coconut oil has some benefits in reducing weight, fat accumulation and glucose homeostasis. Nonetheless, long-term supplementation is associated with negative effects and a higher risk such as increased triglycerides and fructosamine levels and structural dienes for people with Mets.

2.5 Effects of Fibre on Growth, Haematology, Serum Biochemistry and Histology of organs.

2.5.1 Effect of Fibre on Feed intake and Body Weight

There have been claims that high-fibre foods increase satiety by causing one to eat less and feel satisfied for a longer time. Consuming higher amounts of soluble fibre can promote weight loss (Leech, 2017), especially when the caloric content of the diet is lower. Ioniță-Mîndrican *et al.* (2022) concluded from their study that high-fibre foods cause weight loss and reduce obesity. Ansah *et al.* (2012) conducted a study to evaluate the effect of a corn cob on the growth performance of Grasscutter (*Thryonomys swinderianus*). They found no considerable difference in feed intake and weight gain among the treatments. Balaceanu *et al.* (2017) also had similar results when they fed rabbits diets with different fibre and starch levels. A confirmation was reported by the results Pu *et al.* (2022) obtained from pigs.

A contrasting report was submitted by Wachirapakorn *et al*. (2016) with the claim that cows fed with higher proportions of ground corn cob (40 % and 33 %) had a higher feed intake and growth than those that had lower proportions (27 % and 20 %). Based on this finding they concluded that ground corn cob improved feed and nutrient intake. As an objective to determine the influence of corncobs on the feed and growth of grower pigs for 16 weeks, Bumbie (2017) grouped 40 pigs into five groups (n = 8) and supplemented the feed of the treatment groups with either 15 % or 25 % corn cob with or without enzyme. Bumbie (2017) had no considerable difference in feed intake among treatments however he had a difference ($p < 0.05$) in feed conversion ratio and weight gain between the control and the 25 % corncob with fibre group. The difference in the feed intake could be due to the inclusion of enzymes that would feed and also aid in the digestion of the fibre in the gut of the pigs (Bumbie, 2017). Tsado *et al*. (2019) also performed a similar experiment in which the different levels of corncob fed to broiler chickens were hydrolyzed and treated with enzymes. They observed a notable increase in the feed intake and growth of the broilers that were fed with an enzyme-treated fibre diet.

2.5.2 Effect of Fibre on Blood Glucose

Soluble fibre lower blood sugar levels in diabetics by slowing the absorption of sugar. as earlier reported by Riccardi & Rivellese (1991) and confirmed by the work of Goff *et al.* (2018) among several others. Balaceanu *et a*l. (2017) submitted from their research that blood glucose levels were remarkably lower ($P = 0.048$) in the groups fed fibre-enriched diets. Mao *et al*. (2021) submitted that consuming 10 g of fibre per day remarkably reduced fasting blood glucose (FBG) as compared to the control groups. Only two other studies presented no significant difference in FBG levels (Mao *et al*., 2021). Inference from this review indicates that there is a strong link between the intake of dietary fibre and the reduction of FBG levels.

2.5.3 Effect of Fibre on Haematology

Balaceanu *et al.* (2017) reported that the variable fibre and starch-enriched diets did not have any significant effect on the haematological parameters of rabbits ($P > 0.05$). These unaltered haematological parameters imply that at least during the study time the levels of fibre and starch, used in the study did not affect the hematopoietic process of the rabbits (Balaceanu *et al.*, 2017). This aligns with the report of Ewuola *et al*., (2012), that except for neutrophils there were no significant changes in blood parameters of rabbits fed different levels of *Moringa oleifera* leaf meal (MOLM).

However, a later work by Tsado *et al.* (2019) reported some improvement in blood parameters when they fed broiler chickens with graded levels of hydrolyzed corncob. They reported that the enzyme-treated corncob diets significantly ($P < 0.05$) increased packed cell volume (PCV), mean corpuscular haemoglobin (MCH), red blood cell count (RBC), and white blood cell count (WBC). Although they had some significant differences in the blood parameters considered, that cannot be entirely attributed to the fibre since it was hydrolyzed and treated with an enzyme which might have influenced the difference compared to other findings.

2.5.4 Effect of Fibre on Lipid Profile

Dietary fibre, primarily obtained from plants improves lipid profiles by reducing LDL cholesterol and increasing HDL cholesterol (Balaceanu *et al.*, 2017) reducing the likelihood of stroke, and type 2 diabetes. This lowers the risk of cardiovascular disease, dyslipidemia and obesity (Hartley *et al.*, 2016; Ioniță-Mîndrican *et al.*, 2022). Balaceanu *et al*. (2017) similarly reported that fibre levels are positively associated with HDL cholesterol (r = 0.78), but negatively linked with triglycerides (r = -0.78), and LDL cholesterol (r = 0.86). Fibre and cholesterol were rarely associated (r = 0.15). The work of Tsado *et al.* (2019) also confirmed that fibre causes a significant decrease in blood cholesterol levels. It can be concluded that fibre improves HDL levels and causes a reduction in LDL as claimed by various researchers.

2.5.5 Effect of Fibre on the Liver, Heart and Kidney

A study conducted by Kieffer *et al*. (2016) on the impact of dietary fibre on nutrient management and detoxification organs (Gut, Kidney and Liver) reported that changes in the gut induced by fibre improve gut barrier function which helps to protect the liver and kidney from pro-inflammatory bacteria and bacterial products. This allows the liver and kidneys to function effectively (Kieffer *et al*., 2016). They also reported that dietary fibre may reduce nitrogen burden and systemic inflammation in the kidney. Dietary fibre can affect liver metabolism by changing bile acid pools and reducing the risk of NAFLD. It was reported by Ioniță-Mîndrican *et al*. (2022) from their review of the therapeutic benefits of fibre that consuming 7 g of fibre daily protects the heart from cardiovascular and coronary disease by 9 %.

2.5.6 Effect of Fibre on Metabolic Health and Development of Metabolic Syndrome

Metabolic disorders hurt vital organs like the liver, heart, and kidney. These adverse effects can lead to the onset of non-alcoholic fatty liver disease (NAFLD) and cardiac dysfunction (Buzzetti *et al*., 2016). On the other hand, dietary fibre has shown protective effects against hepatic steatosis (Narayanankutty *et al*., 2018) and cardiovascular damage (MaćKowiak *et al*., 2016). Identifying and understanding the interactive effects that fat and fibre could have on vital organs such as the heart, liver, and kidney require histological examinations.

There have been a lot of contradictory reports on the impact of fibre on metabolic health and the development of MetS. McRae (2018) reviewed published articles and concluded that the majority of the reports and findings indicated that dietary fibre decreases the effect and onset of obesity and diabetes. Evidence from their study also demonstrated that numerous studies revealed an adverse relationship between fibre intake and the risk of coronary heart disease and several cancer types (McRae, 2018). He *et al*. (2022) reported from their study on the effects of dietary fibre on human health that dietary fibre improves human metabolic health by reducing obesity, the risk of developing T2DM and several cancers.

2.6 Interactive Effect of Dietary Fibre and Dietary Fat

A lot of research studies have been conducted on the individual effect dietary fat and dietary fibre have on feed intake, growth, haematology, biochemical indices and vital organs. However, limited research has been conducted to investigate the combined and interactive effects of dietary fat and fibre. Some claims suggest that dietary fibre may help to reduce some of the negative effects caused by dietary fat such as obesity, and a rise in blood glucose and cholesterol levels. Limited evidence supports the claim that the inclusion of fibre in a fatty diet may mitigate the detrimental effects of fat. Jakobsdottir *et al.* (2013) reported from their study that fibre mitigates the adverse effects caused by fat. They observed that fibre partly counteracted the increase in inflammation, liver fat and cholesterol levels in rats.

Jiménez-Moreno *et al.* (2009) performed a study on the effect of dietary fat on the performance (feed intake, weight gain and mortality) and digestive traits of broilers. They concluded from their study that average levels of dietary fibre diet might increase the performance and nutrient absorption in young chicks especially when the diet contains saturated fats. Earlier research conducted by Jackson *et al*. (1996) reported no considerable interaction between fat and fibre concerning food intake but was observed in body weight gain. Comparatively fat increased body weight while fibre caused a reduction in body weight (Jackson *et al***.**, 1996). For instance, it has been found from research that dietary fibre aids in reducing increased levels of cholesterol, obesity and cardiovascular diseases that can be caused by saturated fatty acids (MaćKowiak *et al.*, 2016).

Reports from previous research indicate that dietary fat can cause detrimental effects on the lipid profile, blood glucose regulation, and vital organs thereby contributing to the development of metabolic syndrome and cardiovascular diseases. Contrary to that, research claims that dietary fibre has a positive impact on improving lipid profile, blood glucose control, and organ health.

Very little research has been conducted to find out the interactive effects of dietary fibre and dietary fat on health and growth performance. Limited evidence suggests that the inclusion of dietary fibre can mitigate the negative consequences of high-fat intake. To completely comprehend the interactive effects of varied levels of dietary fat and dietary fibre on haematology, biochemical indices, blood glucose, and essential organs in Albino rats, more research is necessary. Premised on this, further research is warranted to comprehensively evaluate the interactive effects and potential interventions of fibre for better human health.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Location and Period of the Study

The present study was conducted at the Animal Science farm at Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development, Mampong Campus (AAMUSTED-Mampong). Asante Mampong is the capital of the Mampong Municipal Assembly located northeast of Kumasi within the Ashanti region with the coordinates 7^0 4’ N 1^0 24’W (Geodatos, 2021). Sekyere Central District lies to the east of Asante Mampong while Ejura Sekyedumase Municipality lies to the north and Sekyere South District borders the area to the south. 56,965 men and 59,667 women made up the Municipality's population of 116,632 as reported by the 2021 Population and Housing Census.

The Municipality covers a total land area of 782 km^2 with 69 settlements, approximately 58 % being rural (Ghana Districts, 2019). The Municipality’s highest point is 2,400 m above sea level, while the lowest is about 135 m. In light of this, the Municipality is typically low-lying and gradually climbs through rolling hills that extend southeast near Mampong. The Municipality is fairly drained by several streams and rivers, notably, Afram and Kyirimfa rural (Ghana Districts, 2019). The study commenced on 15th April 2023 and ended on 9th June 2023.

3.2 Experimental Animals and Management

The animal model utilized in this research was 24 male Albino rats with an average weight of 178 ± 4.73 g. The rats were bought from a notable local breeder in Asante

Mampong. Before the onset of the study, the rats were acclimatized for two weeks. They were housed individually in a compartmentalized wooden cage secured with a wire mesh at the Animal Science Farm. The dimensions of each compartment were 40 cm x 20 cm x 30 cm. The research environment was siren and the conditions of the room were very conducive with a room temperature of 23 ± 3^0 C and 12-hour light/dark cycles. The rats were fed with their respective treatment diet and clean water twice a day *ad libitum* throughout the experimental period. The cages and rooms were cleaned and swept every morning and drinkers and feeders were washed and refilled with fresh water and feed.

3.3 Experimental Design and Treatments

The treatments were completely randomized in a 2 × 2 factorial arrangement. The factors were dietary fat (Fa) (low or high), and dietary fibre (Fb) (low or high) in the diets. Throughout the study duration (d 0 to d 56), the diets were provided *ad libitum.* Each treatment diet had two variable levels of the two dietary factors under consideration as shown below:

Treatment 1: Low fat & low fibre (LFa-LFb); Treatment 2**:** Low fat & high fibre (LFa-HFb); Treatment 3**:** High fat & low fibre (HFa-LFb) and Treatment 4: High fat & high fibre (HFa-HFb).

3.4 Experimental Diet and Feed Formulation

The various treatment diets used for the study were formulated based on the nutrient and energy requirements of the Albino rats. All the diets were isocaloric and supplied all the basic nutrients in their right amount and proportion.

3.4.1 Ingredients

The ingredients of the diets were secured from the local market and study area. Salt and well-dried healthy maize free from pest infestation was bought from the Asante Mampong Market. Soybean meal, dicalcium phosphate, and vitamin premix were bought from Moonlight Farms; a local animal feed distributor. The corn cob was collected from a local maize farm immediately after they threshed the corn. The cobs were dried and had no mould or other infestations. Unrefined pure natural coconut oil extracted via semi-cold pressed which was manufactured by Akono Manufacturing Limited located in Accra, Ghana was bought (Akono Pure Coconut oil, Batch no. AKO I-082020).

3.4.2 Feed formulation

The Concept 4 feed formulation software (Creative Formulation Concepts, LLC, Annapolis, MD) was used to formulate the diets (Table 3.1). The major ingredients (corn, corncob, soybean meal, and coconut oil) were then used to formulate four distinct experimental diets, as detailed in Table 3.1. Before the feed preparation, the corncob and corn were milled separately at the animal farm mill.

The amount of each ingredient (g) was measured accurately with an electronic digital scale. The measured ingredients were poured into a large basin and mixed carefully and thoroughly to ensure uniform distribution of the various nutrients in each diet. After mixing the feed each was placed in a separate sack and labelled according to the treatment. The sacks were tightly placed in a jute bag to preserve their palatability and state. The feed was prepared weekly based on the percentage and weight of food ingredients for each treatment diet as shown in Table 3.1.

Table 3.1: Formulated feed

Ingredients (%)	**Treatment 1 (Low Fat vs Low Fibre)**	**Treatment 2 (Low Fat vs High Fibre)**	**Treatment 3 (High Fat vs Low Fibre)**	**Treatment 3 (High Fat vs High Fibre)**
Corn	50.00	5.00	50.00	5.00
Soybean meal	26.41	31.09	25.00	29.40
Corn cob	21.09	60.00	19.00	58.00
Coconut oil	1.00	2.41	4.50	6.10
Di-Calcium phosphate	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50
Premix	0.50	0.50	0.50	0.50
Calculated nutrients (%)				
Fat	3.04	3.00	6.16	6.3
Fibre	8.29	18.30	7.65	17.67
Protein	17.5	17.3	17.58	17.3

3.5 Ethical Approval and Considerations

Ethical clearance for this study was acquired from the University for Development Studies Institutional Review Board (UDSIRB) with the approval reference number UDS/RB/187/23. The study protocol and procedures complied with the ethical standards outlined by the UDSIRB.

3.6 Data Collection

All weight measurements were done using the Kern® Electronic Digital Scale (Kern & Sohn Company Limited, Balingen, Germany).

3.6.1 Proximate Analysis

Proximate analysis was conducted on the corncob and the four treatment diets that were formulated to ascertain the nutrient and energy composition. The proximate analysis was performed at the Animal Science Nutrition Laboratory of Kwame Nkrumah University of Science and Technology. The chemical analysis was performed according to the guidelines as illustrated by A.O.A.C (1990). The result of the feed analysis is shown in Table 4.1.

3.6.2 Feed intake

The feed consumed by each animal was measured and recorded every morning. Measurement of the feed intake commenced on day 15 of the experimental period after safe and effective measures were employed to prevent feed wastage. Each rat was fed 30 g of feed daily; 20 g was given in the morning and an additional 10 g in the evening. The feed intake was calculated by deducting the leftover feed in the feeder and what was collected in the bowl placed directly under the cage from the total feed served. The leftover feed was collected and measured with an electronic scale and the value was subtracted from 30 g to get the feed consumed by the rat. The value was then recorded as the feed intake for that particular rat. The data results for the feed intake are shown in Table 4.2. Feed intake = Total feed served (30 g) – (leftover in feeder + disposable bowl).

3.6.3 Bodyweight

The body weight of the Albino rats was measured with an electronic digital scale every week. Their initial body weight was measured on Saturday 15th April 2023 before the onset of the study. Every week the animals were weighed in the morning before they were fed. The results of the body weight analysis are shown in Table 4.3.

3.6.4 Organ Weight

After 56 days of experimental study, the rats were euthanized at the AAMUSTED Science Laboratory. They were anaesthetized using chloroform before dissection. The Albino rats were carefully dissected and their heart, kidney and liver were harvested after blood samples were collected via heart puncture using sterile syringes. The vital internal organs of interest (heart, kidneys and liver) were carefully incised and extraneous tissues were removed before measuring with a digital electronic scale. The left and right kidneys were measured separately. The measured organ weights were expressed as a percentage of their ratio to the body weight (w/BW %). This was calculated by dividing the organ weight by the body weight of the organism before sacrificing it and multiplying the results by 100 %.

$$\text{w/BW \%} = \frac{organ\ weight}{Body\ weight} \text{ x } 100\ \%$$

The results of the relative organ weight analysis are shown in Table 4.4.

3.6.5 Blood Glucose

The blood glucose of the Albino rats was measured using an IVD No code-Easy use blood glucometer (Yuanfang Company Limited, China). A blood sample collected via cardiac puncture was used to measure the blood glucose levels. The measured value (mg/dL) was recorded for each rat. The analyzed data is shown in Table 4.5

3.6.6 Haematological Analysis

5 ml of blood sample was collected from each rat via cardiac puncture after the rats were dissected via a ventral incision to expose the thoracic cavity. Blood samples were placed in a tube containing the anticoagulant agent Ethylenediaminetetraacetic acid (EDTA). The tubes were labelled according to the treatment group of the rats and the number designated to them in order of their dissection. The blood samples were immediately sent to the Asante Mampong Municipal Hospital for haematological analysis (Full blood count). The haematological parameters were analyzed with an automated haematology analyzer; Rayto RT-7600s (Rayto Life and Analytical Sciences Company Limited, China). The results of the analysis are shown in Tables 4.6 A and 4.6 B.

