EFFECTS OF FENUGREEK, ANTIBIOTIC, IGNATIA AMARA AND GINGER ON GROWTH PERFORMANCE OF JAPANESE QUAIL

A THESIS

BY

MARUF-UL-MOSTAKIM
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SEMESTER: JANUARY - JUNE, 2017
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MASTER OF SCIENCE (MS)
IN
PHYSIOLOGY

DEPARTMENT OF PHYSIOLOGY AND PHARMACOLOGY
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HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY, DINAJPUR-5200, BANGLADESH

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Submitted to
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Approved as to the style and content by

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DEPARTMENT OF PHYSIOLOGY AND PHARMACOLOGY
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JUNE, 2018

DEDICATED
TO MY
BELOVED PARENTS

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ABSTRACT

Effect of fenugreek, antibiotics, ginger and ignatia on body weight, body weight gain, feed consumption and FCR of Japanese quails was evaluated in this study. Fifty Japanese quails were randomly allotted to five treatments identified as T_0, T_1, T_2, T_3 and T_4. Birds on T_0 served as control and T_1, T_2, T_3 and T_4 groups were treated with fenugreek, antibiotics, ginger and ignatia respectively. Fenugreek and ginger was in powder form while others were in liquid form. Average body weight in different treatments were different from the control for body weight in 1% level of significance. Feed consumption, body weight gain and feed conversion ratio in different treatments were different from the control for body weight in 5% level of significance. The birds fed the liquid form of ignatia showed better body weight, body weight gain, feed consumption and feed conversion ratio and are comparatively significant than those feed with fenugreek, antibiotics and ginger with those of control group.

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LIST OF ABBREVIATIONS

ACE	: Angiotensin I converting enzyme
AD	: Alzheimer's disease
B.wt.	: Body weight
BSMC	: Bronchial smooth muscle cell
EU	: European union
ER	:Estrogen independent
ESP	: Exchangeable sodium percentage
et al.	: Et alia (associates)
etc.	: Etcetra
FAO	: Food and agricultural organization
Fig.	: Figure
G	: Gram
GIT	: Gastrointestinal tract
GCL	: Glutamylcysteine ligase
GEO	: Ginger oil
HSTU Technology	: Hajee Mohammad Danesh Science and University
HO-1	: Heme oxygenase-1
HDL-C	: High-density lipoprotein cholesterol
ISSR	: Inter-Simple Sequence repeat
i.e.	: That is
J.	: Journal
LDL-C	: Low-density lipoprotein cholesterol
Ltd.	: Limited

NAEs	:N-acylethanolamines
No.	: Number
–OH	:Hydroxyl radical
RAPD	:Random amplified polymorphic DNA
SE	: Standard error
SOD	:Superoxide dismutase
SM	: Sample mean
TXB2	: Thromboxane –B2
PGF2	: Prostaglandins-F2
%	: Percent
&	: And
@	: At the rate of
<	: Less than
>	: Greater than
±	: Plus minus
5-HETE	: 5-hydroxyeicosatetraenoic acid

CHAPTER: 1

INTRODUCTION

Quail is the smallest and latest domesticated poultry species. There are about 131 species and 17 to 18 varieties of wild quail found all over the world, of which Japanese, Bobwhite, King and Stable quail are most important. Japanese quails are the natural inhabitant of Japan. Quails are reared in Japan from the time immemorial. The scientific name of Japanese quail is *Coturnix coturnix japonica* under the class aves and family *Phasianoidea* (Hashanuzzaman, 2013). Quail farming for egg and meat is quite popular in Japan, Hongkong, Korea, China, Singapore, India, Thailand, Malaysia, Indonesia, France, Italy, Germany, Britain and Russia. Only Bobwhite quail and Japanese quail have been domesticated for commercial purposes in Bangladesh, these two are commercially available. Besides, scientists developed many quail lines e.g. white egg shell line, meat line etc. Japanese quail, a recently introduced economic avian species is ideally suited for meat and egg under intensive management due to their low maintenance cost, early sexual maturity, higher exponential growth, higher heat tolerance, fitness for higher density rearing, higher disease resistance and higher egg production than that of other poultry species. The climate and natural condition of Bangladesh are very suitable for quail rearing. Quail can be reared in this country throughout the year with a good performance in meat and egg production.

Growth promoters are the organic or non organic compounds which promotes growth in animal or bird body. Mostly antibiotics are used as growth promoter in poultry. Many alternative substances obtained from nature and belonging to the groups of prebiotics, organic acids, enzymes, silicates, herbs and spices etc., have been also vigorously tested and evaluated for their potential to replace antibiotic growth promoters in poultry diets (Panda *et al*., 2006; Khan *et al*., 2012). Such, alternative substances were referred as natural growth

promoters. There are a number of such investigated natural growth promoters that are mainly utilized for providing beneficial role for improving health of poultry against various infectious diseases rather than regular nutrition. The involvement of these natural growth promoters in improving of intestinal morphology and nutrient absorption may also encourage the scientists to include these compounds in the diet to improve gut health, promote the growth and overall performance of birds.

It is a matter of sorrow that natural growth promoters are still not using in Japanese quail widely. It may be due to the residual effect of antibiotic in quail which transfers to human body after consuming flesh. This residual effect of antibiotics in human body can ultimately cause antibiotic resistance. On the other hand, Peoples are still not concerned about the use of natural growth promoters which have a less or no residual effect. Homeopathic drugs are also being used as growth promoter in our neighboring country India. But when it is a word of quail, we cannot find any authentic document regarding use of growth promoters in quail. So, it is an urgent to find out a suitable growth promoter for quail.

According to my hypothesis use of natural growth promoter or homeopathic drugs instead of using antibiotic growth promoter in quail will be more effective and economic. Alternative use of growth promoter will start a new era in quail farming.

The general objective of this study is to compare the efficacy of different growth promoter in quail production with the following specific objectives:

a) To determine the feed consumption and feed conversion ratio in Japanese quail.

b) To examine the efficacy of growth promoters on body weight and body weight gain.

CHAPTER: 2
REVIEW OF LITERATURE

2.1. Japanese quail (*Coturnix japonica*)

Japanese quail (*Coturnix coturnix japonica*) is a species that belongs to the same, biological family as chickens and pheasants, the Phasianidae, so they have many similar physiological and behavioral characteristics. The Japanese quail has a small to medium body size and plays major roles in industry and research, and it is the most common species bred for human consumption (Mizutani, 2003; and Ikhlas *et al*, 2010). The species was first domesticated in Japan, from where it spread all over the world, and large numbers can now be found in Asia, Europe and Africa. Nowadays, the main producer of quail meat is China (over 160,000 t), followed by Spain (9,000 t), France (8,000 t) and Italy and the USA (3,000 t each; Ionita *et al*, 2011).

The breeding of quail for meat and egg production has grown rapidly, aided by early sexual maturity (4-6 weeks of age), short generation interval, inexpensive maintenance and good egg-laying ability (Baumgartner, 1994; Cain and Cawley, 2000). Quail meat is considered superior to red meat as it has lower levels of calories, and considered superior to chicken and duck meat because it has higher levels of protein, omega-3 fats, iron and vitamins A, C, B_2, B_6, and B_{12} (Ionita *et al*, 2011). Quail eggs are rich in vitamins, minerals and antioxidants, and have a much higher nutritive value than chicken eggs. Quail eggs are also thought to confer medical benefits by strengthening the immune system, increasing brain activity, increasing haemoglobin levels, and removing heavy metals and toxins from the blood (Troutman, 1999-2012; Lalwani, 2011; and Tunsaringkarn *et al*, 2013).

The requirements for Japanese quail differ from those for the chicken, as can be seen in the 1994 recommendations of the NRC. In addition, Feed Conversion Ratio (FCR) for quail is higher than for chickens (3.3-4.9 vs. 1.3-2.2), and this increases the cost of feeding quail compared to chicken (Scott, 2005; and Ali *et al*, 2009; Chantiratikul et al, 2010; Hascik *et al*, 2010; Hazim *et al*, 2010; Prayogi, 2011).

Majority of the farmers in Bangladesh have practiced mixed type quail farming. Rahman *et al*. 2016 reported that layer; parent stock and broiler or meat type quail were only reared by 21.1%, 3.8% and 9.6% farmers, respectively. Mixed type quail farming is practiced worldwide because Japanese quails are suited for commercial rearing for egg and meat production under intensive management (Egbeyale *et al*. 2013). This is because of their hardiness and ability to thrive in small cages (Odunsi *et al*. 2007); the relative short generation interval and cheaper cost of production (Ojo *et al*. 2014)

In a recent study found that Japanese quail produce hatching egg weight ranges from 10 to 12 g, average body weight at 5-6 weeks is 180-200 g, and adult body weight is 200 250 g. However, Sultan *et al*.

(2013) reported that there might be a significant variation in all the laying parameters among different local and imported stocks of Japanese quails. The domestic quail shows rapid growth and attains sexual maturity at 5-6 weeks of age. Nowadays, bobwhite strains are slaughtered at 5 weeks of age with a weight of 160-250 g. Females enter into full lay at about 8-9 weeks of age. Layers are usually kept up to 8-10 m of age and produce about 300 eggs per year each with an egg weight ranges between 7- 11 g/egg.

Rahman *et al*., (2016) found that the average quail pullet weight was 145.0±0.12, 110.0±0.07, 120.0±0.22 and 128.0±0.17 g for layer, parent stock, hatchery and mixed farms, respectively. The average age at the first lay was 46.0±0.04, 42.0±0.31, 42.0±0.09, and 45.2±0.05 days; rearing period was 15.0±0.01, 12.0±0.14, 15.0±0.32, and 15.2±0.18 months; culling period 15.5±0.14, 13.0±0.06, 15.0±0.03 and 15.4±0.26 months for layer, parent stock, hatchery and mixed farms, respectively.

Quail tend to be quite sensitive to daylight length. To get desired egg production from adult quail lighting system must be provided (Pizzolante *et al*., 2006). In another report, Gilders leeve *et al*., (1976) stated the lighting hours requirement depending on age of the quail.

Quail chicks are very sensitive to temperature than chicken. When the temperature rises above 28℃, production and quality of eggs decreases. Seasonal temperature increases can reduce egg production by about 10 percent (Ciftci *et al*. 2005). Kekeocha (1985) citied that layer quail performed better at 11-260C and reduced egg production with high mortality at 400C or above temperature.

Many forms of cannibalism occur in quail raised in captivity. Cannibalism comprises vent pecking, feather pecking, toe pecking, head pecking and nose pecking. The latter, which is the most common type of cannibalism among quail, is generally seen only in birds of two to seven weeks of age (Randall *et al*., 2008). There are 59 registered

commercial Feed Mills in Bangladesh but no feed miller produces specialized feed for the quail production (BPD, 2009). Low level of dietary protein affects growth and egg production of quail negatively (Ela *et al*., 1992). It was reported that (Shanaway, 1952) temperature requirement of quail vary according to age ranging from 35 ℃ to 21 ℃.

There are a lot of factor should be considered during raising quail chicks like adequate temperature, sufficient light, proper air movement, density of quail chicks, supply of food and water, hygienic rearing rules etc.(Randall *et al*. 2008). Yilmaz *et al*, (2011) suggested that layer quail chicks should be provided the heat and light according to their age.

