EFFECT OF IPIL IPIL AND EGG SHELL SUPPLEMENTS ON EGG AND GROWTH PERFORMANCES OF JAPANESE QUAIL

A THESIS

BY

MT. ROJINA BEGUM

Registration No.: 1505012

Session: 2015-2016

Semester: JULY-DECEMBER, 2016

MASTER OF SCIENCE (M.S.)

IN

PHYSIOLOGY

DEPARTMENT OF PHYSIOLOGY AND PHARMACOLOGY

HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY, DINAJPUR-5200

DECEMBER, 2016

EFFECT OF IPIL IPIL AND EGG SHELL SUPPLEMENTS ON EGG AND GROWTH PERFORMANCES OF JAPANESE QUAIL

A THESIS

BY

MT. ROJINA BEGUM

Registration No.: 1505012

Session: 2015-2016

Semester: JULY-DECEMBER, 2016

Submitted to the Department of Physiology & Pharmacology,
Hajee Mohammad Danesh Science and Technology University, Dinajpur,
Bangladesh in Partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE (M.S.)

IN

PHYSIOLOGY

DEPARTMENT OF PHYSIOLOGY AND PHARMACOLOGY

HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY, DINAJPUR-5200

DECEMBER, 2016

EFFECT OF IPIL IPIL AND EGG SHELL SUPPLEMENTS ON EGG AND GROWTH PERFORMANCES OF JAPANESE QUAIL

A Thesis

By

MT. ROJINA BEGUM

Registration No.: 1505012

Session: 2015-2016

Semester: JULY-DECEMBER, 2016

Approved as to style and content by

____

(Dr. Rakibul Islam)
Supervisor

____

(Dr. Fahima Binthe Aziz)
Co-Supervisor

____

(Dr. Rakibul Islam)
Chairman
Examination Committee

DEPARTMENT OF PHYSIOLOGY AND PHARMACOLOGY

HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY, DINAJPUR-5200

DECEMBER, 2016

DEDICATED
TO MY
BELOVED PARENTS

ACKNOWLEDGEMENT

I am ever grateful to my creator Almighty Allah for my blessings to enable me to carry out this research work and complete the thesis.

I am would like to express heartfelt gratitude to my honorable Supervisor, ***Dr. Rakibul Islam,*** *Associate Professor and chairman, Department of physiology and Pharmacology, Hajee Mohammad Danesh Science and Technology University, Dinajpur for his supervision, scholastic guidance, innovative suggestions, constructive criticism, helpful comment, inspiration and timely instructions throughout the entire period of the research.*

I express deep indebtedness to my Co-supervisor, ***Dr. Fahima Binthe Aziz,*** *Associate Professor, Department of Physiology and Pharmacology, Hajee Mohammad Danesh Science and Technology University, Dinajpur for his scholastic guidance, untiring assistance and advice in preparing the thesis.*

I owe arrears of gratitude to ***Dr. Md. Mahmudul Hasan****, Assistant Professor,* ***Dr. Md. Bazlar Rashid,*** *Assistant Professor, and* ***Mst. Misrat Masuma Pervez****, Lecturer, Department of Physiology & Pharmacology, Hajee Mohammad Danesh Science and Technology University, Dinajpur for their helpful advice and co-operation in providing facilities to conduct the experiments.*

I humbly desire to express profound gratitude and thanks to my all reverend teachers of the Faculty of Veterinary and Animal Science, Hajee Mohammad Danesh Science and Technology University, Dinajpur for their kind help, co-operation, encouragement and valuable suggestions.

With due pleasure I wishes to acknowledge the healthy working relationship of staff of the Department of Physiology and Pharmacology, Hajee Mohammad Danesh Science and Technology University, Dinajpur.

Finally, I am very much grateful to my beloved parents and siblings, uncle and aunts for their sacrifice, inspiration, encouragement and endless love and continuous blessing for educating herself up to the postgraduate level.

December, 2016

ABSTRACT

This study was carried out in the Department of Physiology and Pharmacology at Hajee Mohammad Danesh Science and Technology University to evaluate the effect of Ipil ipil and Egg shell supplements on Egg production and live body weight of Japanese quail. Forty two days old "Japanese Quail" were divided into four groups (n=10 birds in each group). Group T_0 was considered as control, fed only with commercial layer ration. Group T_1 was T_2, T_3 were supplemented with 2 g grinded Ipil Ipil leaves, 2g egg shell as Ca source, 2g grinded Ipil Ipil leaves plus 2 g egg shell supplement per kg feed respectively. Observations were recorded for growth performance, egg production and egg quality of Japanese quail. Body weight was increased significantly ($p \leq 0.05$) in all treated groups compared to control and best gain was recorded in combine action of Ipil Ipil and Egg shell supplemented groups. Egg production were also increased significantly ($p \leq 0.05$) in all comparing to controls. Best result was found in combination of ipil ipil and egg shell supplemented group. The present study reveals that combine supplementation of Ipil Ipil and Egg shell supplements give better effects in respect to growth performance, egg production and egg quality of Japanese quail.

CONTENTS

CHAPTER	TITLE		PAGE NO.
	ACKNOWLEDGMENT		**i**
	ABSTRACT		**ii**
	LIST OF TABLES		**iii-iv**
	LIST OF FIGURES		**v**
	LIST OF PLATES		**vi**
I	**INTRODUCTION**		**1-5**
II	**REVIEW OF LITERATURE**		**6-14**
	2.1	Domestication	6
	2.2	Distribution and habitat	6
	2.3	Behavior	9
	2.4	Physical Description	9
	2.5	Reproduction	10
	2.6	Production performance of Japanese quail	10
	2.7	Present status of Japanese quail	11
	2.8	Effect of Ipil Ipil on egg production and growth performance	11
	2.9	Preparing the leaf meals	13
	2.10	Effect of Egg shell supplements as sources of Ca on Egg Production	13
III	**MATERIALS AND METHODS**		**15-20**
	3.1	Collection and management of quails	16
	3.2	Collection of IpilIpil and Egg shell (Ca sources) supplement	17
	3.3	Experimental diet preparation and supply	17
	3.4	Egg production record	17
	3.5	Observation of egg quality	18
	3.6	Measurement of body weight	19

CONTENTS (Contd.)

CHAPTER	TITLE		PAGE NO.
	3.7	Weight of different egg component	19
	3.8	Shell thickness	20
	3.9	Statistical analyses	20
IV	**RESULTS AND DISCUSSION**		**21-24**
	4.1	Egg Production	21
	4.2	Body weight	23
	4.3	Egg quality	24
V	**CONCLUSION**		**25-26**
	REFERENCES		**27-30**

LIST OF TABLES

TABLE NO.	TITLE	PAGE. NO.
2.1	Compositions of ipil ipil leave	12
4.1	Effect of dietary Ipil ipil and Egg shell powder on egg performance of quail	22
4.2	Body weight at the age of 70 days	24

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE NO.
1	Layout of the experimental design (each group consisting of ten quails)	16
2	Japanese quail in experimental shed	17
3	Ipil ipil leave	17
4	Egg shell (source of dietary Ca)	17
5	Observation of egg quality	18
6	Measurement of Fresh yolk weight	19
7	Measurement of Egg shell weight	19
8	Measurement of shell thickness	20
9	Effect of Ipil ipil and Egg shell supplementation on the number of egg	23
10	Effect of ipil ipil and egg shell supplementation on growth performance	24

CHAPTER I

INTRODUCTION

CHAPTER I

INTRODUCTION

Poultry is one of the best growing segments of the agricultural sector in Bangladesh. It plays a vital role in the subsistence economy and contributes 1.6% in GDP (SAEDF 2008) in Bangladesh. It is sometimes used as the first investment for a livestock ladder (in the sense that one can move from poultry to goat/sheep to cattle etc.) to increase income and get out of poverty. Therefore, Government, as well as the NGO sector in Bangladesh has pursued poultry production as a tool for poverty alleviation. The poultry sector in Bangladesh is very important for the reduction of poverty and creation of employment opportunities. The livelihoods of a substantial section depend directly on this industry. Creation of employment, poverty alleviation and improved nutrition are all potential benefits which should be considered for continued support and encouragement to poultry development in Bangladesh. During the mid-1980s, considering the condition of the landless, especially of distressed women and their socio-economic condition, the Bangladesh Government initiated activities with the aim of improving the livelihoods of the poor sections by involving them in livestock and poultry rearing. The smallholder livestock development programme involving this group of people began in Bangladesh in 1984-85. To this end, the World Food Programme (WFP) played a vital role by providing assistance in the form of food aid, training and other logistical support. Still the Government is trying to protect the poultry sector from any hazards and is also promoting this sector through the motivation of village people and youth, training of rural women and landless farmers, small credit, and input supply etc. with the aim of poverty reduction.

