

بسم الله الرحمن الرحيم

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COLLEGE OF GRADUATE STUDIES

**EFFECT OF FEEDING BROILER CHICKS ON DIFFERENT
LEVELS OF FENUGREEK SEEDS ON THE PERFORMANCE
AND CARCASS CHARACTERISTICS**

أثر تغذية مستويات مختلفة من بذور الحلبة في الأداء العام للدجاج اللحم وخصائص الذبيح

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إِسْتِهْلَالٌ

قال تعالى:

﴿وآية لهم الأرض الميتة أحييناها وأخرجنا منها حبا فمنه يأكلون﴾

يس (33)

صدق الله العظيم

DEDICATION

I would like to make a number of important dedications with this work.

First, to **my mother and my father's soul**

who have allowed me to become the person I am, and they were my eyes
when I couldn't see.

To my dearest helpmate, **my wife**

for constant encouragement, limitless giving and great sacrifice,
helped me accomplish my study. For every dream she made come true.

She has been my inspiration.

To my beloved **brothers and sisters**

for all those time they stood by me.

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ABBREVIATIONS

FSP	<i>Fenugreek Seed Powder</i>	6
LDL	<i>Low Density Lipoprotein</i>	6
HDL	<i>High Density Lipoprotein</i>	6
VLDL.C	<i>Very Low Density Lipoprotein Cholesterol</i>	6
SDF	<i>Soluble Dietary Fiber</i>	6
TG	<i>Triglyceride</i>	6
FBS	<i>Fasting Blood Sugar</i>	6
RBCs	<i>Red Blood Cells</i>	6
T.WBCs	<i>Total White Blood Cells</i>	13
Hb	<i>Hemoglobin Concentration</i>	13
PCV%	<i>Packed Cell Volume Percentage</i>	14
CHOD	<i>Cholesoxidase</i>	14
POD	<i>Peroxidase</i>	19
FSF	<i>Fenugreek Seeds Flour</i>	19

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ABSTRACT

A total of hundred and twelve day-old unsexed broiler chicks (Ross 308) were used to investigate the effect of graded levels (0, 1, 2 and 3%) of fenugreek seed powder on the performance, carcass characteristics and some blood serum attributes of broiler chicks. Chicks were randomly distributed in a complete randomized design into four groups (A, B, C and D) each group having four replicates with seven chicks per each. Chicks in group A fed control diet, group B fed on diet containing 1% Fenugreek seed powder (FSP), group C fed on diet supplemented with 2% FSP and group D fed on diet supplemented with 3% FSP. The experimental diets were formulated to satisfy the nutritional requirements of growing broiler chicks according to NRC (1994) recommendations. The results obtained revealed that chicks fed on 1% FSP recorded significantly ($P < 0.05$) the heaviest body weight compared to all tested groups, while those fed on control diet recorded significantly the lowest body weight value. There were no significant differences in body weight gain among groups fed on FSP, but they were recorded significantly high body weight gain compared to control groups. Chicks fed on diets supplemented with FSP consumed significantly more feed and recorded the best conversion ratio (FRC) value compared to untreated group. Result also indicated no significant affect on the health of the experimental chicks due to the treatments. The addition of FSP significantly affects on the dressing percentage, no significant affects on the carcass characteristics and the value of subjective meat quality. Supplementation of FSP on the broiler diets significantly decreased serum cholesterol, total protein, albumin and calcium. It can be concluded that supplementation of FSP to broiler diets showed a great role in improving growth performance, carcass characteristics and reduction in serum cholesterol. Economically chicks fed on diets supplemented with FSP recorded the highest profit.

