Effect of Feeding of Black Soldier Fly Larvae (BSFL) and Anchovy Waste on Egg Production of Japanese Quail

By

Muhammad Afiq Bin Zahri

F18B0075

A Report Submitted in Fulfilment of The Requirements for The Degree of Bachelor of Applied Science (Animal Husbandry Science) with Honours

Faculty of Agro-Based Industry

University Malaysia Kelantan

2022

DECLARATION

I hereby declare that the work embodied in here is the result of my own research except for the excerpt as cited in the references.

_____

Signature :

Student name : MUHAMMAD AFIQ BIN ZAHRI

Matric number : F18B0075

Date :

Verified by :

_____

Supervisor signature :

Supervisor name : DR.KHAIRIYAH BINTI MAT

Stamp :

Date :

ACKNOWLEDGEMENT

Alhamdulillah and thanks to Almighty for bestowing upon me some strength which allows me to complete my Final Year Project successfully, for me to graduate on time. Personally I would like to thank to my supervisor, Dr. Khairiyah Binti Mat with my deepest and sincere gratitude. Without her continuously guidance, assistant and encouragement throughout all the process in this thesis, this report would have never accomplished.

I also want to dedicate my gratitude to my friend for their help, encourage and supporting me mentally to cope with the problem that I faced during this project and finally, my greatest appreciation to my family for their unbelievable support.

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

Effects of Feeding Black Soldier Fly Larvae (BSFL) and Anchovy Waste on Egg Production of Japanese Quail

ABSTRACT

In general, the market for poultry products including quails is growing around the world. Collared eggs are a healthy, delicious, cheap and readily available protein source. Two and a half eggs of quail have the same saturated fat and cholesterol as an egg of a chicken. Egg industry has expanded exponentially in our country and has become one of the most advanced industries. This is because of the big processing units, a wide selection of egg made to the specific needs of customers and goods manufactured on our market. In this, about 40 million eggs are made daily. In Malaysia, most supplies of protein for feed are imported from other countries that are costly and that impact feed costs. For that cause, local raw materials to replace the import protein supply are important to find. The group treatment of this study constructed as control group which composed of 100% of soybean meal as protein sources, Treatment 1 and Treatment 2 group which consists of 50% BSFL, 50% anchovy waste and 25% BSFL, 75% anchovy waste as substitution of protein sources, respectively. The eggs were obtained from 5 weeks old quail. The results shown for the egg production, the control group recorded the lowest. Differences among eggs weight ($p<0.05$) for the treatment 1 and treatment 2 groups were significant and not significant at the control groups while for the differences among weight ($p>0.05$) on the other hand have no significant between all groups The highest production of egg was found in Treatment 1 however Treatment 2 was determined the highest FR (p-0.05). In conclusion, this analysis shows a positive impact, as evidenced by the treatment 2 group, which consists of 25% BSFL and 75% anchovy by products as a protein source in the composition.

Keywords: *BSFL, protein source, anchovy waste, quail, egg production*

Kesan Memberi Makan Larva Lalat Askar Hitam (BSFL) dan Sisa Ikan Bilis terhadap Pengeluaran Telur Puyuh Jepun

ABSTRAK

Secara amnya, pasaran produk ternakan termasuk burung puyuh semakin berkembang di seluruh dunia. Telur berkolar adalah sumber protein yang sihat, lazat, murah dan mudah didapati. Dua setengah telur puyuh mempunyai lemak tepu dan kolesterol yang sama seperti telur ayam. Industri telur telah berkembang dengan pesat di negara kita dan telah menjadi salah satu industri yang paling maju. Ini kerana unit pemprosesan yang besar, pelbagai pilihan telur yang dibuat untuk keperluan khusus pelanggan dan barangan yang dikeluarkan di pasaran kami. Dalam hal ini, kira-kira 40 juta telur dibuat setiap hari. Di Malaysia, kebanyakan bekalan protein untuk makanan diimport dari negara lain yang mahal dan memberi kesan kepada kos makanan. Atas sebab itu, bahan mentah tempatan untuk menggantikan bekalan protein import adalah penting untuk dicari. Rawatan kumpulan kajian ini dibina sebagai kumpulan kawalan yang terdiri daripada 100% tepung soya sebagai sumber protein, Kumpulan Rawatan 1 dan Rawatan 2 yang terdiri daripada 50% BSFL, 50% sisa ikan bilis dan 25% BSFL, 75% sisa ikan bilis sebagai pengganti. sumber protein, masing-masing. Telur diperolehi daripada burung puyuh berumur 5 minggu. Keputusan yang ditunjukkan untuk pengeluaran telur, kumpulan kawalan mencatatkan yang paling rendah. Perbezaan antara berat telur ($p<0.05$) bagi kumpulan rawatan 1 dan rawatan 2 adalah signifikan dan tidak signifikan pada kumpulan kawalan manakala bagi perbezaan antara berat ($p>0.05$) sebaliknya tidak signifikan antara semua kumpulan Pengeluaran tertinggi. telur ditemui dalam Rawatan 1 namun Rawatan 2 telah ditentukan FR tertinggi (p-0.05). Kesimpulannya, analisis ini menunjukkan kesan positif, seperti yang dibuktikan oleh kumpulan rawatan 2, yang terdiri daripada 25% BSFL dan 75% ikan bilis oleh produk sebagai sumber protein dalam komposisi.

Kata kunci: *BSFL, sumber protein, sisa ikan bilis, puyuh, pengeluaran telur*

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

1.0 RESEARCH BACKGROUND

Many studies are currently being conducted on the ability of Black Soldier Fly Larvae (*Hermetia illucens*) as a protein source in feed ingredients. BSFL is a tropical, subtropical, and warm temperate that can be feed to poultry (Marono et al., 2018). Studies showed that BSFL is a good source of protein and minerals. Moreover, BSFL has been reported to have an abundance of essential amino acids in the protein that is good for optimum growth and egg production for the quails. Japanese quail is one of the species of quail that are produced as domestic quail and one of the sources of protein in the poultry segment in Malaysia. Domestic quail are usually rear for the meat, eggs and as a pet. Quail farming was relatively small compared to other poultry segments like chicken and duck. This project aims to measure the effect of feeding black soldier fly larvae (BSFL) on the egg production of Japanese quails.

