THE EFFECT OF FEED SUPPLEMENTED WITH *Curcuma longa* AND *Moringa oleifera* ON IKTA QUAIL GROWTH PERFORMANCE AND EGG PRODUCTION

By

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ABSTRACT

THE EFFECT OF FEED SUPPLEMENTED WITH *Curcuma longa* AND *Moringa oleifera* ON IKTA QUAIL GROWTH PERFORMANCE AND EGG PRODUCTION

Pang Liang Ee

Research using herbal ingredients to enhance animal feed efficiency has received increase attention as consumers preferred natural additives. This led to the aim of this study to determine the effect of feed supplemented with 4% of *Curcuma longa* powder and 0.3% of *Moringa oleifera* seed powder on quail's growth performance and egg production. In this study, 42 Institut Kemahiran Ternakan Ayam (IKTA) female quails were randomly assigned to the control and a treatment group with three replications each. Proximate analyses were conducted to determine the nutritional content of the feed prior to feeding trials. The feed supplemented with *C. longa* powder and *M. oleifera* seed powder consists of 21.54% crude protein (CP) that meets the standard quail CP requirement. The weight gain, feed conversion ratio (FCR), egg production rate and egg yolk colour were determined in this study. The findings of this study showed that there was no significant difference ($p \geq 0.05$) between the control and treatment groups for all the parameters studied. The average weight gain in treatment group (74.23 ± 11.28 g) was relatively higher compared to the control (72.24 ± 7.91 g). However, the average FCR for the control group (2.47 ± 0.36) was relatively lower compared to the treatment (2.61 ± 0.25). The average egg production rate from 6 weeks old to 9 weeks old between treatment group (63.49 ± 4.94%) and control (69.84 ± 1.62%) were not significantly different ($p \geq 0.05$). The egg yolks from treatment group showed the average delta L*, a* and b* of -0.15, 0.03 and -0.12, respectively which indicates that the colour prone to darker shades of yellow. In conclusion, the findings of this study showed that the supplementation of 4% of *C. longa* powder and 0.3% of *M. oleifera* seed powder into the quail feed diet neither improves nor causes adverse effects on the growth performance and egg production of the quail.

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Last but not least, I would like to thank my family members and friends for their continuous support and encouragement throughout the period of my project.

DECLARATION

I hereby declare that this final year project report is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UTAR or other institutions.

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APPROVAL SHEET

This final year project report entitled **"THE EFFECT OF FEED SUPPLEMENTED WITH *Curcuma longa* AND *Moringa oleifera* ON IKTA QUAIL GROWTH PERFORMANCE AND EGG PRODUCTION"** was prepared by PANG LIANG EE and submitted as partial fulfilment of the requirements for the degree of Bachelor of Science (Hons) Agricultural Science at Universiti Tunku Abdul Rahman.

Approved by:

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Dr. Kwong Phek Jin — Date: 05/12/2022

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PERMISSION SHEET

It is hereby certified that **PANG LIANG EE** (ID No: **20ADB01483**) has completed this final year project thesis entitled "THE EFFECT OF FEED SUPPLEMENTED WITH *Curcuma longa* AND *Moringa oleifera* ON IKTA QUAIL GROWTH PERFORMANCE AND EGG PRODUCTION" under the supervision of Dr. Kwong Phek Jin (Supervisor) from the Department of Agricultural and Food Science, Faculty of Science, and Pn. Nurdiyana 'Aqilah Binti Roslan (Co-Supervisor) from the Department of Agricultural and Food Science, Faculty of Science.

I hereby give permission to the University to upload the softcopy of my final year project thesis in pdf format into the UTAR Institutional Repository, which may be made accessible to the UTAR community and public.

Yours truly,

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(PANG LIANG EE)

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LIST OF ABBREVIATIONS

AGPs	Antibiotic growth promoters
AOAC	Association of Official Analytical Chemists
CP	Crude protein
$CuSO_4$	Copper (II) sulphate
DPPH	2,2-diphenyl-1-picrylhydrazyl
DVS	Department of Veterinary Service
EC_{50}	Half maximal effective concentration
FCR	Feed Conversion Ratio
HCl	Hydrochloric acid
H_2SO_4	Sulphuric acid
IKTA	Institut Kemahiran Ternakan Ayam
K_2SO_4	Potassium sulphate
NaOH	Sodium hydroxide
SPSS	Statistical Package for the Social Sciences

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Japanese quail is a type of bird species that belongs to the order of *Galliformes*, genus *Coturnix* and species *japonica* (Wahab, et al., 2018). In the late 1900s, the Department of Veterinary Service Malaysia (DVS) had established a new breed named as IKTA (Institut Kemahiran Ternakan Ayam) from the cross-breeding between Japanese quail (*Coturnix* japonica) and France quails (*Coturnix coturnix*) (Ramli, et al., 2017). The IKTA quail breed has improved traits with dual-purpose for meat and egg production (Kamarudin, 2016). The DVS, Malaysia had developed IKTA breed to help the quail farmers in Malaysia to have better production in meat and egg from the quails that could adapt well to our local climate in order to commercialize the quail as one of the poultry industry segmentations (Wahab, et al., 2018).

The special characteristics of quails compared to broiler chickens are the quail meat is leaner, lesser fat and lower in calories (Fakolade, 2015). Quail egg is usually smaller in size compared to chicken eggs however quail egg is rich in minerals, vitamins and essential amino acids (Elkhair, et al., 2020). The average quail egg weight is around 10-12 g per egg, average egg yolk weight is around

4.3-4.5 g, average egg white weight is around 4.9-5.0 g and the thickness of quail eggs with membranes ranges from 0.191 to 0.219 mm (Wahab, et al., 2018).

According to FAOSTAT (2018), the statistic of the global trend showed that quail meat and egg production was around 12% per year, tailing behind poultry production. Quail farming is the second most popular due to the benefits of quail farming. According to Zacaria and Ampode (2021), quails are quite resistant to various diseases, quickly adapt to multiple rearing conditions, reach full maturity at six to eight weeks old and provide a financial return in a short period of time provided the feed cost and husbandry of the birds are well managed.

In order to improve the production in quail farming, not only the breed or genetics of birds could influence the production but the types of feed and environment the birds are raised play an important role. One of the main focuses in improving the growth performance of quail or any poultry is through the supplementation of feed additives that can protect gut health as it could influence the efficiency of digestion and nutrient absorption (Cotrelle, et al., 2021). In line with this, the research on using herbs and spices that have phytochemicals that could be served as alternatives to antibiotic growth promoters (AGPs) are gaining its popularity due to their advantages such as natural, non-toxic and non-chemical products (Yang, et al., 2019). Among the types of herbs and spices, turmeric (*Curcuma longa*) is a bright yellow spice under the family of Zingiberaceae mostly cultivated in tropical countries (Choudhury, 2019). Turmeric consists of saponin (0.45%), flavonoid (0.40%), tannin (1.08%), beta-carotene, vitamin C and other essential nutrients such as thiamine (0.89%), riboflavin (0.16%) and niacin (2.30%) (Nwankwo, 2014). Turmeric has been reported to contain antioxidant, anti-inflammatory, anti-platelet, antibacterial and antifungal effects (Suwarta and Suryani, 2019). In addition, turmeric consists of active components such as curcumin which is contribute to the yellow color of turmeric (Choudhury, 2019). Curcumin has been reported to be able to enhance egg yolk color (Marchiori, et al., 2019).

Moringa oleifera seed also known as Merunggai seed belongs to the family of Moringaceae which is mostly cultivated in the tropics and subtropics (Liang, et al., 2019). *M. oleifera* seed consists of bioactive compounds such as phenols, vitamin C, vitamin, beta-carotene, zinc, selenium and flavonoids which have antioxidant activity (Mousa, et al., 2016; Liang, et al., 2019). In addition, *M. oleifera* seed contains high crude protein content about 36% (Elkhair, et al., 2020).

1.2 Statement of Problems

According to Thirumalaisamy, et al. (2016), around 60-70% of production costs in poultry farming is due to feed cost. In order to reduce the feed cost, research to use *M. oleifera* seed powder as quail feed supplement can be carried out as *M. oleifera* seed powder contains high crude protein content therefore can reduce feed intake and improve feed conversion ratio (Mini, et al., 2018). In addition, the impacts of conventional usage of antibiotic growth promoters in animal feed has led to the development of antibiotic-resistant and this affects human health (Nuraini, Mirzah and Djulardi, 2019). In order to replace the use of AGPs, research to evaluate the effect of using turmeric powder as phytogenic feed additive can be carried out as turmeric powder is known to contain a phytochemical contains antimicrobial properties and could boost immune system (Rivia, et al., 2021). However, up to date there is still lack of study on the effectiveness of turmeric powder and *M. oleifera* seed powder supplement on quail diet as most of the studies were on *Gallus gallus domesticus*.

