Effects of Locally Available Ingredients on Haematological Composition, Physicochemical Properties, Proximate Analysis and Sensory of Broiler Chicken

Nur Nazihah Binti Mat Pozian

F18A0268

Degree of Bachelor of Applied Science (Animal Husbandry Science) With Honours

Faculty of Agro-Based Industry

Universiti Malays Kelantan

2021

DECLARATION

I hereby declare that the work embodied in this report of the original research and has not been submitted for a higher degree to any universities or institutions.

Nazihah

Signature

Student Name: Nur Nazihah Binti Mat Pozian

Matrix No: F18A0268

Date: 17 February 2022

Approved by:

Supervisor’s Signature

Name:

Chop:

Date

ACKNOWLEDGEMENT

Foremost, I would like to express my sincere gratitude to my supervisor Dr. Khairiyah Binti Mat, for my Final Year Project (FYP) 's continuous support for her patience, motivation, enthusiasm, and immense knowledge. Her guidance helps me in the project and writing of this thesis.

Appreciation to my members and friends for all the tutoring and spending time with me during this period. Without their help and tolerance, I would not be able to complete this project successfully.

I also want to express my deepest thanks to my beloved family for their caring, encouragement and support both financially and morally, which made me manage to finish this project.

Last but not least, I would like to thank all people that were involved either directly or indirectly, in this project. A special thanks to University Malaysia Kelantan for providing me many information and guidance to complete this project.

Effects of Locally Available Ingredients on Haematological Composition, Physicochemical Properties, Proximate Analysis and Sensory of Broiler Chicken

ABSTRACT

The poultry industry has been dramatically affected by the high costs of animal feed ingredients, which has resulted in expensive commercial feeds. A high-quality with enough nutrients feed can help the birds grow faster. Therefore, the price of protein ingredients is very high, making it difficult for many farmers to sustain their farms and survive. Black Soldier Fly Larvae (BSFL), fermented coconut dregs, water spinach, and turmeric were ingredients with a good source of protein that can be effectively optimized within feed formulations compared to other expensive protein ingredients. A study was conducted to determine the effect of local ingredients in poultry feed on broiler chicken. Haematological analysis, meat quality of physicochemical properties and proximate analysis, and sensory evaluation were tested to ensure that the broiler meat is safe for human consumption. Results from the haematological analysis showed that all parameters have a significant difference ($p<0.05$) except on white blood cells. The physicochemical properties of broiler meat were high in pH; thus, the pH value influenced other physicochemical properties. Proximate analysis of all groups has a significant difference with $p<0.05$. Lastly, the sensory evaluation did not significantly differ ($p<0.05$) for all parameters except for the colour of raw broiler chicken. There was no effect on the sensory evaluation of broiler meat. To summarise, Treatment 2 with 15% BSFL is a good feed formulation for poultry because it had the optimum pH value as pH value will influence other physicochemical properties in broiler meat, had the value closest in haematological analysis to the standard value in broiler and had the closest value in proximate analysis to Control when compared to the other treatments.

Keywords: BSFL, haematology, physicochemical properties, proximate analysis, sensory evaluation

Kesan Bahan-bahan Tempatan ke atas Komposisi Hematologi, Sifat Fisikokimia, Analisis Proksimat dan Deria Ayam Pedaging

ABSTRAK

Industri poltri telah terjejas secara mendadak kerana kos bahan makanan haiwan yang tinggi, mengakibatkan makanan komersial yang mahal. Makanan berkualiti tinggi dengan nutrien yang mencukupi boleh membantu burung membesar dengan lebih cepat. Oleh itu, harga bahan protein yang sangat tinggi, menyukarkan petani-petani untuk mengekalkan ladang mereka dan terus bertahan. Larva Lalat Askar Hitam (BSFL), hampas kelapa bayam air, dan kunyit adalah bahan dengan sumber protein yang baik yang boleh digunakan dengan berkesan dalam formulasi makanan berbanding bahan protein mahal yang lain. Kajian telah dijalankan untuk menentukan kesan bahan tempatan dalam makanan poltri ke atas ayam pedaging. Analisis hematologi, kualiti daging iaitu sifat fizikokimia dan analisis proksimat, dan penilaian deria telah diuji untuk memastikan daging ayam pedaging selamat untuk dimakan oleh manusia. Keputusan daripada analisis hematologi menunjukkan semua parameter mempunyai perbezaan yang ketara ($p<0.05$) kecuali pada sel darah putih. Sifat fizikokimia daging ayam pedaging adalah tinggi dalam pH; oleh itu, nilai pH mempengaruhi sifat fizikokimia yang lain. Analisis proksimat bahan semua kumpulan mempunya perbezaan ketara dengan nilai $p<0.05$. Akhir sekali, penilaian deria tidak berbeza dengan ketara ($p<0.05$) untuk semua parameter kecuali warna ayam daging mentah. Tiada kesan ke atas penilaian deria daging ayam pedaging. Secara ringkasnya, Rawatan 2 dengan 15% BSFL adalah formulasi makanan yang baik untuk poltri kerana ia mempunyai nilai pH optimum kerana nilai pH akan mempengaruhi sifat fizikokimia lain dalam daging ayam pedaging, mempunyai nilai yang paling hampir dalam analisis hematologi dengan nilai piawai dalam ayam pedaging dan mempunyai nilai terdekat dalam analisis proksimat kepada Kawalan jika dibandingkan dengan rawatan lain.

Kata kunci: BSFL, hematologi, sifat fizikokimia, analisis proksimat, penilaian deria

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

LIST OF ABBREVIATIONS

NA	Not Available	20
WCH	Water Holding Capacity	21
TPA	Texture Profile Analysis	23
L*	Lightness	41
a*	Redness	41
b*	Yellowness	41
PSE	Pale, soft, exudative	42
DFD	Dark, firm, dry	42

CHAPTER 1

INTRODUCTION

1.1 Research Background

Consumer preference has shifted from red meat (beef) to white meat (poultry) in recent decades. Many factors influence consumer preferences, including population growth, price, and religion (Magdelaine, Spiess, and Valceschini, 2008). The demand for broiler meat as the primary source in their daily diet increases year by year. With a per-capita intake of 35.3kg in 2011, Malaysia was one of the countries with the highest consumption of poultry globally (Minister of Agriculture, 2018). Malaysia has experienced a high self-sufficient level for poultry production, with 103% in 2018 (Ministry of Agriculture, 2018).

Broiler meats produce high energy because they contain glycogen and lipid (Overland, Borge, Voght, Schoyen, Skrede, 2011). Lipid in broiler meat can affect the colour and texture of meat and its flavour (Overland et al., 2011). This study was conducted to determine the effect of black soldier fly larvae (BSFL), fermented coconut dregs, water spinach and turmeric on meat.

Black soldier fly larvae (BSFL) (*Hermetia illucens* sp.) can live in both temperate and tropical climates. The female black soldier fly will lay up to 500 eggs in decomposed matter such as kitchen waste, garbage, and other organic waste. These larvae are often used in research on animal feed. Many positive feedbacks from other research indicated that BSFL might be a healthy nutritional source for layer hens and broiler chickens (Jansen, 2018). Black soldier larvae have a high protein material. Defatted BSFL meal, according to Schiavone, is an excellent source of apparent metabolized energy and digestible amino acid for broilers with highly efficient nutrient digestion. (Schiavone et al., 2015).

Water spinach, fermented coconut dregs, and turmeric are also high in protein. These local ingredients are easy to obtain and grow. Furthermore, turmeric is a medicinal plant that provides an alternate source of natural antibiotics to feed poultry (Mahesh Manjunath Gouda & Yashodhar Prabhakar Bhandary, 2018).

1.2 Problem Statement

The most common issue that farmers face is high feed costs. Soybean meal, cornmeal, and fishmeal are all expensive, but they contain high-quality protein recommended for poultry feed formulation. BSFL is an edible insect used as animal feed due to its high protein content.

1.3 Hypothesis

1.3.1 Hypothesis of Haematological Analysis on Broiler Blood

H^o = BSFL, fermented coconut dregs, water spinach, and turmeric have no significance effect on the haematology of broiler blood.

H^1 = BSFL, fermented coconut dregs, water spinach, and turmeric have significance effect on the haematology of broiler blood.

1.3.2 Hypothesis of Physicochemical Properties of Broiler Meat

H^o = BSFL, fermented coconut dregs, water spinach, and turmeric causes no significance changes on the physicochemical properties of broiler meat.

H^1 = BSFL, fermented coconut dregs, water spinach, and turmeric causes significance changes on the physicochemical properties of broiler meat.

1.3.3 Hypothesis of proximate Analysis of Broiler Meat

H^o = BSFL, fermented coconut dregs, water spinach, and turmeric causes no significance changes on the proximate of broiler meat.

H^1 = BSFL, fermented coconut dregs, water spinach, and turmeric causes significance changes on the proximate of broiler meat.

1.3.4 Hypothesis on Sensory Evaluation on Broiler Meat

H^o = BSFL, water spinach, fermented coconut dregs and turmeric causes no significance effect in the sensory evaluation of broiler meat.

H^1 = BSFL, water spinach, fermented coconut dregs and turmeric causes significance changes in the sensory evaluation of broiler meat.

1.4 Scope of The Study

This research was focused on animal nutrition. This is because the experiment included testing new formulated feed from BSFL, water spinach, fermented coconut dregs, and turmeric as a protein source in broiler chicken and evaluating haematological analysis of blood to determine the state of health the broiler chicken. Lastly, it will improve meat quality of physicochemical properties, proximate analysis, and sensory in broiler chicken.

1.5 Limitation of The Study

The limitation of this study is that the weather on the east coast of Malaysia can be unpredictable, such as sudden scorching hot weather and cold environment due to heavy rain and monsoon that cause stress to the broiler chicken.

Next, the lack of laboratory equipment available for the experiment causes discrepancies in the accuracy of results that will affect data eligibility. For example, the kjeldahl machine that was used every day will cause inaccurate data.

1.6 Objectives

1. To determine the effect of BSFL, fermented coconut dregs, water spinach, and turmeric on the haematology on broiler chicken.
2. To evaluate the effect of BSFL, fermented coconut dregs, water spinach, and turmeric on the meat quality of physicochemical properties and proximate analysis of broiler meat.
3. To observe the effect of BSFL, fermented coconut dregs water spinach, and turmeric on the sensory evaluation on broiler meat.

CHAPTER 2

LITERATURE REVIEW

2.1 Production of Broiler Chicken in Malaysia

Malaysian broiler chicken production contributes significantly to the Malaysian economy and meets the needs of Malaysian consumers by providing a low-cost protein source to the country's multi-ethnic population (Abdurofi et al., 2017). Chicken meat is the most famous meat protein because there is no dietary prohibition against chicken meat consumption (DVS, 2012). In 2012, the percentage of broiler meat consumption reached 96% in Peninsular Malaysia, compared to other poultry meat such as duck and other, they only reached 1% to 3% of consumption in Malaysia (Agrofood Statistic, 2013). Thus, broiler meat production should be proportional to the demand for broiler meat. The broiler industry should be continually produced to sustain profit and reasonable price of the chicken meat (Abdurofi et al., 2017). The amount of broiler meat in 2012 was 637.00 million birds and 673.87 million for day-old chick (DOC). In 2013, an increasing number of broiler production happened, which was 770.22 million DOC and 720.11 million broilers (Department of Veterinary Service, 2012).

2.2 Nutrient Requirements for Broiler Chicken

The vital nutrient requirements for birds vary according to their age (starter, grower, finisher), breed, and development mode (meat or egg producer). The amount of metabolized energy and crude protein supplied by their diet are two factors that influence broiler efficiency (Zaman et al., 2008). The presence of arginine and lysine promotes faster development (Chamruspollert et al., 2002). The ratio of energy to protein in chicken diets is the primary concern during formulation to avoid weight loss (Aletor et al., 2000; Nalle et al., 2012).

Table 2.1: Nutrient Requirements of Broiler Chicken in Feed Formulation.

No	Characteristics	Unit	Requirement for Broiler Feed (Starter)
1	Moisture	% by mass, Max	11
2	Crude Protein	% by mass, Min	22
3	Ether Extract	% by mass, Min	3.5
4	Crude Fiber	% by mass, Max	5.0
5	Acid insoluble ash	% by mass, Max	2.5
6	Salt	% by mass, Max	0.5
7	Calcium	% by mass, Min	1.0
8	Total Phosphorus	% by mass, Min	0.7
9	Lysine	% by mass, Min	1.2

10	Methionine	% by mass, Min	0.5
11	Methionine + Cystine	% by mass, Min	0.9
12	Metabolise Energy	(Kcal/kg), Min	3100
13	Aflatoxin B_1	Ppb, Max	20

Source : Reddy (2017), Specification of Feed Ingredients and Finished Feeds and BisStandards

2.3 Black Soldier Fly Larvae (BSFL)

Black soldier fly larvae (BSFL) are known to reduce the predominance and rearing of the housefly, which can lessen the conceivable spreading of diseases by the housefly (Bradley and Sheppard, 1984). Likewise, it is trusted that the BSF larvae can devour and process natural waste faster and more effective rate than the housefly larvae (Kim, Bae, Park, Choi, Han, and Koh, 2011). Commonly, the BSFL can be discovered all over South America and Asia, yet is local to Colombia (Canary and Gonzalez, 2012).

