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

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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.

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Physicochemical Properties, Proximate Analysis and Sensory of Hybrid Chicken

ABSTRACT

The high prices of fish meal and soybean meal had significantly impacted on the poultry industry, resulting in expensive commercial feeds. Black Soldier Fly larvae are not widely known as a possible protein source where its superior characteristics of high feed conversion rate, high nutritional value, and short lifecycle can be effectively optimised within feed formulations as opposed to costly fish meal. Fermented coconut dregs, water spinach, and turmeric also a good source that can replace other expensive protein ingredients. A study was conducted to determine the effect of local ingredients in poultry feed on hybrid chicken. Haematological analysis, meat quality of physicochemical properties and proximate analysis, and sensory evaluation were tested to ensure that the hybrid chicken meat is safe for human consumption. SPSS's One Way-Anova was used to analyse the obtained results. Results from the haematological analysis showed that all parameters had a significant difference. The physicochemical properties of hybrid meat were high in ph. Only pH and b* had significant different. Thus, the pH value influenced other physicochemical properties. Proximate analysis of dry matter (DM), crude protein (CP) ether extract (EE), crude fibre (CF), and ash content had only slight differences in the treatment group compared to Control. All proximate analysis was significantly different. Lastly, the sensory evaluation did not significantly differ for all parameters except for the colour of raw broiler chicken. There was no effect on the sensory evaluation of hybrid chicken meat. Treatment 3 with 10% BSFL, water spinach, fermented coconut dregs, and turmeric was the best meat quality for consumers due to closest average red blood cell count, ideal pH value and closest value to Control when compared to the other groups.

Keywords: BSFL, hybrid chicken, blood plasma, proximate analysis, sensory evaluation

Kesan Bahan-bahan Setempat pada Komposisi Hematologi, Sifat Fisikokimia,

Analisis Proksimat dan Deria Ayam Hibrid

ABSTRAK

Harga tinggi tepung ikan dan tepung kacang soya telah memberi kesan yang ketara kepada industri poltri, mengakibatkan makanan komersial yang mahal. Ulat lalat askar hitam tidak dikenali secara meluas sebagai sumber protein yang mungkin di mana ciri-ciri unggulnya iaitu kadar penukaran makanan yang tinggi, nilai pemakanan yang tinggi dan kitaran hayat yang singkat boleh dioptimumkan dengan berkesan dalam formulasi makanan berbanding tepung ikan yang mahal. Ampas kelapa yang ditapai, kangkung, dan kunyit juga merupakan sumber yang baik yang boleh menggantikan bahan protein mahal yang lain. Kajian telah dijalankan untuk menentukan kesan bahan tempatan dalam makanan ayam ke atas ayam hibrid. Analisis hematologi, kualiti daging sifat fizikokimia dan analisis proksimat, dan penilaian deria telah diuji untuk memastikan bahawa daging ayam hibrid selamat untuk dimakan manusia. One Way-Anova SPSS digunakan untuk menganalisis keputusan yang diperolehi. Keputusan daripada analisis hematologi menunjukkan bahawa semua parameter mempunyai perbezaan yang ketara. Sifat fizikokimia daging hibrid adalah tinggi dalam ph. Hanya pH dan b* mempunyai perbezaan yang ketara. Oleh itu, nilai pH mempengaruhi sifat fizikokimia yang lain. Analisis proksimat bahan kering (DM), protein kasar (CP) ekstrak eter (EE), gentian mentah (CF), dan kandungan abu hanya mempunyai sedikit perbezaan dalam kumpulan rawatan berbanding Kawalan. Semua analisis proksimat adalah berbeza dengan ketara. Akhir sekali, penilaian deria tidak berbeza dengan ketara untuk semua parameter kecuali warna ayam daging mentah. Tiada kesan ke atas penilaian deria daging ayam hibrid. Rawatan 3 dengan 10% BSFL, bayam air, hampas kelapa yang ditapai, dan kunyit adalah kualiti daging terbaik untuk pengguna kerana purata kiraan sel darah merah yang paling hampir, nilai pH yang ideal dan nilai yang paling hampir dengan Kawalan jika dibandingkan dengan kumpulan lain.

Kata kunci: BSFL, ayam hibrid, plasma darah, analisis proksimat, penilaian deria

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Kg	Kilogram	1
%	Percent	1
^{o}C	Degree Celsius	16
g	Gram	24
ml	Millilitres	26
^	Power of	34
µL	Volume of Acid Used	34
g/dL	Gram per decilitre	34
µm	Micrometre	34
pg	Picograms	34
mm	Milimetre	34
W	Weight of Sample	28
L*	Lightness	44
a*	Redness	44
b*	Yellowness	44

LIST OF ABBREVIATIONS

TPA	Texture Profile Analysis	25
N	Nitrogen	28
SPSS	Statistical Package for the Social Sciences	32
SEM	Standard Error of Mean	35
PCV	Packed-cell Volume	37
WHC	Water Holding Capacity	44

CHAPTER 1

INTRODUCTION

1.1 Research Background

Consumer preference has shifted from red meat (beef) to white meat over the last few decades (poultry). The changes in consumer preference are due to population growth, low prices, an increase in the number of processed products, and religion (Magdelaine, Spiess, and Valceschini, 2008). Malaysia's demand for poultry meat, particularly broiler meat, has increased year after year. According to The Edge Financially Daily, Malaysia will be among the top consumers in 2020, with an estimated 49.4kg of poultry meat consumed per person and ten times more for beef and veal. Malaysia has a diverse culture, religion, and ethnicity. Muslims are prohibited from eating pork, while Hindus are prohibited from eating beef.

Year after year, the demand for broiler meat as the primary protein source in their daily diet grows. Malaysia had a high level of self- sufficiency in poultry production, which was 128% in 2017 and decreased to 103% in 2018 (Ministry of agriculture, 2018). Malaysia's broiler production cycle is 5.33 times per year on average. Only a few large companies, particularly multinational corporations, can produce broiler six times per year.

Meanwhile, Malaysia's average feed conversion ratio (FCR) is 1.67, indicating the efficiency with which broilers convert feed into animal weight. However, that FCR remains competitive among the world's top broiler producers. In Malaysia, the average market size for broiler meat is 2.2kg (MARDI 2). Research is done by Thirumalaisamy, Muralidharan, Senthilkumar, Sayee, and Priyadharsini (2019) stated that 70% of a poultry farm's costs were reliant on the cost of purchasing commercial feed and fish meal prices, which were relatively higher than other feed ingredients. Given the importance of cost and efficiency in this matter, BSFL has undoubtedly been demonstrated to be a credible and viable protein substitute for future animal feed.

Broiler meat produces a lot of energy because it contains a lot of glycogen and lipids (Overland, Borge, Voght, Schoyen, Skrede, 2011). Lipids in broiler meat can affect the colour, texture, and flavour of the meat (Overland et al.,2011). However, the quality of chicken meat is concern because lipids in broiler meat, particularly cholesterol and saturated fatty acids, are strongly linked to the risk of cardiovascular disease. This problem necessitates researcher awareness and solutions to meet market demand, including alternative sources of feed ingredients (Oliveiera, Avanco, Gracia-Neto, Pansano, 2016). In broiler chickens, BSFL oil improves feed conversion ratio and increases the incorporation of medium-chain fatty acids into abdominal fat pad and serum antioxidant capacity.

The purpose of this study is to determine the effect of a new protein larvae source with the ability to turn waste into feed, Black Soldier Fly Larvae meal (BSFL), on broiler chicken growth performance and carcass quality. BSFL larvae originated from native America (Sheppard, Newton, Thompson, Savage ,1994). It can live in both temperate and

tropical climates. Black soldier flies naturally consume decomposable matter such as manure and biomass.They have also been used to reduce animal dung in animal farms (Newton, Sheppard, Watson, Burtle, Dove, 2005). It is now possible to improve the waste management industry. Although mature soldier flies are not considered disease carriers, they do have the ability to carry pathogens. It is not suitable for human or animal consumption (Goddard, 2003). The female black soldier fly can lay up to 500 eggs in cracks and crevices of decomposed matter like kitchen waste, dung, garbage, and other organic waste. In about four days, the eggs will hatch and turn into larvae (NCIPMI 1998). These larvae are frequently used in animal feed research.

It is showed many positives reviews from various types of research claimed that BSFL could be an excellent nutritional source for layer hens (Jansen, 2018), broiler chicken (Cockroft, 2018), fish (Xiao, Jin, Zheng, Cai, Jeffrey, Jibin and Zhangand, 2018) and pig (Nekrasov, Pravdin, Kravtsova, Bastrakov, Pashkova and Ushakova, 2018). This is due to the high protein and source content of Black soldier larvae (*Hermetia illucens sp.*). Defatted BSFL meal, according to Schiavone, is a fantastic source of apparent metabolised energy and digestible amino acid for broilers with highly efficient nutrient digestion (Schiavone et al., 2015).

Furthermore, these are important in understanding the effect of feeding BSFL on their growth performance and identifying any presence of ailments caused by the feeding ratio. As a result, the hybrid chickens will be subjected to a battery of tests in order to determine their health status. The haematological parameters will allow us to identify the count of normal and abnormal blood cells such as 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) by understanding and analysing their blood constituents. These haematological tests can be effectively analysed using a haematology analyser. All the hybrid chickens were slaughtered and weighed to determine their final body weight (slaughter weight). The samples were then properly cleaned, and visceral organs were removed to determine the carcass weight of the sample in separate parts of the breast and thigh. Finally, the physicochemical properties of hybrid chicken meats were investigated in order to identify the quality of the meat and its properties such as colour, pH, water holding capacity, and tenderness through the use of various methods to determine accurate values.

1.2 Problem Statement

The most common issue that farmers face is high feed prices. Soybean meal, corn meal, and fish meal are relatively expensive, but they contain high-quality protein that is recommended for use in poultry feed formulation; however, researchers are still looking for alternative sources that can provide high-quality protein at a low cost.

Because of its high protein content, BSFL, also known as *Hermetia illucens*, is an edible insect that can be used as animal feed. The insect has the ability to convert waste into nutritious protein, which helps to reduce feed costs, waste, and is environmentally friendly. Black soldier larvae are an insect that grows easily on farms and can be fed directly to animals or processed into conventional feed. This item has the potential to boost our local economic output. Insects are also naturally consumed by chickens as

food. Insects contained a high concentration of protein, which could reach 64% for the highest (Hwangbo et al., 2009) and 39.16% for the lowest (Atteh and Ologbenla, 1993).

Black soldier larvae also have a high concentration of essential amino acids such as lysine, which aids in animal growth, as well as other protein content (Koethe, 2018). In comparison to other plant-based protein sources such as soybean meal, corn meal, and maize, it necessitates extensive maintenance, care, workers, space (field or land), water, and environmental sustainability (soil and weather). Because of these factors, more money is required to raise the animal, and people begin to question whether it is necessary for them to start the business. Fish meal is also an excellent protein source with the highest protein content compared to other sources that could supply broiler meat, but it is the most expensive protein.

Expensive protein supply can also be overcome by using locally sourced ingredients. Fermented coconut dregs have the potential to improve growth performance, protein digestibility, and digestible dry matter intake. Meanwhile, water spinach can provide protein and vitamins to growing chickens, and turmeric meat supplementation effectively increases the growth rate and weight of broiler chickens.

1.3 Hypothesis

1.3.1 Hypothesis of Haematological Analysis on Hybrid Meat

Ho = BSFL, water spinach, fermented coconut dregs and turmeric have no significance effect on the haematology of hybrid chicken.

Ha = BSFL, water spinach, fermented coconut dregs and turmeric have significance effect on the haematology of hybrid chicken.

1.3.2 Hypothesis of Physicochemical Properties of Hybrid Meat

Ho = BSFL, water spinach, fermented coconut dregs and turmeric causes no significance changes on the physicochemical properties of hybrid chicken meat.

Ha = BSFL, water spinach, fermented coconut dregs and turmeric causes significance changes on the physicochemical properties of hybrid chicken meat.

1.3.3 Hypothesis of Proximate Analysis of Hybrid Meat

Ho = BSFL, water spinach, fermented coconut dregs and turmeric causes no significance effect on the proximate analysis of hybrid chicken meat.

Ha = BSFL, water spinach, fermented coconut dregs and turmeric causes significance changes on the proximate analysis of hybrid chicken meat.

1.3.4 Hypothesis of Sensory Evaluation of Hybrid Meat

Ho = BSFL, water spinach, fermented coconut dregs and turmeric causes no significance effect in the sensory evaluation of hybrid chicken meat.

Ha = BSFL, water spinach, fermented coconut dregs and turmeric causes significance changes in the sensory evaluation of hybrid chicken meat.

1.4 Scope of The Study

This study concentrated on animal nutrition. This was due to the fact that the experiment included the testing of a new formulated feed containing BSFL, water spinach, fermented coconut dregs, and turmeric as a protein source in hybrid chicken feed. This new meal will contain varying percentages of BSFL, water spinach, fermented coconut dregs, and turmeric. Based on the health of the hybrid chickens, the feeding trial of this newly formulated feed determined the percentage of BSFL, water spinach, fermented coconut dregs, and turmeric that is suitable for hybrid chicken consumption. It also aids in the improvement of meat quality and taste in chicken meat. Water holding capacity, colorimeter, tenderness, pH, proximate analysis, and sensory evaluation can all be used to test it. This is critical for other farmers to accept BSFL, water spinach, fermented coconut dregs, and turmeric legibility as a potential raw material for protein sources in poultry feed.

This experiment, to focus on animal nutrition, also covered animal health. Since animal nutrition and animal are inextricably linked, by determining the effect of BSFL and water spinach, fermented coconut dregs, and turmeric inclusion in the new formulated feed on the health of the chicken and determining the most effective meal ratio for the health and growth of the hybrid chickens, it can be stated that the hybrid chickens'health status should improve if the appropriate amount of nutrition meal was provided. To ensure that the hybrid chickens received enough feed per day, the required feed consumption for the hybrid chickens was based on ad libitum. In addition, haematological analysis determined the hybrid chickens' state of health. A successful evaluation of these criteria in relation to hybrid chicken fed with BSFL, water spinach, fermented coconut dregs, and

turmeric proves the safety and quality of hybrid chicken carcass for human consumption, thereby influencing human health and opening a larger market option for daily meat source.

1.5 Significance of The Study

Malaysia has a high demand for chicken meat, but the cost of producing chicken is high. This is due to the use of soybean meal, fish meal, and maize as primary protein sources in feed formulation, with most of these ingredients being imported. Black soldier fly larvae are an excellent alternative protein source for use in feed formulation (Schiavone et al., 2017). Due to their high palatability, larvae or maggots are also known as natural chicken feed. The goal of this research is to determine the potential of BSFL meal as a primary protein source in Malaysia that can replace more expensive feed ingredients. Aside from that, to determine the ability of BSFL meal to improve hybrid growth rate and produce high quality carcass hybrid meat.