1.1 PROBLEM STATEMENT

Quail a kind of poultry creatures that are reared for meat and eggs utilization in Malaysia. Quail rearing in Malaysia is still moderately little and in its underlying stage. Most reproducers do not know about the business capability of quail egg and think of it as hard to be done. It is noticeable, in Malaysia that, the interest in quail egg is outperforming the chicken egg. In any case, because of the absence of providers, quail eggs are generally costly contrasted with chicken eggs. The production of quails in Malaysia was increasing dramatically to cater and satisfy the interest from the consumer. Quails experience a problem related to the renewing calcium in the bones during their creation period, which further exhibits the need to anticipate the full development of the body to accomplish better outcomes just as showing how significant nourishment is during reproducing.

1.2 AIM AND OBJECTIVE

- To determine the effect of feeding black soldier fly larvae (BSFL) and anchovy by product on egg production of Japanese quails.
- To determine the effect of feeding black soldier fly larvae (BSFL) and anchovy by product on egg quality of Japanese quails.

1.4 HYPOTHESIS

H_o: There is no significant effect of feeding black soldier fly larvae (BSFL) and anchovy by-products on egg production of Japanese Quails.

H_1: There is significant effect of feeding black soldier fly larvae (BSFL) and anchovy by-products on egg production of Japanese Quails.

1.5 SCOPE OF STUDY

The scope of this study is to determine the best effect of feeding black soldier fly larvae(BSFL) and anchovy by product on egg production of Japanese quails. The feed will be formulated nutrient requirement by only replacing the protein source in their commercial feed. This study will involve 3 treatment and 1 control for start week 5 until week 11.

1.6 SIGNIFICANCE OF THE STUDY

This study helped to know the best effect of feeding black soldier fly larvae (BSFL) and anchovy by product on egg for the productivity of Japanese quails. This study also will give benefit to many farmers for a small scale or poultry feed industry manufacturer by using local ingredient and waste product by replacing another alternative protein source which is cheaper from the market. Hence, this will reduce dependency of imported protein source like soybean meal and fish meal which is usually used in poultry feed industry. It was important to get determine positive effect if the black soldier fly larvae (BSFL) and anchovy by product can improve on quail production. This study helps to fulfil demand and alternative feed to give on quail.

CHAPTER 2

LITERATURE REVIEW

2.1 Japanese quail, *Coturnix japonica* in Malaysia

Today, in many places in the world typically many of the common larger quail species are farm raised for table food or egg consumption. During breeding season, usually it starts in In Malaysia, Coturnix cortunix japonica is the normal types of quail that is utilized economically for meat and egg creation. Since 1995, alone the interest for quail is accounted for to increment at 20-25% each year. Other than poultry, quail has assumed numerous significant parts in industry and research as it has little size, low farming expenses, short age stretch also, versatility to a wide scope of farming conditions. As they it is simple to deal with, it has been marketed generally in cultivating enterprises furnishing agricultural nations for elective creature proteins. Quail contains high protein content in its stomach related lot in which explicit epithelial cells discharge bodily fluid, shielding it from pathogenic microorganisms. Nonetheless, like poultry, quail is additionally helpless against gastrointestinal infection including throat, stomach, little and

digestive organs. All together to satisfy the developing need, enormous scope quail creation will require great fruitfulness, hatchability and sound chicks.

2.2 Quail's egg

Quails are average sized birds having a place with the request Galliformes of the Phasianidae family. Among the different genera of the quails worldwide the most utilized agent in egg creation is viewed as the Japanese quail (Coturnix japónica). Japanese quails are transitory game birds (Sanford, 1957; Weatherbee and Jacobs, 1961). Since the training of Japanese quail during the most recent couple of many years, they have been utilized widely for creation purposes. The Japanese quails have been likewise utilized broadly as a model animal variety in research on poultry rearing and hereditary qualities of development characteristics (Wilson et al., 1961; Marks, 1990; Baumgartner, 1994). They have been utilized to concentrate on nourishment, embryology, hereditary qualities, toxicology, physiology, endocrinology, oncology and gerontology, and in biomedical examination including virology (Ratnamohan, 1985; Shanawany, 1994). Notwithstanding, Japanese quail research estimated by the quantity of distributed papers has bit by bit lessened over the previous years and the pattern seems, by all accounts, to be because of the reduction of works utilizing Japanese quail as a creature model or for natural examinations (Minvielle, 2004). Precise information on Japanese quail table egg creation overall is hard to acquire despite of critical quail cultivating in Europe, America

and Asia (Minvielle, 2004). The main nations in quail table egg creation are China, Japan and Brazil (7.0, 1.8 and 1.7 million eggs every year, separately: Minvielle, 2004). In any case, it is hard to appraise the quantity of non-table eggs delivered by quails. Japanese quails are generally kept in confines under business conditions yet they can likewise be kept in profound litter floor frameworks. A base space stipend reasonable for quails is 145 cm2 when they are brought up in floors and 125 cm2 when brought up in confines. Quails raised under escalated conditions require appropriate consideration and sickness avoidance and control programs.

In dietary examinations in reproducer quails Yannakopoulos and Tserveni-Gousi (1989) announced the accompanying attributes: starting body weight 167.9 g (at day 42), last body weight 212.6 g (at day 105), acquire 44.7 (42-105 days), food utilization 31.4 g/bird/day, egg creation 87.1%, egg number 54.9 eggs/bird, average egg weight 10.8 g and feed/egg 36.0 g. Essentially creation attributes as of late revealed by Abdel-Mageed et al. (2009) in Japanese quail reproducers were: starting body weight 204.03 g/bird, last body weight 227.00 g/bird, feed consumption 19.95 g/hen/day, feed change proportion 2.10, egg creation 81.91%, 0.82 eggs/hen/day, egg weight 11.62 g, egg mass 9.52 g/hen/day. Great layer strains of Japanese quail arrive at a pinnacle creation of 92-95% and produce somewhere in the range of 300 and 320 eggs during the laying cycle.

Quail strains arrive at a lower top somewhere in the range of 80 and 85% and produce around 250 eggs in a year (Shanawany, 1994). Quail eggs are almost one-fifth of the size of chicken eggs. By and large, egg weight goes from 6 to 16 g, with an average

load of 10 g. This addresses about 8% of the body weight of the quail layer, as opposed to chicken and turkey eggs, which address about 3.5% and 1.0% of body loads, separately (Panda et al., 1979; Bitman and Wood, 1980). In contrast to the eggs of chickens and turkeys, the principal quail egg of a succession is more modest than the succeeding eggs (Woodard and Wilson, 1963). The principal proliferation attributes of the Japanese quails can be summed up as follows: age in development 6-7 weeks, age in greatest egg creation 7 two months, future 2.5 years, body weight of grown-up male 100-140 g, and grown-up female 120-160 g, brooding and bring forth period 17-18 days, egg weight 6-16 g, egg creation up to 280-300 eggs/bird in the main year (Reddish et al., 2003; Sezer, 2007).