They can endure and adjust to a comprehensive exhibit of ecological temperatures (McCallan, 1974). These flies fall under the *Stratiomyidae* family and, in the wild, are usually found in environments appropriate for larval development, for example, marshlands and moist places with animal waste, spoiled fruits, or any organic decomposed (Rozkošný, 1982; Li, Zheng, Qiu, Cai, Tomberlin, & Yu, 2011). The BSFL is not considered as a vermin animal group (Sheppard et al., 1994; Newton et al., 2005) since the grown-up fly does not eat or search for food and hence does not enter a place where human lives (Sheppard, Newton, Thompson, & Savage, 1994). The adult fly depends on the energy stores collected during the larval stage. Black soldier fly larvae are generous in a range of nutrients. Table 2.2 shows the basic nutritional value of 100g of dried BSFL.

Defatted BSFL meal, according to Schiavone et al. (2018), is a rich source of apparent metabolised energy and digestible amino acid for broilers with extremely effective nutrient digestion. BSFL includes a high concentration of important amino acids, such as lysine, which aids in animal growth and protein content (Shumo et al., 2019). Following that, BSFL are an excellent source of energy and protein (37% to 65% protein), and it has been suggested that their amino acid composition is more favourable for poultry (Barragan-Fonseca et al., 2017; Schiavone et al., 2017). BSFL may also provide health benefits to broilers. Some of the possible health advantages are derived from lauric acid, which accounts for up to 64% of the BSFL's total saturated fatty acid composition. Fortuoso et al. (2019) and Londok and Rompis (2019) studied the possible benefits of including 0.03 percent and 2.6 percent lauric acid in broiler diets, respectively, and discovered a significant reduction in Escherichia coli and total bacterial counts in excreta samples, improving intestinal health as well as broiler performance. Similarly, an in vitro investigation found that BSFL micro compounds can inhibit the growth of a potentially harmful microbes (Park et al., 2014).

Table 2.2: Basic Nutritional Value in 100g of dried BSFL.

Nutrient	Nutritional Value (%)
Protein	50
Fat	35
Calcium	6
Phosphorus	1.2
Magnesium	1
Sodium	0.3

Source: Farm (2020), Nutritional Value of Black Soldier Fly Larvae

2.4 Fermented Coconut Dreg

Coconut (*Cocos nucifera*), also known as copra, are one of the most common crops in the tropics and is thought to have originated somewhere in Indo-Malaya. Coconut flesh is rich in fat and can be consumed fresh or dried. The nut's liquid is used in drinks. Based on the Malaysian Agricultural Research and Development Institute (MARDI), Malaysia is one of the top ten coconut producers globally, although production fell between 2014 and 2016. Coconut meal is the meal that remains after extracting the oil from the dried endosperm of the coconut. In many tropical countries, coconut meal is an essential protein supplement for livestock. It contains approximately 25% to 30% crude protein, 10% crude fibre, and 70% to 75% of total digestible nutrients (TDN) (Coconut meal | Dairy Information Portal, 2021). The oil content of coconut meal ranges between

2.5% to 6.5%. Meals with a higher oil content are incredibly beneficial in preparing high-calorie diets. Since it is available at a low cost in some areas, copra meal can be a valuable raw material in poultry diets.

Coconut dreg fermentation could boost growth performance, carcass percentage, faecal dry matter, dry matter digestibility, and digestible dry matter intake (Sundu et al., 2019). Furthermore, a study on the effect of fermentation period of coconut dregs found that fermenting coconut dregs for 5 days boosted body weight gain (Hafsah et al., 2020).

2.5 Water Spinach

This tropical plant is known as *kangkong* in Southeast Asia, while in English as water spinach, river spinach, water morning glory, water convolvulus has the scientific name *Ipomoea Aquatica* that belong to the *Convolvulaceae* family. This plant has no known origin, but it can be quickly grown in a wet area because it is a 20 semi-aquatic plant that can be found easily throughout the tropical and subtropical region of the world, especially in the rural or villages areas. This plant's reproductive parts are both sexually and asexually where the seeds are sexually and asexually by the rooting at the nodes or by fragmentation, and the propagation is by seeds and cuttings. Water spinach can relish heat, humidity, water, and nutrient. This plant requires an optimal temperature of around 20°C to 30°C. Water spinach cannot grow when the temperature is below that temperature.

In rural Cambodia, smallholders usually use water spinach as a substitute mixed with rice bran to feed their scavenging poultry. The use of water spinach for local chickens suggests that it is also favoured foliage for providing protein and vitamins to growing chickens (Saroeun, 2010). According to Nguyen Thi Thuy and Ogle (2005), when layer chickens were given green feed, such as water spinach, the colour of their skin and egg yolk improved, making the products more appealing to consumers. Thus, Table 2.3 shows the main proximate analysis of water spinach.

Table 2.3: The Main Analysis of Water Spinach

Main Analysis (%)	Fresh leaves and shoots	Fresh Leaves	Fresh Whole Plant
Crude Protein	34.3	21.4	18.8
Crude Fibre	10.2	14.2	20.9
Ether Extract	3.9	2.9	2.1
Ash	12.9	18.3	18.2

Source: Payne (1956), Khuc Thi Hue et al. (2006), Bartha (1970)

2.6 Turmeric

Turmeric, turmeric root, and Indian saffron are the shared names, or its scientific name is *Curcuma longa* is a rhizomatous herbaceous perennial plant of the ginger family *Zingiberaceae*. The turmeric extract is a yellow-orange polyphenol, and its usual form is a dry yellow powder that is oil-soluble in its natural state. Curcumin, a polyphenolic phytochemical with anti-microbial, anti-inflammatory, anti-cancer, and antioxidant properties, is produced by turmeric. According to recent studies, the effectiveness of turmeric in poultry feed to replace antibiotic use has been suggested by Mahesh Manjunath Gouda & Yashodhar Prabhakar Bhandary (2018). It was discovered that using turmeric rhizome powder in the poultry diet reduced morbidity and mortality in broiler chickens. It has also been shown that turmeric in poultry feed is beneficial to public health and has no adverse side effects.

According to an article-title Dietary Addition of a Standardized Extract Of Turmeric (Turmafeedtm) Improves Growth Performance And Carcass Quality Of Broilers (2018), the dietary addition formulation of lipophilic turmeric extract containing curcumin and turmerones improved the chicken's growth performance and health status. Turmeric, as a result, can be a good source of nutrition for poultry feed. Table below shwos the nutritional value in 100g of turmeric.

Table 2.4: Nutritional Value in 100g of Turmeric

Nutrient	Nutritional Value (g)
Carbohydrate	21
Dietary Fibre	21
Protein	8
Total Fat	10
Calcium	0.2
Sodium	0.01
Potassium	2.5
Iron	47.5

Source: Prasad & Aggarwal (2013), Turmeric, the Golden Spice.

2.7 Haematology in Poultry Chicken

The blood composition of broiler chicken consists of various cells to make up the blood tissue. The red blood cell (RBC), haemoglobin (HGB) haematocrit (HTC), mean corpuscular volume (MCV), mean corpuscular haemoglobin concentration (MCHC), mean haemoglobin concentration (MHC), white blood cell (WBC), lymphocyte (LYM) and monocyte (MON). Within the blood composition existed a blood serum. Blood serum comprises other components such as protein, albumin, globulin, and creatinine. As such, the protein content of the serum was dependent on the protein gained from the consumption of feed (Scanes, 2015). There had been researched conducted investigating on the effect investigating on the relation of blood serum to animals infected with the disease, and the result had shown that a higher amount of globulin within the serum indicated that there was higher production of antibodies against the disease (Tothova, Nagy, & Kovac, 2016).

Haematology was science regarding numbers of blood constituents and morphology as well as metabolites in the blood. Blood metabolites and volume of constituents vary from one to another as they are affected by a wide variety of factors such as species, age, size, feed, and health. Typically, red blood cell (RBC) was correlated with the quality of feed and nutrition it provides; however, if the level of monocyte within the blood falls, the animal may be affected by stress and become more prone to disease.

2.8 Meat Quality

In the meat industry, meat quality describes its overall characteristics, including its physical, chemical, biochemical, morphological, microbial, technological, sensory, hygienic, nutritional, and culinary properties (Ingr, 1989). Broiler mass production has already been achieved, and the emphasis is now on improving meat quality by modifying different aspects of broiler meat.

2.8.1 Physicochemical Properties

Food processing is required to increase product shelf life (Foods, 2022). All processing methods such as dehydration, heat treatment and extrusion cause changes in the physicochemical qualities and structure of the food, which might be desirable or undesirable. The physicochemical properties of food are mostly crucial for the end product's quality. Furthermore, measuring these properties is essential for design and quality control throughout food preparation.

The physicochemical properties of meat, such as water holding capacity, tenderness, pH, and colorimetric, are indispensable for processors involved in manufacturing value-added meat products.

2.8.2 Proximate Analysis

Proximate Analysis refers to a method for determining the levels of macronutrients in food samples (BÜCHI Labortechnik AG, 2017). Generally, those values are reported as nutritional facts, which are typically displayed on the labels of end food products, although they are also determined throughout the manufacturing process. Different techniques are used to determine dry matter (DM), crude protein (CP), ether extract (EE), and ash content.

2.9 Sensory Evaluation

Descriptive sensory evaluation methods provide a new technique for product development, research, and marketing. Furthermore, descriptive sensory evaluation methods involve a panel of assessors rather than a single expert; thus, the outcome indicates a consensus that is less subjective and less susceptible to bias than the outcome obtained when a single expert performs the evaluation (Penfield & Campbell, 1990). For sensory evaluation, appearance, texture, odour, and flavour are the most essential and perceptible meat features that influence consumers' initial and final quality judgment before and after purchasing a meat product.

CHAPTER 3

METHODOLOGY

3.1 Animal Feed Trial

A total of 50 broiler chickens was used and reared from day-old age until they reached the maturity stage of 5 weeks of age or 35 days. The animal feeding trial was conducted in Agro Techno Park, University Malaysia Kelantan, Jeli Campus. The broilers were divided into five groups: one control and four treatment diets. The feed ingredients for control, Treatment 1 (10% BSFL), Treatment 2 (15% BSFL), Treatment 3 (10% BSFL, fermented coconut dregs, water spinach and turmeric), and Treatment 4 (15% BSFL, fermented coconut dregs, water spinach and turmeric) were based on Farahin (2019). Each formulation was chosen based on the ratio obtained from the Winfeed software after the chemical composition was determined. The broilers were fed two times a day at 7 in the morning and 6 in the evening, respectively, until they reached a maturity of 5 weeks of age.

Table 3.1: Feed Ingredients Used for Animal Feed Trial

	Starter					Finisher				
Ingredients(g)	C	T1	T2	T3	T4	C	T1	T2	T3	T4
BSFL	NA	100	150	100	150	NA	100	150	100	150
Corn Meal	NA	425	400	320	290	NA	500	500	330	330
Soybean Meal	NA	336.2	400	320	290		280	225	200	150
Coconut Dreg	NA	0	0	100	100	NA	0	0	100	100
Water Spinach	NA	0	0	100	100	NA	0	0	100	100
Turmeric	NA	0	0	5	5	NA	0	0	5	5
Salt	NA	2.3	2.3	2.3	2.3	NA	2.3	2.3	2.3	2.3
Sodium Bicarbonate	NA	1.3	1.3	1.3	1.3	NA	1.3	1.3	1.3	1.3
Limestone	NA	12	12	12	12	NA	12.5	12.5	12.5	12.5
Dicalcium Phosphate	NA	10.5	10.5	10.5	10.5	NA	12	12	12	12
Methionine	NA	2.3	2.3	2.3	2.3	NA	1.9	1.9	1.9	1.9
Lysine	NA	5.4	5.8	5.4	5.8	NA	5	5	5	5
Canola Oil	NA	105	105	120	122.8	NA	85	90	130	130
ME (kcal/kg)	NA	3.31	3.27	3.15	3.12	NA	3.26	3.28	3.22	3.2
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

Source: Farahin (2019), Development of Optimal Feed Broiler Chicken Production Using Locally Available Ingredients.

3.2 Haematological Analysis

A haematological test was done on the blood samples collected from each respective group of broilers. Blood sampling was held when the broilers had reached five weeks of age. The broilers were restrained appropriately to ensure safe blood collection from the wings of the broiler by the vein under the wing using a needle and 1ml disposable capacity syringe. The collected blood was transferred into anti-coagulated vacutainer tubes and chilled at 4°C using an icebox or refrigerator (Sujata, Mohanty, & Malik 2014). The blood was kept cooled to delay the clotting process and was analysed in the haematology analyser machine. The blood reached the lab and was analysed within 24 hours after extraction from the broiler.

3.3 Meat Quality

3.3.1 Physicochemical Properties

The final quality of a product is primarily determined by its physicochemical properties. The pH value, water holding capacity (WHC), colorimetric, and tenderness of broiler meat were analysed in this experiment.

a. pH Value Determination of Meat

A digital pH meter was used to determine the pH of the meat sample. The meat was thinly sliced in the same form of meat grain and the pH of the meat was measured in triplicates. The data were recorded.

b. Water Holding Capacity

The water holding capacity method involves the gravimetric method or drip loss method. This method is also known as the Honikel bag method where it involves measuring the weight loss of the meat within a bag drip. The Honikel bag method was modified by hanging the meat in an enclosed 1.5 litre plastic water bottle using nylon string. 10g of meat samples were prepared and suspended within the bottle for three days in a cold room. Triplicates of each treatment were applied. The initial and final weight was recorded and calculated by the percentage of loss of weight sample over the period (Dikeman & Devine, 2014).

c. Colorimetric Analysis of Meat

The colorimetric index of broiler meat was determined by using CR-400 Chroma Meter, Konica Minolta. The meat sample was prepared, and the colorimeter was taken in the same form of the plane and meat grain position where the direction or surface grain of meat was in the same position to ensure the test was accurate. Each treatment was triplicated for an accurate result.

d. Tenderness of Meat

Texture profile analysis (TPA) of broiler meat was obtained by evaluating meat's tenderness (hardness). The machine used was Brookfield CT3 Texture Analyzer with a flat-faced cylindrical probe. 15 samples of 5 breast meat were cut into a large enough size and labelled accordingly to its sample. The direction and surface of the grain of meat were in the same position to ensure the test could be done with a constant variable applied, therefore producing results of more accurate value (Freeman & Freeman, 2015). The data was analyzed by using Duncan's multiple range tests.