With this newly formulated feed containing BSFL, water spinach, fermented coconut dregs, and turmeric, farmers will save money on feed, lowering the cost of production and, as a result, the cost of the poultry product itself.

The formulation of feed and the use of the BSFL, water spinach, fermented coconut dregs, and turmeric in this experiment was a critical step in determining the best proportion of meal inclusion on the health of the hybrid chicken in order for it to be safely consumed by humans. Small-holder farmers can also make their own feed for their

livestock that meets the requirements for their stage and age.

Also, by using locally sourced ingredients, waste can be reduced such as water spinach, which was previously only consumed by humans in small quantities, and coconut dreg, which is a byproduct of the coconut industry.

1.6 Limitation of The Study

The study's limitation is that the weather on Malaysia's east coast can be unpredictable, with sudden scorching hot weather as well as cold environments caused by heavy rain and monsoon, causing stress to the hybrid chicken.

Next, the lack of laboratory equipment available for the experiment results in discrepancies in the accuracy of the results, which affects the data's eligibility. For example, University Malaysia Kelantan did not have a Warner-Bratzler knife with guillotine block to determine meat tenderness. Kjeldahl machine also became inaccurate because of everyday usage that can affect data analysis.

1.6 Objectives

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

CHAPTER 2

LITERATURE REVIEW

2.1 Production of Hybrid Chicken in Malaysia

Local fowl is a product with a desire and market of its own. To satisfy local demand as well as export markets, this livestock is still being worked on either traditionally or commercially. In 2005, the number of poultry farms amounted to 4.9 million tails, up from 8 million tails in 2007. In big city centres such as Kuala Lumpur, Ipoh and Penang, commercial development of village chickens is intended to meet demand. Half of the performance is exported abroad. A total of 334 tons of village chickens were exported in 2007, and approximately 53% of them were exported to Singapore. Increased knowledge of halal food opens room for the poultry industry in Malaysia, especially for the Middle East market, to thrive internationally.

The present stocks of native chickens of Malaysia or the popularly known ‘kampung’ (village) chickens (*Gallus domesticus*) are the descendants of the red jungle fowl (*Gallus gallus*). They developed between the original Malay fowl, the jungle fowl, and the exotic commercial breeds from spontaneous and indiscriminate crossbreeding. Because they are no longer purebreds, their physical characteristics are so complex that

the entire flock does not match any single definition. Native chicken or Ayam Kampung is known as a hybrid, the product of natural crossbreeding between the Malay fowl, jungle fowl, and mixed exotic races brought in during periods of European colonization (Azahan and Zahari, 1983; Azahan, 1994). The plumage colour of village chickens varies considerably, with the black-red variety being the most common (Azahan etal., 1980; Azahan and Zahari, 1983; Azahan, 1994). In Southeast Asia and other developing nations, native chickens are mainly raised in the backyard, providing local households with both a lateral income and a protein source (Aini, 1990; Padhi, 2016).

To complement their dietary feed requirements, these chickens are free to roam and scavenge for food and are fed leftovers and other household scraps. However, the conventional method of rearing small flocks of free- range chickens has been increasingly discouraged since the outbreak of highly pathogenic avian influenza (Safman, 2010).

In many Southeast Asian nations, including Malaysia, village chicken is popular and has always been regarded as superior in terms of health and health benefits compared to commercial broiler chicken (Hassan etal., 2005). With little to no antibiotics or other medications, these chickens are usually raised. In recent years, awareness of animal welfare concerns and the drugs used in the commercial processing of poultry has increased (i.e., intensive production) the demand for free-range native chickens has risen rapidly as a result, consumers found that they were safer and healthier, (Hassan etal., 2005; Miao etal., 2005; Rahman and Haziqah, 2015). As a result, Ayam Kampung goods cover a wider niche market compared to previous years due to emerging concerns regarding food safety and animal welfare.

2.2 Nutrient Requirements for Chicken

The essential nutrient for birds varies depending on their age (starter, grower, finisher), breed, and developmental mode (meat or egg producer). Table 2.2.1 is an example of a summary for selected nutrients in meat chicken at different ages. They must be fed in accordance with their developmental stages to meet the needs and requirements for growth and production.

Table 2.2.1: Nutrient requirement for broiler diet

Nutrients	Units	Starter	Grower	Finisher
		0-10 days	11-24 days	>25 days
Protein	%	22-25	21-23	19-21
Metabolism energy	MJ/Kg	12.6	13.3	13.5
	Kcal/kg	3010	3175	3225
Total arginine	%	1.48	1.31	1.11
Total lysine	%	1.44	1.25	1.05
Total methionine	%	0.51	0.45	0.39
Total methionine +cystine	%	1.09	0.97	0.83
Total threonine	%	0.93	0.82	0.71
Total tryptophan	%	0.25	0.22	0.19
Total valine	%	1.09	0.96	0.81
Calcium	%	1	0.9	0.85
Av. phosphorous	%	0.5	0.45	0.42
Sodium	%	0.16	0.16	0.16

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

2.3 Black Soldier Fly Larvae (BSFL) and Its Nutritional Value

The Black Soldier fly larvae were reported to haves 42% crude protein with a higher crude fat content of 38% (Newton, Booram, Barker, & Hale, 1977). The black soldier fly (BSF) is known to reduce the dominance and rearing of the housefly, which may reduce the possibility of disease transmission by the housefly (Bradley and Sheppard, 1984). It is also assumed that BSFL can consume and process natural waste at a faster and more efficient rate than housefly larvae (Kim, Bae, Park, Choi, Han, and Koh, 2011). The BSF is found all over South America and Asia, but it is unique to Colombia(Canary and Gonzalez, 2012).

They can withstand and adjust to a wide range of environmental temperatures (McCallan, 1974). These flies belong to the *Stratiomyidae* family and are typically found in environments suitable for larval development, such as marshlands and moist places with animal waste, spoiled fruits, or any organic decomposed material (Rozkošný, 1982; Li, Zheng, Qiu, Cai, Tomberlin, & Yu, 2011). The BSFL is not classified as a vermin animal group (Sheppard et al., 1994; Newton et al., 2005b) because the adult fly does not eat or search for food and thus does not enter a human-inhabited area (Sheppard, Newton, Thompson, & Savage, 1994). The adult fly is entirely dependent on the energy reserves accumulated during the larval stage.

2.4 Fermented Coconut Dreg and Its Nutritional Value

Coconut (*Cocos nucifera*), also known as copra, is one of the most widely grown crops in the tropics and is thought to have originated in Indo-Malaya. Coconut flesh contains a lot of fat and can be eaten fresh or dried. Malaysia. According to the Malaysian Agricultural Research and Development Institute (MARDI), is one of the top ten coconut producers in the world, despite production falling between 2014 and 2016.

Fermented coconut dregs or coconut pulp have been used as an alternative livestock feed. The fermentation of coconut pulp has been done to improve the nutritional composition of that waste, such as lowering the fat content and increasing the protein content to ensure maximum nutrition. Syahri et al. (2016) performed fermentation between coconut meal and *Aspergillus niger* to improve the product for fish and poultry. Pravitasari et al. (2017) conducted another study in which coconut pulp was fermented with Raprima yeast, used as the yeast to ferment with soybean to make tempeh and composition of 10% coconut dregs fermentation and 90% control feed is the optimal amount t given to the chicken.

According to Miskiyah et al. (2006), fermentation of coconut dregs increased protein content from 11.35% to 26.09%, or by 130%, while decreasing fat content by 11.39%. As a result, the feed produced is relatively safe for livestock, as the aflatoxin content is less than 20 ppb. However, according to Pravitasari et al. (2017), the effect of fermentation of coconut dregs on protein content shows that commercial feed that has been mixed with fermented coconut dregs has a lower protein content than commercial feed that is 100% commercial feed.

2.5 Water Spinach and Its Nutritional Value

This tropical plant, known as kangkong in Southeast Asia and water spinach, river spinach, water morning glory, and water convolvulus in English, has the scientific name *Ipomoea aquatica* and is a member of the *Convolvulaceae* family. According to Umar et al. (2007), the dry weight basis of the leaves contains high moisture 72.83 %, ash 10.83 %, ether extract 11%, crude fibre 17.76 %, but low crude protein 6.3 %.

This plant reproduces both sexually and asexually, with seeds produced both sexually and asexually via rooting at nodes or fragmentation, and propagation via seeds and cuttings. Water spinach enjoys heat, humidity, water, and nutrients, and this plant prefers temperatures ranging from 20°C to 30°C. When the temperature falls below that level, the plant cannot grow.

Smallholders in rural Cambodia typically feed their scavenging poultry with water spinach mixed with rice bran. Water spinach is used for local chickens, which suggests that it is also a favourite foliage for providing protein and vitamins to growing chickens (Saroeun, 2010). According to Nguyen Thi Thuy and Ogle (2005), the colour of layer chicken skin and egg yolk improved when they were fed green feed, such as water spinach, making the products more appealing to consumers.

2.6 Turmeric and Its Nutritional Value

Turmeric, turmeric root, and Indian saffron are some of its common names, and its scientific name is *Curcuma longa*. *Curcuma longa* is a rhizomatous herbaceous perennial plant in the *Zingiberaceae* family. Turmeric extract is a yellow-orange polyphenol that is commonly found in the form of a dry yellow powder that is oil-soluble in its natural state. Turmeric produces curcumin, a polyphenolic phytochemical with anti-microbial, anti-inflammatory, anti-cancer, and antioxidant properties. 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). The use of turmeric rhizome powder in the poultry diet was found to reduce morbidity and mortality in hybrid chickens. Turmeric in poultry feed has also been shown to be beneficial to public health and to have no negative side effects.

Previous research by Puvaca et al. (2018) concluded that turmeric may help to prevent antioxidant deficiency, resulting in mitochondrial protection against premature oxidative damage, loss of ATP synthesis, and loss of specialised cellular functions. It is recommended to use 0.3 to 0.6g/kg turmeric powder or a 0.5% addition of turmeric powder.

2.7 Blood Plasma Constituent in Hybrid Chicken

The composition of chicken blood consists of various cells that make up the blood tissue. Every cell contributes to the body's ability to function properly. A blood serum was present in the blood composition. Other components of blood serum include protein, albumin, globulin, and creatinine. As a result, the protein content of the serum was determined by the protein obtained from feed consumption (Scanes, 2015). A study was conducted to investigate the effect of blood serum on animals infected with disease, and the results revealed that a higher amount of globulin within the serum indicated a higher production of antibodies against the disease (Tothova, Nagy, & Kovac, 2016).

Haematology was a science that studied the number of blood constituents, morphology, and metabolites in the blood. Blood metabolites and constituent volume differ from one another due to a variety of factors such as species, age, size, feed, and health. Typically, RBC was correlated with the quality of feed and nutrition it provides. However, if the level of monocyte within the blood drops, the animal may be affectedby stress and become more susceptible to disease.

2.8 Meat Quality

Meat quality is a term used in the meat industry to describe the overall characteristics of meat, including its physical, chemical, biochemical, morphological, microbial, technological, sensory, hygienic, nutritional, and culinary properties (Ingr, 1989). Hybrid chicken mass production is now complete, and the focus is on improving meat quality by modifying various aspects of hybrid chicken meat. For sensory evaluation, the most important and perceptible meat features that influence consumers' initial and final quality judgments before and after purchasing a meat product are appearance, texture, odour, and flavour.

The quantifiable properties of meat such as water holding capacity, tenderness, pH, and colourimetric are indispensable for processors involved in the manufacture of value-added meat products. In addition, proximate analysis refers to the quantitative analysis of macromolecules in food such as determination on dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF) and ash.

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

From the day they are born until they reach the maturity stage of 5 weeks or 35 days, a total of 50 hybrid chickens will be used and reared. The animal feeding trial was taken place at the Agro Techno Park on the University Malaysia Kelantan's Jeli Campus. The hybrid chickens were divided into five groups, with one control and four treatment diets in each. According to Aman (2019), the feed ingredients for Control, Treatment 1, Treatment 2, Treatment 3, and Treatment 4 contain varying percentages of dietary inclusion of black soldier fly larvae meal (BSFL), water spinach, fermented coconut dregs, and selected corn plant by-product for hybrid chicken chicken at various stages. Each formulation was chosen based on the ratio obtained from the Winfeed software after the chemical composition was determined. The hybrid chickens were fed twice daily at 7 a.m. and 6 p.m. until they reach maturity at 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: Aman (2019), Development of Optimal Feed Hybrid Chicken Production Using Locally Available Ingredients.

3.2 Sample Preparation

The feed materials used in this study were BSFL, water spinach, fermented coconut dreg, and a selected corn plant by-product that can be easily obtained in the area surrounding Lakota and Gemang, Jeli.

The fermentation of the coconut dregs was started early because it took longer. The coconut dregs were steamed for 30 to 40 minutes after being taken from the seller of fresh coconut milk. They were then cooled before being mixed with the Raprima yeast in the scientific ratio. After that, the coconut dregs mixture was tightly sealed in the packaging and left at room temperature for 48 hours to ferment.

3.3 Haematological Analysis

Blood samples from each group of hybrid chickens were subjected to a haematological test when the hybrid chickens reach the age of 5 weeks. The hybrid chickens were properly restrained to ensure safe blood collection from the hybrid chicken's wings via the vein under the wing with a needle and a 1ml disposable capacity syringe. The blood was transferred into anti-coagulated vacutainer tubes and chilled at 4°C in an ice box or refrigerator (Sujata, Mohanty, & Malik, 2014). The blood was kept cool to delay the clotting process and keep the blood fresh for analysis in the haematology analyzer machine. The blood was transported to the lab and analyzed within 24 hours of being extracted from the hybrid chickens.

3.4 Meat Quality

3.4.1 Physicochemical Properties

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

a. pH Determination of Meat

The pH of a meat sample was determined using a digital pH meter. The meat was thinly sliced in the same manner as meat grain, and the pH of the meat was measured in triplicate. The data were recorded.

b. Water Holding Capacity

The gravimetric method and the drip loss method were both used to calculate water holding capacity. This method, also known as the Honikel bag method, entails measuring the weight loss of the meat within a bag drip. The meat was hung in an enclosed 1.5-liter plastic water bottle with nylon string in a variation on the Honikel bag method.

The meat samples were prepared in 3 grams and suspended within the bottle in a cold room for three days. Each treatment was used in triplicate. The initial and final weights of the sample were recorded to calculate the water holding capacity and multiplied by the age of loss of weight over the period (Dikeman & Devine, 2014).

c. Colourimetric Analysis of Meat

The colourimetric index of hybrid chickens meat was determined using a Konica Minolta CR-400 Chroma Meter. The meat sample was prepared, and the colorimeter was taken in the same plane and meat grain position where the direction or surface grain of the meat must be in the same position to ensure the test is accurate. Each treatment was performed in triplicate to ensure the accuracy of the results.

d. Tenderness of Meat

Texture profile analysis (TPA) of hybrid chickens meat can be obtained by determining meat tenderness (hardness). The Brookfield CT3 Texture Analyzer with a flat faced cylindrical probe was used. 15 samples of 5 breast meat were cut into large enough pieces and labelled with the sample number. The direction and surface of the grain of meat must in the same position to ensure that the test can be performed with a constant variable, yielding more accurate results (Freeman & Freeman, 2015).