1.3 Objectives

The objectives of this study include:

1. To determine the key proximate compositions of feed supplemented with *Curcuma longa* and *Moringa oleifera.*

2. To evaluate the effect of feed supplemented with *C. longa* and *M. oleifera* on female IKTA quail's growth performance.

3. To evaluate the effect of feed supplemented with *C. longa* and *M. oleifera* on IKTA quail's egg production.

CHAPTER 2

LITERATURE REVIEW

2.1 Background of Turmeric

Turmeric powder is usually derived from the rhizome part of *Curcuma longa* that belongs to the family of Zingiberaceae. This natural plant product has been used for various purposes such as in the medicinal treatment, as foodstuff and animal feed additive (Prasad and Aggarwal, 2011). Nowadays, turmeric is widely cultivated in the tropical countries with different common names (NIH, 2022). The turmeric rhizome part has to be boiled and ground to a yellow powder (Prasad and Aggarwal, 2011). Turmeric powder is mostly used as a spice and coloring agent in cooking purpose due to its yellow color and flavor (Avey, 2015). According to Lao, et al. (2006) and Sharifi-Rad, et al. (2020), there is no any toxic effects when using the turmeric powder even at high concentration such as 8 g/day.

2.1.1 Compounds Found in Turmeric Powder

The nutrient composition of turmeric powder contains 83.81% dry matter, 9.78% crude protein and 9.17% crude ash (Zacaria and Ampode, 2021). According to

Nwankwo (2014) and Suwarta and Suryani (2019), turmeric contains saponin (0.45%), flavonoid (0.40%), tannin (1.08%), beta-carotene, vitamin C and other essential nutrients such as thiamine (0.89%), riboflavin (0.16%) and niacin (2.30%) which have been identified in turmeric plant as antioxidant properties and improve the immune system. Imoru, Onibi and Osho (2018) also reported that turmeric contains antioxidant, anti-inflammatory, anti-platelet, antibacterial and antifungal effects. In addition, turmeric powder consists of bioactive components such as curcumin and its related compounds such as demethoxycurcumin and bisdemethoxycurcumin (Choudhury, 2019; Zhang and Kitts, 2021). Curcumin is the compound which attribute to the yellow colour of turmeric (Choudhury, 2019). Curcumin also acts as the natural coloring agent.

2.2 Background of *M. oleifera* Seeds

M. oleifera seeds also known as Merunggai seeds, belongs to the family of Moringaceae (Gopalakrishnan, Doriya and Kumar, 2016). *Moringa* trees are mostly cultivated in subtropical and tropical countries (Leone, et al., 2016). Leone, et al. (2016) reported that different parts of *M. oleifera* such as leaves and seeds are suitable for human and animal consumption. According to Mallenakuppe, et al. (2019), *M.* oleifera has been used as a feed supplement in most livestock species and poultry due to its high nutritional value.

2.2.1 Compounds Found in *M. oleifera* Seed Powder

Generally, *M. oleifera* seed powder has been reported to contain high crude protein content which can be used as alternative protein source in animal feed (Elkhair, et al., 2020). In addition, the *M. oleifera* seeds are also known to be rich in methionine and cysteine which are the crucial essential amino acid which is required for layer hen (Leone, et al., 2016).

The compositions of *M. oleifera* seed powder has been reported to contain 92% dry matter, 36% crude protein, 37.2% crude fat and 14.2% of ash (Elkhair, et al., 2020). Besides rich in protein, *M.* oleifera which is also rich in bioactive compounds such as phenols, vitamin C, vitamin E, beta-carotene, zinc, selenium and flavonoids have been identified as antioxidant properties (Liang, et al., 2019). The studies conducted by Mousa, et al. (2016) and Liang, et al. (2019), reported that *M. oleifera* seeds optimal EC_{50} estimation of antioxidant activity determined using DPPH scavenging assay was 4.0 mg/ml.

2.3 Background of IKTA Quail

In late 1900s, Department of Veterinary Service Malaysia had established a new strain from Japanese quail (*Cortunix japonica*) which is IKTA strain for dual-purpose meat and egg production to help the quail's farmers in Malaysia to produce the good strain and improve the quail eggs production (Kamarudin, 2016; Wahab, et al., 2018). IKTA quails are cross breed from Japanese quails and France quails which are the new Malaysian quail's variety (Ramli, et al., 2017). According to Wahab, et al. (2018), the hatchability rate and egg quality in terms of exterior trait and interior trait of eggs of IKTA strains was better than the other strains from Japanese quail which reared in Malaysia.

2.3.1 Nutrients Requirement and Management of Quail

The basic nutrients requirement of quail are water, protein, carbohydrate, fat, minerals and vitamins. The most important nutrient is adequate water for quail. Fresh clean water should be provided *ad libitum* to quails especially under hot climate (Akanbi and Kabir, 2019). In addition, 24% of crude protein level is required for quail in starter feed and at least 20% of crude protein content for quail starting from 3rd week of age (Akanbi and Kabir, 2019). Some essential vitamins such as vitamin A, D, E, K and B are required in quail diet (Akanbi and Kabir, 2019). Moreover, the minerals such as calcium and phosphorus are essential for quails' egg production (Akanbi and Kabir, 2019).

According to Randall (2006), the suitable brooding temperatures for day-old quail are very important which it should be maintained at about 35°C for the first week of brooding and decreased the temperature about 3.5°C for every week until the quails are fully feathered around 3-4 weeks. In addition, the housing management of quail is also important which the quails should be placed in the well-insulated, well-ventilated room and must provide protection from predators (Randall, 2006). Moreover, the cages for rearing the quails have to comfortable and make food and water readily accessible (Randall, 2006).

2.3.2 Methods to Differentiate between Male and Female Quail

In order to differentiate male and female quail, there are some features to distinguish the quails. Based on the feathers, the females have light colour breast with brown speckles while males have dark colour breast without speckles (Randall, 2006). In addition, the female quails are slightly heavier than the males in terms of body weight and size (Akanbi and Kabir, 2019).

2.4 Egg Production and Egg Yolk Colour of Quails

Among the animal protein sources available, poultry eggs are more affordable for consumers. In poultry, the demand for quail eggs is increasing as it is rich in minerals, vitamins and amino acids compared to chicken eggs (Elkhair, et al., 2020; Zacaria and Ampode, 2021). Nowadays, the cost of quail egg production had increased thus this led to the hike in the price of quail eggs as the demand increased (Wahab, et al., 2018). Hence, it is important to use feed supplement to improve the performance of egg production (Cabuk, et al., 2014; Ooi, et al., 2018; Dosoky, et al., 2021).

Egg yolk colour is an important trait of egg quality for consumers (Hassan, 2016; Berkhoff, et al., 2020). Mostly, consumers preferred egg yolk with the darkest colour hue due to yolk colour determined by the content and profile of pigmented carotenoids present in the feed (Zacaria and Ampode, 2021). According to Hassan (2016), mostly consumers preferred not only to have to taste good but also look good. Hence, it is important to use herbs such as turmeric powder to enhance the egg yolk color due to its curcumin content which is contributed to the yellow color of turmeric (Choudhury, 2019).

2.5 Common Types of Herbs and Phytogenic Supplements as Quail's Feed Additives

Phytogenic feed additives refer to the natural plant-based products added into animal feed at optimal level to improve the animal production performance (Ooi, et al., 2018). The common types of herbs and phytogenic supplements as quail's feed additives are herbal mixture essential oil mixture, cinnamon, turmeric, onion and so on (Cabuk, et al., 2014; Ooi, et al., 2018; Dosoky, et al., 2021). According to Cabuk, et al. (2014), the basal diet supplemented with 24 mg/kg feed essential oil mixture derived from different herbs including oregano, laurel leaf, citrus peel and so on has significantly increased egg production in quail and concluded that essential oil mixture can be an alternative to AGP. In addition, Dosoky, et al. (2021) reported that the dietary supplementation with 800 mg of dried cinnamon significantly improved the egg production rate. Moreover, Ooi, et al. (2018) reported that the addition of 1% turmeric powder or 1% Dayak onion powder had significantly improved the hen-day egg production.

2.6 Turmeric Powder as Quail's Feed Additive

According to Suwarta and Suryani (2019), the research showed that supplementation of 40 g turmeric and 40 g cinnamon mixture significantly increased egg production, egg weight and yolk colour index. In addition, 3-5% turmeric powder in the diet of laying quails improved the body weight gain, feed conversion ratio, egg yolk color, yolk weight, increase egg production, increase calcium deposition and increase the weight and thickness of eggshell (Zacaria and Ampode, 2021; Rivia, et al., 2021). Marchiori, et al. (2019) reported that the data showed that bioactive compound in turmeric such as curcumin can be used as feed additive for quails and has positive effects on egg quality, egg production rate, boost immune system and reduces saturated fatty acids. Moreover, Nuraini, Mirzah and Djulardi (2019) reported that 20 ppm turmeric extract in the drinking water increased feed intake, egg production rate and enhance egg yolk color however significantly decreased feed conversion ratio.