2.3 Feed formulation

Feed formulation allude to the interaction to decide volumes of fixing and added substances to mix to deliver compound feeds that meet the supplement for creature necessity and accomplished creation objective at a streamlined expense (Lall and Dumas, 2015). There are a few angles that must be worried prior to forming the feed. For instance, the supplement necessity for the creature those are relying upon their stages (starter, producer and finisher). Aside from that, the general expense to create the feed should be considered to diminish the expense of creation later. The utilization of neighbourhood feedstuff that has comparable supplement substance can be as elective fixing to supplant imported feedstuff.

Table 2.3: recommended nutritional requirement for quail.

RECOMMENDED NUTRITIONAL REQUIREMENTS

Diet	Protein (%)	Calcium (%)	Phosphorus (%)	Methionine (%)
Bobwhite Quail - Meat-type				
Starter (0 - 6 wk)	23.0	1.0	.50	.50
Finisher (6 wk - mkt)	19.0	.90	.50	.40
Flight				
Starter (0 - 6 wk)	24.0	1.0	.50	.55
Developer (6 - 16 wk)	20.0	.90	.50	.42
Breeders				
Starter (0 - 6 wk)	23.0	1.0	.50	.50
Developer (6 - 20 wk)	18.0	1.0	.50	.40
Layer (20 wk +)	19.0	2.75	.65	.50
Coturnix (Pharaoh) Quail				
Starter (0 - 6 wk)	24.0	.85	.60	.50
Finisher (6 wk - mkt)	18.0	.65	.50	.40
Layer (6 wk +)	18.0	2.75	.65	.45

Source: https://www.thepoultrysite.com/articles/feeding-quail

2.4 Protein sources for animal feeding

In Malaysia, significant protein sources are used in hydroponics to care for soybeans as a fish feed much as non-ruminant food sources. In Malaysia, 120.000-meter massive fish food loads are required for Malaysians as well as 800.000 meter big soy food loads are needed. However, aside, much of the four hundred thousand metric tons of soy food and 100 thousand metric ton of fish demand would fulfil the animal's interest in Malaysia (Wong, 2009).

2.5 Anchovies-by product

Previously, fishery area had been one of the significant assuming parts in providing creature protein to Malaysian populace. The fish will be sold as newer and cooled, and any marketed in a live structure will be shipped off coffee with higher prices compared to the industry sectors. One of the fishes acquired from marine movement is anchovy or otherwise called Stolephorus spp. in their logical terms. They are reaped by anchovy satchel seine strategy and ordinarily worked in inshore waters (FAO, 2009). In 1997, it had been recorded that the collection reached as much as 22,288 tons. Even though anchovies just contributed 1.96% of the total number of marine arrivals is undeniably critical and significant, especially for the populace. Anchovies are then turned into budu, or aged cod, one of Malaysia's well-known traditional fixings. Nonetheless, the production of budu sometimes results in anchovies-by-product, which consists of their head and guts, being discarded rather than used in other ways. Therefore, there are opportunities to capitalize on the outcome.

2.6 Black Soldier Fly (BSFL)

Bug are viewed as a sound wellspring of protein because of its ability of raised utilizing natural source and have an ideal feed change. Their trait of being a poikilothermic of which they don't expect energy to direct their own internal heat level in this way permitting them to store more energy in their body and be incredible feed converter effectiveness (Veldkamp et al., 2012). BSFL are known to be types of flies that doesn't lived in methods of basic fly where their natural surroundings rather depend on products of the soil away from human populace. Fundamental amino corrosive in the creepy crawly might have the option to limit utilization of costly and top-notch fish feast consequently diminishing expense of feed.

2.7 Incidence of diseases to quail, Japanese coturnix

Japanese quail had been stated to be greater immune to not unusual place chicken sicknesses. The mortalities encountered in Japanese quail are specifically because of control issues, mainly in younger chicks. Major motives for mortalities for the duration of the brooding duration (0-10 days of age) are insufficient brooder temperature, access of chill air because of damaged facet curtains, too many chicks below one brood,

improper drinkers etc. If good enough interest is given, the mortality fee may be confined to two in step with cent from day-vintage to marketplace age. Due to extensive machine of rearing in huge numbers, the Japanese quails also are being affected with infectious and non-infectious sicknesses as that of hen. Major sicknesses affecting Japanese quail and the preventive. Japanese quail chicks are greater touchy to aspergillosis (brooder pneumonia), a fungal ailment. It is caused through inhalation of spores of Aspergillus fumigatus. When the wet litter material, mainly improperly dried coir pith are used for brooding chicks or whilst the hatcher trays are infected with aspergillus spores, the incidence of incidence of brooder pneumonia is greater. The affected chicks feel problems in breathing; gasping can be observed. Chicks might also additionally display paralytic signs. On autopsy examination, white shade nodules of pin head to large length can be observed withinside the lungs and air sacs. Secondly, Improper healing of naval, incomplete yolk sac absorption and irritation of naval alongside with bacterial contamination, mainly Eischerichia coli outcomes in Omphalitis. It is in any other case known as "Mushy chick ailment". Since yolk is the point of interest of contamination, many embryos die earlier than hatching, mainly for the duration of later duration of incubation. If hatched, the chicks display enlarged abdomen. The navels emerge as infected and wet. After that, Coccidiosis is a protozoan ailment affecting the intestines. Confinement of quail in ground pens promotes the unfold of coccidial infections (Eimeria uzura, E. bateri and E. tsunodai 2002). Bloody droppings, ruffled feathers, hunched posture and mortalities are the signs of coccidiosis in Japanese quail. The lifestyles cycle of quail coccidian is about seven days. Young quail are greater prone than adults; recovered birds have resistance to the unique stress they recovered from however may be inflamed with different strains. The cage reared quails are much less inclined for