3.4.2 Proximate Analysis

This analysis typically used for determination of the chemical composition of the hybrid chickens meats and expressed in percentage (%). The parameter that had taken in this analysis from all the treatment feed samples were dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE) and ash. These experiments were carried out on five different groups of meat. The breast part of hybrid chicken meat was analysed to justify the nutrient content. This had been conducted at animal science laboratory, Universiti Malaysia Kelantan, Jeli Campus.

a. Preparation of Sample for Proximate Analysis

The samples were prepared before they can be analysed proximally. Thus, it was to ensure that the sample was safe, free of any particles or substances, and to facilitate the process of proximate analysis so that the results provided were good and more accurate. Drying and grinding were critical steps in sample preparation. The sample was dried to remove any remaining water and moisture to keep it from contaminated. The samples were dried in an air-circulation oven at 105 °C for about 24 hours. The samples were ground with a blender to a particle size of about 1 mm. The ground sample was stored in an airtight container to avoid contamination.

b. Determination of Dry Matter (DM)

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

The percentage of dry matter (DM):

DM (%) = 100 – Moisture (%)

c. Determination of Crude Protein (CP)

The amount of protein in animal feed or a specific food was referred to as crude protein. The nitrogen content of food proteins influenced crude protein. The Kjeldhal method was used to determine the protein content. This method included three steps: digestion, distillation, and titration. For the first step, which was the digestion process, a catalyst was added to accelerate the rate of organic breakdown during acid digestion. The sample was digested in boiling concentrated sulphuric acid until it was completely dissolved and oxidised. Nitrogen in protein were oxidised to ammonium sulphate using sulphuric acid and a catalyst. An excess of sodium hydroxide solution caused ammonium ion to release in ammonia form, which was then distilled and received on a boric acid solution or a sulphuric acid volumetric solution. The final step of the titration is to receive sulphuric acid after ammonia was determined by back titration with a known concentration of sodium hydroxide solution. The results had been expressed as a

percentage of N and protein (%N x factor). The following were the formulations and calculations:

The percentage of nitrogen in dried sample

N (%) = 100 [(A x B) / C] x 0.014

Where,

A= Volume of acid neutralised sample (ml)

B = Concentration of HCl

C = Weight of sample (g)

The percentage of crude protein (CP)

CP (%) = N (%) x 6.25

d. Determination of Ether Extract (EE) or Crude Fat

The amount of fat or oil content of a feed extracted by ether was referred as crude fat. This ether extract contains fat-soluble vitamins A, D, E, and K, as well as free fatty acids, cholesterol, chlorophyll, lecithin, resins, and volatile oils. It was carried out using the Soxhlet apparatus, which consists of three major components: an extractor that holds the sample, a condenser that cools and condenses the water vapour, and a round bottom flask.

Both the dried sample (W1) and the round bottom flask (W2) were weighed, and the results were recorded. The round bottom flask was filled with 80 ml of petroleum

ether and placed inside the machine. After finishing the process at the machine, the condensing unit was removed from the extraction and placed in the air-circulated oven for 20 minutes before being allowed to cool in the desiccator for 10 minutes. Following that, the round bottom flask was weighed (W3). The following are the formulations and calculations:

Crude fat (%) = [(W3 - W2) / W1] x 100

Where;

W1 = The weight of sample (g)

W2 = The weight of empty flask (g)

W3 = the weight of flask with extract (g)

e. Determination of Crude Fiber (CF)

The FibertecTM 8000 Fully automated Crude and Detergent Fiber analysis was used to examine the crude fibre. It was a fully automated system for determining crude fibre and detergent fibre, as well as related parameters, using standard reference 'crucible' methods such as Weende and van Soest. Each sample was treated individually in accordance with the official procedures. The samples (W1) containing 1g of celite were placed in the crucible and inserted into the machine. The digestion process between acid and alkali, as well as the draining and boiling, were all carried out. After completion, the crucibles were placed in an air-circulated oven at 130 °C for 2 hours before being weighed (W2). The crucible will then be moved to the furnace before being weighed (W3). The following was the formulation and calculation:

CF (%) =(W2-W3) / W1 X 100

Where;

W1: Weight of sample (g)

W2: Weight of crucible and samples after oven (g)

W3: Weight of crucible and samples after furnace (g)

f. Determination of Ash

Heating was the primary method for determining ash content. (W1) was the weight of the empty crucible, and (W2) was the weight of the feed sample. The feed sample was placed in empty crucibles and incinerated for 8 hours in a muffle furnace at 550°C. The crucibles were then removed and cooled in a desiccator until they reached room temperature. The crucible was then removed from the desiccator, and the ash was weighed (W3).

Ash (%) = (W3 – W1) / W2 x 100

Where;

W1 = Weight of empty crucible (g)

W2 = Weight of sample (g)

W3 = Weight of crucible and ash (g)

3.5 Sensory Evaluation

Meat sensory analysis provides methods for interpreting human perceptions of products. Product, environment, and panellist control must be established and consistently applied through sensory methods for accurate, repeatable sensory data. Discriminative sensory evaluation, descriptive sensory evaluation, and consumer sensory evaluation were the three basic sensory approaches (Miller, 2017). Consumer sensory evaluation was used in this experiment. The sensory attributes of food quality were measured to determine consumer acceptance/preference to manufacture an acceptable and affective product at the lowest possible cost of production. The purpose of consumer acceptance testing was to categorise likes and dislikes for a specific set of samples. Consumers will be given sensory evaluations and asked to indicate liking or disliking using hedonic scales.

3.6 Data Analysis

Data was analysed using the One-Way-Anova Test and IBM SPSS Statistics 64 software to identify the effect of feeding BSFL, water spinach, fermented coconut dregs, and turmeric on haematological composition, physicochemical properties, proximate analysis and sensory evaluation. The Tukey and Duncan Multiple Range Test will be used to compare the data that had been collected and analysed. All the data will be analysed with replicates and the significant difference of ($P < 0.05$) will be determined.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Haematological Parameter of Hybrid Chickens Meat

The data was analysed on haematological parameters of blood samples from hybrid chicken using a Haematology analyser. Table 4.1 shown the mean and standard error of haematological parameters 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). The highest mean for red blood cells was Treatment 3 (2.54), followed by Treatment 1, Treatment 4, Treatment 2, and Control. The highest mean for haemoglobin and haematocrit was Treatment 3 (12.50,26.65), followed by Treatment 1, Treatment 2, Treatment 4, and Control. The highest mean for mean corpuscular volume was Control (135.65), followed by Treatment 4, Treatment 3, Treatment 2, and Treatment 1. The highest mean for mean corpuscular haemoglobin was Control (61.95), followed by Treatment 2, Treatment 1, Treatment 4, and Treatment 3. The highest mean for mean corpuscular haemoglobin concentration was Control (44.40), followed by Treatment 1, Treatment 2, Treatment 4, and Treatment 3. The highest mean

for white blood cells was Treatment 1 (121.05), followed by Treatment 3, Treatment 4, Treatment 2 and Control. The highest mean for lymphocyte was Treatment 4 (92.00), followed by Treatment 1, Treatment 2, Treatment 3 and Control. Lastly, the highest mean for monocyte was Treatment 3 (29.00), followed by Treatment 1, Treatment 4, Treatment 2 and Control.

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

Parameter	Group					p-value
	Control	Treatment 1	Treatment 2	Treatment 3	Treatment 4	
RBC (10^6/µL)	0.40±0.01^{a}	2.09±0.10^{c}	0.89±0.09^{ab}	2.54±0.27^{c}	1.16±0.20^{b}	0.00
HGB (g/dL)	2.80±0.23^{a}	11.55±0.03^{c}	5.00±0.52^{b}	12.50±0.29^{c}	4.75±0.20^{b}	0.00
HCT (%)	5.75±0.26^{a}	26.45±1.13^{c}	11.45±0.89^{b}	26.65±0.32^{c}	11.15±0.32^{b}	0.00
MCV (µm^3)	135.65±0.14^{b}	127.00±0.75^{a}	129.70±3.41^{ab}	130.40±0.58^{ab}	131.45±0.32^{ab}	0.02
MCH (pg)	61.95±0.26^{c}	55.75±2.57^{b}	56.20±0.00^{b}	45.55±0.06^{a}	55.70±0.81^{b}	0.00
MCHC (g/dL)	44.40±0.52^{b}	43.85±1.76^{b}	43.40±1.15	33.35±0.32^{a}	41.70±0.12^{b}	0.00
WBC (10^3/mm3)	40.5±0.26^{a}	121.05±0.53^{e}	81.30±0.69^{b}	115.00±0.17^{d}	94.95±0.09^{c}	0.00
LYM (%)	39.25±0.14^{a}	79.20±1.91^{c}	78.70±0.46^{c}	69.55±0.43^{b}	92.00±0.58^{d}	0.00
MON (%)	0.70±0.05^{a}	27.45±0.78^{c}	1.55±0.14^{ab}	29.00±0.69^{c}	3.20±0.06^{b}	0.00

The value for significant difference was $p<0.05$; RBC = red blood cell, HGB = hemoglobin, HCT = haematocrit , MCV = mean corpuscular volume, MCH = mean corpuscular hemoglobin, MCHC = mean corpuscular hemoglobin concentration, WBC = white blood cell, LYM = lymphocyte, MON = monocyte.

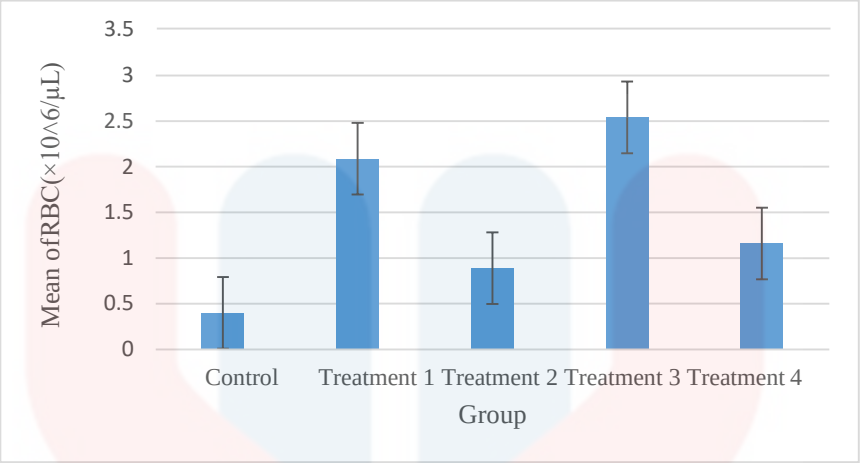

Figure 4.1: Mean and SEM error of Red Blood Cell (×10^6/µL).

In broiler chicken, the optimal red blood cell count ranges from 2.5103/L to 3.5103/L. (Devrim Saripinar Aksu et al., 2010). Only Treatment 3 produced the best red blood cell counts (2.54). The numbers obtained from the other treatments, on the other hand, did not fall within the optimum range specified in the experiment. Control had the lowest red blood cell count (0.40). Because of the low red blood cell level, the hybrid chicken could be infected with the chicken anaemia virus. Anaemia occurs when a chicken's blood contains insufficient healthy red blood cells (erythrocytes) or when the chicken suffers either external or internal blood loss (Animal DVM LLC, 2014). The symptoms of this disease are most commonly observed in young chicks. Infected chicken over three or four weeks old, on the other hand, usually does not show clinical indications but may increase immunosuppression, resulting to recurrent infections or economic losses even in the absence of disease manifestations (Vicky, 2019). This was because when seronegative adult chickens become infected, no symptoms of sickness or negative effects on egg production develop (Overview of Chicken Anaemia Virus Infection: Chicken Anaemia Virus Infection: Merck Veterinary Manual, 2012). As a result, we may infer that only Treatment 3 was healthy.

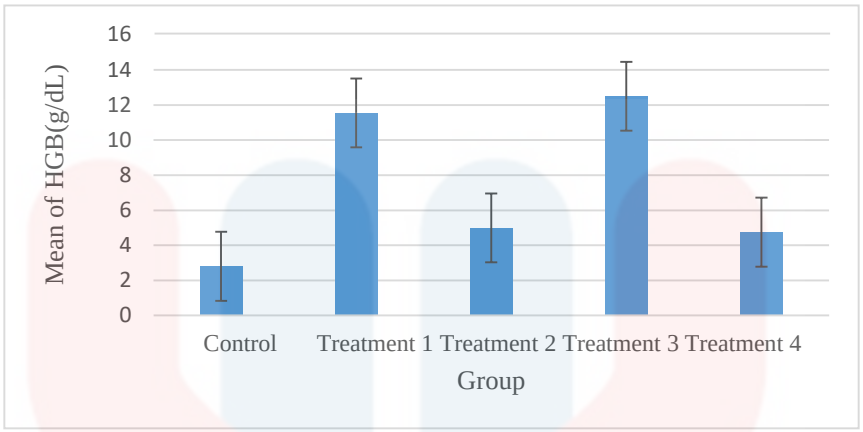

Figure 4.2: Mean and SEM error bar of Haemoglobin (g/dL).

In chicken, the standard value of haemoglobin ranges from 7 g/dL to 13 g/dL. (Devrim Saripinar Aksu et al., 2010). In general, haemoglobin, erythrocytes and haematocrit were responsible for binding oxygen molecules. Only Treatments 3 (12.50) and 1 (11.55) fall within the specified range. Treatments 2 and 4 differed slightly from the typical value. Control, on the other hand, had the lowest haemoglobin value. Hill and Matrone (1961) conducted a study on Copper and Iron Deficiencies in Growing Chickens, and the results show that the immediate result of iron deficiency was a drop in erythrocyte haemoglobin concentration. The most common cause of anaemia was a lack of iron in the body. If animals did not consume enough iron, they could not manufacture haemoglobin.

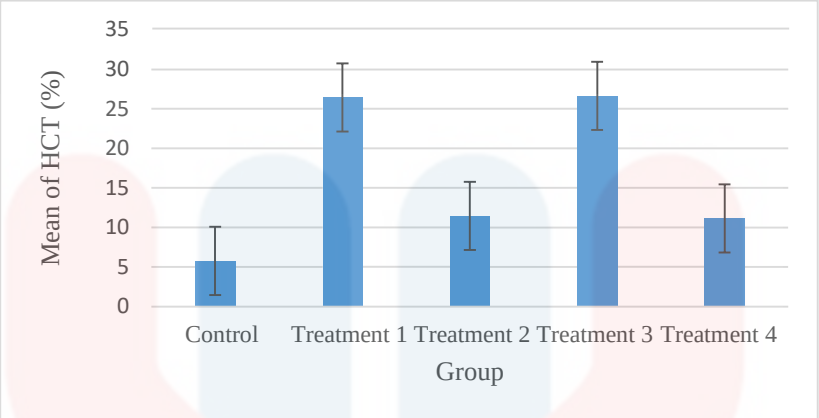

Figure 4.3: Mean and SEM error bar of Haematocrit(%).