ملخص الدراسة

تم اجراء هذه الدراسة لتقييم اثر إضافه مستويات مختلفه من بذور الحلبه في علائق الدجاج الاحم على الأداء الإنتاجي وصفات الذبيح وصفات الدم. استخدمت في هذه الدراسه عدد ١٢٠ كتكوت عمر يوم غير مجنسة من سلالة روس ٣٠٨، بهدف دراسة تأثير إضافه مستويات مختلفه (٠ ، ١ ، ٢ ، و ٣ %) من مسحوق بذور الحلبه الي علائق الدجاج اللاحم في الأداء الإنتاجي، صفات الذبيح وبعض خصائص المصل. قسمت الكتاكيت عشوائيا الي اربعة مجاميع (أ، ب، ج و د) وتم تقسيم كل معاملة الي اربعة مكررات بواقع (٧طيور/مكرر). غذيت الكتاكيت في المجموعه (أ) بالعليقه القياسيه (بدون اي إضافه). المجموعه (ب) غذيت علي العليقه القياسيه +١% من مسحوق بذور الحلبه. المجموعه (ج) غذيت علي العليقه القياسيه مضافا اليها ٢% من مسحوق بذور الحلبه والمجموعه (د) غذيه علي العليقه القياسيه مضافا اليها ٣% من مسحوق الحلبه. تم تركيب العلائق لتتفق باحتياجات الدجاج اللاحم حسب توصيات NRC (١٩٩٢) واطهرت النتائج تفوقا معنويا ($P > 0.05$) لصالح المجموعه التي تغذت علي العليقه المحتويه علي ١% من مسحوق بذور الحلبه علي الوزن الحي مقارنة بالمجموعات الأخرى بينما سجلت المجموعه القياسيه اقل فرق معنوي ($P > 0.05$) وعلي كل اظهرت النتائج تفوقا معنويا ($p < 0.05$) لصالح المعاملات (ب، ج، د) معاملات الحلبه مقارنة بالمعاملة القياسيه في كل من الوزن المكتسب واستهلاك العليقه ونسبة التحويل الغذائي. لم تظهر النتائج فروقات معنويه ($p > 0.05$) في نسبة النفوق، خصائص الذبيح وصفات اللحم.

اما بالنسبه لصفات المصل فقد اظهرت النتائج إنخفاضا معنويا للكلاسترول والبروتين الكلي، الزلال والكالسيوم في الدم. نستنتج من هذه الدراسه ان لإضافه مسحوق بذور الحلبه الي علائق الدجاج اللاحم القدرة علي تحسين النمو، خصائص الذبيح وتخفيض كلاسترول الدم وزيادة ربحية.

Chapter One

Introduction

Use of antibiotics as growth promoters in animal nutrition have been banned due to their adverse and side effects on both animal and human health (Marzo, 2001), so there has been an increasing trend towards using natural feed additives which noted to improve the performance, increase the dietary protein, energy utilization and to maintain health of birds (Abdel-Aal and Attia, 1993, El-Katcha, 1990). Herbs and plant extracts are good alternatives to antibiotics (Tuncer; Kutlu, 2007).

Fenugreek (*Trigonella foenum-graecum.*), is an annual legume, cultivated all over the world, is one of the herbs having multi-functional characteristics (Anonymous, 2011a). It is a good source of dietary protein for consumption by human and animals. Nazar and ElTinay (2007) reported that fenugreek seeds contained 28.4% protein, 9.3% crude fiber and 7.1% crude fat and have many chemical compounds. Seeds are considered as an appetizer and helps in digestion; improve growth performance and health (Abou El-wafa *et al.*, 2003 and Sadoval *et al.*, 1999). Seeds also have many therapeutic effects like hypoglycemic, antibacterial, anti-inflammatory, antipyretic, antimicrobial and antioxidant properties (Basch *et al.*, 2003; Ahmadiani *et al.*, 2001; Devasena and Menon, 2003 and Xue *et al.*, 2007), and sufficient vitamins (Srinivasan, 2006).

Several investigators reported that supplementation of poultry diets with fenugreek seed lower plasma total lipids and total cholesterol in broiler chicks (Azoua, 2001) and improve the reproductive and physiological performance of rabbit and mouse and broiler breeder males (Taha, 2008).

Therefore, this study was designed to examine the effect of graded levels of fenugreek seed powder supplementation on the performance, carcass characteristics, plasma blood constituents and economical attributes of broiler chicks.

Chapter Two

Literature Review

2.1 Description and Distribution:

The fenugreek is an erect small annual leguminous herb belonging to the family of fabaceae of the genus *Trigonella*. The plant grows up to about 2 feet high, similar in habit to Lucerne, with light green color trifoliate leaves and white flowers, it bears long slender, yellow-brown pods containing 10-20 golden-yellow color seeds. The seeds are brownish, about 1/8 inch long, rhomboidal, with a deep furrow dividing them into two unequal lobes.