3.6.7 Biochemical Analysis

Another 5 ml of blood was collected and placed in a serum-separating tube. The tubes were labelled accordingly to identify the individual rats in a treatment group. The samples were sent to the Asante Mampong Municipal Hospital for a lipid profile and liver function test to be performed using a Mindray Biochemistry analyzer (Mindray Bio-Medical Electronic Company Limited, China). The results of the analysis are shown in Tables 4.7 and 4.8.

3.6.8 Histological Examination

Histological examination was performed on the liver, heart and kidney to detect any changes. After the harvested organs weight were measured they were placed in a container containing freshly prepared 10 % formalin. The various organs were placed in different containers that were designated and labelled for each particular treatment group and organ. The preserved organs were sent to the histology laboratory of the Department of Anatomy at the University of Ghana, Legon for histological examination.

The liver, heart and kidney sections were initially fixed in 10 % buffered formalin (pH: 7.4), followed by a process of dehydration using graded ethanol and clearing in xylene. Subsequently, these sections were embedded in paraffin wax. Slices measuring 4-5 μm in thickness were prepared. These sections were stained with haematoxylin and eosin (H&E). Finally, the stained sections were examined under a compound light microscope at a magnification of 400X. The images were captured using a digital camera attached to the microscope for further analysis and documentation. The histological micrographs are shown in Plates 4.1 - 4.12.

3.7 Statistical Analysis

Data collected in this study were analyzed using Minitab Statistical Software Version 20.0. Firstly, the data were analyzed as 2 × 2 factorial arrangements using the General Linear Models (GLM) Procedure to assess the main effects; dietary fat and fibre (low or high) and their 2-way interactions (Fa× Fb). Tukey LSD means separation test was then used to make pairwise comparisons among treatment means ($P < 0.05$).

CHAPTER FOUR

RESULTS AND DISCUSSIONS

RESULTS

4.1 Proximate Analysis

The results from the proximate analysis of the corn cob and experimental diets are shown in Table 4.1.

Table 4.1: Proximate analysis of corn cob and experimental diet, as fed basis

Parameter on as fed basis	% Corn Cob	% T 1	% T 2	% T 3	% T 4
Moisture content	10.28	11.78	11.38	12.54	11.25
Ash content	2.05	4.69	5.46	4.48	4.76
Crude fat	6.25	5.75	6.90	19.37	19.41
Crude fibre	23.41	9.97	15.80	9.79	16.12
Crude protein	2.41	20.58	19.70	17.51	19.05
Nitrogen free extract	55.6	47.23	40.76	36.31	29.41

As shown in Table 4.1, the corn cob had the highest nitrogen free extract and crude fibre levels and the lowest ash and crude protein content. Treatment 1 which consisted low levels of coconut oil and corn cob had the lowest crude fat level and relatively higher crude fibre level than treatment 3 that was composed of high coconut oil and low corncob. Treatment 2 which was made up of low fat and high fibre had the highest crude protein. Treatment 4 which was composed of high levels of coconut oil and corn cob had the highest level of crude fat and fibre and the lowest nitrogen free extract.

4.2 Feed Intake

As shown in Table 4.2, high fat as a main effect tended to decrease feed intake (g) during d 15-35 ($P = 0.058$), d 15-42 ($P = 0.070$) and d 15- 49 ($P = 0.097$) compared to low fat. Similarly, high fibre as a main effect tended to decrease the feed intake (g) of Albino rats compared to low fibre ($P = 0.067$) from d 15-21. No fat x fibre interaction was detected ($P > 0.05$) throughout the study. The orthogonal comparison shows that the high-fat and high-fibre (HFa-HFb) diet tended to decrease feed intake (g) ($P = 0.082$) as compared to the low-fat and low-fibre (LFa-LFb) diet.

4.3 Body Weight

The experimental rats' body weight results are shown in Table 4.3. The results indicate that high fibre as a main effect decreased ($P < 0.05$) the body weight throughout the study compared to the low-fibre diet. Similarly, the high-fat diet as a main effect decreased ($P < 0.05$) body weight on d 56 as compared to the low-fat diet. No Fat x Fibre interaction ($P > 0.05$) was detected on body weight throughout the study. Orthogonal comparisons of the treatments indicate that the high-fat and high-fibre (HFa-HFb) diet compared to the high-fat and low-fibre (HFa-LFb) diet decreased body weight ($P < 0.05$) from d 7 till the end of the study except on d 49 ($P = 0.165$). Similarly, the HFa-HFb diet decreased body weight ($P < 0.05$) from d 14 till the end of the study when compared to the low-fat and low-fibre (LFa-LFb) diet. The LFa-HFb diet also decreased body weight ($P < 0.05$) from day 14 to day 42 as compared to the HFa-LFb diet. Also, LFa-HFb diets caused a reduction in body weight ($P < 0.05$) from d 21 till the end of the study compared to LFa-LFb.

Table 4.2: Effects of two dietary fat and fibre levels on the daily feed intake (g) of Albino rats

Effects	**Fat**	**Fibre**	**d 15- 21**	**d 15-28**	**d 15-35**	**d 15-42**	**d 15-49**	**d 15-56**
	Low		13.34	13.03	13.08	12.60	12.10	12.02
	High		11.76	10.98	10.53	10.33	10.09	10.08
SEM			0.069	0.077	0.074	0.071	0.072	0.075
		Low	13.81	13.17	12.86	12.29	11.69	11.56
		High	11.36	10.87	10.72	10.59	10.44	10.48
SEM			0.069	0.077	0.074	0.071	0.072	0.075
Interactions								
Low fat x low fibre			15.25	14.86	14.66	13.92	13.12	12.84
Low fat x high fibre			11.67	11.43	11.68	11.40	11.15	11.25
High fat x low fibre			12.51	11.67	11.29	10.85	10.41	10.41
High fat x high fibre			11.05	10.33	9.831	9.839	9.778	9.755
SEM			0.098	0.109	0.105	0.101	0.101	0.106

P- value						
Fat	0.233	0.142	0.058	0.070	0.097	0.122
Fibre	0.067	0.102	0.107	0.165	0.290	0.378
Fat x fibre	0.485	0.537	0.684	0.626	0.637	0.761
Orthogonal comparison						
(High Low) - (High High)	0.808	0.858	0.791	0.901	0.971	0.972
(Low High) - (High High)	0.978	0.912	0.658	0.731	0.795	0.779
(Low Low) - (High High)	0.155	0.146	0.082	0.127	0.238	0.331
(Low High) - (High Low)	0.959	0.999	0.995	0.985	0.963	0.954
(Low Low) - (High Low)	0.537	0.460	0.362	0.365	0.435	0.555
(Low Low) - (Low High)	0.288	0.390	0.482	0.550	0.704	0.836

Means bearing different superscripts ($^{\mathbf{abc}}$) in the same column are significantly different ($P < 0.05$).

Table 4.3: Effects of two levels of dietary fat and fibre on the body weight (g) of Albino

Effects			**d 0**	**d 7**	**d 14**	**d 21**	**d 28**	**d 35**	**d 42**	**d 49**	**d 56**
	Fat	**Fibre**									
	Low		181.0	193.7	200.4	202.3	202.5	198.4	190.5	192.6	220.8^{a}
	High		173.0	184.4	188.2	186.8	179.4	175.9	187.0	172.0	170.0^{b}
SEM			0.378	0.044	0.047	0.041	0.041	0.053	0.041	0.063	0.060
		Low	183.9	207.3^{a}	229.5^{a}	235.4^{a}	231.5^{a}	234.1^{a}	224.7^{a}	216.5^{a}	239.4^{a}
		High	170.2	172.3^{b}	164.4^{b}	160.5^{b}	156.9^{b}	149.2^{b}	158.5^{b}	153.5^{b}	156.7^{b}
SEM			0.378	0.044	0.047	0.041	0.041	0.051	0.043	0.063	0.060
Interactions											
Low fat x low fibre			184.3	204.3	233.3	239.1	242.5	241.9	232.2	236.8	276.5
Low fat x high fibre			177.7	183.6	172.2	171.1	169.1	162.8	156.3	156.7	176.3
High fat x low fibre			183.5	210.4	225.7	231.8	221.0	226.5	217.4	198.0	207.3
High fat x high fibre			163.0	161.7	157.0	150.5	145.6	136.6	160.8	149.5	139.3
SEM			0.054	0.063	0.069	0.057	0.058	0.072	0.061	0.084	0.085

P- value									
Fat	0.407	0.444	0.340	0.191	0.056	0.128	0.762	0.226	0.013
Fibre	0.163	0.008	0.000	0.000	0.000	0.000	0.000	0.002	0.001
Fat x fibre	0.449	0.227	0.650	0.417	0.637	0.477	0.457	0.471	0.772
Orthogonal comparison									
(High Low) - (High High)	0.417	0.035	0.003	0.000	0.000	0.001	0.020	0.165	0.031
(Low High) - (High High)	0.667	0.494	0.727	0.411	0.296	0.342	0.988	0.982	0.264
(Low Low) - (High High)	0.390	0.068	0.002	0.000	0.000	0.000	0.005	0.018	0.001
(Low High) - (High Low)	0.974	0.434	0.030	0.007	0.020	0.029	0.005	0.247	0.558
(Low Low) - (High Low)	1.000	0.987	0.984	0.983	0.710	0.935	0.869	0.509	0.181
(Low Low) - (Low High)	0.963	0.628	0.628	0.005	0.003	0.008	0.001	0.025	0.024

Means bearing different superscripts (^{ab}) in the same column are significantly different ($P < 0.05$).

4.4 Organ Weight

As shown in Table 4.4, high fat as a main effect increased the w/BW (%) of the right kidney and heart but caused a decrease in that of the liver ($P < 0.05$) when compared to low fat. High fibre as a main effect increased ($P < 0.05$) the w/BW (%) of the right and left kidney as compared to low fibre. A fat and fibre interaction was detected on the weight of the right kidney and heart ($P < 0.05$). The interaction indicated that w/BW (%) of the right kidney was increased ($P < 0.05$) when both fat and fibre levels were high. On the other hand, the fat and fibre interaction observed for the heart indicated that only in the presence of high fibre does high fat increase the w/BW (%) of the heart ($P < 0.05$). An intended interaction detected for the liver ($P = 0.067$) indicated that low fat tends to increase the w/BW (%) of the liver only when the fibre level is low.

An orthogonal comparison of the treatments indicated that the HFa-HFb diet tends to increase the w/BW (%) of the left kidney when compared to the HFa-LFb diet ($P < 0.053$). HFa-HFb diets increased the weight of the right kidney and heart as compared to HFa-LFb, LFa-HFb, and LFa-LFb diets ($P < 0.05$). The LFa-LFb diet increased the weight of the liver when compared to the LFa-HFb diet.

4.5 Blood Glucose

Neither fat nor fibre as a main effect, nor their interaction, affected the blood glucose levels of the Albino rats on d 56 ($P > 0.05$) as shown in Table 4.5.

Table 4.4: Effects of two dietary fat and fibre levels on the weight/body weight % (w/BW %) of the heart, liver and kidney of Albino rats on day 56

Effects	Fat	Fibre	Left Kidney	Right Kidney	Liver	Heart
	Low		0.318	0.304 ^{b}	3.75 ^{a}	0.364
	High		0.333	0.352 ^{a}	2.904 ^{b}	0.422
SEM			0.034	0.036	0.024	0.028
		Low	0.303 ^{b}	0.306 ^{b}	3.058	0.378
		High	0.349^{a}	0.350 ^{a}	3.015	0.406
SEM			0.034	0.036	0.024	0.028
Interactions						
Low fat x low fibre			0.307	0.307 ^{b}	3.313 ^{a}	0.379 ^{b}
Low fat x high fibre			0.299	0.304 ^{b}	2.823 ^{b}	0.378 ^{b}
High fat x low fibre			0.329	0.300 ^{b}	3.043 ^{ab}	0.349 ^{b}
High fat x high fibre			0.370	0.407 ^{a}	2.987 ^{ab}	0.472 ^{a}
SEM			0.047	0.050	0.034	0.039

P- value				
Fat	0.372	0.020	0.028	0.005
Fibre	0.018	0.028	0.682	0.110
Fat x fibre	0.174	0.014	0.067	0.005
Orthogonal comparison				
(High Low) - (High High)	0.372	0.012	0.979	0.003
(Low High) - (High High)	0.053	0.014	0.644	0.017
(Low Low) - (High High)	0.091	0.018	0.206	0.018
(Low High) - (High Low)	0.513	0.998	0.435	0.525
(Low Low) - (High Low)	0.726	0.998	0.339	0.507
(Low Low) - (Low High)	0.979	0.998	0.038	1.000

Means bearing different superscripts (^{abc}) in the same column are significantly different ($P < 0.05$)

Table 4.5 Effects of two dietary fat and fibre levels on the Blood Glucose (mg/dL) of Albino rats on day 56

Effects	**Fat**	**Fibre**	**Blood glucose**
	Low		177.8
	High		167.8
SEM			0.269
		Low	177.8
		High	167.8
SEM			0.269
Interactions			
Low fat x low fibre			159.1
Low fat x high fibre			198.7
High fat x low fibre			198.7
High fat x high fibre			141.7
SEM			0.380
Reference Range			148-208*

P- value	
Fat	0.883
Fibre	0.882
Fat x fibre	0.482
Orthogonal comparison	
(High Low) - (High High)	0.920
(Low High) - (High High)	0.920
(Low Low) - (High High)	0.996
(Low High) - (High Low)	1.00
(Low Low) - (High Low)	0.975
(Low Low) - (Low High)	0.975

Means bearing different superscripts (^{abc}) in the same column are significantly different ($P < 0.05$). *(Geffen, 2019)

4.6 Haematological Analysis

Data from the haematological analysis are shown in Tables 4.6 A and 4.6 B. About the data in Table 4.6 A, high fat as a main effect increased ($P < 0.05$) the number of MID and also tended to increase the percentage of MID ($P = 0.053$) in the blood of Albino rats as compared to low fat. A fat x fibre interaction was tended on MID % ($P = 0.07$) indicating that high fat caused an increase in MID % when the fibre level in a diet was also high. Orthogonal comparisons of the treatments also reveal that the HFa-HFb diet tended to increase the MID# ($P = 0.058$) and MID % ($P = 0.059$) compared to LF-HFb diets. Neither fat nor fibre as a main effect nor the effect of their interactions was detected for WBC, RBC, HGB, LYM #, GRA #, LYM %, GRA %, and HCT at d 56.

According to the data shown in Table 4.6 B on the haematological analysis, both high fat and high fibre as the main effects reduced the PLT and PCT levels in the blood of the Albino rats ($P < 0.05$) compared to low fat. However, an interaction of fat and fibre on PLT ($P = 0.05$) and PCT ($P < 0.05$) showed that a reduction in PLT and PCT levels in the blood occurred when both fat and fibre levels in a diet were high. Orthogonal comparisons of the treatments also indicate that HFa-HFb decreased both the PLT and PCT levels in the blood compared to HFa-LFb, LFa-HFb and LFa-LFb diets ($P < 0.05$). Similarly, high fibre as a main effect decreased the MCV level ($P < 0.05$) compared to low fibre.

A fat x fibre interaction ($P = 0.077$) was observed for MCV levels indicating that high fat tended to decrease the level of MCV when the fat content is low. An orthogonal comparison indicates that the HFa-HFb diet decreased the levels of MCV than the LFa-LFb diet ($P < 0.05$). Also MCV level was lower in rats fed LFa-HFb than those fed LF-

LFb diet ($P < 0.05$). A fat x fibre interaction was observed for the MCH levels ($P = 0.078$) indicating that only in the presence of low fat did high fibre tend to reduce MCH levels ($P = 0.078$).