Quail lay about 280-300 eggs in the first year whereas 150-175 eggs in the second year. So, it is not economic to rear quail up to 2nd years. Laying efficiency can be easily maintained within the average range of 63-68% for maximum 300 days if balance ration is provided (Woodard *et al*, 1976).

Nowadays, meat type (broiler) quail strains are slaughtered at 5 weeks of age with a weight of 160-250 g (Nasar *et al*., 2016). Females enter into full lay at about 8-9 weeks of age. Layers are usually kept up to 8-10 m of age and produce about 300 eggs per year each with a weight of 7- 11 g (Ophir *et al*. 2003; and Ophir *et al*.2005).

Quail egg has some popularity in the several regions, but meat is not yet popularized in the Bangladesh. So, because of narrower market range, farmers are not interested about the quail farming (Siddiqui *et al*.1996).

Although Japanese quails are comparatively more resistant to infectious diseases than chickens, like salmonellosis, coccidiosis, infectious coryza, enteric diarrhea, and pneumonia have etc. (Rahman *et al*., 2016). So, no vaccination is given to quails.

Coturnix japonica is widely utilized include: genetics, nutrition, physiology, pathology, embryology, cancer, behavior, and the toxicity of pesticides (Huss *et al* 2012). Japanese quails are used for laboratory animal for many reason like require little space and maintenance, adaptable to laboratory conditions, short generation intervals and high fecundity, many specialized strains (Ophir *et al*. 2005). Quail meat is a sweet and delicate white game meat with extremely low skin fat and low cholesterol value. Ihejirikamba (2012).

2.2. Fenugreek (*Trigonella foenum-graecum L*.)

2.2.1. General introduction:

Fenugreek belongs to Fabaceae family; it was named, Trigonella, from Latin language that means ‘‘little triangle” due to its yellowish-white triangular flowers (Flammang*et al*., 2004). Fenugreek (*Trigonella foenum-graecum L*.) is oneof the oldest medicinal plants from Fabaceae family originated in central Asia about 4000 BC (Altuntas *et al*., 2005). Its description and benefits had been reported in the Ebers Papyrus (one of the oldest maintained medicinal document) earlier in 1500 BC in Egypt (Betty, 2008). It is being commercially grown in India, Pakistan, Afghanistan, Iran, Nepal, Egypt, France, Spain, Turkey, Morocco, North Africa, Middle East and Argentina (Flammang *et al*., 2004; Altuntas *et al*., 2005).

Fenugreek seeds contain a substantial amount of fiber (Montgomery, 2009; Meghwal and Goswami, 2012), phospholipids, glycolipids, oleic acid, linolenic acid, linoleic acid (Sulieman *et al*., 2000; Chatterjee *et al*., 2010), choline, vitamin A, B1, B2, C, nicotinic acid, niacin (Leela and Shafeekh, 2008), and many other functional elements.

2.2.2. Morphological description, phenology and cultivation:

Fenugreek is an annual legume, diploid (2n =16) plant (Ahmad *et al*., 1999) with no aneuploidy (Petropoulos, 2002; Trease and Evans, 2002; Flammang *et al*., 2004). Morphologically, it is an erect,

aromatic annual closely resembling large clover. The stem is long cylindrical (30–60 cm long) and pinkish in color; whereas its roots are massive finger like structures (Basu, 2006; Mehrafarin *et al*., 2011; Moradi kor and Moradi, 2013). Fenugreek has pinnate, trifoliate, long stalked compound leaves having toothed, lanceolate, stipules triangular, obviate to oblanceolate leaflets (Srinivasan, 2006; Basu, 2006). It blooms with white to yellowish white, axillary and sessile flowers that are hermaphrodite and insect pollinated. Flowers have 5 petals referred as banner, wing and keel. The ovary is deep green and glaucous while the pollen grains are oval to circular in shape (Basu, 2006; Montgomery, 2009; Mehrafarin *et al*., 2011). Fenugreek flower produces brownish to yellowish brown about 15 cm long 2–8 pods. Each pod contains 10–20 seeds per pod; seeds are small (about 5 mm long), hard, smooth, dull yellow to brownish yellow in color (Altuntas *et al*., 2005; Moradi kor and Moradi, 2013). Fenugreek requires 5–10 days for germination while the first trifoliate leaf appears 5–8 days after germination. It is a fast growing plant, which may grow on dry grasslands, cultivated or uncultivated lands, hillsides, planes as well as field edges but it requires a fair amount of sunlight. Fenugreek needs four to seven months to reach maturity (Petropoulos, 2002). Flowering period is midsummer (June to August) and seeds ripen during late summer (August to September). It is a drought tolerant plant and grows well in tropical climate with mild winter and cool summer; however, its leaf and flower development is temperature dependent (McCormick *et al*., 2006).

2.2.3. Nutritional constituents and associated functionality:

Fenugreek green leaves are one of the most ancient medicinal herbs containing β-carotene (19 mg/100 g), ascorbate (220 mg/100 g) (Thomas *et al*., 2011), fiber, iron, calcium and zinc even more than the regular food items (Muralidhara *et al*., 1999). Its seeds, biologically endosperm, are the most valuable plant part. Raw seeds are golden in color with maple flavor but bitter in taste. However, this

bitterness may be reduced by roasting. The seeds are fibrous, sticky and gummy in nature (Jani *et al.*, 2009). Saponins and alkaloids are considered as anti-nutritional factors in seeds. However, defatted seeds are free from these compounds and may be consumed by people having problem with fat (Altuntas *et al.*, 2005).

2.2.3.1 Fiber

Fenugreek seeds are a rich source of fiber (50–65 g/100 g) mainly non-starch polysaccharides (Montgomery, 2009). Galactomannans constitute the major portion of soluble fiber in seeds that lower glucose absorption in body (Meghwal and Goswami, 2012). Seed gum consists of mannose and galactose that gives high viscosity to an aqueous solution (Youssef *et al.*, 2009). Purified gum contains 0.8% residual protein that could reduce the surface tension and form stable emulsions with oil droplets (2–3 lm) as compared to other hydrocolloids (Meghwal and Goswami, 2012).

2.2.3.2 Protein

Fenugreek endosperm is rich in proteins (43.8 g/100 g): globulin, lecithin and albumin; Mathur and Choudhry, 2009; and Naidu *et al.*, 2011). It has a high proportion of free amino acids (20–30%), particularly 4-hydroxyisoleucine and histidine, which may stimulate insulin activity (Isikli and Karababa, 2005). Fenugreek proteins are stable enough, and are not affected during booking (Srinivasan, 2006). Moreover, debitterized fenugreek seeds are rich in protein and lysine contents.

2.2.3.3 Fat

Seeds contain 5.5–7.5% lipids in total mainly comprised of neutral lipids (85%), phospholipids (10%) and glycolipids (5%). Unsaturated lipids constitute oleic (14%), linolenic (25%) and linoleic (40%) acids (Sulieman *et al.*, 2000; Chatterjee *et al.*, 2010). Owing to the presence

of N-acylethanolamines (NAEs) and oleamide, fenugreek has strong pain relieving and appetite stimulating potential (Kaviarasan *et al*., 2007).

2.2.3.4 Aromatic compounds

Aroma of fenugreek seeds attributed to the presence of volatile oils. For instance, Meghwal and Goswami (2012) detected butanoic acid, 1-octene-3-one, 3-isobutyl-2-methoxypyrazine by gas chromatography.

2.2.3.5 Vitamins and minerals

Exposure to radiations significantly reduces the vitamin contents (Leela and Shafeekh, 2008). Its leaves also contain vitamins, but on boiling, steaming or frying, 7–11% of them may be lost. Fenugreek seeds contain fair amount of sulfur, phosphorus (ElNasri and El Tinay, 2007) and calcium (Jani *et al*., 2009).

2.2.3.6 Biologically active compounds

Interestingly, germinating seeds are more beneficial than un-germinated dry seeds in this regard. On the other hand, the aqueous fraction of fenugreek portrays considerable antioxidant activity than flavonoids and phenolics (Balch, 2003; Meghwal and Goswami, 2012; Khole *et al*., 2014). Fenugreek contains a fairly high amount of flavonoids, alkaloids, saponins and other antioxidants. It contains a major class of phenolics like gallic acid (1.7), protocatechuic acid (4.0), catechin (0.4), gentisic acid (35.8), chlorogenic acid (0.7), vanillic acid (58.5) and syringic acid (0.3) as mg per 100 g of the seed extract (Rababah *et al*., 2011). Fenugreek endosperm contains 35% alkaloids, primarily trigonelline (Jani *et al*., 2009). Flavonoid constitutes more than 100 mg/g of fenugreek seed (Naidu *et al*., 2011). Their use should, therefore, be promoted in daily diet to manage hypercholesterolemia, cancer and diabetes mellitus as they possess hypoglycemic, antilipidemic, anti-carcinogenic and cholagogic properties (Meghwal and Goswami, 2012).

2.2.4. Uses

Fenugreek had been applied to embalm mummies and in incense in ancient Egypt. In modern Egypt, it is still being used as wheat and maize flour supplement for bread making while one of the staple foods in Yemen (Mehrafarin *et al*., 2011). In Indian subcontinent, fenugreek was being consumed as lactation stimulant and condiment (Betty, 2008). Rome, it was purportedly used in labor pain and delivery; while in traditional Chinese medicine, fenugreek seeds were used as tonic and in treatment of edema and legs weakness (Yoshikawa *et al*., 2000). Seeds of fenugreek were traditionally used as a remedy for diabetes in many Asian and African civilizations (Miraldi *et al*., 2001; Basch *et al*., 2003). Numerous other folkloric uses of fenugreek are verified by the primary results of human and animal trials (Basch *et al*., 2003).

Both ripened and unripened seeds as well as green leaves have been used as vegetable, food additive, medicinal plant and fodder in South and Central Asian countries (Petropoulos, 2002). However, it is well known as flavor, curry powder and spice, and has also been used in tea and as food preservative in sauces and pickles (Betty, 2008).

2.2.5. Therapeutic/pharmacological claims

Food is undoubtedly a major determinant of human health under his own control. Apart from helping the normal body functioning and metabolism, food constituents such as antioxidants, vitamins, minerals, fiber, proteins, fat and carbohydrates also contribute to prevent overall aging and the onset of chronic diseases, in particular, metabolic disorders and oxidative damage (Mullaicharam *et al*., 2013). Plant-based natural antioxidants are getting popularity among the researcher, industry and users as cure from cancer, atherosclerotic heart disorders and other epidemics (Rababah *et al*., 2011). The secondary metabolites of plants origin may provide a wide

range of biological and pharmacological compounds, which have been used extensively as food additives, flavor ants, colorants, and as drugs and insecticides (Priya *et al*., 2011).