Haematocrit (HCT), also known as Packed Cell Volume (PCV), was associated with red blood cells since it quantifies the amount of red blood cells in the blood. Certain illnesses can be indicated by the presence of too few or too many red blood cells. The optimal HCT value ranges from 22% to 35%. (Devrim Saripinar Aksu et al., 2010). Treatments 3 (26.65%) and 1 (26.45%) fall within the stipulated range. Treatments 2 and 4 had a deficient value of HCT, while Control had the lowest quantity. According to Farahin (2019), the amount of iron employed in the feed formulation could be low, lowering the red blood cell count. As a result, the HCT was likewise low. Good PCV and HGB levels indicate high feed conversion efficiency (Nyaulingo, 2013). As a result, low HCT and HGB levels are signs of poor feed conversion efficiency.

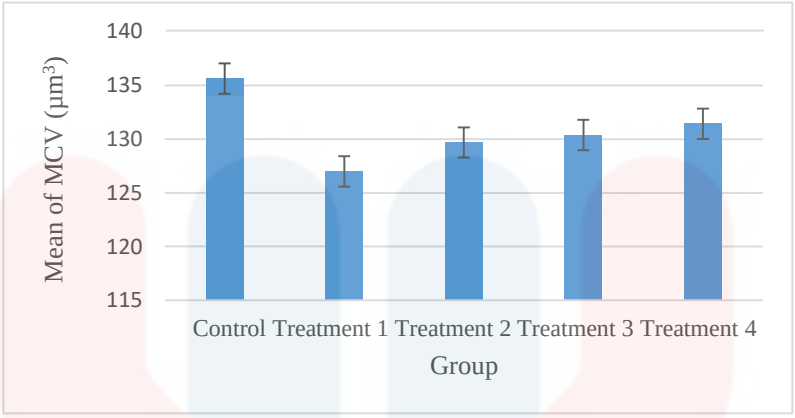

Figure 4.4: Mean and SEM error bar of MCV (µm^3).

The average size of red blood cells, often known as erythrocytes, was measured by mean corpuscular volume (MCV). The average MCV ranges from 90 µm^3 to 143 µm^3. MCV values were within the normal ranges in all groups. As a result, the red blood cells in the hybrid chicken are of average size. A hybrid chicken with a normal MCV, on the other hand, can be anaemic if there are insufficient red blood cells or other RBC indices are abnormal. Aside from the chicken anaemia virus, the hybrid chicken could be suffering from normocytic anaemia. Low haemoglobin and haematocrit levels with a normal MCV are considered normocytic anaemia (Maner & Moosavi, 2021). Normocytic anaemia occurs when the RBC size and haemoglobin content are normal but there are too few of them (Epstein, 2012). Normalcytic anaemia was defined by a decrease in total erythrocyte counts, haemoglobin, packed cell volume, and an increase in erythrocyte sedimentation rate, according to Chandra et al. (1984).

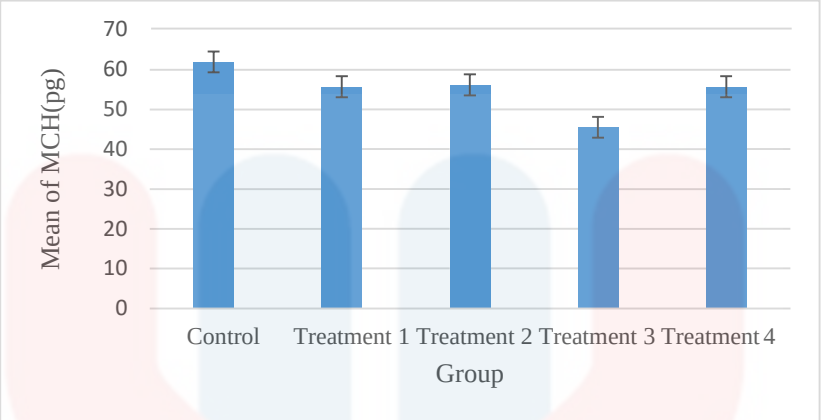

Figure 4.5: Mean and SEM error bar of MCH (pg).

Mean Corpuscular Haemoglobin (MCH) was a measurement of the average haemoglobin concentration in a single erythrocyte (Samour, 2009). As a result, the value of MCH reflects the RBC's haemoglobin content. Variations in MCH value, on the other hand, are caused by a number of factors, including nutritional status, production efficiency, and the animal's genetic makeup. In short, this was an important element in determining the forms of anaemia. The normal MCH value ranges from 33 to 47 pg (Devrim Saripinar Aksu et al., 2010). However, based on the results of the experiment, only Treatment 3 was within the ranges, while the other groups were slightly higher than typical.

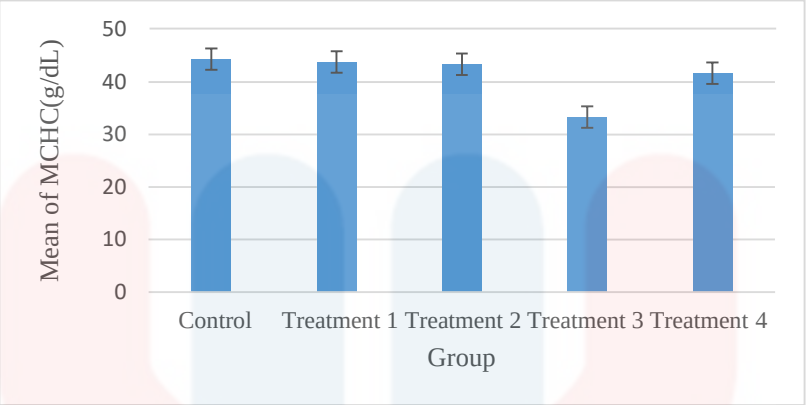

Figure 4.6: Mean and SEM error bar of MCHC (g/dL).

In contrast to MCH, Mean Corpuscular Haemoglobin Concentration (MCHC) was the mean concentration of haemoglobin or the haemoglobin content per unit volume of red blood cells. The typical range for MCHC in broilers was 26 g/dL to 35 g/dL. Only Treatment 3 fit within the given range. Other groups' values were slightly higher than the average. Anaemia was usually associated with a high MCH value.

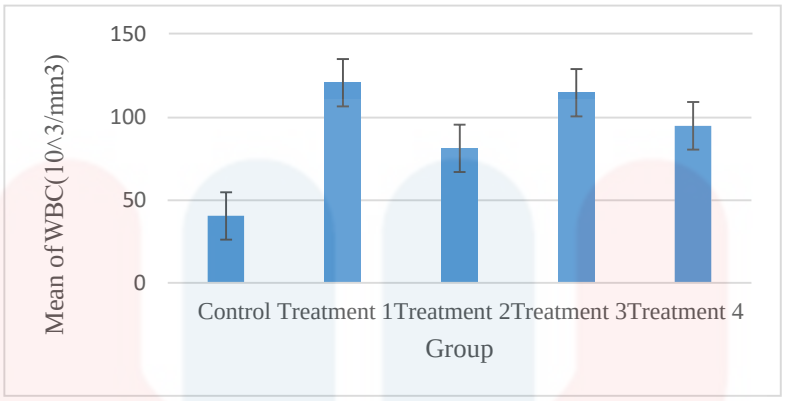

Figure 4.7: Mean and SEM error bar of WBC (10^3/mm3).

Total leukocyte counts are a crucial determinant in suggesting health issues when they surpass the maximum standard level, a condition known as leucocytosis. Trauma, infection, toxicity, haemorrhages, leukaemia, and quickly growing neoplasms within the body can all induce leucocytosis (Pare, 1997). The quantity of leucocytes varies and changes constantly as a result of numerous factors such as stress, hormones, and disease. White blood cell (WBC) optimal values range from 11.40×10 ^ 3/mm3 to 30×10 ^ 3/mm3 (Swenson, 1984; Orawan and Aengwanich, 2007). The results of the experiment show that all treatments' values were significantly higher than the standard value, which ranged from 40.50×10^3/mm3 to 121.05×10^3/mm3. As a result, the hybrid chicken could be contaminated with diseases. The increased leukocyte count indicates a humoral and cellular response to the pathogenic agent that was causing the sickness. According to Moyes and Schute (2008) and Soeharsono et al. (2010), total leukocyte can be used to estimate animal health because rising leukocyte was a criterion of body immune, and decreasing leukocyte may simply no infection or pathogenic bacteria in the body. Bacterial infection can cause health issues, as seen by an increase in WBC.

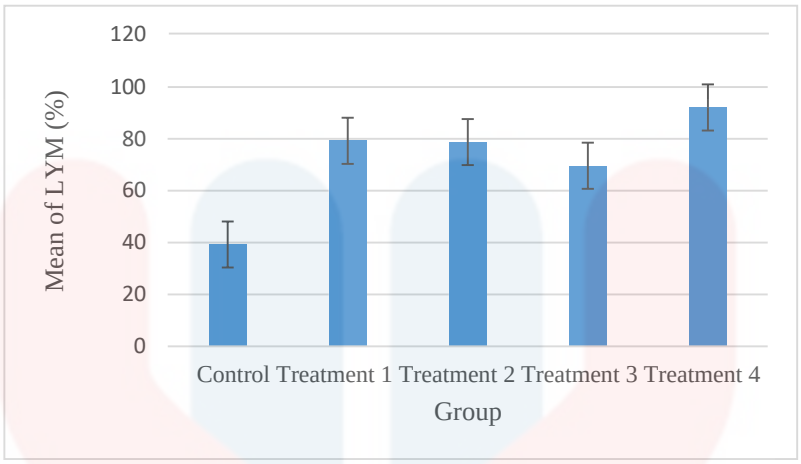

Figure 4.8: Mean and SEM error bar of LYM (%).

Makeri (2017) discovered that the level of LYM detected in broiler was higher than the typical range of 50% to 62%. Variations in the number of leukocytes, according to Olson (1965), are connected with a variety of disorders that increase the number of lymphocytes. The hybrid chicken's blood could be infected with illnesses or cancer due to the elevated lymphocyte count. Curcumin, found in turmeric, was a powerful immune system booster in chicken, promoting general health and well-being. It also acts as an anti-inflammatory agent, which was useful in the treatment of bumblefoot and other inflamed injuries in chickens (Kerrie, 2016). However, because the treatment's LYM levels were all high, the addition of turmeric in feed ingredients had no effect on hybrid chicken health. This could be due to insufficient turmeric in the animal feed study.

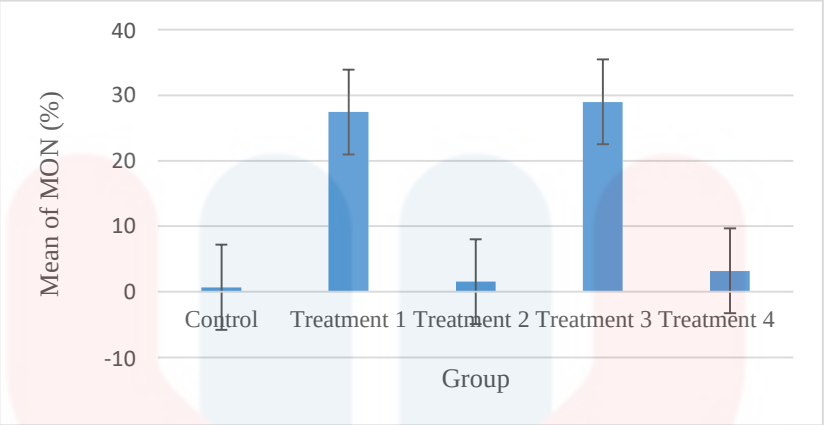

Figure 4.9: Mean and SEM error bar of MON (%).

Monocytes (MON) are leukocytes that originate in the bone marrow and circulate throughout the body via the blood and spleen (Chiu & Bharat, n.d.). A healthy amount of MON in the body lets the immune system to fight specific infections while also assisting other WBC in the removal of dead and damaged tissues and immunity 31 against foreign toxins. Monocytes are recognised for their phagocytic involvement in immune response systems, as well as their ability to change into macrophages when they migrate through tissues, when it comes to their position as a defensive mechanism in the immune response to foreign substances (Harmon and Blisson, 1990). The percentage of MON in Treatment 3 and 1 was considerably higher than in Treatment 4, Treatment 2 and Control.

4.2 Physicochemical Properties of Hybrid Chicken Meat

The physicochemical properties of chicken meat had a significant role in determining product acceptance in the public market, where it was strongly tied to nutritional and commercial value (Li et al., 2011). The mean and standard error of the physicochemical parameters of broiler meat of pH value, water holding capacity (WHC), colour (L*: lightness, a*: redness, and b*: yellowness) and tenderness are shown in Table 4.2. Only pH and colour (b*) were found to be substantially different ($p<0.05$) in the experiment. The mean for WHC in Treatment 3, and Treatment 4 was 9.67, compared to 9.33 in Control and Treatment 1. Treatment 2 had the highest WHC which was 10.00. The highest mean in colorimetric analysis for L* in Treatment 1 (39.52) was followed by Treatment 2, Treatment 4, Control, and Treatment 3. The mean colorimetric analysis for a* in Treatment 2 was 7.17, followed by Treatment 4, Treatment 3, Treatment 1, and Control. The mean colorimetric analysis for b* in Treatment 1 and Treatment 2 was 8.98, followed by Treatment 4, Treatment 3, and Control. The greatest mean for tenderness was Treatment 3 (13.33), followed by Treatment 2, Treatment 1, Control, and Treatment 4. Finally, Treatment 2 had the highest mean pH (6.40), followed by Control, Treatment 4, Treatment 3, and Treatment 1.