2.7 *M. Oleifera* Seed Powder or Leaf Meal as Quail's Feed Additive

According to Elkhair, et al. (2020), 0.3% of *M. oleifera* seed powder can improve growth performance and egg quality in Japanese laying quail under heat-stress. Stohs and Hartman (2015) reported that *M.* oleifera seeds extract at level of 0.4% showed the signs of acute toxicity and mortality observed at level of 0.5% while no adverse effect was observed when the concentration of *M. oleifera* lower than 0.3%. According to Mousa, et al. (2016), germinated *M. oleifera* seed improved performance, immune organs and blood constituents at levels 0.25%-0.75% in Japanese quail diets. *M. oleifera* leaves can also be used as animal feed additive. According to Garcia, et al. (2021), 3.83% of *M. oleifera* leaves supplemented in quail basal diet improved the egg quality and production. In addition, Sati, et al. (2021) reported that 1% of *M. oleifera* leaf meal improve nutritional quality of eggs and meat. Moreover, 1.5%-3% of *M. oleifera* leaf powder improved the quail's growth performance (Mini, et al., 2018).

2.8 Measurement of Growth Performance and Egg Production Quality of Quail

According to Elkhair, et al. (2020), this study was conducted to evaluate the growth performance and egg production quality of quail using three different concentrations of *M. oleifera* seed powder such as 0.1%, 0.2% and 0.3% as feed supplement with basal diet. During experiment, the eggs were collected daily and egg production rate (%) was calculated (Elkhair, et al., 2020). Twenty-five eggs were randomly collected from quail in each treatment group at 11 weeks old and 15 weeks old to evaluate the egg quality parameters such as eggshell thickness and egg yolk index (Elkhair, et al., 2020). In addition, Suwarta and Suryani (2019) reported that the growth performance and egg production quality of quail was evaluated by feeding feed supplemented with different treatments contained mixed supplementation of turmeric powder and cinnamon powder. Measurement of feed intake, body weight, FCR and egg production was done every week at each replication (Suwarta and Suryani, 2019). Moreover, egg quality measurements such as egg weight, yolk weight, egg white weight, eggshell weight, egg colour index were carried out at the end of week 6, 10 and 14 (Suwarta and Suryani, 2019).

CHAPTER 3

MATERIALS AND METHODS

3.1 Location of Experiment

This study was carried out from June 2022 to September 2022 in Agriculture Laboratory II, Food Processing Laboratory, Food Science Laboratory and Agricultural Park, Universiti Tunku Abdul Rahman (UTAR), Kampar campus. This study obtained approval from the Scientific and Ethical Review Committee of Universiti Tunku Abdul Rahman under approval number U/SERC/126/2022.

3.2 Preparation of Feed Supplement and Quails

Tumeric and *M. oleifera* seed powder were bought from Revolusi Merak Sdn. Bhd. and the source of IKTA quails was bought from local quail's farms at Hutan Melintang, Perak. The basal quail diet such as grower feed and layer feed were bought from Gold Coin Feedmills (M) Sdn. Bhd. Treatment feed was supplemented with 40 g turmeric powder and 3 g *M. oleifera* seed powder in 1 kg of commercial feed while control feed only contained commercial feed.

The composition and nutrient level of the basal diet including grower feed and layer feed are shown in Table 3.1. The main raw ingredients of quail feed are corn, soybean meal, other grains and grain-by-products, animal protein, vegetable oil, salt, calcium carbonate, coccidiostats and approved antimicrobials.

Proximate analysis such as dry matter content, crude ash, crude protein and crude fat determination were carried out for all the samples such as control grower feed, treatment grower feed, control layer feed and treatment layer feed.

Table 3.1: Composition and nutrient level of the commercial basal diet (%).

Calculated nutrients	**Grower feed (%)**	**Layer feed (%)**
Crude protein, Min	21.00	18.00
Crude fibre, Max	5.00	6.00
Crude fat, Min	4.50	3.00
Moisture, Max	13.00	13.00
Ash, Max	8.00	14.00
Calcium, Min	0.80	3.80
Phosphorus, Min	0.40	0.40

3.3 Key Proximate Compositions of Feed

3.3.1 Determination of Dry Matter Content

In order to determine dry matter content of feed samples, the drying oven was heated to 105°C until the temperature was kept constant. The crucible and its lid were cleaned and dried in the oven for at least 2 hours. The crucible and its lid were transferred using a thong into desiccator to cool for 10 minutes. Subsequently, the weight of crucible with lid was measured. Then, approximately 2 g of feed sample was taken out and put into the crucible. The weight of crucible with lid and feed sample was measured before drying. The crucible was put into the drying oven at 105°C for 16 hours. The covered crucible was taken out using a thong and placed into the desiccators for 10 minutes. The weight of crucible with lid and feed sample was measured after drying. The result was read and recorded. The percentage of dry matter of feed samples were calculated based on Formula 3.1 (AOAC, 2000).

Formula 3.1:

Percentage of dry matter (%) = $(W_C – W_A)/ (W_B – W_A)$

Where W_A = Weight of crucible with lid, W_B = Weight of crucible with lid and feed sample before drying and W_C = Weight of crucible with lid and feed sample after drying

3.3.2 Determination of Crude Ash

In order to determine crude ash content of feed, the weight of the dried sample, crucible and cover were recorded before putting into the furnace. The crucible with the dried sample prepared earlier was inserted into a muffle furnace at 550°C for 24 hours. The cooled-down crucible with the sample was removed from the furnace and placed it into the desiccators. The crucible with the ashed sample and lid was weighed. The result was read and recorded. The percentage of crude ash of feed samples were calculated based on Formula 3.2 (AOAC, 2000).

Formula 3.2:

Percentage of crude ash (%) = $(W_C - W_A)/ (W_B - W_A)$

where W_A = Weight of crucible with lid, W_B = Weight of crucible with lid and feed sample before combustion and W_C = Weight of crucible with lid and feed sample after combustion

3.3.3 Determination of Crude Protein

In order to determine crude protein of feed samples, started with digestion process. The digester block was pre-heated to 420°C. Then, approximately 2 g of sample was weighed and placed inside the digester flask. The weighed sample was transferred into a Kjeldahl flask. A blank without sample was prepared. A total of 7.8 g of catalyst (7 g of K_2SO_4 + 0.8 g of $CuSO_4$) and 15 ml of concentrated H_2SO_4 were added into the same flask in the fume hood. The digester flask was placed into the preheated block and allowed the digestion to take place for 2 hours 30 minutes until the content became a clear green. The flask was removed from the heating block and allowed to be cooled down in the fume hood. After that, followed by distillation process. Once the flask cooled down, 30 ml of distilled water was added into each flask. The distillation involves the neutralization of the digested sample with 45 ml of 32% NaOH. A total of 25 ml of Boric acid solution was dispensed and 3 drops of dyes of methyl red and bromocresol green was added into a conical flask until a pink solution formed. The flask was connected to the distillation apparatus so that the end of tube was submerged in the boric acid solution. The distillation was set for 4 minutes. After distillation, followed by titration. The Erlenmeyer flask was removed and replaced it with a beaker containing 400 ml of distilled water. The equipment was turned off. The distillate and boric acid mixture were titrated with 0.2 N HCl. The titration was stopped when the green colour solution turned into pink colour. The amount of acid being used in the titration to change the green distillate back to pink colour was recorded. The percentage of crude protein was calculated based on Formula 3.3 (AOAC, 2000).

Formula 3.3:

Percentage of crude protein (%) = [ml Acid used (sample – blank) x Normality of Acid x 14 x 6.25 x 100]/ (Sample weight x 1000)

3.3.4 Determination of Crude Fat

In order to determine crude fat of feed samples, approximately 1 g of feed sample was weighed. The feed sample was homogenized with 2:1 chloroform-methanol mixture. A total of 50 ml of distilled water was added into the tube and homogenized for 2 minutes and poured into the Buchner funnel for lipid extraction. The homogenate was transferred into the separatory funnel and 10 ml of distilled water was poured into separatory funnel. The separatory funnel was shaken for 1 minute until no pop sound when opened the cap. The weight of a clean dry beaker was measured. The lower layer of solvent was collected into a beaker and the lipid extract was dried in the oven at 40°C for overnight until all the solution had finally evaporated. The beaker was cooled down in a desiccator for 5 minutes and the weight of beaker was measured. The percentage of crude fat was calculated based on Formula 3.4 (AOAC, 2000).