Fenugreek possesses pharmacological properties such as antimicrobial, anti-cholesterolemic, carminative, emollient, febrifuge, laxative, restorative, uterine tonic, expectoral, galactogogue, anti-carcinogenic, anti-inflammatory, antiviral, antioxidant, demulcent and hypotensive (Moradi kor and Moradi, 2013). In addition, it regulates several enzymatic activities, relieves fever, reduces body pain and fat, alleviates swelling, augents appetite and promotes lactation and sex hormones. Compounds isolated from fenugreek have remarkable biological activities including protection against cancer, malaria, allergies, bacteria and viruses (Naidu and Priya *et al*., 2011). Fenugreek, in particular, is abundant in polyphenolics that inhibit peroxidation and remarkably reduce oxidative hemolysis in human erythrocytes (Rayyan *et al*., 2010; Belguith-Hadriche *et al*., 2013). Moreover, their optimal consumption may lower triglycerides and cholesterol concentrations in the blood (Afef *et al*., 2000), prevent cancer (Raju *et al*., 2004) and control diabetes mellitus (Broca *et al*., 2000). The oral intake of ethyl acetate extract of fenugreek seeds has been tested to reduce triglycerides and low-density lipoprotein cholesterol (LDL-C) while increasing high-density lipoprotein cholesterol (HDL-C); hence had a noteworthy antioxidant and hypocholesterolemic effects (Belguith-Hadriche *et al*., 2013). Furthermore, it exhibits scavenging of free hydroxyl radical (–OH) and discourages hydrogen peroxide induced peroxidation in liver mitochondria and protects cellular organelles from oxidative damage (Kaviarasan *et al*., 2007).

2.2.6. Crop prospective

Ranging from dry tropical zones to temperate forests, fenugreek may grow well in areas receiving 300–1500 mm annual precipitation and annual mean temperature of 7.8–27℃ (Petropoulos, 2002). Being a

legume, fenugreek may fix about 283 kg N ha year¯1, and may therefore be grown as a potential crop onmarginal lands to improve health (Petropoulos, 2002; Ali, 2012; and Solorio-Sa´ nchez *et al*., 2014). However, the use of effective Rhizobium inoculums with fenugreek crop still lacks sound research (Abdelgani *et al*., 1999). Fenugreek as ‘‘fodder bank” may provide not only a fodder in off seasons but can also promote the main fodder growth by continuous N supply (Solorio-Sa´ nchez *et al*., 2014). It may grow well during summer conditions with low night temperature (Billaud and Adrian, 2001). Although, yields low seed, successful cultivation of fenugreek on sandy soil in arid environment with limited fertilizer input is profitable (Deora *et al*., 2009). .Above mentioned properties also make it a useful green manuring crop, particularly for short term rotations (Basu, 2006; and Acharya *et al*., 2008).

Fenugreek has also been adapted to slightly alkaline soils or marginal saline lands. Though salt affected soils exist throughout the world under almost all climatic zones, and a wide exploration on salt effects have also been reported; unfortunately only a fraction of fenugreek potential to saline soils has been revealed (Acharya *et al*.,2006). Garg (2012) reported that some of the fenugreek genotypes are capable of tolerating higher exchangeable sodium percentage (ESP). Elleuch *et al*. (2013) have reported survival of fenugreek under copper stress, even higher up to 10 mM (CuSO4).

Many of the plants produce secondary metabolites to cope with limitations; some of these compounds exhibit allelopathic properties, growth inhibition of surrounding plants (Duke *et al*., 2000). These compounds provide excellent weed control in intercropping and have herbicidal potential or templates for new herbicides (Duke, 2000; and Caamal-Maldonado *et al*., 2001). Fenugreek species possesses weedicidal, insecticidal and antifungal potentials (Evidente, 2007; and Haouala *et al*., 2008).

2.2.7. Research advances and crop improvement

Fenugreek is one of the potential candidates to be acclimatized under stress regions or on However; Garg (2012) reported successful cultivation of fenugreek under saline sodic soils followed by Farahmandfar and his team (2013) who made efforts to facilitate fenugreek cultivation by seed priming. In addition, Ahari *et al*. (2009, 2010) made several experiments to check fenugreek's drought tolerance potential and genotypic screening of available landraces for drought stress. One step ahead, Ali *et al*. (2012) advocated the efficient use of rhizobial inoculation for fenugreek and claimed a fruitful improvement in its adoption to arid and semiarid soils, but unfortunately no further research was made for rhizobial inoculations. Moreover, in the last decade fenugreek was investigated for heavy metal toxicity (Sinha 2007; and Elleuch *et al*., 2013), sowing date (Nandre *et al*., 2011), intercropping (Shirzadi *et al*., 2011), phosphorous fertilizer doses (Khan, 2005; and Jat *et al*., 2012), fodder bank (Solorio-Sa´ nchez *et al*., 2014) and response to exogenous application of plant growth regulators (Danesh- Talab *et al*., 2014). More recently, Pouryousef *et al*. (2015) have recently introduced fenugreek as intercrop, a living mulch, to suppress weeds and found significant results.

Estimation of genetic variability is important for improvement of any crop, but in spite of fenugreek's diverse importance and applications, genetic diversity among fenugreek genotypes has rarely been estimated (Harish *et al*., 2011). For instance, Najafi *et al*. (2013) explored the karyotype of fenugreek, Banerjee and Kole (2004) analyzed the genetic variability in twenty-two genotypes. Prajapati *et al*. (2010) and his co-scientists accessed genetic variability and character association in 94 fenugreek genotypes. Furthermore, genetic variability and its association with yield and yield component characters were studied by Fufa (2013) and Jain *et al*. (2013). Harish *et al*. (2011) and his team used RAPD (Random Amplified Polymorphic DNA) and ISSR (Inter-Simple Sequence repeat) for molecular and biochemical characterization of ten accessions.

2.3 Ginger:

2.3.1. General description

Ginger (*Zingiber officinale Roscoe*) belongs to the family Zingiberaceae (Wagner, 1980) and genus Zingiber. Other names of ginger are African ginger, Black ginger, Cochin ginger, Gan Jiang, Gegibre, Ingwer, Jamaican ginger, and Race ginger. Turmeric, cardamom, and galangal are other notable members of the ginger family. The English botanist William Roscoe (1753-1831) gave the plant the name Zingiber, derived from a Sanskrit word singabera which means horn-shaped due to the protrusions on the rhizome (Katzer, 1999). Worldwide, over 25 varieties of ginger are grown. Zingiber, ISR- Varada 2, Suprabha, Suruchi, Suravi,Himagiri, IISR Mahima, IISR Rejatha, Rio-de-Janerio, Nadia, and China are some of the important cultivars grown across the world (Shasikaran *et al*, 2008). Cautleya, Globba, Roscoea, Kaempferia, and Siphonochilusare grown for ornamental and medicinal purpose but not for spice (Branney, 2005 and Byers, 1999). Depending on the variety and location where the crop is being grown the yield of dry ginger is 19-25% of fresh ginger (Shasikaran *et al*, 2008). Ginger is grown throughout South Eastern Asia, China and in parts of Japan, Austria, Latin America, Jamaica and Africa. India is the top producer of Ginger, followed by China, Indonesia, Nepal and Thailand, but the most expensive and high quality varieties come from Jamaica, Australia, and South India (Gilani and Gayur, 2005, Ali and Gilani, 2007).

2.3.2. History, popular and traditional uses

Ginger is native to Southeastern Asia (Wagner, 1980). It is mentioned in ancient Chinese, Indian, and Middle Eastern periodicals and has

long been valued for its aromatic, culinary, and medicinal properties (Langner, 1998). Confucius wrote about ginger in his Analects and the Greek physician Dioscorides listed ginger as an antidote to poisoning, as a digestive, and as being warming to the stomach in De Materia Medica (Langner, 1998). Many religious holy books—the Quran, the Talmud, the Bible, Ayurveda, Charak Sushutra, Vagbhatta and Charak Dutta—have mentioned ginger (Gajnavi, 1996, Hrdayam of Srimadvagbhat, 1999). Medieval writing from many European countries indicates that ginger was a standard ingredient in recipes for the kitchen and the apothecary (Widmaier, 1986).

Ginger is an integral part of Ayurveda, the traditional medicine of India, and is known as sunthi in Ayurveda (Hrdayam of Srimadvagbhatt, 1999). As ginger resembles fingers, pregnant women in China are advised to avoid ginger during pregnancy, as they might give birth to babies with more than five fingers. But after birth a woman may take it for strength, to clean out all poison from her body, and to protect the newborn (Wong, 2001). In Malaysia and Indonesia, ginger soup is given to new mothers for 30 days after their delivery to help them sweat out impurities. In Arabian medicine, ginger is considered an aphrodisiac. Some Africans believe that eating ginger regularly will help repel mosquitoes and women of central Africa make belts of ginger roots to attract the attention of their husbands. Ginger flowers are traditionally worn by Hawaiian dancers (Gilani, 2005).

2.3.3. Culinary Use

Ginger is consumed worldwide as spice, flavoring agent, garnish, medicine, and food preservative and is used either fresh, in a fresh paste, or dry, in a dry powder. In the traditional KoreanKimchi, ginger is finely minced and added to the ingredients of the spicy paste just before the fermenting process (Kim *et al*, 2005). In the Ivory Coast, ginger is ground and mixed with orange, pineapple, and lemon to produce a juice called Nyamanku. Yemenite Jews add ginger

powder in Hawaij, a spice mixture used mostly for soups and coffee (Roden, 1996).

2.3.4. Nutritional composition of ginger

2.3.4.1 Chemical Composition

Ginger contains approximately 50% carbohydrates, 9% protein and free amino acids, 6-8 % fatty acids and triglycerides, 3-6% ash, and 3-6% crude fiber (on dry matter basis) depending on variety, geography, and climatic conditions (Leung, 1984, Tang, 1992). Some African ginger varieties contain 5.98 and3.72g /100 proteins and fat (Shrin Adel, 2010). Small amount of vitamins A, E and some amounts of B- vitamins and Vitamin C are also found in ginger rhizome (Adel and Prakash, 2010).

2.3.4.2 Phytochemical Composition

Ginger is a complex substance consisting of more than 60 compounds (Srivastava *et al*, 2000). A very small amount of curcumin is also found in ginger. In addition to that it also contains small amounts of alkaloids, tannins, carotenoids, saponins, flavonoids, steroids, and cardinolides (Shrin Adel, 2010). Dry ginger oil also has higher content of sesquiterpene hydrocarbons and they are reported to have less activity compared to oxygenated compounds (Srivastava, *et al*, 2000 and Sinha, *et al*, 1990, Sasidharan and Menon, 2010). Ginger oil (GEO) has been characterized to have a high content of sesquiterpene hydrocarbons, including β-sesquiphellandrene (27.16%), caryophyllene (15.29%), zingiberene (13.97%), α-farnesene (10.52%) and ar-curcumin (6.62%) (El-Baroty *et al*, 2010).

