EFFECT OF DIETARY INCORPORATION OF CORIANDER SEED (*Coriandrum sativum L.*) AT VARYING LEVELS ON THE PRODUCTION PERFORMANCE OF JAPANESE QUAIL

By

NARALA BALA CHENNA REDDY
B.V.Sc. & A.H.

ID.No: GVM/2014-009

THESIS SUBMITTED TO THE
SRIVENKATESWARAVETERINARYUNIVERSITY
IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE OF

MASTER OF VETERINARY SCIENCE
(ANIMAL NUTRITION)

IN THE FACULTY OF VETERINARY SCIENCE

DEPARTMENT OF ANIMAL NUTRITION
NTRCOLLEGE OF VETERINARY SCIENCE, GANNAVARAM
SRIVENKATESWARAVETERINARYUNIVERSITY
TIRUPATI – 517 502.

MARCH, 2017

CERTIFICATE

NARALA BALA CHENNA REDDY, GVM / 14 - 009 has satisfactorily prosecuted the course of research and that the thesis entitled **"EFFECT OF DIETARY INCORPORATION OF CORIANDER SEED (*Coriandrum sativum L.*) AT VARYING LEVELS ON THE PRODUCTION PERFORMANCE OF JAPANESE QUAIL"** submitted is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that the thesis or part thereof has not been previously submitted by him for a degree of any University.

Date:

(Dr. D. SRINIVAS KUMAR)
Major Advisor
Principal Scientist & Head
Sri Venkteswara Veterinary University
Krishi Vigyan Kendra
Guntur-522 034

CERTIFICATE

This is to certify that the thesis entitled **"EFFECT OF DIETARY INCORPORATION OF CORIANDER SEED (*Coriandrum sativum L.*) AT VARYING LEVELS ON THE PRODUCTION PERFORMANCE OF JAPANESE QUAIL"** submitted in partial fulfilment of the requirements for the degree of MASTER OF VETERINARY SCIENCE for Sri Venkateswara Veterinary University, Tirupati, is a record of the bonafide research work carried out by NARALA BALA CHENNA REDDY, under our guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee. No part of the thesis has been submitted by the student for any other degree or diploma. The published part has been fully acknowledged. All the assistance and help received during the course of investigations have been duly acknowledged by the author of the thesis.

(Dr. D. SRINIVAS KUMAR)
Chairman of the advisory Committee

Thesis approved by the Student Advisory Committee

Chairman: **Dr. D. Srinivas Kumar** ______________________
Principal Scientist & Head
Krishi Vigyan Kendra
Guntur - 522034

Member: **Dr.K.Raja Kishore** ______________________
Assistant Professor
Department of Animal Nutrition
N.T.R College of Veterinary Science
Gannavaram – 521 102

Member: **Dr. K.Naga Raja Kumari** ______________________
Assistant Professor
Department of Poultry Science
N.T.R College of Veterinary Science
Gannavaram – 521 102

CONTENTS

TABLE OF CONTENTS

LIST OF TABLES

Acknowledgements

*First of all, I thank **Almiighty** for his inspiration and benevolence for giving me brain and brawn to work so hard on this research project.*

*Secondly, I consider it my utmost duty to express gratitude to the major advisor **Dr. D. Srinivas Kumar**, Principal Scientist and Head, Sri Venkateswara Veterinary University, Krishi Vigyan Kendra, Guntur for giving me opportunity to do this research work and collaborating so nicely and constructively during the long drawn out stages of the research project.*

*I express my heartfelt gratitude to **Dr. K. Raja Kishore,** Assistant Professor, Department of Animal Nutrition, NTR College of Veterinary Science, Gannavaram and member of my advisory team for his constant encouragement, generous help and advice in all aspects during the course of my research work.*

*I express special regards to Dr**. K. Naga Raja Kumari**, Assistant professor, Department of Poultry Science, NTR College of Veterinary Science, Gannavaram for her valuable suggestions and help during my investigation.*

*I am deeply indebted to **Dr. E. Raghava Rao,** Director of Research, Sri Venkateswara Veterinary University for his invaluable guidance at each and every step of research work. I also thank the support extended by **Dr. Ch. Venkata Seshaiah,** Associate Professor and Head, Department of ILFC, NTR College of Veterinary Science, Gannavaram during my period of research.*

*I also thank and acknowledge **Dr. Janardhan Reddy**, Professor, Retd, Department of Animal Nutrition, **Dr.Ch. Anil kumar**, Assistant Professor, Department of Animal Nutrition, **Dr. M. Mala Kondaiah**, Professor and Head, Department of Parasitology, **Dr. K. Satish**, Associate Professor, Department of Pathology, **Dr. M. Muralidhar,** Assistant Professor, Department of Animal Genetics and Biostatistics, **K.S.R. Vital**, Professor and Head, Department of Library, **Dr. T. Srinivasa Rao,** Associate professor and Head, Department of Veterinary public health, **Dr. S. Gangu Naidu,** Assistant Professor, Department of Veterinary Biochemistry, NTR College of Veterinary Science, Gannavaram, and **Dr. Ramesh Babu,** Assistant Professor, Department of Animal Nutrition, College of Veterinary Science, Proddutur for their support during my research work.*

The support and valuable suggestions from my colleagues ***Dr. M. Madesh****,* ***Dr. V. Pratap reddy, Dr. B. Vamsidhar, Dr. Ch. Harish khanna, Dr. Siva Nagendra Babu, Dr. V. Aditya Kumar, Dr. M. Vasundhara, Dr. K.V. Aruna, Dr. V. Sri Divya, Dr. A. Nagurjuna Reddy, Dr. Chandra Sekhar Reddy*** *and* ***Dr. P. Ravikanth Reddy*** *are highly acknowledged.*

I also pay my sincere thanks to ***Dr. N. Rajani Kumari****, Joint director, Animal Husbandry, Ongole for valuable suggestions bestowed upon me during my post graduation course.*

I wish to extend my thanks to ***Sri. P. Venkateswarlu****, Veterinary Assistant and* ***Sri L. Mala Kondaiah****, Office subordinate of Veterinary dispensary, Singarayakonda, Prakasam district and, all the technical and non technical staff of Animal Nutrition department, NTR College of Veterinary Science, Gannavaram, for their support during my post graduation course.*

Above all, I owe my loving thanks to my father ***Sri. N. Pakki Reddy*** *and my* ***mother Smt. N. Obulamma,*** *whom I shall be indebted all my life. I express my deep sense of love and affection for my wife,* ***N. Triveni*** *and sons,* ***N. Chenna Kesava Hemanth Reddy*** *and* ***N. Chenna kesava Rahul Reddy*** *for their patience and encouragement during the course of post graduation.*

I express my sincere thanks and gratitude to ***Animal Husbandry Department, Andhra Pradesh*** *and* ***Sri Venkateswara Veterinary University, Tirupati*** *for providing financial assistance and facilities to carry out my M.V.Sc research work in time.*

Lastly, thank you to anyone else that I might have forgotten who lent support, knowledge and encouragement along the way.

(N.BALA CHENNA REDDY)

DECLARATION

I, D**r. NARALA BALA CHENNA REDDY** hereby declare that the thesis entitled **"EFFECT OF DIETARY INCORPORATION OF CORIANDER SEED (*Coriandrum sativum L.*) AT VARYING LEVELS ON THE PRODUCTION PERFORMANCE OF JAPANESE QUAIL"** submitted to **SRI VENKATESWARA VETERINARY UNIVERSITY** for the Degree of **MASTER OF VETERINARY SCIENCE** is a result of original research work done by me. It is further declared that the thesis or any part thereof has not been published earlier in any manner.

Date: (N.BALA CHENNA REDDY)

LIST OF ABBREVIATIONS

%	:	Per cent
±	:	Plus or Minus
<	:	Lesser than
>	:	Greater than
/	:	Per
°C	:	Degrees Celsius
µ	:	micro
₹	:	Rupee
d	:	Day
dl	:	Deciliter
g	:	Grams
mg/dl	:	Milligrams per deciliter
mg	:	Milli gram
ml	:	Milli liter
nm	:	Nanometer
ADF	:	Acid detergent fibre
ADL	:	Acid detergent lignin
AIA	:	Acid insoluble ash
AOAC	:	Association of Official Analytical Chemists
avg.b.wt	:	Average Body Weight
BHA	:	Butylated Hydroxy Anisole
BW	:	Body weight
BWG	:	Body weight gain
Ca	:	Calcium
CF	:	Crude fibre
CP	:	Crude protein
CRD	:	Completely Randomized Design
CSM	:	Coriander seed meal
DORB	:	De-oiled rice bran
DM	:	Dry matter
DMB	:	Dry matter basis

EE	:	Ether extract
et al.	:	And others
FCR	:	Feed conversion ratio
FE	:	Feed efficiency
F : G	:	Feed: Gain
g	:	gram
GE	:	Gross energy
HDL-C	:	High density lipoprotein cholesterol
HMG-COA	:	3-enzyme-3-methyl glutaryl coenzyme A
Kcal	:	Kilocalories
Kg	:	Kilogram
LDL-C	:	Low density lipoprotein cholesterol
LW	:	Live weight
LWG	:	Live weight gain
ME	:	Metabolizable energy
MEq	:	Milli-equivalent
NDF	:	Neutral detergent fibre
NFE	:	Nitrogen free extract
NIN	:	National Institute of Nutrition
NRC	:	National Research Council
NS	:	Non-significant
OM	:	Organic matter
P	:	Phosphorus
PUFA	:	Poly Unsaturated Fatty Acid
Rpm	:	Rotations per minute
SBM	:	Soybean meal
SEM	:	Standard error mean
SS	:	Statistical significance
T	:	Treatment
TA	:	Total ash
USDA	:	United States Department of Agriculture
VLDL-C	:	Very low density lipoprotein cholesterol
viz;	:	Namely

Name of the author : **NARALA BALA CHENNA REDDY**

Title of thesis : **EFFECT OF DIETARY INCORPORATION OF CORIANDER SEED (*Coriandrum sativum L.)* AT VARYING LEVELS ON THE PRODUCTION PERFORMANCE OF JAPANESE QUAIL**

Degree to which it is submitted : **MASTER OF VETERINARY SCIENCE**

Faculty : **VETERINARY SCIENCE**

Department : **ANIMAL NUTRITION**

Major advisor : **Dr. D. SRINIVAS KUMAR** Ph.D.,
Principal Scientist & Head
Krishi Vigyan Kendra
Guntur-522 034

University : **SRI VENKATESWARA VETERINARY UNIVERSITY**
Tirupati – 517 502.

Year of submission : **March, 2017**

ABSTRACT

The present investigation is carried out to study the effect of dietary incorporation of coriander seed at varying levels on the growth performance, serum biochemical profile, carcass characteristics and nutrient utilization of Japanese quails. One hundred and fifty, day old quail chicks distributed randomly to five dietary groups each with three replicates of ten quails and were offered a basal diet containing 24% CP and 2900 kcal/kg ME. During the experiment, coriander seed powder is included at 0.0% (T_1; Control), 0.5% (T_2), 1.0% (T_3), 1.5% (T_4) and 2.0% (T_5) level by marginal adjustment of other feed ingredients. All the rations were made iso-caloric and iso-nitrogenous.

Chemical analysis indicated that coriander seed contained 14.70% CP, 9.34% EE, 0.64% calcium and 0.35% phosphorous. Results indicated that the body weight gains and feed intake increased ($P<0.01$) while feed consumed/kg

gain decreased ($P<0.01$) with increased level of incorporation of coriander seed from 0 to 2.0% in the diet.

The serum biochemical profile of quails revealed that the total protein, globulin, albumin, calcium and phosphorous contents increased ($P<0.01$) while serum triglycerides, total cholesterol and creatinine levels decreased ($P<0.01$) with increase in the level of incorporation of coriander seed from 0 to 2.0% in the diet. Further, the study indicated that the HDL cholesterol level increased ($P<0.01$), while LDL and VLDL cholesterol levels decreased ($P<0.01$) in serum with increased level of incorporation of coriander seed from 0 to 2.0% in the diet. Furthermore, serum glucose level decreased ($P<0.05$) with increase in the level of incorporation of coriander seed from 0 to 2.0% in the diet.

The digestibility of OM, CP, EE and fibre fractions increased ($P<0.01$) with increased level of incorporation of coriander seed from 0 to 2.0% level in the diet. Similarly, the per cent nitrogen utilization increased ($P<0.01$) and per cent calcium and phosphorous utilization also increased ($P<0.05$) with increase in the level of incorporation of coriander seed from 0 to 2.0% level in the diet. Further, the study indicated that the meat to bone ratio increased ($P<0.01$) with increased level of incorporation of coriander seed from 0 to 2.0% level in the diet. However, incorporation of coriander seed at graded levels in the diet of quails had no effect ($P>0.05$) on carcass yield, dressing percentage, ready to cook yield and, per cent weight of heart, liver, gizzard and giblet.

The feed cost / kg gain decreased by ₹ 6.15 (T_5) and 2.72 (T_4) and increased by 0.97 (T_2) and 0.34 (T_3) in quails fed diets containing coriander seed at varying levels as compared to the control. The present study indicated that coriander seed can be incorporated up to 2.0% level as a natural feed additive in the diet of quails without any adverse effect on production performance of quails.

CHAPTER – I

INTRODUCTION

Demand for the consumption of poultry is increasing day by day due to medical achievements, merits and health advices. Quail is considered to be a bird which has been bred and produced in India. Although, quail farming is a new poultry venture to India, being a prolific meat and egg producer with dual production capacity, it attained a valuable status in commercial enterprises. Quails are popular for their high protein (26%) and less fatty (3%) meat, which is also known for increasing the sexual instinct in humans (Shinde *et al*., 2014). Further, quail has unique qualities like hardiness and adaptability to diversified agro-climatic condition making it ideal for intensive production, thus creating employment opportunities. Thus, industrial breeding of quail has become a profitable and productive venture throughout the world (Shukuhmand, 2008).

The use of antibiotics as growth promoters has been banned in many countries, due to public concern about their residues in animal products and development of antibiotic resistance bacteria (Lee *et al*., 2004) and this forced the nutritionist to search for an alternative to antibiotics. The use of herbs and spices is considered a promising alternative to the use of antibiotics. Herbs and spices are the most important part of human diet. In addition to boosting flavour, herbs and spices are also known for their potential antimicrobial and stimulating effects on the digestive system.

In recent years, organic poultry is a relatively new expression in western countries and is becoming popular in India. In this process, farmers do not use chemical compounds or may use it at a very low level and tried alternatives like organic acids, probiotics and medicinal plants. These products have more craziness in the customers (Ipu *et al*., 2006). Plant extracts and spices as single compound or as mixed preparations can play a role in supporting both performance and health status of the poultry (Gill 2000; William and Losa, 2001).

Coriander (*Coriandrum sativum L*), a well-known aromatic medicinal plant grows in nature and is cultivated in India. Coriander seed is used primarily as a flavouring agent in the food industry or as a spice in bread, cheese, curry, fish, meat and confections. Coriander seed has got health supporting reputation. It has anti-diabetic, anti-inflammatory, anti-fungal, anti-parasitic, anti-helminthic, anti-septic, analgesic, sedative and antioxidant properties (Chithra and Leelamma, 1997; Lee *et al*. 2004). Coriander seed contains significant quantities of minerals like potassium, calcium, phosphorous, magnesium, sodium, iron, zinc and vitamins like niacin, riboflavin and thiamine apart from containing valuable essential oils and poly unsaturated fatty acids (Prerna Nath *et al*., 2015). It is also reported to enhance liver function (Hernandez *et al*., 2004) and appetizing and stimulatory effects in digestion process (Cabuk *et al*., 2003).

Inconsistent results and inadequate data exist regarding the potential use of coriander seed powder as growth promoter in poultry diet. Coriander seed powder as an alternative to antibiotic growth promoters has been recommended for feeding broilers (Abou-Elkhair *et al*., 2014; Saleh *et al*., 2014 and Naeemasa *et al*., 2015) while some researchers reported no significant improvement in body weight gain and feed conversion (Ramadan *et al*., 2014; Rashid *et al*., 2014). On the other hand, studies on the feeding value of coriander in Japanese quails (Guler *et* al., 2005) are very limited. Hence, the present study has been proposed to evaluate the effect of incorporating coriander seed at varying levels as a growth promoter in Japanese quail with the following objectives:

1. To determine the optimum level of inclusion of coriander seed in the diet of Japanese quails.
2. To study the effect of coriander seed incorporation in the diet as growth promoter on production performance of quails.
3. To evaluate the effect of dietary incorporation of coriander seed on nutrient utilization in quails.
4. To study the carcass characteristics in quails fed diets containing coriander seed.
5. To study the economics of coriander seed inclusion in quail diets.

CHAPTER - II

REVIEW OF LITERATURE

Coriander commonly renowned as cilantro, Chinese parsley or dhania belongs to the family Umbelliferae. It is extensively grown in Bangladesh, Russia, Italy, Netherlands, central and eastern Europe, China and .India. Coriander seed is an unconventional feed stuff but with feed it has been recognized as an important tool for improving growth performance and feed conversion (Collington *et al*., 1990). The present investigation is conducted by incorporating coriander seed in poultry rations and the effect of incorporation of coriander seed in poultry rations on various parameters are reviewed in this chapter.

2.1 CHEMICAL COMPOSITION OF CORIANDER SEED

2.1.1 Proximate Composition of Coriander seed

The DM, CP, CF, EE, TA and NFE content of coriander seed as reported by different authors ranged from 88.00 to 93.80%, 11.00 to 15.27%, 28.43 to 37.14%, 9.12 to 20.00%, 4.40 to 9.50% and 11.00 to 54.99%, respectively. The calcium and phosphorous contents of coriander seed ranged from 0.63 to 0.71% and 0.39 to 0.41%, respectively (Table 1).