3.3.2 Proximate Analysis

The proximate analysis was performed to determine the chemical composition of the broiler meats. These experiments determined the amount of crude protein, ether extract, and ash. These experiments were tested on five groups of meat from a different treatment. The breast part of broiler meat was analyzed to justify the nutrient content with three replicates.

a. Determination of Dry Matter (DM)

The dry matters of broiler meat are analysed by removing the moisture of the meat. Moisture Analyzer MX-50 was used to measure the moisture content of broiler meat. Dry matter was obtained by subtracting the percentage of moisture content.

The percentage of dry matter (DM):

DM (%) = 100 – Moisture (%)

b. Determination of Crude Protein (CP)

Based on AOAC official, the Kjeldahl method was used to determine the crude protein content of broiler meat by measuring the amount of nitrogen content. The VAPODEST 50s Gerhardt Analytical Systems machine was used to measure the protein content. This method involves three primary steps: digestion, distillation, and titration methods. Below is the formulation and calculation on how to get the percentage of crude protein.

The percentage of nitrogen in fried sample:

$$\boldsymbol{N}(\%) = \frac{(\boldsymbol{V1}-\boldsymbol{V2})\times\boldsymbol{N}\times\mathbf{14.01}}{\boldsymbol{W}} \times \mathbf{100}$$

Where:

V1 = The volume of titration (ml)

V0 = The volume of blank titration (ml)

N = The concentration of hydrochloric acid (HCL) (0.1 M)

W = The weight of sample (mg)

The percentage of crude protein (CP):

CP (%) = N (%) × 6.25

c. Determination of Ether Extract (EE)

Ether extract analysis is a method the measures the number of fats and oils inside of them. Soxhlet method was used to determine crude fat inside the broiler meat samples. In this experiment, Foss Soxtec 2055 machine was used, and the apparatus includes three major components: an extractor, condenser, and a round bottom flask.

To measure crude fat (%):

$$\textbf{Crude Fat (\%)} = \frac{W3-W2}{W1} \times 100$$

Where:

W1 = The weight of sample (g)

W2 = The weight of empty flask (g)

W3 = The weight of flask with extract (g)

d. Determination of Ash

Ash is the inorganic residue remaining after the water and organic materials have been removed from a food, and it provides a measure of the overall amount of minerals in the food (Analysis of Ash and Minerals, 2021). Heating was the most common method for determining ash content. W1 was the weight of the empty crucible, and W2 was the weight of the broiler meat sample (W2). The broiler meat sample was placed in an empty crucible and burned for 8 hours at 550°C in a Muffle Furnace Prolite machine. The crucible was then removed and placed in a desiccator to cool until it reached room temperature. The crucible was then removed from the desiccator and the ash was measured (W3).

To measure the ash content (%):

$$\textbf{Ash (\%)} = \frac{W3-W1}{W2} \times 100$$

Where:

W1 = The weight of empty crucible (g)

W2 = The weight of broiler meat sample (g)

W3 = The weight of the crucible and ash (g)

3.5 Sensory Evaluation

Meat sensory evaluation offers methods for interpreting human perceptions of products. For accurate, repeatable sensory data, product, environment, and panellist control must be established and consistently applied through sensory methods. There are three basic sensory approaches; discriminative sensory evaluation, descriptive sensory evaluation, and consumer sensory evaluation (Miller, 2017). In this experiment, consumer sensory evaluation was used. Consumer acceptance testing aims to classify likes and dislikes for a specific collection of samples. Eighteen sets of sensory evaluation will be used and asked to indicate liking/disliking using hedonic scales to the consumers.

3.6 Data Analysis

Data were analysed via the usage of One-Way Anova Test, and with the usage of IBM SPSS Statistics 64 software, data calculation based on the effect of feeding BSFL, water spinach, fermented coconut dregs, and turmeric on blood plasma composition and meat quality on broiler chicken can be identified. Tukey's HSD (honestly significant difference) was used to compare the data collected and analysed except for the tenderness and mean corpuscular haemoglobin (MCH) (Duncan's Multiple Range Test). All the data were analysed and assessed ($P<0.05$) significant difference

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Haematological Parameter of Broiler Meat

In order to analyse the data on haematological parameters of blood samples from broiler meat, the blood samples are analysed using a Haematology analyser, and the result is as shown in Table 4.1 after applying statistical analysis in SPSS. Table 4.1 shows the mean and standard error of haematological parameters broiler meat of red blood cell (RBC), haemoglobin (HGB), haematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), Mean corpuscular haemoglobin concentration (MCHC), white blood cell (WBC), lymphocyte (LYM) and monocyte (MON). Between all the parameters stated, only white blood cells did not have a significant different $p<0.05$. The p-value for white blood cells is 0.57. The highest mean for red blood cells is Treatment 1 (2.45), followed by Treatment 2, Treatment 3, Treatment 4, and Control. The highest mean for haemoglobin is Treatment 2 (13.40), followed by Treatment 1, Treatment 4, Treatment 3, and Control. Lastly, the highest mean for white blood cells is Treatment 2 (115.87), followed by Treatment 1, Treatment 4, Control, and Treatment 3.

Table 4.1: The Mean and Standard Error of blood parameters on broiler.

Parameter	**Group**					**p-value**
	Control	**Treatment 1**	**Treatment 2**	**Treatment 3**	**Treatment 4**	
RBC(×10^6/µL)	0.86±0.00^{a}	2.45±0.34^{a}	2.43±0.05^{a}	1.27±0.04^{a}	1.30±0.00^{a}	0.00
HGB(g/dL)	4.80±0.00^{a}	13.27±1.09^{c}	13.40±0.10^{c}	6.90±0.30^{a}	10.00±0.00^{b}	0.00
HCT (%)	11.70±0.00^{a}	37.07±3.05^{b}	32.07±0.17^{b}	16.97±0.50^{a}	16.30±0.00^{a}	0.00
MCV(µm^3)	136.00±0.00^{bc}	138.43±0.64^{c}	133.23±2.33^{bc}	129.73±2.63a^{b}	125.40±0.00^{a}	0.01
MCH(pg)	55.80±0.00^{b}	51.93±0.90^{c}	55.60±0.80^{bc}	54.23±1.50^{bc}	43.10±0.00^{a}	0.00
MCHC(g/dL)	41.00±0.00^{c}	37.14±0.83^{b}	41.80±0.10^{c}	41.77±0.33^{c}	34.40±0.00^{a}	0.00
WBC(10^3/mm^{3})	105.80±0.00	115.60±4.00	115.87±0.52	103.40±13.92	111.80±0.00	0.57
LYM (%)	94.80±0.00^{b}	65.53±2.96^{a}	65.87±0.52^{a}	94.93±1.35^{b}	105.70±0.00^{c}	0.00
MON (%)	4.60±0.00^{a}	23.03±1.20^{b}	23.00±0.06^{b}	4.47±1.34^{c}	5.60±0.00^{c}	0.00

The value for significant difference is $p<0.05$.

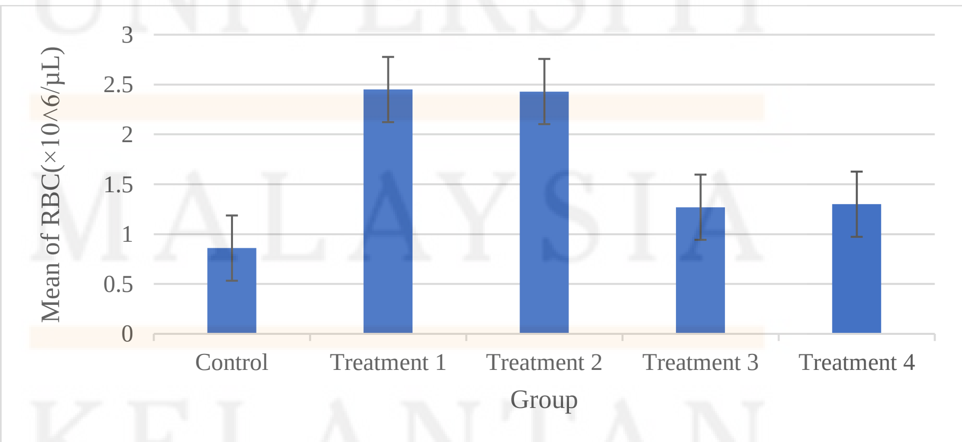


Figure 1: Mean and SEM error of RBC (×10^6/µL).

The optimum red blood cell count in broiler chicken is 2.5×10^3/µL to 3.5×10^3/µL (Devrim Saripinar Aksu et al., 2010). The values obtained from all treatments did not fit within the optimum range given in the experiment. The red blood cell counts in Treatments 1 and 2 are practically identical. The red blood cell count in Control is the lowest. The broiler chicken might be infected with the chicken anaemia virus because of low red blood cell count. Anaemia develops when inadequate healthy red blood cells (erythrocytes) are in a chicken's blood or when the chicken suffers either external or internal blood loss (Animal DVM LLC, 2014). This disease's signs are most typically noticed in young chicks. Infected chicken older than three or four weeks of age, on the other hand, usually does not result in clinical signs but might promote immunosuppression, leading to subsequent infections or economic losses even in the absence of disease evidence (Vicky, 2019). This is due to the fact that when seronegative adult hens become infected, no symptoms of disease or harmful effects on egg production appear (Overview of Chicken Anaemia Virus Infection: Chicken Anaemia Virus Infection: Merck Veterinary Manual, 2012).

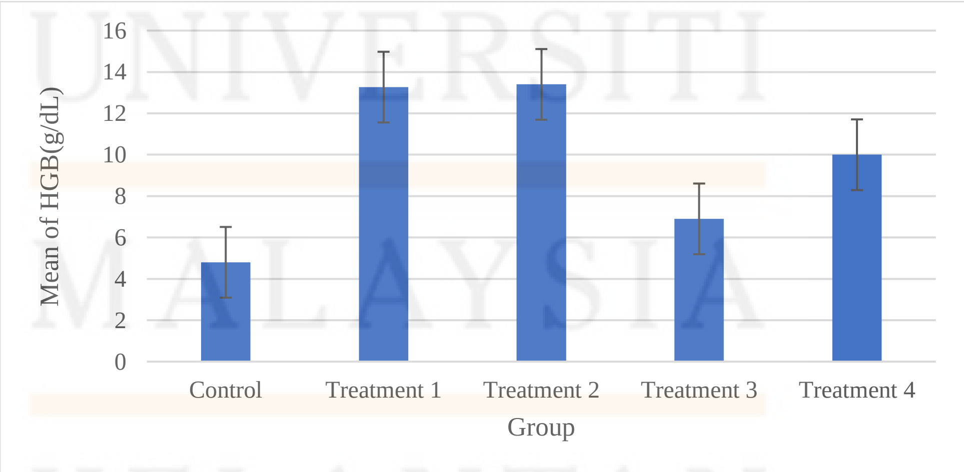


Figure 4.2: Mean and SEM error bar of HGB (g/dL).

The standard value of haemoglobin in chicken ranges from 7 g/dL to 13 g/dL (Devrim Saripinar Aksu et al., 2010). In general, haemoglobin is closely related to red blood cells (erythrocytes) and haematocrit responsible for binding oxygen compounds. Only Treatments 4 fits within the range stated. Treatment 1, Treatment 2 and Treatment 3 were varied slightly from the standard value. However, Control has the lowest value of haemoglobin. The most prevalent cause of anaemia is a deficiency of iron in the body. This is known as iron deficiency anaemia. Animals could not produce haemoglobin if they did not consume enough iron. Hill and Matrone (1961) did a study on Copper and Iron Deficiencies in Growing Chickens, and the results show that the immediate consequence of iron shortage was a decrease in haemoglobin content of the erythrocyte.

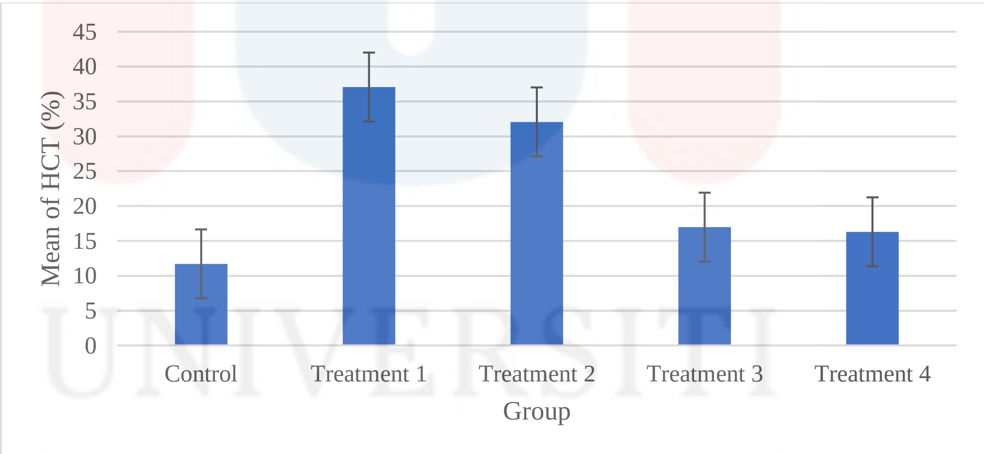


Figure 4.3: Mean and SEM error bar of HCT (%).