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

Parameter	Group					p-value
	Control	Treatment 1	Treatment 2	Treatment 3	Treatment 4	
pH	6.33±0.09^{ab}	5.97±0.09^{a}	6.40±0.06^{b}	6.00±0.07^{a}	6.23±0.12^{ab}	0.01
WHC	9.33 ±0.33^{a}	9.33±0.33^{a}	10.00±0.33^{a}	9.67±0.33^{a}	9.67±0.33^{a}	0.51
Tenderness	3.41±0.04^{a}	3.48±0.13^{a}	3.50±0.05^{a}	3.65±0.05^{a}	3.45±0.11^{a}	0.39
Colour						
L*	34.78±0.74^{a}	39.52±0.83^{b}	36.67±0.97^{ab}	34.25±1.90^{a}	35.71±1.09^{ab}	0.07
a*	4.65±0.36^{a}	4.84±0.37^{a}	7.17±0.63^{a}	5.33±2.14^{a}	5.40±1.11^{a}	0.57
b*	10.91±0.59^{a}	11.53±0.54^{a}	12.03±0.19^{ab}	13.33±0.07^{b}	10.88±0.05^{a}	0.01

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

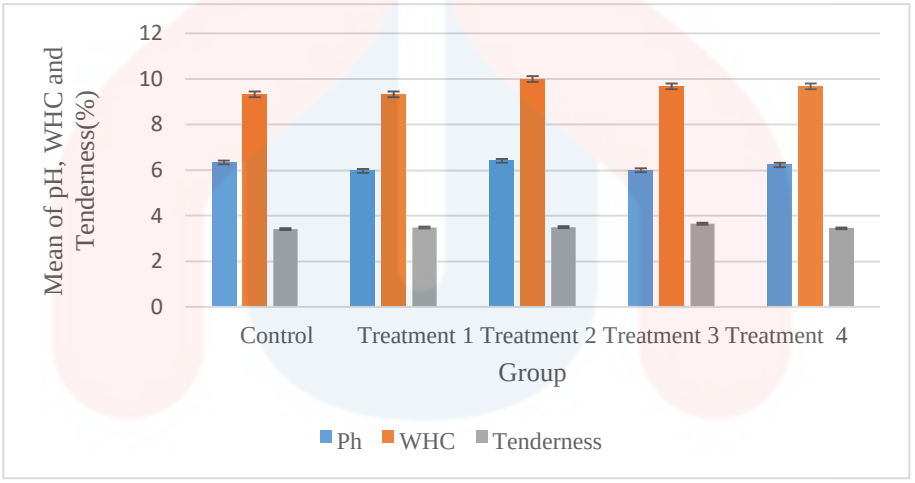

Figure 4.10: Mean and SEM error bar of pH, WHC and Tenderness of hybrid meat.

Various studies show that the highest quality broiler breast meat products frequently range within the ultimate pH range of 5.7 to 6.0. (Glamoclija et al., 2015). According to the results, the values obtained from Treatments 1 and 3 are within the stated range. The next three treatments had a range of 6.23 to 6.40, which was somewhat outside the specified data range. Treatment 2 had the greatest pH value. The more the stress, the higher the pH levels (Barrasso et al., 2021). During the slaughter phase, stress lowers muscle glycogen levels, leading in a high ultimate pH (Tarrant et al., 1992).

The pH value influences tenderness, water-holding capacity, colour, juiciness, and shelf life. Meat with a high pH holds more water than meat with a low pH. (Mir et al., 2017). According to the results of the experiment, all treatments had enhanced water holding capacity ranging from 9.33 to 10 since the majority of treatments had a higher pH value. Treatment 2 had the highest pH value and hence a high water holding capacity, whereas Treatment 1 had a low pH value and thus a poor water holding capacity. According to Warner (2017), meat with a high final pH did not shrink in myofibrils and muscle cells after death. Meat with a low pH and denatured proteins, on the other hand, shrinks excessively, causing water loss in the myofibrils and muscle cells.

Lower final pH chicken meat had less water holding capacity, which affects cooking loss and drip loss, whereas meat with a higher final pH had better tenderness (Froning et al. 1978, Barbut 1993). Treatment 3 was the most tender, whereas Control was the least tender. Anything that interferes with the establishment of rigour mortis or the subsequent softening process will impact the tenderness of the flesh. The hybrid chicken may struggle prior to or during slaughter, causing their muscles to expend more energy and rigour mortis to form more quickly than usual. Because the living bird's energy level was lowered, the texture of these muscles was rough. As a result, this was less tender than other treatments.

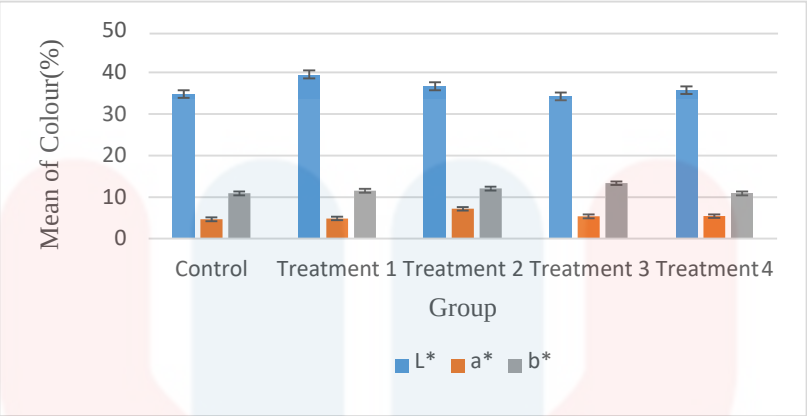

Figure 4.11: Mean and SEM error bar of color; L*: lightness, a*: redness, b*: yellowness.

Meat proteins with a low final pH hold less water and are lighter in colour. A higher ultimate pH will result in a darker colour and less drip loss. Lightness (L*) levels in hybrid chicken meat are classified into three categories: PSE (pale, soft, exudative), normal, and DFD (dark, firm, dry). PSE must be greater than 53, normal must be between 44 and 53, and DFD must be less than 44. (Kralik et al., 2014). All treatments were DFD, according to the analysis results, because the values obtained ranged from 34.25 to 39.52. The hybrid chicken meat in Treatment 2 was the darkest (a*=7.17). The results could be terrible. DFD meats may occur when animals are subjected to chronic or long-term stress prior to slaughter. Chronic stress was exemplified by long-distance transportation of animals, prolonged periods of food scarcity, and long-term crowding of animals in the lairage. Chronic stress prior to slaughter depletes stored glycogen, making less glycogen available post-mortem, interfering with the natural acidification process and raising the pH of meat (Adzitey & Nurul, 2011).

4.3 Proximate Analysis

The proximate analysis was performed to determine the quantitative analysis of macromolecules inside the broiler meat (foodnavigator.com, 2020). Table 4.3 shown a mean and standard error of proximate analysis hybrid chicken meat of dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF), and ash content. In the proximate analysis, the experiment produced a significant difference for all parameters ($p<0.05$).

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

Parameter(%)	Group					
	Control	Treatment 1	Treatment 2	Treatment 3	Treatment 4	p-value
Dry Matter	85.09±0.03^{a}	85.40±0.12^{ab}	85.58±0.05^{b}	85.96±0.10^{c}	86.43±0.10^{d}	0.00
Crude Protein	84.43±0.54^{d}	66.34±1.13^{a}	71.15±0.89^{b}	72.17±0.61^{b}	75.81±0.22^{c}	0.00
Ether Extract	17.42±0.44^{b}	10.38±0.46^{a}	11.39±0.18^{a}	17.10±0.33^{b}	23.33±0.37^{c}	0.00
Crude Fibre	0.78±0.04^{b}	0.50±0.01^{a}	0.43±0.04^{a}	1.05±0.03^{c}	1.14±0.03^{c}	0.00
Ash	3.32±0.03^{a}	3.28±0.04^{a}	3.25±0.17^{a}	4.52±0.03^{b}	4.54±0.01^{b}	0.00

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

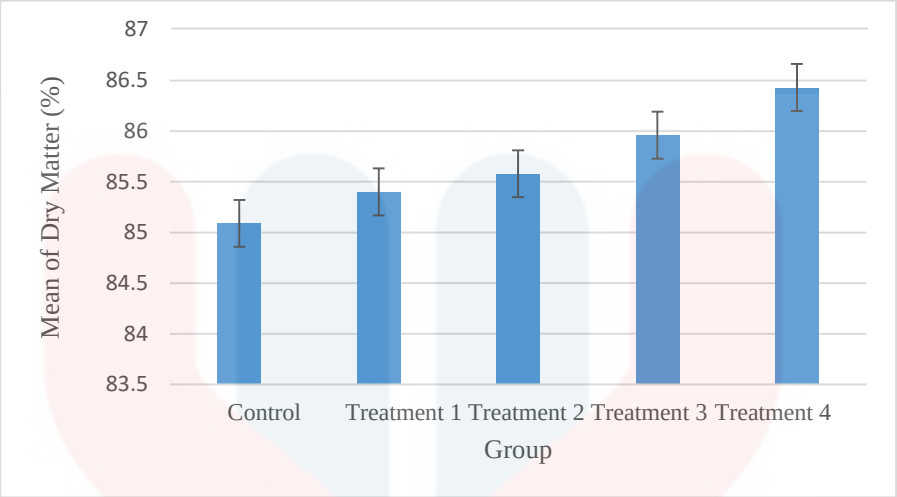

Figure 4.12: Mean and SEM error bar of Dry Matter (%).

Dry matter was the removal of water from the feed, leaving just the dry ingredients which are fibre, protein, minerals, carbohydrates, and other nutrients (*Dry Matter Determination – DAIReXNET,* 2019). According to the Table 4.3, the dry matter in Control was 85.09 %. Each treatment group's dry matter percentage differs from the Control. The BSFL content in Treatments 1 and 3 was just 10%, while the BSFL content in Treatments 2 and 4 was 15%. Treatment 4 had the highest dry matter (86.43), followed by Treatment 3, Treatment 2, and Treatment 1. This was true because the average of crude fibre in Treatment 4 was the highest among the other feed (1.14).

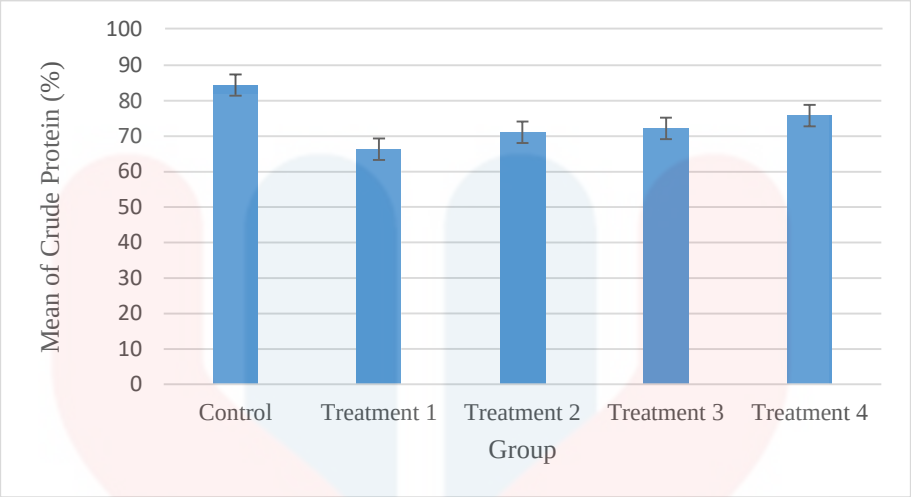

Figure 4.13: Mean and SEM error bar of Crude Protein (%).

Crude protein was a measurement of the amount of protein in food based on laboratory tests that examine the chemical composition of the meal. The food's nutrition label at the packaging was crude protein (Food labels: nutritional information and ingredients, 2020). According to the Journal of Animal Research and Nutrition (2021), food manufacturers determine the number of carbohydrates in food using crude protein content. Control in crude protein had a mean of 84.43 %. Treatment 4 was the most similar to Control, with a value of 75.81 %. Treatment 1 had the lowest crude protein concentration, at 66.34 %. The meat in Treatment 4 contained more crude protein. Despite the fact that Treatment 2 and Treatment 4 both included the same amount of BSFL (15%), Treatment 4 contains additional protein source ingredients such as water spinach and coconut dregs.

However, the percentage of CP in all samples from the experiment was invalid because the percent CP for hybrid chicken meat ranges between 20 and 24 % (Panreac, n.d). There was a human error in this experiment. Usually, the digestion period should

had been more than four hours. In this experiment, the samples only digested for three to four hours. Since the kjeldahl machine was used every day, its efficiency was decreased.

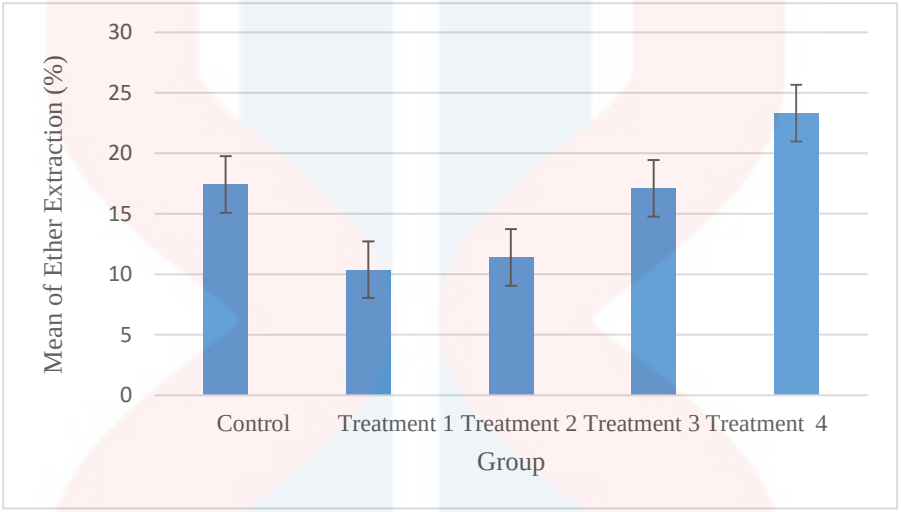

Figure 4.14: Mean and SEM error bar of Ether Extraction (%).

Ether extract (EE) determination was required for food manufacturers to indicate fat content in their products. It was also crucial to carefully check the fat level because it affects the quality or value of the product (Fat Determination - Home., 2022). According to Table 4.3, the ether extract for Control is 17.42 %. Treatments 1 and 2 exhibit lower ether extract levels of 10.38 % and 11.39 %, respectively. Because of the usage of coconut dregs and turmeric, Treatments 3 and 4 had greater ether extract contents of 17.1 % and 23.33 %, respectively. Treatment 3 was the most similar to Control. Local items with crude fat content include water spinach, fermented coconut dregs, and turmeric. The fatter, the less acceptable it was to the consumer. Excess fat content, according to Song, Lin, Zhang, Hayat, Chen, Liu, Xiao, and Niu (2013), can diminish meat shelf life by causing the meat to go rancid. Consumers prefer non-rancid meat.

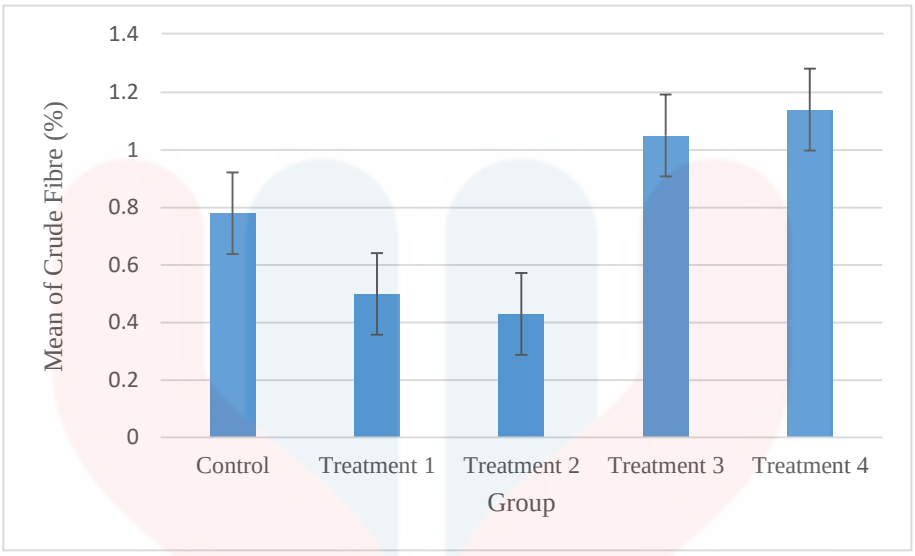

Figure 4.15: Mean and SEM error bar of Crude Fibre (%).