Table 1: Chemical Composition (on % Dry matter basis) Of Coriander seed

S.No.	DM	CP	CF	EE	TA	NFE	Ca	P	Author
1	88.20	14.10	32.60	16.10	4.40	21.60	0.63	0.39	NIN, 1989.
2	-	11.00	30.00	20.00	-	11.00	-	-	Peter, 2004.
3	88.63	11.49	28.43	19.15	4.98	12.45	-	-	Momin *et al*. 2012.
4	88.00	15.27	33.64	20.00	9.50	-	-	-	Hosseinzadeh *et al*. 2014.
5	93.80	12.58	37.14	9.12	-	54.99	0.71	0.41	Prerna Nath *et al*. 2015.

*values expressed per 100g

2.1.2 Cell wall Constituents of Coriander seed

Yeldho (2010) analyzed the fiber fractions in coriander seed and reported that NDF, ADF and hemi-cellulose content were 39.76, 20.34 and 19.42 per cent, respectively.

2.2 NUTRITIVE VALUE OF CORIANDER SEED

Coriander is one of a few ayurvedically proven herbal and savory medicinal plants, whose exceptional functional qualities are well documented. It is often envisaged to as a store house of bioactive compounds. Coriander Seeds contain zero per cent cholesterol (USDA, 2013). Coriander seeds are also recognized to be one of the valuable sources for dietary potassium (1267 mg/100g) followed by other minerals such as calcium (709 mg/100 g), phosphorus (409 mg/100 g), magnesium (330 mg /100 g), sodium (35 mg/100g), zinc (4.70 mg/100 g) which are important for functioning of cells in the body. In addition, vitamin C is also present in ample amounts (21 mg/100 g) (USDA, 2013).

All plant parts are noble source of essential oil (Linalool 60-70 %) and fatty acid (petroselinic acid) (Diederichsen, 1996). Linoleic acid belonging to PUFA group forms the major component in essential fatty acids of coriander seed oil. Minor active constituents include hydrocarbons namely; α- pinene, limonene, γ-terpinene, p-cymene, boroneol, citronellol, camphor, geranyl and geranyl acetate with some heterocyclic compounds viz., pyrazine, pyridine, thiazole, furan and tetra hydro furan derivatives, isocoumarins, coriandrin, dihydrocoriandrin, flavonoids, pthalides, neochidilide, digustilide phenolic acids and sterols (Zlatanov and Ivanov, 1995). The plant composition is found to be different from any other seed oil. Oil of coriander also forms a valuable component in perfumes and is also used in cosmetic industry in various lotions and shampoos and pharmaceuticals. It is a potential source of active phenolic acid compounds such as caffeic and chlorogenic acid and flavonoids (Barros et al., 2012).

Coriander is an egregious source of phyto-chemicals and functional compounds namely polyphenols, flavonoids and ascorbic acid which ultimately constitute for its high antioxidant activity. A study demonstrated that free radical scavenging activity of coriander seed essential oil was higher than its corresponding leaf extract essential oil which might be due to presence of high amounts of linalool in seed essential oil than the fresh leaf. Further, it was found that at the proportion of 0.02%, its effects were almost equal to BHA (Darughe *et al*., 2012).

2.3 EFFECT OF INCORPORATION OF CORIANDER SEED ON THE PERFORMANCE OF POULTRY

Guler *et al*. (2005) studied the effect of coriander seed as dietary ingredient on the performance of Japanese quails. Five hundred and ninety four, 3-day old

Japanese quails were divided in to six groups of 99 birds each and randomly assigned to six treatment diets and fed over a period of 42 days (6 weeks). Four of the diets contained coriander seed at 0.5, 1.0, 2.0 and 4.0% levels of inclusion, one contained 10 mg of the antibiotic, avilamycin per kg and a control group received no supplement. Results indicated that highest feed intake was observed in 4% coriander group. Birds receiving the diet containing 2% coriander seed showed the highest weight gain followed by those receiving 1% coriander, the antibiotic, 4% and 0.5% coriander seed while the lowest weight gain was observed in the control group. Further, they reported that the feed conversion ratio was significantly better in group receiving 2% coriander seed as compared to other treatments.

In another study, Guler *et al*. (2006) studied the effect of feeding coriander seed on production performance in laying Japanese quails. A total of three hundred and seventy five birds of forty two days old were randomly and equally divided into five treatment groups and fed diets incorporated with 0, 0.5, 1, 2 or 4% ground coriander seed. They reported that the feed intake of the birds fed on diets containing coriander seed was higher than control diet and significantly best feed efficiency was recorded in 1% and 2% coriander incorporated groups.

An experiment was carried out to study the effect of coriander seed as dietary ingredient on the performance of broilers under high ambient temperature. One hundred and eighty, day old birds were randomly assigned to four dietary treatments with three replicate pens (15 birds / pen). Birds were fed experimental diets containing 0% (T_1), 1% (T_2), 2% (T_3) and 3% (T_4) coriander seed over a period of six weeks. Result showed that inclusion of 2% coriander seed in broiler diets significantly improved weight gain, feed consumption and feed conversion as compared to other treatments (Hamodi *et al.,* 2010).

Saeid and Al-Nasry (2010) conducted a trial to determine the effect of different levels of coriander seed supplementation on growth performance in broiler chicken. Two hundred and forty, day old commercial broiler chicken were divided into 4 groups of sixty birds each and randomly assigned to four treatment diets with three replicates and birds were fed basal diet supplemented with 0.1, 0.2 and 0.3% of coriander seed. They observed that birds fed diets contain 0.3% coriander seed had improved body weight gain, feed conversion ratio and decreased feed intake when compared to other treatments.

Al-Jaff (2011) conducted a study to investigate the potential effect of coriander seeds on growth performance in broiler chicks under high ambient temperature. One hundred and eighty, day-old Arbor Acer broiler chicks were randomly assigned to four dietary treatments with three replicate pens (15 birds / pen). The experimental diets include control (T_1), 1% coriander seed (T_2), 2% coriander seed (T_3), and 3% coriander seed (T_4). Results indicated significantly higher final body weights in 2% coriander seed group as compared to other groups while feed conversion ratio was significantly better in 2% and 3% coriander seed groups when compared to other treatments.

Similarly, Al-Mashhadani *et al.* (2011) conducted a study to investigate the potential effect of coriander oil on broiler performance. 135 day-old broiler chicks were randomly assigned to three dietary treatments with three replicate pens per treatment (15 birds / pen) and were fed diets containing coriander oil at 0 (T_1), 0.5 (T_2) and 1.0% (T_3) level. They reported that feeding coriander oil at 0.5 and 1.0% level in the diet of broilers resulted in significantly improved weight gain, feed intake and feed conversion ratio as compared to those in the control group.

One hundred and thirty five, day-old Arbor acers broiler chicks were randomly assigned to 3 dietary treatments with 3 replicate pens per treatment (15 birds / pen) to study the histological effect of inclusion of coriander oil in the diet on growth performance. Birds were fed experimental diets containing 0 (T_1), 0.5 (T_2) and 1.0% (T_3) coriander oil. Results indicated that feed conversion ratio was significantly higher in 0.5 and 1.0% coriander oil supplemented groups as compared to the control (Al-Tememy *et al.,* 2011).

In another investigation, Jang (2011) studied the effects of using different levels of coriander oil on growth performance of broilers. In this study, three hundred and seventy five, one day old broiler chicks were divided to 5 groups with 5 replicates of 15 chicks each and fed over a period of 6 weeks. Experimental groups include T_1, control group with no coriander oil supplementation while T_2, T3, T_4 and T5 received 0.75%, 1%, 1.5%, and 2% coriander oil. Results revealed that use of different levels of coriander oil had significant effect on growth performance particularly, 2% coriander oil inclusion group showed significantly higher feed intake, weight gain and better feed conversion ratio.

Farag (2013) conducted an experiment of 6 weeks duration to investigate the effect of dietary coriander seeds supplementation on the performance of broilers. Coriander seeds were supplemented to the basal diet at 0 (control), 0.2 (T_1), 0.4 (T_2) and 0.6% (T_3) levels. Results indicated that coriander seed supplementation at 0.2, 0.4 and 0.6% improved body weight gain, feed consumption and feed conversion ratio when compared to the control. Further, they reported that the best feed conversion ratio (FCR) is observed at 0.6% level for the entire experimental period.

An experiment was carried out to determine the effect of herbal plant powders such as coriander, savory, dill and mix powder of these three plants compared with virginiamycin in their diets as a growth stimulant on the performance of broilers. In a 6 week CRD experiment, 480 day old Ross 308 chicks were divided into 6 treatments including coriander, savory and dill powders as well as a mix powder of these plants in 1% dose, virginiamycin (150 g/ton) and basic feed with 4 replicate (20 birds/replicate). The study indicated that feeding coriander seed in the diet resulted in significantly decreased weight gain and feed intake and poor feed conversion ratio as compared to the control (Abadi and Andi, 2014).

Abou-Elkhair *et al.* (2014) conducted a study to determine the effect of black pepper (*Piper nigrum*), turmeric powder (*Curcuma longa*), coriander seeds (*Coriandrum sativum*) and their combinations as feed additives on the performance of broilers. A total of two hundred and ten day old Cobb chicks were divided into 7 groups of 30 birds each. The treatments were: a control group receiving no supplement (C), 0.5% black pepper (T_1), 0.5% turmeric powder (T_2), 2% coriander seeds (T_3), a mixture of 0.5% black pepper and 0.5% turmeric powder (T_4), a mixture of 0.5% black pepper and 2% coriander seed (T_5), and a mixture of 0.5% black pepper, 0.5% turmeric powder and 2% coriander seeds (T_6). Results indicated significantly increased body weight gains and improved FCR in 2% coriander seed group as compared to control.

In a CRD experiment, 360 female Japanese quail chicks were randomly allotted to 6 dietary treatments *viz.,* control (T_1), control diet supplemented with antibiotic (T_2) or coriander seed at 1.0 (T_3), 2.0 (T_4), 3.0 (T_5) and 4.0% (T_6) to investigate the effect of dietary supplementation of coriander (*Coriandrum sativum*) seeds on the food intake of Japanese quail (*Coturnix japonica*). Results indicated that highest feed intake rate was observed in chicks fed coriander seed at 1.0 and 4.0% level during 1st and 2nd week while no variation was observed during the rest of experimental period (Esteghamat, 2014).

In another experiment, Hosseinzadeh *et al.* (2014) studied the effects of different levels *viz.,* 1.5, 2.0 and 2.5% of coriander (*Coriandrum Sativum*) seed powder and coriander extract in water on performance indices in broiler chicks. A total of 420 day-old broiler chicks (Ross 308) were randomly allocated to 7 treatments of 60 birds per group with four replications per treatment and fed for 42 days. The study revealed that coriander supplementation had better FCR than the control group during the grower period while there was no effect on weight gain.

Kumari *et al.* (2014) investigated the effect of dietary supplementation of sugar beet, neem leaf, linseed and coriander on growth performance of Vanaraja chicken. 150 male chicks were distributed to 5 groups each with 3 replicates of 10 birds. Birds in T_1 group were fed basal ration while those in T_2, T_3, T_4 and T_5 groups were fed basal ration mixed with 2.5% sugar beet meal, neem leaf meal, linseed meal, and coriander seed meal (CSM), respectively for 6 weeks. Results indicated that body weight gains were higher in CSM supplemented group as compared to the control but are similar when compared to other groups. Further, lowest feed intake and improved FCR were reported in CSM fed group as compared to the control.

Ramadan *et al.* (2014) conducted an experiment to determine the effect of coriander seed along with black seed on the performance of heat stressed broilers. 135 day old Ross 308 broiler chicks were allotted to 3 treatment groups with 3 replicates and 15 birds per replicate were fed a basal diet (Control, T_1), basal diet containing 1% *Nigella Sativa* seeds (black seed; T_2) or 2% coriander seeds (T_3). They reported that feeding either black seed or coriander seed in the diet resulted in improved feed intake and weight gain in chicks while there was no effect on feed conversion ratio as compared to those in control group.

Seventy two, Cobb 500 broilers were fed *ad- libitum* on a diet supplemented with coriander seed meal (CSM) at 0, 0.5, 1.0 and 1.5 % level to study the effect of different levels of Dhania seed (*Coriandrum sativum*) on the performance of broilers. Results revealed that treatment group with 1.5 % of CSM significantly affected live weight of broilers at the age of 28 and 35 days but there is no effect on feed intake and feed efficiency among treatments with coriander seed supplementation (Rashid *et al.*, 2014).

Later, in another study, 36 male chicks at 15 days of age were divided into three groups each with 3 replicates of 4 birds and were used to evaluate the effects of herb mixture (summer shield) on growth performance in broilers. Summer shield is a mixture of seven herbs and contains 35% *Mentha spicata* (spear mint), 15% *Mangifera indica* (mango), 10% *coriandrum sativum* (coriander), 10 % *Aegle marmelos* (bael), 10% *Centella asiatica* (gotu kola) and 10 % *Allium cepa* (onion). The control group of chicks was fed a basal diet and the remaining two groups of chicks were fed basal diet supplemented with summer shield at a concentration of 1 g /kg or 2 g /kg, respectively, until 37 days of age. Results revealed that summer shield supplementation significantly increased body weight gain and improved FCR while feed intake was not affected among three experimental groups (Saleh *et al.*, 2014).

Recently, Naeemasa *et al.* (2015) conducted a study to investigate the effects of different levels of coriander (*Coriandrum sativum*) seed powder and extract on the performance of broiler chicken. A total of four hundred and twenty day-old broiler chicks (Ross 308) were allocated randomly into 7 treatments with 4 replicates of 15 chicks. The treatments include control (C); three treatments, which included the control diet plus three levels of coriander extract in water (750, 1000, and 1250 mg/kg); and the other three, which received the control diet plus three levels of coriander powder (1.5%, 2.0% and 2.5%). Results showed that coriander powder supplementation level of 1.2% maximized feed intake of broiler chicken. Further, they reported that coriander powder supplementation in the diet improved FCR in broilers.

2.4 EFFECT OF INCORPORATION OF CORIANDER SEED ON SERUM BIOCHEMICAL PROFILE

Saeid and AL- Nasry (2010) conducted a trial to study the effect of different levels of coriander seed supplementation on serum biochemical parameters in broiler chicken and reported significantly higher serum protein levels and significantly lower serum glucose, cholesterol and triglyceride concentration in 0.3% coriander seed supplemented group as compared to the control group.

In another investigation, Al-Jaff (2011) determined the potential effect of coriander seeds on serum biochemical parameters in broiler chicks under high ambient temperature. Results showed that inclusion of 2% coriander seed in the diet had significantly higher total serum protein and albumin compared to other groups while serum globulin, glucose and cholesterol were lower in group fed 2% coriander seed when compared to other groups. Further, the study revealed that LDL cholesterol was significantly lower in 2% coriander seed group while HDL cholesterol and serum triglycerides concentration were significantly higher in 2 and 3% coriander seed groups when compared to the control.

Al-Mashhadani *et al.* (2011) conducted a study to investigate the potential effect of coriander oil on serum biochemical profile in broilers and reported significantly decreased plasma cholesterol and glucose concentration in 0.5 and 1% coriander oil supplemented groups when compared to the control group.

Jang (2011) conducted a research to investigate the effects of using different levels of coriander oil on serum biochemical parameters of broilers and reported significantly reduced total cholesterol and LDL cholesterol in 1.5 and 2.0% coriander oil groups. Further, he reported significant reduction of triglycerides for in 2% coriander oil group and no effect of coriander oil in respect of HDL cholesterol.

Farag (2013) conducted an experiment to investigate the effect of dietary coriander seeds supplementation on serum biochemical parameters in broiler chicken and reported that serum total protein increased significantly in birds receiving 0.2, 0.4 and 0.6% coriander seeds while there was no effect on serum albumin and globulin levels among different treatments. Further, he reported that the serum triglycerides, cholesterol and creatinine levels showed a significant decrease in birds fed coriander seed at 0.2, 0.4 and 0.6% level as compared to the control.

Abadi and Andi (2014) conducted an experiment to determine the effect of herbal plant powders such as coriander, savory, dill and mix powder of these three plants compared with virginiamycin in their feeds as a growth stimulant on certain blood parameters in broilers and reported reduced glucose, triglyceride and cholesterol levels in coriander group when compared to antibiotic and control groups. Further, lower LDL cholesterol and higher HDL cholesterol values were reported in coriander group as compared to antibiotic and control groups.

Abou-Elkhair *et al.* (2014) conducted a study to assess the effect of feed supplemented with black pepper (*Piper nigrum*), turmeric powder (*Curcuma longa*), coriander seeds (*Coriandrum sativum*) and their combinations on serum biochemical parameters in broilers and reported that birds fed diets containing a mixture of 0.5% black pepper and 2% coriander seed (T_5) and a mixture of 0.5% black pepper, 0.5% turmeric powder and 2% coriander seeds (T_6) showed significantly ($P<0.05$) increased serum total protein and decreased serum glucose and triglyceride concentrations as compared to the control group.

Hosseinzadeh *et al.* (2014) studied the effect of different levels of coriander (*Coriandrum Sativum*) seed powder and coriander extract in water on serum biochemical profile in broiler chicks. Results indicated that birds fed diets containing 2.0% coriander seed had lower total cholesterol as compared to other treatments while there was no effect on serum glucose, triglycerides, HDL and LDL cholesterol concentration.

Saleh *et al.* (2014) conducted an investigation to evaluate the effects of summer shield on certain blood parameters in broiler chicken and reported that summer shield supplementation improved plasma lipid profiles, *viz.,* total cholesterol, triglycerides and LDL and HDL cholesterol and decreased glucose levels. Further, summer shield supplementation increased total protein, albumin, and globulin levels in plasma.