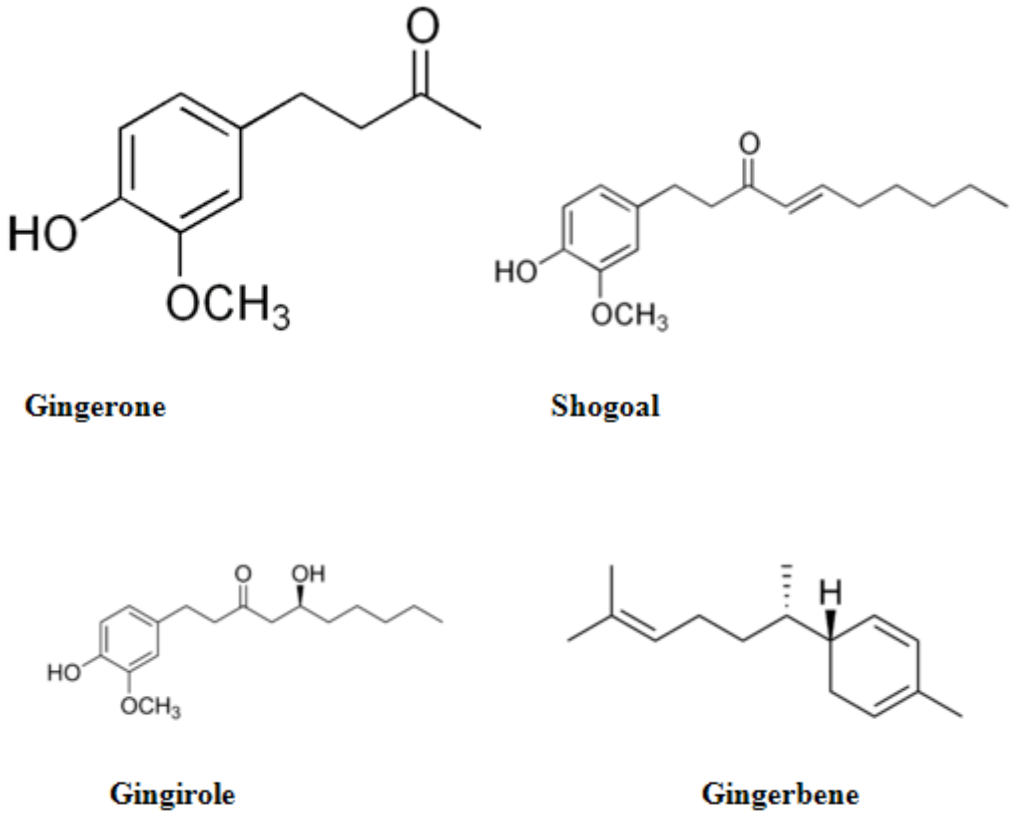


Figure: Chemical structure of important phytochemicals present in ginger.

2.3.5. Health benefits

Ginger is a potential herb used worldwide for its immense phototherapeutic properties. In Ayurveda it is known as Mahaaushdi which means use of this herb improves body functions and helps to eliminates toxins from the body (Nadkarni, 1976).

2.3.5.1 Digestive System

Ginger has a sialagogue action, stimulating the production of saliva, which makes swallowing easier (Bhagyalakshmi and Singh, 1988). A famous Ayurvedic drug trikatu, which is used against digestive disorders, contains ginger as the main constituent (Malhotra *et al*, 2003). Ginger acts as a purgative. Fresh ginger helps to remove constipation while dry ginger powder is a fecal astringent, meaning it dries up the watery portion of the feces and causes constipation (Malhotra *et al*, 2003).

Ginger stimulates the flow of saliva, bile, and gastric secretions and therefore is traditionally used to stimulate appetite, reduce flatulence, colic, and gastrointestinal spasms, and generally act as a digestive aid (Blumenthal *et al*, 2000). Gingerols inhibit the growth of Helicobacter pylori associated with dyspepsia, peptic ulcer disease, and the development of gastric and colon cancer (Mahady *et al*, 2005).

The main anti-ulcerogenic constituents present in ginger are 6 gingesulfonic acid, 6 gingerol,6 shogoal, beta-sesquiphellandrene, beta-bisabolene, gingesulfonic acid,curcumene, and 6 gingglycoprotein A, B and C (Yamahara *et al*, 1988). Of the anti-ulcerogenic constituents, 6 gingesulfonicacid is the most potent. These constituents protect gastric mucosa against alcohol, non-steroidal anti-inflammatory drugs,and hydrochloric acid (Yamahara *et al*, 1992).In mice, zingiberene and gingerol significantly reduced gastric ulceration experimentally induced by ethanol and hydrochloric acid (Yamahara *et al*, 1988).

2.3.5.2 Respiratory System

Ginger can be used for throat infections and to relieve congestion in sinusitis. It reduces fever in colds and flu and suppresses a dry, irritating cough in laryngitis by increasing human bronchial Smooth Muscle Cell (BSMC) migration and proliferation and reversing phthalate ester-mediated airway remodeling. Moreover, (6)-shogaol, (6)-gingerol, (8)-gingerol, and (10)-gingerol, which are major bioactive compounds present in ginger, suppress phthalate ester-mediated airway remodeling, which shows that ginger is capable of preventing phthalate ester-associated asthma.

2.3.5.3 Circulatory System

Cholinergic compounds are known to cause a fall in blood pressure by activation of muscarinic receptors located on the epithelium of blood vessels (Furchgott and Zawdski, 1980). Ginger also contains

saponins, terpenoids, flavonoids, amino acids/peptides, secondary amines, and alkaloids. These compounds demonstrate hypotensive and vasodilator properties and could be the causative agents in the reduction in blood pressure (Gilani *et al*, 1994, Ajay *et al*, 2003).

Ginger has been shown to exhibit antithrombotic activity because it inhibits platelet aggregation and thromboxane –B2 (TXB2) production in vitro. Besides this, gingerdione has been shown to inhibit the production of 5-hydroxyeicosatetraenoic acid (5-HETE) and prostaglandins-F2(PGF2) from arachidonic acid.Shogoal appeared to be a preferential inhibitor of 5-HETE formation, whilegingerol and dehydroparadol favored the inhibition of cyclooxygenase (Nurtjahja-Tjendraputra *et al*, 2003, Thomson *et al*, 2002).

2.3.5.4 Nervous System

Amyloid is involved in the formation of senile plaques (Tirabosch *et al*, 2004, Ohnishi, and Takano, 2004), the typical neuropathological marker for Alzheimer's disease (AD), and has been reported to cause apoptosis in neurons via oxidative and/or nitrosative stress. 6-Gingerol pretreatment can protect cytotoxicity and apoptotic cell death such as DNA fragentation, disruption of mitochondrial membrane potential, elevated Bax/Bcl-2 ratio, and activation of caspase-3. 6-Gingerol is also known to suppress intracellular accumulation of reactive oxygen and/or nitrogen species and to restore depleted endogenous antioxidant glutathione levels. In addition, 6-gingerol treatment up-regulates the mRNA and protein expression of antioxidant enzymes such as glutamylcysteine ligase (GCL) and heme oxygenase-1 (HO-1), the rate limiting enzymes in glutathione biosynthesis and heme degradation, respectively. Therefore, 6-gingerol exhibits preventive and/or therapeutic potential for the management of AD via augentation of antioxidant capacity (Lee *et al*, 2011).

Ginger is useful in treating inflammation, pain, and rheumatism. The anti-inflammatory properties of ginger have been known and valued for centuries (Mascolo *et al*, 1989, Young, *et al*, 2005). It is believed that consuming ginger regularly can reduce pain level and increase mobility in osteoarthritis or rheumatoid arthritis patients. An acetone extract containing gingerols, shogaols, and minor compounds like gingerenone A, gingerdiol, hexahydrocurcumin, and zingerone have been shown synergistically to produce dose-dependent anti-inflammatory effects (Young *et al*, 2005).

Ginger can modulate the biochemical pathways of prostaglandin synthesis through inhibition of cyclooxygenase-1 and cyclooxygenase-2 and leukotriene biosynthesis through inhibition of 5-lipoxygenase. Thus, it functions as a dual inhibitor of eicosanoid biosynthesis (Grzanna, *et al*, 2005).

Ginger extract and Alpinagalanga inhibits the induction of several genes involved in the inflammatory response (Grazanna, *et al*, 2005). These include genes encoding cytokines, chemokines, and the inducible enzyme cyclooxygenase-2. In one experiment Srivastava and Mustafa (1992) utilized powdered ginger to treat 56 patients of different musculoskeletal disorders (28 with rheumatoid arthritis, 18 with osteoarthritis, and 10 with muscular discomfort) against their afflictions. Amongst the arthritis patients more than three-quarters experienced to varying degrees of relief in pain and swelling. All the patients with muscular discomfort experienced relief in pain. None of the patients reported adverse effects during the period of ginger consumption which ranged from 3 months to 2.5 years. The investigators suggested that at least one of the mechanisms by which ginger shows its ameliorative effects could be related to inhibition of prostaglandin and leukotriene biosynthesis (i.e. it works as a dual inhibitor of eicosanoid biosynthesis).

Udea *et al*, (2010) investigated the ability of ginger extract to induce an immune response in RAW-264 cells after repeated oral

administration to mice. They revealed that ginger extract augented the serum corticosterone level and gradually induced tolerance and anti-inflammatory activity in mice.

Corticosterone has been reported to decrease the cytokine production and further the immune response. The phosphoestrase-4 inhibitor has been reported to decrease TNF-α production and has shown dramatic anti-inflammatory efficacy that was dependent on release of corticosterone from adrenal glands (Pethipher *et al*, 1996).

High doses of ginger have also been found to significantly reduce migraine intensity. It plays a role as a circulatory stimulant, peripheral vasodilator, and antispasmodic. Ginger may exert abortive and prophylactic effects in migraine headaches without any side effects. Ginger and its constituents inhibit the metabolism of arachidonic acid through both the cyclooxygenase and lipoxygenase pathways, thus reducing the accumulation of prostaglandins and leukotrienes that contribute to pain and inflammation. This is important because other compounds that are prophylactic against migraine attacks are postulated to work through the same pathways. Additionally, ginger extract inhibits the induction of several genes involved in the inflammatory response, including those that encode cytokines and chemokines. Studies indicate that certain cytokines are overproduced in migraine sufferers. The ability of ginger to inhibit thromboxane A2 and exert antihistamine, anti-inflammatory, and gastric actions makes it a theoretically attractive choice in migraine therapy (Mustafa &Srivastava 1990b).

A combination of ginger and Ginkgo biloba has been shown to reduce anxiety in an animal model (elevated plus-maze test). The effect was similar to diazepam (an allopathic medicine used for anxiety treatment) (Hasenohrl *et al*, 1996). A highly non-polar fraction of a ginger extract has been shown to possess anticonvulsant, anxiolytic, and anti-emetic activities in animals (Vishwakarma *et al*, 2002).

2.3.5.5 Endocrine System

Diabetes mellitus can be defined as a group of metabolic diseases characterized by chronic hyperglycemia resulting from defects in insulin secretion, insulin action, or both resulting in impaired function in carbohydrate, lipid, and protein metabolism and is associated with markedly increased morbidity and mortality rate (Zhang *et al*,2006). Diabetes is known to increase ROS production and oxidative stress probably as a result of glucose auto-oxidation and non-enzymatic glycation (Gupta *et al*, 2007).

Prolonged exposure to hyperglycemic conditions creates predominance of oxidative stress over antioxidative defense systems, leading to oxidative DNA damage, which possibly contributes to pancreatic beta-cell dysfunction (Song *et al*., 2007). Hence, compounds with both hypoglycemic and anti-oxidative properties would be useful anti-diabetic agents (Cemek *et al*., 2008). Ginger has already been proven as an antidiabetic agent and helps in reducing hyperglycemia and hypoinsulinemia conditions (Akhani*et al*, 2004, Sharma *et al*, 1996, Ajith*et al*, 2007).