coccidiosis. Then, this is an acute bacterial contamination characterised through the surprising onset of hastily growing mortality. Ulcerative enteritis is because of Clostridium colinum, which impacts quail of all ages, aleven though younger birds are greater prone. Dying birds might also additionally show off no premonitory symptoms and symptoms. They generally nicely muscled and feature crammed crops; wholesome quail frequently show off the watery white droppings, every so often related to the ailment. Prophylactic management of a hundred g bacitracin / tonne of feed offer safety against contamination. It is crucial to observe that quail emerge as a hundred percentage prone to contamination after discontinuing medication. Cage reared birds are much less affected because the infectious organism is withinside the droppings and stays possible almost indefinitely in litter. Mycoplasmosis It is because of Mycoplasma gallispeticum, which generally impacts Japanese quail from four weeks of age onwards. Unlike different respiration sicknesses, it spreads exceptionally slowly to different birds, and thus known as as Chronic Respiratory Disease (CRD). Affected birds display the signs of sneezing, coughing and gargling sounds for the duration of respiration. Eyes might also additionally display frothy exudates and conjunctivitis. The maximum crucial pathological lesion is cloudy look of 1 or greater air sacs. The severity of the mycoplamosis is relying at the ammonia degree withinside the farm. Fowl cholera because of Pasteurella multocia generally seems as a septicaemic ailment frequently related to high morbidity and mortality and impacts all sorts of birds. Among home birds, turkeys have a tendency to be greater prone. However, it impacts Japanese quail also. Generally, bird cholera takes place among 10 to thirteen weeks in hen. However, in quails the outbreak of pasteurellosis is said as early as eight days of age through. Obvious medical symptoms and symptoms of acute bird cholera won't arise till very late withinside the contamination and consist of

depression, ruffled feathers, mucous discharge from the mouth, diarrhoea and respiration distress. Avian paramyxo virus causes Newcastle ailment that generally impacts hen, geese and turkeys. Japanese quails are incredibly proof against NDV contamination, although they'll be inflamed below disturbing circumstances. Studied approximately the incidence of Newcastle ailment in Japanese quail whilst reared nearer into hen farm and said that susceptibility of quails to NDV contamination become lesser than that of chickens. Further they delivered those quails play an crucial function withinside the epidemiology of ND and its transmission to chickens inflicting heavy financial losses. It offers an perception to increase new vaccine techniques for use in quails to defend birds from each ailment and contamination and to lessen virus losing and spreading to different birds.

CHAPTER 3

METHODOLOGY

3.1 Designation of group and housing

A total of 48, 6 weeks-old quails were used and reared in battery cages at the Agro Techno Park, University Malaysia Kelantan, Jeli Campus. The quails were divided into 4 groups, which consisted of one commercial preference (C1), one control preference (C2), and two treatments group, treatment 1 (T1) and treatment 2 (T2). For each group, it has been made up by 3 replicate and each replicate of the group will have 4 quails each: 1 male and 3 female and being fed with different feed according to each group.

T2R1	T2R2	T2R3	C2R1	C2R2	C2R3
C1R1	C1R2	C1R3	T1R1	T1R2	T1R3

Table 3.1: the distribution of quails' group.

3.2 Animal feeding

Each group will be treated with differ in feed. Treatment 1 group will be fed the formulated feed consisted of 50% of defatted BSFL and 50% anchovy by-products whereas treatment 2 will be fed 25% of defatted BSFL and 75% anchovy by-products constitution of feed and control preference on the other hand were fed with 100% of soybean meal. The commercial preference group will be fed with the commercial feed formulated for layer. The newly formulated feed was formulated for layer quails. The quails were fed twice a day: morning and evening. The waterer and feeder were clean every day to avoid contamination. The quails were fed as it has leftover.

Table 3.2: composition of ingredients and nutrient of formulated feed

INGREDIENTS			
	CONTROL	TREATMENT 1	TREATMENT 2
ANCHOVIES BY PRODUCT	0	19.45	28.5
BSFL	0	18.55	9.5
CORN MEAL	33.29	33	32.51
WHOLE WHEAT MEAL	10.79	18.3	21.49
SOYBEAN MEAL	40.18	0	0
DICALCIUM PHOSPHATE	4.29	3.45	3
L LYSINE	2.29	1.45	1
DL METHIONINE	2.29	1.45	1
LIMESTONE	2.29	1.45	1
VEGETABLE OIL	2.29	1.45	1
PREMIX	2.29	1.45	1
TOTAL	100	100	100

NUTRIENT COMPOSITION (%)			
ENERGY {Kcal/kg}	3080.756	3030.979	2970.07
CRUDE PROTEIN	19.966	19.72	20
CRUDE FIBRE	1.582	0.806	0.884
CRUDE FAT	3.592	6.009	5.412
ASH	5.08	3.761	2.841
MOISTURE	11.112	12.475	13.769

3.3 Collection of the egg

The eggs were collected once a day, early in the morning and being recorded in the log daily. quail eggs will be measured one by one and recorded. measure each parameter using an egg gauge, weighing scale. separate egg yolks and albumen and weighed.

3.4 Sample Collection and Analytical Determination

Egg weights were measured using a 0.01 g digital display scale, their widths and lengths were measured using a 0.01 mm digital display calliper, and the shape index was calculated. In order to determine the internal quality traits of the eggs, they were cracked on a flat glass table. Their albumen length, albumen width, albumen height, yolk width, and yolk height were measured by using the calliper, and the eggs' shell thickness and weight were determined. All these processes will be continued until (six generation) to reach enough data with a genetic structure among the birds. The following formulas were used to determine external and internal quality traits of the eggs (Yannakopoulos and Tserveni – Gousi, 1986; Altan et al., 1995; Altan et al., 1998).

Egg weight (g): The eggs were weighed individually.

Shell weight (g): Shell weight was determined after cracking the eggs and cleaning the residual albumen left on the shell.

Albumen weight (g): Egg weight – (shell weight + yolk weight)

Shape index (%): (Width/length) × 100

Shell thickness (mm): (Pointed end + waist + blunt end)/3

Yolk index (%): (Yolk height/Yolk diameter) × 100

Haugh unit: 100*log (Albumen height + 7.57 – 1.7 × Egg weight 0.37)

Shell ratio (%): (Shell weight/Egg weight) × 100

Yolk ratio (%): (Yolk weight/Egg weight) × 100

Albumen ratio (%): (Albumen weight/Egg weight) × 100

Statistical Analysis

The Minitab (16.0) program was used to determine descriptive statistics of quality traits of the eggs. The model used to analyse the egg traits was:

μ: is the overall mean

Yij: external and internal egg quality traits

ai: rearing group effect (i: 1, 2, 3, 4)

eij: random residual effect.

The REML method was used to determine the genetic parameters of internal and external quality traits through the software Multiple Trait Derivative Free Restricted Maximum Likelihood (Boldman et al., 1995). While model 1, which included animals' direct additive genetic effects, was used for the first eggs, model 2, which also included the random maternal permanent environmental effects of quails, was used for all eggs. According to these models:

Model 1 (For the first eggs): $Yij = \mu + ai + bj + eij$

Model 2 (For all eggs): $Yijk = \mu + ai + bj + ck + eijk$

μ: is the overall mean

Yij(k): any trait (external and internal egg quality)

ai: rearing group effect,

bj: random direct additive genetic effect,

ck: random maternal permanent environmental effect,

eij(k): random residual effect.