2.5 EFFECT OF INCORPORATION OF CORIANDER SEED ON NUTRIENT UTILIZATION

Guler *et al.* (2006) studied the effect of feeding coriander seed on retention of nutrients in laying Japanese quails and reported that retention of nutrients were significantly higher (P<0.05) in birds fed coriander seed at 1 % and 2% level as compared to the control.

Saleh *et al.* (2014) conducted a study to evaluate the effects of herb mixture (summer shield) supplementation on nutrient utilization in broilers and reported that summer shield supplementation at 2 g/kg diet significantly (P<0.05) increased crude protein and crude fat utilization while there was no effect (P>0.05) on dry matter utilization.

2.6 EFFECT OF INCORPORATION OF CORIANDER SEED ON CARCASS CHARACTERISTICS

Guler *et al.* (2005) studied the effect of coriander seed at varying levels as dietary ingredient on carcass characteristics of Japanese quails and reported that the highest carcass yield and liver weights were recorded in 2% coriander group while the lowest abdominal fat percentages present observed in 1.0, 2.0 and 4.0 % coriander groups.

. Saeid and AL-Nasry (2010) conducted a trial to determine the effect of different levels of coriander seed supplementation on carcass characteristics of broiler chicken and reported increased (P<0.05) carcass yield, liver and pancreas weight in birds fed 0.3% coriander seed in the diet as compared to the control.

Jang (2011) conducted a study to investigate the effects of using different levels of coriander oil on carcass traits of broiler and reported significantly higher per cent of breast, thigh, gizzard and liver weights were observed in birds fed 2% coriander oil in the diet followed by those 1.5 % coriander oil in the diet.

Farag (2013) conducted an experiment to study the effect of dietary coriander seed supplementation on carcass traits of broilers. Results indicated that carcass and organs weight of broiler chicks were significantly ($P<0.01$) affected by coriander seeds supplementation, except heart weight. Further, the highest relative weight of carcass, gizzard and liver were observed in broiler fed 0.6% coriander seed in the diet compared to other treatments.

Abou-Elkhair *et al.* (2014) conducted a study to assess the effect of feed supplemented with black pepper, turmeric powder, coriander seeds and their combinations on carcass traits in broilers and reported that black pepper, turmeric powder, coriander seed or their combination had no effect ($P>0.05$) on carcass yield, dressing percentage and on relative weights of heart, gizzard and edible giblets while higher values of liver (% BW) were obtained from birds fed on diets containing a mixture of 0.5% black pepper and 2% coriander seed (T_5) and a mixture of 0.5% black pepper, 0.5% turmeric powder and 2% coriander seeds (T_6) as compared to the control.

Kumari *et al.* (2014) studied the effect of dietary supplement of sugar beet, neem leaf, linseed and coriander seed meal (CSM) on carcass traits of Vanaraja chicken and reported that the average giblet percentage was significantly higher ($P<0.05$) in all treatment group as compared to the control while there was no effect (P>0.05) on dressing percentage.

Ramadan *et al.* (2014) conducted an experiment to determine the effects of coriander seeds along with black seeds on carcass traits of broilers and reported that coriander seed supplementation in the diet increased significantly the dressing percentage as compared to control group while there was no effect (P>0.05) on carcass weight as compared to the control.

Rashid *et al.* (2014) conducted a study to investigate the effect of different levels of coriander seed meal (CSM) on the meat yield characteristics of broilers and reported that dietary CSM had no effect (P>0.05) on per cent dressing yield, gizzard, heart, liver and breast meat.

Saleh *et al.* (2014) conducted investigation to evaluate the effects of coriander herb along with other herbs in the form of summer shield on carcass traits in broiler chicken. Results indicated significantly increased weight of breast muscle and decreased weight of abdominal fat while liver weight was not affected.

Naeemasa *et al.* (2015) conducted a study to investigate the effects of different levels of coriander seed powder and extract on carcass traits of broiler chicken and reported that percent carcass yield, liver, heart and gizzard were not affected (P>0.05) by the coriander seed supplementation in the diet.

2.7 EFFECT OF INCORPORATION OF CORIANDER SEED ON COST ECONOMICS

Farag (2013) conducted an experiment to investigate the effect of dietary coriander seeds supplementation on economic efficiency of broiler chicken. Results indicated highest net revenue in 0.6% coriander seed supplemented group (27.46%), followed by those fed 0.4% (14.42%) and 0.2 % (13.71%) coriander seed in the diet as compared to the control.

Rashid *et al.* (2014) conducted a study to investigate the effect of different levels of Dhania seed on the cost economics of broilers and reported that cost of production per kg live broiler decreased ($P<0.05$) while profit per kg live broiler increased ($P<0.05$) with increased level of dhania seed in the diet.

CHAPTER III

MATERIALS AND METHODS

The present experiment was planned to study the effect of inclusion of coriander seed as natural feed additive on the performance of Japanese quails. The research work was carried out in the Poultry Experimental Unit attached to the Instructional Livestock Farm Complex, N.T.R College of Veterinary Science, Gannavaram (A.P).

3.1 PROCUREMENT OF FEED INGREDIENTS

Coriander seed, de-oiled rice bran, maize, soybean meal, fish meal, mineral mixture (Polchem hygiene laboratories) and salt were procured from the local market and were ground and mixed in the Feed Mixing Plant attached to Department of Animal Nutrition.

3.2 CHEMICAL ANALYSIS

The chemical composition of coriander seed and other feed ingredients used in the experiment and the experimental diets were determined as per AOAC (2007), while the calcium and phosphorus contents were estimated as per Talapatra *et al*. (1940). The cell-wall constituents of coriander seed and other feed ingredients used in the experiment and experimental diets were estimated as per Van Soest *et* *al.* (1991). Hemi-cellulose was calculated as the difference between NDF and ADF.

3.3 EXPERIMENTAL DESIGN

The experiment was carried out for 5 weeks in a completely randomized design (CRD) experiment. During the experiment, coriander seed was ground and is included at 0% (T_1; Control), 0.5% (T_2), 1.0% (T_3), 1.5% (T_4) and 2.0% (T_5) levels in iso-caloric and iso-nitrogenous broiler quail diets. The broiler quail diets were formulated according to NRC, 1994 specifications. One hundred and fifty day-old Japanese quail chicks were weighed individually (avg. b. wt. 7.23 ± 0.27 g), wing banded and randomly divided into 5 equal groups of 3 replicates each with 10 chicks / replicate. Each group of quail was allotted to one of the dietary treatments at random. The data for growth rate and feed intake were recorded at weekly intervals.

3.4 MANAGEMENT AND FEEDING

All the chicks were housed in battery brooders all through the experiment. Feed and water were provided *ad libitum*. The chicks were fed on respective experimental diets *ad libitum* from 0 to 5 weeks. The feed offered and feed leftover was weighed daily, to quantify the feed utilized. B-complex vitamins and antibiotics were offered in water for 3 days during first week.

3.5 NUTRIENT UTILIZATION

3.5.1 Digestibility of nutrients

During the last 3 days of the trial, faeces were collected from all the 5 treatments of 3 replicates which were previously fasted for 12 hours to empty the birds gut to mark the beginning and end of faeces collection. The faeces collected were oven-dried for a period of 18 hours at a temperature of about 105^0C and weighed daily. At the end of the collection period, the faecal samples collected from each treatment per day were pooled, ground and thoroughly mixed to obtain a homogenous mixture. Samples of faeces were subjected to proximate analysis according to standard methods outlined (AOAC, 2007) and the results obtained were used to calculate the apparent digestibility using the following formula.

$$\text{Apparent digestibility coefficient} = \frac{\text{Nutrient in feed} - \text{Nutrient in faeces}}{\text{Nutrient in feed}} \times 100$$

3.5.2 Nitrogen utilization in rations

Total excreta were collected at the end of experiment for 3 days in each group and the dry matter content of excreta was estimated. Total excreta for each group was pooled, dried and stored for further analysis. Feed intake for 3 days was calculated for each group. Total nitrogen in feeds and excreta were determined using Kjeldahl method (AOAC, 2007) and the nitrogen utilization was calculated as follows:

$$\text{N utilization (\%)} = \frac{\text{(N intake – N excretion)}}{\text{N intake}} \times 100$$

3.6 CARCASS CHARACTERISTICS

At the end of study period (5th week), two birds per replicate and thus a total 6 birds per treatment were randomly selected, weighed and slaughtered. The data on dressing percentage, carcass yield, meat bone ratio, ready-to-cook yield and per cent weights of heart, liver and gizzard were recorded. At the time of slaughter, blood samples were collected from each bird to determine serum cholesterol, proteins, triglycerides, glucose, creatinine, calcium and phosphorous.

3.7 SERUM BIOCHEMSITRY

3.7.1 Estimation of Serum cholesterol

Cholesterol was estimated using diagnostic kit (M/s. Span Diagnostics Private Limited) by enzymatic method of Allain *et al*. (1974) for *in vitro* estimation.

Principle

Cholesterol esterase hydrolyzes cholesterol ester and the free cholesterol thus formed is oxidized by the cholesterol oxidase to cholest-4-en-3-one and hydrogen peroxide. The hydrogen peroxide so formed reacts with 4-amino antipyrine and phenol in the presence of peroxides (POD) to produce red coloured quinoneimine dye. The intensity of colour produced is proportional to the cholesterol concentration which is measured colorimetrically at 505 nm.

Procedure

	Blank (B)	Standard (S)	Test (T)
Serum	-	-	10 µl
Cholesterol Standard	-	10 µl	-
Cholesterol reagent	1000 µl	1000 µl	1000 µl

Three test tubes were labeled as blank (B), standard (S) and test (T). 1 ml of cholesterol reagent was added to all the three test tubes. 10 µl of cholesterol standard and 10 µl serum were added to test tubes labeled as standard and test, respectively. Tubes were mixed well and incubated at 37°C for 10 minutes. Absorbance of test (T), standard (S) against blank (B) were recorded at 505 nm

Calculation

$$\text{Cholesterol (mg/dl)} = \frac{\text{Absorbance of Test}}{\text{Absorbance of standard}} \times 200$$

3.7.2 Estimation of HDL-C, LDL-C and VLDL-C

HDL-C was estimated using diagnostic kit (M/s. Span Diagnostics Private Limited) and following the PEG precipitation and enzymatic method of Weibe and Smith (1985).

Principle

Low and very low-density lipoproteins are precipitated by a solution containing PEG 6000, leaving behind the HDL in solution. HDL cholesterol is estimated in the supernatant by a series of enzymatic reactions which are initiated by the oxidation of cholesterol to cholestenone (Cholest-4-en-3-one) by cholesterol oxidase, accompanied by the formation of hydrogen peroxide. In a second reaction catalyzed by peroxidase 4-amino antipyrine, phenol reacts with hydrogen peroxide to form pink coloured quinoneimine. Absorbance at 505 nm is directly proportional to HDL cholesterol concentration.

STEP-A

HDL-Cholesterol separation

The precipitating reagent 0.2 ml and serum 0.2 ml were mixed well and allowed to stand at room temperature for 10 min, and centrifuged at 2000 rpm for 15 min, to get clear supernatant.

STEP-B

HDL-Cholesterol estimation

	Blank (B)	**Standard (S)**	**Test (T)**
Supernatant from Step A	-	-	100 µl
HDL-Cholesterol Standard	-	100 µl	-
Cholesterol reagent	1000 µl	1000 µl	1000 µl

Three test tubes were taken and labeled as blank (B), standard (S) and test (T). In second and third test tubes, 100µl of HDL-standard and 100 µl of supernatant from step A were taken, respectively. Cholesterol reagent, 1000 µl was added to all the three test tubes.

The tubes were mixed well and the absorbance of test (T) and standard (S) against blank (B) are recorded at 505 nm.

Calculation

$$\text{HDL-Cholesterol (mg/dl)} = \frac{\text{Absorbance of Test}}{\text{Absorbance of standard}} \times 50 \times 2$$

$$\text{LDL-Cholesterol} = \text{Total Cholesterol} - \left(\frac{\text{Triglycerides}}{5}\right) - \text{HDL Cholesterol}$$

VLDL-Cholesterol = Total Cholesterol – (HDL-C + LDL-C)

3.7.3 Estimation of Triglycerides

Triglycerides were estimated by using diagnostic kit (M/s. Span Diagnostics Private Limited) using the enzymatic method of Mc Gowan *et al.* (1983).

Principle

Triglycerides from serum are hydrolyzed by lipoprotein lipase (LPL) to produce glycerol and free fatty acid (FFA). In presence of glycerol kinase (GK), Adenosine Triphosphate phosphorylates glycerol to produce Glycerol 3-

Phosphate which is further oxidized by Glycerol 3-Phosphate oxidase (GPO) to produce Dihydroxy Acetone Phosphate (DAP) and H_2O_2. In presence of peroxidase hydrogen peroxide couples with 4-Aminoantipyrine and 4-Chlorphenol to produce red coloured quinoneimine dye. Absorbance of coloured dye is measured at 505 nm. The intensity of colour produced is directly proportional to the concentration of triglycerides in the sample.

Procedure

	Blank (B)	**Standard (S)**	**Test (T)**
Serum	-	-	10 µl
Triglyceride Standard	-	10 µl	-
Triglyceride mono reagent	1000 µl	1000 µl	1000 µl

Three test tubes were taken labeled as blank (B), standard (S) and test (T). 1000 µl of enzyme reagent was taken in all 3 test tubes. 10 µl of triglyceride standard, 10 µl of serum were added to test tubes labeled standard and test, respectively. Absorbance of standard (S) and test (T) were recorded against blank (B) at 505 nm.

Calculation

$$\text{Triglycerides (mg/dl)} = \frac{\text{Absorbance of Test}}{\text{Absorbance of standard}} \times 200$$

3.7.4 Estimation of total proteins in serum

Serum total proteins were estimated by using diagnostic kit (M/s. Span Diagnostics Private Limited) following modified Biuret method.

Principle

Peptide bonds of proteins react with cupric ions in alkaline medium to give a violet coloured chelate, the absorbance of which is measured at 578 nm. The absorbance of final colour is proportional to the total protein concentration in the sample.

Procedure

	Blank (B)	**Standard (S)**	**Test (T)**
Serum	-	-	10 µl
Protein Standard	-	10 µl	-
Biuret reagent	1000 µl	1000 µl	1000 µl

Test tubes were taken and labeled as blank (B), standard (S) and test (T). One ml of biuret reagent was added in all the test tubes. 0.01 ml of standard and 0.01 ml of serum were added to the test tubes labeled as standard and test, respectively. Tubes were mixed well and incubated at 37°C for 5 minutes. Absorbance of standard (S) and test (T) against blank (B) were measured at 578 nm.

Calculation

$$\text{Total protein (g/dl)} = \frac{\text{Absorbance of Test}}{\text{Absorbance of standard}} \times 6.5$$

3.7.5 Estimation of serum albumin

The serum albumin was estimated by using diagnostic kit (M/s. Span Diagnostics Private Limited) using the bromocresol green (BCG), end Point assay method.

Principle

At pH 3.68, albumin binds with bromocresol green (BCG) in a buffered medium to produce a green coloured complex. The absorbance of final colour is measured at 630 nm. The intensity of this colour is proportional to the albumin concentration in the sample.

Procedure

	Blank (B)	**Standard (S)**	**Test (T)**
Serum	-	-	10 µl
Albumin Standard	-	10 µl	-
Albumin reagent	1000 µl	1000 µl	1000 µl

Three test tubes were labeled as blank (B), standard (S) and test (T). 1 ml of BCG reagent was added in all three test tubes. 0.01 ml of standard and 0.01 ml of serum were added to test tubes labeled as standard (S) and test (T), respectively. The tubes were mixed well and the absorbance of standard (S) and test (T) against blank (B) were measured at 630 nm.

Calculation

$$\text{Albumin (g/dl)} = \frac{\text{Absorbance of Test}}{\text{Absorbance of standard}} \times 4$$

$$\text{Globulins} = \text{Total Protein} - \text{Albumin}$$

$$\text{A/G ratio} = \frac{\text{Albumin}}{\text{Globulins}}$$

3.7.6 Estimation of serum calcium

The serum calcium was estimated by using diagnostic kit (M/s. Span Diagnostics Private Limited).

Principle

In alkaline solution, calcium binds with metal complexing dye O-Cresolphththalein Complex one (OCPC) to form a Bluish - Purple complex, which is measured at 578 nm. The intensity of colour formed is proportional to calcium concentration in the Sample. Hydroxyquinoline will act as a masking agent and eliminate the interference of magnesium.

Procedure

	Blank (B)	Standard (S)	Test (T)
Serum	-	-	20 µl
Calcium Standard	-	20 µl	-
Working calcium reagent	1000 µL	1000 µL	1000 µL

Three test tubes were labeled as blank (B), standard (S) and test (T). 1 ml of working calcium reagent was added in all tubes. 0.02 ml of standard and 0.02 ml of serum were added to test tubes labeled standard (S) and test (T), respectively. Test tubes were mixed well and the absorbance of standard (S) and test (T) against blank (B) were measured at 578 nm.

Calculation

$$\text{Calcium (mg/dl)} = \frac{\text{Absorbance of Test}}{\text{Absorbance of standard}} \times 10$$

3.7.7 Estimation of serum Phosphorous

The serum Phosphorous was estimated by using diagnostic kit (M/s. Span Diagnostics Private Limited).

Principle

In acidic medium, inorganic phosphorous reacts with ammonium molybdate to form phosphomolybdate complex. This colorless phosphomolybdate complex is measured at 340 nm and is directly proportional to the concentration of inorganic phosphorous in the sample.

Procedure

	Blank (B)	**Standard (S)**	**Test (T)**
Serum	-	-	10 µl
Phosphorous Standard	-	10 µl	-
Molybdate reagent	1000 µL	1000 µL	1000 µL

Three test tubes were labeled as blank (B), standard (S) and test (T). 1 ml of working molybdate reagent was added in all tubes. 0.01 ml of phosphorous standard and 0.01 ml of serum were added to test tubes labeled standard (S) and test (T), respectively. Test tubes were mixed well and the absorbance of standard (S) and test (T) against blank (B) were measured at 340 nm.