Ginger was found very effective in reversing the diabetic proteinuria and lowering serum glucose, cholesterol, and triacylglycerol levels in the ginger-treated diabetic rats compared with the control diabetic rats (Al-Amin *et al*, 2006). Singh *et al*, (2009) suggested that (6)-gingerol is an effective anti-diabetic agent via its ability to enhance insulin sensitivity and to decrease hyperlipidemia in type 2 diabetic animals. Furthermore, it is also beneficial against oxidative stress, thereby being helpful in delaying or preventing complications of diabetes and aging. Ginger ethanolic extract has shown insulinotropic action similar to chlorpropamide, a sulphonylurea drug, and enhanced insulin sensitivity atthe cellular level (Ojewole *et al*, 2006). Also, ethanolic ginger extract reduced plasma cholesterol and inhibited LDL oxidation in atherosclerotic apoE-deficient mice (Fuhrman *et al*, 2000). Moreover, addition of ginger (1 %) to a normal

diet prevented the formation of free radicals and maintained the integrity of rat erythrocytes (Ahemed *et al*, 2000). The antioxidant potency of ginger has been attributed to gingerols that prevent the production of reactive oxygen species (Ali *et al*, 2008).

At least two active components, 2-(4-hydroxy-3-methoxyphenyl) ethanol and 2-(4-hydroxy-3-methoxyphenyl) ethanoic acid, of ginger have shown aldose reductase inhibitor properties (Ali *et al*, 2008). Also, ginger inhibited serotonin-induced hyperglycemia and hypoinsulinemia by blocking its receptors (Al-Amin *et al*, 2006). Madko *et al* (2011) reported that a ginger, garlic, and turmeric mixture significantly decreased serum total lipid and total cholesterol levels in healthy rats, which may be beneficial as a prophylaxis against hypercholesterolemia.

Ginger not only prevents and cures diabetes but it is also preventive in the progression of cataracts. The aqueous extract of ginger possesses both antiglycating activity and ALR2 (aldolase reductase) inhibition (Saraswat *et al*, 2010, Saraswat *et al*, 2008). Regular consumption of ginger delays the progression and maturation of cataracts. This could be attributed to its ability to prevent the multiple changes associated with the accumulation of AGE (i.e., reduction in the carbonyl stress, inhibition of osmotic stress by reducing the activity of polyol pathway, and prevention of oxidative stress) (Saraswat, 2009).

Angiotensin I converting enzyme (ACE) is a metellopeptidease that catalyses two reactions, leading to constriction of blood vessels and hence blood pressure regulation (Schmaier, 2002).Ginger exhibited relevant ACE inhibitory activities indicating potential anti-hypertension activity likely related to non-phenolic compounds (Ranilla *et al*, 2010).

2.3.5.6 Immune System

Ginger extract raises the thymus index, spleen index, and percentage of phagocytosis significantly, thus improving immunologic function (Kathi, 1999, Schittek *et al*, 2001).

Dermicidin is a protein manufactured in the body's sweat glands, secreted into the sweat, and transported to the skin's surface where it provides protection against invading microorganisms, including bacteria, such as E. coli and Staphylococcus aureus (a common cause of skin infections), and fungi, including Candida albicans (Alternative Medical Review,2003, Schittek *et al*,2001).

Ginger extract and several of its constituents exhibit antimicrobial activity in vitro and in vivo and antischistosomal activity (Akoachere *et al*, 2002). It has been proposed that lipophilicity or hydrophobicity and chemical structure of essential oils or their main compounds such as the presence of functional polar groups and aromaticity could play an important role in the antimicrobial activity (Farag *et al*, 1989b; Daw *et al*, 1994). This activity enables partitioning between lipids of the bacterial or fungal cell membrane and mitochondria, disturbing the cell structures and rendering them more permeable, which will lead to cell death (Sikkema *et al*, 1994).

Some of the major components present in ginger oils can penetrate the membrane of the microorganisms and react with the membrane enzymes and proteins as well as phospholipid bilayer, which causes an impairment of the microbial enzyme system and/or a disturbance of genetic material functionality (Farag *et al*, 1989, Abd El-Baky and El-Baroty, 2008, Conner, 1993). Fresh ginger oil showed strong inhibition against Aspergillusnigerand Candida and inactivity against Pencilliumsppand Trichoderma spp. At the same time, dry ginger oil was more active towards Candida andweaker against Aspergillusniger, Pencilliumspp, and Saccharomyces cereviseae (Sasidharan and Menon 2010).

Ginger extracts have antibacterial effects against both gram-positive and gram-negative bacteria such as Clostridium, Listeria, Enterococcus, Staphylococcus, Streptococcus, and Haemophilus species. The minimum inhibitory concentration of ginger ranged from 0.0003–0.7 µg/mL, and the minimum bactericidal concentration ranged from 0.135–2.04 µg/mL species, but some of this effect is destroyed by heating (e.g., cooking) (Mascolo*et al*, 1989 and Chen*et al*, 1985). Gingerols demonstrated antibacterial activity against Bacillus subtilis and Escherichia coliin vitro (Yamada *et al* 1992). Sasidharan and Menon (2010) found fresh ginger oil was inactive against Bacillus subtiliswhereas dry ginger oil wasmore active towards Pseudomonas aeruginosa and weaker against Bacillus subtilis.

Ginger has been found very effective against the flu virus, due to its warm and bitter property. Several sesquiterpenes, but especially beta-sesquiphellandrene, isolated from ginger has also been shown to have antirhinoviral activity in vitro (Denyer *et al* 1994). Denyer also showed that shogaol and zingerone strongly inhibited Salmonella typhi, Vibrio cholerae and Trichophytonviolaceum.

Gingerol (5.0 ppm) completely abolished the infectivity of Schistosoma spp. (blood flukes) in animal studies (Adewunmi *et al* 1990). Zingibain, another bioactive compound, dissolves parasites and their eggs. Gingerol and shogaol exhibited potent molluscicidal activity in vivo (Adewunmi*et al* 1990). Shogaol and gingerol have demonstrated anti-nematode activities; 6.25 µg/mL 6-shogaol destroyed Anisakis larvae within 16 hours in vitro, whereas the antinematodal medication pyrantel pamoate had no lethal effect at 1 mg/mL (Goto *et al* 1990).

Ginger spares SOD (superoxide dismutase)–an important anti-oxidant, catalase which is essential for breaking down potentially harmful hydrogen peroxide in the cells to glutathione peroxidase. SOD also

acts on hydrogen peroxide and helps maintain integrity of cell membranes (Brock, 2007).

Ginger is a good source of antioxidant and most of the antioxidant components exhibit higher activities in alcoholic media. Hence, apart from its medicinal properties, ginger can also be used as an antioxidant supplement (Adil and Prasad, 2010).

Ginger induces cell death in leukemic, skin, kidney, lung, and pancreatic cancer cells. The anticancer properties of ginger are attributed to the presence of certain constituents such as [6]-gingerol and [6]-paradol, as well as some other constituents like shogaolsand zingerone (Park *et al*., 2006).

As suggested by Cancer Prevention Research, gingerols, the main active components in ginger, inhibit the growth of human colorectal cancer cells (Bode *et al*, 2003). In another experiment, Bode *et al* (2001) studied the effect of 6-paradol and 6-gingerol on the cell proliferation and DNA synthesis of HL-60 cells. They observed that their cytotoxicity was associated with induction of apoptosis and/or inhibition of activator protein-1. Apoptosis can be defined as the cleavage of DNA into discontinuous mono- and oligonucleosomal size fragents that form a typical DNA ladder during gel electrophoresis. 6-gingerol, a natural product of ginger, has been known to possess anti-tumorigenic and pro-apoptotic activities. It has also been suggested that 6-gingerol stimulates apoptosis through up regulation of NAG-1 and G (1) cell cycle arrest through down regulation of cyclin D1. Multiple mechanisms appear to be involved in gingerol action, including protein degradation as well as beta-catenin, PKCepsilon, and GSK-3beta pathways (Lee *et al*, 2008).

Ginger extracts have been shown to have antioxidant, anti-inflammatory, and anti-tumor effects on cells (Rhode *et al*, 2006). A pro-inflammatory state is thought to be an important contributing factor in the development of ovarian cancer (Rhode *et al*, 2006).

Conventional chemotherapeutic agents also suppress these inflammatory markers, but may cause cancer cells to become resistant to the action of the drugs. However, ginger may be of special benefit for ovarian cancer patients because cancer cells exposed to ginger do not become resistant to its cancer-destroying effects (Rhode *et al*, 2006).

Ginger has been found to significantly inhibit mammary tumorigenesis and tumor growth in laboratory mice when fed in drinking water. Gingerol, a component of ginger, has been shown to inhibit cell adhesion, invasion, and motility in ER-negative (estrogen independent) human breast cancer cells in the laboratory (Lee *et al*, 2007). Hence, ginger appears to have promise in fighting breast cancer and is safe to include in the diet.

2.3.5.7 Other Uses

Ginger is on the Food and Drug Administrations list of generally recognized as safe (GRAS) (Alternative Medical Review, 2003). Ginger also acts as an expectorant. It is believe to control common cold and flu symptoms.

Ginger rhizome has been investigated as a source of plant proteolytic enzyme (Thompson *et al*, 1973, Ziauddin *et al*, 1995). Improvement in color, appearance, juiciness, and tenderness of beef samples treated with ginger extract were also tested (Ziauddin*et al*, 1995. The use of ginger extract for improving the qualities of tough meat could prove to be a boon to the meat industry (Naveen *et al*, 2001).

El-Baroty *et al* (2010) reported that cinnamon and ginger essential oils can be used as a preventer of cellular damage due to spoilage bacteria and fungi. Both oils and bioactive components (at concentration levels 20 - 100 µg/ml) could be employed as natural

food preservatives to prevent lipid peroxidation, which causes food spoilage.

Ginger has traditionally been used in Asia as a warming remedy to treat chills associated with colds and flu. The shogaol compounds of ginger significantly inhibited serotonin (5-HT) induced hypothermia in rats. Within 30 minutes of oral administration, ginger raised the body temperature of rats by 0.5°C(Kanu *et al*, 1992). Gingerol increased body temperature and oxygen consumption in rats indicating an increased metabolic rate (Eldershaw *et al*, 1992).

Ginger is useful when taken internally, if menstrual pain is due to ischemic cramp (lack of uterine blood supply) (Alternative Medical Review, 2003). It is also good in the form of hot compresses for abdominal cramps, headaches, and joint stiffness.

2.3.6. Possible interactions

Ginger may alter the effects of some prescribed and non-prescribed medications. If blood-thinners such as warfarin (Coumadin) or aspirin, diabetes medicines, or high blood pressure medicines are being taken ginger therapy is not advisable. Ginger may lower blood sugar, raising the risk of hypoglycemia or low blood sugar, and may lower blood pressure, raising the risk of low blood pressure or irregular heartbeat. Ginger therapy is also not recommended in children less than two years (Heck *et al*, 2000 and Vaes *et al*, 2000).