Table 4.6 A: Effects of two dietary fat and fibre levels on the haematological parameters of Albino rats on day 56

Effects	**Fat**	**Fibre**	**WBC** (10^9/L)	**LYM#** (10^9/L)	**MID#** (10^9/L)	**GRA#** (10^9/L)	**LYM** (%)	**MID** (%)	**GRA %**	**RBC** (10^12/L)	**HGB** (g/dL)	**HCT** (%)
	Low		3.141	2.736	0.207^{b}	0.144	87.08	6.600	4.489	7.673	14.99	40.96
	High		3.740	3.182	0.324^{a}	0.194	85.06	8.731	5.135	7.062	13.61	36.87
SEM			0.144	0.158	0.118	0.277	0.026	0.087	0.322	0.106	0.094	0.112
		Low	3.487	2.863	0.263	0.159	87.16	7.666	4.566	7.958	15.72	43.49
		High	3.369	3.041	0.251	0.175	84.98	7.517	5.048	6.808	12.97	34.72
SEM			0.144	0.158	0.118	0.277	0.026	0.087	0.322	0.106	0.094	0.112
Reference Range*			3.06-8.51	2.405-9.459	0.16-0.45		40.08-79.25	7.68 - 13.25		7.21-9.12	12.80-15.80	40.50-49.81
Interactions												
Low fat x low fibre			3.239	2.812	0.246	0.161	86.75	7.581	4.967	7.474	15.25	42.06
Low fat x high fibre			3.046	2.663	0.174	0.128	87.42	5.746	4.056	7.877	14.73	39.89
High fat x low fibre			3.754	3.289	0.291	0.157	87.58	7.752	4.197	8.474	16.21	44.97
High fat x high fibre			3.726	3.079	0.362	0.239	82.61	9.833	6.282	5.885	11.42	30.23
SEM			0.203	0.224	0.167	0.392	0.036	0.123	0.455	0.150	0.133	0.159

P- value										
Fat	0.416	0.519	0.028	0.469	0.533	0.053	0.775	0.596	0.489	0.525
Fibre	0.870	0.795	0.710	0.811	0.503	0.877	0.831	0.329	0.187	0.194
Fat x fibre	0.898	0.980	0.129	0.435	0.387	0.070	0.524	0.203	0.270	0.309
Orthogonal comparison										
(High Low) - (High High)	1.000	0.997	0.793	0.872	0.675	0.552	0.921	0.376	0.316	0.352
(Low High) - (High High)	0.894	0.966	0.058	0.689	0.695	0.059	0.902	0.548	0.559	0.623
(Low Low) - (High High)	0.960	0.991	0.419	0.890	0.777	0.484	0.982	0.686	0.463	0.494
(Low High) - (High Low)	0.884	0.906	0.212	0.983	1.000	0.375	1.000	0.985	0.955	0.948
(Low Low) - (High Low)	0.954	0.958	0.895	1.000	0.997	0.999	0.993	0.932	0.987	0.990
(Low Low) - (Low High)	0.996	0.998	0.496	0.976	0.999	0.435	0.988	0.994	0.998	0.995

Means bearing different superscripts (^{ab}) in the same column are significantly different ($P < 0.05$). **WBC**: White blood cell, **LYM**: Lymphocytes, **MID**: Minimum inhibitory dilution, **GRA**: Granulocytes, **RBC**: Red blood cell, **HGB**: Haemoglobin, **HCT**: Haematocrit.*(Patel *et al*., 2024)

Table 4.6 B: Effects of two dietary fat and fibre levels on the haematological parameters of Albino rats on day 56 Continuation

Effects	**Fat**	**Fibre**	**MCV** (fL)	**MCH** (pg)	**MCHC** (g/dL)	**RDW-SD** (fL)	**RDW-CV** (%)	**PLT** (10^9/L)	**MPV** (fL)	**PDW** (%)	**PCT** (%)	**P-LCR** (%)
	Low		53.35	19.50	36.59	34.60	13.85	687.3^{a}	6.440	10.90	0.442^{a}	4.459
	High		52.20	19.27	36.91	33.80	13.94	351.2^{b}	6.647	12.16	0.233^{b}	5.953
SEM			0.123	0.018	0.022	0.025	0.018	0.155	0.022	0.049	0.150	0.124
		Low	54.63^{a}	19.74	36.17	34.94	13.62	651.6^{a}	6.574	10.82	0.429^{a}	5.281
		High	50.98^{b}	19.03	37.34	33.48	14.17	370.4^{b}	6.512	12.26	0.240^{b}	5.027
SEM			0.123	0.018	0.022	0.025	0.018	0.155	0.022	0.049	0.150	0.124
Reference Range*			49.20-60.61	16.13-19.30	29.56-34.80			412.25-849.25			0.267-0.550	
Interactions												
Low fat x low fibre			56.22	20.38	36.30	36.20	13.68	708.2^{a}	6.484	10.78	0.459^{a}	4.801
Low fat x high fibre			50.63	18.66	36.88	33.08	14.03	667.0^{a}	6.396	11.02	0.426^{a}	4.142
High fat x low fibre			53.09	19.12	36.03	33.72	13.56	599.5^{a}	6.665	10.85	0.400^{a}	5.810
High fat x high fibre			51.32	19.42	37.80	33.88	14.33	205.7^{b}	6.629	13.63	0.136^{b}	6.100
SEM			0.017	0.026	0.032	0.036	0.025	0.219	0.031	0.069	0.212	0.175

P- value										
Fat	0.245	0.651	0.793	0.534	0.816	0.015	0.339	0.152	0.026	0.227
Fibre	0.004	0.190	0.344	0.269	0.155	0.033	0.765	0.108	0.016	0.826
Fat x fibre	0.077	0.078	0.623	0.223	0.568	0.050	0.899	0.174	0.045	0.664
Orthogonal comparison										
(High Low) - (High High)	0.550	0.974	0.714	1.000	0.465	0.035	0.999	0.169	0.029	0.999
(Low High) - (High High)	0.944	0.701	0.943	0.963	0.932	0.022	0.847	0.210	0.021	0.701
(Low Low) - (High High)	0.025	0.563	0.804	0.588	0.599	0.017	0.957	0.155	0.015	0.900
(Low High) - (High Low)	0.293	0.901	0.952	0.980	0.786	0.985	0.786	0.998	0.996	0.561
(Low Low) - (High Low)	0.171	0.356	0.998	0.537	0.994	0.947	0.920	1.000	0.965	0.866
(Low Low) - (Low High)	0.012	0.145	0.984	0.351	0.899	0.997	0.989	0.996	0.994	0.930

Means bearing different superscripts (^{ab}) in the same column are significantly different ($P < 0.05$). **MCV**: Mean cellular volume, **MCH**: Mean Cellular haemoglobin, **MCHC**: Mean cellular haemoglobin concentration, **RDW**: Red cell distribution width, **PLT**: Platelet, **MPV**: Mean platelet volume, **PDW**: Platelet distribution width, **PCT**: Plateletcrit, **P-LCR**: Platelet larger cell ratio. .*(Patel *et al.*, 2024)

4.7 Biochemical Analysis

Analyzed results of the data on the lipid profile and liver function test are displayed in Tables 4.7 and 4.8 respectively.

4.7.1 Lipid Profile

As shown in Table 4.7, high fat as a main effect decreased the levels of TGA and VLDL compared to low fat ($P < 0.05$). However, fibre as a main effect did not affect ($P > 0.05$) any of the parameters captured in the lipid profile. A fat x fibre interaction was detected for HDL levels ($P = 0.08$) indicating that high fat tended to reduce HDL levels in Albino rats fed a low-fibre diet.

An interaction between fat and fibre was also observed for LDL, TGA, VLDL, and coronary risk levels ($P < 0.05$). Similarly, the interaction between fat and fibre on TGA and VLDL indicated that high fat decreased the levels of TGA and VLDL ($P < 0.05$) when the fibre level is low in a diet. On the other hand, fat x fibre interaction on LDL and coronary risk indicated that only in the presence of low fibre did high-fat increase the LDL levels and coronary risk ($P < 0.05$).

Orthogonal comparisons of the treatments indicated that HFa-LFb diets decrease the levels of TGA and VLDL compared to HFa-HFb diets ($P < 0.05$). However, the HFa-LFb diet tended to increase the levels of LDL ($P = 0.056$) and coronary risk ($P = 0.058$) compared to the HFa-HFb diet. A comparison between the HFa-LFb diet and the LFa-LFb diet shows that the HFa-LFb diet increases the levels of LDL ($P < 0.05$). However, comparing the HFa-LFb diet and the LFa-LFb diet on TGA and VLDL levels indicates that HFa-LFb tends to decrease the levels of TGA ($P = 0.05$) and VLDL ($P = 0.05$).

4.7.2 Liver Function Test

The data shown in Table 4.8 indicates that high fibre as a main effect increased the levels of ALP ($P < 0.05$), and total bilirubin ($P = 0.05$) and also tended to increase indirect bilirubin levels ($P = 0.074$) in blood compared to low fibre. However, high fibre as a main effect decreased albumin levels ($P = 0.053$) than low fibre. Fibre as a main effect did not have any effect on ALT, AST, total protein, globulin and direct bilirubin ($P > 0.05$). There was no main effect of fat and also no fat x fibre interactions ($P > 0.05$) detected for all the parameters observed for the liver function test. An orthogonal comparison of the treatments shows that LFa-HFb diets tended to increase ($P = 0.089$) the level of ALP in blood serum compared to HFa-LFb.

Table 4.7: Effects of two dietary fat and fibre levels on the lipid profile (mmol/L) of Albino rats on day 56

Effects	**Fat**	**Fibre**	**T. Cholesterol**	**HDL**	**LDL**	**TGA**	**VLDL**	**Coronary risks**
	Low		3.512	1.600	1.175	1.544^{a}	0.702^{a}	2.152
	High		3.540	1.491	1.365	1.315^{b}	0.598^{b}	2.211
SEM			0.025	0.065	0.071	0.044	0.045	0.065
		Low	3.520	1.486	1.313	1.384	0.629	2.322
		High	3.532	1.605	1.221	1.467	0.667	2.049
SEM			0.025	0.065	0.071	0.044	0.045	0.065
Reference Range*			2.59-3.75	1.26-1.88	0.79-1.84	0.76-1.66	0.229-0.434	
Interactions								
Low fat x low fibre			3.507	1.688	1.013^{b}	1.723^{a}	0.783^{a}	1.997^{ab}
Low fat x high fibre			3.532	1.516	1.362^{ab}	1.383^{ab}	0.628^{ab}	2.320^{a}
High fat x low fibre			3.516	1.308	1.702^{a}	1.112^{b}	0.505^{b}	2.701^{a}
High fat x high fibre			3.548	1.700	1.094^{ab}	1.556^{a}	0.707^{a}	1.810^{b}
SEM			0.035	0.092	0.100	0.063	0.063	0.091

P- value						
Fat	0.824	0.465	0.172	0.034	0.035	0.774
Fibre	0.924	0.428	0.489	0.385	0.385	0.207
Fat x fibre	0.977	0.080	0.006	0.002	0.002	0.017
Orthogonal comparison						
(High Low) - (High High)	1.000	0.261	0.056	0.022	0.022	0.058
(Low High) - (High High)	0.998	0.818	0.456	0.573	0.571	0.292
(Low Low) - (High High)	0.995	1.000	0.945	0.670	0.676	0.870
(Low High) - (High Low)	1.000	0.681	0.442	0.144	0.144	0.655
(Low Low) - (High Low)	0.999	0.278	0.026	0.005	0.005	0.167
(Low Low) - (Low High)	1.000	0.840	0.233	0.138	0.140	0.665

Means bearing different superscripts (^{abc}) in the same column are significantly different ($P < 0.05$). *(Ihedioha *et al.*, 2013)

T. Cholesterol: Total Cholesterol, **HDL**: High-density lipoprotein, **LDL**: Low-density lipoprotein, **TGA**: Triglyceride, **VLDL**: Very low-density lipoprotein.

Table 4.8: Effects of two dietary fat and fibre levels on the Liver function test of Albino rats on day 56

Effects	Fat	Fibre	ALT (IU/L)	AST (IU/L)	ALP (IU/L)	GGT (IU/L)	T. PRO (g/L)	ALBU. (g/L)	GLOB (g/L)	T. BIL (umol/L)	D. BIL (umol/L)	IND. BIL (umol/L)
	Low		34.94	252.6	470.9	7.109	75.80	24.88	53.77	17.94	9.079	8.291
	High		27.59	223.9	362.8	3.595	73.63	23.91	49.24	18.63	8.312	9.354
SEM			0.251	0.052	0.144	0.267	0.060	0.045	0.089	0.104	0.112	0.206
		Low	29.52	226.8	314.7^{b}	3.689	77.84	26.21	54.05	15.43	8.322	6.536
		High	32.67	249.4	542.8^{a}	6.928	71.70	22.69	48.98	21.65	9.068	11.87
SEM			0.251	0.052	0.144	0.267	0.06	0.045	0.089	0.104	0.112	0.206
Reference Range*#			25.65-54.16*	75.20-215.5*	40-442$^{\#}$	3.2-7.1*	66-88$^{\#}$	34.80-49.00	12-35$^{\#}$	5.1-17$^{\#}$	1.7-5.1$^{\#}$	3.4-12$^{\#}$
Interactions												
Low fat x low fibre			32.35	237.5	350.4	5.518	78.65	26.15	58.57	15.31	7.644	6.745
Low fat x high fibre			37.74	268.7	632.7	9.158	73.05	23.66	49.36	21.02	10.78	10.19
High fat x low fibre			26.94	216.5	282.6	2.466	77.04	26.27	49.88	15.55	9.060	6.332
High fat x high fibre			28.26	231.4	465.7	5.241	70.38	21.76	48.61	22.31	7.626	13.82
SEM			0.355	0.073	0.204	0.378	0.084	0.064	0.126	0.147	0.158	0.291
P- value												

Fat	0.525	0.137	0.237	0.109	0.740	0.550	0.506	0.804	0.591	0.689
Fibre	0.783	0.230	0.028	0.134	0.358	0.053	0.458	0.050	0.601	0.074
Fat x fibre	0.855	0.708	0.828	0.752	0.924	0.508	0.581	0.886	0.141	0.545
Orthogonal comparison										
(High Low) - (High High)	1.000	0.915	0.368	0.527	0.870	0.234	0.999	0.369	0.865	0.301
(Low High) - (High High)	0.937	0.509	0.720	0.730	0.989	0.790	1.000	0.991	0.453	0.878
(Low Low) - (High High)	0.993	0.994	0.761	1.000	0.789	0.249	0.731	0.337	1.000	0.364
(Low High) - (High Low)	0.905	0.235	0.089	0.143	0.968	0.665	1.000	0.509	0.861	0.668
(Low Low) - (High Low)	0.982	0.807	0.876	0.477	0.998	1.000	0.806	1.000	0.870	0.999
(Low Low) - (Low High)	0.989	0.648	0.247	0.781	0.923	0.692	0.776	0.469	0.459	0.752

Means bearing different superscripts (^{ab}) in the same column are significantly different ($P < 0.05$) **ALT**: Alanine transaminase, **AST**: Aspartate aminotransferase, **ALP**: Alkaline phosphate, **GGT**: Gamma-glutamyl transferase, **T. PRO**: Total Protein, **ALBU**: Albumin, **GLOB**: Globulin, **T. Bil**: Total Bilirubin, **D. BIL**: Direct Bilirubin, **IND. Bil**: Indirect Bilirubin. .*****(Patel *et al.*, 2024) $^{\#}$(Houtmeyers *et al.*, 2016)

4.8 Histological Examinations

4.8.1 Heart

Histological micrographs of Heart tissues (Haematoxylin & Eosin stained) are presented below:

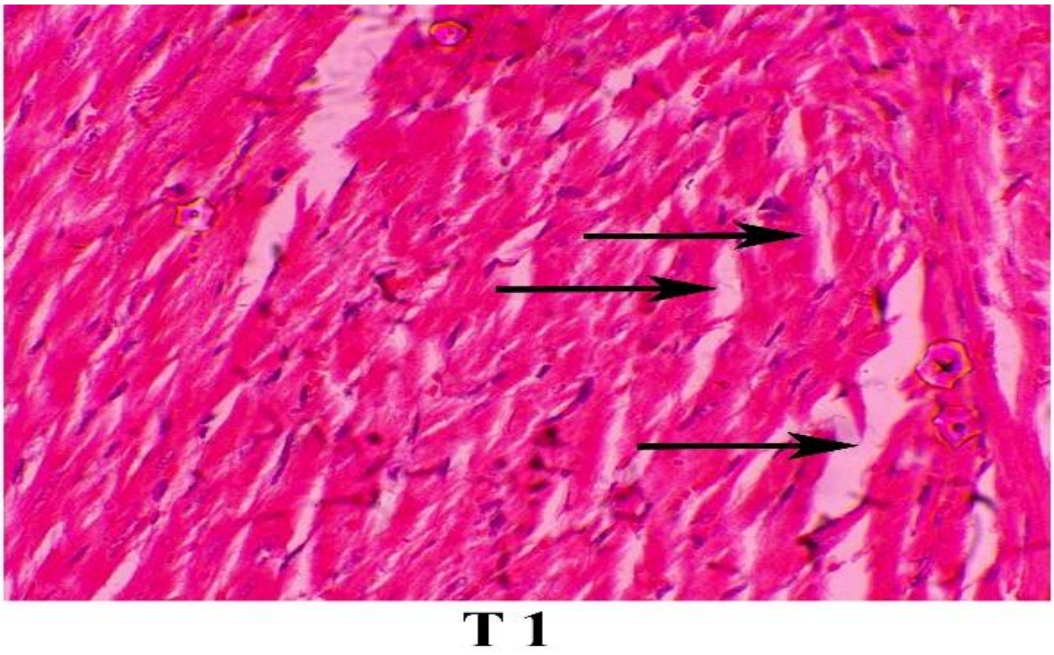


Plate 4.1: Histological micrographs of Heart tissues (T1)