They are contained, ten to twenty together, in long narrow, sickle, like pods. Raw seeds have maple flavor and bitter taste, however, their taste becomes more acceptable once they were gently dry-roasted under light heat. It is a self-pollinating crop (Petropoulos, 2002).

Fenugreek is native to the Indian subcontinent and the Eastern Mediterranean region. It is currently widely cultivated in central Asia, central Europe, northern Africa, North America and parts of Australia, however, India being the leading fenugreek producer in the world (Fotopoulos, 2002 and Altuntas *et al.*, 2005). The plant is suited to cool and temperate growing regions which have low to moderate rainfall (Acharya *et al.*, 2008). It is known by various names in different countries, i.e. methi (Hindi) in India and also as fenugreek (France), Bockshorcklee (German), Hulba (Arabic), Halba (Malaya), Koroha (Japan), and Ku-Tou (China), (Srinivason, 2005 and Petropoulos, 2002).

2.2 Chemical Constituents:

Chemical composition and antioxidant activity of husk (seed coat) and endosperm of fenugreek seeds have revealed that endosperm has the highest content of saponin (4.63%) and protein (43.8%) (Madhava Naidu *et al.*, 2010). In contrast, husk (seed coat) contains higher amount of polyphenols (103.8 mg of gallic acid equivalent) and total dietary fiber (77.1%).

Schryver, (2002) reported that fenugreek is a good source of dietary protein (20-30%), the fatty acids from 5-10% which are predominantly linoleic, linolenic, oleic and palmitic acids. It had 45-65% total carbohydrates with 15% galactomannan (a soluble fiber).

The seeds contain many phytochemical compounds such as choline trigonelline, diosgenin, yamogenin, gitogenin, tigogenin and neotigogenins. The fenugreek seed is an excellent source of minerals like copper, potassium, calcium, iron, selenium, zinc, manganese and magnesium. It is also rich in many vital vitamins that are essential nutrients for optimum health including thiamin, pyridoxine (vit B6), folic acid, riboflavin, niacin, vitamin A and vitamin C, (Michael and Kumawat, 2003). Rao and Sharma (1987) found that the seeds of fenugreek contained 4.8% saponins. Fenugreek seeds contained 27% protein, 7-10% oil (Akgul, 1973) also, Abd El-Aal and Rahma, (1986) reported that fenugreek is considered to be a good source of crude protein, crude fat and total carbohydrates.

Srinivasan (2006) reported that fenugreek mature seeds (100g) contained protein 30g, fat 7.5g, fiber 50g, saponins, diosgenins, yamogenin, gitogenin, neogitogenin, yuccagenin, tigogenin, sarsasapogenin, smilagenin 2g, trigonelline 380 mg, Ca 160mg, Mg 160mg, P 370mg, Fe 14mg, Na 19mg, K 530mg, Cu 33mg, S 16mg, Cl

165mg, Mn 1.5g, Zn 7.0mg, Cr 0.1mg, Choline 50mg, vitamin C 50mg, B-caroten 90mg, Thiamine 340mg, Riboflavin 290 mg, Nicotinic acid 1.1mg, folic acid 84mg.

Fenugreek seed contains approximately 4-10% moisture, 6-8 fat, 18-30% protein and 48-55% fibers (sauvaire *et al.*, 1976; Sharma, 1986b; Vats *et al.*, 2003 and Srinivasan, 2006) depending on varietal and ecological factors. Hemavathy and Prabhakar (1989) reported the lipid composition of fenugreek seeds that total lipids extracted from dry seeds were 7.5% (neutral lipid 84.1%, 5.4% glycolipids and 10.5% phospholipids).

2.3 Health benefits of fenugreek seeds:

Fenugreek is one of the oldest medicinal plant, dating back to Hippocrates and ancient Egyptian times (Jensen,1992). Fenugreek leaves and seeds have been used extensively to prepare extracts and powders for medicinal (Basch *et.al.* 2003). fenugreek has been used for over two thousand years as a medicinal plant in various parts of the world (Srinivasan, 2006) and may regarded as the oldest medicinal plant, use of fenugreek is associated with a wide range of therapeutic applications including its use as a carminative (prevents flatulence) to its use as an aphrodisiac (Chopra *et al.*, 1982).