The phenotypic correlation values related to the external and internal quality traits of the eggs were determined by the Pearson correlation analysis (SPSS 16.0).

illustrates mean values of external quality traits of the eggs according to the rearing groups. The mean values of egg weight, egg length, egg width, egg shape index, shell weight, shell thickness, and shell ratio were respectively 11.9 g, 3.3 cm, 2.6 cm, 78.9%, 1.3 g, 0.20 mm, and 10.8%.

3.5 Data Analysis

Least square variation analysis was used to compare egg and hatching weight in groups fed with BSFL and anchovy by-products, soybean meal, and commercial feed, and the Excel was used to determine the importance of discrepancies between the groups.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Egg weight, length, width treatment

The means of egg weight for each group are presented in table 4.1.1. The week 4 weight treatment was significant 0.002. Meanwhile, for the weight treatment, week 5, week 6, week 7, week 8 the control group recorder the lowest. There was a significant difference among weight ($p<0.05$). In this study, significant level week 4 weight treatment was 0.002, for week 5 was significant level 0.000. For week 6, week 7 and week 8 the significant level was 0.000. These result show that the feeding weight treatment means in the same row with different superscript consider significant different ($P<0.05$). This showed that the composition of 25% of BSFL and 75% anchovy by-products in treatment 2 groups were influential on the quails.

Table 4.1.1: The Average Of Egg Weight Among Treatments

WEEKS	FEEDING WEIGHT TREATMENT (Gram)				
	C1	C2	T1	T2	Significant level
WEEK 4	4.11±0.99	0.71±0.50	2.86±0.91	0.50±0.50	0.002
WEEK5	10.18±0.12	2.64±0.80	8.82±0.71	4.71±0.92	0.000
WEEK6	7.71±0.78	1.64±0.69	6.18±0.19	6.32±0.90	0.000
WEEK7	9.61±0.13	1.86±0.69	8.54±0.59	9.82±0.17	0.000
WEEK8	9.86±0.17	0.96±0.54	10.04±0.18	9.75±0.18	0.000

Means in the same row with different superscript consider significant different (P<0.05)

Table 4.1.2: The Average Of Egg Length Treatment

WEEKS	FEEDING LENGTH TREATMENT (cm)				
	C1	C2	T1	T2	Significant level
WEEK 4	12.61±3.02	2.40±1.70	7.76±2.62	1.29±1.29	0.002
WEEK5	31.67±0.25	9.16±2.79	26.28±2.36	15.76±3.04	0.000
WEEK6	25.24±2.55	5.74±2.37	31.62±0.33	20.22±2.90	0.000
WEEK7	31.39±0.17	6.56±2.42	28.02±1.88	31.61±0.16	0.000
WEEK8	31.76±0.16	3.35±1.86	31.99±0.16	32.05±0.15	0.000

Means in the same row with different superscript consider significant different (P<0.05)

Table 4.1.3: The Average Of Egg Width Treatment

WEEKS	FEEDING WIDTH TREATMENT (cm)				
	C1	C2	T1	T2	Significant Level
WEEK 4	9.97±2.39	1.79±1.24	65.2±2.19	0.99±0.99	0.002
WEEK5	23.78±1.16	6.94±2.17	21.27±1.69	12.28±2.37	0.000
WEEK6	18.93±2.09	4.46±1.84	25.07±0.30	16.04±2.31	0.000
WEEK7	25.02±0.64	5.15±1.90	22.14±1.48	25.24±0.13	0.000
WEEK8	24.78±0.16	2.67±1.48	24.88±0.16	25.15±0.13	0.000

Means in the same row with different superscript consider significant different (P<0.05)

The research of this study was reported by Widjastuti et al. (2014), their results are Reduce feed intake from the diet. In the same study, lower feed intake It was better consumed than the BSFL diet because of its palatability. commercial diet. Quail Feed Consumption Affected by Energy Feed level (Lotfi et al., 2018). The increase in dietary BSFL is Higher protein and fat content of feed (Widjastuti et al., 2014). V Higher levels of additional fat or higher energy intake triggers eating. Consumption to reduce and increase feed conversion or feed efficiency laying hens (Zou, Wu, 2005). Indicator of high feed efficiency Raw material utilization has decreased. People who made it to the BSFL A proportion of up to 25% did not affect the palatability of the feed. Quail appetite. Up to 50% BFSL meal replacement in quail has been shown to have no deleterious effect on feed intake (Widjastuti et al., 2014). However, when BSFL was used in a stratified diet, the FCR was significantly (P & lt; 0.01) higher (AlQazzaz et al., 2016). similar findings Amao et al. (2010), he FCR Laying are produced by replacing fish meal with caterpillar meal per 100 birds. g / 100 g This may be due to the action of chitin (AlQazzaz et al., 2016) About 9% of chitin is found in BSFL (Caligiani et al., 2018) According to Alagany et al. (2014).

According to Uğurlu et al. (2017), many researchers reported that different protein levels in the chicken diet had different effects on egg weight in poultry species. Constructive results for dietary protein per egg weight have also been reported. Consequently, the relationship between egg weight and dietary protein levels in chickens is very important. It was also found that there was a relationship between egg weight and hatch weight. Previous research has shown that replacing fishmeal with BSF maggot meal by up to 50% significantly reduces egg weight. This means that replacing fishmeal with

caterpillar meal increases the weight of quail eggs. BSFL can replace 50% fish meal without affecting egg production, egg weight or eggshell strength. Replacing BSF larval meal with fish meal throughout the study resulted in an accurate control egg weight of 75%. (Widjastuti et al., 2014). This study increased egg weight in both treatment groups and was significant compared to controls equivalent to Zotte et al. (2019). Weight of eggs produced by quails in experiments in which soybean meal was replaced with BSFL flour. It was higher than the value commonly found in the literature (14.5 g).

In this study, Treatment 2, which contained 25% BSFL and 75% anchovy pomace alternative protein source, recorded the highest egg weight and hatched chick weight. Finally, we indicate that there is a significant relationship between protein level and egg weight and positive effect on egg weight, length , width.