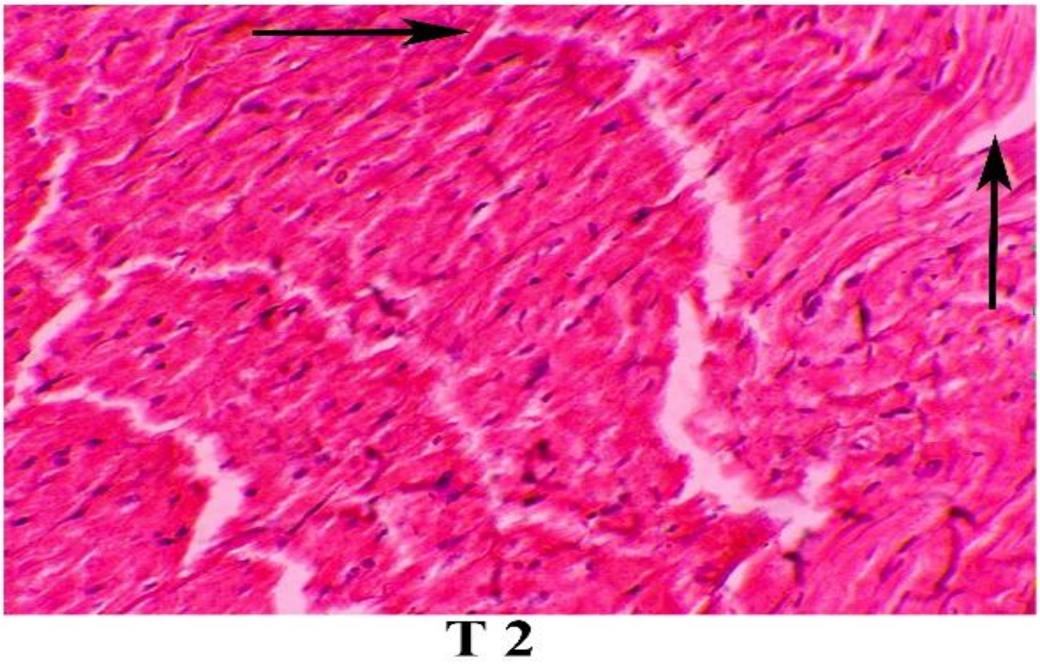
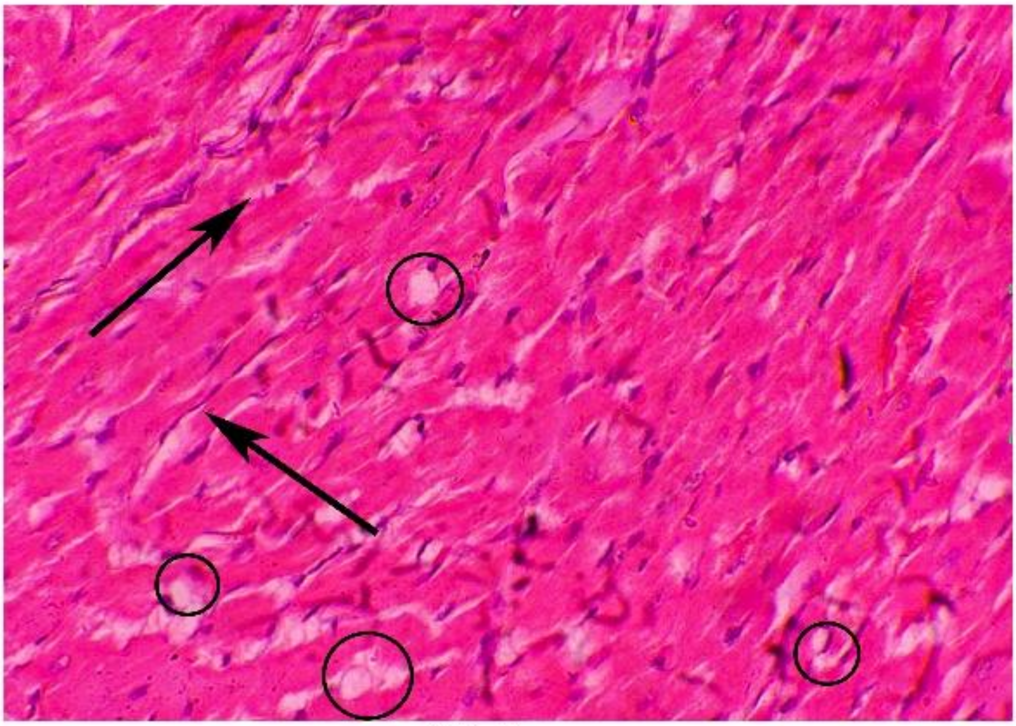
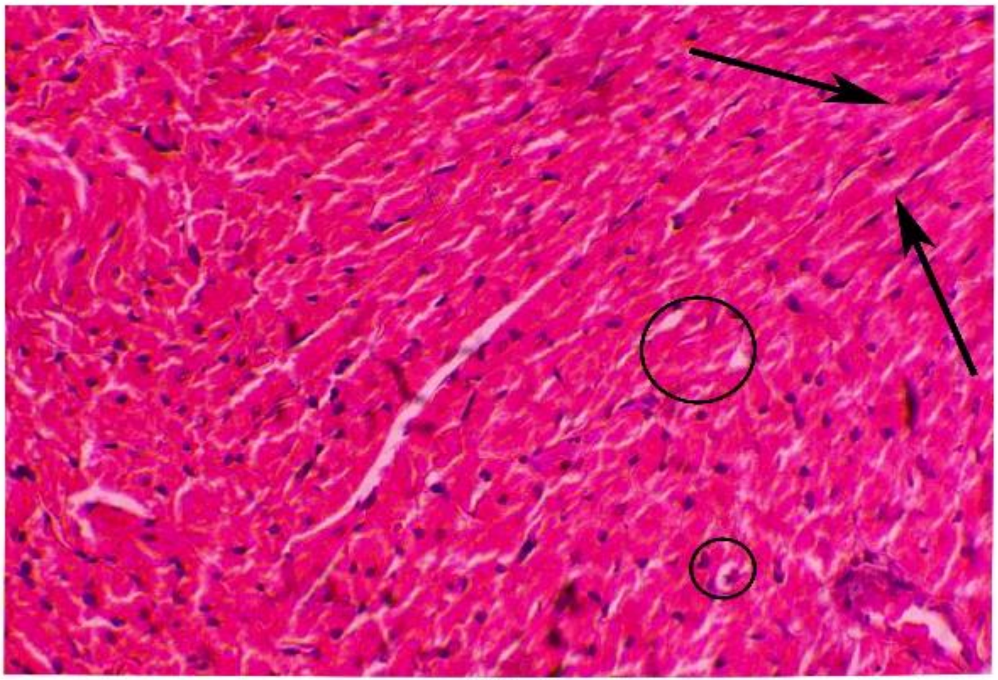


Plate 4.2: Histological micrographs of Heart tissues (T2)



T 3

Plate 4.3: Histological micrographs of Heart tissues (T3)



T 4

Plate 4.4: Histological micrographs of Heart tissues (T4)

As shown in Plate 4.1- 4.4 above, T1 shows normal histology of the heart of Albino rats. T 1 depicts well-distinct branched cardiac muscles with striations (Thin arrows, →), it also has elongated cardiomyocytes bearing centrally placed oval-shaped nuclei typical of a normal heart architecture. T 2 (Plate 4.2) also shows a normal heart architecture with branched and striated cardiomyocytes (Thin arrows, →) and regularly shaped nuclei in cardiomyocytes. The histological micrograph in T 3 (Plate 4.3) depicts unclear branching and striations of cardiac muscles (Thin arrows, →) and small oval or vacuolated pale structures (Circles, O) in the cardiomyocytes. T 4 (Plate 4.4) on the other hand shows comparably moderate distinct striations and few oval and vacuolated (Circles, O) structures in cardiomyocytes. The nuclei are well-distinct and regularly shaped.

4.8.2 Liver

Histological micrograph of Liver tissues (Haematoxylin & Eosin stained) are presented below

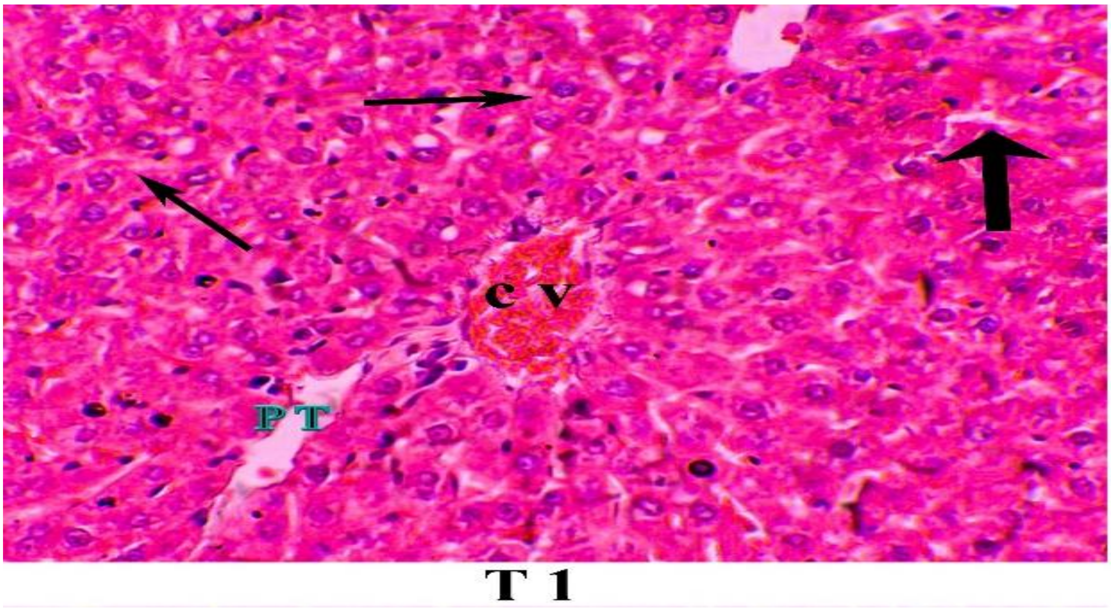


Plate 4.5: Histological micrographs of Liver tissues (T1)

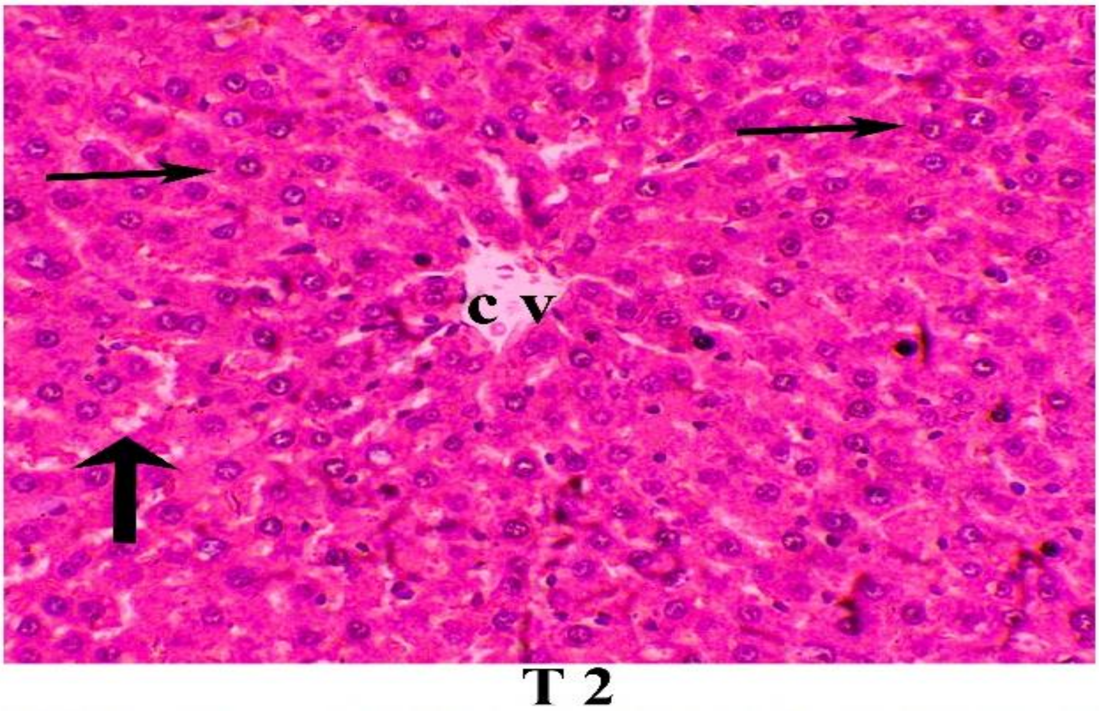


Plate 4.6: Histological micrographs of Liver tissues (T2)

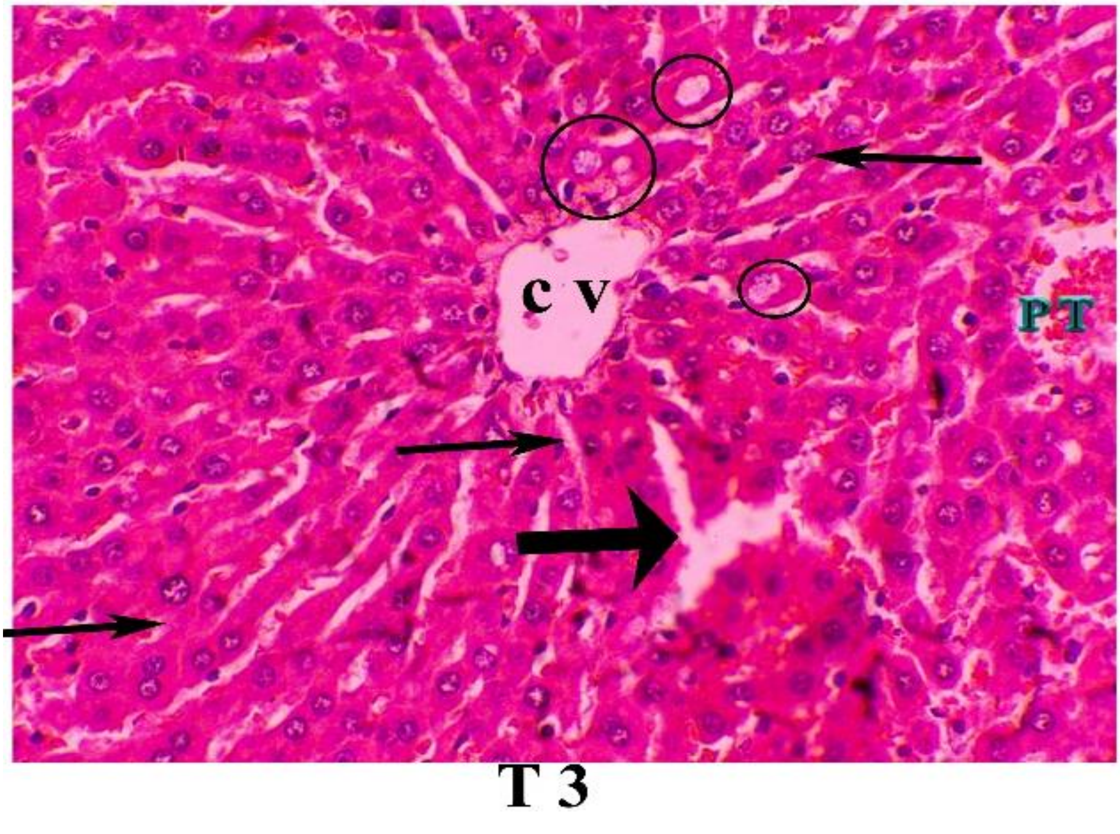


Plate 4.7: Histological micrographs of Liver tissues (T3)

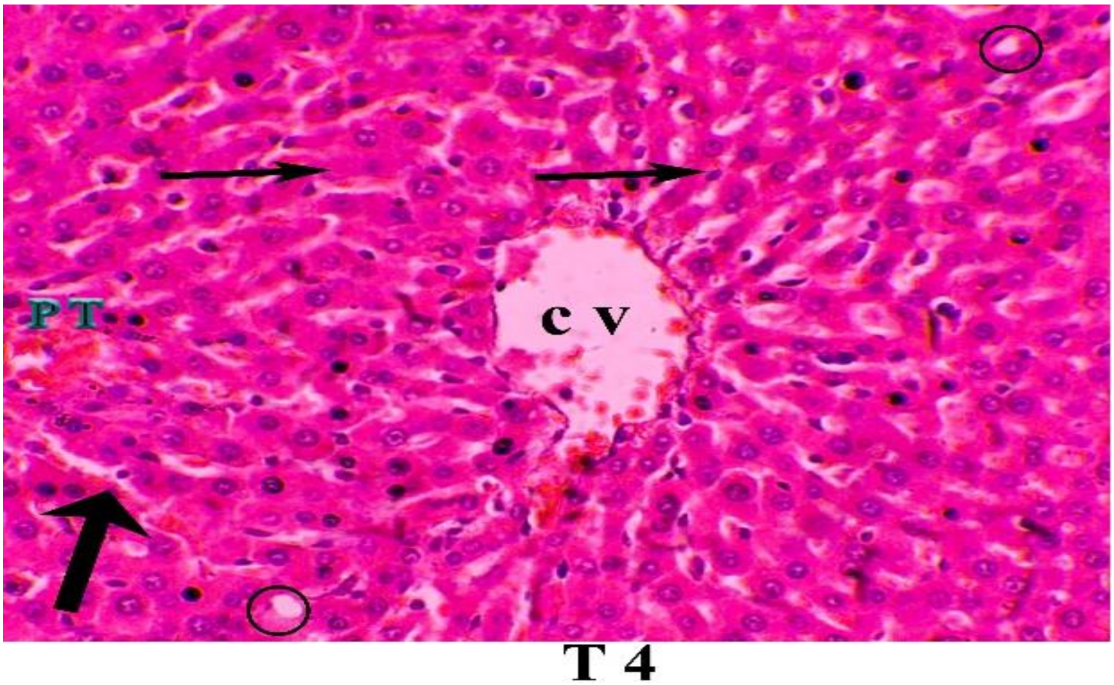


Plate 4.8: Histological micrographs of Liver tissues (T4)

As shown in Plates 4.5 - 4.8 above, T 1 shows normal liver histology indicative of the relatively large oval central vein (C V) surrounded by a thin layer of hepatocytes. The presence of normal and regularly shaped oval nuclei (thin arrows, →). It also has a distinct normal portal tract architecture (P T) and normal sinusoids (pale spaces, thick arrow ➞). T 2 also displays a normal liver architecture with a relatively smaller central vein (C V) with distinct regularly oval-shaped nuclei (thin arrows, →). It also has normal sinusoids (pale spaces, thick arrows ➞). T 3 has a comparatively normal central vein (C V), a portal tract (P T), and moderately large nuclei (thin arrows, →). It also has some clear oval vacuolated structures (circle o) and comparably large sinusoids and pale spaces (thick arrow ➞). T 4 on the other hand has a relatively C V, PT, few clear oval vacuolated structures (circle o) and relatively moderate sinusoids (pale spaces (thick arrow ➞).

4.8.3 Kidney

Histological micrograph of Kidney tissues (Haematoxylin & Eosin stained) are presented below.