Fenugreek seeds are considered as an appetizer and helps indigestion. The seed has antioxidant, antiviral and anticarcinogenic activities (Mazur *et al.*, 1998). The plant is often used for over two thousand years as a medicinal plant in various parts of the world.

2.4 The effect of fenugreek seeds on blood sugar profile:

Pharmacological of fenugreek have been explored to identify a role for the plant in diabetes management (Sharma *et al.*, 1996a; Puri *et al.*, 2002) and in cardiovascular health (Petit *et al.*, 1995b; Sauvaire *et al.*, 1996; Hannan *et al.*, 2003), indicating the presence of bioactive compounds in fenugreek which may be responsible for its health benefits.

Sharma *et al.*, (1990) evaluated the effect of fenugreek seeds on blood glucose and the serum lipid profile in insulin dependent (type 1) diabetic patients. Defatted fenugreek seed powder (100g) divided into two equal doses was incorporated into isocaloric diets for 10 days during lunch and dinner. The fenugreek diet significantly reduced fasting blood sugar and improved the glucose tolerance test. LDL and LDL cholesterol and triglycerides were also significantly reduced, the HDL cholesterol fraction remained unchanged.

Kassaian *et al.*, (2009) carried study to evaluate the hypolipidemic and hypoglycemic effects of fenugreek seeds in types 2 diabetic patients, diabetic patients were placed on 10 g/day powdered fenugreek seeds mixed with yoghurt or soaked in hot water for 8 weeks. Findings showed that FBS, TG and VLDL.C decreased significantly (25%, 30% and 30.6% respectively) after taking fenugreek seeds soaked in hot water, whereas there were no significant changes in lab parameters in cases consumed it mixed with yogurt.

The soluble nature of galactomannan fiber from fenugreek has been linked to numerous human health benefits mainly in the reduction of plasma glucose levels which has an antidiabetic effect (Sharma, 1986b, Madar *et al.*, 1988, Madar and Shomer, 1990). Hannan *et al.*, (2007) also have demonstrated that soluble dietary fiber (SDF) protein of fenugreek can significantly improve glucose homeostasis in type 1

and type 2 diabetics delaying reported use of soluble fiber from fenugreek resulted inhibition glucose absorption in the intestine. Zargar *et al.*, (1992) found that patients taken orally 20gm of powdered fenugreek seed showed significantly drop in fasting sugar levels. Trigonelline, coumarin and nicotinic acid have been isolated from fenugreek seed and shown to be useful in diabetes (Moorthy *et al.*, 2010). Fenugreek leaves and seeds have been used extensively for preparing extracts and powders in medical performance (Basch *et al.*, 2003; Nithya and Ramachandrmurty, 2007).

2.5 The effect of fenugreek seed on lipid profile:

Fenugreek have properties of reducing blood sugar level (Raghuram *et al.*, 1994), anthelmintic, antibacterial (Bhatti *et al.*, 1996), anti-inflammatory, antipyretic (Ahmadiani *et al.*, 2001), and antimicrobial (Alkofahi *et al.* 1996). Administration of fenugreek seed powder 25gm orally twice daily for three weeks and six weeks produces significant reduction of serum total cholesterol, triacyl glyceride and LDL-cholesterol in hyper cholesteremic group (Abu Saleh *et al.*, 2006).

Al-Habori *et al.*, (1998) showed the effect of fenugreek seeds and its extracts on plasma lipid profile on rabbits. Studies have also shown that fenugreek seeds reduce serum lipids in experimental animals. Sharma (1984, 1986) demonstrated that fenugreek administration increased excretion of bile acid and neutral in feces, thus depleting the cholesterol stores in the body of experimental rats. Awal *et al.*, (1999) studied the effect of fenugreek and Karela on lipid profile in hepercholesterolemic diabetic patients and shown that fenugreek significantly reduces the lipid levels .Basch, (2003) suggested the antihyperlipidemic properties of oral fenugreek seed powder.