4.2 Egg shell thickness top, middle, bottom treatment

The means of shell thickness for each group are presented in table 4.2.1. The week 4 shell thickness top was significant 0.001. Meanwhile, for the shell thickness week 5, week 6, week 7, week 8 the group significant 0.000. There was a significant difference among weight ($p<0.05$). These result show that the feeding weight treatment means in the same row with different superscript consider significant different ($P<0.05$). This showed that the composition of 25% of BSFL and 75% anchovy by-products in treatment 2 groups were influential on the quails

Table 4.2.1: The Average Of Egg Shell Thickness Top Treatment

WEEKS	FEEDING SHELL THICKNESS TOP TREATMENT (cm/mm)				
	C1	C2	T1	T2	Significant level
WEEK 4	0.96±0.24	0.01±0.010	0.54±0.18	0.01±0.01	0.001
WEEK5	0.20±0.01	0.03±0.01	0.16±0.02	0.76±0.02	0.000
WEEK6	0.12±0.02	0.02±0.01	0.17±0.01	0.10±0.02	0.000
WEEK7	0.16±0.01	0.03±0.01	0.13±0.01	0.16±0.01	0.000
WEEK8	0.17±0.01	0.01±0.01	0.17±0.01	0.15±0.01	0.000

Means in the same row with different superscript consider significant different ($P<0.05$)

Table 4.2.2: The Average Of Egg Shell Thickness Middle Treatment

WEEKS	FEEDING SHELL THICKNESS MIDDLE TREATMENT (cm/mm)				
	C1	C2	T1	T2	Significant level
WEEK 4	0.96±0.02	0.01±0.001	0.05±0.08	0.01±0.01	0.002
WEEK5	0.21±0.01	0.03±0.01	0.15±0.01	0.10±0.02	0.000
WEEK6	0.13±0.02	0.02±0.01	0.17±0.01	0.11±0.02	0.000
WEEK7	0.17±0.01	0.03±0.01	0.14±0.01	0.17±0.01	0.000
WEEK8	0.20±0.01	0.01±0.01	0.19±0.01	0.17±0.01	0.000

Means in the same row with different superscript consider significant different (P<0.05)

Table 4.2.3: The Average Of Egg Shell Thickness Bottom Treatment

WEEKS	FEEDING SHELL THICKNESS BOTTOM TREATMENT (cm/mm)				
	C1	C2	T1	T2	Significant level
WEEK 4	0.10±0.02	0.01±0.10	0.06±0.02	0.01±0.01	0.001
WEEK5	0.21±0.01	0.03±0.01	0.14±0.02	0.09±0.02	0.000
WEEK6	0.13±0.02	0.02±0.01	0.18±0.01	0.11±0.02	0.000
WEEK7	0.16±0.01	0.03±0.01	0.14±0.01	0.18±0.01	0.000
WEEK8	0.18±0.01	0.01±0.01	0.19±0.01	0.17±0.01	0.000

means in the same row with different superscript consider significant different (P<0.05)

Studies show that eggs are better in terms of consistency, quails at later stages were provided with 2.5-3.5% calcium (Arpasova et al., 2010). but other variables Success in breeding quails in addition to feed, including breeds (Wahab et al., 2018) Lighting programs (Pizzolante et al., 2006) and environmental impacts (Redoy) et al., 2017). The current results clearly show the addition of the Black Soldier. Fly larvae, which make up up to 25% of the quail diet, improve growth and Stacking efficiency of quails excluding shell thickness egg. There was no difference in skin thickness, but the BSFL diet Treatment can still maintain acceptable and consistent results. Because the thickness of

the eggshell is close to the thickness of the quail fed commercial diet. laying performance are the results of efficiency in previous reports. Testing by replacing fishmeal with maggot meal has shown up to 50%. There was a significant increase in egg size (Widjastuti et al., 2014). Results were also obtained for egg development. AlDaraji et al. (2010), result was found to have a significant effect (p < or > ? 0.05) on the shell thickness. Olgun et al. (2013) found that neither. Significant effect of diet on eggshell thickness in laying. However, Pelicia et al. (2009) has a feed The conversion and consistency of poultry eggshells are improved by: Diet gradually with a calcium content of up to 4.5%. until there It greatly affects the thickness of the eggshell, and the quail is fed with BSFL.

Ensuring or improving the quality of eggshells in laying is of great interest as good eggshell quality prevents economic losses from cracking or damage. In this sense, physical parameters such as shell thickness. Despite inclusion of a BSF fat-free larval meal to increase the egg shape index, the results were consistent with values reported for this avian species (J. Poult. Sci. 2005) and close to the indicated optimal range of 72-76% for chicken eggs (Eur. Poult. Sci. 20160. Eggs with higher shape index also have higher shell weight) are consistent with the results of this study. And it was found that there was a positive correlation between the ovality index and the shell mass. The amount of BSFL skim fed to laying quails increased. Eggs from laying with 100% dietary replacement of soybean meal with BSFL skim larvae. On the other hand, this result may be related to the higher corn content of the feeds contained in the BSFL diets in both experiments. Meanwhile, in the aforementioned study, the increase in yolk redness was justified by the total carotenoid content of the insect meal, which also increased the total carotenoid content of the egg yolk. Although previous studies have shown that BSF larvae can

contain 2.00-2.15 mg carotenoids/kg, the effect of BSF larval feed supplementation on egg pigment content in laying hens is limited by the studies above, so this aspect should not be considered. Emphasize extra effort. It is necessary because it can have a significant impact on the market. In addition, carotenoids are antioxidants known for their ability to scavenge singlet oxygen and scavenge peroxyl radicals, and may play a role in improving human health by preventing cardiovascular disease, cancer and other chronic diseases (Karadas F 2006).

4.3 Egg shell, albumen, yolk treatment

The means of shell, albumen, yolk treatment for each groups are presented in table 4.3.1. The week 4 shell weight and albumen weight treatment were significant 0.002. Meanwhile, for shell, albumen, yolk week 5, week 6, week 7 and week 8 the group significant 0.000. There was a significant difference among weight ($p<0.05$). These result show that the feeding weight treatment means in the same row with different superscript consider significant different ($P<0.05$). This showed that the composition of 25% of BSFL and 75% anchovy by-products in treatment 2 groups were influential on the quails.