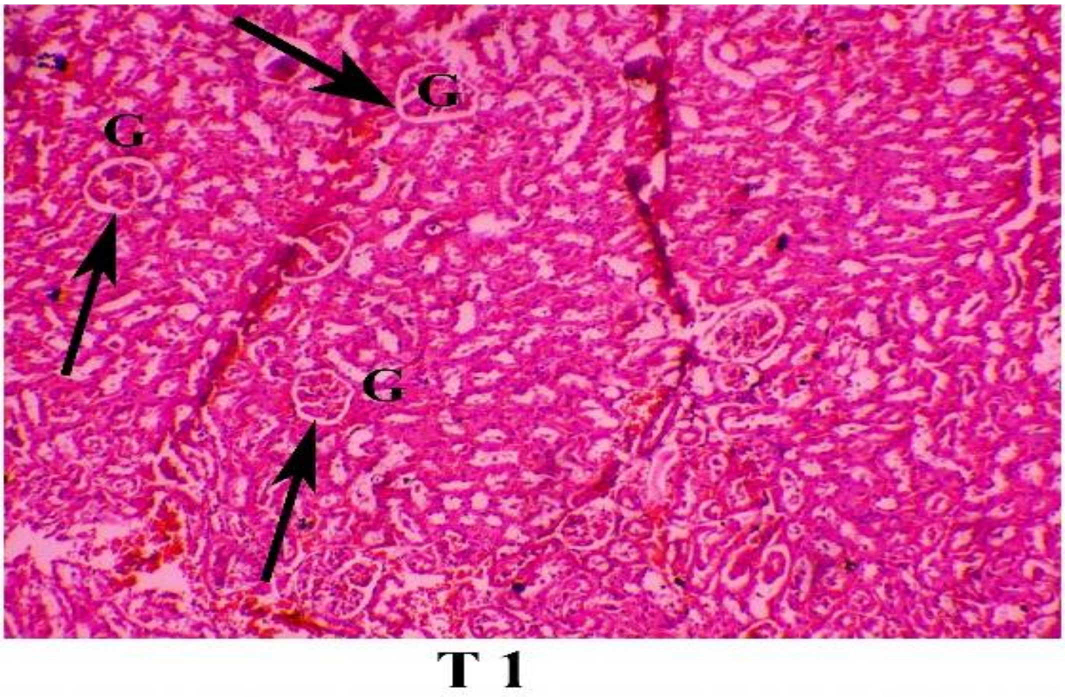


Plate 4.9: Histological micrographs of Kidney tissues (T1)

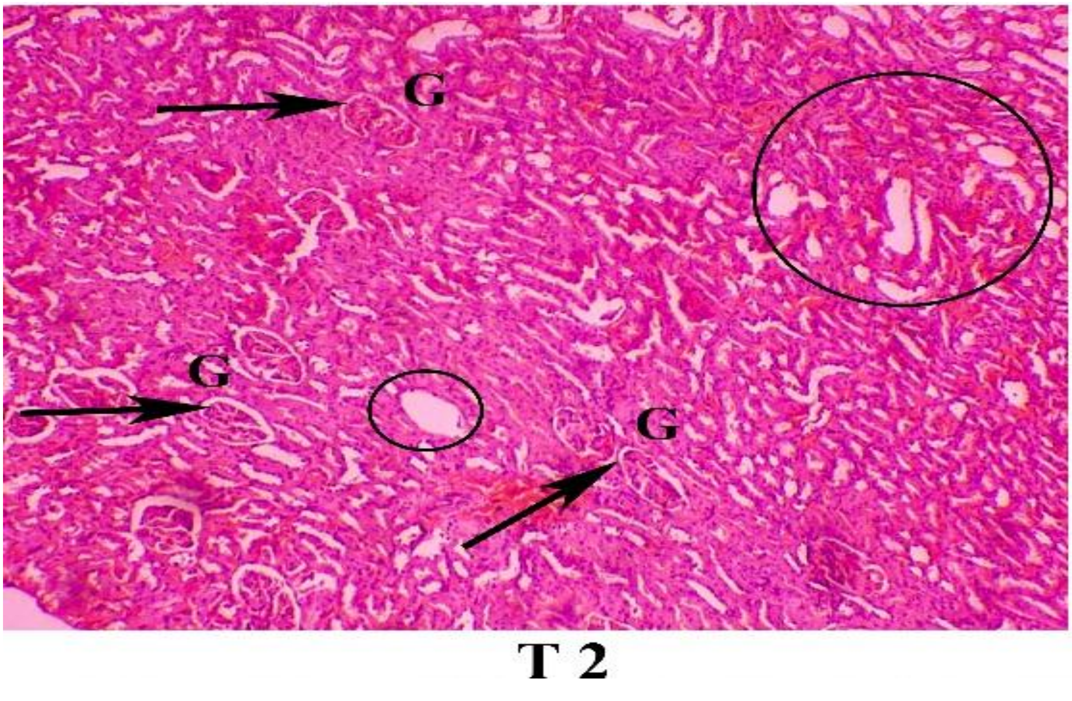


Plate 4.10: Histological micrographs of Liver tissues (T2)

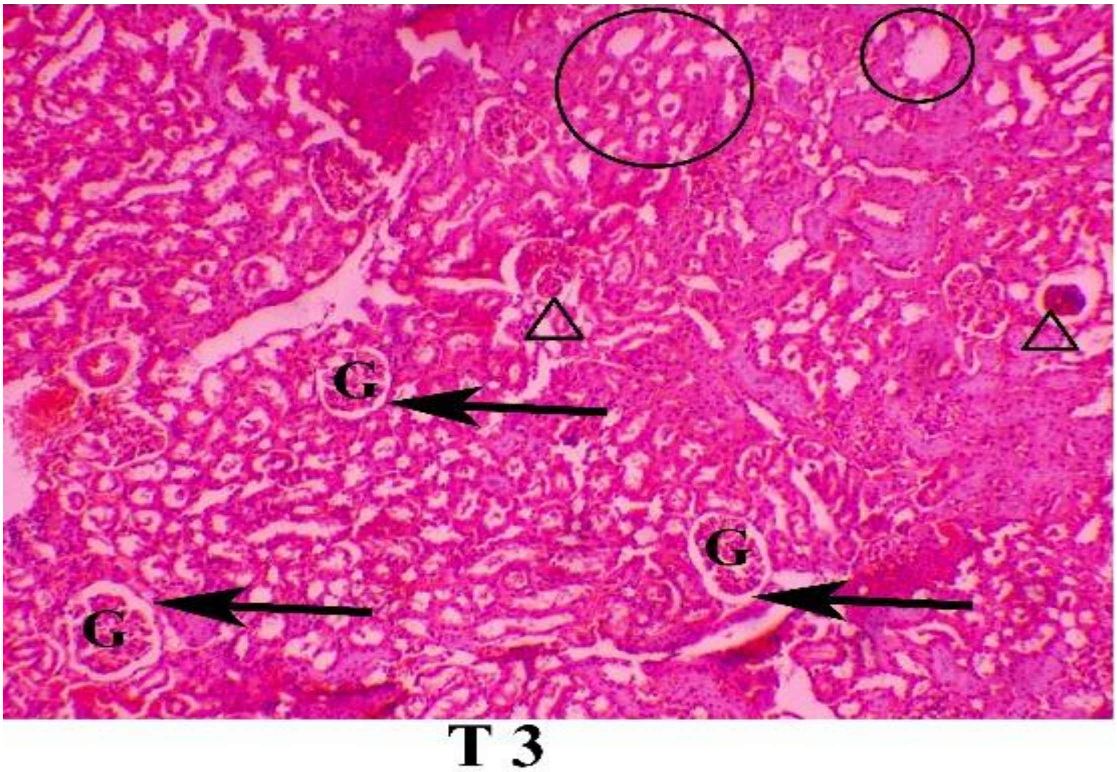


Plate 4.11: Histological micrographs of Kidney tissues (T3)

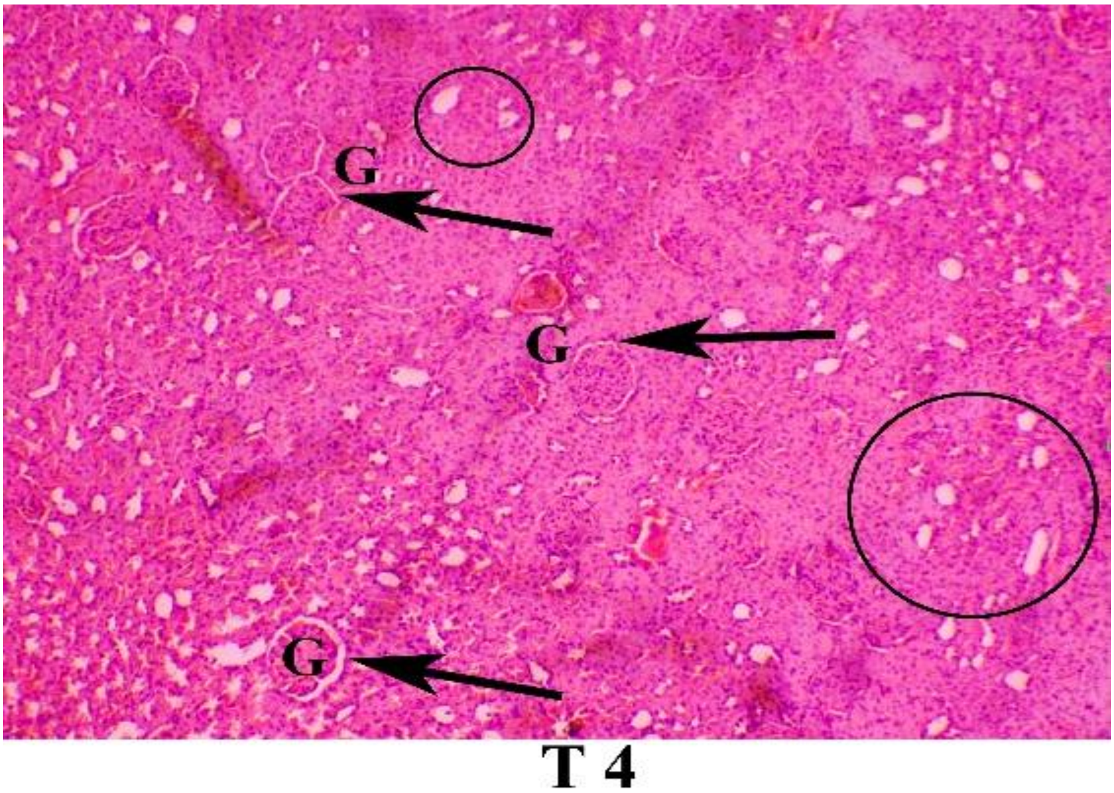


Plate 4.12: Histological micrographs of Kidney tissues (T4)

As shown in Plates 4.9 - 4.12 above, T 1 depicts normal kidney histology and architecture indicative of the normal renal corpuscles with glomeruli (G) that perfectly fit in the Bowman's capsules with a little Bowman's space (thin arrows, →). T 2 shows a moderately normal kidney physiology. It depicts a moderately large Bowman's space (thin arrows, →) and some oval vacuolated pale spaces with a central one resembling an empty Bowman's capsule. T 3 on the other hand has relatively larger Bowman's spaces (thin arrows, →), some deformed glomeruli (Δ) and numerous oval, vacuolated pale structures (circle O) with which some appearing as empty Bowman's capsules. T 4 displays Glomeruli (G) that perfectly fit in Bowman's capsule with very little Bowman's space (thin arrows, →) it has relatively small numerous oval vacuolated pale structures (circle O).

DISCUSSIONS

4.1 Proximate Analysis

As shown in the proximate analysis results in Table 4.1 above, the corn cob fibre was relatively low in crude fat, protein, ash content and moisture content. The moisture content of 10.28 % and ash content of 2.05 % are very similar to the 9.27 % and 2.42 % that were reported by Kpalo *et al*. (2020). The moisture content and crude fat of the corn cob fibre in this study were relatively higher than the 6.00 % and 4.72 % reported by Abubakar *et al*., (2016). However, the 2.49 % ash content, 33.33 % fibre, and 4.19 % protein Abubakar *et al*. (2016) reported were relatively higher than the values obtained for the corn cob fibre used for this study. The 48.56 % of carbohydrates Abubakar *et al*. (2016) reported was relatively lower than the 55.6 % obtained from the corncob fibre indicating that the corncob used in this study had a comparatively higher content of carbohydrates.

Corn cob fibre is well-known for its high crude fibre content, making it a valuable dietary source for increasing fibre content (Bede *et al*., 2020). The addition of higher levels of corn cob fibre, as seen in T 2 and T 4, significantly increased the crude fibre content of the diet to 15.80 % and 16.12 % respectively. Treatment 1 (T 1) which was composed of low coconut oil and low corn cob fibre had a moisture content of 11.78 %, ash content of 4.69 %, 5.75 % crude fat, 9.97 % crude fibre, 20.58 % crude protein, and 47.23 % nitrogen-free extract. In T 2 (low coconut oil and high corn cob fibre), the main distinction is the increased corn cob fibre content of 15.80 % and a slight increase in crude protein to 6.90 % compared to T 1, which resulted in an increase in ash content to 5.46 %, and a decrease in crude protein to 19.70 %. For T 3 (high coconut oil and low corn cob fibre), the primary difference is the increased coconut oil content, leading to an increase in crude fat content to 19.37 %. T 4 diet which is composed of high levels of both coconut oil and corn cob fibre had elevated levels of both crude fat and crude fibre compared to T 1 and T 2. The nitrogen-free extract decreased to 29.41 % compared to T 3 due to the presence of high corn cob fibre.

In summary, the treatment diets vary in terms of their nutritional composition. The proximate analysis results indicated that the variations in coconut oil and corn cob fibre content had distinct influence on the nutritional components of the diets. The inclusion of variable levels of corn cob fibre and coconut oil contributed significantly to the variable crude fat and fibre contents of the diets.

4.2 Feed Intake

Corn cob as the main source of fibre for this experiment is a rich source of fibre, mainly consisting of insoluble fibre which is relatively not digested and assimilated as an energy source (Phillips & Dugdale, 2022). Diets that contain higher levels of fibre increase satiety (Du *et al*., 2010) than low-fibre diets, since relatively they contain less energy and palatability. Hence, albino rats that consume high fibre tend to eat less and feel satisfied for a relatively long time. High-fibre foods take longer time to consume and have a low caloric value. Since high-fibre diets increase satiety and contain fewer calories per unit of food, they provide relatively little energy to the body.

High fat as a main effect tended to decrease feed intake (g) during d 15-35, d 15-42 and d 15- 49 compared to the low fat. This suggests that, although the high level of coconut oil compared to the low level reduced the feed intake of the rats, the reduction was not high enough to be significant. This is similar to the findings of Adelusi *et al*. (2020)

and Wang *et al.* (2015) who reported that coconut oil did not affect the feed intake of cattle and broilers respectively.

Similarly, the main effect of high fibre tended to decrease the feed intake (g) of Albino rats compared to low fibre from days 15 to 21. However, this reduction was not statistically significant. This lack of significance could be attributed to the relatively small difference in feed intake between the higher and lower fibre groups (11.92 g and 9.79 g, respectively). This report agrees with the report of Ansah *et al*. (2012) who reported from their study that the inclusion of 15 % corn cob in a diet did not affect the feed intake of grasscutters compared to the control group which had 0 % corn cob. This indicates that both fibre and fat sources used in this experiment did not significantly affect the feed intake of the rats.

There was no significant fat x fibre interaction detected throughout the study similar to a study pioneered by Jackson *et al*. (1996) who investigated the interactive effects of varying levels of dietary fat, fibre and carbohydrate on food consumption and utilization. They also found no fat x fibre interaction on feed intake. The orthogonal comparison shows that the HFa-HFb diet tended to decrease feed intake as compared to the LFa-LFb diet which implies that when both coconut oil and corncob levels in a diet were high they reduced feed intake compared to when both levels were low. This signifies that both fat and fibre levels in this study did not affect the feed intake of the rats confirming that the observed weight loss in this study was not due to a reduced feed intake.

4.3 Body Weight

The fact that high levels of fibre in the diet caused a decrease in body weight affirms the claim that fibre aids in weight loss and weight management. Jiménez-Moreno *et al*. (2009) reported from their study in which they fed dietary fibre and fat to day-old chicks for 21 days that, dietary fibre consistently increased and improved body weight gain and feed gain of broilers from d 1 to 5 compared to those on controlled diets. They attributed the weight gain to the fact that young broilers require a minimum level of fibre in the diet to increase growth performance. The fibre level used by Jiménez-Moreno *et al.* (2009) was 3 % which is lower than the minimum 9.79 % used for this study. The very young age and energy demand of the broilers coupled with the low fibre content of the diet suggests that the fibre was too low to increase satiety in the chicks since it reportedly increased feed gain. The broilers consumed enough feed providing them with enough calories for metabolic activities and growth.

Another study by Tsado *et al.* (2019) reported an increase in body weight in broilers fed with hydrolyzed dietary fibre. The improvement in weight gain as reported by Tsado *et al.* (2019) could be attributed to the relatively lower fibre level (3 % - 6 %) which is optimum for the growth of broilers coupled with the hydrolysis that reduced the fibre content in the feed. Leech (2017) stated in his study that increasing the consumption of soluble fibre intake can cause weight loss, especially when the caloric content of the diet is lower. Ioniță-Mîndrican *et al.* (2022) also concluded from a review of several kinds of research that fibre reduces the risk of obesity by causing weight loss. The findings from the present study confirm the claim that high fibre (either soluble or insoluble) could lead to weight loss, reducing the risk of obesity. A similar study by Barber *et al.* (2020) to review the health benefits of dietary fibre submitted that consumption of dietary fibre reduces feed intake and the urge to eat hence causing weight loss.