Calculation

$$\text{Inorganic Phosphorous (mg/dl)} = \frac{\text{Absorbance of Test}}{\text{Absorbance of standard}} \times 5$$

3.7.8 Estimation of serum glucose

The serum glucose was estimated by using diagnostic kit (M/s. Span Diagnostics Private Limited).

Principle

Glucose oxidase (GOD) oxidises glucose to gluconic acid and hydrogen peroxide. In presence of enzyme peroxidase, released hydrogen peroxide is coupled with phenol and 4-aminoantipyrine (4-AAP) to form coloured quinoneimine dye. Absorbance of coloured dye is measured at 505 nm and is directly proportional to Glucose concentration in the sample.

Procedure

	Blank (B)	**Standard (S)**	**Test (T)**
Serum	-	-	20 µl
Glucose Standard	-	20 µl	-
Working Glucose Reagent	1500 µL	1500 µL	1500 µL
Mix well. Incubate at 37^{0}C for 10 minutes or at room temperature (15 – 30^{0}C) for 30 minutes.			
Purified water	1500 µL	1500 µL	1500 µL

Three test tubes were labeled as blank (B), standard (S) and test (T). In each test tube 1.5 ml of Working Glucose reagent was added. 0.02 ml of Glucose standard and 0.02 ml of serum were added to test tubes labeled standard (S) and test (T), respectively. The tubes were mixed well and incubated at 37^{0}C for 10 minutes. In each test tube 1.5 ml of purified water was added and the absorbance of standard (S) and test (T) against blank (B) were measured at 490-550 nm.

Calculation

$$\text{Glucose (mg/dl)} = \frac{\text{Absorbance of Test}}{\text{Absorbance of standard}} \times 100$$

3.7.9 Estimation of serum creatinine

The serum creatinine was estimated by using diagnostic kit (M/s. Span Diagnostics Private Limited) by following Jeffe's method.

Principle

Creatinine reacts with alkaline picrate to produce an orange-yellow colour (the Jeffe's reaction). Specificity of the assay has been improved by the introduction of an initial rate method. The absorbance of the orange-yellow colour formed is directly proportional to creatinine concentration and is measured colorimetrically at 500-520 nm.

Procedure

	Blank (B)	**Standard (S)**	**Test (T)**
Distilled Water	1000 µl	-	-
Serum	-	-	100 µl
Creatinine Standard	-	100 µl	-
Working Creatinine Reagent	-	1000 µl	1000 µl

Three test tubes were labeled as blank (B), standard (S) and test (T). In blank (B) test tube 1 ml of distilled water was added. In standard (S) and test (T) test tubes 1 ml of Working Creatinine reagent was added. 0.1 ml of Creatinine standard (concentration 2 mg/dl) and 0.1 ml of serum were added to test tubes labeled standard (S) and test (T), respectively. The tubes were mixed well and read initial absorbance (A_1) 20 seconds after mixing and final absorbance (A_2) 80 seconds after mixing against blank at 505 nm.

Calculation

$\Delta A = A_2 - A_1$

$$\text{Creatinine (mg/dl)} = \frac{\Delta A \text{ of Test}}{\Delta A \text{ of Standard}} \times \text{Concentration of standard}$$

3.8 COST ECONOMICS

The relative economy of rearing quails up to 5 weeks of age by incorporating coriander seed at varying levels in the diets was calculated based on the actual feed cost at the prevailing market.

3.9 STATISTICAL ANALYSIS

Statistical analysis of the data was carried out according to the procedures suggested by Snedecor and Cochran (1993).

CHAPTER - IV

RESULTS

The results on various aspects pertaining to chemical composition, digestibility of nutrients, growth performance, serum biochemical profile and carcass characteristics of quails fed diets containing coriander seed at varying levels are presented in this chapter.

4.1 CHEMICAL COMPOSITION OF FEED INGREDIENTS

4.1.1 Proximate composition of feed ingredients

The chemical composition of coriander seed and other feed ingredients used in the present study are shown in Table 2. The per cent DM, OM, CP, EE, CF, NFE, TA and AIA of coriander seed were 88.50, 94.51, 14.70, 9.34, 33.93, 36.54, 5.49 and 0.11, respectively. The per cent calcium and phosphorous contents of coriander seed were 0.64 and 0.35, respectively.

The per cent DM, OM, CP, EE, CF, NFE, TA and AIA content of maize, de-oiled rice bran, soybean meal and fish meal were 91.80, 93.60, 91.00 and 87.00; 97.95, 81.73, 88.37 and 79.80; 8.32, 17.90, 46.02 and 50.57; 1.85, 1.00, 1.01 and 8.00; 2.47, 6.01, 13.01 and 3.42; 85.31, 56.82, 28.33 and 17.81; 2.05, 18.27, 11.63 and 20.20 and, 0.71, 2.74, 2.12 and 6.05, respectively. The per cent

Table 2: Chemical composition* (%) of feed ingredients

Nutrient	Maize	DORB	SBM	Fish meal	Coriander seed
Dry matter	91.80	93.60	91.00	87.00	88.50
Organic matter	97.95	81.73	88.37	79.80	94.51
Crude protein	8.32	17.90	46.02	50.57	14.70
Ether extract	1.85	1.00	1.01	8.00	9.34
Crude fibre	2.47	6.01	13.01	3.42	33.93
NFE	85.31	56.82	28.33	17.81	36.54
Total Ash	2.05	18.27	11.63	20.20	5.49
AIA	0.71	2.74	2.12	6.05	0.11
Calcium	0.02	0.07	0.29	3.73	0.64
Phosphorus	0.28	1.50	0.65	2.43	0.35

*On dry matter basis except for DM

calcium and phosphorous content of maize, de-oiled rice bran, soybean meal and fish meal were 0.02, 0.07, 0.29 and 3.73 and, 0.28, 1.50, 0.65 and 2.43, respectively.

4.1.2 Cell wall constituents of feed ingredients

The per cent cell wall constituents of coriander seed and other feed ingredients used in the present study are shown in Table 3. The per cent NDF, ADF, hemi-cellulose, cellulose, ADL and silica content of coriander seed were 39.35, 20.55, 18.80, 6.30, 14.20 and 0.10, respectively. The per cent NDF, ADF, hemi-cellulose, cellulose, ADL and silica contents of maize, de-oiled rice bran, soybean meal and fish meal were 17.42, 31.60, 24.62 and 40.10; 8.10, 19.50, 17.04 and 21.10; 9.32, 12.10, 7.58 and 19.00; 4.92, 9.15, 10.66 and 6.28; 2.50, 7.50, 4.02 and 9.03 and, 0.74, 2.98, 2.35 and 6.35, respectively.

4.2 INGREDIENT COMPOSITION OF QUAIL DIETS

Five diets were formulated (Table 4) incorporating coriander seed at 0.0% (T_1), 0.5% (T_2), 1.0% (T_3), 1.5% (T_4) and 2.0% (T_5) by marginal adjustment of other ingredients. Mineral mixture with salt was included up to 0.4 per cent level in all the diets. Feed additives like Hyblend AB_2D_3K (150 g/100 kg), trace mineral mix (150 g/100 kg) and mycosorb (100 g/100 kg) were included in all the diets.

Table 3: Cell-wall constituents* (%) of feed ingredients

Constituent	Maize	DORB	SBM	Fish meal	Coriander seed
NDF	17.42	31.60	24.62	40.10	39.35
ADF	8.10	19.50	17.04	21.10	20.55
Hemi-cellulose	9.32	12.10	7.58	19.00	18.80
Cellulose	4.92	9.15	10.66	6.28	6.30
ADL	2.50	7.50	4.02	9.03	14.20
Silica	0.74	2.98	2.35	6.35	0.10

*On dry matter basis.

Table 4: Ingredient composition (%) of quail diets

Constituent	T_1	T_2	T_3	T_4	T_5	Cost/kg (Rs)
Maize	49.80	49.5	49.40	49.20	49.00	16.00
DORB	8.30	8.10	7.70	7.40	7.10	13.50
Soybean meal	34.50	34.50	34.50	34.50	34.50	38.00
Fish meal	5.00	5.00	5.00	5.00	5.00	30.00
Coriander seed	0.00	0.50	1.00	1.50	2.00	80.00
DCP	0.30	0.30	0.30	0.30	0.30	26.00
Stone grit	1.20	1.20	1.20	1.20	1.20	0.00
Salt	0.25	0.25	0.25	0.25	0.25	3.00
Trace min mix	0.15	0.15	0.15	0.15	0.15	240.00
Feed additives	0.50	0.50	0.50	0.50	0.50	1116.00
Total	100	100	100	100	100	
Feed cost/100 kg (Rs)	2669.00	2701.00	2734.00	2767.00	2800.00	

The feed cost (₹) per kg of diet was 26.69 (T_1), 27.01 (T_2), 27.34 (T_3), 27.67 (T_4) and 28.00 (T_5), respectively.

4.3 CHEMICAL COMPOSITION OF QUAIL DIETS

4.3.1 Proximate composition of quail diets

The proximate composition of quail diets is presented in Table 5. The diets were iso-caloric and iso-nitrogenous with ME (kcal/kg) and CP (%) content of 2900 Kcal and 24.00 per cent, respectively. The EE, CF, TA and AIA contents were within the range of 1.93 to 2.09; 7.04 to 7.64; 7.19 to 8.26 and 1.84 to 1.90 per cent, respectively.

Calcium and phosphorous content of diets were within the range of 0.82 to 0.83 and 0.65 to 0.67 per cent, respectively. The protein: energy ratio is about 1:121 in all the treatments.

4.3.2 Cell-wall constituents of quail diets

The cell-wall constituents of quail diets are presented in table 6. The NDF, ADF, hemi-cellulose, cellulose, lignin and silica of the diets ranged from 24.03 to 24.27; 13.87 to 13.99; 10.16 to 10.28; 7.86 to 7.96; 4.08 to 4.25 and 1.86 to 1.92 per cent, respectively.

Table 5: Chemical composition* (%) of quail diets

Nutrient	T_1	T_2	T_3	T_4	T_5
Dry matter	90.72	90.64	90.35	90.90	91.25
Organic matter	91.74	92.03	92.38	92.45	92.81
Crude protein	24.03	24.05	24.04	24.04	24.05
Ether extract	1.93	1.97	2.02	2.06	2.09
Crude fibre	7.04	7.21	7.39	7.51	7.64
NFE	58.74	58.80	58.93	58.84	59.03
Total Ash	8.26	7.97	7.62	7.55	7.19
AIA	1.89	1.90	1.87	1.85	1.84
ME kcal/kg (calculated)	2900.33	2900.58	2903.13	2904.53	2905.93
Protein energy ratio	1:121	1:121	1:121	1:121	1:121
Calcium	0.82	0.82	0.83	0.83	0.83
Phosphorus	0.67	0.66	0.66	0.66	0.65

*On dry matter basis except for DM.

Table 6: Cell-wall constituents* (%) of quail diets

Constituent	T_1	T_2	T_3	T_4	T_5
NDF	24.03	24.14	24.27	24.20	24.18
ADF	13.87	13.93	13.99	13.94	13.91
Hemi-cellulose	10.16	10.21	10.28	10.26	10.27
Cellulose	7.93	7.94	7.96	7.90	7.86
ADL	4.08	4.14	4.19	4.22	4.25
Silica	1.92	1.91	1.90	1.88	1.86

*On dry matter basis.

4.4 EFFECT OF DIETARY INCORPORATION OF CORIANDER SEED ON GROWTH PERFORMANCE OF JAPANESE QUAILS

4.4.1 Effect of coriander seed on body weight gain

Body weight gains during the experimental period are given in Table 7. During the experimental period (0-5 weeks), the body weight gains ranged from 157.13 to 184.17 g among different treatments. The body weight gains increased linearly from T_1 to T_5 with increased level of incorporation of coriander seed in the diet and the differences between the treatments were significant ($P<0.01$). The body weight gain was significantly higher ($P<0.01$) in quails fed diets containing 2.0% coriander seed as compared to those fed diets containing 0, 0.5, 1.0 and 1.5% coriander seed. However, no significant difference ($P>0.05$) was observed between quails fed diets containing coriander seed at 0 and 0.5% levels.

4.4.2 Effect of coriander seed on feed intake

Feed intake of quails during experimental period are given in Table 7. During the experimental period (0-5 weeks), feed intakes ranged from 581.16 to 609.10 g among different treatments. The feed intake increased linearly from T_1 to T_5 with increased level of incorporation of coriander seed in the diet and the differences between the treatments were significant ($P<0.01$). The feed intake was significantly higher ($P<0.01$) in quails fed diets containing 2.0% coriander seed as compared to those fed diets containing coriander seed at 0 and 0.5% levels. However, no significant difference (P>0.05) was observed between quails fed diets containing coriander seed at 0 and 0.5%, 1.0 and 1.5%, 1.0 and 2.0% and, 1.5 and 2.0% levels.

4.4.3 Effect of coriander seed on feed conversion ratio

Feed conversion ratio of quails during experimental period is given in Table 7. The feed consumed / kg gain during experimental period (0-5 weeks) ranged from 3.30 to 3.70 kg among different treatments. Feed consumed / kg gain decreased linearly from T_1 to T_5 with increased level of incorporation of coriander seed from 0 to 2.0% in the diet and the differences between the treatments were significant (P<0.01). However, no significant difference (P>0.05) was observed between quails fed diets containing coriander seed at 0 and 0.5%, 0 and 1.0%, 0.5 and 1.0%, 1.0 and 1.5% levels.

Table 7: Effect of dietary incorporation of coriander seed at varying levels on body weight gain (g), feed intake (g), and feed conversion ratio

Treatment	B.Wt gain(g)	Feed intake(g)	Feed Conversion Ratio
T_1	$157.13^{a} \pm 1.90$	$581.16^{a} \pm 2.04$	$3.70^{c} \pm 0.06$
T_2	$159.91^{a} \pm 2.41$	$590.10^{a} \pm 3.52$	$3.69^{c} \pm 0.07$
T_3	$167.46^{b} \pm 1.89$	$607.01^{b} \pm 8.11$	$3.62^{bc} \pm 0.02$
T_4	$175.36^{c} \pm 3.58$	$608.20^{b} \pm 1.92$	$3.47^{b} \pm 0.06$
T_5	$184.17^{d} \pm 0.23$	$609.10^{b} \pm 2.50$	$3.30^{a} \pm 0.01$
SEM	2.80	3.44	0.04
SS	**	**	**

Values in column bearing different super scripts differ significantly ** ($P<0.01$).

4.5 EFFECT OF DIETARY INCORPORATION OF CORIANDER SEED ON SERUM BIOCHEMICAL PROFILE OF JAPANESE QUAILS

4.5.1 Effect of coriander seed on serum total protein

The values of serum total protein are given in Table 8. The serum total protein content ranged from 3.80 to 4.10 g/dl among different treatments. The serum total protein content increased significantly (P<0.01) with increase in the level of incorporation of coriander seed from 0 to 2.0% in the diet. The serum total protein content was significantly higher (P<0.01) in quails fed diets containing 2.0% coriander seed as compared to those fed diets containing coriander seed at 0, 0.5, 1.0 and 1.5% levels.

4.5.2 Effect of coriander seed on serum albumin

The values of serum albumin are given in Table 8. The serum albumin content ranged from 2.36 to 2.54 g/dl among different treatments. The serum albumin content increased significantly (P<0.01) with increased level of incorporation of coriander seed from 0 to 2.0% in the diet. However, no significant differences (P>0.05) in serum albumin content was observed between quails fed diets containing coriander seed at 0 and 0.5% and, 1.5 and 2.0% levels.

4.5.3 Effect of coriander seed on serum globulin

The values of serum globulin are given in Table 8. The serum globulin content of different treatments ranged from 1.44 to 1.56 g/dl. The serum globulin content increased significantly ($P<0.01$) with increased level of incorporation of coriander seed from 0 to 2.0% in the diet. However, no significant differences ($P>0.05$) in serum globulin content was observed between quails fed diets containing coriander seed at 0 and 0.5%, 0 and 1.0%, 0.5 and 1.0% and, 1.5 and 2.0% levels.

4.5.4 Effect of coriander seed on serum glucose

The values of serum glucose are given in Table 9. The serum glucose content of different treatments ranged from 219.80 to 235.56 mg/dl. Serum glucose levels decreased significantly ($P<0.05$) with increase in the level of incorporation of coriander seed from 0 to 2.0% in the diet. However, no significant difference ($P>0.05$) in serum glucose content was observed between quails fed diets containing coriander seed at 0 and 0.5%, 0 and 1.0%, 0.5 and 1.0%, 1.0 and 1.5%, 1.0 and 2.0% and, 1.5 and 2.0% levels.

Table 8: Effect of dietary incorporation of coriander seed at varying levels on total serum protein, albumin and globulins (g/dl)

Treatment	**Total protein**	**Albumin**	**Globulin**
T_1	$3.80^a \pm 0.01$	$2.36^a \pm 0.01$	$1.44^a \pm 0.01$
T_2	$3.86^b \pm 0.01$	$2.40^a \pm 0.02$	$1.46^a \pm 0.02$
T_3	$3.93^c \pm 0.16$	$2.45^b \pm 0.01$	$1.48^a \pm 0.01$
T_4	$4.05^d \pm 0.01$	$2.51^c \pm 0.01$	$1.54^b \pm 0.01$
T_5	$4.10^e \pm 0.01$	$2.54^c \pm 0.13$	$1.56^b \pm 0.01$
SEM	0.02	0.01	0.01
SS	**	**	**

Values in column bearing different super scripts differ significantly ** ($P<0.01$).