Poultry feedstuffs are expensive, thereby limiting the growth of poultry industry in the tropics. Most of the developing countries are situated in tropical areas, and there is lack of the necessary funds to import the ingredients for human and livestock feeding. The current acute short supply of animal protein in developing countries justifies. The research into the potentials of some novel local produced feed resources for productive animals such as leaf meals, which could be included into the poultry diets in order to sustain the poultry enterprises and to improve the profit margin through reducing the use of the conventional protein sources (D'Mello 1995, Agbede 2003, Reddy and

Qudratullah 2004, Nworgu and Fasogbon 2007, Atawodi *et al.* 2008, Iheukwumere *et al.* 2008 and Sarmiento 2011).

Bangladesh possesses a large variety of Japanese quails This study consisted of two experiments, aimed at determining the effect of the dietary inclusion of ipil ipil Leucaena leucocephala leaf meals and Egg shell supplement on Japanese quails egg production.

Leucaena leucocephala is among the leaf meals that could be used as feed alternatives in commercial livestock and poultry in the tropics (Makkar and Becker 1997 and Agbede 2003).

Leucaena leucocephala is available and spread almost world-wide, and it is estimated that Leucaena covers 2-5 million worldwide (Brewbaker and Sorensson 1990 and Kakengi *et al.* 2007). The LLM is distinguished by their high protein contents, which ranges from 20 to 34% CP in LLM on dry matter basis. Also, they have an average metabolizable energy content for poultry ranges from 700 to 1365 kcal/kg in LLM on dry matter basis, in addition to an appreciable profile of essential amino acids, vitamins and minerals (D'Mello and Taplin 1978, Makkar and Becker 1997, Ramirez *et al.* 2000, Echeverría *et al.* 2002, Elkhalifa *et al.* 2007, Kakengi *et al.* 2007, and Atawodi *et al.* 2008). Also, it has been reported that hens are capable of finding and utilizing a considerable amount of nutrients from forages (Horsted 2006). The utilization of LLM leaf meals is expected to be a sustainable resource for commercial egg production in the tropics, as they are easily available and contain a considerable amount of nutrients.

Egg breakage still represents a major economic loss to the poultry industry. It was estimated that 13 to 20% of total egg production was cracked or lost before reaching their final destination (Roland, 1988). So, laying quail should be given proper calcium rich feed in their diet not only for the formation of egg shell but also for the high quality of egg shell, necessary for the prevention of breakage during handling and hatching. In general, the symptoms of calcium deficiency cause thin egg shell, reduced egg production, loss of appetite, leg weakness, cage layer fatigue and osteoporosis. Feeding with mild calcium deficiency, egg production generally decreases but does not stop completely. However, sometimes quail could lay at a high rate, even though they fed on a low calcium diet. In such cases, calcium is removed from the bones of quail becoming lame and crippled and sometimes death ensures (Singh and Panda, 1988). A number of calcium sources are being used to meet up the requirement of egg shell supplement for birds. Among these, egg shell and oyster shell are the excellent sources of calcium and are extensively used in poultry diet (McNaughton *et al.*, 1974; Gerry, 1980; Roland, 1989). The other calcium sources are steamed animal bone meal, dicalcium phosphate, rock phosphate, calcium phosphate, marine shell, calcium carbonate, pulverized egg-shell, zeolite, aragonite, gypsum, marble chips and even port land cement (North and Bell, 1990; Angulo *et al*., 1987). Although problems associated with shell quality have been studied extensively in the hen, very limited information is available in quails. As in the case of quail a deficiency of calcium in the diet of quails cause decline in egg production. The optimum level of egg shell supplement for high egg production and hatchability appears to be 2.5 to 3 percent, while higher level caused reduced hatchability.

Singh and Panda (1988) found among the three calcium levels of 2, 3.4 and 3.75. Only calcium level 3 showed better result in increasing egg production and egg shell quality. Farmers have to produce quality shelled egg. To do so, they have to select good quality and cheap egg shell supplement. There are lots of calcium sources available to choice as egg shell supplement to boost up shell quality but still confrontation sometimes arises that which one to be most effective. Oyster shell is harder than egg- shell, but it is well known that for egg shell formation blood Ca must be available in the uterus. With regard to the level of calcium, it is revealed that there is a gap of research. Thus, there is a definite controversy regarding the level of calcium for Japanese quail. Therefore, more research is needed to solve this problem. Moreover, many works have been done only viewing shell quality. Very limited works have been under taken regarding overall egg quality and egg production of laying quail.

Now a day's our unemployed young generation is coming in this business for long return of value and profit. Pharmaceutical companies take this advantage. They are convincing farmers for using synthetic phytase as a growth promoter and egg increaser for chicken as well as quail. As a result, each and every quail is a depot of antibiotics and other inorganic substances. When these quails are consumed by human these antibiotic and other inorganic residue enters into human body and causing serious human health hazards with drug resistance (Kibria *et al.,* 2009).

So, scientists are again concentrating on the use of our ancient medicinal system to find beneficial herbs and plants which can be safely used to increase the production. Such plants, Ipil Ipil (*Leucaena leucocephala) is* common plant which can be used as an alternative source of phytase. A phytase (myo-inositol hexakisphosphate phosphohydrolase) is any type of phosphatase enzyme that catalyzes the hydrolysis of phytic acid (myo-inositol hexakisphosphate) – an indigestible, organic form of phosphorus that is found in grains and oil seeds – and releases a usable form of inorganic phosphorus. While phytases have been found to occur in animals, plants, fungi and bacteria, phytases have been most commonly detected and characterized from fungi.

Phytic acid and its metabolites have several important roles in seeds and grains, most notably, phytic acid functions as a phosphorus store, as an energy store, as a source of cations and as a source of myo-inositol (a cell wall precursor). Phytic acid is the principal storage forms of phosphorus in plant seeds and the major source of phosphorus in the grain-based diets used in intensive livestock operations. The organic phosphate found in phytic acid is largely unavailable to the animals that consume it, but the inorganic phosphate that phytases release can be easily absorbed. Ruminant animals can use phytic acid as a source of phosphorus because the bacteria that inhabit their gut are well characterized producers of many types of phytases. However, monogastric animals do not carry bacteria that produce phytase, thus, these animals cannot use phytic acid as a major source of phosphorus and it is excreted in the feces.

Phytic acid and its metabolites have several other important roles in Eukaryotic physiological processes. As such, phytases, which hydrolyze phytic acid and its metabolites, also have important roles. Phytic acid and its metabolites have been implicated in DNA repair, clathrin-coated vesicular recycling, control of neurotransmission and cell proliferation. The exact roles of phytases in the regulation of described above are still largely unknown and the subject of much research.

Phytase is used as an animal feed supplement often in poultry and swine – to enhance the nutritive value of plant material by liberation of inorganic phosphate from phytic acid (myo-inositol hexakisphosphate). Ravindran V. *et al.* (1994) stated Ipil ipil as a promising source of phytate phosphorus.