Crude fibre was the amount of indigestible cellulose, pentosans, and lignin (Crude Fiber, 2022). These components provide the bulk necessary for proper peristaltic action in the intestine. According to Table 4.3, the crude fibre content of Control was 0.78 %. Treatments 1 and 2 exhibit reduced crude fibre levels of 0.5% and 0.43 %, respectively. Treatments 3 and 4 exhibit greater crude fibre levels of 1.05 % and 1.14 %, respectively. Treatment 3 was the most similar to Control. Because they contain fermented coconut dregs, water spinach, and turmeric, Treatments 3 and 4 had a larger amount of crude fibre than Treatments 1 and 2. These local ingredients help to boost the crude fibre content of hybrid chicken meat. Crude fibre was crucial in the diets of ruminants, who may ferment a significant portion of it. Although crude fibre had low calorie value, it was essential for the digestive health of pigs and fowl (Cherian, 2019). Because they are easy to access, produce, and are inexpensive, increased use of these local foods in animal feed may help improve crude fibre while reducing ingredient feed costs.

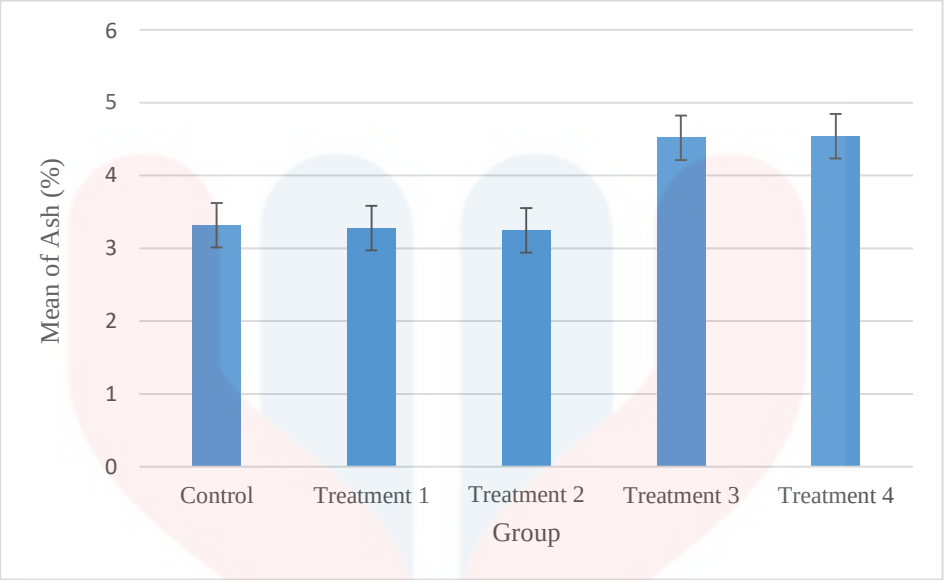

Figure 4.16: Mean and SEM error bar of Ash (%).

A food's ash content was assessed as part of proximate analysis for nutritional evaluation, and it was a critical quality attribute for specific food ingredients. The removal of organic content to disclose inorganic minerals was all that was required to determine ash concentration in food. This helps determine the amount and type of minerals in diet. It was significant because mineral content can affect the physiochemical properties of foods as well as microbial proliferation (Moisture, Ash Testing in Food Processing, 2010). As a result, mineral content was critical for food nutrition, just as quality and microbiological viability are. Control contains 3.32 % ash. Because of the fermented coconut dregs, water spinach, and turmeric, Treatments 3 and 4 had a higher ash level than Treatments 1 and 2. These local ingredients contribute to the hybrid chicken meat's higher ash content. In his study (Ash Level Determination, 2017), Baraem Ismail mentioned that the lower the ash content of the sample, the lower the minerals in the food product. As a result, minerals are more abundant in Treatments 3 and 4. The utilisation of these locally sourced ingredients can help to produce low-cost animal feed.

4.4 Sensory Evaluation

A sensory test was used to determine sensory evaluation. Sensory analysis was a scientific approach for analysing and measuring human responses such appearance, touch, odour, texture, temperature, pH, and taste (Sensory evaluation - Food a fact of life, 2018). Furthermore, it can advise product developers and scientists about the sensory characteristics and acceptability of their product (Lawless, 1999). The sensory evaluation was carried out on both raw and cooked meat. Raw meat had colour and odour, while cooked meat had tenderness and flavour. Finally, customers' overall acceptance of hybrid chickens meat. Only colour had a statistically significant difference in sensory evaluation ($p<0.05$).

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

Parameter(%)	Group					p-value
	Control	Treatment 1	Treatment 2	Treatment 3	Treatment 4	
			Raw Meat			
Colour	2.78±0.26^{b}	2.11±0.27^{ab}	4.11±0.24^{c}	3.94±0.24^{c}	1.72±0.27^{a}	0.00
Odour	2.17±0.28^{a}	1.94±0.26^{a}	1.94±0.17^{a}	2.11±0.29^{a}	1.67±0.18^{a}	0.63
			Cooked Meat			
Tenderness	2.61±0.26^{a}	3.28±0.27^{a}	2.78±0.21^{a}	2.78±0.22^{a}	2.56±0.33^{a}	0.31
Flavour	3.17±0.20^{a}	3.50±0.22^{a}	3.28±0.18^{a}	3.28±0.16^{a}	3.61±0.78^{a}	0.45
Overall Preferences	2.67±0.20^{a}	3.06±0.22^{a}	2.72±0.16^{a}	2.89±0.18^{a}	2.94±0.25^{a}	0.65

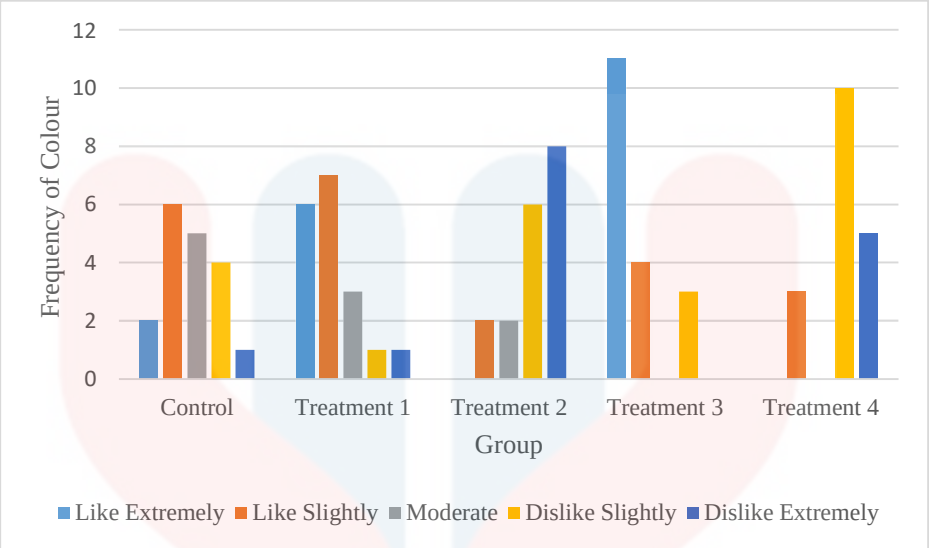

Figure 4.17: Frequency and SEM Error Bar of Colour of Hybrid Meat.

According to figure 4.16, Treatment 3 had the highest frequency of preferable colour on raw hybrid chicken meat; 11 on like extremely and four on like slightly, followed by Treatment 1 and Control, Treatment 2 and Treatment 3 had the least preferable for consumers.

There was no significant difference $p<0.05$ for all groups after statical analysis using One Way ANOVA, except for the colour of raw hybrid chicken meat. As a result, the feed trial had no effect on the odour, tenderness, or flavour of hybrid chicken meat, and customers will accept the hybrid meat.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

According to the study findings, Treatment 3 with 10% BSFL, water spinach, fermented coconut dregs, and turmeric was the best meat quality for customers. This was due to Treatment 3 having the closest average red blood cell count and ideal pH value, as pH value influences other physicochemical qualities in hybrid meat. In proximal analysis, Treatment 3 also had the closest value to Control when compared to the other groups. Finally, the sensory evaluation had no effect on the hybrid meat. As a result, people can continue to eat hybrid meat with no harmful effects. To summarize, BSFL, water spinach, fermented coconut dregs, and turmeric can be recommended as an alternative to expensive protein feedstuffs like fish meal and soybean meal.

5.2 Recommendation

Aside from that, the feed should be palletised to guarantee that the animals get the most out of their meal. This was due to the bird's ability to select the feed and the bird's inability to receive the entire nutritional value from the diet. Furthermore, the availability of laboratory equipment, such as the Warner-Bratzler knife with guillotine block, should be expanded to allow proper comparison of acquired data with existing research which was most commonly used in determining meat tenderness. The addition of iron in feed ingredients may aid in the growth of red blood cells in hybrid chicken meat. Last but not least, further research in blood serum biochemistry analysis and histopathological analysis are highly recommended to be carried out in order to better understand and investigate the components in BSFL, water spinach, fermented coconut dregs, and turmeric, as well as the effects on hybrid chicken's health level.

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APPENDICES

APPENDIX A

Table A.1: Table of Descriptive Analysis of Haematological Sample via SPSS

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
WBC	Control	4	40.0500	.51962	.25981	39.2232	40.8768	39.60	40.50
	TR1	4	121.0500	1.09697	.54848	119.3045	122.7955	120.10	122.00
	TR2	4	81.3000	1.38564	.69282	79.0951	83.5049	80.10	82.50
	TR3	4	115.0000	.34641	.17321	114.4488	115.5512	114.70	115.30
	TR4	4	94.9500	.17321	.08660	94.6744	95.2256	94.80	95.10
	Total	20	90.4700	29.68555	6.63789	76.5767	104.3633	39.60	122.00
LYM	Control	4	39.2500	.28868	.14434	38.7907	39.7093	39.00	39.50
	TR1	4	79.2000	3.81051	1.90526	73.1366	85.2634	75.90	82.50
	TR2	4	78.7000	.92376	.46188	77.2301	80.1699	77.90	79.50
	TR3	4	69.5500	.86603	.43301	68.1720	70.9280	68.80	70.30
	TR4	4	92.0000	1.15470	.57735	90.1626	93.8374	91.00	93.00
	Total	20	71.7400	18.28495	4.08864	63.1824	80.2976	39.00	93.00
MON	Control	4	.6950	.10970	.05485	.5204	.8696	.60	.79
	TR1	4	27.4500	1.55885	.77942	24.9695	29.9305	26.10	28.80
	TR2	4	1.5500	.28868	.14434	1.0907	2.0093	1.30	1.80
	TR3	4	29.0000	1.38564	.69282	26.7951	31.2049	27.80	30.20
	TR4	4	3.2000	.11547	.05774	3.0163	3.3837	3.10	3.30
	Total	20	12.3790	13.33593	2.98201	6.1376	18.6204	.60	30.20

RBC	Control	4	.4000	.01155	.00577	.3816	.4184	.39	.41
	TR1	4	2.0850	.20207	.10104	1.7635	2.4065	1.91	2.26
	TR2	4	.8900	.18475	.09238	.5960	1.1840	.73	1.05
	TR3	4	2.5350	.53694	.26847	1.6806	3.3894	2.07	3.00
	TR4	4	1.1550	.39837	.19919	.5211	1.7889	.81	1.50
	Total	20	1.4130	.85450	.19107	1.0131	1.8129	.39	3.00
HGB	Control	4	2.8000	.46188	.23094	2.0650	3.5350	2.40	3.20
	TR1	4	11.5500	.05774	.02887	11.4581	11.6419	11.50	11.60
	TR2	4	5.0000	1.03923	.51962	3.3464	6.6536	4.10	5.90
	TR3	4	12.5000	.57735	.28868	11.5813	13.4187	12.00	13.00
	TR4	4	4.7500	.40415	.20207	4.1069	5.3931	4.40	5.10
	Total	20	7.3200	4.06495	.90895	5.4175	9.2225	2.40	13.00
HCT	Control	4	5.7500	.51962	.25981	4.9232	6.5768	5.30	6.20
	TR1	4	26.4500	2.25167	1.12583	22.8671	30.0329	24.50	28.40
	TR2	4	11.4500	1.78979	.89489	8.6021	14.2979	9.90	13.00
	TR3	4	26.6500	.63509	.31754	25.6394	27.6606	26.10	27.20
	TR4	4	11.1500	.63509	.31754	10.1394	12.1606	10.60	11.70
	Total	20	16.2900	8.92665	1.99606	12.1122	20.4678	5.30	28.40
MCV	Control	4	135.6500	.28868	.14434	135.1907	136.1093	135.40	135.90
	TR1	4	127.0000	1.50111	.75056	124.6114	129.3886	125.70	128.30
	TR2	4	129.7000	6.81273	3.40637	118.8594	140.5406	123.80	135.60
	TR3	4	130.4000	1.15470	.57735	128.5626	132.2374	129.40	131.40
	TR4	4	131.4500	.63509	.31754	130.4394	132.4606	130.90	132.00
	Total	20	130.8400	4.04220	.90386	128.9482	132.7318	123.80	135.90
MCH	Control	4	61.9500	.51962	.25981	61.1232	62.7768	61.50	62.40
	TR1	4	55.7500	5.13842	2.56921	47.5736	63.9264	51.30	60.20
	TR2	4	56.2000	.00000	.00000	56.2000	56.2000	56.20	56.20
	TR3	4	45.5500	.00000	.00000	45.5500	45.5500	45.55	45.55
	TR4	4	55.7000	1.61658	.80829	53.1277	58.2723	54.30	57.10
	Total	20	55.0300	5.84102	1.30609	52.2963	57.7637	45.55	62.40
MCHC	Control	4	44.4000	1.03923	.51962	42.7464	46.0536	43.50	45.30
	TR1	4	43.8500	3.52184	1.76092	38.2460	49.4540	40.80	46.90
	TR2	4	43.4000	2.30940	1.15470	39.7252	47.0748	41.40	45.40
	TR3	4	33.3500	.00000	.00000	33.3500	33.3500	33.35	33.35
	TR4	4	41.7000	.23094	.11547	41.3325	42.0675	41.50	41.90
	Total	20	41.3400	4.54288	1.01582	39.2139	43.4661	33.35	46.90