Formula 3.4:

Percentage of crude fat (%) = [(c – b)/ a] x 100

where a = weight of dried sample, b = weight of beaker and c = weight of beaker with lipid

3.4 Feeding Feed Supplement to Quails

A total of 42 female IKTA quails (21 days old) were chosen as the experimental animals (Figure 3.1). The 42 female IKTA quails were divided into two groups which were the control and treatment groups and raised in 6 different cages at Agriculture Park, UTAR as shown in Figure 3.2. Each group had three replicates and each replicate had seven quails. The quails were acclimatized for 2 weeks prior the feeding trial with commercial grower feed and drinking water as well. Daily, 250 g of commercial layer feed were provided to control group of quails. As for the treatment group, 4% of turmeric powder and 0.3% of *M. oleifera* seed powder were supplemented with commercial layer feed and given 250 g to the quails. The study of feed supplement to quails was conducted for 6 weeks from 3 weeks old to 9 weeks old.

Figure 3.1: The image of female IKTA quail aged 21 days old.

Figure 3.2: The location of experiment in Agriculture Park, UTAR.

3.4.1 Determination of Weight and Weight Gain of Quails

The digital weighing scale was calibrated before use. The weight of both groups of quails were measured weekly from 3 weeks old to 5 weeks old (Figure 3.3). The readings were recorded. The weight gain was calculated based on Formula 3.5 (Suwarta and Suryani, 2019).

Formula 3.5:

Weight gain (g) = Final weight – Initial weight

Figure 3.3: The digital weighing scale was used to weigh the quails.

3.4.2 Determination of Total Feed Consumed by the Quails and Feed Conversion Ratio

The total feed consumed by the quails were measured and recorded daily throughout the feeding trial using digital weighing scale. The feed conversion ratio (FCR) was calculated based on Formula 3.6 (Suwarta and Suryani, 2019).

Formula 3.6:

FCR = Total feed consumed / weight gain

3.4.3 Determination of Egg Production Rate

The number of quails eggs produced in each cage was recorded daily from 6 weeks old to 9 weeks old. The egg production rate was calculated based on Formula 3.7 (Krzysztof, et al., 2017).

Formula 3.7:

Egg production rate (%) = [(number of eggs laid)/ (number of quails x number of days)] x 100

3.4.4 Determination of Egg Weight

The egg's weight of both groups were measured from 6 weeks old to 8 weeks old using a digital weighing scale (Figure 3.4). The readings were recorded.

Figure 3.4: The digital weighing scale was used to weigh the eggs.

3.4.5 Determination of Eggshell Thickness

The eggshell thickness of both groups were measured from 6 weeks old to 8 weeks old using digital calliper (Figure 3.5). The readings were recorded.

Figure 3.5: The digital calliper was used to measure the eggshell thickness.

3.4.6 Determination of Egg Yolk Colour Index

The egg yolk colour index of both groups were measured on 9 weeks old using colorimeter (Figure 3.6). The readings were recorded. The egg yolk colour differences between control group and treatment group were identified using L* a* b* coordinates (Figure 3.7) from Konica Minolta (2022).

Figure 3.6: The colorimeter was used to measure the egg yolk colour index.

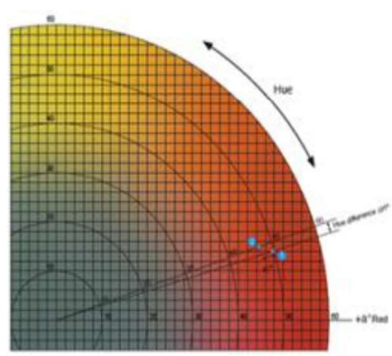


Figure 3.7: The image of identifying colour differences using L* a* b* coordinates (Konica Minolta, 2022).

3.5 Statistical Analysis

All measurements were performed in triplicates and all data were expressed as mean ± standard error. All the data collected were subjected to analysis by using Statistical Package for the Social Sciences (SPSS) software (IBM SPSS Statistics Version 28, USA). Data obtained from key proximate compositions of both feed samples which include dry matter content, crude ash, crude protein and crude fat were statistically analysed using Independent Samples T-Test. Data obtained to evaluate the effect of feeding feed supplement to quails included weight gain, feed conversion ratio, egg production rate, egg weight, eggshell thickness and egg yolk colour index were analysed using Independent Samples T-Test. Means comparison was accomplished using Independent Samples T-Test with $p < 0.05$ was considered statistically significant in this study.

CHAPTER 4

RESULTS

4.1 Key Proximate Compositions of Feed Samples

The key proximate compositions of the feed samples identified in this experiment included the dry matter content, crude ash, crude protein and crude fat. The feed samples tested were the control feed (commercial feed from Gold Coin Feedmills (M) Sdn. Bhd.) for grower and layer stage and treatment feed (commercial feed supplemented with 4% turmeric powder and 0.3% *Moringa oleifera*).

4.1.1 Key Proximate Compositions of Feed Samples

Table 4.1 shows the key proximate compositions of data in this study. The dry matter content in feed samples refers to the materials remaining including protein, fat, minerals and so on except for water. In this study, the result shows that it does not any significant different between the control group versus the treatment group. The dry matter content for both control grower feed (88.98±0.22%) and treatment grower feed (89.00±0.12%) were not significantly different ($p \geq 0.05$). The dry matter content for both control layer feed

(88.54±0.67%) and treatment layer feed (88.76±0.05%) did not differ significantly ($p \geq 0.05$).

The crude protein content in feed samples refers to the total nitrogen content in the diet. In this study, the result shows that the crude protein content for both control grower feed (21.19±0.57%) and treatment grower feed (20.52±0.38%) were not significantly different ($p \geq 0.05$). The crude protein content for both control layer feed (21.81±0.38%) and treatment layer feed (21.54±0.14%) did not differ significantly ($p \geq 0.05$).

The crude fat content in feed samples refers to the total fat content in the diet. In this study, the result shows that the crude fat content for both control grower feed (3.55±0.07%) and treatment grower feed (5.01±0.07%) were highly significantly different ($p < 0.01$). The crude fat content for both control layer feed (3.37±0.03%) and treatment layer feed (3.08±0.10%) did not differ significantly ($p \geq 0.05$).

The crude ash content in feed samples refers to the residue containing inorganic minerals in the diet. In this study, the result shows that the crude ash content for both control grower feed (5.78±0.04%) and treatment grower feed (5.42±0.41%) were not significantly different ($p \geq 0.05$). The crude ash content for both control layer feed (13.06±0.07%) and treatment layer feed (13.12±0.26%) did not differ significantly ($p \geq 0.05$).

Table 4.1: The key proximate compositions of feed samples

Composition (%)	Grower Feed		Layer Feed	
	Control	Treatment	Control	Treatment
Dry Matter	88.98±0.22^{a}	89.00±0.12^{a}	88.54±0.67^{x}	88.76±0.05^{x}
Crude Protein	21.19±0.57^{a}	20.52±0.38^{a}	21.81±0.38^{x}	21.54±0.14^{x}
Crude Fat	3.55±0.07^{a}	5.01±0.07^{b}	3.37±0.03^{x}	3.08±0.10^{x}
Crude Ash	5.78±0.04^{a}	5.42±0.41^{a}	13.06±0.07^{x}	13.12±0.26^{x}

^{ab}Means with different superscripts within the grower feed group were significantly different ($p < 0.05$).

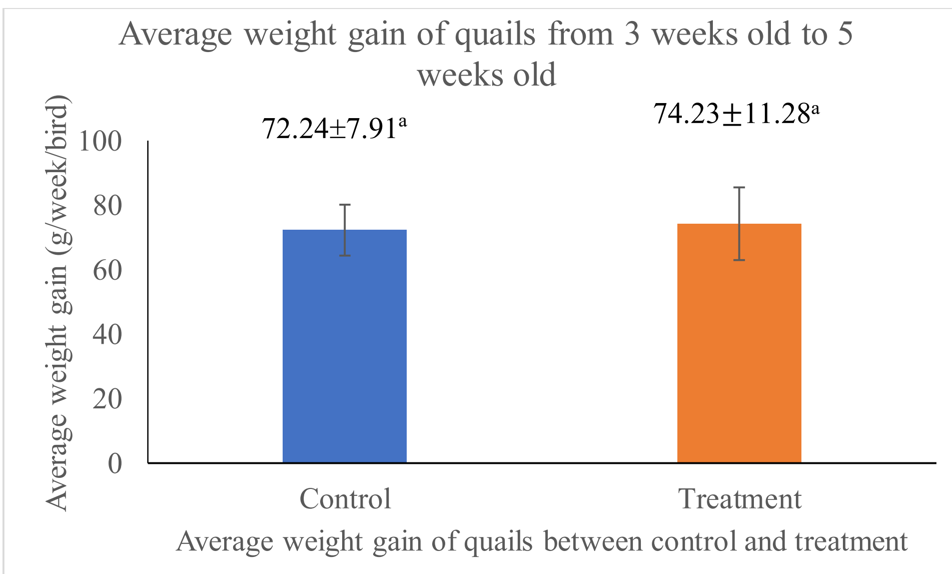
^{x}Means with same superscript within the layer feed group were not significantly different ($p \geq 0.05$).