The general objective is to see the egg and growth performances of quail by providing Ipil ipil and Egg shell supplements.

1. To enumerate the no. of egg of quail by providing ipil ipil and egg shell supplement.
2. To see the effect of Ipil ipil and egg shell supplementation on egg production with egg quality.
3. To see the growth performance of quail by providing ipil ipil and egg shell supplements.

CHAPTER II

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

2.1 Domestication

The earliest records of domesticated Japanese quail populations are from 12th century Japan; however, there is evidence that the species is actually domesticated as early as the 11th century (Hubrecht R, Kirkwood J, 2010). These birds were originally bred as songbirds, and it is thought that they were regularly used in song contests (Hubrecht R, Kirkwood J, 2010, Mills, AD, 1997).

In the early 1900s, Japanese breeders began to selectively breed for increased egg production. By 1940, the industry surrounding quail eggs was flourishing. However, the events of World War II led to the complete loss of quail lines bred for their song type, as well as almost all of those bred for egg production. After the war, the few quails left were used to rebuild the industry, and all current commercial and laboratory lines today are considered to have originated from this population of quails (Hubrecht R, Kirkwood J, 2010, Mills, AD, 1997)

2.2 Distribution and habitat

Populations of the Japanese quail are known to mainly inhabit East Asia and Russia. This includes India, Korea, Japan, and China (Barilani, M *et al*., 2005, Puigcerver *et al.,* 2007). Though several resident populations of this quail have been shown to winter in Japan, most migrate south to areas such as Vietnam, Cambodia, Laos, and southern China (Birdlife International, 2013) This quail has also been found to reside in many parts of Africa, including Tanzania, Malawi, Kenya, Namibia, Madagascar, and the area of the Nile River Valley extending from Kenya to Egypt (Pappas, J 2013).

Breeding sites of the Japanese quail are largely localized to East and Central Asia (Barilani, M *et al*., 2005, Puigcerver *et al.,* 2007), in such areas as Manchuria, southeastern Siberia, northern Japan, and the Korean Peninsula. However, it has also been observed to breed in some regions of Europe, as well as Turkey (Pappas, J 2013).

The Japanese quail is primarily a ground-living species that tends to stay within areas of dense vegetation in order to take cover and evade predation (Buchwalder, T; Wechsler B, 1997). Thus, its natural habitats include grassy fields, bushes along the banks of rivers, and agricultural fields that have been planted with crops such as oats, rice, and barley (Pappas, J 2013, Buchwalder, T; Wechsler B, 1997). It has also been reported to prefer open habitats such as steppes, meadows, and mountain slopes near a water source.

The establishment of quail production assumed importance worldwide in the last decade, not only for being a laboratory animal for poultry and biomedical research, but also because it is commercially exploited for production of meat and eggs. The poultry meat and egg industry have a rich story, which goes through various stages of development since the beginning, from captive birds, now reaching the most advanced and organized segment of agriculture worldwide .The quail production story is more recent and also has the same characteristics that occurred in the broiler and laying hen production.

During the 60's to 80's the quail production was regarded as subsistence activity in Brazil, in the small backyard rearing system. From the investment small backyard rearing system. From the investment of the genetic selection and quality of product, quail breeding producers could see a good deal for the future. Since then, it was seen the growth of large farms producing eggs, housing more than 100,000 birds in automated low-cost production and a regular supply of eggs with good quality, well packed, and safe to the market, and still making room for growth. The production of quail has been derived in meat and egg production. The major meat production countries are Spain, France eggs are China, Japan, Brazil and France, China and the United States of America. Leading the production of quail eggs are China, Japan, Brazil and France. In the Latin America, Brazil leads the production, followed by Venezuela, Peru, Colombia and Bolivia.

Global trends in the rearing of quail follow opposed directions when compared Brazil and the rest of the world. Worldwide there is a decrease in the use of quails in research as animal models, followed by a significant decline in peer reviewed articles. Nonetheless, in Brazil, it has been seen an increase in scientific papers regarding quail production since 2002, with the development of new production technologies giving support for the continued growth of the segment. Following this trend, a research group led by the author, founded the Center for Studies in Poultry Science and Technology (NECTA) at the Federal University of Lavras, Minas Gerais, contributing with advanced studies in poultry science and discussing the quail production. Then, the first forum for discussion of quail production occurred in 2002. Since then, it has been accomplished international symposia every 2 years with abundant discussions and exchange of technical expertise what resulted in improvement in the Brazilian quail egg and meat chain. As result from these meetings, could be ranked the main research lines to be followed by the quail industry led by the feeding studies (nutritional requirements specific to the stages of breeding / rearing, production, performance and internal and external quality of eggs), management practices (housing density, beak trimming, feed management, equipment, environmental comfort), health (diseases and vaccines, biosecurity) and genetics (genotype environment interaction, production, uniformity of egg, viability, selection and breeding).

The current situation in Brazil is a growing demand for processed eggs (pickles), however, there is a limited supply in day-old chicks what will restrict the market. On the other hand, there is a need to develop breeding programs to obtain better defined strains to produce eggs of good size and in the case of quails for meat production, the reduction of the effects of inbreeding. Studies of interaction between factors responsible for changes in production characteristics are critical for the quail egg chain.

The general trend in egg production is the automation in big farms, integrated with the egg processing industries. Advances have also been observed in the production technology of pickled eggs, always seeking to improve the quality of the product to the consumer.

Populations of the Japanese quail are known to mainly inhabit East Asia and Russia. This includes India, Korea, Japan, and China. Though several resident populations of this quail have been shown to winter in Japan, most migrate south to areas such as Vietnam, Cambodia, Laos, and southern China. This quail has also been found to reside in many parts of Africa, including Tanzania, Malawi, Kenya, Namibia, Madagascar, and the area of the Nile River Valley extending from Kenya to Egypt.

Breeding sites of the Japanese quail are largely localized to East and Central Asia, in such areas as Manchuria, southeastern Siberia, northern Japan, and the Korean Peninsula. However, it has also been observed to breed in some regions of Europe, as well as Turkey.

The Japanese quail is primarily a ground-living species that tends to stay within areas of dense vegetation in order to take cover and evade predation. Thus, its natural habitats include grassy fields, bushes along the banks of rivers, and agricultural fields that have been planted with crops such as oats, rice, and barley. It has also been reported to prefer open habitats such as steppes, meadows, and mountain slopes near a water source.

2.3 Behavior

From studies of captive-bred Japanese quail, seven distinct displays and calls have been recognized in males. Three of the calls were also observed to be uttered by females (Johnsgard 1988). The call of this quail consists of "deep hollow sounds, several times repeated in quick succession" (Finn 1911). The male's call is typically three notes. The female will utter a "long" call which allerts the male to her receptivity to copulate (Johnsgard 1988). In addition, these quail engage in courtship-feeding. The male will hold a small worm in his beak, uttering a soft croaking call. The female approaches the male and takes the small worm to eat. The male then attempts to copulate with the female (Lambert 1970).

This quail and its European counterpart are migratory. *Coturnix japanica* will migrate to India (Finn 1911), northern Japan and Korea for the summer (Hoffmann 1988). They winter in southeast China, Hainan, Taiwan, and southern Japan. Their migration covers 400-1000 km, which is remarkable for a bird not known for its flying capability (Hoffmann 1988). Overall, their migration route follows a north-south pattern (Johnsgard 1988).