Table A.2: Table of Statistical Analysis ANOVA in SPSS on Haematological Parameters

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
WBC	Between Groups	16732.772	4	4183.193	5902.906	.000
	Within Groups	10.630	15	.709		
	Total	16743.402	19			
LYM	Between Groups	6299.828	4	1574.957	448.962	.000
	Within Groups	52.620	15	3.508		
	Total	6352.448	19			
MON	Between Groups	3365.719	4	841.430	943.582	.000
	Within Groups	13.376	15	.892		
	Total	3379.095	19			
RBC	Between Groups	12.307	4	3.077	29.465	.000
	Within Groups	1.566	15	.104		
	Total	13.873	19			
HGB	Between Groups	308.572	4	77.143	215.083	.000
	Within Groups	5.380	15	.359		
	Total	313.952	19			
HCT	Between Groups	1485.968	4	371.492	198.659	.000
	Within Groups	28.050	15	1.870		
	Total	1514.018	19			
MCV	Between Groups	158.988	4	39.747	3.936	.022
	Within Groups	151.460	15	10.097		
	Total	310.448	19			
MCH	Between Groups	560.372	4	140.093	23.918	.000
	Within Groups	87.860	15	5.857		
	Total	648.232	19			
MCHC	Between Groups	335.508	4	83.877	22.225	.000
	Within Groups	56.610	15	3.774		
	Total	392.118	19			

Table A.3: Table of Homogenous Subsets in Statistical Analysis (WBC)

WBC

			Subset for alpha = 0.05				
	Group	N	1	2	3	4	5
Tukey HSD[a]	Control	4	40.0500				
	TR2	4		81.3000			
	TR4	4			94.9500		
	TR3	4				115.0000	
	TR1	4					121.0500
	Sig.		1.000	1.000	1.000	1.000	1.000
Duncan[a]	Control	4	40.0500				
	TR2	4		81.3000			
	TR4	4			94.9500		
	TR3	4				115.0000	
	TR1	4					121.0500
	Sig.		1.000	1.000	1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Table A.4: Table of Homogenous Subsets in Statistical Analysis (LYM)

LYM

			Subset for alpha = 0.05			
	Group	N	1	2	3	4
Tukey HSD[a]	Control	4	39.2500			
	TR3	4		69.5500		
	TR2	4			78.7000	
	TR1	4			79.2000	
	TR4	4				92.0000
	Sig.		1.000	1.000	.995	1.000
Duncan[a]	Control	4	39.2500			
	TR3	4		69.5500		
	TR2	4			78.7000	
	TR1	4			79.2000	
	TR4	4				92.0000
	Sig.		1.000	1.000	.711	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Table A.5: Table of Homogenous Subsets in Statistical Analysis (MON)

MON

			Subset for alpha = 0.05			
	Group	N	1	2	3	4
Tukey HSD[a]	Control	4	.6950			
	TR2	4	1.5500	1.5500		
	TR4	4		3.2000		
	TR1	4			27.4500	
	TR3	4			29.0000	
	Sig.		.706	.150	.192	
Duncan[a]	Control	4	.6950			
	TR2	4	1.5500			
	TR4	4		3.2000		
	TR1	4			27.4500	
	TR3	4				29.0000
	Sig.		.220	1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Table A.6: Table of Homogenous Subsets in Statistical Analysis (RBC)

RBC

			Subset for alpha = 0.05		
	Group	N	1	2	3
Tukey HSD[a]	Control	4	.4000		
	TR2	4	.8900	.8900	
	TR4	4		1.1550	
	TR1	4			2.0850
	TR3	4			2.5350
	Sig.		.253	.773	.326
Duncan[a]	Control	4	.4000		
	TR2	4		.8900	
	TR4	4		1.1550	
	TR1	4			2.0850
	TR3	4			2.5350
	Sig.		1.000	.264	.068

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Table A.A7: Table of Homogenous Subsets in Statistical Analysis (HGB)

HGB

	Group	N	Subset for alpha = 0.05			
			1	2	3	4
Tukey HSD[a]	Control	4	2.8000			
	TR4	4		4.7500		
	TR2	4		5.0000		
	TR1	4			11.5500	
	TR3	4			12.5000	
	Sig.		1.000	.974	.217	
Duncan[a]	Control	4	2.8000			
	TR4	4		4.7500		
	TR2	4		5.0000		
	TR1	4			11.5500	
	TR3	4				12.5000
	Sig.		1.000	.564	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Table A.8: Table of Homogenous Subsets in Statistical Analysis (HCT)

HCT

	Group	N	Subset for alpha = 0.05		
			1	2	3
Tukey HSD[a]	Control	4	5.7500		
	TR4	4		11.1500	
	TR2	4		11.4500	
	TR1	4			26.4500
	TR3	4			26.6500
	Sig.		1.000	.998	1.000
Duncan[a]	Control	4	5.7500		
	TR4	4		11.1500	
	TR2	4		11.4500	
	TR1	4			26.4500
	TR3	4			26.6500
	Sig.		1.000	.761	.839

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Table A.9: Table of Homogenous Subsets in Statistical Analysis (MCV)

MCV

	Group	N	Subset for alpha = 0.05	
			1	2
Tukey HSD[a]	TR1	4	127.0000	
	TR2	4	129.7000	129.7000
	TR3	4	130.4000	130.4000
	TR4	4	131.4500	131.4500
	Control	4		135.6500
	Sig.		.321	.111
Duncan[a]	TR1	4	127.0000	
	TR2	4	129.7000	
	TR3	4	130.4000	
	TR4	4	131.4500	131.4500
	Control	4		135.6500
	Sig.		.087	.081

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Table A.10: Table of Homogenous Subsets in Statistical Analysis (MCH)

MCH

	Group	N	Subset for alpha = 0.05		
			1	2	3
Tukey HSD[a]	TR3	4	45.5500		
	TR4	4		55.7000	
	TR1	4		55.7500	
	TR2	4		56.2000	
	Control	4			61.9500
	Sig.		1.000	.998	1.000
Duncan[a]	TR3	4	45.5500		
	TR4	4		55.7000	
	TR1	4		55.7500	
	TR2	4		56.2000	
	Control	4			61.9500
	Sig.		1.000	.786	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Table A.11: Table of Homogenous Subsets in Statistical Analysis (MCHC)

MCHC

	Group	N	Subset for alpha = 0.05	
			1	2
Tukey HSD[a]	TR3	4	33.3500	
	TR4	4		41.7000
	TR2	4		43.4000
	TR1	4		43.8500
	Control	4		44.4000
	Sig.		1.000	.328
Duncan[a]	TR3	4	33.3500	
	TR4	4		41.7000
	TR2	4		43.4000
	TR1	4		43.8500
	Control	4		44.4000
	Sig.		1.000	.089

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Table A.12: Table of Descriptive Analysis of pH via SPSS

Descriptives

pH

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Control	3	6.3333	.15275	.08819	5.9539	6.7128	6.20	6.50
TR1	3	5.9667	.15275	.08819	5.5872	6.3461	5.80	6.10
TR2	3	6.4000	.10000	.05774	6.1516	6.6484	6.30	6.50
TR3	3	6.0000	.00000	.00000	6.0000	6.0000	6.00	6.00
TR4	3	6.2667	.20817	.12019	5.7496	6.7838	6.10	6.50
Total	15	6.1933	.21865	.05646	6.0722	6.3144	5.80	6.50

Table A.13: Table of Statistical Analysis ANOVA in SPSS on pH Parameters

ANOVA

pH

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.469	4	.117	5.867	.011
Within Groups	.200	10	.020		
Total	.669	14			

Table A.14: Table of Homogenous Subsets in Statistical Analysis (pH)

pH

	Group	N	Subset for alpha = 0.05	
			1	2
Tukey HSD[a]	TR1	3	5.9667	
	TR3	3	6.0000	
	TR4	3	6.2667	6.2667
	Control	3	6.3333	6.3333
	TR2	3		6.4000
	Sig.		.060	.775
Duncan[a]	TR1	3	5.9667	
	TR3	3	6.0000	
	TR4	3		6.2667
	Control	3		6.3333
	TR2	3		6.4000
	Sig.		.779	.296

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Table A.15: Table of Descriptive Analysis of WHC via SPSS

Descriptives

WHC

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Control	3	9.3333	.57735	.33333	7.8991	10.7676	9.00	10.00
TR1	3	9.3333	.57735	.33333	7.8991	10.7676	9.00	10.00
TR2	3	10.0000	.00000	.00000	10.0000	10.0000	10.00	10.00
TR3	3	9.6667	.57735	.33333	8.2324	11.1009	9.00	10.00
TR4	3	9.6667	.57735	.33333	8.2324	11.1009	9.00	10.00
Total	15	9.6000	.50709	.13093	9.3192	9.8808	9.00	10.00

Table A.16: Table of Statistical Analysis ANOVA in SPSS on WHC Parameters

ANOVA

WHC

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.933	4	.233	.875	.512
Within Groups	2.667	10	.267		
Total	3.600	14			

Table A.17: Table of Homogenous Subsets in Statistical Analysis (WHC)

WHC

	Group	N	Subset for alpha = 0.05 1
Tukey HSD[a]	Control	3	9.3333
	TR1	3	9.3333
	TR3	3	9.6667
	TR4	3	9.6667
	TR2	3	10.0000
	Sig.		.539
Duncan[a]	Control	3	9.3333
	TR1	3	9.3333
	TR3	3	9.6667
	TR4	3	9.6667
	TR2	3	10.0000
	Sig.		.176

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Table 18: Table of Descriptive Analysis of Tenderness via SPSS

Descriptives

Tenderness

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound	Minimum	Maximum
Control	3	3.4067	.07024	.04055	3.2322	3.5811	3.34	3.48
TR1	3	3.4833	.22546	.13017	2.9233	4.0434	3.25	3.70
TR2	3	3.5000	.08660	.05000	3.2849	3.7151	3.40	3.55
TR3	3	3.6500	.08660	.05000	3.4349	3.8651	3.55	3.70
TR4	3	3.4500	.20000	.11547	2.9532	3.9468	3.25	3.65
Total	15	3.4980	.15200	.03925	3.4138	3.5822	3.25	3.70

Table A.19: Table of Statistical Analysis ANOVA in SPSS on Tenderness Parameters

ANOVA

Tenderness

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.102	4	.025	1.150	.388
Within Groups	.222	10	.022		
Total	.323	14			

Table A.20: Table of Homogenous Subsets in Statistical Analysis (Tenderness)

Tenderness

			Subset for alpha = 0.05
	Group	N	1
Tukey HSD[a]	Control	3	3.4067
	TR4	3	3.4500
	TR1	3	3.4833
	TR2	3	3.5000
	TR3	3	3.6500
	Sig.		.331
Duncan[a]	Control	3	3.4067
	TR4	3	3.4500
	TR1	3	3.4833
	TR2	3	3.5000
	TR3	3	3.6500
	Sig.		.095

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Table A.21: Table of Descriptive Analysis of Colour Sample via SPSS

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
L	Control	3	34.7833	1.28048	.73929	31.6024	37.9642	33.98	36.26
	TR1	3	39.5167	1.43396	.82790	35.9545	43.0788	37.93	40.72
	TR2	3	36.6700	1.68651	.97370	32.4805	40.8595	35.16	38.49
	TR3	3	34.2467	3.28862	1.89869	26.0773	42.4161	30.65	37.10
	TR4	3	35.7067	1.89358	1.09326	31.0028	40.4106	33.58	37.21
	Total	15	36.1847	2.58760	.66811	34.7517	37.6176	30.65	40.72
a	Control	3	4.6500	.63151	.36460	3.0813	6.2187	4.19	5.37
	TR1	3	4.8400	.63647	.36747	3.2589	6.4211	4.23	5.50
	TR2	3	7.1667	1.09144	.63014	4.4554	9.8779	5.92	7.95
	ATR3	3	5.3267	3.71360	2.14405	-3.8984	14.5518	1.81	9.21
	TR4	3	5.4033	1.91683	1.10668	.6417	10.1650	4.07	7.60
	Total	15	5.4773	1.90560	.49202	4.4220	6.5326	1.81	9.21
b	Control	3	10.9100	1.02191	.59000	8.3714	13.4486	10.32	12.09
	TR1	3	11.5333	.93458	.53958	9.2117	13.8550	10.55	12.41
	TR2	3	12.0300	.32234	.18610	11.2293	12.8307	11.66	12.25
	TR3	3	13.3267	.12858	.07424	13.0073	13.6461	13.18	13.42
	TR4	3	10.8833	.08505	.04910	10.6721	11.0946	10.82	10.98
	Total	15	11.7367	1.07875	.27853	11.1393	12.3341	10.32	13.42

Table A.22: Table of Statistical Analysis ANOVA in SPSS on Colour Parameters

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
L	Between Groups	51.858	4	12.964	3.095	.067
	Within Groups	41.882	10	4.188		
	Total	93.739	14			
a	Between Groups	11.918	4	2.980	.766	.571
	Within Groups	38.920	10	3.892		
	Total	50.838	14			
b	Between Groups	12.201	4	3.050	7.456	.005
	Within Groups	4.091	10	.409		
	Total	16.292	14			

Table A.23: Table of Homogenous Subsets in Statistical Analysis (L*)

L*

	Group	N	Subset for alpha = 0.05	
			1	2
Tukey HSD[a]	TR3	3	34.2467	
	Control	3	34.7833	
	TR4	3	35.7067	
	TR2	3	36.6700	
	TR1	3	39.5167	
	Sig.		.062	
Duncan[a]	TR3	3	34.2467	
	Control	3	34.7833	
	TR4	3	35.7067	35.7067
	TR2	3	36.6700	36.6700
	TR1	3		39.5167
	Sig.		.206	.054

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Table A.24: Table of Homogenous Subsets in Statistical Analysis (a*)

a*

	Group	N	Subset for alpha = 0.05
			1
Tukey HSD[a]	Control	3	4.6500
	TR1	3	4.8400
	TR3	3	5.3267
	TR4	3	5.4033
	TR2	3	7.1667
	Sig.		.550
Duncan[a]	Control	3	4.6500
	TR1	3	4.8400
	TR3	3	5.3267
	TR4	3	5.4033
	TR2	3	7.1667
	Sig.		.181

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Table A.25: Table of Homogenous Subsets In Statistical Analysis (b*)

b*

	Group	N	Subset for alpha = 0.05	
			1	2
Tukey HSD[a]	TR4	3	10.8833	
	Control	3	10.9100	
	TR1	3	11.5333	
	TR2	3	12.0300	12.0300
	TR3	3		13.3267
	Sig.		.256	.171
Duncan[a]	TR4	3	10.8833	
	Control	3	10.9100	
	TR1	3	11.5333	
	TR2	3	12.0300	
	TR3	3		13.3267
	Sig.		.068	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Table A.26: Table of Descriptive Analysis of Dry Matter Sample via SPSS