On d 56, it was observed that the body weight of Albino rats on high levels of dietary fat decreased when compared to those on the low fat. Coconut oil as the source of fat for this study continually reduced the weight of the rats until it became significant on d 56. Unlike other saturated fats known to cause obesity, coconut oil reduces weight. Similar to this finding is the work of Gomes *et al*. (2023) which showed that coconut oil supplementation aids in weight loss. However, they failed to report on the effect of coconut oil supplementation on feed intake. Since a lower feed intake could lead to the weight loss they witnessed in their study.

Adelusi *et al.* (2020) in their study to find the "*Effects of coconut oil on the weight and blood status of grazing cattle fed concentrate as supplementary feed*" reported that, there was no significant difference in the final body weight of the cattle. Also, De Moura e Dias *et al.* (2018) reported that coconut oil did not significantly affect body weight. They found no difference in the body measurements such as abdominal and thoracic perimeters, Body mass index (BMI) and Lee index among the participants in the different groups after 10 weeks. However, Swarnamali *et al.* (2021) submitted from their systematic review of literature and meta-analysis that consuming coconut oil for more than a month can significantly increase weight.

The observed decrease in body weight of Albino rats caused by coconut oil in this study could be a result of its higher level of medium-chain triglycerides (MCT). Bueno *et al*. (2015) and Mumme & Stonehouse (2015) reported that MCT increases the number of calories the body burns leading to a relative loss of weight. Since coconut oil is composed of about 65 % of MCT it is also believed to contribute to weight loss. In addition, MCTs are readily utilized by the liver just as proteins and carbohydrates. MCTs are easily oxidized by the liver and absorbed by cells, unlike long-chain triglycerides (Watanabe & Tsujino, 2022). Hence MCTs are not stored as fats to contribute to increasing body weight or obesity.

No significant fat and fibre interaction was detected for body weight throughout the study indicating that the impact of dietary fibre and fat on the reduction of body weight could have occurred independently rather than through a synergistic or antagonistic interaction. The mechanisms involved in the reduction of body weight appear to be different. The corncob fibre improves satiety and provides fewer calories to meet energy demands leading to further loss in weight. Coconut oil as an MCT serves as a readily oxidized source of energy that also increases the number of calories the body oxidizes to cause a reduction in body weight.

Due to the higher fibre content of the high-fat and high-fibre (HFa-HFb) diet compared to the high-fat and low-fibre (HFa-LFb), the former significantly reduced the body weight of the rats (Ioniță-Mîndrican *et al.*, 2022). This indicated that a high level of dietary fibre significantly reduced the body weight of the rats. The weight loss was not significant on d 49 which could be a result of the observed sharp weight loss in the HFa-LFb (19.4 g) rats compared to the HFa-HFb (11.3 g) on d 49. The HFa-LFb diet consistently caused an increase in body weight from d 0 to d 21 until it dropped on d 28. Bodyweight increased on d 35 but further reduced on d 42 and 49 and finally bounced back with an increase on d 56.

Similarly, the HFa-HFb diet decreased body weight from d 14 till the end of the study when compared to the low-fat and low-fibre (LFa-LFb) diet because the higher levels of fibre and fat in the former diet contributed a lot to the weight loss of the rats (Ioniță-Mîndrican *et al.*, 2022). The LFa-HFb diet also decreased body weight from day 14 to day 42 as compared to the HFa-LFb diet. This comparison suggests that high levels of fibre considerably reduced weight than high fat. Also, LFa-HFb diets caused a reduction in body weight from d 21 till the end of the study compared to LFa-LFb as a result of the high fibre content which is attributed to the weight loss (Leech, 2017; Ioniță-Mîndrican *et al.,* 2022).

4.4 Organ Weight

High fat as a main effect increased the w/BW (%) of the right kidney and the left kidney compared to low fat. The combined w/BW (%) of the right and left kidneys (0.614 %, 0.603 %, 0.629 % and 0.77 %), are similar to the 0.71 % of both kidneys from the study of Ijioma *et al*. (2018). The observed increase in kidney weight as observed in the Albino rats fed a diet high in both dietary fat and fibre could be attributed to fat deposition (Roever *et al*, 2021) and improved kidney health associated with high-fibre diets since fibre reduces the workload of the kidney by aiding in the excretion and egestion of waste (Kieffer *et al*., 2016).

High levels of dietary fat increased the relative weight of the right kidney compared to low fat which could be attributed to the increase in LDL, total cholesterol, and VLDL against the decreased levels of HDL associated with the high level of fat. This according to Noels *et al*. (2021) might have led to increased fat disposition to increase pro-inflammatory and pro-atherogenic processes, oxidative stress and scarring of the kidney thus making it less efficient in removing waste from the blood leading to an apparent increase in size. Fat accumulated in the adipose tissue referred to as perirenal fat protects the kidneys (Donahue-Taylor, 2023). However, an excessive increase in perirenal fat can compress the kidney to cause an increased internal pressure. A build-up of this internal pressure can cause the tissues to enlarge and increase in weight as observed in the Albino rats that were fed higher levels of coconut oil. Roever *et al.* (2021) reported that increased perirenal fat can lead to increased inflammatory cytokines, atherosclerosis, dyslipidemia and metabolic syndrome.

An increased heart weight observed in Albino rats fed higher levels of coconut oil could be due to the accumulation of fat, increased cholesterol levels in blood vessels, high blood pressure or inflammation. The increase in w/BW (%) of the heart in the high-fat groups could be due to the relatively increased levels of total cholesterol, LDL and coronary risk in the rats fed with a high level of coconut oil. The build-up of these cholesterols in the blood vessels can increase the weight of the heart, and clog vessels and reduce the lumen of the blood vessels to cause an increase in blood pressure (Forward, 2021). Increased blood pressure can cause the cardiac muscles to increase in size, which can cause an increase in the weight of the heart.

The liver of rats fed with the high level of coconut oil had a lower liver weight compared to that of those on low coconut oil probably because of the antioxidant properties and health benefits of the coconut oil. Coconut oil reduces the workload of the liver by reducing inflammation and the accumulation of excess fat in the liver (Wunderling *et al.*, 2021). An increased liver may be a result of inflammation or an increased workload on the liver to oxidize and store excess fat. Since coconut oil is an MCT it is easily oxidized to prevent accumulation of excess fat in the liver. Barreto *et al.* (2023) concluded from their study that virgin coconut oil provided a better antioxidant response and oxidative stress relief in Albino rats compared to those that received animal fat.

The increased kidney weight/BW observed in the Albino rats fed with a high-fibre diet could be a result of improved gut microbiota which might have positively influenced the health of the kidneys. The potential increase in beneficial gut bacteria caused by the high fibre might have played a beneficial role by capturing and removing excess nitrogen in the gut. This mechanism causes more nitrogen to be egested leaving lower levels of nitrogen-related compounds in the blood which the kidney would have to excrete (Kieffer *et al*., 2016). This reduces the workload of kidneys in excreting waste materials leading to improved kidney health and function thereby maintaining its healthy size. Kieffer *et al*. (2016) noted that the changes caused in the gut by fibre could serve as a barrier to prevent bacteria that cause inflammation from invading the liver and kidney.

Glenn (2022) submitted that as people grow older usually around the age of 30 – 40 years, the kidney weight begins to decline slightly even in people who do not have underlying kidney conditions. The renal arteries get narrower and may not be able to supply enough blood to support the normal functioning and size of the kidney. The weight of the kidney can decrease in size due to these age-related structural and functional changes. These age-related structural changes might have led to the decreased kidney w/BW (%) of the Albino rats fed a low-fibre diet since their age, 9-10 months is approximately 32 - 34 human years (Miller, 2023). The rats fed with a high-fibre diet probably maintained a healthy kidney size and function due to the less workload and health benefits derived from the high level of dietary fibre.

The interaction between high levels of both dietary fat and fibre indicated an increase in the weight of the right kidney and heart. This suggests that high levels of dietary fat and fibre lead to an increase in the w/BW (%) of the heart and right kidney. This could be attributed to the increased total cholesterol, HDL, LDL, TGA and VLDL levels caused by the high levels of both fat and fibre. Increased levels of the lipid profile will increase fat in the blood vessels which might have clogged the arteries leading to an increased heart pressure which can cause an increase in the weight of the heart (Forward, 2021). Also, fat deposits in the heart and kidneys due to elevated lipid profiles can result in an increased kidney and heart weight (Kochan *et al.,* 2021).

An intended interaction detected for the liver indicated that when both fat and fibre levels are low the w/BW (%) of the liver tends to be higher. The high levels of coconut oil and corncob reduced the body weight of the Albino rats in this study which might have caused the loss of fat and weight in the liver since it is the organ responsible for metabolizing energy. Khatri (2022) reported that a decrease in weight could also lead to a decrease in the fat deposits in the liver and the risk of inflammation. The loss of fat in the liver could decrease the weight of the liver as observed in the rats fed diets high in fat and fibre. It also indicated that for rats on a low-fat diet, the w/BW (%) of the liver tended to be lower when the fibre level was high. This could be a result of the high fibre which contributed to improved liver function and reduced fat absorption by binding to fat in the gut which further reduced fat deposits in the liver (Ioniță-Mîndrican *et al.,* 2022).

An orthogonal comparison of the treatments indicated that the HFa-HFb diet tends to increase the w/BW % of the left kidney when compared to the HFa-LFb diet. This shows that the high fibre tended to improve kidney health by reducing its workload and age-related changes which could have led to a decrease in kidney weight (Glenn, 2022). HFa-HFb diets increased the weight of the right kidney and heart as compared to HFa-LFb, LFa-HFb, and LFa-LFb diets. This confirms that in this study, the w/BW % of the right kidney and heart were higher when both the fat and fibre levels in the diet were high. The comparably high kidney weight in the HFa-HFb could be possibly attributed to increased fat deposits in the kidney and inflammation caused by the high levels of coconut oil. This might have subsequently led to increased kidney weight and the optimum kidney health provided by fibre to prevent age-related decline in weight and function. The increased w/BW % of the heart could be attributed to the increased lipid profile that might have caused an elevated blood pressure and subsequent increase in the weight of the heart. The LFa-LFb diet increased the weight of the liver when compared to the LFa-HFb diet because the LFa-HFb caused a decrease in weight which would have caused loss of fat in the liver cells and a subsequent liver w/BW % (Khatri, 2022).

4.5 Blood Glucose

The blood glucose of the Albino rats was not affected by dietary fat and fibre when measured on d 56. Similarly, Adelusi *et al.* (2020) and De Moura e Dias et al. (2018) reported that coconut oil did not affect the blood glucose levels of grazing cattle and Albino rats respectively. It was reported by Mao *et al.* (2021) that soluble fibre products are more effective in improving steady blood sugar levels than fibre from natural foods. This could be so because the fibre content of natural foods is mainly insoluble fibre.

The result from this present study contradicts that of Mao *et al*. (2021) who reported that soluble fibre improves steady blood sugar levels since the source of fibre in corn cob is mainly insoluble fibre. Soluble fibre, unlike insoluble fibre, can slow down digestion by forming a gel-like substance in the presence of water. This mechanism slows down the digestion of the carbohydrate thus enhancing a steady release of glucose into the blood thereby regulating glucose levels (Balaceanu *et al*., 2017; Goff *et al.*, 2018). The average blood glucose levels of all the rats were in the normal reference range of 148-208 mg/dL reported by Geffen, 2019.

The high levels of the coconut oil and corncob led to a relatively lower blood glucose level (141.7 mg/dL) compared to when both levels were low (159.1 mg/dL) or when only one was high (198.7 mg/dL). This suggests that both coconut oil and corn cob have a relatively small impact on improving the blood glucose of the Albino rats. However, their impact was not significant in this study. A review on the function of corn cob by Islam *et al.* (2023) submitted that corn cob helps to reduce blood glucose levels. The result from this present study aligns with that of Islam *et al.* (2023); however, the reduction observed was minimal, and therefore not deemed significant in this study.

4.6 Haematological Analysis

Results from the Haematological analysis indicated that high levels of dietary fat increased the MID# (Minimum inhibitory dilution number) and MID % (Minimum inhibitory dilution percentage) compared to the low fat. Minimum inhibitory dilution (MID) refers to the combined number of other rare types of white blood cells (WBCs) that are neither lymphocytes nor granulocytes. An elevated MID# indicates an increase in these rare or precursor WBCs. MID includes various progenitor white cells within a specific size range, such as monocytes, basophils, blasts and eosinophils (Alcalalabs, 2020). The MID % of the rats fed the diet low in both fat and fibre (7.581 %) and those fed a diet low in fat but high fibre (5.746 %) was lower than the reference range of 7.675 % - 13.25 % reported by Vigneshwar *et al.* (2021). This indicated that Albino rats that were fed low-fat diets had a relatively lower MID # and MID % compared to those fed high-fat diets.

A lower MID# and MID % could be caused by a reduction in one or more of these rare or precursor WBCs. The relatively lower level of both MID# and MID% in rats fed low-fat diets may be a result of inflammation, an immune response to an infection, or a disease (Dugan, 2014). An increase in MID# and MID% could also be attributed to the antimicrobial activity of coconut oil because of its high lauric content of about 50 % (Hewlings, 2020; Liang *et al*., 2021). Considering that monocytes, which form a part of the MID, consist of rare and precursor white blood cells fighting infections, the elevation observed might not be attributed to an infection or autoimmune response. Rather, it could potentially be due to the antimicrobial properties associated with coconut oil. The high levels of coconut oil upon digestion could have released enough lauric acid and monolaurin with antimicrobial activities (Joshi *et al*., 2020) which might have increased MID# and MID% in the rats fed higher levels of coconut oil.

The fat x fibre interaction showed a tendency toward an increase in MID% when both fat and fibre levels in the diet were high. This suggests that the interactive effects of high fat and fibre levels might influence antimicrobial activity (Joshi *et al*., 2020), improve gut microbiota (Kieffer *et al.*, 2016), and enhance immune responses to combat pathogens. Conversely, it could also potentially lead to inflammation or infection, resulting in an elevated percentage of MID in the blood (Dugan, 2014).

Orthogonal comparisons of the treatments revealed that the HFa-HFb diet tended to increase both MID# and MID% compared to LFa-HFb diets. This suggests that high fat levels may elevate MID# and MID% when the fibre level is high (Joshi *et al*., 2020). However, neither fat nor fibre, as a main effect or in their interactions, significantly affected the other parameters indicating that the dietary components had no significant impact on such parameters in this study (Balaceanu *et al*., 2017). Nandakumaran *et al*. (2011) reported that coconut oil seems to reduce WBC, HGB, platelet, and lymphocyte in rats, although the differences were not statistically significant. Some haematological results from this study align with their findings, showing that high levels of coconut oil decreased HGB while insignificantly increasing WBC and lymphocytes. However, it notably decreased Platelet (PLT) and Plateletcrit (PCT).

High fat and high fibre as the main effects reduced the PLT and PCT levels in the blood of the Albino rats compared to their lower levels. This result aligns with that of Nandakumaran *et al*. (2011) and Oghenemaro *et al*., (2022) also observed some decrease in PLT in the blood of Albino rats fed a variable amount of coconut oil. However, it contradicts the report of Adelusi *et al*. (2020) who observed an increase in PLT in the blood of grazing cattle fed variable amounts of coconut oil. The contradiction could be attributed to the rats' small size, laboratory settings, short lifespan, and sedentary lifestyle making them more susceptible to dietary changes. Also, the grazing behaviour and diverse diet of the cattle may mitigate the effects of coconut oil on PLT and PCT levels.

High Platelet (PLT) and plateletcrit (PCT) levels could be associated with obesity and type 2 diabetes mellitus (T2DM) but a reduction of these two parameters could arise as a result of hepatic fibrosis (Fang *et al.*, 2017). Making inferences from this information it becomes obvious that, the high levels of fibre and fat led to a reduction in platelet count since they also decreased body weight. Platelets (thrombocytes) are fragments of cells that clump together to aid in blood clotting whereas plateletcrit refers to the volume occupied by platelets in the blood, usually expressed as a percentage of the total blood volume.

According to Mayo Clinic (2022), a reduction in platelet levels also known as thrombocytopenia could be caused by an immune system disorder or bone marrow disease. The observed reduction of PLT and PCT could be a result of a compromised immune system, thrombocytopenia, NAFLD or a possible hepatic disorder caused by the high levels of coconut oil. Sheila *et al*. (2020) concluded that coconut oil could be associated with metabolic syndromes such as NAFLD and NASH (non–alcoholic steatohepatitis). Hence, this could be a cause of the decreased PLT and PCT in the blood. Paes *et al*. (2019) concluded that platelet function was increased with increasing intake of polyunsaturated fats against saturated fats. This suggests that saturated fats decreased platelet function and since coconut oil is a saturated fat it possibly might have decreased the platelet level and its function was confirmed by the reduction in PCT and PLT.

High dietary fat intake can influence lipid metabolism, which may indirectly affect platelet function and count (Paes *et al*., 2019). Abnormalities in the liver can also affect the production and function of PLT and PCT in the blood. The liver plays a major role in lipid metabolism and affects the production of various blood components, including platelets. High-fat diets, such as those containing coconut oil, can impact liver function and may affect platelet function and production (Paes *et al*., 2019). Megakaryocytes in the bone marrow manufacture platelets, a process primarily controlled by the hormone thrombopoietin (TPO) (Lambert, 2016). Since TPO is produced mainly by the liver, any abnormalities in the liver such as fatty liver disease that could be caused by high coconut oil can adversely affect the production of PCT and PLT. Valdes *et al.* (2018) and Wastyk *et al.* (2021) reported that improved gut microbiota can regulate immune response and platelet function. Since high fibre is reported to improve gut microbiota (Kieffer *et al*., 2016), it could have also affected the immune status and platelet function by decreasing PCT and PLT as observed in this study.