Xue *et al.*, (2007) concluded that fenugreek extract can lower kidney or body weight ratio, blood glucose, blood lipids and improve hematological properties in experimental diabetes rats. Supplementation of fenugreek seeds were shown to lower serum cholesterol, triacylglycerol and low density lipoprotein in human patients and experimental models of hypercholesterolemia and hypertriglyceridemia (Kassaian *et al.*, 2009).

2.6 Fenugreek as a forage crop:

Fenugreek can be interesting for cultivation as a forage crop for many reasons: as a legume crops which can profit soil for following crops by fixing nitrogen from the atmosphere (Acharya *et al.*, 2008), as a dry land crop (Kumar *et al.*, 2000) as a leguminous component of annual fodder mixtures in feeding of livestock (Mir *et al.*, 1998) and to produce a high quality forage, hay or silage (Mir *et al.*, 1997). Fenugreek has potential as forage crop for ruminant because it contains high quality protein and others benefits of a legume crop rotation (Acar, 2000).

2.7 fenugreek as a functional food:

Fenugreek is best known for presence of the distinctive, pungent aromatic compound in the seed (Max, 1992) that impart flavor, color and aroma to foods, making it a highly desirable supplement for use in culinary application. As a spice, it constitutes one of the many ingredients that make up curry powder (Srinivasan, 2006).

In countries such as India, fenugreek leaves are consumed as leafy-vegetable in the diet (Sharma, 1986b), while in Ethiopia and Egypt, the plant is used as a supplement in maize and wheat flour for bread-making (Al-Habori and Raman, 2002). In Yemen and Persia, fenugreek represents key ingredients in the preparing of daily meals among the

general population (Al-Habori and Raman, 2002). As human food in Turkey, bastoorma is made with meat and spices that included fenugreek seed specially. Fenugreek have a great effect in relation to increasing milk supply in lactating women (Chantry *et al.*, 2004), also it helps to increase urine and menstruation in women. It helps rickets and anemia. Owing to the existence of mucilage, it helps relieve sore throat and is useful in the treatment of asthma and difficult breathing, fenugreek is considered as appetizer and helps in digestion (Mazur *et al.*, 1998). Fenugreek seeds have been recognized as a potential source of saponin, carotene and sex hormones (Brenac and Sauvaire, 1996a,b).

The fenugreek has many traditional uses in Sudan country, like it used for digestive system attractions, and many other extra uses. The young leaves and sprouts are good source of protein mineral and vitamin (Khan *et al.*, 2005; Chhibba *et al.*, 2007) and are used as green vegetable in Pakistan and India alone or with potatoes, spinach and meat. Fenugreek seeds have been extracted for polysaccharide, galactomannan, different saponins such as diosgenin, yamogenin, mucilage, volatile oil and alkaloids such as choline and trigonelline (Aasim *et al.*, 2010).

The herb is widely used in cooking as it adds a distinctive flavor to food; it is an appetizer and lends a good aroma to curries. Its extract used to flavor maple syrup in Germany, cheese Switzerland (Rajagopalan, 1998).

Nabila *et al.*, (2012) studied the improvement role of fenugreek leaves, seeds (dried and germinated) and wheat flour supplemented with germinated fenugreek powder at 5 to 10% levels on iron deficiency anemia in rats. Results of nutritional characteristics revealed that fenugreek flour is a good source of protein, fat, fiber and minerals (Fe,

Carcass and Zn). Biscuits supplemented with 10% germinated fenugreek had the highest content polyphenols. Supplementation of wheat flour with fenugreek flour at 5% and 10% levels increased the vitamin B2 and carotene contents of biscuits, also produced acceptable and high nutritive values of biscuits.

2.8 Use of fenugreek seeds in poultry diets:

Fenugreek in rabbit diets has traditionally been supplemented through different phases of production. Seleem *et al.*, (2008) reported that supplementation of 0-3% fenugreek to rabbit diet showed a great role in enhancing the immune system, improved growth performance, blood metabolites and reproductive performance.