Descriptives

Dry Matter

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Control	4	85.0900	.06928	.03464	84.9798	85.2002	85.03	85.15
TR1	4	85.4000	.23094	.11547	85.0325	85.7675	85.20	85.60
TR2	4	85.5750	.10970	.05485	85.4004	85.7496	85.48	85.67
TR3	4	85.9650	.19053	.09526	85.6618	86.2682	85.80	86.13
TR4	4	86.4250	.19053	.09526	86.1218	86.7282	86.26	86.59
Total	20	85.6910	.49847	.11146	85.4577	85.9243	85.03	86.59

Table A.27: Table of Statistical Analysis ANOVA in SPSS on Dry Matter Parameters

ANOVA

Dry Matter

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4.293	4	1.073	37.585	.000
Within Groups	.428	15	.029		
Total	4.721	19			

Table A.28: Table of Homogenous Subsets in Statistical Analysis (Dry Matter)

Dry Matter

	Group	N	Subset for alpha = 0.05			
			1	2	3	4
Tukey HSD[a]	Control	4	85.0900			
	TR1	4	85.4000	85.4000		
	TR2	4		85.5750		
	TR3	4			85.9650	
	TR4	4				86.4250
	Sig.		.122	.599	1.000	1.000
Duncan[a]	Control	4	85.0900			
	TR1	4		85.4000		
	TR2	4		85.5750		
	TR3	4			85.9650	
	TR4	4				86.4250
	Sig.		1.000	.164	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Table A.29: Table of Descriptive Analysis of Crude Protein Sample via SPSS

Descriptives

Crude Protein

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Control	4	84.4300	1.08542	.54271	82.7029	86.1571	83.49	85.37
TR1	4	66.3400	2.26321	1.13161	62.7387	69.9413	64.38	68.30
TR2	4	71.1450	1.77247	.88623	68.3246	73.9654	69.61	72.68
TR3	4	72.1650	1.22976	.61488	70.2082	74.1218	71.10	73.23
TR4	4	75.8050	.43301	.21651	75.1160	76.4940	75.43	76.18
Total	20	73.9770	6.33437	1.41641	71.0124	76.9416	64.38	85.37

Table A.30: Table of Statistical Analysis ANOVA in SPSS on Crude Protein Parameters

ANOVA

Crude Protein

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	728.937	4	182.234	81.780	.000
Within Groups	33.425	15	2.228		
Total	762.362	19			

Table A.31: Table of Homogenous Subsets in Statistical Analysis (Crude Protein)

Crude Protein

	Group	N	Subset for alpha = 0.05			
			1	2	3	4
Tukey HSD[a]	TR1	4	66.3400			
	TR2	4		71.1450		
	TR3	4		72.1650		
	TR4	4			75.8050	
	Control	4				84.4300
	Sig.		1.000	.866	1.000	1.000
Duncan[a]	TR1	4	66.3400			
	TR2	4		71.1450		
	TR3	4		72.1650		
	TR4	4			75.8050	
	Control	4				84.4300
	Sig.		1.000	.349	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Table A.32: Table of Descriptive Analysis of Ether Extract Sample via SPSS

Descriptives

Ether Extract

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Control	4	17.4200	.88912	.44456	16.0052	18.8348	16.65	18.19
TR1	4	10.3800	.92376	.46188	8.9101	11.8499	9.58	11.18
TR2	4	11.3900	.36950	.18475	10.8020	11.9780	11.07	11.71
TR3	4	17.0950	.65241	.32620	16.0569	18.1331	16.53	17.66
TR4	4	23.3250	.73323	.36662	22.1583	24.4917	22.69	23.96
Total	20	15.9220	4.85007	1.08451	13.6521	18.1919	9.58	23.96

Table A.33: Table of Statistical Analysis ANOVA in SPSS on Ether Extract Parameters

ANOVA

Ether Extraction

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	438.709	4	109.677	199.873	.000
Within Groups	8.231	15	.549		
Total	446.940	19			

Table A.34: Table of Homogenous Subsets in Statistical Analysis (Ether Extract)

Ether Extraction

	Group	N	Subset for alpha = 0.05		
			1	2	3
Tukey HSD[a]	TR1	4	10.3800		
	TR2	4	11.3900		
	TR3	4		17.0950	
	Control	4		17.4200	
	TR4	4			23.3250
	Sig.		.345	.969	1.000
Duncan[a]	TR1	4	10.3800		
	TR2	4	11.3900		
	TR3	4		17.0950	
	Control	4		17.4200	
	TR4	4			23.3250
	Sig.		.073	.544	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Table A.35: Table of Descriptive Analysis of Crude Fibre Sample via SPSS

Descriptives

Crude Fibre

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Control	4	.7750	.08660	.04330	.6372	.9128	.70	.85
TR1	4	.4950	.01732	.00866	.4674	.5226	.48	.51
TR2	4	.4250	.08660	.04330	.2872	.5628	.35	.50
TR3	4	1.0500	.00000	.00000	1.0500	1.0500	1.05	1.05
TR4	4	1.1350	.05196	.02598	1.0523	1.2177	1.09	1.18
Total	20	.7760	.29722	.06646	.6369	.9151	.35	1.18

Table A.36: Table of Statistical Analysis ANOVA in SPSS on Crude Fibre Parameters

ANOVA

Crude Fibre

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.624	4	.406	112.811	.000
Within Groups	.054	15	.004		
Total	1.678	19			

Table A.37: Table of Homogenous Subsets in Statistical Analysis (Crude Fibre)

Crude Fibre

	Group	N	Subset for alpha = 0.05		
			1	2	3
Tukey HSD[a]	TR2	4	.4250		
	TR1	4	.4950		
	Control	4		.7750	
	TR3	4			1.0500
	TR4	4			1.1350
	Sig.		.491	1.000	.311
Duncan[a]	TR2	4	.4250		
	TR1	4	.4950		
	Control	4		.7750	
	TR3	4			1.0500
	TR4	4			1.1350
	Sig.		.120	1.000	.064

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Table A.38: Table of Descriptive Analysis of Ash Sample via SPSS

Descriptives

Ash

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Control	4	3.3200	.05774	.02887	3.2281	3.4119	3.27	3.37
TR1	4	3.2750	.08660	.04330	3.1372	3.4128	3.20	3.35
TR2	4	3.2500	.34641	.17321	2.6988	3.8012	2.95	3.55
TR3	4	4.5150	.05196	.02598	4.4323	4.5977	4.47	4.56
TR4	4	4.5400	.01155	.00577	4.5216	4.5584	4.53	4.55
Total	20	3.7800	.64328	.14384	3.4789	4.0811	2.95	4.56

Table A.39: Table of Statistical Analysis ANOVA in SPSS on Ash Parameters

ANOVA

Ash

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7.461	4	1.865	69.776	.000
Within Groups	.401	15	.027		
Total	7.862	19			

Table A.40: Table of Homogenous Subsets in Statistical Analysis (Ash)

Ash

	Group	N	Subset for alpha = 0.05	
			1	2
Tukey HSD[a]	TR2	4	3.2500	
	TR1	4	3.2750	
	Control	4	3.3200	
	TR3	4		4.5150
	TR4	4		4.5400
	Sig.		.972	.999
Duncan[a]	TR2	4	3.2500	
	TR1	4	3.2750	
	Control	4	3.3200	
	TR3	4		4.5150
	TR4	4		4.5400
	Sig.		.575	.832

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Table A.41: Table of Descriptive Analysis of Sensory Evaluation Sample via SPSS

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
Colour	Control	18	2.7778	1.11437	.26266	2.2236	3.3319	1.00	5.00
	TR1	18	2.1111	1.13183	.26678	1.5483	2.6740	1.00	5.00
	TR2	18	4.1111	1.02262	.24103	3.6026	4.6196	2.00	5.00
	TR3	18	3.9444	.99836	.23532	3.4480	4.4409	2.00	5.00
	TR4	18	1.7222	1.12749	.26575	1.1615	2.2829	1.00	4.00
	Total	90	2.9333	1.42844	.15057	2.6342	3.2325	1.00	5.00
Odour	Control	18	2.1667	1.20049	.28296	1.5697	2.7637	1.00	4.00
	TR1	18	1.9444	1.10997	.26162	1.3925	2.4964	1.00	4.00
	TR2	18	1.9444	.72536	.17097	1.5837	2.3052	1.00	3.00
	TR3	18	2.1111	1.23140	.29024	1.4988	2.7235	1.00	5.00
	TR4	18	1.6667	.76696	.18078	1.2853	2.0481	1.00	4.00
	Total	90	1.9667	1.02168	.10769	1.7527	2.1807	1.00	5.00
Tenderness	Control	18	2.6111	1.09216	.25742	2.0680	3.1542	1.00	4.00
	TR1	18	3.2778	1.12749	.26575	2.7171	3.8385	1.00	5.00

	TR2	18	2.7778	.87820	.20699	2.3411	3.2145	1.00	4.00
	TR3	18	2.7778	.94281	.22222	2.3089	3.2466	1.00	4.00
	TR4	18	2.5556	1.38148	.32562	1.8686	3.2426	1.00	5.00
	Total	90	2.8000	1.10362	.11633	2.5689	3.0311	1.00	5.00
Flavour	Control	18	3.1667	.85749	.20211	2.7402	3.5931	2.00	5.00
	TR1	18	3.5000	.92355	.21768	3.0407	3.9593	2.00	5.00
	TR2	18	3.2778	.75190	.17723	2.9039	3.6517	2.00	4.00
	TR3	18	3.2778	.66911	.15771	2.9450	3.6105	2.00	5.00
	TR4	18	3.6111	.77754	.18327	3.2244	3.9978	2.00	5.00
	Total	90	3.3667	.79958	.08428	3.1992	3.5341	2.00	5.00
Overall Preferences	Control	18	2.6667	.84017	.19803	2.2489	3.0845	2.00	4.00
	TR1	18	3.0556	.93760	.22099	2.5893	3.5218	2.00	5.00
	TR2	18	2.7222	.66911	.15771	2.3895	3.0550	2.00	4.00
	TR3	18	2.8889	.75840	.17876	2.5117	3.2660	2.00	4.00
	TR4	18	2.9444	1.05564	.24882	2.4195	3.4694	1.00	5.00
	Total	90	2.8556	.85540	.09017	2.6764	3.0347	1.00	5.00

Table A.42: Table of Statistical Analysis ANOVA in SPSS on Sensory Evaluation Parameters

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Colour	Between Groups	82.378	4	20.594	17.642	.000
	Within Groups	99.222	85	1.167		
	Total	181.600	89			
Odour	Between Groups	2.733	4	.683	.644	.632
	Within Groups	90.167	85	1.061		
	Total	92.900	89			
Tenderness	Between Groups	5.844	4	1.461	1.211	.312
	Within Groups	102.556	85	1.207		
	Total	108.400	89			
Flavour	Between Groups	2.400	4	.600	.936	.447
	Within Groups	54.500	85	.641		
	Total	56.900	89			
Overall Preferences	Between Groups	1.844	4	.461	.619	.650
	Within Groups	63.278	85	.744		
	Total	65.122	89			

Table A.43: Table of Homogenous Subsets in Statistical Analysis (Colour)

Colour

	Sensory	N	Subset for alpha = 0.05		
			1	2	3
Tukey HSD[a]	TR4	18	1.7222		
	TR1	18	2.1111	2.1111	
	Control	18		2.7778	
	TR3	18			3.9444
	TR2	18			4.1111
	Sig.		.816	.352	.990
Duncan[a]	TR4	18	1.7222		
	TR1	18	2.1111	2.1111	
	Control	18		2.7778	
	TR3	18			3.9444
	TR2	18			4.1111
	Sig.		.283	.068	.645

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 18.000.

Table A.44: Table of Homogenous Subsets in Statistical Analysis (Odour)

Odour

	Sensory	N	Subset for alpha = 0.05
			1
Tukey HSD[a]	TR4	18	1.6667
	TR1	18	1.9444
	TR2	18	1.9444
	TR3	18	2.1111
	Control	18	2.1667
	Sig.		.593
Duncan[a]	TR4	18	1.6667
	TR1	18	1.9444
	TR2	18	1.9444
	TR3	18	2.1111
	Control	18	2.1667
	Sig.		.201

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 18.000.

Table A.45: Table of Homogenous Subsets in Statistical Analysis (Tenderness)

Tenderness

	Sensory	N	Subset for alpha = 0.05 1
Tukey HSD[a]	TR4	18	2.5556
	Control	18	2.6111
	TR2	18	2.7778
	TR3	18	2.7778
	TR1	18	3.2778
	Sig.		.288
Duncan[a]	TR4	18	2.5556
	Control	18	2.6111
	TR2	18	2.7778
	TR3	18	2.7778
	TR1	18	3.2778
	Sig.		.081

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 18.000.

Table A.46: Table of Homogenous Subsets in Statistical Analysis (Flavour)

Flavour

	Sensory	N	Subset for alpha = 0.05 1
Tukey HSD[a]	Control	18	3.1667
	TR2	18	3.2778
	TR3	18	3.2778
	TR1	18	3.5000
	TR4	18	3.6111
	Sig.		.461
Duncan[a]	Control	18	3.1667
	TR2	18	3.2778
	TR3	18	3.2778
	TR1	18	3.5000
	TR4	18	3.6111
	Sig.		.143

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 18.000.

Table A.47: Table of Homogenous Subsets in Statistical Analysis (Overall Preferences)

Overall Preferences

	Sensory	N	Subset for alpha = 0.05 1
Tukey HSD[a]	Control	18	2.6667
	TR2	18	2.7222
	TR3	18	2.8889
	TR4	18	2.9444
	TR1	18	3.0556
	Sig.		.660
Duncan[a]	Control	18	2.6667
	TR2	18	2.7222
	TR3	18	2.8889
	TR4	18	2.9444
	TR1	18	3.0556
	Sig.		.236

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 18.000.

APPENDIX B

a. Google Form of Sensory evaluation

SENSORY EVALUATION OF HYBRID 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. Gender *

Mark only one oval.

- Female
- Male

2. Age *

Mark only one oval.

- 18-22
- 23-30
- 31 and above

RAW MEAT

Please tick according to your preference

3. Color *

Mark only one oval per row.

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

4. Odour *

Mark only one oval per row.

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

5. 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					

COOKED MEAT

Please tick according to your preference

6. Flavour (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					

7. Overall Preferences *

Mark only one oval per row.

	1 (Like extremely)	2 (Like slightly)	3 (Moderate)	4 (Dislike slightly)	em5 (Dislike extremely)
Control					
Treatment 1					
Treatment 2					
Treatment 3					
Treatment 4					

GENERAL ACCEPTABILITY

Please tick according to your preference

7. Overall Preferences *

Mark only one oval per row.

	1 (Like extremely)	2 (Like slightly)	3 (Moderate)	4 (Dislike slightly)	em5 (Dislike extremely)
Control					
Treatment 1					
Treatment 2					
Treatment 3					
Treatment 4					