Fat x fibre interaction on PLT and PCT showed that a reduction of PLT and PCT levels in the blood occurred significantly when both fat and fibre levels in a diet were high. This interaction consolidates the findings that high levels of fibre and fat both reduced the levels of PCT and PLT in this study. Possibly the high fibre improved the gut microbiota which in turn affected the immune response and platelet function, whereas the high level of coconut oil also might have affected the liver function to contribute to this interactive reduction in PCT and PLT in the blood. Orthogonal comparisons of the treatments also indicated that HFa-HFb decreased both the PLT and PCT levels in the blood compared to HFa-LFb, LFa-HFb and LFa-LFb diets. This comparison confirms that the PLT and PCT levels were significantly reduced in Albino rats that were fed diets high in fat and fibre in this study.

High fibre as a main effect decreased the Mean corpuscular volume (MCV) level in the blood of the Albino rats compared to low fibre. However, it was still within the reference range of 49.2 - 60.61 fL reported by Patel *et al*. (2024). MCV is the mean size of red blood cells. Since the red blood cells transport oxygen in the blood a reduction in MCV could lead to microcytic anaemia (Eldridge, 2022). Reduction in MCV could be caused by iron deficiency, anaemia, bone marrow disorder, blood loss and a diet deficient in iron, vitamin B_9 (Folate) and B_{12} (Cobalamine). The decrease in MCV and RBC among Albino rats fed a high-fibre diet compared to a low-fibre diet may be linked to potential factors such as inflammation or nutritional deficiencies caused by the high-fibre diet, particularly low levels of iron, vitamin B_9, and B_{12}. These deficiencies could have hampered or limited the essential nutrients required for the production of RBCs (Musallam & Taher, 2018).

A fat x fibre interaction observed for MCV levels indicated that high fibre tended to reduce MCV when the fat levels in the blood were low. The interaction also indicated that MCV levels in the blood were increased when the level of coconut oil in the diet was high however, MCV levels were reduced when the coconut level was low. This can be a result of the immune response, anti-inflammatory, and improved cell health properties of coconut oil due to its phytosterols and polyphenols content (Hydes *et al*., 2020; Illam *et al*., 2021). The traces of vitamins, iron, copper, zinc and other minerals in the coconut oil could also have compensated for the deficiencies in the high-fibre diet. The orthogonal comparison revealed that both the HFa-HFb and LFa-HFb diets resulted in a greater decrease in Mean Corpuscular Volume (MCV) compared to the LFa-LFb diet. This decrease in MCV suggests that high levels of dietary fibre led to a reduction in MCV, indicating that higher dietary fibre content correlated with decreased MCV levels in this study.

A fat x fibre interaction observed for the Mean corpuscular haemoglobin (MCH) levels indicated that only in the presence of low fat did high fibre tend to reduce MCH levels. MCH is the average amount of haemoglobin found in a single red blood cell (Sherell, 2022). A reduction in MCH levels could indicate a limited amount of iron in the blood (anaemia), nutrient deficiency such as iron and vitamins, autoimmune disease, kidney or liver disease, or blood loss (Sherell, 2022). The interaction showed that high fibre tends to reduce the MCH in the blood when the fat level is low.

This suggests that despite the anti-inflammatory properties, enhanced cellular health, and trace amounts of iron and vitamins provided by low levels of coconut oil, these elements and functions were insufficient to offset the deficiencies arising from the high corn cob fibre. It is worth noting that 100 g of coconut oil contains only 0.5 mg of iron (Wong, 2017). However, the reduction in MCH in rats fed a high-fibre diet was reduced when the coconut oil was high indicating that iron was not deficient as compared to when the coconut oil was low.

Tsado *et al.* (2019) reported that the corncob treated with enzyme considerably increased packed cell volume (PCV), MCH, RBC, and WBC. Though they had some significant differences in some of the blood parameters considered, that cannot be entirely attributed to the fibre. Since the fibre was hydrolyzed and treated with an enzyme it might have influenced the difference as compared with this study and other findings. Balaceanu *et al.* (2017) reported that variable levels of fibre and starch-enriched diets did not affect the haematology of rabbits. The fact that there were not many changes in the haematological parameters in this study implies that dietary fat and fibre do not have a significant effect on the haematology or hematopoietic process of Albino rats. Or at least the variable levels of fibre and fat, used in the study did not affect the hematopoietic process of the Albino rats during the study period.

4.7 Biochemical Analysis

4.7.1 Lipid Profile

The levels of triglycerides (TGA) and very low-density lipoprotein (VLDL) were reduced in the lipid profile of Albino rats fed high levels of coconut oil. This result corresponds to that of Gomes *et al.* (2023) who concluded that coconut oil supplementation decreased the levels of triglycerides (TGA) and an earlier work by Nevin & Rajamohan (2004) in which they reported that coconut oil decreased VLDL compared to copra oil in Sprague-Dawley rats.

Excess calories from carbohydrates and fats are stored in the form of TGA, hence TGA serves as an essential source of energy while VLDL is a lipoprotein that transports triglycerides in the bloodstream. A rise in TGA and VLDL may indicate obesity, eating high-caloric food or a sedentary lifestyle. A rise in TGA and VLDL is a risk factor to cardiovascular health especially when associated with High LDL levels (Das & Ingole, 2023). A reduction in TGA and VLDL could improve heart and metabolic health and prevent cardiovascular diseases and the development of pancreatitis (Lee *et al*., 2022). By reducing triglycerides and VLDL, the high levels of coconut oil improved lipid metabolism and cardiovascular health. To an extent, high coconut oil reduced the risk of atherosclerosis, stroke and subsequent heart attacks compared to the low fat since it lowered TGA and VLDL.

The results of coconut oil on the HDL, LDL and total cholesterol of the Albino rats in this study relate to that of De Moura e Dias *et al*. (2018) in which they observed a similarity in the HDL, LDL and total cholesterol among the experimental groups. Wang *et al*. (2015) reported that total cholesterol, LDL and LDL/HDL cholesterol were linearly decreased as the coconut oil level increased. Adelusi *et al*. (2020) reported from their research that increasing levels of coconut oil (0, 50, 100, 150 g/day) had a notable increase in total cholesterol, HDL and LDL**.** However, in this study, HDL was slightly decreased while total cholesterol and LDL were slightly increased. The levels of HDL, LDL and total cholesterol were not significant and were within the reference range reported by Ihedioha *et al*. (2013). Some earlier research reported that coconut oil may increase LDL cholesterol levels, therefore, increasing the risk of heart disease (Sankararaman and Sferra, 2018; Hewlings, 2020; Neelakantan *et al.*, 2020). Although coconut oil increased LDL levels in this study, the increment was not significant.

Oghenemaro *et al.* (2022) also reported a decrease in HDL, LDL and total cholesterol in Albino rats that were fed with 0.5 mL/kg daily as compared to the control. Chinwong *et al.* (2017) concluded that coconut oil may help boost levels of HDL. However, in this study, HDL was reduced slightly, while total cholesterol and LDL also increased slightly. The range of total cholesterol levels in this study (3.507 - 3.548 mmol/L), LDL levels (1.03 – 1.72 mmol/L) as well as HDL (1.308 – 1.700 mmol/L) were all within the normal reference ranges of 2.59 – 3.75 mmol/L, 0.79 - 1.84 mmol/L and 1.26 – 1.88 mmol/L reported by Ihedioha *et al.* (2013) respectively. However, some levels of

TGA (1.112 - 1.723 mmol/L) and all levels of VLDL (0.505 – 0.783 mmol/L) in this study were respectively above the 0.76 -1.66 mmol/L and 0.200 – 0.390 mmol/L reported by Ihedioha *et al*. (2013).

Fibre as a main effect did not affect any of the parameters measured in the lipid profile. This indicates that for the duration of this study, the fibre levels in the diets did not significantly affect the lipid profiles of the Albino rats. The finding is similar to that of Ojo *et al.* (2021) who reported from their systematic review and meta-analysis that except for total cholesterol that dietary fibre decreased it had no significant effect on the HDL, LDL and other parameters of the lipid profile. The effect of corncob fibre contradicts that of Tsado *et al.* (2019) possibly because they used a hydrolyzed corncob fibre. They reported that the inclusion of 5 % - 15 % of corncob fibre in the diet of broilers improved their lipid profile by lowering cholesterol levels. The hydrolysis of the corn cob with enzymes reduced the indigestibility and insolubility of the corn cob fibre. This in effect made it soluble to bind to dietary fat to reduce the absorption and incorporation of fat into the blood. Soluble dietary fibre such as gum and pectin bind to cholesterol in bile to excrete excess cholesterol, thus reducing the cholesterol in the body (Rose-Francis, 2022). Since the fibre of corn cob is mostly insoluble it could not form a gel-like substance to bind with the coconut oil to moderate the cholesterol levels in the blood.

The high fat and low fibre interaction observed on HDL levels indicated that high fat tends to reduce HDL levels in Albino rats fed a low-fibre diet. Implicating that when the dietary fibre content of the diet was low an increased level of fat reduced the levels of HDL. The high level of coconut oil as a main effect slightly reduced the HDL levels while high levels of corncob fibre as a main effect insignificantly increased HDL levels of the Albino rats in this study. High fat and fibre as the main effect had contrasting effects on the HDL levels. The interaction indicated that high fat was able to reduce HDL levels of rats that were fed a low-fibre diet. This reveals that the effect of the coconut oil on reducing the HDL levels of the rats became significant when the corncob fibre was low in a diet. Just like other saturated fats, coconut oil reduces the levels of HDL which can impose a risk to cardiovascular health. Since the reduction was not significant the risk would be minimal compared to other saturated fats.

The HDL, however, increased when both fat and fibre levels were high indicating that the interactive effects of high fibre in corncob and dietary fat in coconut oil improved the HDL levels of the coconut oil. This could be attributed to the improved microbiota and gut health associated with the intake of dietary fibre which might have aided in the digestion and absorption of the coconut oil to improve the ability of coconut oil to increase the HDL levels interactively. The interaction between fat and fibre on TGA and VLDL indicated that high fat decreased the levels of TGA and VLDL when the fibre level is low in a diet. The low-fibre level interacted with the high levels of fat to cause a reduction in the TGA and VLDL, reducing the risk of cardiovascular disease by reducing bad cholesterol levels. This indicated that High levels of coconut oil effectively reduce TGA and VLDL levels in the blood of the rats fed a low-fibre diet.
On the other hand, fat x fibre interaction on LDL and coronary risk indicated that only in the presence of low fibre did high-fat increase the LDL levels and coronary risk. The high levels of coconut oil were observed to have increased the LDL and coronary risk of the Albino rats fed a low-fibre diet. This shows that high levels of coconut oil

increase “bad” cholesterol levels and the risk of cardiovascular disease when the fibre content in a diet is low.

Orthogonal comparisons of the treatments indicated that HFa-LFb diets decrease the levels of TGA and VLDL compared to HFa-HFb diets in this study. This comparison confirms the observation from this study that levels of TGA and VLDL in rats fed a high level of coconut oil were significantly decreased when the fibre in a diet was low. This proves that the inclusion of high levels of dietary fibre mitigated the reduction of TGA and VLDL levels as reported earlier by Soliman (2019). The tendency of the HFa-LFb diet to increase the levels of LDL and coronary risk compared to the HFa-HFb diet points out the fact that when the fibre level in a diet is high it tends to mitigate the adverse effect the coconut oil has on the cholesterol levels by reducing LDL (bad cholesterol). The HFa-LFb diet increases the levels of LDL compared to the LFa-LFb establishing the fact that LDL was increased as the level of coconut oil was increased in a diet as reported by Neelakantan *et al.* (2020). However, comparing the HFa-LFb diet and the LFa-LFb diet on TGA and VLDL levels indicates that HFa-LFb tends to decrease the levels of TGA and VLDL. These comparisons confirm the observation that the high levels of coconut oil caused the rise in LDL levels and the observed decrease in TGA and VLDL of the Albino rats that were fed a low-fibre diet.

4.7.2 Liver Function Test

High fibre as a main effect increased the levels of alkaline phosphatase (ALP), and total bilirubin (T.BIL) and also tended to increase indirect bilirubin (IND.BIL) levels in the blood of the Albino rats compared to low fibre. ALP is an enzyme present in many bodily tissues and is essential to many physiological functions such as the metabolism of protein and fat (Huizen & Haghighi, 2021). An unusually elevated ALP could be caused by an inflammation or scarring of the tissues in the liver, a disorder in the bones or intestines or mononucleosis (Cleveland, 2021). An increase in phosphorus and iron deficiency anaemia can also cause an elevated ALP by affecting liver health. Since the dietary fibre used in this study increased the levels of ALP it shows that the intake of high levels of corncob fibre might have affected fat metabolism, influenced hepatic function by affecting the production, metabolism and excretion of bile, or led to iron deficiency and anaemia (Xie *et al.*, 2021).

Bilirubin is a yellowish substance produced from the disintegration of red blood cells in the liver and bone marrow cells before it is excreted (David Rossiaky, 2022). Elevated bilirubin levels can be caused by a viral infection, gallstones, liver diseases, hemolytic anaemia, obstruction of the bile duct and other health conditions (Kerkar, 2019; David Rossiaky, 2022). The increase in the total bilirubin and the tendency to increase indirect bilirubin levels caused by the high fibre compared to low fibre in this study indicate an obstruction in fat metabolism affecting bile production and metabolism or a possible hemolytic anaemia (Xie *et al.*, 2021). The increase in indirect (unconjugated) bilirubin serves as a sign of the development of hemolytic anaemia since it is characterized by increased production of unconjugated bilirubin from excessive premature removal of RBCs (Cornell, 2020). High fibre intake might have stimulated the liver to produce more bilirubin for detoxification, contributing to the increase in unconjugated bilirubin. Increased bile secretion due to fibre intake could lead to higher levels of bilirubin in the blood, which is usually excreted via the bile.

In this study, the high-fibre decreased albumin levels than low fibre which agrees with Adelusi *et al*. (2020) who reported that hydrolyzed corn cob (5 %-15 %) also decreased albumin levels of broilers. Albumin is considered the most abundant protein that circulates in the blood. Albumin is synthesized by the hepatocytes in the liver but very little is stored in the liver since it is rapidly excreted into the bloodstream at the rate of about 10 g to 15 g per day (Moman *et al*., 2022). In humans, albumin in the serum regulates plasma oncotic pressure, transportation of various substances in the bloodstream, and regulating the fluid balance between blood vessels and body tissues. It also serves as an indicative measure of the nutritional status of an individual (Moman *et al.*, 2022). A decrease in the level of albumin in the serum can indicate reduced protein absorption or metabolism, liver dysfunction, malnutrition, kidney disorder or other health conditions that affect albumin synthesis or metabolism. The high levels of fibre might have counteracted the absorption and metabolism of protein, hurt the liver and kidney or the synthesis of albumin leading to its reduction in the serum of the Albino rats compared to the low-fibre diets. This connotes that concerning albumin levels the low fibre diet performed better than the high fibre diet.

Fibre as a main effect did not affect ALT, AST, total protein, Globulin and direct bilirubin. This result varies with that of Adelusi *et al*. (2020) who submitted that hydrolyzed corn cob increased total protein, AST and ALT in broilers. This posits that the variable levels of the corncob fibre used in this study did not have a significant effect on the ALT, AST, total protein, globulin and direct bilirubin on d 56, unlike the work of Adelusi *et al*. (2020) who used a hydrolyzed corn cob fibre.

Fat as a main effect nor its interaction with fibre did not affect any of the parameters detected for the liver function test. The fact that the coconut oil could not considerably affect the parameters of the liver function means that the duration of this experiment and the variable levels of fat used did not have a significant impact on the liver function test. This means that fat as a main effect did not have a significant impact on the physiology and function of the liver of the Albino rats used. The no significant effect of fat x fibre interaction in this study shows that the different levels of fat and fibre in the diet did not cause a significant synergistic or contrasting effect on the liver function parameters. It could be inferred that the effects of fat and fibre on the function of the liver appeared to act independently in this experimental study.

The LFa-HFb diets tended to increase the level of ALP in blood serum than HFa-LFb. This connotes that the high levels of the corncob fibre led to the elevation of ALP levels of the Albino rats that were fed low levels of coconut oil. Comparably the ALP levels were increased in the rats fed LFa-HFb than HFa-LFb indicating that the high amount of coconut oil compensated for the increment of ALP caused by high dietary fibre used in this study.

4.8 Histological Examinations

4.8.1 Heart

The histological micrograph of the Albino rats in treatment 1 (Plate 4.1) that were fed a diet low in both dietary fat and fibre showed a normal and healthy heart (Buckberg *et al.*, 2018; Arackal & Alsayouri, 2023). This indicates that low levels of dietary fat and fibre in the diet did not have any recognizable adverse effect on heart function and health (Bhandari & Sapra, 2023).

Comparatively, that of the Albino rats in treatment 2 (Plate 4.2) fed a low-fat diet with a high fibre content (LFa-HFb) showed a normal and healthy heart architecture. Indicating that increasing the fibre content in the diet of the Albino rats in this study did not have a significant or recognizable adverse effect on the histology and health of the heart. The high level of dietary fibre in the diet might have even improved the health of the heart as increasing the amount of dietary fibre has been associated with improved cardiovascular health (Evans, 2020).