2.4 Physical Description

The Japanese quail is similar in appearance to the European Common Quail, *Coturnix coturnix*. Overall, they are dark brown with buff mottling above and lighter brown underneath. They have a whitish stripe above the eye on the side of the head. Legs are orangish-gray to pinkish-gray as is the beak (Hoffmann 1988). In contrast to the males, females usually (but not always) lack the rufous coloring on the breast and black flecking or markings on the throat (Johnsgard 1988). There are variations in plumage color. Some birds are whitish to buff with rufous to chestnut mottling above. Others have a very dark brown appearance with little to no mottling. In addition, there have been golden-brown varieties bred in captivity (Hoffmann 1988). Wing sizes in males and females is similar ranging from 92 to 101 mm. Both male and female have similar sized tails ranging from 35-49 mm in length (Johnsgard 1988).

2.5 Reproduction

As with other quail, eggs were laid at a rate of one per day (Lambert 1970), with 7-14 eggs per clutch (Hoffmann 1988). An egg averages 29.8 by 21.5 mm is size and weighs 7.6 g (Johnsgard 1988). Incubation time is 19-20 days (Lambert 1970), although clutch sizes have been associated with latitude and length of photoperiod. In Japan, clutch size is 5-8 eggs, while in Russia, clutch size is 5-9 eggs (Johnsgard 1988). The chicks are considered to be mature and able to mate after four weeks old (Hoffmann 1988). The breeding season varies with location. In Russia, the season starts in late April and continues to early August. In Japan, nesting occurs from late in May and usually ends in August. On the rare occasion, eggs may be found in nests in September (Johnsgard 1988).

2.6 Production performance of Japanese quail

The production of eggs with eggshell quality is an important concern of the egg industry. According to Roland (1988), losses due to low eggshell quality or other reasons may reach 20% before the eggs arrive at retail. Hurwitz (1989) asserted that the nutritional factors that affect eggshell quality depend on the metabolic exchanges, which occur during egg formation. In the uterus, the organic fraction of the eggshell is synthesized by the glands, and calcium – its largest component – is mobilized from the blood. Eggshell is sensitive to calcium availability, and carbonate is influenced by dietary factors that affect acid-base balance. This author also observes that eggshell mineral content is 90%, out of which 98% consist of calcium carbonate. It is well known that, during eggshell formation, the transference of calcium from the plasma to the uterus in layers in very fast, of an average of one minute.

According to Etches (1996), eggshell is formed mostly during the night, when birds do not eat, and this may increase calcium deficiency for egg formation. Therefore, calcium is mobilized from the bones. Leeson *et al.* (1991) verified that calcium requirements are generally very low, except at the time eggshell is deposited. Faria *et al.* (2000) observed that commercial layers lay more frequently during the morning, after a period of fasting during the night, when eggshell is formed.

Aiming at improving eggshell quality in commercial layers, Joly *et al.* (2003) mentions some techniques, such as feeding calcium-rich feeds in the afternoon, high particle size calcium dietary addition, short lighting period during the night, etc. However, in order to successfully apply these techniques in quails, feed intake behavior and lay times must be similar between these two bird species.

Therefore, this study aimed at investigating performance, internal egg quality, and eggshell quality parameters of quails during the day, and the possible influence of the lighting program on these parameters.

2.7 Present status of Japanese quail

Within Japan, the Japanese quail *Coturnix japanica* is bird species familiar to many people. It was first designated as a game species in 1918, and has been captive-bred and released into the wild since the early 1970s. An examination of the annual numbers of quails hunted, based on Wildlife Statistics data and other literature sources, indicates that the population level of Japanese quail started to decline in the 1930s, and has subsequently shown a dramatic decrease. Japanese quail is thought to have no harmful effects on agriculture, and has retained its status as a game species solely owing to its value as a hunting target. In 1998 the Japanese quail was listed as DD (Data Deficient) on the Japanese Red List, and its designation as a game species should therefore be reconsidered as soon as possible. For the Japanese quail population to recover from itsfrom endangered status a combination of stricter hunting regulations and the active restoration of suitable habitat is urgently required quail.

2.8 Effect of Ipil Ipil on egg production and growth performance

Leucaena leucocephala is a medium sized fast growing tree belongs to the family Fabaceae. It is native to Southern Mexico and Northern Central America and now it has naturalized in many tropical and sub tropical locations (Hughes *et al.,* 1998). The specific name 'leucocephala' comes from 'leu' meaning white and 'cephala', meaning head, referring to the flowers. It is commonly known as White Lead tree, White Popinac, Jumbay and Wild Tamarind in India, it is popularly known as kubabul or subabul (Chandrasekhara, 1984). During the 1970s and 1980s it was promoted as a "miracle tree" due to its multiple uses (Gutteridge, R C 1998). It has also been described as a "conflict tree" because it has been promoted for its forage production and naturally spreads like a weed grows up to 20m height. Leaves are looking like that of tamarind having white flowers tinged with yellow, and having long flattened pods. Seeds are dark brown with hard shining seed coat and having long flattened pods. Seeds are dark brown with hard shining seed coat.

Table 2.1: Compositions of ipil ipil leave

(a) General compositor	Leucaena leaf
Total ash (%)	11.0
Total N (%)	4.2
Crude protein (%)	25.9
Modified-acid-detergent fibre (%)	20.4
Calcium (%)	2.36
Phosphorus (%)	0.23
Carotene (mg/kg)	536.0
Gross energy (kJ/g)	20.1
Tannin (mg/g)	10.15

The relatively high Crude Protein (CP) content of leaf meals in comparison with that of cereals is well recognised. However, the fibre component is also a major fraction of the dry matter (DM). In many instances the fibre content of leaf meals may equal or exceed CP concentrations. Consequently, digestibility of the CP fraction of many leaf meals is low which tends to depress overall CP digestibility when leaf meals constitute a significant proportion of the diet (Tangendjaja *et al.*, 1990).

Although lysine concentrations in leaf meals are considerably higher than those of cereal grains and certain by-products such as coconut oil meal, they are somewhat inferior to those of soyabean meal and fish meal. It follows that leaf meals cannot be expected to fully replace high quality ingredients in diets for monogastric animals. Deficiencies of the sulphur containing amino acids add a further dimension to the nutritional limitations of leaf meals. For example, biological values (BV) for cassava leaf meal range from 0.49 to 0.57 which may be enhanced to 0.80 on supplementation with methionine (Eggum, 1970). Although this leaf meal confers a superior dietary amino acid profile relative to by-products such as coconut oil meal, this difference is not reflected in BV determinations with pigs (Ravindran *et al.*, 1987).

Further insight into the nutritional value of leaf meals is provided by a consideration of metabolisable energy (ME) content. The limited data point to extremely low ME values for *Leucaena* (D'Mello and Acamovic, 1989) and *Robinia* as determined with poultry.

2.9 Preparing the leaf meals

L. leucocephala fresh leaves were harvested from trees (two years old trees. Leucaena leaves (Morton 1991; Shelton and Brewbaker 1994) were separated from branches, spread out and dried under shade for a period of 1 day; thereafter, they were dried in the oven (60ºC) for two days. The dried leaves were grounded with a hammer mill (2.0-3.0 mm sieve) to make the LLM which were incorporated to the experimental diets. Composition of used for ages and diets. Chemical composition of forage meals and diets (dry matter (DM), crude protein (CP), acid detergent Items.

2.10 Effect of Egg shell supplements as sources of Ca on Egg Production

Calcium is very important for layers, as eggshell consists of 90% mineral matter, out of which 98% is composed of calcium carbonate (Mendonça Junior, 1993). Losses caused by eggshell defects vary from 6 to 8% of laid eggs (Roland, 1977). In Brazil, Vicenzi (1996) estimated that losses due to cracked and/or broken eggs reach 6.0 to 12.3% annually. According to Leeson & Summers (1997), the use of medullar bones for eggshell formation results in sudden loss of 2g of body calcium, and therefore, a calcium bone reserve must be build up before the production period. Calcium is an important nutrient in commercial layer diet, and essential for eggshell formation. Feed intake can be influenced by dietary calcium level, which seems to act on the hypothalamus, inducing the release of norepinephrine, a neurotransmitter that acts in the central nervous system, stimulating feed intake (Borges, 1999). Eggshell works as a "package" of egg contents and protects the embryo, and must be sufficiently strong to resist egg laying, collection, grading, and transport, until it reaches the final consumer. Eggshell quality is also commercially important, as consumers are increasingly concerned with food safety, and poor eggshell quality presents potential bacterial contamination (Kussakawa *et al*., 1998). Calcium may be supplied by different sources, such as limestone, calcium sulfate, calcite, oyster shell meal, aragonite, eggshells, etc., the most commonly used in layer diets are calcitic limestone and oyster shell meal (Kussakawa *et al*., 1998).