4.2 Effect of Feeding Feed Supplement with Turmeric Powder and *M. oleifera* Seed Powder to Quails

Upon evaluating the compositions, the feed supplemented with 4% of turmeric powder and 0.3% of *M. oleifera* seed powder was applied in the feeding trial for the quails as the data showed that it does not reduce the key nutrients requirement for the quail. The feeding treatment were conducted concurrently with the control group which did not receive the supplementation of the herbs. The effect of the feed supplemented with the herbs were determined based on the average weight gain of quails, average FCR of quails, egg production rate, average egg weight, average eggshell thickness and average egg yolk colour.

4.2.1 Average Weight Gain of Quails

The result in Figure 4.1 shows that there was no significant difference ($p \geq 0.05$) in the average weight gain between the control (72.24±7.91 g) and treatment (74.23±11.28 g) group.

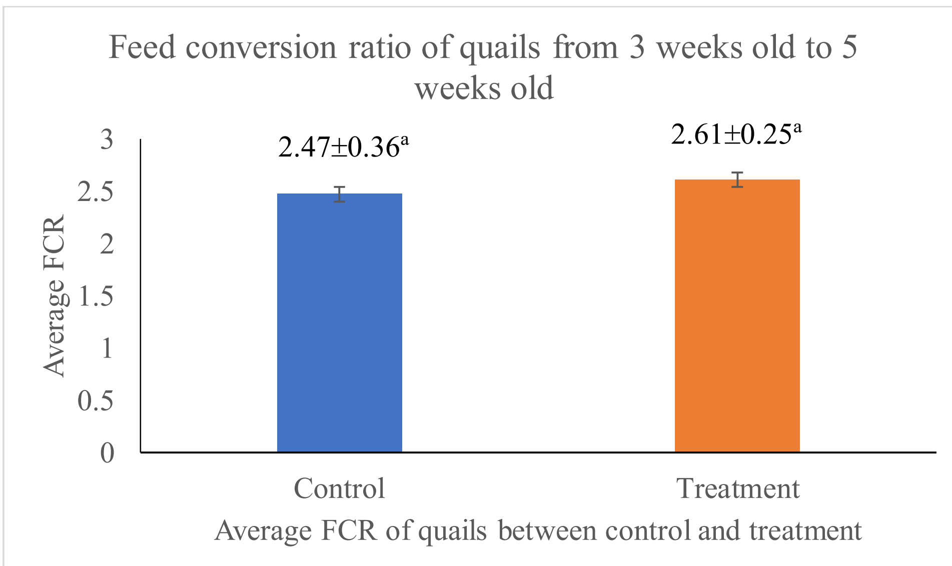


[a]Means with the same superscript letter are not significantly different ($p \geq 0.05$).

Figure 4.1: Average weight gain of quails from 3 weeks old to 5 weeks old.

4.2.2 Average Feed Conversion Ratio (FCR) of Quails

The average FCR of quails in both groups are shown in Figure 4.2. The average FCR of quails in treatment group that supplemented with 4% of turmeric powder and 0.3% of *M. oleifera* seed powder (2.61±0.25) was relatively higher compared to control group in which only commercial feed was given to the quails (2.47±0.36). However the difference was not significant ($p \geq 0.05$).

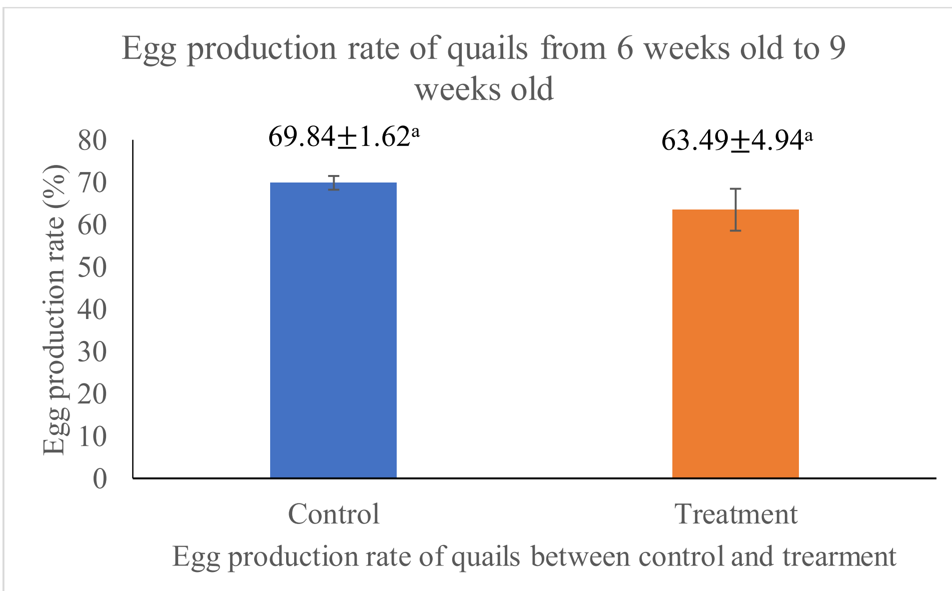


[a]Means with the same superscript letter are not significantly different ($p \geq 0.05$).

Figure 4.2: Average FCR of quails from 3 weeks old to 5 weeks old.

4.2.3 Egg Production Rate of Quails

Figure 4.3 shows the egg production rate of quails in control and treatment group. No significant difference ($p \geq 0.05$) was noted for the egg production rate for both experiment groups from 6 weeks old to 9 weeks old. The egg production rate of treatment group (63.49±4.94%) was relatively lower compared to control group (69.84±1.62%).

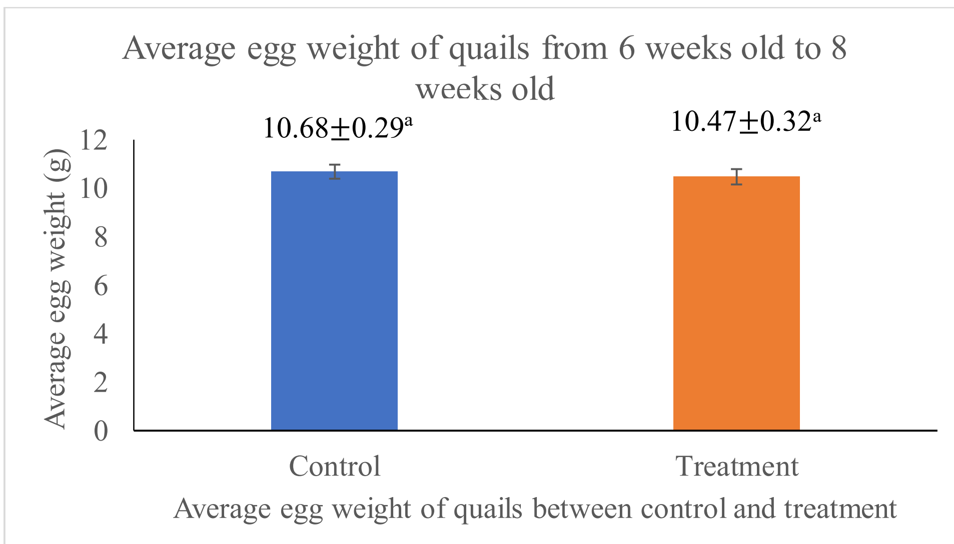


[a]Means with the same superscript letter are not significantly different ($p \geq 0.05$).

Figure 4.3: Egg production rate of quails from 6 weeks old to 9 weeks old.

4.2.4 Average Egg Weight of Quails

The average egg weight of quails in both groups from 6 weeks old to 8 weeks old was shown in Figure 4.4. The average egg weight of quails in treatment group which supplemented with 4% of turmeric powder and 0.3% of *M. oleifera* seed powder (10.47±0.32 g) was relatively lower compared to control group in which only commercial feed was given to the quails (10.68±0.29 g).

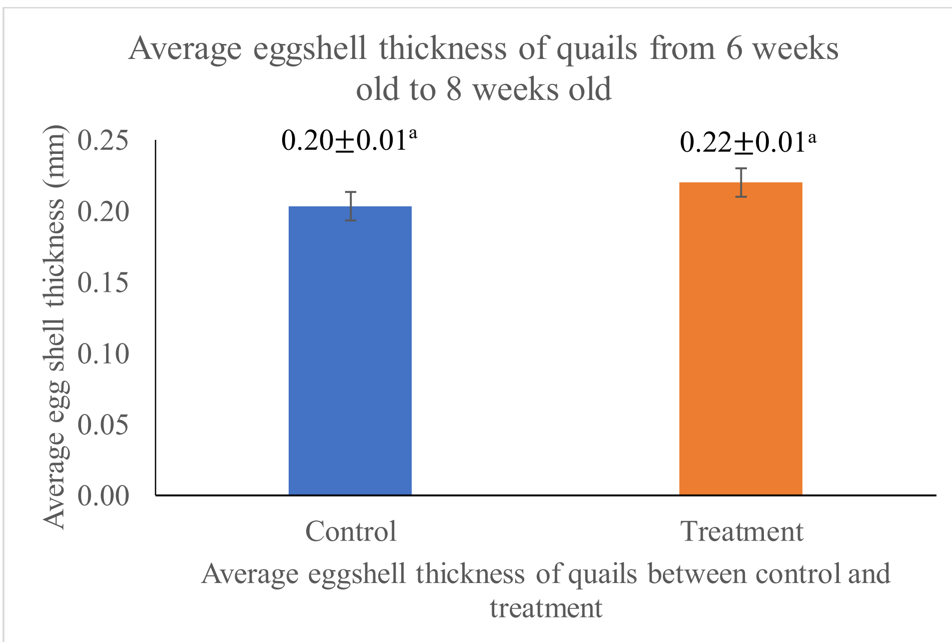


[a]Means with the same superscript letter are not significantly different ($p \geq 0.05$).