2.4. Ignatia amara

Ignatia, or ignatia amara, is a homeopathic remedy people sometimes use to treat anxiety. Anxiety and depression are among the symptoms most frequently reported by patients seeking complementary or alternative medical treatments, such as homeopathy and natural remedies (Mathie RT, Robinson TW.2006; Thompson EA, Mathie RT and Baitson ES, *et al*. 2008; Greeson JM, Rosenzweig S, Halbert SC, Cantor IS, Keener MT and Brainard GC 2008; Guethlin C, Walach H,

Naumann J, Bartsch HH and Rostock M 2010). In the present work, we employ the same protocol to (Magnani P, Conforti A, Zanolin E, Marzotto M, Bellavite P. 2010) test another homeopathic remedy that is widely used for anxiety syndromes. Ignatia (also named Ignatia amara), obtained from the extract of Strychnos ignatii beans. Strychnos ignatii is a plant belonging to the Loganiaceae family, native to South East Asia, with long branches and pear shaped fruit that contain hard, 2.5 cm long seeds that are odourless but bitter and very poisonous due to high strychnine content. Although it is best known as a poison, small doses of strychnine were once used in medicine as a stimulant, as a laxative, and as a treatment for other stomach ailments (Morton 1934).The Jesuits valued the seeds as a remedy against cholera and named them Ignatius beans after the Jesuit founder St Ignatius Loyola. Strychnine's stimulant effects also led to its use historically for enhancing performance in sports. . The rationale for testing Ignatia is both clinically and experimentally grounded. Ignatia is one of the homeopathic remedies most commonly used on patients with anxiety symptoms, depression, manic episodes, emotive urination and diarrhoea, as well as hyperaesthesia and hypersensitivity to emotions (BoerickeW .1927: Barbancey J. 1987. Guermonprez M. 200). It is also one of the first remedies to have been studied in laboratory animals. However these works were published in non-indexed journals and consistent evidence for efficacy with validated models is lacking. Recent in vitro studies on the rat spinal cord and limbic system have shown that synthesis of the stress-related neurosteroid allopregnanolone is stimulated by Gelsemium and blocked by strychnine (the latter in non-homeopathic doses). Ignatia has been previously investigated by some authors in rodent models, but the results reported are not always consistent, chiefly due to uncertainty connected with the methodology and a lack of statistical evaluations. In 1978 Binsard tested the effect of Ignatia 3C, 7C and 30C in the 'hole-board' and 'escape' tests, finding a possible anxiolytic effect for the 3C dilution/dynamization. In order to rule out

any possible bias due to experimenter interventions or cage effects, a procedure was introduced using randomised and blind conditions. Two validated animal models, the Open-Field test and the Light-Dark choice test, were used to acquire various behavioural parameters widely employed in neuro psychopharmacology for drug screening.

2.5. Antibiotics

Antibiotics were widely utilized as a growth promoter in animal nutrition (Grashorn, 2010; Nasir and Grashorn, 2010). Antibiotic utilization in animal nutrition was restricted causing an increase in diseases, morbidity and mortality of animals (Khan *et al*., 2012; Attia *et al*., 2014 a, b and Attia *et al*., 2017).

The antibiotic growth promoters have been used for decades as growth promoters to increase the animal daily weight gain (Walton 1983). “The administration of sub therapeutic antibiotics and antimicrobial agents has been shown to be effective” (Hughes & Heritage 2009). However, there has been a concern from the beginning that the use of antibiotics in feed may lead to either direct or cross resistance in microorganisms and reduce the activity of clinically useful antibiotics (Walton 1983). With regard to human and animal health, as well as to the risk for environment, the European Union banned the use of antibiotics as growth promoters from the year 2006 (European Commission 2003). The concern of course stays in countries where the antibiotics are still in use. The removal of antibiotic growth promoters from poultry diets has generated wide interest in searching alternatives. Recently, many studies have focused on the effects of essential oils (EOs) in animal nutrition as substitutes of antibiotic growth promoters. So far, there is no evidence that the essential oils help significantly to gain weight. However, they show to maintain the health and performance of animals. In addition, they have shown to have a positive effect on intestinal microbiota and in the secretion of endogenous digestive enzymes in poultry nutrition (Williams & Losa 2001; Jamroz *et al*.

2005; Jang *et al*. 2007). Antibiotic growth promoters, as well as other compounds, such as organic acids, ligosaccharides, probiotics, and enzymes, are some typical compounds added to animal diets to increase the efficiency of digestion, absorption and consumption of nutrients (McDonald, 2002). Antibiotics have been used in animal nutrition since the 1940s when the growth promoting effect was discovered (Dibner & Richards 2005). The best known feed antibiotics include mocimycin, avilamycin, and flavophospholipol (Castanon 2007).The knowledge about the mode of action of these chemical compounds is indistinct. They are thought to promote animal growth by interacting with intestinal microbial populations, reducing the number of bacteria in the gut and thereby increasing the availability of nutrients to the animal (Dibner & Richards 2005). Recently, it was hypothesized that the antibiotics alter the inflammatory cells in the intestinal wall, andin that way cause changes in intestinal microbiota (Niewold 2007). However, some bacteria have developed antibiotic resistance and thereby increased concern about the use of antibiotics as growth promoters in animal feed. The use of antibiotics as growth promoters is in several countries restricted (McDonald *et al*. 2002; Castanon 2007). In the European Union (EU) antibiotics as growth promoters were prohibited from 1 January, 2006 (European Commission 2003). The ban of antibiotic growth promoters can have consequences in international trade as the EU imports only animal products obtained from farms not using antibiotics. This is also one of the reasons, why it is expected that the antibiotics will also be restricted outside the European Union, for example in the United States (Castanon 2007 and Windisch *et al*.2008).

Antibiotic growth promoters in livestock and poultry production are practiced for many years to promote the growth and to improve the feeding efficiency thereby improving the health of the animal and the birds. But the inclusion of these growth promoters increases not only the cost of production but also increases the development of resistant

microbes and produces residues in meat and eggs (Sojoudi *et al.*, 2012; Yang *et al.*, 2009).

Currently natural alternatives like probiotics, prebiotics, plant extracts and the essential oils are gaining importance as alternative supplement (Pirogozliev *et al.*, 49 2008; Yang *et al.*, 2008; Ayasan, 2013).

Antibiotics exert a number of therapeutic effects on the gastrointestinal tract (GIT) of animals, with the majority of these being associated with the microbial population established within. To prevent disease outbreaks and promote growth, low, sub-therapeutic concentrations of antibiotics are often added to the diets of livestock. The precise mechanisms of how antibiotics promote growth are not fully understood, but the main effects are focused around the microbiota within the GIT (Gaskins *et al.*, 2002), since some of these antibiotics are not absorbed and early studies demonstrated that oral antibiotics do not promote the growth of germ-free animals (Coates *et al.*, 1955; 1963). It has been proven that microbiota do provide real benefits to the monogastric animal such as production of B vitamins and protection from pathogenic bacteria through competitive exclusion, but it is often forgotten that these benefits come at a cost. Bedford (2000), Dibner and Richards (2005), and Niewold (2007) proposed that microbiota within the GIT exert their negative effects on animal performance.

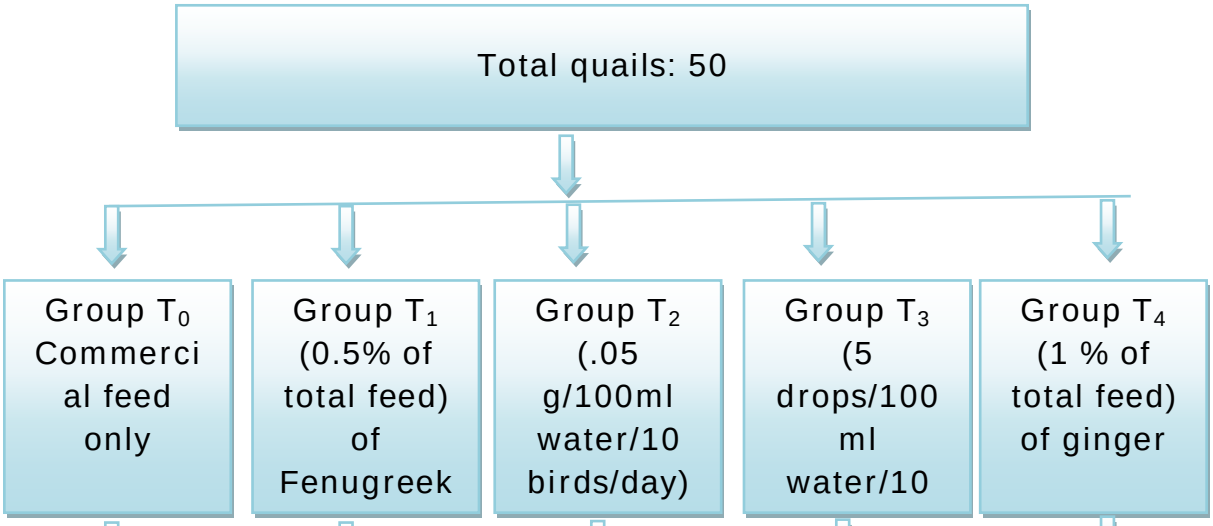
Antibiotics were routinely used in broiler diets at low than therapeutic doses as to improve bird's performance [Kim, S. W., Fan, M. Z. & Applegate, T. J. (2008)]. The use of antibiotics in poultry feed as growth promoter and for health maintenance can cause drug resistance bacteria and antibiotic residue effects [Wray, C. & Davies, R.H. (2000)]. Most antibacterial performance promoters have been banned due to cross and multiple resistances Therefore, researches have been directed towards natural antimicrobial products as

indispensable resources [Ferrini, G., Baucells, M. D.., Esteve- Garcia, E. & Barroeta, A. C. (2008)].

CHAPTER: 3

MATERIALS AND METHODS

Layout of the experiment



In order to find out the effect of different growth promoters on body weight, the studies were made with the following details:

3.1. Ethical approval:

This research was carried out as a part of MS in Physiology after the approval of Chairman of Department of Physiology and Pharmacology, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh.

3.2. Management of experimental birds:

Fifty day-old quails with average body weight 5-8 g were procured from a reputed hatchery for the experiment and distributed randomly into five groups having 10 birds each by randomized block design and allocated to 5 dietary treatments as T_0, T_1 T_2, T_3 and T_4. All experimental birds were fed commercial feed. Experimental birds in control group (T_0) were fed only commercial ration while birds in T_1, T_2, T_3 and T_4 groups were fed on commercial ration supplemented

with 0.50% fenugreek,. 05 g antibiotics, 0.50% ignatia and 0.50% ginger respectively. The average body weight did not differ significantly (P>0.05) among the five groups.

Figure 1: Inspection of day old Quails.

The experiment was carried out at the at poultry farm of Physiology and Pharmacology Department located at Hajee Mohammad Danesh Science & Technology University, city of Dinajpur district in Bangladesh.

A total of 50 day-old quail were taken and maintained for two weeks on similar standard feeding and managemental conditions. These quail were divided randomly into five experimental groups T_0, T_1, T_2, T_3, T_4 having 10 birds in each group.

After two weeks all experimental groups were given different treatments to study the effect of growth promoters on different parameters in quail up to six weeks of age.

Figure 2: Experimental Cage T_0, T_1, T_2, T_3,T_4.

3.3. Growth Promoters:

Growth promoters are the substances that are added to a nutritionally balanced diet which provoke response towards the exploitation of maximum genetic potential of the host, in terms of growth as well as improvement in feed conversion ratio.