Dietary calcium from different sources e.g. egg shell, Oyster shell, limestone and Calcium premix. They were placed in the experimental cages. Ten birds were considered for a replication of each treatment. The birds were reared in clean laying cages an open sided house. The experimental quails were exposed to identical care and management throughout the experimental period. Feed and water were offered ad libitum. Eggs were collected twice daily at morning and evening. The number of eggs laid by birds in each replication was recorded daily. The external quality of collected eggs were measured weekly from each treatment and leave randomly. But as the birds were getting older calcium premix produced better shell quality than oyster shell and limestone. It was concluded that any of these calcium sources can be considered for laying Japanese quail but calcium premix produces better shell quality at later age. This result also suggested that calcium increases egg weight.

CHAPTER III

MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted at Hajeepara, Thakurgaon District under the Department of Physiology and Pharmacology at Hajee Mohammad Danesh Science and Technology University, Dinajpur. The duration of experiment was about 28 days. The total number of 40 female quails were randomly selected and divided into 4 groups (T_0, T_1, T_2, T_3) at completely randomized design for assessing the effect of Ipil ipil and Egg shell supplementation on egg production, egg quality and growth performance of quail. Group T_0 were kept in control. Group T_1, T_2 and T_3 were fed 2g ipil ipil, 2g egg shell powder and 2g ipil ipil plus 2g egg shell powder, respectively.

LAYOUT OF THE EXPERIMENT

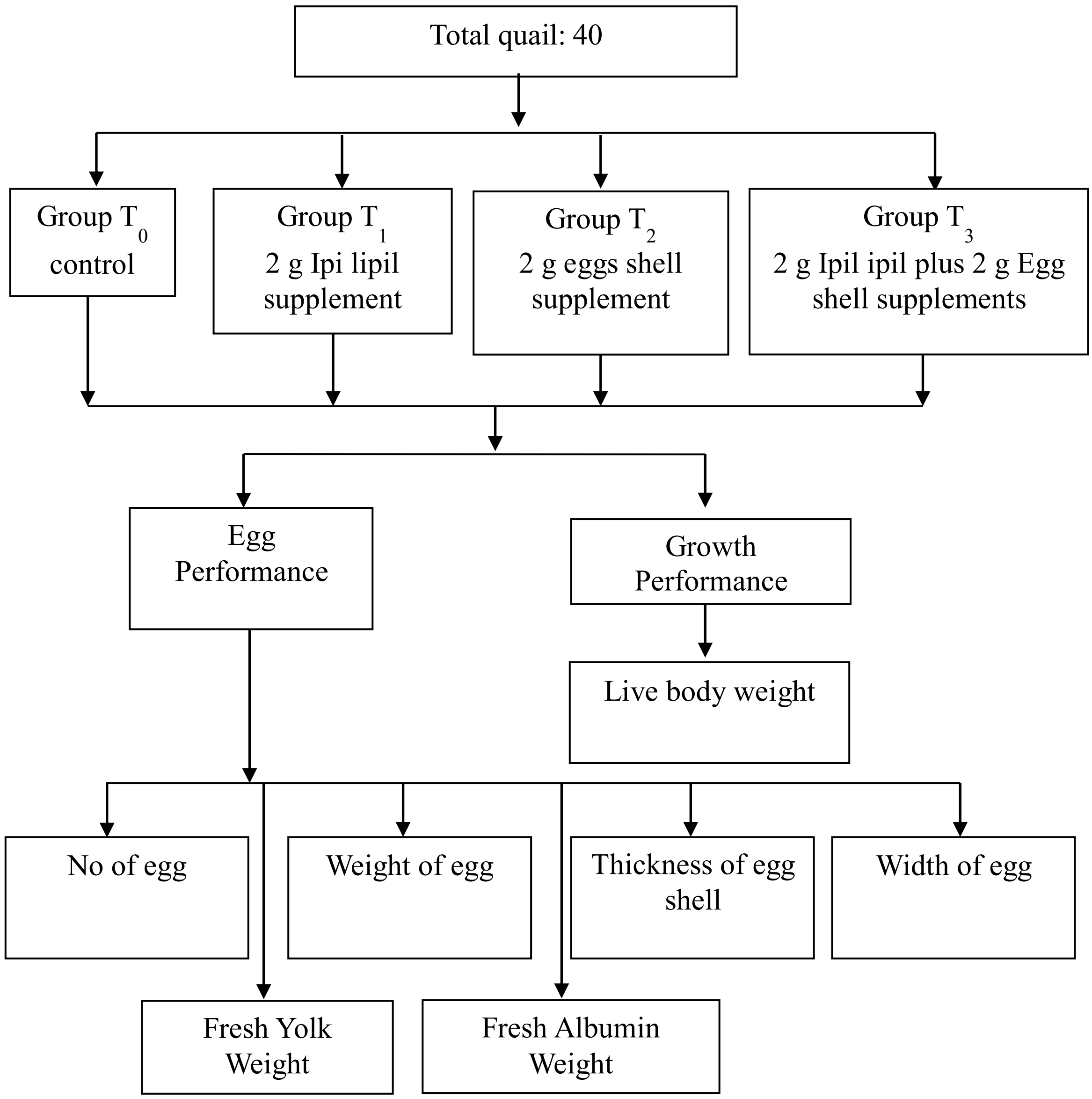

Figure 1: Layout of the experimental design (each group consisting of ten quails)

3.1 Collection and management of quails

At 6 week days of age, Japanese layer quails were collected from A. R. Enterprise (quail hatchery and farm), Bogra. Body weights of assigned quails were taken with digital weight balance and the data were recorded. The finally selected 40 quails were housed under normal husbandry condition and reared quail in quail cage. All the birds were fed with commercial crumbled + mesh feed at the rate of 30 g per bird per day and fresh water ad-libitum.

Figure 2: Japanese quail in experimental shed

3.2 Collection of IpilIpil and Egg shell (Ca sources) supplement

IpilIpil collected from the Khaja Nursery, Thakurgaon

Figure 3: Ipil ipil leave

Figure 4: egg shell (source of dietary Ca)

3.3 Experimental diet preparation and supply

The Ipil Ipil grinded and mixed with Egg shell supplement. The grinded leaves were added with commercial quail ration and served to different groups

3.4 Egg production record

Egg production was recorded for each quail at the same time each day during laying period. The incidence of broken eggs and soft-shelled eggs were identified and recorded. The number of eggs laid on successive days by a particular quail determined the length of each sequence and the number of pauses in each quail's oviposition determined the number of sequences. For each quail, the length of laying sequence was determined on the day the last egg of the quail was laid.

3.5 Observation of egg quality

Egg qualities wear measured from those eggs laid by quails of different treatment group. Measured egg qualities wear egg weight, shell dry weight, fresh albumin weight, fresh yolk weight, egg shell thickness, height of the thick albumin, height of the yolk, width of the yolk, width of the egg, diameter of the egg albumin. For quality determination egg weight was recorded by an electric weighing balance. The length of egg was measured by a slide calipers. The width was also estimated by slide calipers. The eggs were then carefully broken down on a glass plate (40 × 20cm) to determine the internal egg qualities.