Ahmed, (2011) evaluated the effect of graded levels (5, 10 and 15 gm/kg) fenugreek seeds addition to the Japanese quail males ration on semen quality and testis histological traits. Results showed a significant improvement in ejaculation volume, spermatozoa mortality, viability and semen concentration in comparison with control group. Also, the testis weight, seminiferous tubules diameter, germinal layer thickness and germinal layer area showed significant increase in fenugreek groups. However, fenugreek used as a supplement to poultry feeding to lowering plasma total lipids and total cholesterol in Hubbard broiler chicks (Azoua, 2001) and improve antioxidant status and production performance in laying hens (ALkatan, 2006). Fenugreek seeds improve the reproductive and physiological performance of broiler breeder males (Taha, 2008) and revealed positive significant results of semen trait in aged broiler breeder males (Abdul-Rahman *et al.*, 2010).

Nadir *et al.*, (2012) found that Fenugreek seeds supplementation to broiler chickens diets significantly affected live body weight, feed intake and feed conversion ratio, however, there is no significant difference for the slaughter parameters and mortality.

Sayed and Hesham (2002) studied the feeding broiler chicks on diets containing various levels (1,1.5 and 2%) of local natural feed additives (hot pepper and Fenugreek seeds) at different levels of metabolizable energies (3200,3000 and 2800 Kcal/kg). Chicks fed fenugreek diet had significantly less body weight and higher feed intake and decrease abdominal fat percent.

Rabia (2010) studied the effect of fenugreek, parsley and sweet Basil seeds as natural feed additives on broiler performance. He observed that chicks fed basil diet had significantly heaviest body weight than those fed Fenugreek seeds. However, carcass characteristics had no significant differences.

Alloui *et al.*, (2012) studied the effect of Fenugreek seeds at (3gFenugreek seeds/ kg) as natural growth promoter for broiler chicken. They found that Fenugreek seeds supplementation significantly affected live body weight, feed intake and feed conversion ratio, however, there is no significant difference for the slaughters parameters and mortality.

Farman Ullah *et al.*, (2009) studied the effect of Fenugreek seed extract on the visceral organs of broiler chicks. They found that aqueous extract of fenugreek has amply good effect on the weight of visceral organs. Guo *et al.*, (2004) reported that Chinese herbal medicine containing fenugreek and an antibiotic virginiamycin did not influence the fiber weight in broiler chicks.

Abaza (2007) studied the effect of using some medicinal plants (Fenugreek seeds, chamomile and radish) as feed additives on performance, egg quality, digestibility, blood constituents of laying hens, at the level of 0.5% for each the results showed that supplementation of diet with the medicinal plants increased numerically egg number than those fed control diet, at the same time significantly decreased feed consumption and improved feed conversion.

Metin *et al.*, (2013) fed broiler chicks on diets containing (0, 5, 10, 20 and 40g) fenugreek seed powder per kg commercial broiler diet. Their results revealed decreased in body weight and breast weight in diets supplemented with fenugreek seed powder compared with untreated one, feed intake decreased after 5g Fenugreek seed, while 40g fenugreek treatment decreased feed efficiency. A 20g treatment enhanced blood glucose level and decreased triglyceride level compared to control.

Morsy, (1995) reported significant improvement in body weight gain and dressing percentage with broiler fed diets containing 500g fenugreek. El-Husseiny *et al.*, (2002) also found that chicks fed fenugreek diet had significantly less body weight and higher feed intake than those fed the control diet.

2.9 Effect of some treatments

Shalini and Sudesh (2002) studied the effect of soaking and germination on nutrient and anti-nutrient content of Fenugreek seeds, they found that seeds contained higher amount of dietary fiber (46.5%) compared to soak seeds (42.12%) and germination seeds (32.5%). Soaking reduced the level of total soluble sugars, reducing sugars, non-reducing sugars and dietary fiber but improved the protein and mineral availability. Germinated fenugreek seeds had higher total protein (29%)

content compared to un-germinated fenugreek seeds. Germination decreases dietary fiber and starch content, thereby, raising the level of sugars. Availability of minerals (Fe, Carcass and Zn) improved after germination. Laila and Ahmed (1983) investigated that the major fatty acids of fenugreek seeds reduced after germination.