Table 4.3.1: The Average Of Egg Shell Weight Treatment

WEEKS	FEEDING SHELL WEIGHT TREATMENT (gram)				
	C1	C2	T1	T2	Significant level
WEEK 4	0.75±0.18	0.14±0.10	0.36±0.15	0.07±0.07	0.002
WEEK5	1.25±0.10	0.29±0.11	1.50±0.13	0.86±0.18	0.000
WEEK6	1.29±0.18	0.29±0.12	1.64±0.09	0.93±0.16	0.000
WEEK7	1.04±0.04	0.21±0.08	1.04±0.10	1.18±0.07	0.000
WEEK8	1.00±0.00	0.11±0.06	1.00±0.00	1.11±0.06	0.000

Means in the same row with different superscript consider significant different (P<0.05)

Table 4.3.2: The Average Egg Albumen Weight Treatment

WEEKS	FEEDING ALBUMEN WEIGHT TREATMENT (gram)				
	C1	C2	T1	T2	Significant level
WEEK 4	1.86±0.45	0.32±0.22	1.04±0.42	0.18±0.18	0.002
WEEK5	4.36±0.21	0.86±0.32	3.68±0.33	2.10±0.39	0.000
WEEK6	3.43±0.35	0.64±0.27	4.21±0.09	2.79±0.42	0.000
WEEK7	4.50±0.10	0.86±0.32	4.04±0.29	4.54±0.10	0.000
WEEK8	4.86±0.10	0.46±0.26	4.97±0.11	4.75±0.11	0.000

Means in the same row with different superscript consider significant different (P<0.05)

Table 4.3.3: The Average Egg Yolk Weight Treatment

WEEKS	FEEDING YOLK WEIGHT TREATMENT (gram)				
	C1	C2	T1	T2	Significant level
WEEK 4	1.46±0.36	0.25±0.18	0.68±0.29	0.00±0.00	0.000
WEEK5	3.96±0.20	0.86±0.32	3.46±0.34	2.21±0.41	0.000
WEEK6	3.00±0.31	0.71±0.29	3.79±0.09	2.46±0.36	0.000
WEEK7	4.04±0.06	0.75±0.28	3.57±0.25	4.07±0.07	0.000
WEEK8	4.00±0.10	0..39±0.22	4.04±0.13	3.89±0.09	0.000

Means in the same row with different superscript consider significant different (P<0.05)

Quail performance was determined by observing growth rate and laying performance, including measuring feed intake, body weight gain, feed conversion ratio (FCR), growth rate, also calculate shell, albumen, yolk weight. From this study, it was shown that the hypothesis of this experiment was accepted as all the results showed significant (p0.05) in the results, but it still showed better performance in Quails provided BSFL in the feed compared to quails provided with commercial feed only. In addition, quails that consumed 25% of the BSFL in the diet led to overall results. Therefore, it shows better growth performance and egg production than the other. A ratio of 25% BSFL to commercial feed can be concluded to be a better diet than other types and can be given to quail to improve their performance. Those who received the basic diet and those who received BSFL at a dose of 10 g/kg with Energy level reduced from 2800 to 2700 kcal/kg. , Egg weight decreased from 47.66 g to 46.41 g. this result Wu et al. (2005). Sohail et al. (2003) report the fact that increased dietary energy has a positive effect on eggs weight. Feed conversion was significant (P & lt; 0.01). BSFL is higher when included in the layer diet. V The increase in feed conversion rate Use of feed that may be related to the action of chitin. Amao et al. (2010) reported that it replaces fishmeal. with larval flour per 100 g/100 g, leading to a significant increase. in feed conversion for laying hens. feed consumption and Diet had no effect on weight gain. BSFL.

CHAPTER 5

CONCLUSION

In conclusion, the usage of BSFL and anchovy by product waste as alternative of protein sources, soybean meal in the quail feed were to produce the egg and good eggs of quail especially in size weight and performance. This was proven by observation eggs quail by hen fed with BSFL and anchovy by waste. Treatment 2 consists of 25% BSFL and 75% anchovy by-products as a substitution for the protein sources.

RECOMMENDATION

In terms of infrastructure, the poultry housing system offered at Agro-techno park, UMK must be expanded to a much higher level to guarantee that the feeding trial can be carried out without interruption, to increase the safety of the quail and researchers, and to ensure more accurate results. Furthermore, the availability of laboratory equipment, such as the incubator, should be increased and maintained to allow accurate comparison. Therefore, this study is important in assisting quail breeders by providing excellent information on how to select the best alternative proteins that are more practical and economical. Then it can help the country to become one of the best quail exporters in the world.

REFERENCES

Marono, S., Loponte, R., Lombardi, P., Vassalotti, G., Pero, M. E., Russo, F., Bovera, F. (2018). Productive performance and blood profiles of laying hens fed Hermetia illucens larvae meal as total replacement of soybean meal from 24 to 45 weeks of ag*e*. (February), 8.

Liu, L. L. (2019). Comprehensive Resource Utilization of Waste Using.

Faqi et al., (1997).A.S. Faqi, R. Solecki, R. Pfeil, V. Hilbig. Standard values for reproductive and clinical chemistry parameters of Japanese quail.

T.C. Fitzgerald, (1969). The Coturnix Quail: Anatomy and Histology. The Iowa State University Press, Ames (1969).

Ichilcik and Austin, (1978). R. Ichilcik, J.C. Austin. The Japanese quail (Coturnix coturnix japonica) as a laboratory animal. J. S. Afr. Vet. Assoc., 49 (1978), pp. 203-207.

Fudge, (1997) A.M. Fudge. Avian clinical pathology–Hematology and chemistry R.B. Altman, S.L. Clubb, G.M. Dorrestein, K. Quesberry (Eds.), Avian Medicine and Surgery, W. B. Saunders Co., Philadelphia, PA (1997), pp. 142-157

Lumeij, (1997). J.T. Lumeij. Avian clinical biochemistry. J.J. Kaneko, J.W. Harvey, M.L. Bruss (Eds.), Clinical Biochemistry of Domestic Animals, Academic Press, San

Diego, CA (1997), pp. 857-883

Ross et al., (1976),J.G. Ross, G. Christie, W.G. Halliday, R.M. Jones Determination of haematology and blood chemistry values in healthy six-week old broiler hybrids.Avian Pathol., 5 (1976), pp. 273-281

Farhat, E.R. Chavez. (2000). Comparative performance, blood chemistry, and carcass composition of two lines of Pekin ducks reared mixed or separated by sex. Poult. Sci., 79, pp. 460-465

G.R. Huff, W.E. Huff, N.C. Rath, N.B. Anthony, K.E. Nestor. (2008. Effects of Escherichia coli challenge and transport stress on hematology and serum chemistry values of three genetic lines of turkeys Poult. Sci., 87, pp. 2234-.

F.A. Verstappen, J.T. Lumeij, R.G. Bronneberg. (2002). Plasma chemistry reference values in ostriches. J. Wildl. Dis., 38, pp. 154-159

Abdurehman, A., & Urge, M. (2016). Evaluation of fertility, hatchability and egg quality of rural chicken in Gorogutu District, eastern Hararghe, Ethiopia. *Asian Journal of Poultry Science*, *10*(2), 111–116. https://doi.org/10.3923/ajpsaj.2016.111.116

Abdul Manaf, M. S. Bin. (2017). *Status of aquaculture feed and feed ingredient production and utilisation in Malaysia*. Retrieved from https://enaca.org/?id=894#:~:text=Since 2012 Malaysia produced has,tonnes of fish meal annually.&text=Malaysia also imported 1.5 million,at 120%2C000

tonnes in 2014.