Figure 5: Observation of egg quality

3.6 Measurement of body weight

The body weight of each quail measured with the help of digital balance.

3.7 Weight of different egg component

The method outlined by Chowdhury (1988) was followed for partition in different egg components. At first, egg was broken on glass plate. Then the yolk was separated carefully from albumin with the help of a spatula and transferred to a previously weighed petridish by a spatula and weighed. Precautions wear taken at all stages to avoid rupture of yolk.

Figure 6: Measurement of Fresh yolk weight

Figure 7: Measurement of Egg shell weight

The shell of the broken eggs wear rinsed and washed thoroughly in tap water keeping the membranes intake. The washed shells with membrane were immersed in a beaker of water for removal of the shell membranes. The shell and shell membranes were oven dried separately at 105 cover night keeping them in a glass petridish. On the following day, oven dried shell and shell membranes were taken. Finally the following calculations were made for different components suggested by Chowdhury (1988).

1. Fresh yolk weight:

   (weight of yolk + weight of petridish)-weight of petridish.

2. Fresh albumin weight:

   (Weight of wet albumin + weight of petridish)-weight of petridish.

3.8 Shell thickness

After removing of shell membrane, shell thickness (mm) was measured by screw gauge.

Figure 8: Measurement of shell thickness

3.9 Statistical analyses

Data were analyzed by analysis of variance using Completely Randomized Design with factorial arrangement of time and treatments (Steel and Torrie, 1986). All analyses wear performed by MSTATC and SPSS program.

CHAPTER IV

RESULTS AND DISCUSSION

CHAPTER IV

RESULTS AND DISCUSSSION

This study investigated the effect of Ipil ipil and egg shell supplementation on growth, egg production performances of quail. This experiment was conducted under the Department of Physiology and Pharmacology, Faculty of Veterinary and Animal Science. The results of these studies are discussed under following headings.

4.1 Egg Production

Egg production of different groups of quail were recorded from 6 weeks to 10 weeks quail treated with ipil ipil, Ca supplement and combined ipil ipil plus, Ca supplement. The average egg production of different groups of quail were recorded. Quails treated with ipil ipil leaves showed average egg production 20.5± 0.33 within 06-10 weeks, Ca supplement treated groups showed average egg production 21.80 ± 0.50 and combined treatment supplementation showed average egg production 22.5 ± 0.47 within 6 weeks to 10 weeks. (Table 1). Control group showed average egg production 18.5 ± 0.34. Result showed highest egg production in combined treatment group (22.5 ± 0.47) and lowest in control group (18.5 ± 0.34). Ipil ipil and Egg shell supplements increased egg production (Kurtoglu *et al.,* 2004 and Panda *et al*., 2008) also showed that.

Table 4.1 Effect of dietary Ipil ipil and Egg shell powder on egg performance of quail

Parameter	T_0 (Mean ± SE of mean)	T_1 (Mean ± SE of mean)	T_2 (Mean ± SE of mean)	T_3 (Mean ± SE of mean)
No. of Egg	18.5^{c} ± 0.34 (52.8%)	20.50^{b} ± 0 .33 (58.38%)	21.80^{ab} ± 0 .50 (62.00%)	22.50^{c} ± 0.47 (64.00%)
Weight of the Egg (g)	8.80^{a} ± 0.74	9.40^{a} ± 0.63	10.70^{a} ± 0.73	10.00^{a} ± 0.63
Width of the Egg (mm)	25.19^{a} ± 0.11	25.14^{a} ± 0.16	25.04^{a} ± 0.13	24.99^{a} ± 0.18
Height of Thick Albumin (mm)	3.13^{b} ± 0.06	3.23^{b} ± 0.06	3.42^{a} ± 0.06	3.50^{a} ± 0.05
Length of Egg (mm)	32.66^{a} ± 0.13	32.33^{a} ± 0.29	32.54^{a} ± 0.25	32.69^{a} ± 0.10
Diameter of Albumin (mm)	45.50^{a} ±.09	44.44^{a} ±.09	45.45^{a} ±3.01	41.43^{a} ± 0.15
Height of Yolk (mm)	6.80^{a} ± 0.10	6.41^{b} ± 0.13	6.32^{b} ± 0.11	6.88^{a} ± 0.08
Egg shell thickness (mm)	0.17^{a} ± 0.00	0.17^{a} ± 0.00	0.18^{a} ± 0.01	0.18^{a} ± 0.01
Width of the yolk (mm)	31.75^{a} ± 0.09	32.07^{a} ± 0.18	29.48^{c} ±0.11	30.12^{b} ± 0.18
Shell dry weight (g)	3.36^{a} ± 0.09	3.17^{a} ± 0.08	3.30^{a} ± 0.08	3.30^{a} ± 0.07

N.B: Values followed by different superscript in the same rows indicate statistically significant (P< 0.05).

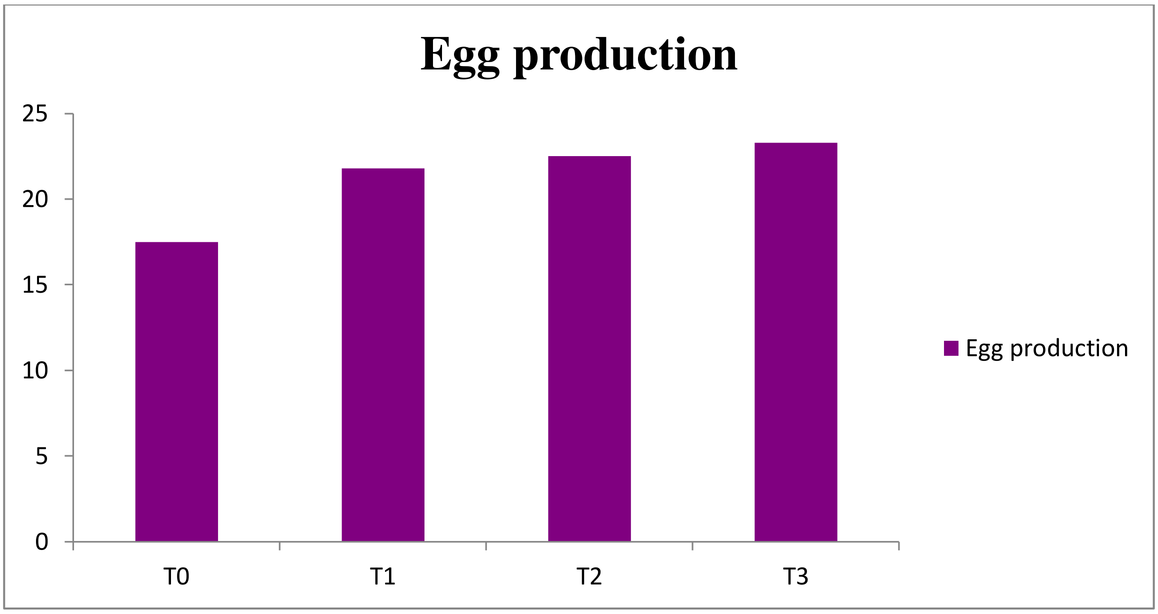

Fig. 9: Effect of Ipil ipil and Egg shell supplementation on the number of egg

4.2 Body weight

Body weight of different groups of quails were recorded from 06 weeks to 10 weeks quail treated with ipil ipil leaves, Egg shell supplement and combined ipil ipil and Egg shell supplement. The average body weight of different group of quails were recorded. Quails treated with ipil ipil leaves showed average Body weight gain $113.5^{a}\pm 3.44$gm to $142.9^{a}\pm4.28$g within 06-10 weeks Egg shell supplement treated groups showed body weight gain $116.2^{a}\pm 4.07$ to $143.60^{a}\pm 5.00$ g and combined treatment supplementation showed body weight $118.3^{a}\pm 3.49$ to $155.1^{a}\pm 2.59$g within 06-10 weeks (Table 4.2). Control group showed average body weight gain $113.3^{a}\pm 4.12$ to $143.6.9^{a}\pm 4.85$g. Result showed that the bodyweight of different groups same with the control group. Results are contrary to that observed by Saima *et al.* (2014) A 42 days' trial was conducted to evaluate efficacy of microbial phytase in diets for Japanese quails. For this purpose, 900 experimental birds were divided into six groups, each group containing 150 chicks and further sub-divided into 10 replicates. Diet A (positive control) was formulated according to NRC (1994) requirements set for the Japanese quail (CP 24% and ME 2900 Kcal/Kg). Diet T_1 differed from diet T_0 in Ca (Calcium) and P (Phosphorus) i.e. 0.15% Ca and 0.20% P less to Diet T_0, respectively.