4.5.5 Effect of coriander seed on serum triglycerides

The values of serum triglycerides are given in Table 9. The serum triglyceride content ranged from 131.16 to 143.35 mg/dl among different treatments. The serum triglyceride levels decreased significantly (P<0.01) with increased level of incorporation of coriander seed from 0 to 2% in the diet. However, no significant difference (P>0.05) in serum triglyceride content was observed in quails fed diets containing coriander seed at 0.5 and 1.0% and, 1.5 and 2.0% levels.

4.5.6 Effect of coriander seed on serum total cholesterol

The values of serum total cholesterol are given in Table 9. The serum total cholesterol content of different treatments ranged from 201.97 to 210.61 mg/dl. The serum total cholesterol level decreased significantly (P<0.01) with increase in the level of incorporation of coriander seed from 0 to 2.0% in the diet. However, no significant difference (P>0.05) in serum total cholesterol content was observed in quails fed diets containing coriander seed at 1.5 and 2.0% levels.

Table 9: Effect of dietary incorporation of coriander seed at varying levels on glucose, triglycerides and total cholesterol in serum (mg/dl)

Treatment	**Glucose**	**Triglycerides**	**Total cholesterol**
T_1	$235.56^{b} \pm 0.22$	$143.35^{c} \pm 0.01$	$210.61^{d} \pm 0.01$
T_2	$233.07^{b} \pm 2.22$	$138.04^{b} \pm 0.01$	$208.54^{c} \pm 1.00$
T_3	$225.66^{ab} \pm 7.41$	$136.34^{b} \pm 1.27$	$204.69^{b} \pm 0.94$
T_4	$221.51^{a} \pm 0.12$	$133.01^{a} \pm 1.44$	$202.17^{a} \pm 0.01$
T_5	$219.80^{a} \pm 0.09$	$131.16^{a} \pm 0.01$	$201.97^{a} \pm 0.01$
SEM	1.84	0.86	0.69
SS	*	**	**

Values in column bearing different super scripts differ significantly ** (P<0.01), *(P<0.05).

4.5.7 Effect of coriander seed on HDL cholesterol

The values of HDL cholesterol are presented in Table 10. The HDL cholesterol content in different treatments ranged from 131.62 to 138.25 mg/dl. The HDL cholesterol content in serum increased ($P<0.01$) with increased level of incorporation of coriander seed from 0 to 2.0% in the diet. However, no significant difference ($P>0.05$) in serum HDL cholesterol content was observed in quails fed diets containing coriander seed at 0 and 0.5% and, 1.5 and 2.0% levels.

4.5.8 Effect of coriander seed on LDL cholesterol

The values of LDL cholesterol are presented in Table 10. The LDL Cholesterol content ranged from 37.48 to 50.32 mg/dl among different treatments. The LDL cholesterol content in serum decreased ($P<0.01$) with increase in the level of incorporation of coriander seed from 0 to 2.0% in the diet. However, no significant difference ($P>0.05$) in serum LDL cholesterol content was observed in quails fed diets containing coriander seed at 0 and 0.5% and, 1.5 and 2.0% levels.

4.5.9 Effect of coriander seed on VLDL cholesterol

The values of VLDL cholesterol are presented in Table 10. The VLDL cholesterol content in different treatments ranged from 26.23 to 28.69 mg/dl. The

Table 10: Effect of dietary incorporation of coriander seed at varying levels on different cholesterol components (mg/dl)

Treatment	HDL-C	LDL-C	VLDL-C
T_1	$131.62^a \pm 0.01$	$50.32^c \pm 0.01$	$28.69^c \pm 0.01$
T_2	$133.21^a \pm 0.92$	$47.72^c \pm 1.90$	$27.60^b \pm 0.01$
T_3	$135.16^b \pm 1.04$	$42.26^b \pm 1.66$	$27.27^b \pm 0.25$
T_4	$137.26^c \pm 0.01$	$38.30^a \pm 0.29$	$26.60^a \pm 0.29$
T_5	$138.25^c \pm 0.01$	$37.48^a \pm 0.01$	$26.23^a \pm 0.01$
SEM	0.52	1.05	0.17
SS	**	**	**

Values in column bearing different super scripts differ significantly ** (P<0.01).

VLDL cholesterol content in serum decreased (P<0.01) with increased level of incorporation of coriander seed from 0 to 2.0% in the diet. However, no significant difference (P>0.05) in serum VLDL cholesterol content was observed among quails fed diets containing coriander seed at 0.5 and 1.0% and, 1.5 and 2.0% levels.

4.5.10 Effect of coriander seed on Serum creatinine

The values of serum creatinine are given in Table 11. The serum creatinine content ranged from 1.22 to 1.30 mg/dl among different treatments. The serum creatinine content decreased significantly (P<0.01) with increase in the level of incorporation of coriander seed from 0 to 2.0% in the diet. However, there was no significant difference (P>0.05) in serum creatinine content of quails fed diets containing coriander seed at 0 and 0.5%, 0.5 and1.0%, 0.5 and 1.5%, 1.0 and 1.5% and, 1.5 and 2.0% levels.

4.5.11 Effect of coriander seed on serum calcium

The values of serum calcium are given in Table 11. The serum calcium content ranged from 18.44 to 20.09 mg/dl among different treatments. The serum calcium content increased (P<0.01) with increased level of incorporation of coriander seed from 0 to 2.0% in the diet. The serum calcium content was significantly higher (P<0.01) in quails fed diets containing 2.0% coriander seed as compared to those fed diets containing coriander seed at 0, 0.5, 1.0 and 1.5% levels.

4.5.12 Effect of coriander seed on serum phosphorous

The values of serum phosphorous are given in Table 11. The serum phosphorous content ranged from 8.36 to 8.76 mg/dl among different treatments. The serum phosphorous content increased ($P<0.01$) with increase in the level of incorporation of coriander seed from 0 to 2.0% in the diet. However, there is no significant difference ($P>0.05$) in serum phosphorous content between quails fed diets containing coriander seed at 0 and 0.5%, 0 and 1.0%, 0.5 and 1.0% and, 1.5 and 2.0% levels.

Table 11: Effect of dietary incorporation of coriander seed at varying levels on serum creatinine, calcium and phosphorous (mg/dl)

Treatment	Creatinine	Calcium	Phosphorous
T_1	$1.30^{c} \pm 0.01$	$18.44^{a} \pm 0.01$	$8.36^{a} \pm 0.01$
T_2	$1.27^{bc} \pm 0.01$	$18.71^{b} \pm 0.01$	$8.48^{a} \pm 0.01$
T_3	$1.26^{b} \pm 0.01$	$19.35^{c} \pm 0.01$	$8.51^{a} \pm 0.01$
T_4	$1.24^{ab} \pm 0.01$	$19.93^{d} \pm 0.01$	$8.75^{b} \pm 0.10^{b}$
T_5	$1.22^{a} \pm 0.01$	$20.09^{e} \pm 0.05$	$8.76^{b} \pm 0.08$
SEM	0.01	0.12	0.04
SS	**	**	**

Values in column bearing different super scripts differ significantly ** ($P<0.01$).

4.6 EFFECT OF DIETARY INCORPORATION OF CORIANDER SEED ON DIGESTIBILITY OF NUTRIENTS

4.6.1 Effect of coriander seed on digestibility of proximate constituents

The effect of dietary incorporation of coriander seed at varying levels in quail diets on digestibility of proximate constituents is given in Table 12. The digestibility coefficients of dry matter ranged from 65.64 to 70.22 per cent. The digestibility of DM increased linearly with increased level of incorporation of coriander seed from 0 to 2.0% in the diet and the differences between different treatments were statistically not significant ($P>0.05$).

The digestibility coefficients of organic matter ranged from 67.01 to 72.70 per cent. The digestibility of OM increased significant ($P<0.01$) with increased level of incorporation of coriander seed from 0 to 2.0% in the diet. However, no significant differences ($P>0.05$) were observed between quails fed diets containing coriander seed at 0.5 and 1.0%, 0.5 and 1.5%, 1.0 and 1.5%, 1.0 and 2.0% and, 1.5 and 2.0% levels.

The digestibility coefficients of crude protein ranged from 64.09 to 69.60 per cent. The digestibility of CP increased linearly with increased level of incorporation of coriander seed from 0 to 2.0% in the diet and the differences between treatments were statistically significant ($P<0.01$). However, no significant differences ($P>0.05$) were observed between quails fed diets containing coriander seed at 0.5 and 1.0, 0.5 and 1.5%, 0.5 and 2.0%, 1.0 and 1.5%, 1.0 and 2.0% and, 1.5 and 2.0% levels.

The digestibility coefficients of crude fibre ranged from 53.96 to 59.58 per cent. The digestibility of CF increased linearly with increased level of incorporation of coriander seed from 0 to 2.0% in the diet and the differences between treatments were statistically significant (P<0.01). However, no significant differences (P>0.05) were observed between quails fed diets containing coriander seed at 0 and 0.5%, 0.5 and1.0%, 0.5 and 1.5%, 1.0 and 1.5%, 1.0 and 2.0% and, 1.5 and 2.0% levels.

The digestibility coefficients of ether extract ranged from 70.06 to 75.45 per cent. The digestibility of EE increased significantly (P<0.01) with increased level of incorporation of coriander seed from 0 to 2.0% in the diet. However, no significant differences (P>0.05) were observed between quails fed diets containing coriander seed at 0 and 0.5%, 0.5 and 1.0%, 1.0 and1.5%, 1.0 and 2.0% and, 1.5 and 2.0% levels.

The digestibility coefficients of nitrogen free extract ranged from 71.56 to 75.54 per cent. The digestibility of NFE increased linearly with increased level of incorporation of coriander seed from 0 to 2.0% in the diet and the differences between treatments were statistically non significant (P>0.05).

Table 12: Effect of dietary incorporation of coriander seed at varying levels on digestibility of proximate constituents

Treatment	Dry matter	Organic matter	Crude protein	Crude fibre	Ether extract	NFE
T_1	65.64 ± 1.22	67.01^{a} ± 0.20	64.09^{a} ± 0.13	53.96^{a} ± 0.16	70.06^{a} ± 0.03	71.56 ± 2.00
T_2	67.15 ± 1.44	69.79^{b} ± 1.28	66.92^{b} ± 1.31	55.78^{ab} ± 1.23	71.62^{ab} ± 1.41	72.47 ± 1.29
T_3	68.49 ± 0.76	70.09^{bc} ± 1.22	67.33^{b} ± 1.03	57.97^{bc} ± 0.86	73.98^{bc} ± 0.70	73.76 ± 0.69
T_4	69.06 ± 0.46	71.77^{bc} ± 0.44	68.77^{b} ± 0.33	58.18^{bc} ± 0.57	74.30^{c} ± 0.60	74.66 ± 0.46
T_5	70.22 ± 0.64	72.70^{c} ± 0.51	69.60^{b} ± 0.50	59.58^{c} ± 0.57	75.45^{c} ± 0.49	75.54 ± 0.52
SEM	0.56	0.61	0.58	0.60	0.60	0.58
SS	NS	**	**	**	**	NS

Values in column bearing different super scripts differ significantly ** (P<0.01), NS: Non significant.

4.6.2 Effect of coriander seed on digestibility of cell wall constituents

The digestibility of cell wall constituents in quails fed diets containing coriander seed at varying levels is given in Table 13. The digestibility coefficients of NDF, ADF, hemi-cellulose and cellulose ranged from 60.63 to 64.71%, 56.53 to 61.73%, 62.36 to 66.42% and 48.42 to 53.20%, respectively. The digestibility of cell wall constituents increased significantly (P<0.01) with increased level of incorporation of coriander seed from 0 to 2.0% in the diet. However, no significant differences (P>0.05) were observed between quails fed diets containing coriander seed at 0.5 and 1.0, 0.5 and 1.5%, 0.5 and 2.0%, 1.0 and 1.5%, 1.0 and 2.0% and, 1.5 and 2.0% levels.

4.7 EFFECT OF DIETARY INCORPORATION OF CORIANDER SEED ON NUTRIENT UTILIZATION

The data pertaining to nitrogen, calcium and phosphorous utilization in quails fed diets containing coriander seed at varying levels is given in Table 14.

4.7.1 Effect of coriander seed on nitrogen utilization

The per cent nitrogen utilization in quails during the experimental period is presented in Table 14. The nitrogen utilization ranged from 64.09 to 69.60 per cent among different treatments. The per cent nitrogen utilization increased linearly

Table 13: Effect of dietary incorporation of coriander seed at varying levels on digestibility of cell wall constituents

Treatment	NDF	ADF	Hemi cellulose	Cellulose
T_1	60.63[a] ± 0.27	56.53[a] ± 0.48	62.36[a] ± 0.80	48.42[a] ± 0.50
T_2	63.14[b] ± 1.00	60.08[b] ± 1.28	65.22[b] ± 0.73	51.45[b] ± 1.20
T_3	63.92[b] ± 0.40	60.72[b] ± 0.84	65.97[b] ± 0.54	52.13[b] ± 0.52
T_4	64.26[b] ± 0.07	61.25[b] ± 0.33	66.09[b] ± 0.37	52.89[b] ± 0.38
T_5	64.71[b] ± 0.20	61.73[b] ± 0.43	66.42[b] ± 0.25	53.20[b] ± 0.05
SEM	0.43	0.57	0.45	0.52
SS	**	**	**	**

Values in column bearing different super scripts differ significantly ** (P<0.01).

with increase in the level of coriander seed from 0 to 2.0 % in the diet and the differences between treatments were statistically significant (P<0.01). However, no significant differences (P>0.05) were observed between quails fed diets containing coriander seed at 0.5 and 1.0, 0.5 and 1.5%, 0.5 and 2.0%, 1.0 and 1.5%, 1.0 and 2.0% and, 1.5 and 2.0% levels.

4.7.2 Effect of coriander seed on calcium utilization

The per cent calcium utilization in quails during the experimental period is presented in Table 14. The calcium utilization ranged from 66.44 to 70.67 per cent among different treatments. The per cent calcium utilization increased (P<0.05) with increased level of incorporation of coriander seed from 0 to 2.0% in the diet. However, no significant difference (P>0.05) was observed between quails fed diets containing coriander seed at 0 and 0.5%, 0.5 and 1.0, 0.5 and 1.5%, 0.5 and 2.0%, 1.0 and 1.5%, 1.0 and 2.0% and, 1.5 and 2.0% levels.

4.7.3 Effect of coriander seed on phosphorous utilization

The per cent phosphorous utilization in quails during the experimental period is presented in Table 14. The phosphorous utilization ranged from 43.90 to 47.00 per cent among different treatments. The per cent phosphorous utilization increased (P<0.05) with increase in the level of incorporation of coriander seed from 0 to 2.0% in the diet. However, no significant difference (P>0.05) was observed between quails fed diets containing coriander seed at 0 and 0.5%, 0 and 1.0%, 0.5 and 1.0, 0.5 and 1.5%, 0.5 and 2.0%, 1.0 and 1.5%, 1.0 and 2.0% and, 1.5 and 2.0% levels.

Table 14: Effect of dietary incorporation of coriander seed at varying levels on per cent nitrogen, calcium and phosphorous utilization

Treatment	Nitrogen	Calcium	Phosphorous
T_1	$64.09^{a} \pm 0.12$	$66.44^{a} \pm 1.32$	$43.90^{a} \pm 0.92$
T_2	$66.92^{b} \pm 1.31$	$67.83^{ab} \pm 1.22$	$44.92^{ab} \pm 0.80$
T_3	$67.33^{b} \pm 1.03$	$69.76^{b} \pm 0.65$	$45.96^{ab} \pm 0.68$
T_4	$68.77^{b} \pm 0.33$	$70.16^{b} \pm 0.38$	$46.56^{b} \pm 0.08$
T_5	$69.60^{b} \pm 0.50$	$70.67^{b} \pm 0.55$	$47.00^{b} \pm 0.33$
SEM	0.59	0.55	0.39
SS	**	*	*

Values in column bearing different superscripts differ significantly ** ($P<0.01$), *($P<0.05$).

4.8 EFFECT OF DIETARY INCORPORATION OF CORIANDER SEED ON CARCASS CHARACTERISTICS

The carcass yield (g), dressing percentage, ready to cook yield (g) and meat to bone ratio in quails fed diets containing coriander seed at varying levels are presented in Table 15. The carcass yield ranged from 106.50 to 123.17 g, ready to cook yield from 114.83 to 132.83 g and meat to bone ratio from 5.70 to 7.13 among different treatments. The carcass yield (g) ($P<0.05$), ready to cook yield (g) ($P<0.05$) and meat to bone ratio ($P<0.01$) increased with increased level of incorporation of coriander seed in the diet and the differences between treatments were statistically significant. Results indicated that the carcass yield (g), ready to cook yield (g) as well as meat to bone ratio were significantly higher in quails fed diets containing coriander seed at 2.0% level as compared to other treatments. On the other hand, the dressing per cent ranged from 60.47 to 60.98% among different treatments. The dressing per cent increased linearly with increased level of incorporation of coriander seed from 0 to 2.0% in the diet. However, the differences between treatments were not statistically significant ($P>0.05$).