Haematocrit (HCT), also known as Packed Cell Volume (PCV), is linked with red blood cells since it quantifies the proportion of red blood cells in the blood. The presence of too few or too many red blood cells can indicate the presence of certain disorders. The optimum value for HCT is 22% to 35% (Devrim Saripinar Aksu et al., 2010). Control, Treatment 3 and Treatment 4 have a deficient value of HCT. Based on Farahin (2019), the amount of iron used in the feed formulation might be small and lower the red blood cell count. Therefore, the HCT was also low. High HCT and high HGB are indicators of high feed conversion efficiency (Nyaulingo, 2013). Thus, low HCT and HGB are indicators of low feed conversion efficiency.

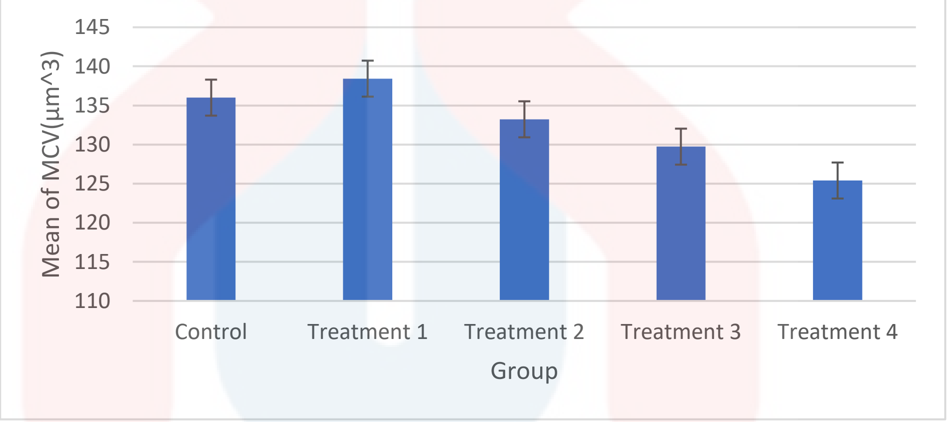


Figure 4.4: Mean and SEM error bar of MCV (µm^3).

Mean corpuscular volume (MCV) measures the average size of red blood cells, also known as erythrocytes. The average MCV value is 90 µm^3 to 143 µm^3. All groups were in the standard ranges of MCV. Thus, the broiler has an average size of red blood cells. However, a broiler with a normal MCV can be anaemic if insufficient red blood cells or other RBC indices are abnormal. Aside from the chicken anaemia virus, the broiler could have normocytic anaemia. Normocytic anaemia is defined as low haemoglobin and haematocrit levels but a normal MCV (Maner & Moosavi, 2021).

Normocytic anaemia occurs when the RBC is normal in size and haemoglobin content but have too few of them (Epstein, 2012). According to Chandra et al. (1984), normocytic anaemia is characterised by a decrease in total erythrocyte counts, haemoglobin, packed cell volume, and an increase in erythrocyte sedimentation rate.

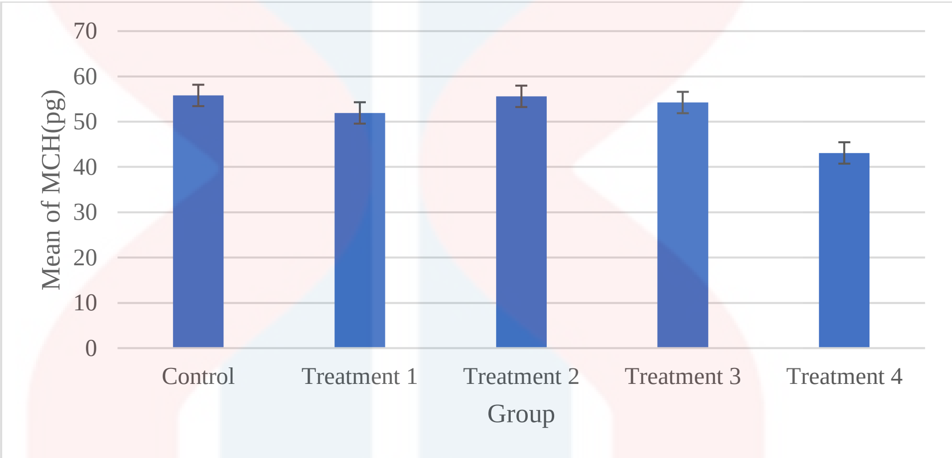


Figure 4.5: Mean and SEM error bar of MCH (pg).

Mean Corpuscular Haemoglobin (MCH) measure of the mean of haemoglobin in a single erythrocyte (Samour, 2009). As a result, the value of MCH reflects the haemoglobin content of the RBC. However, variations in MCH value are caused by a variety of factors, including nutritional status, production efficiency, and the animal's genetic makeup. In short, this is a crucial factor in identifying the types of anaemia. Normal MCH value is 33 to 47 pg (Devrim Saripinar Aksu et al., 2010). However, based on the experiment conducted, only Treatment 4 within the ranges and other groups were slightly higher than usual.

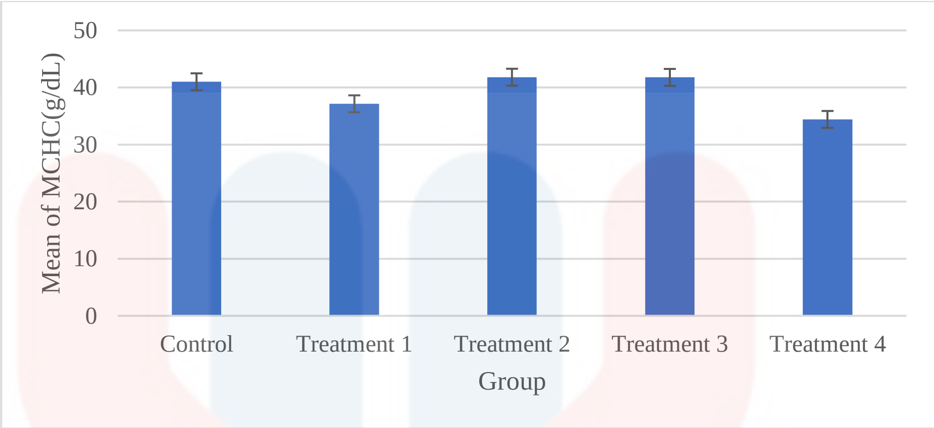


Figure 4.6: Mean and SEM error bar of MCHC (g/dL).

Mean Corpuscular Haemoglobin Concentration (MCHC), in contrast to MCH, is the mean concentration of haemoglobin or the haemoglobin content per unit volume of red blood cells. In the broiler, the normal range for MCHC is 26 g/dL to 35 g/dL. Only Treatment 4 fit within the specified value. Other groups had slightly higher than average values. A high MCH value frequently indicates anaemia.

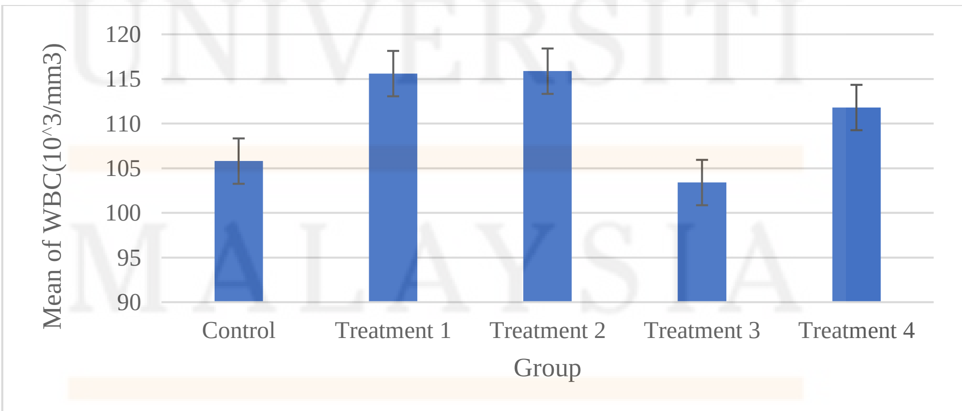


Figure 4.7: Mean and SEM error bar of WBC (10^3/mm3).

Total leukocyte counts are a significant determinant in indicating health abnormalities if the count exceeds the maximum standard level, referred to as leucocytosis. Leucocytosis can be caused by various reasons, including trauma, infection, toxicity, haemorrhages, leukaemia, and rapidly growing neoplasms within the body (Pare, 1997). The number of leukocytes varies and constantly changes due to various circumstances, including stress, hormones, and disease.

The optimum value for white blood cell (WBC) ranges from 11.40×10^{3}/mm3 to 30×10^{3}/mm3 (Swenson, 1984; Orawan and Aengwanich, 2007). The findings in the experiment demonstrate that the values for all treatments were significantly higher than the standard value, which ranged from 103.40×10^{3}/mm3 to 115.68×10^{3}/mm3. As a result, the broiler might well be infected with illnesses. The increased leukocyte count suggests a humoral and cellular response to the pathogenic agent causing illness. According to Moyes and Schute (2008) and Soeharsono et al. (2010), animal health can be determined by total leukocyte because increasing leukocyte is a criterion of body immune and decreasing leukocyte may translate into no infection or pathogenic bacteria in the body. Bacterial infection can lead to health problems, as seen by an increase in WBC.

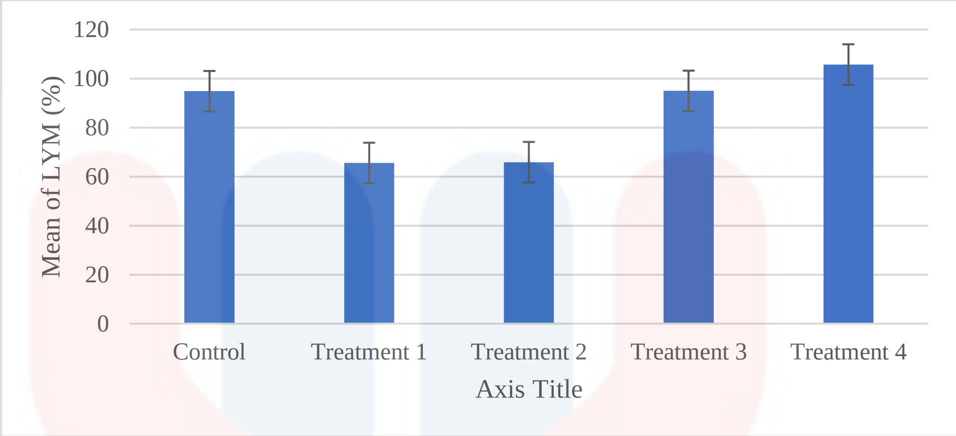


Figure 4.8: Mean and SEM error bar of LYM (%).

According to Makeri (2017), the amount of LYM found in broiler is higher than the normal range of 50% to 62%. According to Olson (1965), variations in the number of leukocytes are associated with numerous diseases that increase the number of lymphocytes. Because of the high lymphocyte count, the broiler's blood could be infected with diseases or cancer. Curcumin, found in turmeric, is a robust immune system booster in chicken, benefiting overall chicken health and well-being. It also functions as an anti-inflammatory agent, which is beneficial in bumblefoot or other inflamed injuries in chicken (Kerrie, 2016). However, because LYM levels in the blood are high, the presence of turmeric in feed ingredients did not affect broiler health. This could be since the turmeric used in the animal feed trial was insufficient.

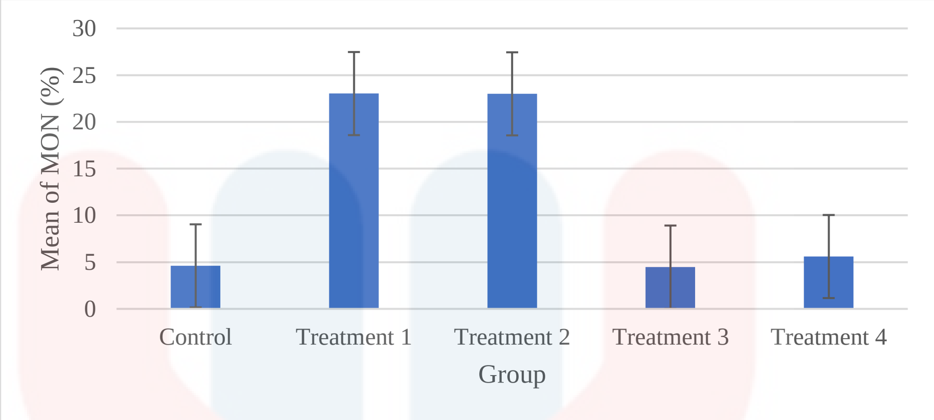


Figure 4.9: Mean and SEM error bar of MON (%).

Monocytes (MON) are developed from leukocytes produced in the bone marrow and circulate throughout the body via the blood and spleen (Chiu & Bharat, n.d.). A healthy number of MON in the body allows the immune system to act against specific infections, assisting other WBC in the clearance of dead and damaged tissues and immunity 31 against external substances. When it comes to the role of monocytes as a defensive mechanism in the immune response to foreign substances, monocytes are recognized for their phagocytic involvement in immune response systems, as well as their potential to transform into macrophages as they migrate across tissues (Harmon and Blisson, 1990). The percentage of MON in Treatment 1 and 2 are far higher than in Control, Treatment 3 and Treatment 4.