Table 4.2: Body weight at the age of 70 days

Group	Body weight (g) at the age of 70 days (end of the experiment)
T_0	143.6 ^{a} ± 4.85
T_1	142.9 ^{a} ± 4.28
T_2	143.6 ^{a} ± 5.00
T_3	155.6 ^{a} ± 2.59
P-value	0.174

N.B: Values followed by different superscript in the same column indicate statistically significant (P< 0.05).

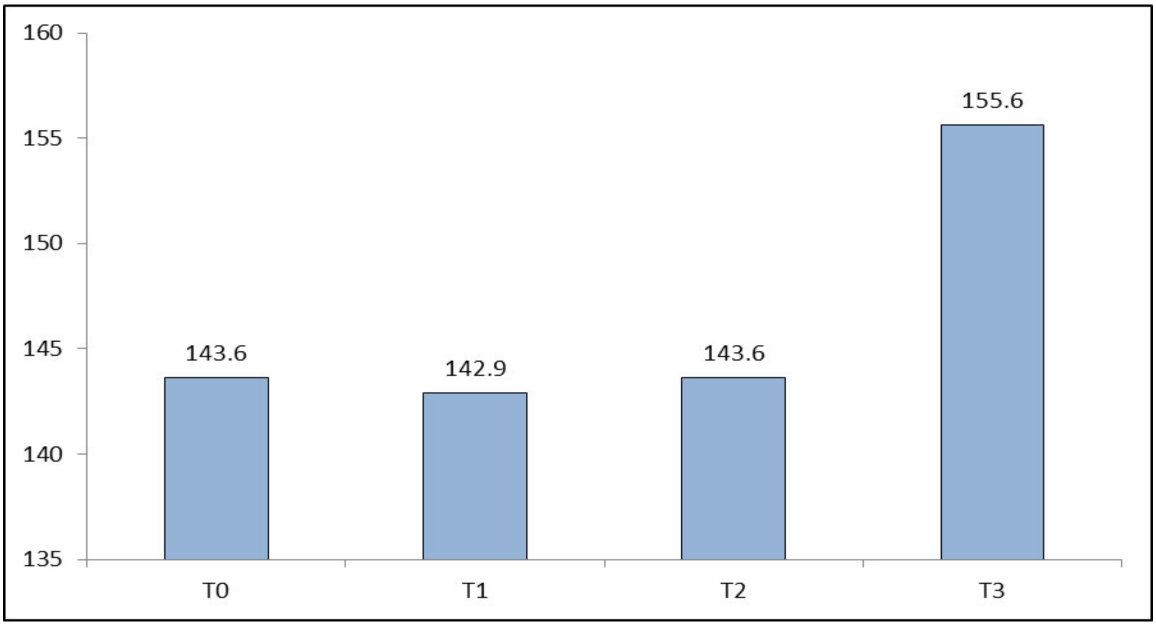

Fig. 10: Effect of ipil ipil and egg shell supplementation on growth performance

4.3 Egg quality

Table 4.3 demonstrate that there exist a significant (P<0.05) difference among the mean values like, Height of the thick albumin (mm), Height of the yolk (mm), width of the yolk corresponding to the different level of ipil ipil and Egg shell supplement treatment. But no significant (P>0.05) difference among the mean values like height of the egg, length of the egg (mm), diameter of albumin (mm), egg cell thickness (mm), Width of the yolk (mm) corresponding to the different level of ipil ipil and Egg shell supplement treatment. These results indicate that treated with ipil ipil and Egg shell supplement had no adverse effect on external and internal qualities of eggs.

CHAPTER V

CONCLUSION AND RECOMMENDATION

CHAPTER V

CONCLUSION AND RECOMMENDATION

This research work was conducted to study the effect of Ipil ipil and Egg shell supplementation on egg production, growth performance and egg quality of quail. The treatment group T_1, T_2, T_3 recorded statistically significant ($P<0.01$) increase for egg production than that of control group T_0. Net egg production was increased in Ipil Ipil and Egg shell supplemented group than control group T_0. Body weights were increased significantly ($P<0.05$) in all treated groups in respect to the control group and highest was recorded in combined Ipil Ipil and Egg shell supplemented groups (Group T_3). It is concluded that supplementation of 2 g grinded Ipil Ipil leaves plus 2 g grinded Egg shell per kg feed (T_3) of treatment groups caused significant increase in egg production ($P<0.01$) and as compared to that of other groups of quails. From this experiment we found that, between the control group and the treatment group of birds, the combined group is more suitable than any other groups. That there exist a significant ($P<0.05$) difference among the mean values like Length of the egg (mm), Height of the thick albumin (mm), Diameter of the albumin (mm), Shell thickness (mm) corresponding to the different treatment. But no significant ($P>0.05$) difference among the mean values like Weight of the egg (g), Width of the egg (mm), Height of the yolk (mm), Width of the yolk (mm), Shell dry wt (g) corresponding to the different treatment. From the present field and laboratory trial, it can be concluded that combined supplementation of 2g grinded Ipil Ipil leaves plus 2 g grinded Egg shell per kg feed is highly beneficial for enhancing egg production and our formulations could be used as an egg enhancer and growth promoter for quail.

In fact, only few trials had been performed to evaluate the effects of Ipil Ipil and Egg shell supplementation on growth performance, egg production and egg quality of quail. I did the work in short term basis (only 4 weeks) and modern equipment's were not available. Before field application as an egg enhancer of quail, further trial on a large scale basis is needed and also to make the findings more accurate and effective. Further study is essential to see any adverse effect in relation to histopathology before making a definite conclusion.

This was a preliminary work and the technology was very simple. Farmers could adopt that technology without any specialized technical knowledge and medicinal ingredients. As a result by using grinded Ipil ipil and Egg shell with normal commercial ration, small scale quail farmers would be able to sustain in their farming business and fulfill our protein demand. As well as a positive contribution in our national GDP of Bangladesh, these can helps in alleviating poverty through creating employment opportunity especially for rural population.

Further study can be concluded Ipil ipil and Egg shell supplement may be used as a feed supplement to increase the number of eggs of quail which may encourage the quail farmers to rear quail commercially and earn more profit as well as can contribute to meet the national protein demand.

Further study can be recommended to see biodigestibility of nutrients, blood characteristics and biochemical constituents of egg.

REFERENCES

REFERENCES

Agbede O. A. and Adegbola A. A. (2003). "Application of The Numerical Modeling Techniques to the simulation of Groundwater flow in the Gwandu Formation of the North-Western Nigeria Basin". Journal of Applied Science and Technology, Vol. 3, No. 1, p. 13-18.

Angulo, E., J. Brufau and. Puchal F. (1987). Portland cement as a source of calcium for ayinghens: Effects on egg quality and other parameters of production. Avancesen Alimentaciony Major an Animal, 27: 27-31.

Atawodi, S.E., Mari, D., Atawodi, J.C and Yahaya, Y. (2008). Assessment of Leucaena leucocephala leaves as feed supplement in laying hens. Afr. J. Biotechnol. 7: 317.