Figure 4.4: Average egg weight of quails from 6 weeks old to 8 weeks old.

4.2.5 Average Eggshell Thickness of Quails

Figure 4.5 shows average eggshell thickness of control and treatment group. No significant difference ($p \geq 0.05$) was noted for the average eggshell thickness of quails for both experiment groups from 6 weeks old to 8 weeks old. After 3 weeks of feeding trial, the average eggshell thickness of treatment group (0.22±0.01 mm) was relatively higher compared to control group (0.20±0.01 mm).



[a]Means with the same superscript letter are not significantly different ($p \geq$ 0.05).

Figure 4.5: Average eggshell thickness of quails from 6 weeks old to 8 weeks old.

4.2.6 Average Egg Yolk Colour of Quails

The average egg yolk colour of quails are shown in Table 4.2. The average egg yolk colour of treatment group was not significantly different ($p \geq 0.05$) than the control group. The egg yolks from treatment group showed the average delta L*, a*, b* of -0.15, 0.03 and -0.12 respectively which indicates that the colour prone to skewed towards darker shades of yellow compared to control group (Figure 4.6).

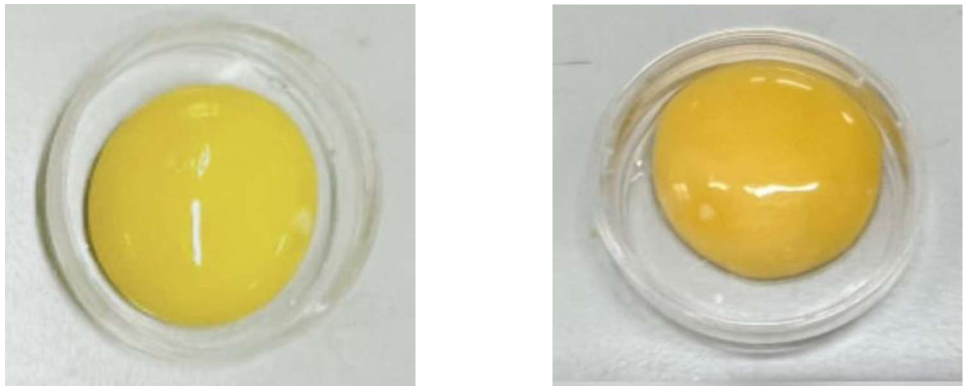
Table 4.2: The average egg yolk colour between control and treatment measured using colorimeter

	Average L*	**Average a***	**Average b***
Treatment	57.03±0.92^{a}	2.64±0.13^{c}	19.29±0.60^{x}
Control	57.18±0.95^{a}	2.60±0.11^{c}	19.41±0.33^{x}
Delta, Δ	-0.15	0.03	-0.12
Description	Darker	More red	Less yellow

^{a} refers to the same superscript letters within average L* that did not differ significantly ($p \geq 0.05$).

^{c} refers to the same superscript letters within average a* that did not differ significantly ($p \geq 0.05$).

^{x} refers to the same superscript letters within average b* that did not differ significantly ($p \geq 0.05$).



(a) (b)

Figure 4.6: Egg yolk colour in different groups. (a) Control group; (b) Treatment.

4.2.7 Mortality Rate of Quails

Mortality refers to the natural causes of death such as predation, disease and starvation. Throughout the feeding trial, there isn't any mortality observed in both control and treatment group.

CHAPTER 5

DISCUSSION

5.1 Key Proximate Compositions of Feed Samples

5.1.1 Dry Matter Content of Feed Samples

In this experiment, the dry matter content of control grower feed and treatment grower feed were 88.98% and 89.00%, respectively (Table 4.1). This percentage were quite similar to the dry matter (88.40%) reported by Suwarta and Suryani (2019), whom also study on the formulation of quail feed supplemented with 40 g of turmeric and 40 g of cinnamon powder. The dry matter content of control layer feed and treatment layer feed in this experiment were 88.54% and 88.76%, respectively. According to Zacaria and Ampode (2021), the dry matter content of basal diet of quail layer feed is 88.66%. The increment of dry matter content of treatment feed was due to the feed being supplemented with additional herbs (El-Ashry, et al., 2006) and in this research the 4% turmeric powder and 0.3% of *M. oleifera* seed powder might be contributing to the additional percentage of dry matter. Ideal moisture content in animal feed should not be more than 11.5% (Alengadan, Babu and Kallanickal, 2013). If the moisture content is more than 30%, the shelf life of feed will be shorter because prone to fungal growth (Mazili, 2021). In addition, it is important to have higher dry matter content in animal feed which lead to less amount of feed needed to fulfil the nutrient requirement (Mazili, 2021).

5.1.2 Crude Protein Content of Feed Samples

The crude protein (CP) content of control grower feed (21.19%) and treatment grower feed (20.52%) does not differ significantly ($p \geq 0.05$) even though the treatment shows a relatively lower CP percentage. In addition, the crude protein content of control layer feed and treatment layer feed shows similar trend with the value of 21.81% and 21.54%., respectively. These results were also similar to the CP reported by Gumus, et al. (2018) which indicates the CP of their treatment feed supplemented with 0.5% turmeric (18.05%) was relatively lower compared to their control feed (18.75%). Even though the CP of the treatment feeds in this study were relatively lower compared to the control, however, the overall CP does meet the standard quail crude protein requirement which is 20% starting from 3rd week of age (Akanbi and Kabir, 2019). There are different studies reported that using different level of crude protein content in the quail feed such as 19.9% by Elkhair, et al. (2020) and 24% by Mousa, et al. (2016). The difference in CP were due to the types of raw ingredients use. For example, in our study the main raw ingredients were corn and soybean meal, other grains and grain-by-products while Elkhair, et al. (2020) and Mousa, et al. (2016) their raw ingredients were corn-soybean meal added with 3.8% corn gluten and 7.3% corn gluten respectively. Study have shown that the soybean meal contains high protein. *M. oleifera* seed is known to contain high protein content (Elkhair, et al., 2020). However in this study upon adding 3 g of *M. oleifera* seed powder, the CP of the treatment feed does not increase significantly. This might be due to the amount added is not high enough to exert significant difference.

5.1.3 Crude Fat Content of Feed Samples

In this study, the crude fat content of control grower feed (3.55%) and treatment grower (5.01%) does differ significantly ($p < 0.01$). In addition, the crude fat content of control layer feed and treatment layer feed with the value of 3.37% and 3.08%, respectively. The crude fat content in treatment grower feed was increased 1.46% while the treatment layer feed was decreased 0.29%. According to Nuraini, Mirzah and Djulardi (2019), the crude fat content in the quail basal diet is 3.63% which is quite similar number of crude fat content in this study.

5.1.4 Crude Ash Content of Feed Samples

Ash content refers to the inorganic residue remaining after combustion process of organic matter in a feed sample (Ismail, 2017). In this study, the crude ash content of control grower feed and treatment grower feed were 5.78% and 5.42%, respectively while the crude ash content of control layer feed and treatment layer feed were 13.06% and 13.12%, respectively. There was no significant difference between crude ash of the control versus the treatment feed ($p \geq 0.05$). When comparison were made between the crude ash content of grower and layer feed, the crude ash of the layer feed were significantly higher ($p < 0.001$). This result is in agreement with the report by Al-Kendi and Al-Gubary (2022) that their layer feed had a higher percentage of crude ash compared to grower poultry feed. This is due to layer feed had higher calcium content compared to grower feed for poultry to lay eggs with strong shells (CDC, 2008; NDVSU, 2022).