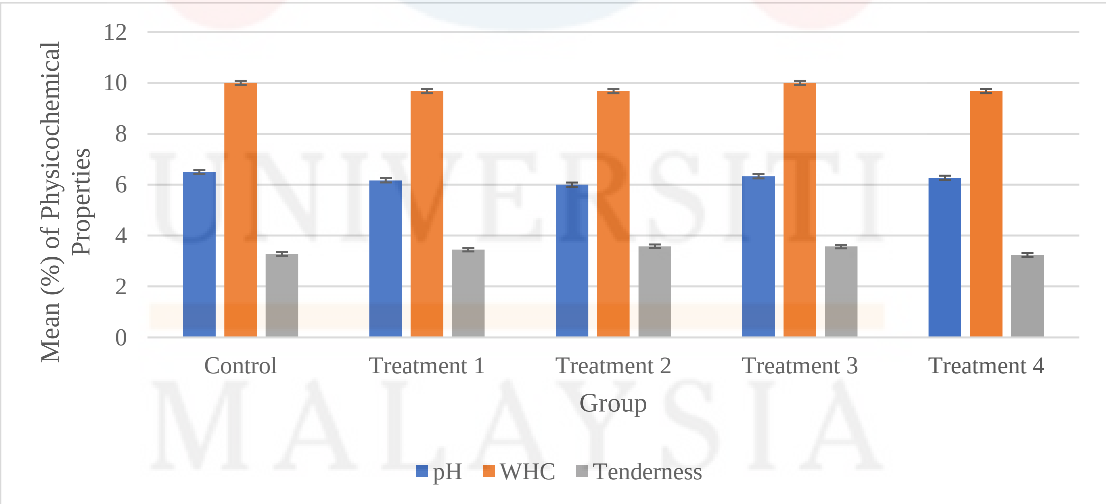
4.2 Physicochemical Properties of Broiler Meat

Physicochemical properties of meat cover a considerable percentage in determining acceptance of the product within the public market where it is closely related to the nutritional and commercial value (Li et al., 2011). Table 4.2 shows mean and standard error of physicochemical properties broiler meat of pH value, water holding capacity (WHC), colour (L*: lightness, a*: redness and b*: yellowness) and tenderness. Based on the experiment, only water holding capacity and colour (b*) do not have significantly different ($p>0.05$). The mean for WHC in Treatment 1 and Treatment 4 is the highest, 10.00, compared to Control, Treatment 2, and Treatment 3, 9.67. Next, colorimetric analysis for L* in Treatment 1 (36.69) has the highest mean, followed by Treatment 2, Treatment 3, Treatment 4, and Control. Colorimetric analysis for a* in Treatment 1 and Treatment 2 has the highest mean, 4.74, followed by Treatment 4, Treatment 3, and Control. Colorimetric analysis for b* in Treatment 1 and Treatment 2 has the highest mean, 8.98, followed by Treatment 4, Treatment 3, and Control. For tenderness, the highest mean is Treatment 2, followed by Treatment 3, Treatment 1, Control, and Treatment 4. Lastly, the highest mean for pH is Control followed by Treatment 3, Treatment 4, Treatment 1, and Treatment 2.

Table 4.2: The Mean and Standard Error of Physicochemical Properties of Broiler Meat.

Parameter	**Group**					**p-value**
	Control	**Treatment 1**	**Treatment 2**	**Treatment 3**	**Treatment 4**	
pH	6.50±0.06^{b}	6.17±0.12^{ab}	6.00±0.06^{a}	6.33±0.07^{ab}	6.27±0.03^{ab}	0.01
WHC	10.00±0.00	9.67±0.33	9.67±0.33	10.00±0.00	9.67±0.33	0.73
Tenderness	3.28±0.01^{a}	3.45±0.16^{ab}	3.58±0.06^{b}	3.57±0.02^{b}	3.24±0.06^{a}	0.04
Colour						
L*	31.25±0.35^{a}	36.69±1.15^{b}	34.67±1.47^{ab}	32.20±0.71^{a}	31.93±0.67^{a}	0.01
a*	3.51±0.12^{a}	4.74±0.30^{b}	4.74±0.30^{b}	4.17±0.15^{ab}	4.58±0.16^{b}	0.01
b*	8.03±0.20	8.98±0.29	8.98±0.29	8.27±0.44	8.29±0.47	0.27

The value for significant difference is $p<0.05$; L* = lightness; a* = redness; b* = yellowness.

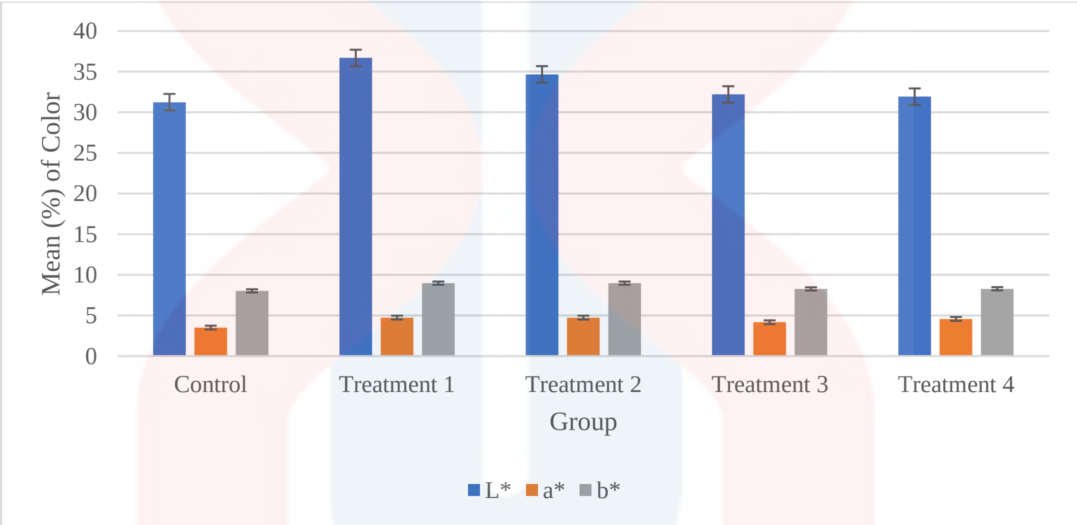


4.10: Mean and SEM error bar of pH, WHC and Tenderness of broiler meat.

According to various studies, the finest quality broiler breast meat products often fall within the ultimate pH range of 5.7 to 6.0 (Glamoclija et al., 2015). According to the experiment results, the values obtained from Treatment 2 are the only ones that fall within the earlier stated range. The following five treatments ranged from 6.17 to 6.50, slightly outside the indicated data range. The pH value for Control is the highest. The higher the pH levels, the greater the stress (Barrasso et al., 2021). The high pH value might come from the pre-slaughter and not from the feeding trial. Stress during the slaughter phase reduces muscle glycogen levels, resulting in a high final pH. (Tarrant et al., 1992). Furthermore, animals were subjected to slaughter in the hours leading up to stress, which resulted in less muscle glycogen.

Tenderness, water holding capacity, colour, juiciness, and shelf life are all affected by the pH value. Meat with a high pH value holds more water than meat with a lower pH value (Mir et al., 2017). According to the experiment results, all treatments had increased water holding capacity ranging from 9.67 to 10.00 since most treatments had a higher pH value. The Control has the highest pH value, resulting in a high-water holding capacity, whereas Treatment 2 has a low pH value, resulting in a low water holding capacity. Warner (2017) stated that meat with a high final pH did not shrink in the myofibrils and muscle cells after death. In contrast, meat with low pH and denatured proteins shrinks excessively, causing water loss in the myofibrils and muscle cells.

Lower final pH chicken meat has a lower water holding capacity, which affects cooking loss and drip loss, but meat with a higher final pH typically has improved tenderness (Froning et al. 1978, Barbut 1993). Treatment 2 had the highest tenderness, whereas Treatment 3 had the second lowest. Anything that interferes with the formation of rigour mortis or the subsequent softening process will affect meat tenderness. The broiler may struggle before or during slaughter, making their muscles spend more energy and rigour mortis to form faster than usual. Because the energy level in the living bird was reduced, the texture of these muscles is rough. Thus, it has low tenderness compared to other treatments.



L*: lightness, a*: redness, b*: yellowness.

4.11: Mean and SEM error bar of color.

Meat proteins with a low final pH have less water holding capacity and are lighter in colour. On the other hand, a higher ultimate pH will result in a darker color and less drip loss. Broiler meat lightness (L*) levels are divided into three categories: PSE (pale, soft, exudative), normal, and DFD (dark, firm, dry). PSE should be greater than 53, normal should be between 44 and 53, and DFD should be less than 44 (Kralik et al., 2014). According to analysis results, all treatments were DFD because the values obtained ranged from 31.25 to 36.69. Treatment 1's broiler meat is the darkest (a*=4.74). The effects could be harmful. When animals are subjected to chronic or long-term stress prior to slaughter, DFD meats might develop. Transportation of animals over large distances, protracted periods of food deprivation, and long-term crowding of animals in the lairage are all examples of chronic stress. Chronic stress before slaughter depletes stored glycogen, resulting in less glycogen accessible post-mortem, interfering with the natural acidification process and elevating the pH of meat (Adzitey & Nurul, 2011).

4.3 Proximate Analysis

Table 4.3 shows a mean and standard error of proximate analysis broiler meat of dry matter (DM), crude protein (CP), ether extract (EE), and ash content. The experiment conducted has a significant difference for all parameters in the proximate analysis ($p<0.05$).

Table 4.3: The mean and Standard Error of Proximate Analysis of Broiler Meat.

Parameter (%)	Group					p-value
	Control	Treatment 1	Treatment 2	Treatment 3	Treatment 4	
Dry Matter	87.72±0.13[a]	88.99±0.23[c]	88.77±0.12[bc]	88.88±0.00[c]	88.23±0.05[ab]	0.00
Crude Protein	83.32±0.94[b]	75.74±0.25[a]	85.46±1.92[b]	95.32±1.19[c]	91.18±1.55[c]	0.00
Ether Extract	0.75±0.12[a]	5.34±0.07[c]	3.15±0.37[b]	9.55±0.64[d]	9.52±0.12[d]	0.00
Ash	0.43±0.11[a]	3.55±0.14[b]	3.30±0.08[b]	4.68±0.14[c]	4.40±0.02[c]	0.00

The value for significant difference is p<0.05.

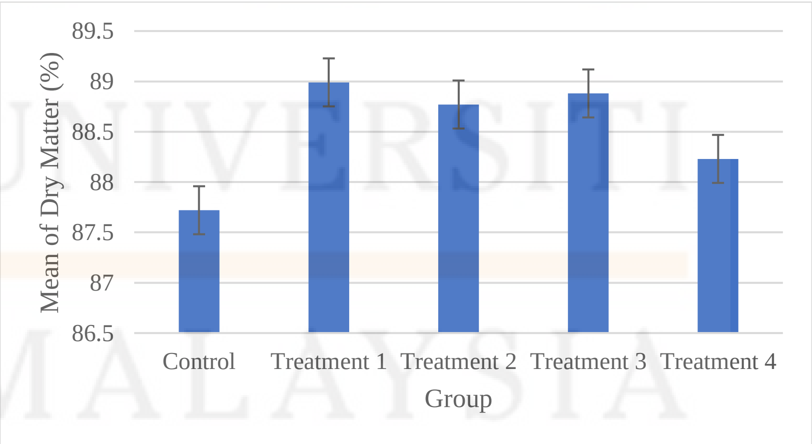


Figure 4.12: Mean and SEM error bar of DM (%).

The amount of dry matter in an animal's meat measures the amount of nutrients available. After removing all moisture, dry matter is fibre, protein, minerals, carbohydrates, and other nutrients (Wiersma, 2020). Based on the table, dry matter in Control is 87.72. The percentage of dry matter of each treatment group is slightly different from the Control. BSFL content in Treatment 1 and Treatment 3 is only 10% and BSFL content in Treatment 2 and 4 is 15%. However, the highest dry matter is Treatment 1 (88.99), followed by Treatment 3, Treatment 2 and Treatment 4.

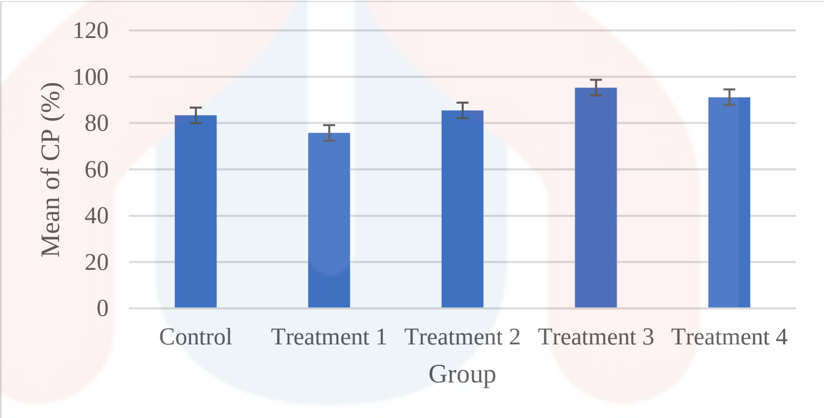


Figure 4.13: Mean and SEM error bar of CP (%).