The per cent weight of heart, liver, gizzard and giblet in quails fed on different diets ranged from 0.84 to 0.89, 1.68 to 1.74, 2.17 to 2.22 and 4.69 to 4.85%, respectively (Table 16). The per cent weight of heart, liver, gizzard and giblet increased linearly with increased level of incorporation of coriander seed

Table 15: Effect of dietary incorporation of coriander seed at varying levels on carcass yield, dressing per cent, ready to cook yield and meat to bone ratio

Treatment	Carcass yield (g)	Dressing (%)	Ready to cook yield (g)	Meat:Bone ratio
T_1	$106.5^{a} \pm 1.94$	60.47 ± 1.02	$114.83^{a} \pm 2.63$	$5.70^{a} \pm 0.01$
T_2	$111.17^{ab} \pm 2.67$	60.56 ± 2.16	$119.50^{ab} \pm 2.70$	$5.83^{b} \pm 0.01$
T_3	$116.00^{ab} \pm 7.76$	60.83 ± 1.77	$125.67^{ab} \pm 7.99$	$6.21^{c} \pm 0.01$
T_4	$117.17^{ab} \pm 4.48$	60.97 ± 1.32	$126.83^{ab} \pm 5.46$	$7.06^{d} \pm 0.01$
T_5	$123.17^{b} \pm 6.29$	60.98 ± 1.49	$132.83^{b} \pm 6.69$	$7.13^{e} \pm 0.03$
SEM	2.37	0.67	2.57	0.11
SS	*	NS	*	**

Values in column bearing different super scripts differ significantly ** (P<0.01), *(P<0.05)
NS: Non significant.

Table 16: Effect of dietary incorporation of coriander seed at varying levels on heart, liver, gizzard and giblet %

Treatment	**Heart (%)**	**Liver (%)**	**Gizzard (%)**	**Giblet (%)**
T_1	0.84 ± 0.12	1.68 ± 0.39	2.17 ± 0.15	4.69 ± 0.45
T_2	0.85 ± 0.13	1.69 ± 0.19	2.18 ± 0.11	4.72 ± 0.31
T_3	0.86 ± 0.12	1.71 ± 0.17	2.19 ± 0.23	4.76 ± 0.44
T_4	0.88 ± 0.12	1.73 ± 0.26	2.21 ± 0.02	4.82 ± 0.45
T_5	0.89 ± 0.09	1.74 ± 0.22	2.22 ± 0.14	4.85 ± 0.31
SEM	0.05	0.11	0.11	0.17
SS	NS	NS	NS	NS

NS: Non significant

from 0 to 2.0% in the diet, but the differences between treatments were not statistically significant (P>0.05).

4.9 EFFECT OF DIETARY INCORPORATION OF CORIANDER SEED ON COST ECONOMICS

The feed cost / kg gain in quails fed diets containing coriander seed at varying levels is presented in table 17. The feed cost / kg gain ranged from ₹ 92.60 to 99.72 among different treatments. The feed cost / kg gain decreased linearly with increased level of incorporation of coriander seed from 0.5 to 2.0% in the diet and the differences between treatments were statistically significant (P<0.05). However, no significant differences (P>0.05) were observed between quails fed diets containing coriander seed at 0 and 0.5%, 0 and 1.0%, 0 and 1.5%, 0.5 and 1.0%, 0.5 and 1.5%, 1.0 and 1.5% and, 1.5 and 2.0% levels.

Table 17: Effect of dietary incorporation of coriander seed at varying levels on feed cost per kg gain (₹)

Treatment	0-5 weeks
T_1	$98.75^{b} \pm 1.54$
T_2	$99.72^{b} \pm 2.00$
T_3	$99.09^{b} \pm 0.48$
T_4	$96.03^{ab} \pm 1.66$
T_5	$92.60^{a} \pm 0.33$
SEM	0.88
SS	*

Values in column bearing different super scripts differ significantly,*(P<0.05).

CHAPTER - V

DISCUSSION

The chemical composition of coriander seed (CS) and the effect of inclusion of coriander seed at varying levels in the diet on the growth performance, serum biochemical profile, nutrient digestibility and carcass characteristics of quails are discussed in conjunction with the available literature.

5.1 CHEMICAL COMPOSITION OF CORIANDER SEED

5.1.1 Proximate composition of coriander seed

The chemical composition of coriander seed used in the present study was 88.50, 94.51, 14.70, 9.34, 33.93, 36.54, 5.49, 0.11, 0.64 and 0.35 per cent for DM, OM, CP, EE, CF, NFE, TA, AIA, Ca and P, respectively (Table 2). The CP content (14.70%) of coriander seed observed in the present study was higher than the values reported by NIN (1989), Peter (2004), Momin *et al*. (2012) and Prerna Nath *et al*. (2015), who reported the CP content in coriander seed as 14.10, 11.00, 11.49 and 12.58%, respectively and lower than the values reported by Hosseinzadeh *et al*. (2014), who reported the CP content in coriander seed as 15.27%.

The EE content (9.34%) of coriander seed obtained in the present study corroborated with values reported earlier (Prerna Nath *et al*., 2015). However, NIN (1989), Peter (2004), Momin *et al*. (2012) and Hosseinzadeh *et al*. (2014) reported higher EE values in coriander seed as compared to EE value observed in the present study. Similarly, the crude fibre content (33.93%) of coriander seed reported in the present study corroborated with the findings of Hosseinzadeh *et al*. (2014), who reported the CF content in coriander seed as 33.64%. On the other hand, Prerna Nath *et al.* (2015) reported higher CF content while NIN (1989), Peter (2004) and Momin *et al*. (2012) reported lower CF content in coriander seed as compared to that observed in the present study.

The NFE content of coriander seed in the present study was estimated as 36.54%. In contrast, NIN (1989), Peter (2004) and Momin *et al*. (2012) reported lower NFE content while Prerna Nath *et al.* (2015) reported higher NFE content in coriander seed as compared to the present findings. In the present study, the total ash content of coriander seed was reported as 5.49%, which corroborated with the finding of Momin *et al*. (2012). On the contrary, NIN (1989) reported lower (4.4%) total ash content while Hosseinzadeh *et al*. (2014) reported higher (9.5%) total ash content in coriander seed as compared to that reported in the present study.

The calcium content (0.64 %) of coriander seed observed in the present study was comparable to the values reported earlier (NIN, 1989). On the other hand, Prerna Nath *et al*. (2015) reported higher (0.71%) calcium content in coriander seed as compared to that reported in this study. Further, the phosphorous content of coriander seed in the present study was estimated as 0.35%. The phosphorous content observed in the present study was lower than the values reported earlier (NIN, 1989; Prerna Nath *et al*., 2015).

5.1.2 Cell wall constituents of coriander seed

The NDF (39.35%) and ADF (20.55%) contents of coriander seed observed in the present study were similar to the findings of Yeldho (2010), who reported NDF and ADF content in coriander seed as 39.76 and 20.34 per cent, respectively. However, the hemi-cellulose (18.80%) content of coriander seed reported in the present study was lower than the value (19.42%) reported earlier (Yeldho, 2010).

These differences in chemical composition and cell wall constituents of coriander seed observed in the present study when compared to those values reported earlier may be attributed to variation in the strain, climatic conditions, cultivation practices, processing methods adopted etc.

5.2 INGREDIENT COMPOSITION OF QUAIL DIETS

The quail diets were formulated based on the recommendations of NRC (1994). Maize, DORB, soybean meal and fish meal were used in formulating diets, as these are the most commonly used and available ingredients in the region. The coriander seeds were ground and incorporated in powder form up to 2.0 % level after reviewing the literature. Rashid *et al*. (2014) studied the effect of inclusion of coriander seeds at 0, 0.5, 1.0 and 1.5% level in the diet of broilers and reported that broilers can be fed up to 1.5% level with better profitability and without any adverse effects. On the other hand, Guler *et al*. (2005) fed quails with diets containing coriander seeds up to 4.0% level and reported that coriander seeds can be fed up to 2.0% level in the diet of quails without any adverse effects while a negative effect was recorded at 4.0% level. Similarly, Hamodi *et al*. (2010) and Al-Jaff (2011) studied the effect of inclusion of coriander seed powder up to 3.0% level in the diet of broiler chicks and reported that better results were obtained at 2.0% level. Based on the results obtained by different workers, in the present study coriander seed was incorporated up to 2.0% in quail diets.

5.3 CHEMICAL COMPOSITION OF QUAIL DIETS

5.3.1 Proximate composition of quail diets

The chemical composition of diets formulated by incorporating coriander seed at varying levels and fed to Japanese quails in the present study was shown in Table 5. The diets were iso-nitrogenous and iso-caloric with a protein energy ratio of 1:121. Iso-nitrogenous and iso-caloric diets were formulated using maize, DORB, soybean meal, fish meal and coriander seeds as per NRC (1994) specifications. The study revealed that the proximate constituents did not follow a particular trend. However, it is observed that the DM, OM, EE, CF and NFE contents of the diets were highest in T_5 while TA content was highest in T_1 and AIA content was highest in T_2 as compared to the other diets. This might be due to adjustments made in the levels of feed ingredients to make the diets iso-nitrogenous and iso-caloric (Table 4).

5.3.2 Cell wall constituents of quail diets

The study indicated that the cell wall constituents also did not follow a particular trend (Table 6). It is observed that the ADL content was highest in T_5 and silica content was highest in T_1 while the other cell wall constituents (NDF, ADF, cellulose and hemi-cellulose) were highest in T_3 as compared to the other diets. This might be due to adjustments made in the levels of feed ingredients to make the diets iso-nitrogenous and iso-caloric (Table 4).

5.4 EFFECT OF DIETARY INCLUSION OF CORIANDER SEED ON GROWTH PERFORMANCE OF JAPANESE QUAILS

5.4.1 Effect of coriander seed on body weight gain

During the experimental period, the body weight gain was significantly higher ($P<0.01$) in quails fed diets containing 1.0, 1.5 and 2.0% coriander seed as compared to those fed diets containing 0% (control diet) and 0.5% coriander seed (Table 7). However, no significant difference ($P>0.05$) was observed between quails fed diets containing coriander seed at 0 and 0.5% levels. Similar results were shown by Guler *et al*. (2005), who stated that coriander seed supplementation at a level of 2% improved body weight gain in Japanese quails. The increased body weight gains observed in quails upon feeding coriander seed in the diet might be attributed to antioxidant properties of coriander seeds which act as natural growth promoter (Rashid *et al*., 2014) or due to enhanced liver function (Hernandez *et al*., 2004) or due to appetizing and stimulatory effects in digestion process (Cabuk *et al*., 2003).

Similarly, increased body weight gains upon feeding diets containing coriander seed were reported by Hamodi *et al*. (2010), Saeid and Al-Nasry (2010), Al-Jaff (2011), Al-Mashhadani *et al*.(2011), Jang (2011), Farag (2013), Abou-Elkhair *et al*. (2014), Hosseinzadeh *et al*. (2014), Ramadan *et al.* (2014) and Saleh *et al*. (2014) in broiler chicken and Kumari *et al*. (2014) in Vanaraja chicken. However, Naeemasa *et al*. (2015) reported no effect (P>0.05) on live body weight in broilers fed coriander powder in the diet.

5.4.2 Effect of coriander seed on feed intake

During the experimental period (0-5 weeks), feed intake ranged from 581.16 to 609.10 g among different treatments (Table 7). The feed intake increased linearly from T_1 to T_5 with increased level of inclusion of coriander seed in the diet and the differences between the treatments were significant (P<0.01). The feed intake (g) during the experimental period increased significantly (P<0.01) in quails fed diets containing 1.0, 1.5 and 2.0% coriander seed as compared to those fed diets containing coriander seed at 0 (control diet) and 0.5% levels (Table 7). These results are in line with the findings of Guler *et* *al.* (2005), who reported significant increase (P<0.05) in feed intake with inclusion of coriander seed at 1.0, 1.5, 2.0 and 4.0% levels in the diet of Japanese quails as compared to other levels of inclusion (0 and 0.5%), where 0.5% coriander group did not differ (P>0.05) from that of control (0%). The improvement in the feed intake observed with the addition of coriander seed could be attributed to the presence of essential oils and their main component, linalool, in coriander seeds. It has been reported that linalool has an appetizing effect in diets and stimulates the digestive process in animals (Cabuk *et al*., 2003). Positive effects of essential oils on feed intake have also been reported previously (Williams and Losa, 2001).

Similarly, increased feed intake upon feeding diets containing coriander seed were also reported by Esteghamat (2014) in Japanese quails and, Hamodi *et al*. (2010), Al-Mashhadani *et al*. (2011), Jang (2011), Farag (2013), Abadi and Andi (2014), Ramadan *et al*. (2014), and Naeemasa *et al* (2015) in broiler chicken. On the other hand, no effect (P>0.05) of feeding coriander seeds in the diet on feed intake was reported by Abou-Elkhair *et al*. (2014), Rashid *et al*. (2014) and Saleh *et al*. (2014) in broiler chicken. In contrast, Kumari *et al*. (2014) reported significantly (P<0.05) lower feed intake in Vanaraja chicken fed basal ration mixed with 2.5% coriander seed meal as compared to the control diet.

5.4.3 Effect of coriander seed on feed conversion ratio

Inclusion of coriander seed at varying levels from 0 to 2.0% in the diet of quails had significant effect (P<0.01) on feed conversion ratio. The study indicated that the feed intake / kg gain was lower (P<0.01) in quails fed diets containing coriander seed at 2.0% level as compared to the other treatments (Table 7). In line with the findings of the present study, Guler *et al*. (2005) reported significantly lower (P<0.05) feed intake / kg gain in Japanese quails upon feeding 2.0% coriander seed in the diet. The improved feed utilization upon feeding coriander seed as observed in the present study could be attributed to the stimulating effect of the essential oils on the digestive process.

In agreement with these results, Hernandez *et al*. (2004) reported that the supplementation of essential oils improved apparent whole tract and ileal digestibility of nutrients in broilers. Further, the positive effect of dietary coriander seed on body weight gain and feed conversion ratio could be related to the increased efficiency of feed utilization. Similarly, improved FCR upon feeding diets containing coriander seed were also reported by earlier (Hamodi *et al*., 2010; Saeid and Al-Nasry, 2010; Al-Jaff, 2011; Al-Mashhadani *et al*., 2011; Al-Tememy *et al*., 2011; Jang, 2011; Farag, 2013; Abadi and Andi, 2014; Abou-Elkhair *et al*., 2014; Saleh *et al*., 2014 and Naeemasa *et al*., 2015) in broiler chicken. On the other hand, some researchers reported that feeding coriander seed in the diet had no effect (P>0.05) on FCR (Hosseinzadeh *et al*., 2014; Ramadan *et al*., 2014; Rashid *et al*., 2014) in broiler chicken.

5.5 EFFECT OF DIETARY INCORPORATION OF CORIANDER SEED ON SERUM BIOCHEMICAL PROFILE OF JAPANESE QUAILS

5.5.1 Effect of coriander seed on serum total protein

The serum total protein content (g/dl) increased significantly (P<0.01) with increased level of coriander seed in the diet of quails (Table 8). These results corroborated with the findings of Al-Jaff (2011), who reported significantly (p<0.05) higher serum total protein upon feeding 2.0% coriander seed in broiler diet under high ambient temperature. Similarly, increased serum total protein concentration upon feeding diets containing coriander seed were also reported by Saeid and Al-Nasry (2010), Farag (2013) and Abou-Elkhair *et al*. (2014) in broiler chicken.

5.5.2 Effect of coriander seed on serum albumin

The present study indicated a significant increase (P<0.01) in serum albumin content (g/dl) with increased level of incorporation of coriander seed from 0 to 2.0% in the diet of quails (Table 8). Corroborating the results of the present study, Al-Jaff (2011) reported significantly (P<0.05) higher serum albumin content in broilers fed coriander seed at 2.0% level in the diet under high ambient temperature. Similarly, Saleh *et al*. (2014) reported increased plasma albumin levels in broiler chicken upon feeding basal diet with 0.1 and 0.2% levels of summer shield supplementation, which contained 10% coriander extract along with other herbs. On other hand, Farag (2013) reported that feeding diets containing different levels of coriander seeds (0.2, 0.4 and 0.6% levels) had no effect (P>0.05) on serum albumin content in broiler chicken as compared to the control.

5.5.3 Effect of coriander seed on serum globulin

The serum globulin content (g/dl) increased significantly (P<0.01) with increased level of incorporation of coriander seed in the diet of quails (Table 8). The increased serum globulin content observed in quails upon feeding coriander seed in the diet might be attributed to enhancement of immune system. The results of the present study are in agreement with those of Saleh *et al*. (2014), who reported increased plasma globulin levels in broiler chicken upon feeding basal diet with 0.1 and 0.2% levels of summer shield supplementation, which contained 10% coriander extract along with other herbs. On other hand, no effect (P>0.05) of feeding coriander seed in the diet on serum globulin content were reported earlier (Farag, 2013) in broiler chicken. In contradiction to the results observed in the present study, Al-Jaff (2011) reported lower (P<0.05) serum globulin levels in broiler chicken fed 2.0% coriander seed in the diet as compared to the control .

It is reported that coriander has anti-microbial effects (Cabuk *et al*., 2003), anti-fungal effects (Soliman and Badea, 2002) and contain anti-oxidants that decrease lipid oxidation (Al-Mamary, 2002) which might have enhanced the immune system resulting in increased concentration of serum parameters related to immunity *viz.*, total protein, albumin and globulin levels.

5.5.4 Effect of coriander seed on serum glucose

The serum glucose content (mg/dl) decreased significantly (P<0.05) with increased level of coriander seed from 0 to 2.0% in the diet of quails (Table 9). However, incorporation of coriander seed at 0.5 and 1.0% in the diet had no effect (P>0.05) on serum glucose content in quails as compared to the control. These results are in agreement with the findings of Al-Jaff (2011) in broiler chicks under high ambient temperature, who reported a significant decrease (P<0.05) in glucose content when fed 2.0% coriander seed in the diet as compared to the control. The reduction in serum glucose content observed upon coriander seed inclusion in the diet may be attributed to the insulin-releasing and insulin-like activity of coriander seed (Deepa and Anuradha, 2011).

In line with the findings of the present study, Saeid and Al-Nasry (2010), Al-Mashhadani *et al*. (2011), Abou-Elkhair *et al*. (2014) and Saleh *et al*. (2014) reported decreased serum glucose content in broiler chicken. On the other hand, no effect (P>0.05) of feeding coriander seed in the diet on serum glucose concentration was reported by Hosseinzadeh *et al*. (2014) in broiler chicken.