5.2 Effect of Feeding Feed Supplement with Turmeric Powder and *M. oleifera* Seed Powder to Quails

5.2.1 Average Weight Gain of Quails

In this study, the average weight gain of quails were measured from 3 weeks old to 5 weeks old. The result of this study shows that the average weight gain in treatment group (74.23 g) does not increase significantly ($p \geq 0.05$). However, numerically the weight of the treatment group were relatively higher compared to control group (72.24 g). This study in agreement with Mousa, et al. (2016), the quail feed supplemented with 0.25% of germinated *M. oleifera* seed powder had relatively increased the weight gain of quails (63.00 g) at week 4-6 due to rich nutrient content of *M. oleifera* seed powder such as good source of fat, protein, antioxidants and minerals. Interestingly, Kennedy, et al. (2020) also reported similar finding that feed upon supplemented with 0.5% of turmeric rhizome powder had better growth performance on quails due to rich bioactive components in turmeric such as curcumin can encourage the bioavailability and utilization of nutrients. In studies conducted on poultry, generally feed supplemented with herbs, upon feed to both broiler and layer, the growth performance of birds were showing significant positive effects (Omar, Hejazi and Badran, 2016; Lokaewmanee, et al., 2020).

M. oleifera seed powder contains high crude protein content therefore can reduce feed intake and improve feed conversion ratio (Mini, et al., 2018). Turmeric powder is known to contain a phytochemical contains antimicrobial properties and could boost immune system (Rivia, et al., 2021). Therefore, the feed supplemented with turmeric and *M. oleifera* could improve growth performance and as alternative AGP.

5.2.2 Average FCR of Quails

In this study, the average FCR of quails from 3 weeks old to 5 weeks old in treatment group (2.61) was relatively higher than control group (2.47). The higher FCR in treatment group was due to higher feed intake. According to Nuraini, Mirzah and Djulardi (2019), the curcumin content in turmeric supplemented into the diet of quail, improve the palatability of the feed. Hence, this increase the intake of feed, which is related to the findings of this study where the treatment quail tends to eat more compared to the control. Avaiti, Siti and Tyas (2014) also reported that curcumin compound can increase appetite by enhancing the feed digestion process through regulating the pepsin enzymes in the digestive system. The result in this study is in agreement with the results reported by Nuraini, Mirzah and Djulardi (2019), in which the feed intake in the 20 ppm turmeric extract treatment group (22.98 g/head/day) was relatively higher than control group (22.13 g/head/day). According to Mousa, et al. (2016), the FCR of quails by using 0.25% of *M. oleifera* seed powder is 2.69 which is quite similar number of FCR in this study.

5.2.3 Egg Production Rate of Quails

In this study, the egg production rate of quails from 6 weeks old to 9 weeks old in the treatment group (63.49%) was relatively lower compared to control group (69.84%). This result is in agreement with the results reported by Liu, et al. (2019), in which the feed supplementation of turmeric at 200 mg/kg decreased the egg production of the layer chicken. Zacaria and Ampode (2021) also reported that the feed supplemented with 5% turmeric rhizome powder (82.86%) numerically decrease in Japanese laying quails egg production compared to control group (84.29%) from week 16 to week 22 which had similar trend as this study. However, the egg production rate reported by Zacaria and Ampode (2021) has relatively higher than this study was due to different experimental period and also different species of quails used in experiment. According to Ratriyanto, et al. (2014), the egg production rate increased and reached the peak which more than 80% during the age of week 13. The modern Japanese quail is a good egg layer and it is raised intensively for egg production compared with IKTA quail used in this study (Vali, 2007).

5.2.4 Average Egg Weight of Quails

The average egg weight of quails from 6 weeks old to 8 weeks old fed with feed supplemented with 4% of turmeric powder and 0.3% of *M. oleifera* seed powder (10.47 g) was relatively lower compared to control group (10.68 g) in this study. Similar trend was observed in the study conducted by Zacaria and Ampode (2021), in which the laying quails diet supplemented with 3% of turmeric powder (10.20 g). This result could be due to the reduction in dietary fatty acids (Zacaria and Ampode, 2021). In this study, the crude fat content in treatment layer feed (3.08%) was relatively lower than control layer feed (3.37%). This might be due to the curcumin that is inside the turmeric powder that was claimed to lower down the levels of free fatty acid (Jang, et al., 2008). The average egg weight from the treatment group in this study was quite similar to the findings reported by Suwarta and Suryani (2019), in which the average egg weight derived from the quail supplemented with 4% turmeric powder and 4% cinnamon powder was 10.46 g/egg.

5.2.5 Average Eggshell Thickness of Quails

In this study, the average eggshell thickness of eggs laid by quails from 6 weeks old to 8 weeks old in treatment group (0.22 mm) and control group (0.20 mm) does not differ significantly ($p \geq 0.05$) another word, there isn't any obvious increment in the eggshell thickness upon feeding with 4% turmeric powder and 0.3% *M.* oleifera seed powder that was in agreement with Saraswati and Tana

(2016) that supplementation of turmeric powder did not affect levels of calcium in eggshell in terms of eggshell thickness.

On the other hand, Gumus, et al. (2018) and Liu, et al. (2019) suggested that supplementation could enhance the calcium deposition in the uterus media of the hen. Different results in the average eggshell thickness might be due to the different concentrations of turmeric powder supplemented in the poultry diet, experimental duration and animal age.

5.2.6 Average Egg Yolk Colour of Quails

In this study, the egg yolks from treatment group showed the average delta L*, a*, b* of -0.15, 0.03 and -0.12 respectively which indicates that the colour prone to skewed towards darker shades of yellow. According to Zacaria and Ampode (2021), the improvement in egg yolk colour with the diet supplemented with the turmeric rhizome powder indicated that the bioactive components in turmeric such as curcumin were deposited in the yolk. The result in this study is in agreement with the results reported by Riasi, et al. (2012), in which the effect of feed supplemented with turmeric powder improve the egg yolk colour after four weeks of feeding trial and the enhancement of yolk colour was due to the bioactive compound of turmeric such as curcumin and its related compounds. In this study, the egg yolk colour in terms of L* a* b* coordinates in treatment group did not differ significantly ($p \geq 0.05$) with the control group. A similar trend was also reported by Silva, et al. (2017) in their study on the effect of turmeric levels up to 2% was not sufficient to increase yolk pigmentation with L* value (75.50), a* value (4.39) and b* value (45.48) compared to control with L* value (73.73), a* value (3.56) and b* value (45.17) which indicates that egg yolk colour in treatment group has lighter shades of yellow. However, contrasting results have been reported by Suwarta and Suryani (2019) who indicated that the supplementation of turmeric powder up to 4% significantly improved the yolk colour index (5.45) compared to control (3.31). Differences results observed could be due to the duration of the experiment period which egg yolk colour measurement carried out after 10 weeks of feeding trials in Suwarta and Suryani (2019) study which differ in this study that only carried out the egg yolk colour measurement after 6 weeks of feeding trials.

5.2.7 Mortality Rate of Quails

In this study, there was no mortality observed on the quails in both control and treatment group. According to Mousa, et al (2016), the absence of mortality among the birds was due to anti-microbial and availability of vitamins, proteins and minerals in *M. oleifera* seed powder which can boost the immunity system. Ochi, et al. (2015) also reported that non adverse effect on mortality rate of birds which fed on *M. oleifera* seed powder. Interestingly, Kennedy, et al. (2020) reported that the improvement in survivability of Japanese quails fed on turmeric rhizome powder supplemented diet was due to the antioxidant and antimicrobial properties of turmeric and the ability to suppress pathogenic bacteria thus feed supplemented with turmeric powder can promote the immune status of birds.

The absence of mortality in control group was due to the good house management during the experiment which increased liveability of birds (Mousa, et al., 2016).

5.3 General Discussion

5.3.1 Suggestion for Future Study

For the future study, the evaluation on the effect of feed supplemented with turmeric powder and *M. oleifera* seed powder on growth performance and egg production can be carried out using higher concentrations of both the phytogenic supplement. Besides that, the experiment duration for laying performance can be prolonged to enable data for egg production and quality of older laying quail. Last but no least, it is worth to study about the supplementation of both phytogenic feed additives on the total cholesterol level in quail egg.

CHAPTER 6

CONCLUSIONS

In conclusion, the treatment feed supplementation of 4% turmeric and 0.3% *M. oleifera* seed powder in the quail basal diet does not improve significantly in key proximate compositions to the control feed. However, the crude protein content does meet the standard crude protein content of quail diet requirement. The supplementation of 4% of turmeric powder and 0.3% of *M. oleifera* seed powder into the quail feed diet neither improves nor causes adverse effect on the growth performance and egg production of the quail because there is no significant effects in the average body weight gain, feed conversion ratio, egg production rate, average egg weight, eggshell thickness and egg yolk colour between treatment and control group. It is worth mentioning that there was no mortality recorded throughout the whole feeding experiment. Hence, there is a potential to use the combination of turmeric powder and *M.* oleifera seed powder as phytogenic supplement for quail upon optimization of the appropriate concentration in future study.