The amount of protein in animal feed or a specific diet is crude protein. The nitrogen content of dietary proteins influences crude protein. Based on the Journal of Animal Research and Nutrition (2021), food manufacturers use crude protein content to calculate the number of carbohydrates in food. The mean for Control in crude protein is 83.32%. Treatment 2 had the closest value to Control which is 85.46%. The highest crude protein content in Treatment 3 with 95.32% and the lowest crude protein content is

Treatment 1 with 75.74%. Treatment 3 had the highest amount of carbohydrates in the meat. Even though Treatment 3 and Treatment 2 had the same percentage of BSFL, Treatment 3 has extra protein source ingredients of water spinach and coconut dregs.

However, the percentage of CP in all samples from the experiment conducted is invalid because the range of the %CP for broiler meat is around 20-24% (Panreac, n.d). There was a human error in this experiment; the digestion time should take more than four hours to digest the samples. However, in this experiment, the samples only digest one to two hours to digest. Even though the kjedahl method was conducted correctly, but the kjeldahl machine is used every day, the machine's efficiency is reduced.

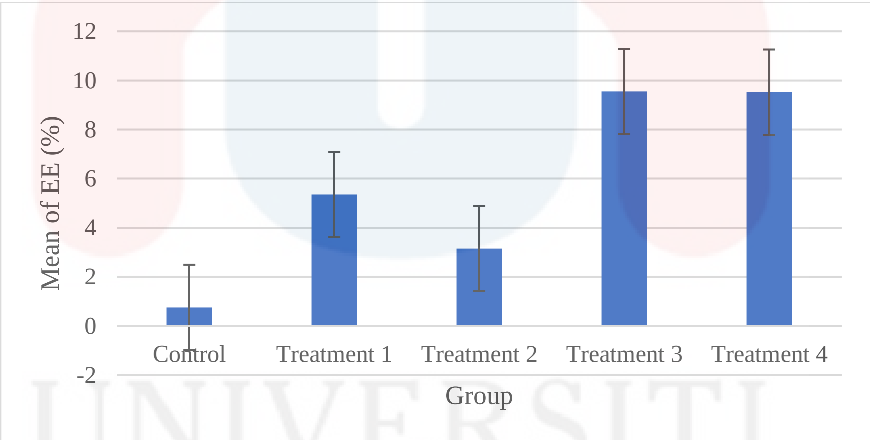


Figure 4.14: Mean and SEM error bar of EE (%).

The determination of ether extract (EE) is necessary for food manufacturers to declare fat content in their goods. It is also critical to properly check the fat level because it impacts its quality or value (Fat Determination - Home., 2022). Table 4.3 shows that ether extract for Control is the lowest, only 0.75%, followed by Treatment 2, Treatment

1, Treatment 4 and Treatment 3. The treatment group's value was so high with the ranges 3.15% to 9.55%. Treatment 3 and Treatment 4 have a higher ether extract content because of the use of coconut dregs and turmeric. These local ingredients also have crude fat content. The higher the fat content, the less appealing it is to the consumer. According to Song, Lin, Zhang, Hayat, Chen, Liu, Xiao, and Niu (2013), excessive fat content can reduce meat shelf life since excess fat can cause the meat to become rancid. Consumers prefer meat that is not rancid.

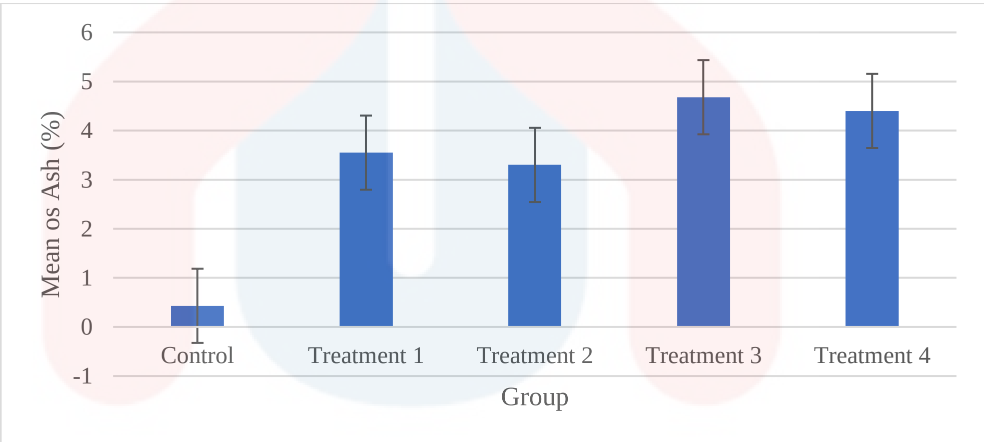


Figure 4.15: Mean and SEM error bar of ash (%).

The ash content of a food is determined as part of proximate analysis for nutritional evaluation, and it is a critical quality attribute for particular food ingredients. The determination of ash content in food simply removes organic content to reveal inorganic minerals. This aids in determining the amount and type of minerals present in food. It is significant because mineral content can influence the physiochemical qualities of foods and the growth of microbes (Moisture, Ash Testing in Food Processing, 2010).

As a result, mineral content, like quality and microbiological viability, is essential for food nutrition. Control has the lowest ash content with 0.43%, followed by Treatment 2, Treatment 1, Treatment 4 and Treatment 3. Treatment 3 and Treatment 4 have higher ash than Treatment 1 and Treatment 2 because of coconut dregs, water spinach, and turmeric. These local ingredients help to increase the ash content in the broiler meat. Baraem Ismail stated in his paper (Ash Level Determination, 2017) that the lower the ash concentration of the sample, the lower the minerals in the food product. As a result, Treatments 3 and 4 have more minerals. The use of these local ingredients can aid in producing low-cost animal feed.

4.4 Sensory Evaluation

Sensory evaluation is a scientific discipline that studies and examines human responses to food and drink compositions such as appearance, touch, odour, texture, temperature, and taste (Sensory evaluation - Food a fact of life, 2018). The sensory evaluation was conducted on raw meat and cooked meat. Raw meat consists of colour and odour while cooked meat consists of tenderness and flavour. Lastly, the overall acceptance of broiler meat for the consumers.

Table 4.4: The Mean and Standard Error of Sensory Evaluation of Broiler Meat.

Parameter	**Group**					**p-value**
	Control	**Treatment 1**	**Treatment 2**	**Treatment 3**	**Treatment 4**	
			Raw Meat			
Color	2.39±0.23[a]	1.61±0.20[ab]	2.28±0.28[b]	4.11±0.25[c]	3.61±0.24[c]	0.00
Odor	1.94±0.25	2.28±0.25	2.06±0.17	2.61±0.32	1.89±0.18	0.21
			Cooked Meat			
Tenderness	3.44±0.17	3.00±0.33	3.06±0.26	3.17±0.28	3.72±0.18	0.23
Flavor	3.06±0.24	3.17±0.24	3.11±0.23	3.33±0.14	3.50±0.23	0.58
Overall Acceptance	2.72±0.24	2.72±0.24	2.72±0.28	3.06±0.19	3.28±0.23	0.33

The value for significant difference is $p<0.05$.

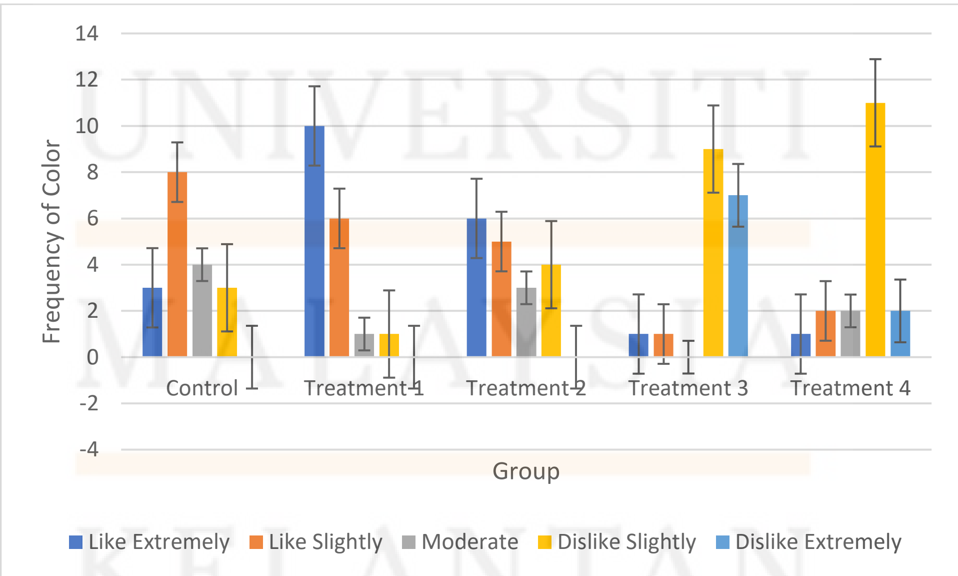


Figure 4.16: Frequency and SEM Error Bar of Colour of Broiler Meat.

Based on figure 4.17, Treatment 1 had the preferable colour on raw broiler meat with the highest frequency; 10 on like significantly and six on like slightly, followed by Control and Treatment 2. Treatment 3 and Treatment 4 had the least preferable for the consumers. After conducting statical analysis using One Way ANOVA, there was no significant difference $p<0.05$ for all groups except on colour of raw broiler meat. Thus, the feed trial did not affect the odour, tenderness and flavour of broiler meat.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

The study findings indicate that Treatment 2 (15% BSFL) was the suitable meat quality for the consumers. This is because Treatment 2 had the optimum pH value as pH value will influence other physicochemical properties in broiler meat. In term of haematology profile, Treatment 2 has the value closest to the standard value in broiler. Besides, in proximal analysis, Treatment 2 also had the closest value to Control when compared to the other treatments. Lastly, the sensory evaluation revealed that none of the treatment have a significant effect on the broiler meat. To conclude, BSFL can be recommended as an alternative to expensive protein feedstuff such as soybean meal.

For recommendation, addition of iron in feed ingredients could help to increase the red blood cell of broiler meat. Thus, it can lower the risk of anaemia diseases. Next, the feed should be palletised to make sure the animals get sufficient nutrition from their meals. Lastly, the availability of laboratory equipment should be widened to allow proper comparison of acquired data with existing research, such as Warner-Bratzler knife with guillotine block, which is most commonly used in determining meat tenderness.

REFERENCES

Adzitey, F., & Nurul, H. (2011). Pale soft exudative (PSE) and dark firm dry (DFD) meats: causes and measures to reduce these incidences -a mini review. International Food Research Journal, 18, 11–20. http://ifrj.upm.edu.my/18%20(01)%202011/(2)%20IFRJ-2010-091%20Nurul[1].pdf

Animal nutrition: the importance of feeding a balanced diet. (2017, May 9). Farm4Trade. https://www.farm4trade.com/animal-nutrition-feeding-balanced-diet/

AnimalDVM LLC. (2014). Anemia in Chickens. PoultryDVM; Anemia in Chickens. http://www.poultrydvm.com/condition/anemia

Atteh, J. O.; Ologbenla, F. D, 1993. Replacement of fish meal with maggots in broiler diets: effects on performance and nutrient retention. Nigerian J. Anim. Prod, 20: 44-4 Martin Koethe, K. W. (2018). Effects of lysine supplementation on Black Soldier Fly larvae. 1.

Barrasso, R., Ceci, E., Tufarelli, V., Casalino, G., Luposella, F., Fustinoni, F., Dimuccio, M. M., & Bozzo, G. (2021). Religious Slaughtering: Implications on pH and Temperature of Bovine Carcasses. Saudi Journal of Biological Sciences. https://doi.org/10.1016/j.sjbs.2021.12.002

Besana, A. T, Swe, K. H, Maw, A. A, & Aung, Y. L. (2020). Effects of supplementing water spinach (Ipomoea aquatica) to basal diet on growth performance and nutrients digestibility of broiler chickens. Journal of Livestock Science, 11(2). https://doi.org/10.33259/jlivestsci.2020.77-84

BÜCHI Labortechnik AG. (2017, September 29). *Proximate Analysis in Food Samples*. ResearchGate; BÜCHI Labortechnik AG. https://www.researchgate.net/institution/BUeCHI-Labortechnik-AG/post/Proximate-Analysis-in-Food-Samples-59ccf1ee217e20073a45f3d2

Chamruspollert, M, Pesti, G. M. & Bakalli, R. I, 2002. Dietary interrelationships among arginine, methionine, and lysine in young broiler chicks. Br. J. Nutr. 88, 655–660.

coconut | Description, Uses, & Facts | Britannica. (2021). In Encyclopædia Britannica. https://www.britannica.com/plant/coconut

Chandra, M., Singh, B., Singh, N., & Ahuja, S. P. (1984). Haematological Changes in Nephritis in Poultry Induced by Diets High in Protein, High in Calcium, Containing Urea, or Deficient in Vitamin A. Poultry Science, 63(4), 710–716. https://doi.org/10.3382/ps.0630710

Cherian, G. (2019, April 14). I. Introduction to Nutrition. Oregonstate.education; Oregon State University. https://open.oregonstate.education/animalnutrition/chapter/chapter-1/

Chinrasri Orawan, & Worapol Aengwanich. (2007, February). Blood Cell Characteristics, Hematological Values and Average Daily Gained Weight of Thai Indigenous, Thai... ResearchGate; Asian Network for Scientific Information. https://www.researchgate.net/publication/23650938_Blood_Cell_Characteristics_Hematological_Values_and_Average_Daily_Gained_Weight_of_Thai_Indigenous_Thai_Indigenous_Crossbred_and_Broiler_Chickens

Coconut meal | Dairy Knowledge Portal. (2021). Dairyknowledge.in. https://www.dairyknowledge.in/article/coconut-meal

Crude Fibre. (2017). Ucdavis.edu. https://anlab.ucdavis.edu/analysis/Feed/635

Crude Protein | List of High Impact Articles | PPts | Journals | Videos. (2021). Imedpub.com. https://www.imedpub.com/scholarly/crude-protein-journals-articles-ppts-list.php

Devrim Saripinar Aksu, Aksu, T., & B. Özsoy. (2010). The Effects of Lower Supplementation Levels of Organically Complexed Minerals (Zinc, Copper and Manganese). ResearchGate;unknown. https://www.researchgate.net/publication/286357350_The_Effects_of_Lower_Supplementation_Levels_of_Organically_Complexed_Minerals_Zinc_Copper_and_Manganese_Versus_Inorganic_Forms_on_Hematological_and_Biochemical_Parameters_in_Broilers

De Marco, M, Martínez, S, Hernandez, F, Madrid, J, Gai, F, Rotolo, L, Belforti, M, Bergero, D, Katz, H, Dabbou, S, Kovitvadhi, A, Zoccarato, I, Gasco, L. & Schiavone, A, 2015. Nutritional value of two insect larval meals (Tenebrio molitor and Hermetia illucens) for broiler chickens: Apparent nutrient digestibility, apparent ileal amino acid digestibility and apparent metabolizable energy. Anim. Feed Sci. Technol. 209, 211–218.