Threapleton *et al.* (2013) revealed from their comprehensive systematic review that consuming 7 g of fibre notably reduced the risk of CVD by a substantial 9 %, with a 95 % confidence interval (CI) spanning from 6 % to 12 %. These results emphasize the considerable cardiovascular benefits associated with a higher dietary fibre intake. The histological micrograph of Albino rats in treatment 3 (Plate 4.3) fed a high-fat diet low in fibre revealed relatively unclear branching and striations of cardiomyocytes (Keepers *et al*. 2020), and some oval vacuolated pale structures that closely resemble fat accumulation. The unclear or disrupted striations in cardiac muscle tissue could indicate damage or degeneration of the muscle fibres. Which might have resulted from conditions such as myocardial infarction (heart attack) or cardiomyopathies, which affect the structural integrity of the heart muscle (Ojha & Dhamoon, 2023). It could also indicate excessive formation of fibrous connective tissue within the heart muscle. Fibrosis can disrupt the normal arrangement of muscle fibres and lead to unclear striations. Fibrosis is, however, often associated with chronic heart diseases (Antar *et al*., 2023). Also, an inflammation in the heart such as myocarditis (Ammirati *et al*., 2020; Stephenson *et al.*, 2017) can affect the appearance of cardiac muscle tissue leading to cellular changes that affect striation patterns.

The old age of the Albino rats coupled with the increased fat deposition could have resulted in the unclear cardiac branching and striations of the heart histomicrograph shown in Plate 4.3. In older individuals, changes in the cardiac muscle structure can occur naturally, leading to alterations in striation patterns (MedlinePlus, 2020). The presence of pale oval vacuolated structures could be attributed to the increased levels of fat in the diet which might have clogged and accumulated in the heart. Or it could have been cellular inclusions or vacuoles containing various substances, including abnormal proteins or metabolic by-products. The presence of such vacuoles could be associated with certain heart diseases or storage disorders (Borradaile & Schaffer, 2005).

Comparatively, the histology of the heart of Albino rats in treatment 4 (Plate 4.4) fed a diet high in both dietary fat and fibre showed moderately distinct striations and branching of cardiac muscles and relatively few smaller pale oval vacuolated structures. This indicates that the increased level of dietary fibre might have mitigated some of the adverse effects on the heart caused by the high level of fat as seen in the histological micrograph of the heart of Albino rats in T3 (Plate 4.3). This could be attributed to the health benefits and protection dietary fibre notably provides against cardiovascular diseases (McRae, 2017).

4.8.2 Liver

The histological micrograph of the liver of Albino rats in treatment 1 (Plate 4.5) revealed normal and healthy liver histology very similar to that of the control group in the research study of Ahmad *et al.* (2012) where hesperidin was used to alleviate acetaminophen-induced toxicity in Albino rats. This indicates that the low levels of fat and fibre in the treatment diet did not have any recognizable adverse effect on the histology and function of the liver.

The histology of the liver of Albino rats in treatment 2 (Plate 4.6) revealed a normal liver with a relatively small central vein and very distinct regularly oval-shaped nuclei in the hepatocytes with very few pale spaces. A relatively small central vein in the liver histology of T 2 indicates that there is no significant dilation or enlargement of the central vein, which is a typical feature of a healthy liver (Rad, 2021). It suggests that blood flow within the liver is well-regulated and functioning normally. The presence of very distinct and regularly oval-shaped nuclei in the hepatocytes indicates that the hepatocytes (liver cells) were healthy and well-preserved to maintain their normal morphology. This also suggests that the cells are healthy and not undergoing significant pathological changes.

The presence of very few pale spaces in the liver tissue suggests minimal or no pathological changes or disruptions in the liver structure. The appearance of normal-sized sinusoids is generally indicative of healthy liver tissue with a well-maintained blood supply (Rad, 2021). These pale spaces are likely to be spaces between cells and connective tissue, and their limited presence indicates that there is no significant accumulation of either fat or abnormal substances or tissue damage. This shows that increasing the fibre content in the diet might have caused this improved liver health and histology. The American Liver Foundation (2023) recommends that people eat more fibre because it helps the liver function at optimal levels. Dietary fibre, particularly insoluble fibre can aid in digestion and helps to flush waste and toxins from the body (Barber *et al.*, 2020), thereby reducing the workload of the kidney and liver. This can contribute to the efficient elimination of waste products and overall liver health. Furthermore, increasing dietary fibre intake has the dual benefit of reducing non-beneficial fats and providing essential compounds and nutrients that reduce inflammation and combat disease (Gasbarre, 2021).

For Albino rats in treatment 3 (Plate 4.7) the histology of the liver also generally appeared normal with a regular size central vein and normal portal tract architecture. The nuclei appeared to be moderately larger and some clear oval-shaped vacuolated structures closely resemble fat molecules accumulated in the liver cells. The presence of a regular-sized central vein and normal portal tract architecture suggests that blood flow within the liver is well-regulated, and the anatomical structures for the exchange of nutrients and metabolic products are intact. This indicates a normally functioning heart and health in the Albino rats suggesting that the high-fat diet did not have a considerable adverse effect on the histology of the heart. This result aligns with the work of Desmawati *et al*. (2022) who claimed that that their high-fat diet (3 ml of beef brain/rat/day) did not affect the histopathological features of the liver in pregnant Albino rats. AbdEl-Fattah & Barakat (2011) reported in their study that olive oil and coconut oil have a protective effect against oxidative stress and liver damage induced by 2, 4 Dichlorophenoxyacetic Acid (2, 4-D). It was also reported by Zakaria *et al.*

(2011) that virgin coconut oil (either dried or fermented) has a hepatoprotective effect on acetaminophen-induced liver damage in rats.

However, the results contradict the work of Dhibi *et al.* (2011) that all the high-fat diets (20 % soybean oil, 20 % oxidized soybean oil and 20 % margarine) used in their study adversely affected the liver. They reported that a strong relationship exists between the consumption of trans fatty acids (TFA) in the oxidized oils and lipid peroxidation and NAFLD. The observed moderately larger nuclei in hepatocytes may be a normal variation or could indicate cellular changes associated with the liver's functional state such as mild inflammation or fat accumulation (Gong *et al*., 2022).

The presence of oval-shaped vacuolated structures may indicate fat accumulation within the hepatocytes and the presence of relatively large pale spaces could indicate dilated sinusoids excess fat accumulation or accumulation of excess fluid. It could also indicate inflammation or fibrosis (Henderson *et al.*, 2020; Antar *et al*., 2023). A dilated sinusoid might indicate increased blood flow, inflammation or congestion. This could result from the higher level of fat in that diet which could have led to the accumulation and storage of excess fat in the liver cells.

Comparably the histology of the liver of Albino rats in treatment 4 (Plate 4.8) revealed a relatively large central vein and a regular portal tract architecture. The presence of a relatively large central vein (CV) suggests that the CV which is the blood vessel responsible for draining blood from the liver lobules (Lorente *et al.*, 2020) is not shrunken, congested or obstructed. A larger central vein may indicate that blood flow within the liver is well-maintained and that there are no significant obstructions or restrictions in the hepatic vasculature. It could also be associated with increased metabolic activity within the liver. This could be due to the liver responding to specific stimuli or metabolic demands. The observed regular portal tract architecture in T 4 suggests that the anatomical structures responsible for the exchange of nutrients, metabolites, and waste products between the liver and the bloodstream are intact and functioning normally. The presence of few clear vacuolated structures in T 4, compared to T 3, indicates a lower accumulation of lipid droplets or fat within the hepatocytes. This observation suggests that there is less risk or occurrence of hepatic steatosis (fatty liver) in T 4 compared to T 3.

Few clear vacuolated structures and pale spaces were observed in T 4 compared to that of T 3 suggesting that the increased level of fibre in the diet might have reduced the fat accumulation seen in T 3. The high-fat diet's impact in this study did not have a significant adverse effect on the liver compared to the findings of Dhibi *et al*. (2011). This disparity could be attributed to the notably higher fat percentage (20 %) and the type of fat utilized (trans-fatty acids) in contrast to the 8 % and 11 % proportions of coconut oil used.

4.8.3 Kidney

The histological micrograph of the kidneys of T 1 (Plate 4.9) depicted a normal and healthy kidney architecture which shows that the low levels of dietary fibre and fat in this study did not have any considerable adverse effect on the histology and health of the kidneys. The observation of normal kidney histology and architecture, where the glomeruli (G) perfectly fit within the Bowman's capsule with a little Bowman's space, indicates a healthy and well-preserved renal structure (Ahmad *et al.* 2012).

The fact that the glomeruli fit perfectly within the Bowman's capsule suggests that the filtration process in the kidneys is functioning normally (Murray & Paolini, 2023). It also implies efficient filtration without leakage. This ensures that essential substances, like nutrients and proteins, are retained in the bloodstream while waste products are filtered out effectively. The observation of normal renal corpuscles, which consist of the glomerulus and Bowman's capsule, indicates that the structural integrity of these components is maintained since this is important for long-term kidney health and function (Murray & Paolini, 2023). The presence of a little Bowman's space suggests that there is minimal accumulation of fluid or filtrate within the capsule. This is consistent with normal kidney function (Falkson & Bordoni, 2023), as excess fluid accumulation can be a sign of kidney dysfunction.

The histology of the kidney of Albino rats in T 2 (Plate 4.10) revealed moderately large Bowman’s spaces. Some small oval vacuolated pale structures were present with one resembling an empty Bowman’s capsule. The presence of moderately large Bowman's spaces might suggest a relatively moderate fluid or filtrate accumulation in the Bowman’s capsule or a normal increase in the Bowman’s space of T 2 (Falkson & Bordoni, 2023). The oval vacuolated structures could suggest the presence of accumulated fluid or material. The structure resembling an empty Bowman's capsule could be an anatomical variation, possibly a developmental anomaly or an artefact in the histological preparation.

In some instances, the absence of a glomerulus or a deformity within a Bowman's capsule may result from developmental anomalies or congenital defects, potentially arising during early kidney development when glomeruli fail to develop properly or are entirely absent. Also, in specific pathological conditions like chronic kidney diseases, glomeruli may undergo degenerative changes, resulting in their loss (Podestà & Ponticelli, 2020; Vaidya & Aeddula, 2022; Murray & Paolini, 2023). Under such circumstances, Bowman's capsules can persist but remain empty or contain remnants of the glomerulus. It could also be that during the process of tissue preparation and histological staining, sections of tissue were distorted or damaged, leading to the appearance of that large oval pale vacuolated structure resembling an empty Bowman's capsule.

The histology of the kidneys of Albino rats in T 3 (Plate 4.11) revealed a relatively larger Bowman’s space and some deformed glomeruli. The presence of numerous pale oval vacuolated structures with some appearing as empty Bowman’s capsules. The relatively larger Bowman’s space as observed in T3 could either indicate that the amount of fluid or filtrate in the Bowman’s capsule is higher compared to the other treatment groups or that the leakage of filtrates is relatively higher. Although the Bowman’s space was relatively larger it was not wide enough to impose or imply a pathological effect (Murray & Paolini, 2023). The presence of structures in Bowman’s capsule that resemble deformed glomeruli may suggest developmental anomalies or irregularities that might have occurred during kidney organogenesis (Little, 2011). A deformed glomeruli and vacuolated structures may be indicative of pathological changes within the kidneys. Various kidney diseases or conditions, such as glomerulonephritis or nephrotic syndrome, can alter the structure of glomeruli and result in abnormal Bowman's capsules (Ranasinghe *et al*., 2017; Vaidya & Aeddula, 2022; Keskinyan *et al*., 2023; Murray & Paolini, 2023). The large pale spaces could also suggest fat accumulation as a result of the increased level of fat in the diet.

Comparably, the histology of the kidneys of Albino rats in T 4 (Plate 4.12) revealed several perfectly fitted glomeruli in Bowman's capsules with very little Bowman's space. A relatively small numerous oval vacuolated pale structures compared to that of T 3. This indicates an improved kidney histology and health which could be assigned to the increment of dietary fibre in the diet (Keskinyan *et al.*, 2023). The high level of fibre might have mitigated some of the effects of the high fat by reducing the risk of inflammation, and fat accumulation and detoxifying the kidney (Kieffer *et al*., 2016). Silvares *et al*. (2019) reported that their high-fat diet induces microvascular dysfunction that precedes a decline in renal function. The adverse effect of the high-fat diet (36 % lard, 56 % carbohydrate, 14 % protein) could be attributed to the type of fat and its relatively higher level of inclusion coupled with the longer time of administration (20 weeks). Pereira *et al.* (2021) concluded that to evaluate the renal effects of a high-fat diet, albino rats are a suitable animal model. Likewise, the 2 ml of cow fat emulsion administered orally to Albino rats in the work of Salim *et al*. (2018) led to some renal abnormalities in the rats.

There was little to no considerable adverse effect on the histology of the heart, liver and kidney and this could be attributed to the relatively lower levels of dietary fat (5.75 % - 19.41 %) used in this study and the source (coconut oil) coupled with the ameliorative and health benefits of dietary fibre (Graham *et al*., 2014; Barber *et al*., 2020; Ioniță-Mîndrican *et al.*, 2022; Noye Tuplin *et al*., 2022; Ziani *et al.*, 2022).

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

1. Both dietary fat and fibre tended to decrease feed intake however it was not significant. There was no significant interaction between fat and fibre on the reduction of feed intake. This suggests that these dietary components might influence appetite regulation, and satisfaction independently to cause a reduction in feed intake.

2. High dietary fibre and high dietary fat reduced the body weight of the Albino rats. This indicates the potential role of high levels of dietary fat and fibre in healthy weight management. Hence, for healthy weight management, the dietary composition of fat and fibre should be considered. The high levels of dietary fibre and fat reduced weight independently since there was no significant interaction on body weight. This suggests that the effects of dietary fat and fibre on body weight are distinct and not influenced by the presence of the other components in the diet. This highlights the separate roles and mechanisms through which both fibre and fat regulate body weight.

3. Both fat and fibre did not influence the blood glucose levels of the Albino rats on day 56 suggesting that the level of dietary fibre and fat used for this study had no impact on the blood glucose regulation after day 56. This indicates that the specific levels of fat and fibre used in this study could not influence blood glucose regulation for the 56-day duration. This suggests that other factors or

longer durations may be required to observe substantial effects on blood glucose levels.

4. High fibre increased the weight of kidneys and heart in the rats while it decreased the weight of the liver. The increased relative weights of the kidneys and heart in the rats implicate the impact of dietary fibre on renal and cardiac health. The decrease in liver weight suggests a potential influence of high fibre intake on liver metabolism and size. Also high fat in the presence of High fibre increased the weight of kidneys and heart in the Albino rats. Indicating that when both fat and fibre levels in a diet are high the weight of kidneys and heart increased in the Albino rats.

5. The platelet (PLT) and plateletcrit (PCT) were lower in the rats fed high-fat and high-fibre. This highlights the potential effect of dietary fat and fibre on platelet and plateletcrit levels in the blood. High fat and high fibre as the main effects reduced the PLT and PCT levels in the blood of the Albino rats compared to their lower levels. This finding points out the fact that increasing the levels of dietary fat and fibre in a diet could cause a reduction in the levels of PLT and PCT. Also, fat and fibre interaction on PLT and PCT showed that a reduction of PLT and PCT levels in the blood occurred significantly when both fat and fibre levels in a diet were high.

6. Increasing the level of dietary fibre decreased the mean corpuscular volume (MCV) in the blood of the Albino rats. The decrease in MCV suggests a potential impact of high dietary fibre levels on the size and oxygen-carrying

capacity of red blood cells in Albino rats. However, high fat increased the number of minimum inhibitory dilutions (MID) and also tended to increase the percentage of MID in the blood of Albino rats as compared to low fat. This suggests that the consumption of dietary fat might influence immune response and the microbial balance within the body.

7. High fibre reduces LDL levels and coronary risk suggesting a potential positive impact of dietary fibre on cardiovascular health by influencing cholesterol levels. High fibre also tended to increase HDL levels. This finding can be considered a potential positive influence on cardiovascular health since elevated HDL levels are often associated with a lower risk of heart disease. On the other hand, high levels of coconut oil reduce TGA and VLDL levels. This also indicates that coconut oil has a potential positive impact on heart health by lowering these risk factors for cardiovascular diseases.

8. The alanine phosphatase (ALP) and total bilirubin (T.Bil) were higher in the Albino rats fed a high-fibre diet. This connotes the potential changes that can occur in liver health and function due to increased dietary fibre intake.

9. Albumin levels were decreased when the fibre level of a diet was high. The decrease in albumin levels associated with a high-fibre diet suggests that dietary fibre may have an impact on protein metabolism and utilization in the Albino rats, possibly affecting liver and kidney function.

10. Dietary fat had no influence on the liver function variables of the Albino rats after day 56 of the study. This indicates that the duration of this study and the level of dietary fat used had no notable impact on the measured liver function parameters. Also, no fat nor fat x fibre interaction was observed on the liver function test. This shows that dietary fibre affected the liver function parameters independent of dietary fat.

11. Increasing the fibre content in a diet mitigated some of the adverse effects caused by high fat on the heart, kidney and liver of the Albino rats. Increasing the fibre content indicated a potential to improve cardiovascular, renal and hepatic health.

5.2 Recommendations

1. Further research that involves female Albino rats is required to clarify the impact of dietary fat and fibre on their growth and physiology.
2. Further research with a wider range of time, dietary fat and fibre levels is required to determine optimal levels for potential benefits and thresholds for adverse effects.
3. Further research with different durations is needed to elucidate the short-term, medium-term and long-term impact of dietary fat and fibre.

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