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APPENDICES

Appendix: Appendix for Chapter 4 (Results)

Appendix (Table 4.1): The dry matter content of control grower feed and treatment grower feed

Group Statistics

	DRYMATTER	N	Mean	Std. Deviation	Std. Error Mean
VAR0001	Control	3	88.9800	.37723	.21779
	Treatment	3	88.9967	.21362	.12333

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Significance One-Sided p	Mean Difference	Std. Error Difference
VAR0001	Equal variances assumed	1.346	.311	-.067	4	.475	-.01667	.25029
	Equal variances not assumed			-.067	3.163	.475	-.01667	.25029

Appendix (Table 4.1): The dry matter content of control layer feed and treatment layer feed

Group Statistics

	DRYMATTER	N	Mean	Std. Deviation	Std. Error Mean
VAR0001	Control	3	88.5400	1.15503	.66686
	Treatment	3	88.7600	.07810	.04509

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Significance One-Sided p	Mean Difference	Std. Error Difference
VAR0001	Equal variances assumed	3.487	.135	-.329	4	.379	-.22000	.66838
	Equal variances not assumed			-.329	2.018	.387	-.22000	.66838

Appendix (Table 4.1): The crude protein content of control grower feed and treatment grower feed

Group Statistics

	CP	N	Mean	Std. Deviation	Std. Error Mean
VAR0001	Control	3	21.1876	.99415	.57397
	Treatment	3	20.5212	.65345	.37727

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Significance One-Sided p	Mean Difference	Std. Error Difference
VAR0001	Equal variances assumed	.331	.596	.970	4	.193	.66640	.68686
	Equal variances not assumed			.970	3.456	.197	.66640	.68686

Appendix (Table 4.1): The crude protein content of control layer feed and treatment layer feed

Group Statistics

	CP	N	Mean	Std. Deviation	Std. Error Mean
VAR0001	Control	3	21.8050	.66371	.38319
	Treatment	3	21.5357	.24369	.14070

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
						Significance		
		F	Sig.	t	df	One-Sided p	Mean Difference	Std. Error Difference
VAR0001	Equal variances assumed	2.620	.181	.660	4	.273	.26927	.40821
	Equal variances not assumed			.660	2.530	.282	.26927	.40821

Appendix (Table 4.1): The crude fat content of control grower feed and treatment grower feed

Group Statistics

	CRUDEFAT	N	Mean	Std. Deviation	Std. Error Mean
VAR0001	Control	3	3.5500	.12000	.06928
	Treatment	3	5.0100	.12000	.06928

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
						Significance		
		F	Sig.	t	df	One-Sided p	Mean Difference	Std. Error Difference
VAR0001	Equal variances assumed	.004	.955	-15.159	4	<.001	-1.46303	.09651
	Equal variances not assumed			-15.159	3.993	<.001	-1.46303	.09651

Appendix (Table 4.1): The crude fat content of control layer feed and treatment layer feed

Group Statistics

	CRUDEFAT	N	Mean	Std. Deviation	Std. Error Mean
VAR0001	Control	3	3.3700	.06000	.03464
	Treatment	3	3.0799	.18015	.10401

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Significance One-Sided p	Mean Difference	Std. Error Difference
VAR0001	Equal variances assumed	1.605	.274	2.646	4	.029	.29010	.10963
	Equal variances not assumed			2.646	2.438	.048	.29010	.10963

Appendix (Table 4.1): The crude ash content of control grower feed and treatment layer feed

Group Statistics

	CRUDEASH	N	Mean	Std. Deviation	Std. Error Mean
VAR0001	Control	3	5.7798	.06969	.04024
	Treatment	3	5.4183	.71146	.41076

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
						Significance		
		F	Sig.	t	df	One-Sided p	Mean Difference	Std. Error Difference
VAR0001	Equal variances assumed	6.776	.060	.876	4	.215	.36150	.41273
	Equal variances not assumed			.876	2.038	.236	.36150	.41273

Appendix (Table 4.1): The crude ash content of control layer feed and treatment layer feed

Group Statistics

	CRUDEASH	N	Mean	Std. Deviation	Std. Error Mean
VAR0001	Control	3	13.0647	.12129	.07003
	Treatment	3	13.1204	.45867	.26481

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Significance One-Sided p	Mean Difference	Std. Error Difference
VAR0001	Equal variances assumed	6.918	.058	-.203	4	.424	-.05570	.27392
	Equal variances not assumed			-.203	2.278	.428	-.05570	.27392

Appendix A: The crude ash content of control grower feed and control layer feed

Group Statistics

	CRUDEASH	N	Mean	Std. Deviation	Std. Error Mean
VAR0001	Control grower	3	5.7798	.06969	.04024
	Control layer	3	13.0647	.12129	.07003

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Significance One-Sided p	Mean Difference	Std. Error Difference
VAR0001	Equal variances assumed	1.479	.291	-90.201	4	<.001	-7.28493	.08076
	Equal variances not assumed			-90.201	3.191	<.001	-7.28493	.08076

Appendix (Figure 4.1): Average weight gain of quails from 3 weeks old to 5 weeks old

Group Statistics

	WG	N	Mean	Std. Deviation	Std. Error Mean
VAR0001	Control	3	72.2367	13.70523	7.91272
	Treatment	3	74.2267	19.53242	11.27705

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Significance One-Sided p	Mean Difference	Std. Error Difference
VAR0001	Equal variances assumed	.509	.515	-.144	4	.446	-1.99000	13.77617
	Equal variances not assumed			-.144	3.585	.446	-1.99000	13.77617

Appendix (Figure 4.2): Average FCR of quails from 3 weeks old to 5 weeks old

Group Statistics

	FCR	N	Mean	Std. Deviation	Std. Error Mean
VAR0001	Control	3	2.4667	.62931	.36333
	Treatment	3	2.6100	.43863	.25325

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Significance One-Sided p	Mean Difference	Std. Error Difference
VAR0001	Equal variances assumed	.735	.440	-.324	4	.381	-.14333	.44288
	Equal variances not assumed			-.324	3.572	.382	-.14333	.44288

Appendix (Figure 4.3): Egg production rate of quails from 6 weeks old to 9 weeks old

Group Statistics

	EPR	N	Mean	Std. Deviation	Std. Error Mean
VAR0001	Control	3	69.8408	2.81186	1.62343
	Treatment	3	63.4917	8.54911	4.93583

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Significance One-Sided p	Mean Difference	Std. Error Difference
VAR0001	Equal variances assumed	5.065	.088	1.222	4	.144	6.34917	5.19596
	Equal variances not assumed			1.222	2.428	.164	6.34917	5.19596

Appendix (Figure 4.4): Average egg weight of quails from 6 weeks old to 8 weeks old

Group Statistics

	EW	N	Mean	Std. Deviation	Std. Error Mean
VAR0001	Control	3	10.6762	.49675	.28680
	Treatment	3	10.4695	.55878	.32261

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
						Significance		
		F	Sig.	t	df	One-Sided p	Mean Difference	Std. Error Difference
VAR0001	Equal variances assumed	.141	.727	.479	4	.329	.20670	.43166
	Equal variances not assumed			.479	3.946	.329	.20670	.43166

Appendix (Figure 4.5): Average eggshell thickness of quails from 6 weeks old to 8 weeks old

Group Statistics

	EST	N	Mean	Std. Deviation	Std. Error Mean
VAR0001	Control	3	.2033	.01155	.00667
	Treatment	3	.2167	.01528	.00882

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Significance One-Sided p	Mean Difference	Std. Error Difference
VAR0001	Equal variances assumed	.235	.653	-1.206	4	.147	-.01333	.01106
	Equal variances not assumed			-1.206	3.723	.149	-.01333	.01106

Appendix (Table 4.2): The average egg yolk colour between control and treatment group in terms of L* value

Group Statistics

	EYCL	N	Mean	Std. Deviation	Std. Error Mean
VAR0001	Control	3	57.1833	1.64452	.94946
	Treatment	3	57.0300	1.58755	.91657

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Significance One-Sided p	Mean Difference	Std. Error Difference
VAR0001	Equal variances assumed	.030	.872	.116	4	.457	.15333	1.31969
	Equal variances not assumed			.116	3.995	.457	.15333	1.31969

Appendix (Table 4.2): The average egg yolk colour between control and treatment in terms of a* value

Group Statistics

	EYCa	N	Mean	Std. Deviation	Std. Error Mean
VAR0001	Control	3	2.6033	.19858	.11465
	Treatment	3	2.6367	.21733	.12548

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Significance One-Sided p	Mean Difference	Std. Error Difference
VAR0001	Equal variances assumed	.008	.934	-.196	4	.427	-.03333	.16997
	Equal variances not assumed			-.196	3.968	.427	-.03333	.16997

Appendix (Table 4.2): The average egg yolk colour between control and treatment in terms of b* value

Group Statistics

	EYCb	N	Mean	Std. Deviation	Std. Error Mean
VAR0001	Control	3	19.4067	.57353	.33113
	Treatment	3	19.2933	1.03963	.60023

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
						Significance		
		F	Sig.	t	df	One-Sided p	Mean Difference	Std. Error Difference
VAR0001	Equal variances assumed	1.920	.238	.165	4	.438	.11333	.68551
	Equal variances not assumed			.165	3.114	.439	.11333	.68551