Epstein, J. (2012, June 15). RBC Indices. Healthline; Healthline Media. https://www.healthline.com/health/rbc-indices

Factors Affecting Poultry Meat Quality. (2021, December 31). Thepoultrysite.com. https://www.thepoultrysite.com/articles/factors-affecting-poultry-meat-quality

Farm, K. (2020, December 25). *Nutritional Value Of Black Soldier Fly Larvae | Kimmy Farm*. Kimmy Farm. https://kimmyfarm.com/en/nutritional-value-of-black-soldier-fly-larvae

Fat Determination - Home. (2022). Home. https://www.liquidline.se/methods/fat-determination/

Foods. (2022). Mdpi.com; https://www.mdpi.com/journal/foods/special_issues/Physicochemical_Properties_Structure_Changes_Food_Products_during_Processing#:~:text=The%20physicochemical%20properties%20of%20food,final%20quality%20of%20the%20product.&text=Physical%20and%20chemical%20changes%20in,%2C%20therefore%2C%20in%20the%20quality.

Glamoclija, N., Starcevic, M., Janjic, J., Ivanovic, J., Boskovic, M., Djordjevic, J., Markovic, R., & Baltic, M. Z. (2015). The Effect of Breed Line and Age on Measurements of pH-value as Meat Quality Parameter in Breast Muscles (m. Pectoralis Major) of Broiler Chickens. Procedia Food Science, 5(89 – 92), 89–92. https://doi.org/10.1016/j.profoo.2015.09.023

Grammelis, P., Margaritis, N., & Karampinis, E. (2016). Solid fuel types for energy generation. Fuel Flexible Energy Generation, 29–58. https://doi.org/10.1016/b978-1-78242-378-2.00002-x

Hill, C. H., & Matrone, G. (1961). Studies on Copper and Iron Deficiencies in Growing Chickens. The Journal of Nutrition, 73(4), 425–431. https://doi.org/10.1093/jn/73.4.425

Hwangbo, J, Hong, E. C, Jang, A, Kang, H. K, Oh, J. S, Kim, B. W, Park, B. S, Korea, S, Korea, S. & Korea, S, 2009. Utilization of house fly-maggots, a feed supplement in the production of broiler chickens. J. Enviro. Bio. 30, 609–614.

Kerrie. (2016, January 12). Turmeric for Your Hens? - CITY GIRL FARMING | Sustainable Living for Regular People. CITY GIRL FARMING | Sustainable Living for Regular People. https://citygirlfarming.com/2016/01/12/turmeric-for-your-hens/

Kralik, G., Ivona Djurkin Kušec, Kralik, Z., & Žarko Radišić. (2014, October). Quality indicators of broiler breast meat in relation to colour. ResearchGate; unknown. https://www.researchgate.net/publication/270888049_Quality_indicators_of_broiler_breast_meat_in_relation_to_colour

Kralik, G., Ivona Djurkin Kušec, Kralik, Z., & Žarko Radišić. (2014, October). Quality indicators of broiler breast meat in relation to colour. ResearchGate; unknown. https://www.researchgate.net/publication/270888049_Quality_indicators_of_broiler_breast_meat_in_relation_to_colour

Kroeckel, S, Harjes, A. G. E, Roth, I, Katz, H, Wuertz, S, Susenbeth, A. & Schulz, C, 2012. When a turbot catches a fly: Evaluation of a pre-pupae meal of the Black Soldier Fly (Hermetia illucens) as fish meal substitute – Growth performance and chitin degradation in juvenile turbot (Psetta maxima). Aquaculture 364-365, 345–352.

Magdelaine, P, Spiess, M.P, Valceschini, E, 2008. Poultry meat consumption trends in management system using the black soldier fly. Bioresour. Technol. 50, 275–279.

Mahesh Manjunath Gouda, & Yashodhar Prabhakar Bhandary. (2018). Natural antibiotic effect of turmeric in poultry management. International Journal of Poultry and Fisheries Sciences, 2(2). https://symbiosisonlinepublishing.com/poultry-fisheries-science/poultry-fisheries-science09.php

Makeri, H. K., Ayo, J. O., Aluwong, T., & Minka, N. S. (2017). Daily Rhythms of Blood Parameters in Broiler Chickens Reared under Tropical Climate Conditions. Journal of Circadian Rhythms, 15(1). https://doi.org/10.5334/jcr.151

Massimiliano Petracci, Betti, M., Bianchi, M., & Claudio, C. (2005). Color variation and characterization of broiler breast meat during processing in Italy. ResearchGate; Oxford University Press (OUP). https://www.researchgate.net/publication/8115440_Color_variation_and_characterization_of_broiler_breast_meat_during_processing_in_Italy

Mir, N. A., Rafiq, A., Kumar, F., Singh, V., & Shukla, V. (2017). Determinants of broiler chicken meat quality and factors affecting them: a review. Journal of Food Science and Technology, 54(10), 2997–3009. https://doi.org/10.1007/s13197-017-2789-z

Miller, R. K. (2017). The Eating Quality of Meat. Lawrie´S Meat Science, 461–499. https://doi.org/10.1016/b978-0-08-100694-8.00015-7

Moisture, Ash Testing in Food Processing. (2010, June 30). Dairyfoods.com; Dairy Foods. https://www.dairyfoods.com/articles/85312-moisture-ash-testing-in-food-processing

NM, J., Joseph, A., Maliakel, B., & IM, K. (2018). Dietary addition of a standardized extract of turmeric (TurmaFEEDTM) improves growth performance and carcass quality of broilers. Journal of Animal Science and Technology, 60(1). https://doi.org/10.1186/s40781-018-0167-7

Onyishi, G., Chinenye, Oguine, C., Chidera, Nwani, S., Iyidiobi, Aguzie, I., Oscar, Nwani, C., Didigwu, & Nwani, C. (2017). Haematological Parameters Dynamics Of Developing Gallus Gallus Domesticus. Animal Research International, 14(2), 2769–2776.

Overview of Chicken Anemia Virus Infection: Chicken Anemia Virus Infection: Merck Veterinary Manual. (2012). Archive.org. https://web.archive.org/web/20131125042946/http://www.merckmanuals.com/vet/poultry/chicken_anemia_virus_infection/overview_of_chicken_anemia_virus_infection.html

Penfield, M. P., & Campbell, A. M. (1990). PREPARING THE REPORT. *Experimental Food Science*, 78–93. https://doi.org/10.1016/b978-0-12-157920-3.50009-0

Prasad, S., & Aggarwal, B. B. (2013). *Turmeric, the Golden Spice*. Nih.gov; CRC Press/Taylor & Francis. https://www.ncbi.nlm.nih.gov/books/NBK92752/#:~:text=Nutritional%20analysis%20showed%20that%20100,total%20carbohydrates%2C%2021%20g%20dietary

Sci-Hub | Characteristics of Pale, Soft, Exudative Broiler Breast Meat | 10.1093/ps/79.7.1057. (2021). Yncjkj.com. https://sci-hub.yncjkj.com/10.1093/ps/79.7.1057

Sensory evaluation - Food a fact of life. (2018). Foodafactoflife.org.uk. http://archive.foodafactoflife.org.uk/Sheet.aspx?siteId=19§ionId=135&contentId=818

Sheppard, C, Newton, L, Thompson, S. A. & Savage, S, 1994. A value added manure

Shumo, M., Osuga, I. M., Khamis, F. M., Tanga, C. M., Fiaboe, K. K. M., Subramanian, S., Ekesi, S., van Huis, A., & Borgemeister, C. (2019). The nutritive value of black soldier fly larvae reared on common organic waste streams in Kenya. *Scientific Reports*, *9*(1). https://doi.org/10.1038/s41598-019-46603-z

Surendra, K. C, Olivier, R, Tomberlin, J. K, Jha, R. & Khanal, S. K, 2016. Bioconversion of organic wastes into biodiesel and animal feed via insect farming. Renew. Energy 98, 197–202.

Tarrant, P. V., Kenny, F. J., Harrington, D., & Murphy, M. (1992). Long distance transportation of steers to slaughter: effect of stocking density on physiology, behaviour and carcass quality. Livestock Production Science, 30(3), 223–238. https://doi.org/10.1016/s0301-6226(06)80012-6

Thiex, N., Novotny, L., & Crawford, A. (2012). Determination of Ash in Animal Feed: AOAC Official Method 942.05 Revisited. *Journal of AOAC INTERNATIONAL*, *95*(5), 1392–1397. https://doi.org/10.5740/jaoacint.12-12

Vicky. (2019, October 18). Chicken Anemia Virus Infection. MSD Veterinary Manual; MSD Veterinary Manual. https://www.msdvetmanual.com/poultry/chicken-anemia-virus-infection/chicken-anemia-virus-infection

Warner, R. D. (2017). The Eating Quality of Meat—IV Water-Holding Capacity and Juiciness. Lawrie´S Meat Science, 419–459. https://doi.org/10.1016/b978-0-08-100694-8.00014-5

Wiersma, D. (2020, February 10). Dry matter or moisture content — what's the difference? Hoards.com; Hoard's Dairyman. https://hoards.com/article-27110-dry-matter-or-moisture-content-&mdash-whats-the-difference.html

Zaman, Q. U, Mushtaq, T, Nawaz, H, Mirza, M. A, Mahmood, S, Ahmad, T, Babar, M. E. & Mushtaq, M. M. H, 2008. Effect of varying dietary energy and protein on broiler performance in hot climate. Anim. Feed Sci. Technol. 146, 302–312

APPENDIX A

SENSORY EVALUATION FORM

SENSORY EVALUATION OF CHICKEN MEAT

Meat sensory evaluation offers methods for interpreting human perceptions of products. The aim of consumer acceptance testing is to classify likes and dislikes for a specific collection of samples.

* Required

1. AGE *

Mark only one oval.

- 18-22
- 23-30
- 31 and Above

RAW MEAT

Please tick according to your preference.

2. Color *

Mark only one oval per row.

	1 (Like Extremely)	2 (Light Slightly)	3 (Moderate)	4 (Dislike Slightly)	5 (Dislike Extremely)
Control					
Treatment 1					
Treatment 2					
Treatment 3					
Treatment 4					

3. Odor *

Mark only one oval per row.

	1 (No off-odor)	2 (Slightly perceptible off-odor)	3 (Moderately perceptible off-odor)	4 (Very perceptible off-odor)	5 (Extremely perceptible off-odor)
Control					
Treatment 1					
Treatment 2					
Treatment 3					
Treatment 4					

COOKED MEAT

Please tick according to your preference.

4. Tenderness *

Mark only one oval per row.

	1 (Very soft)	2 (Slightly soft)	3 (Just right)	4 (Slightly hard)	5 (Very hard)
Control					
Treatment 1					
Treatment 2					
Treatment 3					
Treatment 4					

5. Flavor (Sweetness) *

Mark only one oval per row.

	1 (Too sweet)	2 (Slightly sweet)	3 (Just right)	4 (Slightly bland)	5 (Very bland)
Control					
Treatment 1					
Treatment 2					
Treatment 3					
Treatment 4					

GENERAL ACCEPTABILITY

Please tick according to your preference.

6. Overall Preferences *

Mark only one oval per row.