Barilani, M; Deregnaucourt S; Gellego S; Galli L; Mucci N; Piomobo R; Puigcerver M; Rimondi S; Rodriguez-Teijeiro JD; Spano S; Randi E (2005). "Detecting hybridization in wild (Coturnix c. coturnix) and domesticated (Coturnix c. japanica) quail populations". Biological Conservation 126: 445–455.

Birdlife International. Retrieved 20 October 2013.

Buchwalder, T; Wechsler B (1997). "The effect of cover on the behavior of Japanese quail (Coturnix japanica)".Applied Animal Behaviour Science 54: 335–343.

Chandrasekhara Rao T, Lakshminarayana G, Prasad NBL Sagan Mohan Rao S, Azeemoddin G, Atchynta Ramayya D, ThirumalaRao SD. (198). J Am Oil Chem Soc. 61: 1472-3.

Chowdhury, E. H., N. Shimada, H. Murata, O. Mikami, P. Sultana, S. Miyazaki, M. Yoshioka, N. Yamanaka, N. Hirai, and Nakajima Y. (1988). Detection of Cry1Ab protein in the gastrointestinal contents but not in the visceral organs of genetically modified Bt11-fed calves. Vet. Hum. Toxicol. 45: 72–75.

D'Mello, J. P. F. (1995). Leguminous leaf meals in non-ruminant nutrition. In: Tropical Legumes in Animal Nutrition. D'Mello J.P.F and C. Devendra, Eds. CAB International, Wallingford, UK.

Etches, Robert J. (1996). Reproduction in poultry. Wallingford : CAB international, X, 318 p. ill.

Faria, J.C.; Bezerra, I.C.; Zerbini, F.M.; Ribeiro, S.G.; Lima, M.F. (2000). SituaÁ„oatual das geminiviroses no Brasil. Fitopatologia Brasileira, BrasÌlia, 25: 125-137.

Gerry, R. W. (1980). Ground dried whole mussels as a calcium supplement for chicken ration. Poult. Sci., 59: 2356-2368.

Gutteridge, Ross C, and Max Shelton H. (1998). Tropical Grassland Society of Australia, Inc., 2: 1.

Hoffmann, E. (1988). Coturnix Quail. Taipei: Yi Hisien Publishing Co.

Hubrecht, R. and Kirkwood, J. (2010). The UFAW Handbook on the Care and Management of Laboratory and Other Research Animals.John Wiley & Sons. pp. 655–674.

Hughes, Colin E. (1998). Systematic botany monograph; pp. 55.

Johnsgard, P. (1988). The Quails, Partridges, and Francolins of the World. Oxford: Oxford University Press.

Joly, P., Cadi, A., Delmas, V., Prévot-Julliard, A.-C., Pieau, C., and Girondot, M. (2003). Successful reproduction of the introduced slider turtle (Trachemys scripta elegans) in the south of France. Aquat. Conserv. In press.

Kibria, K., Nur, F., Begum S.N., Islam M.M., Paul S.K., Rahman K.S. and Azam, S.M.M. (2009). Molecular marker based genetic diversity analysis in aromatic rice genotypes using SSR and RAPD markers. Int J Sustain Crop Prod 4(1): 23-34.

Kurtoglu K., V. - Kurto Kurtokurtoglu, F. - Seker, E. - Coskun, B. - Balevi, T. - Polat, E.S. (2004). Effect of probiotic supplementation on laying hen diets on yield performance and serum and egg yolk cholesterol. In: Food Additives & Contaminants, 21(9): 817-823.

Lambert, R. (1970). Notes on the breeding and behaviour of Japanese Quails.Avicultural Magazine, 76(5): 177-179.

Leeson, S., Summers J.D. and L.J. Caston, (1991). Diet dilution and compensatory growth in broilers. Poult. Sci., 70: 867-873.

Leeson, S, Summers JD. (1997). Commercial Poultry Nutricion. 2nd Ed Ontario: Book University, 350p.

McNaughton, J.L., Dilworth J.L. and E.J. Day, 1974. Effect of particle size on the utilization of calcium supplements by the chicks. Poult. Sci., 53: 1024-1029

Mills, AD; Crawford LL; Domjan M and Faure JM. (1997). "The Behavior of the Japanese or Domestic Quail Coturnix japanica". Neuroscience and Biobehavioral Reviews. 21(3): 261–281.

Morton, J. and Johnson, M. H. (1991). Biology and cognitive development: The case of face recognition. Oxford, England: Basil Blackwell.

North, M. O. and Bell, D. D. (1990). Commercial chicken production manual. AVI Publishing Inc, New York, USA.

Nworgu, F.C. and Fasogbon, F.O. (2007). Centrosema (Centrosemapubescens) leaf meal as protein supplement for pullet chicks and growing pullets. Int. J. Poult. Sci. 6: 255.

Panda, A. K., V. R. B. Sastry and A. B. Mandal, (2008). Growth, nutrient utilization and carcass characteristics in broiler chickens fed raw and alkali processed solvent extracted karanj (Pongamia glabra) cake as partial protein supplement. J. Poult. Sci., 45: 199–205.

Pappas, J. "Coturnix japanica". Animal Diversity Web.Retrieved 20 October 2013.

Puigcerver, Manel; Vinyoles, Dolors; Rodríguez-Teijeiro, José Domingo (2007). "Does restocking with Japanese quail or hybrids affect native populations of common quail Coturnixcoturnix?". Biological Conservation 136(4): 628–635.

Ravindran V., G. Ravindran & S. Sivalogan (1994). Total and phytate phosphorus contents of various foods and feedstuffs of plant origin.

Ravindran, V.; Ravindran, G. and Sivalogan, S. (1994). Total and phytate phosphorus contents of various food and feedstuffs of plant origin. Plant Chemistry, 50: 133-136.

Reddy, C.V. and Qudratullah, S. (2004). Strategic feeding supplementation through locally available resources. xx world poultry congress. FAO corporate document. Available: <http://www.fao.org/docrep/004/ac150e/ac150e01.htm> [Consulted: April 18, 2011]

Roland D.A. (1977). The extent of uncollected eggs due to inadequate Shell. Poult. Sci. 56(5): 1517-1521.

Roland, D.A. (1988). Research note: egg shell problems estimates of incidence and economic impact. Poult. Sci. 67: 801-1803.

Roland, P.E., Zilles, K., (1989). Functions and structures of the motor cortices in humans. Curr. Opin. Neurobiol. 6: 773–781.

SAEDF, (2008). South Asia Enterprise Development Facility, a multi-donor facility managed by the International Finance Corporation of the World Bank Group, Dhaka, Bangladesh.

Saima, M. A. Shad, T. N. Pasha, M. Akram, Y. A. Ditta and M. Z. U. Khan (2014). Effect of microbial phytase supplementation on growth performance of Japanese quails. The Journal of Animal & Plant Sciences, 24(1): 19-23

Shelton, H. M. and J. L. Brewbaker (1994). Leucaenaleucocephala – the most widely used forage tree legume. In: Gutteridge, R. C. and Shelton, H. M. (ed.), Forage Tree Legumes in Tropical Agriculture. CAB International, Wallingford, U. K., pp. 15-30.

Singh, K. S. and Panda B. (1988). Poultry Nutrition.1st Ed., Kalyani Publishers, New Delhi, India. pp. 282-293.

Steel, R. G. D. and Torrie, J. H. (1986). Principles and procedures of statistics: a biometrical approach. 2nd ed. New York: McGraw-Hill, p. 633.

Tangendjaja, B., Rahardjo, Y. C. and Lowry, J. B. (1990). Leucaena leaf meal in the diet of growing rabbits: evaluation and effect of a low-mimosine treatment. Anim. Feed Sci. Technol., 29: 63-72.