Afonso, C. L., Miller, P. J., Grund, C., Koch, G., Peeters, B., Selleck, P. W., & Srinivas, G. B. (2012). Newcastle disease (infection with Newcastle disease virus). In *Manual of Diagnostic Tests and Vaccines for Terrestrial Animals*. https://doi.org/10.1080/713655022

Albrektsen, S., Mundheim, H., & Aksnes, A. (2006). Growth, feed efficiency, digestibility and nutrient distribution in Atlantic cod (Gadus morhua) fed two different fish meal qualities at three dietary levels of vegetable protein sources. *Aquaculture*. https://doi.org/10.1016/j.aquaculture.2006.08.031 Barragan-Fonseca, K. B., Dicke, M., & van Loon, J. J. A. (2017). Nutritional value of the black soldier fly (Hermetia illucens L.) and its suitability as animal feed - a review. *Journal of Insects as Food and Feed*, *3*(2), 105–120. https://doi.org/10.3920/JIFF2016.0055

Berkhout, N. (2009). Quail production boost in Malaysia and abroad. Retrieved June 28, 2020, from The Poultry World website: https://www.poultryworld.net/Home/General/2009/2/Quail-production-boost-inMalaysia-and-abroad-WP003543W/#:~:text=Feb 2%2C 2009-,Quail production boost in Malaysia and abroad,25%25 each year since 1995.

Care and incubation of hatching eggs. (2021, April 23). Thepoultrysite.com. https://www.thepoultrysite.com/articles/care-and-incubation-of-hatching-eggs

Cribb, J. (2010). *The Coming Famine : The Global Food Crisis and what We Can Do to Avoid it*. California: University of California Press.

Feeding Quail. (2021, April 23). Thepoultrysite.com. https://www.thepoultrysite.com/articles/feeding-quail

Food and Agriculture Organization of United Nation (FAO). (2005). *APFIC Regional workshop on Low value and "trash fish" in the Asia-Pacific region*. Hanoi, Vietnam.

Gencbay, G., & Turhan, S. (2016). Proximate Composition and Nutritional Profile of the Black Sea Anchovy (Engraulis encrasicholus) Whole Fish, Fillets, and By-Products. *Journal of Aquatic Food Product Technology*, *25*(6), 864–874. https://doi.org/10.1080/10498850.2014.945199

Incubation - Poultry Hub Australia. (2012). Poultry Hub Australia. https://www.poultryhub.org/anatomy-and-physiology/incubation

Iqbal, U. (2018). *Panduan Penternakan Burung Puyuh (Malay Version)* (Volume 1-; U. Iqbal, Ed.). https://doi.org/10.32474/OAJESS.2018.01.000119

Islam, M., Talukder, A., Rahman, M. A., Haider, M., & Rahman, A. (2016). Incidence of diseases in Japanese quail (Coturnix coturnix japonica) with special reference to bacterial and viral diseases in some selected areas of Bangladesh. *Asian-Australasian Journal of Bioscience and Biotechnology*, *2016*, 410–418.

Jacobsen, C., & Silva, M. (2018). Different raw material for fishmeal and fish oil production – Sources, regulations,quality criteria and research needs. *National*

Food InstituteResearch Group for Bioactives – Analysis and Application. Sound/Visual production (digital), Technical University of Denmark.

Leow B.L; Shajaratul Wardah M.Y.; Ramlan M. (2011). Newcastle disease in Malaysia:

diagnostic cases in veterinary research institute (vri) Ipoh from 2004-2009. *Malaysian Journal of Veterinary Research*, *2*(1), 45–51.

Linhoss, J. E., Thomas Table, G., & Wells, J. B. (2020). Quail Feeding Programs. Retrieved June 28, 2020, from Mississippi State University Extension website: http://extension.msstate.edu/content/quail-feeding-programs

Lisa K. Nolan. (2019). Colibacillosis in Poultry. In *MSD MANUAL Veterinary Manual*. Retrieved from https://www.msdvetmanual.com/poultry/colibacillosis/colibacillosisin-poultry

Liu, L. L. (2019). Comprehensive Resource Utilization of Waste Using.

Liu, X., Chen, X., Wang, H., Yang, Q., Rehman, K., Li, W. Zheng, L. (2017). Dynamic changes of nutrient composition throughout the entire life cycle of black soldier fly. 1–21.

Mizutani, M. (2003). *Quail the Japanese Quail*. *4*, 1–21.

Randall, M., & Bolla, G. (2008). Raising Japanese quail. *Primefact. 602. Second Edition*, *January*, 1–5. www.dpi.nsw.gov.au/primefacts

Soybean meal | Feedipedia. (2017). Feedipedia.org.

https://www.feedipedia.org/node/674

Tserveni-Goussi, A., & Fortomaris, P. (2011). Production and quality of quail, pheasant, goose and turkey eggs for uses other than human consumption. *Improving the Safety and Quality of Eggs and Egg Products: Egg Chemistry, Production and Consumption*, 509–537. https://doi.org/10.1533/9780857093912.4.509

Uğurlu, M., Akdağ, F., Teke, B., & Salman, M. (2017). Effects of protein in diet and sex ratio on egg production, egg and hatching chick weight, fertility, hatchability and embryonal mortality in pheasants (Phasianus colchicus). *Revista Brasileira de Ciencia Avicola*, *19*(2), 231–238. https://doi.org/10.1590/1806-9061-2016-0423

Vali, N. (2010). Japanese Quail (Review). In *International Journal of poultary science* (Vol. 7, Issue 9, pp. 925–931).

Veldkamp, T., van Duinkerken, G., van Huis, A., Lakemond, C. M. M., Ottevanger, E., G.;, B., & van Boekel, M. a. J. S. (2012). Insects as a sustainable feed ingredient in pig and poultry diets - a feasibility study. *Wageningen UR Livestock Research*. https://doi.org/ISSN 1570 - 8616

Wahab, M. A., Mat, K., Faiz, M., Nor, M., Adam, M. A., Ramli, M. S., Rusli, N. D., Hasnita, C. H., Ili, R., & Raja, A. (2018). Comparative study of hatchability rate and egg quality between different strains of Japanese Quail (Coturnix japonica). *Journal of Tropical Resources and Sustainable Science*, *6*(2), 68–72.

Wong, M. W. Z. and H. K. (2009). Research and development on animal feed in malaysia.