	1 (Like extremely)	2 (Like slightly)	3 (Moderate)	4 (Dislike slightly)	5 (Dislike extremely)
Control					
Treatment 1					
Treatment 2					
Treatment 3					
Treatment 4					

APPENDIX B

DESCRIPTIVE ANALYSIS AND ANOVA OF HEMATOLOGICAL ANALYSIS VIA SPSS

Oneway

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence ... Lower Bound
WBC	Control	3	105.8000	.00000	.00000	105.8000
	Treatment 1	3	115.6000	6.91592	3.99291	98.4199
	Treatment 2	3	115.8667	.90738	.52387	113.6126
	Treatment 3	3	103.4000	24.11556	13.92312	43.4936
	Treatment 4	3	111.8000	.00000	.00000	111.8000
	Total	15	110.4933	10.84774	2.80088	104.4861
LYM	Control	3	94.8000	.00000	.00000	94.8000
	Treatment 1	3	65.5333	5.11892	2.95541	52.8172
	Treatment 2	3	65.8667	.90738	.52387	63.6126
	Treatment 3	3	94.9333	2.34592	1.35442	89.1057
	Treatment 4	3	105.7000	.00000	.00000	105.7000
	Total	15	85.3667	17.25389	4.45493	75.8118
MON	Control	3	4.6000	.00000	.00000	4.6000
	Treatment 1	3	23.0333	2.07926	1.20046	17.8682
	Treatment 2	3	23.0000	.10000	.05774	22.7516
	Treatment 3	3	4.4667	2.31589	1.33708	-1.2863
	Treatment 4	3	5.6000	.00000	.00000	5.6000
	Total	15	12.1400	9.27638	2.39515	7.0029
RBC	Control	3	.8600	.00000	.00000	.8600
	Treatment 1	3	2.4500	.58412	.33724	.9990
	Treatment 2	3	2.4267	.08327	.04807	2.2198
	Treatment 3	3	1.2667	.06110	.03528	1.1149
	Treatment 4	3	1.3000	.00000	.00000	1.3000
	Total	15	1.6607	.71276	.18403	1.2660
HBG	Control	3	4.8000	.00000	.00000	4.8000
	Treatment 1	3	13.2667	1.89033	1.09138	8.5708
	Treatment 2	3	13.4000	.17321	.10000	12.9697
	Treatment 3	3	6.9000	.51962	.30000	5.6092
	Treatment 4	3	10.0000	.00000	.00000	10.0000
	Total	15	9.6733	3.61336	.93297	7.6723

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence ... Lower Bound
HCT	Control	3	11.7000	.00000	.00000	11.7000
	Treatment 1	3	37.0667	5.28425	3.05087	23.9399
	Treatment 2	3	32.0667	.28868	.16667	31.3496
	Treatment 3	3	16.9667	.87369	.50442	14.7963
	Treatment 4	3	16.3000	.00000	.00000	16.3000
	Total	15	22.8200	10.43423	2.69411	17.0417
MCV	Control	3	136.0000	.00000	.00000	136.0000
	Treatment 1	3	138.4333	1.11505	.64377	135.6634
	Treatment 2	3	133.2333	4.02782	2.32546	123.2277
	Treatment 3	3	129.7333	4.56107	2.63333	118.4030
	Treatment 4	3	125.4000	.00000	.00000	125.4000
	Total	15	132.5600	5.30940	1.37088	129.6198
MCH	Control	3	55.8000	.00000	.00000	55.8000
	Treatment 1	3	51.9333	1.55349	.89691	48.0742
	Treatment 2	3	55.6000	1.38564	.80000	52.1579
	Treatment 3	3	54.2333	2.60064	1.50148	47.7730
	Treatment 4	3	43.1000	.00000	.00000	43.1000
	Total	15	52.1333	5.04787	1.30335	49.3379
MCHC	Control	3	41.0000	.00000	.00000	41.0000
	Treatment 1	3	37.1333	1.42945	.82529	33.5824
	Treatment 2	3	41.8000	.17321	.10000	41.3697
	Treatment 3	3	41.7667	.56862	.32830	40.3541
	Treatment 4	3	34.4000	.00000	.00000	34.4000
	Total	15	39.2200	3.12232	.80618	37.4909

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
WBC	Between Groups	387.003	4	96.751	.768	.570
	Within Groups	1260.427	10	126.043		
	Total	1647.429	14			
LYM	Between Groups	4102.693	4	1025.673	157.650	.000
	Within Groups	65.060	10	6.506		
	Total	4167.753	14			
MON	Between Groups	1185.323	4	296.331	152.800	.000
	Within Groups	19.393	10	1.939		
	Total	1204.716	14			
RBC	Between Groups	6.409	4	1.602	22.766	.000
	Within Groups	.704	10	.070		
	Total	7.112	14			
HBG	Between Groups	175.043	4	43.761	56.490	.000
	Within Groups	7.747	10	.775		
	Total	182.789	14			
HCT	Between Groups	1466.684	4	366.671	63.725	.000
	Within Groups	57.540	10	5.754		
	Total	1524.224	14			
MCV	Between Groups	318.116	4	79.529	10.391	.001
	Within Groups	76.540	10	7.654		
	Total	394.656	14			
MCH	Between Groups	334.540	4	83.635	37.685	.000
	Within Groups	22.193	10	2.219		
	Total	356.733	14			
MCHC	Between Groups	131.691	4	32.923	68.684	.000
	Within Groups	4.793	10	.479		
	Total	136.484	14			

APPENDIX C

DESCRIPTIVE ANALYSIS AND ANOVA OF PHYSICOCHEMICAL PROPERTIES VIA SPSS

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence ... Lower Bound
pH	Control	3	6.5000	.10000	.05774	6.2516
	TR1	3	6.1667	.20817	.12019	5.6496
	TR2	3	6.0000	.10000	.05774	5.7516
	TR3	3	6.3333	.11547	.06667	6.0465
	TR4	3	6.2667	.05774	.03333	6.1232
	Total	15	6.2533	.20307	.05243	6.1409
WHC	Control	3	9.6667	.57735	.33333	8.2324
	TR1	3	10.0000	.00000	.00000	10.0000
	TR2	3	9.6667	.57735	.33333	8.2324
	TR3	3	9.6667	.57735	.33333	8.2324
	TR4	3	10.0000	.00000	.00000	10.0000
	Total	15	9.8000	.41404	.10690	9.5707
Tenderness	Control	3	3.2767	.02517	.01453	3.2142
	TR1	3	3.4500	.27839	.16073	2.7584
	TR2	3	3.5833	.10408	.06009	3.3248
	TR3	3	3.5667	.02887	.01667	3.4950
	TR4	3	3.2433	.09815	.05667	2.9995
	Total	15	3.4240	.18920	.04885	3.3192
Color_L	Control	3	31.2500	.60605	.34990	29.7445
	TR1	3	36.6933	1.99523	1.15195	31.7369

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence ... Lower Bound
	TR2	3	34.6700	2.55149	1.47310	28.3317
	TR3	3	32.2000	1.23077	.71059	29.1426
	TR4	3	31.9300	1.15287	.66561	29.0661
	Total	15	33.3487	2.52717	.65251	31.9492
Color_a	Control	3	3.5100	.20952	.12097	2.9895
	TR1	3	4.7400	.52307	.30199	3.4406
	TR2	3	4.7400	.52307	.30199	3.4406
	TR3	3	4.1700	.26211	.15133	3.5189
	TR4	3	4.5833	.27062	.15624	3.9111
	Total	15	4.3487	.58285	.15049	4.0259
Color_b	Control	3	8.0333	.35005	.20210	7.1638
	TR1	3	8.9833	.50123	.28939	7.7382
	TR2	3	8.9833	.50123	.28939	7.7382
	TR3	3	8.2700	.76922	.44411	6.3592
	TR4	3	8.2933	.84287	.48663	6.1995
	Total	15	8.5127	.66514	.17174	8.1443

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
pH	Between Groups	.417	4	.104	6.521	.008
	Within Groups	.160	10	.016		
	Total	.577	14			
WHC	Between Groups	.400	4	.100	.500	.737
	Within Groups	2.000	10	.200		
	Total	2.400	14			
Tenderness	Between Groups	.302	4	.076	3.800	.040
	Within Groups	.199	10	.020		
	Total	.501	14			
Color_L	Between Groups	62.008	4	15.502	5.657	.012
	Within Groups	27.404	10	2.740		
	Total	89.412	14			
Color_a	Between Groups	3.290	4	.822	5.610	.012
	Within Groups	1.466	10	.147		
	Total	4.756	14			
Color_b	Between Groups	2.339	4	.585	1.517	.270
	Within Groups	3.854	10	.385		
	Total	6.194	14			

APPENDIX D

DESCRIPTIVE ANALYSIS AND ANOVA OF PROXIMATE ANALYSIS

VIA SPSS

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence ... Lower Bound
Crude_Protein	Control	4	83.3200	1.87061	.93531	80.3434
	Treatment 1	4	75.7400	.50807	.25403	74.9316
	Treatment 2	4	85.4600	3.84515	1.92258	79.3415
	Treatment 3	4	95.3100	2.37868	1.18934	91.5250
	Treatment 4	4	91.1800	3.10632	1.55316	86.2372
	Total	20	86.2020	7.27553	1.62686	82.7969
Dry_Matter	Control	4	87.7200	.25403	.12702	87.3158
	Treatment 1	4	88.9900	.46188	.23094	88.2550
	Treatment 2	4	88.7700	.24249	.12124	88.3841
	Treatment 3	4	88.8750	.00577	.00289	88.8658
	Treatment 4	4	88.2250	.09815	.04907	88.0688
	Total	20	88.5160	.54214	.12123	88.2623
Ether_Extract	Control	4	.7450	.23671	.11836	.3683
	Treatment 1	4	5.3350	.13279	.06640	5.1237
	Treatment 2	4	3.1500	.73901	.36950	1.9741
	Treatment 3	4	9.5450	1.28749	.64375	7.4963
	Treatment 4	4	9.5200	.24249	.12124	9.1341
	Total	20	5.6590	3.62180	.80986	3.9639
Crude_Fiber	Control	4	2.1000	.08083	.04041	1.9714
	Treatment 1	4	.9100	.02309	.01155	.8733
	Treatment 2	4	.7750	.02887	.01443	.7291
	Treatment 3	4	1.8450	.10970	.05485	1.6704
	Treatment 4	4	1.5100	.02309	.01155	1.4733
	Total	20	1.4280	.53159	.11887	1.1792
Ash	Control	4	.4300	.21939	.10970	.0809
	Treatment 1	4	3.5500	.28868	.14434	3.0907
	Treatment 2	4	3.2950	.16743	.08372	3.0286
	Treatment 3	4	4.6750	.28290	.14145	4.2248
	Treatment 4	4	4.4000	.04619	.02309	4.3265
	Total	20	3.2700	1.56116	.34909	2.5394

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Crude_Protein	Between Groups	904.184	4	226.046	33.390	.000
	Within Groups	101.550	15	6.770		
	Total	1005.734	19			
Dry_Matter	Between Groups	4.545	4	1.136	16.406	.000
	Within Groups	1.039	15	.069		
	Total	5.584	19			
Ether_Extract	Between Groups	242.223	4	60.556	129.601	.000
	Within Groups	7.009	15	.467		
	Total	249.232	19			
Crude_Fiber	Between Groups	5.308	4	1.327	324.169	.000
	Within Groups	.061	15	.004		
	Total	5.369	19			
Ash	Between Groups	45.582	4	11.396	235.770	.000
	Within Groups	.725	15	.048		
	Total	46.307	19			

APPENDIX E

DESCRIPTIVE ANALYSIS AND ANOVA OF SENSORY EVALUATION VIA SPSS

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence ... Lower Bound
Color	Control	18	2.3889	.97853	.23064	1.9023
	Treatment 1	18	1.6111	.84984	.20031	1.1885
	Treatment 2	18	2.2778	1.17851	.27778	1.6917
	Treatment 3	18	4.1111	1.07861	.25423	3.5747
	Treatment 4	18	3.6111	1.03690	.24440	3.0955
	Total	90	2.8000	1.36736	.14413	2.5136
Odor	Control	18	1.9444	1.05564	.24882	1.4195
	Treatment 1	18	2.2778	1.07406	.25316	1.7437
	Treatment 2	18	2.0556	.72536	.17097	1.6948
	Treatment 3	18	2.6111	1.37793	.32478	1.9259
	Treatment 4	18	1.8889	.75840	.17876	1.5117
	Total	90	2.1556	1.03762	.10937	1.9382
Tenderness	Control	18	3.4444	.70479	.16612	3.0940
	Treatment 1	18	3.0000	1.41421	.33333	2.2967
	Treatment 2	18	3.0556	1.10997	.26162	2.5036
	Treatment 3	18	3.1667	1.20049	.28296	2.5697
	Treatment 4	18	3.7222	.75190	.17723	3.3483
	Total	90	3.2778	1.08128	.11398	3.0513
Flavor	Control	18	3.0556	.99836	.23532	2.5591
	Treatment 1	18	3.1667	.92355	.21768	2.7074
	Treatment 2	18	3.1111	.96338	.22707	2.6320
	Treatment 3	18	3.3333	.59409	.14003	3.0379
	Treatment 4	18	3.5000	.98518	.23221	3.0101
	Total	90	3.2333	.90006	.09487	3.0448
Overall	Control	18	2.7222	1.01782	.23990	2.2161
	Treatment 1	18	2.7222	1.01782	.23990	2.2161
	Treatment 2	18	2.7222	1.17851	.27778	2.1362
	Treatment 3	18	3.0556	.80237	.18912	2.6565
	Treatment 4	18	3.2778	.95828	.22587	2.8012
	Total	90	2.9000	1.00616	.10606	2.6893

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Color	Between Groups	76.178	4	19.044	17.942	.000
	Within Groups	90.222	85	1.061		
	Total	166.400	89			
Odor	Between Groups	6.267	4	1.567	1.487	.213
	Within Groups	89.556	85	1.054		
	Total	95.822	89			
Tenderness	Between Groups	6.556	4	1.639	1.429	.231
	Within Groups	97.500	85	1.147		
	Total	104.056	89			
Flavor	Between Groups	2.378	4	.594	.725	.577
	Within Groups	69.722	85	.820		
	Total	72.100	89			
Overall	Between Groups	4.711	4	1.178	1.172	.329
	Within Groups	85.389	85	1.005		
	Total	90.100	89			