Growth Promoters used in present investigation were:

- Fenugreek (*Trigonella foenum-graecum L.*) the recommended dose of fenugreek is 0.5% of total feed supplied to the group.
- Antibiotics the recommended dose of antibiotic Doxy-A(Vet) Powder is .05 g/100ml water/10 birds/day
- Ginger the recommended dose of Ginger is 1% of total feed supplied to the group.
- Ignatia the recommended dose of Ignatia 200 is 5 drops/100ml water/10 birds/day

Ginger Ignatia Fenugreek Antibiotic

Figure 3: Different growth promoters Fenugreek, Ignatia, Ginger, Antibiotic

The details of experimental groups used in present investigation have been presented in

Table-1. Treatments given to different groups:

T_0	Was provided basal diet and served as control.
T_1	Was given basal diet along with recommended dose (0.5%/ total feed) of Fenugreek seed as poeder.
T_2	Was given basal diet along with recommended dose (.05 g/100ml water/10 birds/day) of DOXY- A (VET).
T_3	Was given basal diet along with recommended dose (5 drops/100ml water/10 birds/day) of ignatia amara.
T_4	Was given basal diet along with recommended dose (1 %/ feed) of ginger powder.

3.4. Experimental Rations:

Experimental quails were supplied commercial quail feed manufactured by Aftab feed limited.

Table 2: Calculated percentage and chemical composition of the commercial diet.

Ingredients	Quantity (%)
Corn	56.32
Soybean meal	33.32
Soybean oil	2.86
Salt	0.35
Limestone	5.35
Dicalcium phosphate	1.31
Vitamin and mineral premix1	0.30
DL-methionine	0.14
Choline (70%)	0.05
Total	100.00

Nutrients

Ingredients	Quantity
Crude protein (%)	20.00
Metabolizable energy (kcal/kg)	2900
Calcium (%)	2.50
Available phosphorus	(%) 0.35
Methionine (%)	0.45
Methionine + Cystine (%)	0.76
Lysine (%)	1.07
Choline (mg/kg)	1564

3.5. Feeds and feeding management:

All the birds were fed ad libitum. The feed was of two types, starter and finisher. The starter ration was given up to the age of two weeks and there after the finisher ration was given till the end of experiment. The quail received measured quantity of feed twice (morning and evening) daily after weighing. The left over feed of

previous day measured and subtracted from the total feed given earlier to estimate the actual consumption.

3.6. Provision of Drinking Water:

Fresh and clean drinking water was made available to quails of all the five groups.

3.7. Data recording:

The experimental data pertaining to different traits as per the objectives were recorded as follows:

3.7.1. Body weight:

The quails were weighed individually at Day 0, Day 14, Day 28 and Day 42 during the experimental period in the morning before offering feed, the body weight gain was also calculated.

Figure 4: Measurement of body weight of quails.

3.7.2 Feed consumption:

Feed consumed by birds (g) was recorded daily by subtracting the residue of feed offered to each group daily from total quantities of feed offered to each group.

3.7.3 Feed conversion ratio:

Feed conversion ratios were calculated by dividing the total quantity of feed consumed (g.) by total gain in body weight (g.) during the same period. The actual daily feed consumption was then added to get actual feed consumption during the different times of the experimental periods. The feed conversion efficiency was estimated

on the basis of actual feed intake and gain in body weight by using following formula:

Feed conversion ratio = Feed consumed (g) in a particular period / Gain in live body weight (g) during the same period

3.8 Statistical analysis:

The recorded data was analyzed by the method of SPSS version 20 in Complete Randomized Design (CRD) model.

CHAPTER-4

RESULTS

The present study was conducted on fifty quail birds to estimate the effects of different growth promoters such as Fenugreek, antibiotic, ignatia and ginger on growth, feed conversion efficiency of quail production under cage system of quail rearing.

A total of 50 day old quail chicks were divided randomly into 5 treatment groups comprised with 50 in each group and kept under cage system of management up to 42 days of age.

The data obtained in respect of various parameters studied in the experiment were arranged and analyzed by using standard statistical method. The same data have been presented in various Tables in this chapter.

4.1. Effect of growth promoters on body growth:

Growth of quail birds was ascertained in terms of absolute body weight at day 0, day 14, day 28 and day 42 days of age (Table-3) and body weight gain during 0-14, 15-28, 29-42 day of age.

The effect of growth promoters on body weight of quail birds raised under cage system is presented in Table-1.

The mean values of weight of birds at 0, 14, 28, & 42 days of age were 5.8 ± 0.11, 14.61± 0.25, 36.23 ± 0.62 and 105.4 ± 2 g. respectively (Table 3).

The average weight (g) of birds of T_0 (15.4 ± 0.43) group was significantly higher at 14 day of age than those of T_1 (14 ± 0.49), T_2 (14.17 ± 0.63), T_3 (14.27 ± 0.64), & T_4 (15.23 ± 0.52).

Age	Treatments					Overall	Level of significance
	T_0	T_1	T_2	T_3	T_4		
0 day	5.45 ± 0.22	5.53 ± 0.29	6 ± 0.22	5.9 ± 0.26	5.9 ± 0.23	5.8 ± 0.11	NS
14th day	15.4 ± 0.43	14 ± 0.49	14.17 ± 0.63	14.27 ± 0.64	15.23 ± 0.52	14.61 ± 0.25	**
28th day	32.12^{a} ± 0.66	39.08^{c} ± 0.34	31.16 ± 0.94^{a}	41.44^{d} ± 0.30	37.32^{b} ± .0.43	36.23 ± 0.62	**
42nd day	93.73^{b} ± 0.88	107.87^{c} ± 0.72	88.08^{a} ± 0.51	127.75^{d} ± 0.64	109.58^{c} ± 0.37	105.4 ± 2	**

The body weight (g) of birds of T_3 group showed significantly higher body weight (41.44 ± 0.30) than those of T_0 (32.12 ± 0.66), T_1 (39.08 ± 0.34), T_2 (31.16 ± 0.94) & T_4 (37.32 ± .0.43) at 28 days.

The body weight (g) of birds of T_3 group showed significantly higher body weight (127.75 ± 0.64) than those of T_0 (93.73 ± 0.88), T_1 (107.87 ± 0.72), T_2 (88.08 ± 0.51 & T_4 (109.58 ± 0.37) at 42 days.

Table-3: Effects of different growth promoters on average body weight of quails at 0 day, 14th day, 28th day and 42nd day:

The effect of growth promoters on body weight of quail birds raised under cage system is presented in Table 3.

Figures in parentheses are the number of observations.

Values with same superscripts in a row did not differ significantly.

** P < 0.01, NS = Non-Significant.

4.2. Effect of growth promoters on body weight gain:

The variations in weight gain during experimental period due to growth promoters are presented in Table 4.

Average body weight gain (g) of quail birds at various ages raised under cage system of management with different growth promoters:

The overall mean values of gain in body weight (g) of birds during 0-14, 15-28 and 29-42 days of age were 9.27 ± 0.60, 21.61 ± 0.70 & 69.17 ± 1.5 respectively (Table 4).

During 0-14 days, the average gain in body weight (g) was significantly more for birds of T_0 group (9.95 ± 0.54) than that of T_1 (8.47 ± 0.61), T_2 (8.17 ± 0.78) & T_3 (8.37 ± 0.6). However, it did not differ significantly from those of T_4 (9.27 ± 0.59).

The average body weight gain (g) was observed to be maximum in T_3 (27.17 ± 0.64) followed by T_1 (25.08 ± 0.53), T_4 (22.09 ± 0.66), T_2 (17 ± 1.34) & T_0 (16.72 ± 0.77) during 15-28 days of age. T_3 group of birds showed significantly higher body weight gain than those of T_0& T_2. However, it did not differ significantly from that of T_1 and T_4.

Analysis of variance revealed that the effects of growth promoters on average body weight gain (g) of quail birds were non-significant at 0-14 days (1.4) and highly significant (P<0.01) at 15-28 days and 29-42 days (Table 4).

Table-4 Effects of different growth promoters on average body weight gain of quails at 0-14 day, 15-28 day and 29-42 day:

Age	Treatments					Overall	Level of significance
	T_0	T_1	T_2	T_3	T_4		
0-14 day	9.95 ± 0.54	8.47 ± 0.61	8.17 ± 0.78	8.37 ± 0.6	9.27 ± 0.59	9.27 ± 0.60	NS
15-28 day	16.72^{a} ± 0.77	25.08^{c} ± 0.53	17^{a} ± 1.34	27.17^{c} ± 0.64	22.09^{b} ± 0.66	21.61 ± 0.70	**
29-42 day	61.6^{b}± 0.87	68.8^{c}± 0.8	56.91^{a} ± 1	86.3^{c} ± 0.7	72.26^{d} ± 0.49	69.17 ± 1.50	**

Figure in parentheses are of number of observations.
Values with same superscripts in a row did not differ significantly.
**P < 0.05, NS = Non-Significant.

4.3. Feed Consumption:

Feed consumption and feed conversion ratio were estimated during experimental periods for different treatment and control groups under cage system of management. The results have been presented in table 5.

4.3.1 Average feed consumption

Average feed consumption in different time interval (0-14, 15-28, 29-42 days of age) have been shown separately in Table 5.

The mean values of feed consumption by birds of control group (T_0) were 16.38± 0.48, 85.76 ± 0.67 and 174.38 ± 0.89g during 0-14, 15-28 & 29–42 days of age respectively.

The birds of treatment groups (T_1) feeding consumed feed on an average 16.37 ± 0.41, 71.58 ± 0.81 and 159.5± 0.92 g during 0-14, 15-28 & 29–42 days of age respectively.

The birds of treatment groups (T_2)feeding consumed feed on an average 15.63 ± 0.52, 83.67 ± 0.79 and 159.74 ± 0.78g during 0-14, 15-28 & 29–42 days of age respectively.

The birds of treatment groups (T_3) feeding consumed feed on an average 16.83 ± 0.44, 97.36 ± 0.96 and 200.74 ± 0.6g during 0-14, 15-28 & 29–42 days of age respectively.

The birds of treatment groups (T_4) feeding consumed feed on an average 16.63 ± 0.52, 83.67 ± 0.79 and 159.74 ± 0.78g during 0-14, 15-28 & 29–42 days of age respectively.

Table 5: Effects of different growth promoters on average feed consumption of quails (g/bird) at 0-14 day, 15-28 day and 29-42 day:

Age	Treatments					Level of significance
	T_0	T_1	T_2	T_3	T_4	
0-14 day	16.38± 0.48	16.37± 0.41`	15.63 ± 0.52	16.83 ± 0.44	16.63 ± 0.51	NS
15-28 day	85.76^{b} ± 0.67	71.58^{a} ± 0.81	83.67^{b} ± 0.79	97.36^{c} ± 0.96	84.07^{b} ± 0.71	**
29-42 day	174.38^{b} ± 0.89	159.5^{a} ± 0.92	159.74^{a} ± 0.78	200.74^{d} ± 0.6	189.1^{c} ± 0.58	**

Figure in parentheses are of number of observations.

Values with same superscripts in a row did not differ significantly.

**< 0.05, NS = Non-Significant.

4.3.2 Feed conversion ratio

Cumulative feed conversion ratio have been calculated for different treatment and control group and presented in Table 6.

The FCR (Feed conversion ratio) ranged from 1.69:1 (T_0), 2:1 (T_1), 2.09:1 (T_2), 2.1:1 (T_3) and 1.85:1 (T_4) during 0-14 days of experimental period. The FCR (Feed conversion ratio) was lower for group T_3 (2.32 ± 0.01) followed by groups T_1 (2.32 ± 0.02), T_4 (2.61 ± 0.01), T_2 (2.81 ± 0.04) and T_0 (2.83 ± 0.04) during 29-42 days.