5.5.5 Effect of coriander seed on serum triglycerides

The serum triglyceride content (mg/dl) decreased significantly ($P<0.01$) with increased level of coriander seed from 0 to 2.0% in the diet of quails (Table 9). The results of the present study are in agreement with the findings of Jang (2011), who reported that supplementation of coriander oil at 2.0 % in the diet had resulted in significant decrease ($P<0.05$) in serum triglyceride content of broilers. The decreased serum triglyceride content observed in quails upon feeding coriander seed in the diet might be attributed to its hypo-lipidaemic effect (Chithra and Leelamma, 1999).

Similarly, Saeid and Al-Nasry (2010), Farag (2013), Abadi and Andi (2014), Abou-Elkhair *et al*. (2014) and Saleh *et al*. (2014) reported decreased serum triglyceride content in broiler chicken upon feeding coriander seed in the diet. In contradiction to the findings of the present study, Al-Jaff (2011) reported higher ($P<0.05$) serum triglyceride content in broilers fed coriander seed at 2.0 and 3.0% in the diet under high ambient temperature compared to control and 1.0% groups. However, Hosseinzadeh *et al*. (2014) reported that feeding coriander seed in the diet had no effect ($P>0.05$) on serum triglyceride content in broiler chicken.

5.5.6 Effect of coriander seed on serum total cholesterol

The serum total cholesterol content (mg/dl) decreased significantly ($P<0.01$) with increased level of incorporation of coriander seed from 0 to 2.0%

in the diet of quails (Table 9). These results are very much in line with the findings of Al-Jaff (2011), who reported lower (P<0.05) serum cholesterol in broilers fed coriander seed at 2.0 and 3.0% level under high ambient temperature. The decrease in the serum cholesterol levels observed in the present study could be attributed to the incorporation of coriander seed in the diet which might reduce the activity of 3- enzyme-3-methylglutaryl CoA (HMG-CoA) in the liver which is the key regulatory enzyme in cholesterol synthesis (Dhanapakiam *et al*., 2008). It is reported that a 5% inhibition of HMG-CoA reductase will cause lowering of serum cholesterol by 2% in poultry (Case *et al*., 1995). Further, coriander seeds increase the concentration of hepatic and fecal bile acids and neutral sterols, which resulted in increasing hepatic degradation of cholesterol (Dhanapakiam *et al*., 2008).

Corroborating the reseults of the present study, several researchers reported that inclusion of coriander seed resulted in decreased serum total cholesterol content (Saeid and Al-Nasry, 2010; Al-Mashhadani *et al*., 2011; Jang, 2011; Farag, 2013; Abadi and Andi, 2014; Hosseinzadeh *et al*., 2014; Saleh *et al*., 2014;) in broiler chicken.

5.5.7 Effect of coriander seed on HDL cholesterol

The serum HDL cholesterol content (mg/dl) increased significantly (P<0.01) with increased level of coriander seed from 0 to 2.0% in the diet of quails (Table 10). Al-Jaff (2011) also reported that feeding coriander seed in the diet resulted in increased ($P<0.05$) serum HDL cholesterol concentration in broiler chicks reared under high ambient temperature. The increased serum HDL content observed in quails upon feeding coriander seed in the diet might be attributed to the significant hypo-lipidaemic effect resulting in lowering the total cholesterol levels and triglycerides and thus increasing the levels of high density lipoprotein (Chithra and Leelamma, 1997).

Similarly, Saleh *et al*. (2014) observed increased serum HDL cholesterol levels in broilers fed diets supplemented with summer shield at 0.1 and 0.2% level, which contained 10% coriander extract along with other herbs. However, Jang (2011) and Hosseinzadeh *et al*. (2014) reported that feeding of coriander seed in the diet had no effect ($P>0.05$) on serum HDL cholesterol content in broiler chicken.

5.5.8 Effect of coriander seed on LDL cholesterol

The serum LDL cholesterol content (mg/dl) decreased significantly ($P<0.01$) with increased level of coriander seed from 0 to 2.0% in the diet of quails (Table 10). These results are in agreement with the findings of Al-Jaff (2011), who reported significantly ($P<0.05$) lower serum LDL cholesterol in broiler chickens fed coriander seed at 2.0% level in the diet under high ambient temperature. The decreased serum LDL content observed in quails upon feeding coriander seed in the diet might be attributed to increasing synthesis of bile by the liver and increasing the breakdown of cholesterol in to other compounds.

Enhanced hepatic bile acid synthesis and the increased degradation of cholesterol to faecal bile acids and neutral sterols appeared to account for hypo-lipidaemic effects of coriander seeds (Dhanapakiam *et al*., 2008).

Similarly, Jang (2011) and Saleh *et al*. (2014) reported significantly (P<0.05) reduced serum LDL cholesterol in broiler chicken upon feeding coriander in the diet. On the other hand, Hosseinzadeh *et al*. (2014) observed that feeding coriander seed in the diet had no effect (P>0.05) on serum LDL cholesterol content in broilers.

5.5.9 Effect of coriander seed on VLDL cholesterol

The serum VLDL cholesterol content (mg/dl) decreased significantly (P<0.01) with increased level of coriander seed from 0 to 2.0% in the diet of quails (Table 10). This may be attributed to the hypo-lipidaemic effects of coriander seeds that enhanced hepatic bile acid synthesis and increased the degradation of cholesterol to faecal bile acids and neutral sterols (Dhanapakiam *et al*., 2008). This might have resulted in significant decrease (P<0.01) in VLDL cholesterol concentration in quails.

5.5.10 Effect of coriander seed on serum creatinine

The study indicated that serum creatinine content decreased significantly (P<0.01) with increased level of coriander seed from 0 to 2.0% in the diet of quails (Table 11). These results are in line with the findings of Farag (2013), who reported that creatinine levels showed a significant (P<0.01) decrease in broilers receiving 0.2, 0.4 and 0.6% coriander seed in the diet as compared to the control. Significant increase in serum creatinine levels is indicative of nephrotoxicity in broiler chicken (Huff *et al*., 1988). Thus, the decreased (P<0.01) serum creatinine content observed in the present study indicate the improved kidney health in terms of filtration rate, which may be attributed to the incorporation of coriander seed in the diet.

5.5.11 Effect of coriander seed on serum calcium

The serum calcium content increased significantly (P<0.01) with increased level of coriander seed from 0 to 2.0% in the diet of quails (Table 11). Similarly, Vamsidhar (2015) fed quails with diets containing fenugreek seed as growth promoter at varying levels and reported that increased level of inclusion of fenugreek seed from 0 to 2.0% in the diet resulted in increased (P<0.01) serum calcium content in quails.

5.5.12 Effect of coriander seed on serum phosphorous

The serum phosphorous content (mg/dl) increased significantly (P<0.01) with increased level of coriander seed from 0 to 2.0% in the diet of quails (Table 11). Similar to these findings, Vamsidhar (2015) reported that increased level of inclusion of fenugreek seed from 0 to 2.0% in the diet resulted in increased (P<0.01) serum phosphorous content in quails.

5.6 EFFECT OF DIETARY INCORPORATION OF CORIANDER SEED ON DIGESTIBILITY OF NUTRIENTS

5.6.1 Effect of coriander seed on digestibility of proximate constituents

The digestibility of OM, CP, CF and EE increased significantly (P<0.01) with increased level of coriander seed from 0 to 2.0 % in the diet (Table 12). However, the digestibility of DM and NFE increased with increased level of coriander seed from 0 to 2.0 % in the diet but the differences were not significant (P>0.05) (Table 12). In line with the findings of the present study, Guler *et al*. (2006) reported that retention of nutrients were significantly (P<0.05) higher in laying Japanese quails fed coriander seed in the diet as compared to control.

The increase in the digestibility of gross nutrients observed in the present study may be attributed to the presence of coriander seed in the diet. Essential oils derived from coriander seeds were reported to negatively affect both gram-positive and gram-negative bacteria (Delaquis *et al*., 2002). Similarly, Cabuk *et al*. (2003) reported that linalool, one of the essential oils from coriander seeds, inhibited the growth of *Escherichia coli, Pseudomonas aeruginosa, Salmonella typhimurium, Staphylococcus aureus, Clostridium botulinum and Clostridium perfringens.* These results suggest that anti-microbial components of coriander may modulate the microflora in the gastrointestinal tract. Consequently, this might led to the increased digestibility of feed in quails.

Similarly, Saleh *et al.* (2014) reported significantly ($P<0.05$) increased crude protein and crude fat utilization by feeding the 0.2% summer shield supplemented diet, which contained 10% coriander extract along with other herbs compared to control diet in broiler chicken, but dry matter utilization was not affected.

5.6.2 Effect of coriander seed on digestibility of cell wall constituents

The digestibility of NDF, ADF, hemi-cellulose and cellulose increased significantly ($P<0.01$) with increased level of coriander seed from 0 to 2.0 % in the diet (Table 13). The increased digestibility of cell wall constituents observed in the present study may be attributed to the potential beneficial effect of coriander seed on gastrointestinal tract micro-organisms and metabolites which reflected in improved digestibility. Further, it is reported that coriander seed has antibacterial activity due to the presence of linalool, one of the essential oils, which helps to improve the balance of intestinal flora (Cabuk *et al*., 2003).

5.7 EFFECT OF DIETARY INCORPORATION OF CORIANDER SEED ON NUTRIENT UTILIZATION

5.7.1 Effect of coriander seed on nitrogen utilization

The per cent nitrogen utilization increased significantly ($P<0.01$) in quails with increasing level of coriander seed from 0 to 2.0% in the diet (Table

14). Similarly, Vamsidhar (2015) reported that increased level of inclusion of fenugreek seed from 0 to 2.0% in the diet resulted in increased ($P<0.01$) nitrogen utilization in quails. The increased nitrogen utilization observed in the present study upon feeding quails with diets containing coriander seed may be attributed to the essential oils, which not only act as antibacterial and antioxidant, but also as stimulant of digestive enzymes in the intestinal mucosa, which might have improved the utilization of nitrogen. However, increasing the level of coriander seed from 0.5 to 2.0% in the diet had no significant effect ($P>0.05$) on per cent nitrogen utilization in quails.

5.7.2 Effect of coriander seed on calcium utilization

The per cent calcium utilization increased significantly ($P<0.05$) in quails fed diets containing coriander seed at 1.0 to 2.0% level as compared to the control and 0.5% level (Table 14). Similar findings were reported by Vamsidhar (2015) in Japanese quails fed fenugreek supplemented diets. This increase in per cent calcium utilization observed in the present study may be attributed to the increased digestibility of nutrients due to incorporation of coriander seed in the diet.

5.7.3 Effect of coriander seed on phosphorous utilization

The per cent phosphorous utilization was highest ($P<0.05$) in quails fed diets containing 2.0% coriander seed as compared to other levels of inclusion and to the control (Table 14). Similarly, Vamsidhar (2015) reported that inclusion of fenugreek seed in the diet resulted in increased (P<0.01) phosphorous utilization in quails as compared to the control. This increase in per cent phosphorous utilization may be attributed to the increased digestibility of nutrients due to incorporation of coriander seed in the diet.

5.8 EFFECT OF DIETARY INCORPORATION OF CORIANDER SEED ON CARCASS CHARACTERISTICS

The carcass yield increased linearly from T_1 to T_5 with increased level of inclusion of coriander seed from 0 to 2.0% in the diet (Table 15). The carcass yield (g) was significantly higher (P<0.05) in quails fed diets containing 2.0% coriander seed in the diet as compared to those fed control diet. These results corroborated with the findings of Guler *et al*. (2005), who reported that carcass yield (%) was significantly higher in quails fed 2.0% coriander seed in the diet as compared to the control. The increase in the carcass yield in quails observed in the present study may be attributed to the presence of essential oils in coriander seed (Williams and Losa, 2001). Similar to the present findings, Saeid and Al-Nasry (2010) reported that incorporation of coriander seed at 0.3% in the diet resulted in increased (P<0.05) carcass yield (g) in broiler chicken while Farag (2013) reported that incorporation of coriander seed at 0.6% in the diet resulted in increased (P<0.01) carcass yield (g) in broiler chicken as compared to the control diets. On the other hand, Abou-Elkhair *et al*. (2014) and Ramadan *et al*. (2014) reported that feeding of coriander seed at 2.0% level in the diet of broilers had no effect (P>0.05) on carcass weight as compared to control.

The dressing per cent increased linearly from T_1 to T_5 with increased level of inclusion of coriander seed from 0 to 2.0% in the diet and the differences between treatments were not statistically significant (P>0.05) (Table 15). In line with the present findings, Rashid *et al.* (2014) fed broilers with diets containing coriander seed meal at 0.5, 1.0 and 1.5% levels and reported that feeding coriander seed meal had no effect (P>0.05) on dressing yield as compared to the control. Similarly, Kumari *et al*. (2014) reported that feeding of coriander seed in the diet had no effect (P>0.05) on dressing percentage in Vanaraja chicken. In contradiction, Ramadan *et al* (2014), reported that the dressing percentage increased significantly (P<0.05) in broilers fed 2% coriander seed in the diet as compared to control.

The ready to cook yield increased linearly from T_1 to T_5 with increased level of inclusion of coriander seed from 0 to 2.0% in the diet (Table 15). The ready to cook yield (g) was significantly higher (P<0.05) in quails fed diets containing 2.0% coriander seed in the diet as compared to those fed control diet. These results are in agreement with the findings of Vamsidhar (2015), who reported that incorporation of fenugreek seed at 2.0% level in the diet of quails resulted in increased (P<0.01) ready to cook yield as compared to those fed control diets.

The meat to bone ratio increased linearly from T_1 to T_5 with increased level of inclusion of coriander seed from 0 to 2.0% in the diet and the differences between treatments were statistically significant ($P<0.01$). Similar findings were reported by Vamsidhar (2015), while feeding fenugreek seed up to 2.0% level in the diet of quails. The increased meat to bone ratio in quails observed in the present study may be attributed to the positive effects of coriander seed in the diet.

The per cent weight of heart increased linearly from T_1 to T_5 with increased level of inclusion of coriander seed from 0 to 2.0% in the diet and the differences between treatments were not statistically significant ($P>0.05$) (Table 16). These results corroborated with those of Guler *et al*. (2005), who reported that incorporation of coriander seed up to 4% in the diet had no effect ($P>0.05$) on heart weight (%) in quails. Similarly, no effect ($P>0.05$) on heart weight (%) upon feeding coriander seed in the diet were also reported earlier (Farag, 2013; Abou-Elkhair *et al*., 2014; Naeemasa *et al*., 2015).

The per cent weight of liver increased with increased level of inclusion of coriander seed from 0 to 2.0% in the diet (Table 16). However, the differences between treatments were not statistically significant ($P>0.05$). Similar to the present findings, some researchers reported that incorporation of coriander seed in the diet had no effect ($P>0.05$) on per cent weight of liver (Saleh *et al*., 2014; Naeemasa *et al*., 2015). In contradiction to the present findings, Guler *et al*. (2005) in quails and, Saeid and Al-Nasry (2010), Jang

(2011) and Farag (2013) in broilers reported that incorporation of coriander seed in the diet resulted in significant increase in heart weight (%).

The per cent weight of gizzard increased linearly with increased level of inclusion of coriander seed from 0 to 2.0% in the diet, but the differences between treatments were not statistically significant (P>0.05) (Table 16). These results are very much in line with the findings of Abou-Elkhair *et al*. (2014), who reported that incorporation of coriander seed at 2% in the diet had no effect (P>0.05) on per cent weight of gizzard in broilers. Similar findings were also reported by Saeid and Al-Nasry (2010) in broilers and Naeemasa *et al*. (2015) in Ross 308 broilers. However, in contrast to the present findings, Farag (2013) reported that incorporation of coriander seed at 0.2, 0.4 and 0.6% in the diet resulted in increased (P<0.01) gizzard weight (%) in broilers. Similarly, Jang (2011) reported increased (P<0.05) gizzard weight (%) upon feeding coriander oil in the diet of broilers.

The per cent weight of giblets increased linearly from T_1 to T_5 with increased level of inclusion of coriander seed from 0 to 2.0% in the diet (Table 16). However, the differences between treatments were not statistically significant (P>0.05). Similarly, Abou-Elkhair *et al*. (2014) reported that incorporation of coriander seed in the diet had no effect (P>0.05) on giblet weight (%) in broilers. In contradiction to the present findings, Kumari *et al*. (2014) reported that incorporation of coriander seed at 2.5% in the diet resulted in significant increase ($P<0.05$) in per cent weight of giblets in Vanaraja Chicken.

Though non-significant ($P>0.05$), the numerical increase in the per cent weight of heart, liver, gizzard and giblets in quails observed upon feeding coriander seed in the diet might be attributed to the fact that aromatic plants in poultry have stimulatory effects on the digestive system by increasing the production of digestive enzymes and improving utilization of digestive products via enhanced liver function (Hernandez *et al*., 2004).

5.9 EFFECT OF DIETARY INCORPORATION OF CORIANDER SEED ON COST ECONOMICS

The feed cost / kg gain in quails decreased with increased level of inclusion of coriander seed from 0 to 2.0% in the diet and the differences between treatments were significant ($P<0.05$) (Table 17). The feed cost / kg gain was significantly ($P<0.05$) lower in quails fed diets containing 2.0% coriander seed as compared to those fed diets containing 0, 0.5 and 1.0% coriander seed. The study indicated that the feed cost / kg gain decreased by ₹ 6.15 in T_5 and 2.72 in T_4 while it is increased by 0.34 in T_3 and 0.97 in T_2 groups of quails fed diets containing coriander seed at varying levels as compared to the control. The decreased feed cost / kg gain observed in the present study might be attributed to the better efficiency of feed utilization and increased weight gains of quails obtained due to incorporation of coriander seed in the diet. In corroboration with the findings of the present study, Rashid *et al*. (2014) revealed that feed cost in different dietary coriander seed meal (CSM) groups were more or less similar, whereas total production cost per kg broiler was lower ($P<0.05$) in 1.5 % CSM compared to control (0%) group. Similarly, Farag (2013) estimated economic efficiency of broilers, was assuming that the other costs were constant and reported that the economic efficiency of broilers fed 0.6% coriander seeds was the best (27.46%), followed by broilers fed 0.4% (14.42%) and 0.2 % (13.71%) coriander seed in the diet as compared to the control.