Table 6: Effects of different growth promoters on average feed conversion ratio of quails at 0-14 day, 15-28 day and 29-42 day:

Age	Treatments					Level of significance
	T_0	T_1	T_2	T_3	T_4	
0-14 day	1.69 ± 0.11	2 ± 0.12	2.09± 0.23	2.1 ± 0.23	1.85 ± 0.12	NS
15-28 day	5.24^{c}± 0.28	2.86^{a} ± 0.08	5.22^{c} ± 0.42	3.6^{b} ± 0.08	3.84^{b} ± 0.15	**
29-42 day	2.83^{c} ± 0.04	2.32^{a} ± 0.02	2.81^{c} ± 0.04	2.32^{a} ± 0.01	2.61^{b} ± 0.01	**

Figure in parentheses are of number of observations.

Values with same superscripts in a row did not differ significantly.

**P < 0.05, NS = Non-Significant.

CHAPTER-5

DISCUSSION

Results mentioned in preceding chapter pertaining to body weight, body weight gain, feed consumption, feed conversion ratio of quail birds reared with different growth promoters under cage system of management have been discussed under the following sub-heads :

Body weight

The mean values of body weight of quail birds reared with growth promoters in cage system of management from day - old to 6th week of age are presented in Table 3.

The overall mean body weight of day-old chicks of quail birds under cage system of management was 5.8 ± 0.11g. The variations in body weight of quail birds from 15-42 days of age due to growth promoters were significant.

The birds of T_3 group which were administered Ignatia weighed heavier 127.75 ± 0.64 at 42 days of age than those of other treatment and control groups (Table 3). It is also evident that birds getting growth promoters from 15-42 days of age weighed heavier than that of control group indicating that growth promoters have positive impact on growth. The findings of this study are in close conformity with the observations of Panda *et al*. (1999), Shinde (2004), Kabir *et al*. (2004), Iyayi and Davies (2005), Dhekane (2005), Kannan *et al*. (2005), Bozkurt et.al.(2008), Paul *et al*. (2010), Amer and Khan (2012) and Ogunwole *et al*. (2012) who reported that supplementation of growth promoter had significant effect on body weight in quail.

The increase in the body weight due to addition of growth promoter Ignatia in drinking water might be due to relief of anxiety symptoms of birds (Boericke W, 1927; Barbancey J.1987; Guermonprez M.,2006). Japanese quails are usually stressed due to anxiety caused by handling during feeding, watering and during other managemental works. They are also stressed during transport and due to other

environmental factors such as extreme hot or cold climate, light, noise, over-crowding, sights and smells surroundings etc. Chronic stress induces numerous and various negative consequences on animals, and birds, psycho-physiological state. It often affects immune system in Japanese quail(Nazar FN, Marin RH:2011).
In the meat industry, it has been clearly shown that stressed animals have lower meat quality. Two major quality problems in meat are DFD (Dark, Firm and Dry) and PSE (Pale, Soft, Exudative). PSE affects pigs and in some cases poultry, whereas DFD affects all kinds of animals. DFD is caused by lack of glycogen, whereas PSE is caused by an increased speed of the glycolysis level in the meat which is a result of stress to the animal due to capture, transport, handling etc. (Warriss, 2000).

Animal or bird in stress does not show optimum growth performance (Broom and Johnson, 1993; Egidius, 1994; Jensen, 1993; Jensen 1996; Johnson, 1993; Klemm 1993; Vestergaard, 1979). As ignatia relieves anxiety and stress condition, body weight increases in Japanese quail.
The results of present study are also in accordance with the findings of Reza *et al*. (1983), Mujeer *et al*. (1988), Mujeer *et al*. (1990), Das and Roy (1991), Dhande *et al*. (1991), Kulkarni and Thakur (1992), Baidya *et al*. (1993), Narhari (1993), Kadlec *et al*. (1994), Mishra & Khan(1994), Okolelova *et al*. (1994), Coelho and Naughtern (1995), Jamroz *et al*. (1995), Kumararaj *et al*. (1997), Kailashwar *et al*. (1998), Biswas *et al*. (1999), Panda *et al*. (1999), Marandi (2001), Kabir *et al*. (2004), Shinde (2004), Suchy *et al*. (2006), Karadkar *et al*. (2007), Hassanein and Soliman (2010), Drinceanu *et al*. (2010), Saied *et al*. (2011), Pervez, Rafiullah and Abdul Sajid (2011), Mehmet Amrutand Ayhan Filazi (2012) and Abdelrahman (2013) who repoted that supplementation of growth promoters resulted improvement in total body weight of quail as compared to those fed Similar results in respect of use of growth promoters and probiotics on body weight in poultry also have been reported by various workers Miles *et al*.

(1981), Kumararaj *et al*. (1997), Chazalal and Ibrahim (1998), Saha (2002), Sar *et al*. (2003), Arslan and Saatchi (2004), Sehu and Cakir (2004), Guler *et al*. (2005), Pakhira and Samanta (2006), Marina *et al*. (2006), Bhardwaj *et al*. (2009) and Panchbuddhe *et al*. (2010) who reported that supplementation of growth promoter had significant effect on body weight in Japenese quail on basal diet only.

However, Miles *et al*. (1981), Tarasewiez *et al*. (2000), Szezerbiska *et al*. (2000), Sar *et al*. (2003) and Sehu and Cakir (2004), Cakir *et al*. (2008), Chumpawadee *et al*. (2009) reported that the supplementation of probiotic did not show any effect on live weight in Japanese quails is not in conformity with the present findings. The differences in the results might be due to differences in the live micro-organisms added in the probiotic used in the experiment, type of birds and the environmental factors.

The present findings revealed that the response of growth promoter and combination of growth promoters reflected by the change in body weight during growth period was significantly better than that of control in cage system of management in quail birds. Therefore, the diet supplemented with growth promoters such minerals, vitamins and probiotics may be provided for proper growth in quail birds.

The average body weight gains of quail birds during various periods reared with growth promoter and probiotic under cage system of management are presented in Table 4. There was significant ($P<0.05$) effect of growth promoters on body weight gain during 0-14, 15-28, and 29-42 days of age in quail birds kept under cage system of management. The weekly and daily body weight gain was observed to be maximum during 29-42 days of age in the birds reared with growth promoters.

The results of present study are in accordance with the findings of Ramakrishna (1991), Pradhan and Basu (1993), Yeo and Kim (1997),

Naik *et al*. (2000), Anjum *et al*. (2005), Mehr *et al*. (2007), Paryad and Mahmoud (2008), Bozkurt (2008) and Paul *et al*. (2010) who reported that supplementation of growth promoters had significant effect on body weight gain in quail birds. The increase in the body weight gain due to addition of growth promoter in the feed might be attributed to the direct action of the different ingredients leading to meet the deficiencies of minerals and vitamins.

The results of present study in respect of probiotic are also in accordance with the findings of Bhatt *et al*. (1995), Kailaswar *et al*. Maiorka *et al*. (2001) and Pervez *et al*. (2011 who reported that supplementation of growth promoters resulted improvement in body weight gain of quail birds as compared to those fed on basal diet only. This action might be due to live micro-organisms mainly lactic acid bacteria and spore forming organisms, minerals, vitamins and its synergistic effect which help in the establishment of intestinal population which are beneficial to the proper growth in quail birds. However, the present findings did not agree with the findings of Florou Paneri *et al*. (1993), Yalcin *et al*. (1997), Maiorka *et al*. (2002), Iyayi and Davies (2005), Pierce *et al*. (2006) and Abdelrahman (2013) who reported that supplementation of probiotic did not show effect on body weight gain in quail birds. The differences in the results might be due to differences in the probiotic, type of birds used in the experiment and the environmental factors.

Similar results in respect of use of growth promoters and probiotics on body weight gain in poultry also have been reported by various workers Joshi and kumar (1987, Asmita *et al*. (2001), Saha (2002), Marina *et al*. (2006), Avci *et al*. (2007), Ocak *et al*. (2009) and Panchbuddhe *et al*. (2010). The present findings revealed that the response of growth promoter reflected by change in body weight gain during growth period was significantly better than that of control in cage system of management in quail. The perusal of results pertaining to growth rate revealed that the diet supplemented with

growth promoter may be provided for better growth efficiency in quail birds.

Feed consumption

The mean values of feed consumption during various periods of growth in the birds reared with growth promoters in cage system of management are presented in Table 5. An increasing trend in feed consumption was observed with increase in age of quail birds raised in different treatment groups including control group under cage system of management. During 29-42 days of age the birds of treatment group consume on an average (T_1) 159.5 ± 0.92, (T_2) 159.74[a] ± 0.78, (T_3) 200.74 ± 0.6, (T_4) 189.1 ± 0.58 g/bird/day, whereas control (T_0) group consume 174.38 ± 0.89 g/bird/day.

The average highest feed consumption was observed in 6th week of age indicating that as the age increases the feed consumption by quail birds increases. The highest feed consumption was observed in (T_3) 200.74 ± 0.6 and lowest in (T_1) 159.5 ± 0.92 during 29 to 42 days of age (Table 5).

The reason of lowest feed consumption in group T_1 may be the adverse effect of antibiotics on quail body. On the other hand, Ignatia relieves excitement and stress in Japanese quail. So, highest feed consumption was observed in group T_3.

Feed conversion ratio

The mean values of average feed conversion ratio (FCR) during various periods of growth in the birds reared with growth promoters in cage system of management are presented in Table 6.

The results of present study are in accordance with the findings of Singh *et al*. (1974), Shrivastava (1980), Ramakrishna (1991, Kulkarni and Thakur (1992), Paneri *et al*. (1993), Shinde (2004), Bozkurt (2008), Cakir *et al*. (2008) who reported that supplementation of growth promoters did not show significant effect on feed

consumption. However, the present findings did not agree with the findings of Maiorka *et al*. (2002) Marina *et al*. (2006), Shareef and Dabbagh (2009 Saied *et al*. (2011) Pervez *et al* (2011), Mehmet *et al*. (2012) and Amer and Khan (2012)who reported that supplementation of growth promoters showed significant effect. The differences in the results might be due to differences in the feed ingredients added in the growth promoters used in the experiment, type of birds and the environmental factors.

Similar findings in respect of use of growth promoters and probiotics on feed conversion ratio in poultry also have been reported by various workers like Miles *et al*. (1981), Kumararaj *et al*. (1997), Szczerbiska *et al*. (2000), Asmita *et al*. (2001), Arslan and Saatchi (2004), Sakhawat *et al*. (2005), Pakhira and Samanta (2006), Panchbuddhe *et al*. (2010), In general, the feed consumption and feed conversion ratio under cage system of management was observed to be better than control. Although, the differences in feed consumption and feed conversion ratio observed in the present study were non-significant during 0-14 days of age in cage systems of management.

CHAPTER 6
CONCLUSION

The quails reared with supplemented growth promoters such as ginger, fenugreek, ignatia and antibiotics in different treatment groups performed better for all economic traits as compared to those reared with commercial diet only. Those growth promoters in combination or alone may be used with commercial diet for getting more return from commercial quail farming. According to this research article ignatia ensures increased body weight gain with good feed conversion ratio. Fenugreek can also be used in quail production as it is more economic than ignatia and serves a good body weight gain. But use of antibiotics as growth promoter can be avoided as it results less and more expensive. In this research, effects of growth promoters in growth performance of quail was seen. Further research may be done on growth promoters regarding its effects on carcass, hematological effects and immunological responses.

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