5.10 CONCLUSION

The present study indicated that incorporation coriander seed up to 2.0% level in the diet of quails had not affected the palatability of the diet as evidence from increased feed intakes. Further, it is observed that incorporation of coriander seed up to 2.0% in the diet had improved the performance of quails as evidenced from increased body weight gains, improved FCR and increased digestibility of nutrients. Furthermore, the serum total cholesterol content decreased, while the meat to bone ratio increased upon feeding coriander seed in the diet. Thus, it is concluded that coriander seed can be incorporated up to 2.0% level in the diet of quails without any adverse effect.

CHAPTER – VI

SUMMARY

Coriander (*Coriandrum sativum L*), a well-known aromatic medicinal plant grows in nature and is cultivated in India. Coriander seed is used primarily as a flavouring agent in the food industry or as a spice in bread, cheese, curry, fish, meat and confections. Coriander seed has got health supporting reputation. Coriander Seeds contain zero percent cholesterol. It contains essential oils, which are considered as appetizer and helps in improved digestion. On the other hand, antibiotics as growth promoters in poultry feed are posing serious health threats in humans, because of their residual effect in poultry meat and eggs. A range of organic feed additives of microbial or plant origin have been tested as growth promoters for their effect on the performance of broilers. Hence, the present investigation was carried out to study the effect of inclusion of coriander seed at varying levels in the diet on growth performance, carcass characteristics, serum biochemical profile and nutrient utilization of Japanese quails.

The results of the present study indicated that the per cent DM, OM, CP, EE, CF, NFE, TA and AIA of coriander seed were 88.50, 94.51, 14.7, 9.34, 33.93, 36.54, 5.49 and 0.11, respectively. The per cent NDF, ADF, hemi-cellulose, cellulose, ADL and silica content of coriander seed were 39.35, 20.55, 18.80, 6.30, 14.20 and 0.10, respectively. The per cent calcium and phosphorous content of coriander seed were 0.64 and 0.35, respectively. Five diets were formulated (Table 4) incorporating coriander seed at 0.0% (T_1), 0.5% (T_2), 1.0% (T_3), 1.5% (T_4) and 2.0% (T_5) by marginal adjustment of other ingredients. The feed cost (₹) per kg of diet was 26.69 (T_1), 27.01 (T_2), 27.34 (T_3), 27.67 (T_4) and 28.0 (T_5), respectively.

The body weight gain increased linearly from T_1 to T_5 with increased level of inclusion of coriander seed from 0 to 2.0% in the diet and the differences between the treatments were significant (P<0.01). However, no significant difference (P>0.05) was observed between quails fed diets containing coriander seed at 0.5% level as compared to the control. The feed intake was significantly higher (P<0.01) in quails fed diets containing coriander seed at 1.0, 1.5 and 2.0% level as compared to those fed control diet. Similarly, feed consumed / kg gain decreased linearly from T_1 to T_5 with increased level of inclusion of coriander seed from 0 to 2.0% in the diet and the differences between the treatments were significant (P<0.01).

The serum biochemical profile of quails revealed that the serum total protein, albumin, globulin, calcium and phosphorous contents increased significantly (P<0.01), while serum triglycerides, total cholesterol and creatinine levels decreased (P<0.01) with increase in the level of inclusion of coriander seed from 0 to 2.0% in the diet. Further, the study indicated that the HDL cholesterol level increased (P<0.01), while LDL and VLDL cholesterol levels decreased (P<0.01) in serum with increased level of inclusion of coriander seed from 0 to 2.0% in the diet. Furthermore, serum glucose level decreased ($P<0.05$) with increase in the level of inclusion of coriander seed from 0 to 2.0% in the diet.

The digestibility of OM, CP, EE, CF, NDF, ADF, cellulose and hemi-cellulose increased ($P<0.01$) with increased level of inclusion of coriander seed from 0 to 2.0% level in the diet. However, incorporation of coriander seed in the diet had no effect ($P>0.05$) on DM and NFE digestibility. Further, it is observed that the per cent nitrogen ($P<0.01$), calcium ($P<0.05$) and phosphorous ($P<0.05$) utilization increased with increase in the level of inclusion of coriander seed from 0 to 2.0% level in the diet

The carcass yield ($P<0.05$), ready to cook yield ($P<0.05$) and meat to bone ratio ($P<0.01$) increased significantly in quails fed diets containing coriander seed at varying levels as compared to the control. However, inclusion of coriander seed at graded levels in the diet of quails had no effect ($P>0.05$) on dressing percentage. On the other hand, it is observed that the per cent weight of heart, liver, gizzard and giblet increased with increase in the level of inclusion of coriander seed from 0 to 2.0 % in the diet but the differences between treatments were not significant ($P>0.05$).

The feed cost / kg gain increased ($P>0.05$) with increased level of inclusion of coriander seed from 0 to 1.0% in the diet. However, incorporation of coriander seed at 1.5 and 2.0% in the diet decreased ($P<0.01$) the feed cost / kg gain as compared to the control. Further, the feed cost / kg gain decreased by ₹ 6.15 (T_5) and 2.72 (T_4) and, increased by 0.97 (T_2) and 0.34 (T_3) in quails fed diets containing coriander seed at varying levels as compared to the control.

Based on the results obtained from the present study the following conclusions are drawn:

1. The chemical composition indicated that coriander seed is a good source of protein, ether extract and minerals for inclusion in quail diets.
2. Inclusion of coriander seed up to 2.0 % in the diet has improved the body weight gain, feed intake and feed conversion ratio in quails.
3. Inclusion of coriander seed up to 2.0 % in diet resulted in decreased serum glucose and total cholesterol content and improved the overall serum biochemical profile in quails.
4. Inclusion of coriander seed up to 2.0 % in the diet has increased the digestibility of gross nutrients and fibre fractions in quails.
5. Inclusion of coriander seed up to 2.0 % in diet has improved the carcass characters in quails.
6. Inclusion of coriander seed at 1.5 and 2.0 % in diet has decreased the feed cost per kg gain in quails.

Thus, the present study indicated that coriander seed can be incorporated up to 2.0% level as a natural feed additive in the diet of quails without any adverse effect on production performance of quails.

LITERATURE CITED

Abadi KMA, Andi MA. 2014. Effect of using coriander (*Coriandrum sativum L.*), savory (*Satureja hortensis L.*) and dill (*Anethum graveolens L.*) herb powder in diet on performance and some blood parameters of broilers. International Journal of Biosciences 5(6):95-103.

Abou-Elkhair R, Ahmed HA, Selim S. 2014. Effects of Black Pepper (*Piper Nigrum*), Turmeric Powder (*Curcuma Longa*) and Coriander Seeds (*Coriandrum Sativum*) and Their Combinations as Feed Additives on Growth Performance, Carcass Traits, Some Blood Parameters and Humoral Immune Response of Broiler Chickens. Asian Australasian Journal of Animal Sciences 27 (6): 847-854.

Al-Jaff FK. 2011. Effect of Coriander Seeds as Diet Ingredient on Blood Parameters of Broiler chicks Raised under High Ambient Temperature. International Journal of Poultry Science 10 (2):82-86.

Allain CC, Poon LS, Chan CSG, Richmond W, Paul CF. 1974. Enzymatic determination of total serum cholesterol. Clinical Chemistry 20 (4): 470 - 475.

Al-Mamary MA. 2002. Antioxidant activity of commonly consumed vegetables in Yemen. Malaysian Journal of Nutrition 2, 179–189.

Al-Mashhadani EH, Al-Jaff FK, Hamodi SJ, Al-Mashhadani HE. 2011. Effect of different levels of coriander oil on broiler performance and some physiological traits under summer condition. Pakistan Journal of Nutrition 1:10-14.

Al-Tememy HSA, Al-Jaff FK, Al-Mashhadani EH, Hamodi SJ. 2011. Histological effect of inclusion different levels of coriander oil in broiler diet on small intestine. Diyala Agricultural Sciences Journal 3(2) 1 – 11.

[AOAC] Association of Official Analytical Chemists, Official methods of Analysis 2007 (18^{th} Ed). Washington DC.

Barros L, Duenas M, Dias MI, Sousa MJ, Santos-Buelga C. 2012. Phenolic profile of in vivo and in vitro grown coriander sativum L. Food Chemistry 132(2):841-848.

Cabuk M, Alcicek A, Bozkurt M, Imer N. 2003. Antimicrobial properties of the essential oils isolated from aromatic plants and using possibility as alternative feed additives. II National Animal Nutrition Congress, 18-20 September, Konya, Turkey. 184-187 p.

Case GL, He HMO, Elson CE. 1995. Induction of geran pyrophosphate pyroph-osphatase activity by cholesterol suppressive isoprenoids. Lipids 30:357-359.

Chithra V, Leelamma S. 1997. Hypolipidemic effect of coriander seeds (*Coriandrum sativum*). Antioxidant enzyme in experimental animals. Indian Journal of Biochemistry and Biophysics 36: 59-61.

Chithra V, Leelamma S. 1999. Coriandrum Sativum Changes the levels of lipid peroxides and activity of antioxidant enzymes in experimental animals. Indian Journal of Biochemistry and Biophysics 13: 65-67.

Collington GK, Park DS, Armstrong DG. 1990. Anti- oxidant properties of coriander seed in poultry. Brazilian Journal of Nutrition 64: 59–70.

Darughe F, Barzegar M, Sahari MA. 2012. Antioxidant and antifungal activity of Coriander (*Coriandrum sativum L.*) essential oil in cake. International Food Research Journal 19(3):1253-1260.

Deepa B, Anuradha CV. 2011. Antioxidant potential of Coriander sativum L. Indian Journal of Experimental Biology 49: 30-38.

Delaquis PJ, Stanich K, Girard B, Mazza G. 2002. Antimicrobial activity of individual and mixed fractions of dill, cilantro, coriander and eucalyptus essential oil. International Journal of Food Microbiology 74(1-2):101-109.

Dhanapakiam P, Mini Joseph J, Ramaswamy UK, Moorthy M, Senthilkumar A. 2008. The cholesterol lowering property of coriander seeds (Coriandrum sativum): Mechanism of action. Journal of Environmental Biology 29:53-56.

Diederichsen A. 1996. "Coriander", Promoting the Conservation and Use of Underutilized and Neglected Crops 3. International Plant Genetic Resources Institute (IPGRI), Rome.

Esteghamat O. 2014. An Investigation on Dietary Supplementation of Coriander (*Coriandrum sativum*) Seeds on the Food Intake and Microbial

Populations of the ceca of Japanese quail (Coturnix japonica). Biological Forum – An International Journal 6(2): 53-56.

Farag SA. 2013. The Efficiency of coriander seeds as dietary additives in broiler chicken's diets. Egyptian Journal of Nutrition and Feeds 16 (3): 491-501.

Gill C. 2000. The chemical changing of Coriandrum sativum for sun drying. Annual Biological Research 5: 578-583.

Guler T, Ertas ON, Ciftci M, Dalkılıc B. 2005. The effect of coriander seed (*Coriandrum sativum L.*) as diet ingredient on the performance of Japanese quail. South African Journal of Animal Science 35 (4):261-267.

Guler T, Ertas ON, Ciftci M, Dalkılıc B. 2006. Effect of Feeding Coriander (*Coriandrum sativum, L.*) on Egg Production Performance and Nutrient Retention in Laying Japanese Quails. Journal of Applied Animal Research 30(2):181-184.

Hamodi S.J, Al-Mashhadani EH, Al-Jaff FK, Al-Mashhadani HE. 2010. Effect of coriander seed (*Coriandrum Sativum L.*) as diet ingredient on broiler performance under high ambient temperature. International Journal of Poultry Science 9: 968-971.

Hernandez F, Madrid J, Garcia V, Orengo J, Megias MD. 2004. Influence of two plant extract on broiler performance, digestibility and digestive organ size. Poultry Science 83:169-174.

Hosseinzadeh H, Qotbi AAA, Seidavi A, Norris D, Brown D. 2014. Effects of Different Levels of Coriander (*Coriandrum sativum*) Seed Powder and Extract on Serum Biochemical Parameters, Microbiota, and Immunity in Broiler Chicks. Scientific World Journal Volume 2014, Article ID 628979, 11 pages.

Huff WE, Kubena LF, Harvey RB. 1988. Progression of ochratoxicosis in in broiler chickens. Poultry Science 67:1139–1146.

Ipu MA, Akhtar MS, Anjumi MI, Raja ML. 2006. Effects of dietary coriander seed on blood and cholesterol level in broiler. Pakistan Veterinary Journal 26:144-148.

Jang JP. 2011. Effect of different levels of coriander seed on performance of broiler Chickens. Annals of Biological Research 2: 578-583.

Kumari P, Chandramoni, Kumar K, Kumar S. 2014. Effect of dietary supplement of sugar beet, neem leaf, linseed and coriander on growth performance and carcass trait of Vanaraja chicken. Veterinary World 7(9): 639-643.

Lee KW, Everts H, Beynen AC. 2004. Essential oils in broiler nutrition. International Journal of Poultry Science 3:738-752.

Mc Gowan MW, Artiss JD, Strandbergh DR. 1983. A peroxidise - coupled method for the colorimetric determination of serum triglycerides. Clinical Chemistry 29:538–42.

Momin AH, Sawapnil SA, Amit VG. 2012. Coriandrum sativum: Review of advances in psychopharmacology. International Journal of Pharmaceutical Sciences and Research 3(5): 1233 – 1239.

Naeemasa M, Qotbi1 AAA, Seidavi1 A, Norri D, Brown D, Ginindza M. 2015. Effects of coriander (*Coriandrum sativum L.*) seed powder and extract on performance of broiler chickens. South African Journal of Animal Science 45 (4).

[NIN] National Institute of Nutrition, Hand book of Nutritive Value of Indian Foods. 1989 (2nd ed). Hyderabad, India.

[NRC] National Research Council, National Academy of Science. Nutrient Requirement of Poultry. 1994 (9th ed). Washington, USA.

Peter KV. 2004. Hand book of Herbs and Spices. Volume 2. Cambridge: Wood Head publishing Ltd. 158-174 p.

Prerna Nath, Kale SJ, Chauhan OP. 2015. Coriander- A potential medicinal herb. Indian Food Industry Magazine 34(2):29-35.

Ramadan DM, EL-Shoukary, Madeha HA, Darwish, Mootaz AM, Rahman A. 2014. Behavioural, Performance, Carcass Traits and Hormonal Changes of Heat Stressed Broilers Feeding Black and Coriander Seeds. Journal of Advanced Veterinary Research 4(3): 93-101.

Rashid MM, Ahammad MU, Ali MS, Rana MS, Ali MY, Sakib N. 2014. Effect of different levels of Dhania seed (*Coriandrum sativum*) on the performance of broiler. Bangladesh Journal of Animal Science 43 (1): 38-44.

Saeid JM, Al-Nasry AS. 2010. Effect of dietary coriander seeds supplementation on growth performance carcass traits and some blood parameters of broiler chickens. International Journal of Poultry Science 9:867-870.

Saleh AA, Ijiri D, Ohtsuka A. 2014. Effects of summer shield supplementation on growth performance, nutrient utilization, and plasma lipid profiles in broiler chickens. Veterinarni Medicina 59 (11): 536–542.

Shinde AS, Laxmi C, Ingale AM, Upadhyay D, Munj CP. 2014. Quail farming - Small but worthy. Poultry Line, September 2014.

Snedecor GW, Cochran WG.1993. Statistical methods. 9thed. IOWA, USA: Iowa state university press.

Soliman KM, Badea RI. 2002. Effect of oil extracted from some medical plants on different mycotoxigenic fungi. Food and Chemical Toxicology 40: 1669–1675.

Shukuhmand M. 2008. Breeding Quail. Tehran: Nour bakhsh Publications.

Talapatra SK, Ray SC, Sen KC. 1940. The analysis of mineral constituents in biological materials. Part-1. Estimation of Phosphorus, chlorine, calcium, magnesium, sodium and potassium in foodstuffs. Indian Journal of Veterinary Science and Animal Husbandry 10: 243.

[USDA] United States Department of Agriculture, National Nutrient Database for Standard Reference Release 26 Full Report (All Nutrients) Nutrient data for 2013, Spices, coriander seed.

Vamsidhar B. 2015 Eeffect of inclusion of fenugreek seed (*Trigonella foenum graecum*) as dietary ingredient on the performance of Japanese quail. M.V.Sc thesis submitted to Sri Venkateswara Veterinary University, Tirupati.

Van Soest PJ, Robertson JB, Lewis BA. 1991. Methods for dietary fiber, neutral detergent fiber and non-starch polysaccharides in relation to animal nutrition. Journal of Dairy Science 74: 3583-3597.

Wiebe DA, Smith SJ. 1985. Six methods for isolating high-density lipoprotein compared with use of the reference method for quantifying cholesterol in serum. Clinical Chemistry 31: 746.1985

Williams P, Losa R. 2001.The use of essential oils and their compounds in poultry nutrition.World Poultry 17:14-15.

Yeldho KM. Analysis of the content of dietary fibre in different food materials. Shodhganga (Internet). 2010. Available from: http://www.inflibnet.ac.in/ bitstream/10603/447/8/08.

Zlatanov M, Ivanov SA. 1995. Studies on sterol composition of the seed oil representatives of the family Apiaceae. Fett Wissenschaft Technologie 97: 381-383.