Carbohydrates of germinating seeds showed an increase of total, reducing, non-reducing sugars and pentosan content and a decrease in polysaccharides and mucilage (El-Mahdy and El-Sebaiy, 1983).

Sathyanarayana *et al.*, (2011) reported that sprouts and endosperm from germinated fenugreek seeds was 49.05% and 13.42% where as the seed coat and endosperm of un-germinated fenugreek exhibited 90.94% and 10.13% antioxidant activity respectively. El-Shimi *et al.*, (1984) reported a decrease in starch content after soaking and germination. Also Hooda and Jood (2003) reported a decrease in soluble dietary fiber of fenugreek seeds on germination, and also a decrease in antioxidant activity.

2.10 Effect of fenugreek seeds on blood parameters

Abdul-Rrahman (2012) found that fenugreek seeds improve blood picture as compared with control represented by the significant in RBCs and hemoglobin concentration, thrombocytes count of broiler breeder males (Arbor Acres cock), treatment has no effect on the T.WBCs and with a significant decrease in the heterophils percentage. Treatment also causes a significant decrease in serum glucose levels, cholesterol and triglycerides levels.

Abdul-Rahman *et al.*, (2010) investigated the role of fenugreek seeds supplementation to the ration of aged broiler breeder male's

inactivation of reproductive performance and improving semen quality in order to elongate their productive age.

Alkatan, (2006) and Taha (2008) studies revealed that fenugreek seeds possess antioxidant activity which increase the stability of RBC membranes through the formation of fatty complexes in the cell membranes that prevent or reduce the free radicles effects (Erin *et al.*, 1984), this was reflected in an increase in the RBCs, and combination of fenugreek and black cumin (T4) improved the body weight gain, FCR, Hb, PCV, serum proteins and reduced serum cholesterol levels (Yatoo *et al.*, 2012).

Chapter three

Materials and Methods

3.1 Duration:

The experiment was conducted in the student poultry premises, College of Agricultural Studies, Sudan University of Science and Technology, Shambat, during the period from 17/12/2011 to 29/1/2012.

3.2 The experimental chicks:

A total of one hundred and twelve, one-day commercial unsexed broiler chicks of Ross-308 strain were obtained from [Inmaa Project for Poultry & Feed-Sudan]. The chicks were divided into four treatment groups of 28 birds each and randomly assigned to the four treatment diets (A, B, C and D), each treatment group was further sub-divided into four replicates of 7 chicks per replicate. Feed and water were provided *adlibitum*. Chicks were vaccinated against Gumboro disease at 9 days of age and against Newcastle disease at 22 days of age. Soluble multivitamins compounds (pantominovit-pantex Holland B.V.5525.ZG Duiz el. Holand), and antibiotic (Colidat), were given to chicks before three days of the vaccination and three days after vaccination in order to guard against stress.

3.3 Housing:

Chicks were kept in an open wire mesh-side poultry house. The house was constructed on concrete floor. The roof was made of metal sheets; the sides were permanently covered with sacks to reduce hot current air. Stands fans and air coolers were used to keep temperature in the house cool. The pens (1m^2) inside the house were prepared using

wire mesh partitioning. The pens were cleaned, washed and disinfected with formalin and phenol solution before the commencement of the experiment. A layer of wood shavings was laid on the pen floor as a litter material. Each pen was provided with 2.5 gallon drinker and 5 kg feeder which were cleaned and disinfected before starting the trial. The feeders and drinkers height was adjusted according to the progressive growth of the chicks. Light was provided 24 hours in a form of natural light during the day and artificial during night.

3.4 Experimental diets:

Fenugreek seeds were purchased from the local market, cleaned, milled, then a sample was analyzed for approximate composition (AOAC, 2000) Table 1. Four experimental (A, B, C and D) diets were formulated to meet the nutrient requirements of broiler chicks according to NRC (1994). Diet A used as control, diets B, C and D contained graded levels (1, 2 and 3%) of raw fenugreek seeds flour. The percent of ingredients inclusion and calculated composition of the experimental diets were present in table 2. The variation in energy concentration were readjusted with aid of vegetable oil where required. Also diets were supplemented with amino acids where necessary.

Table1. Percent composition of fenugreek seeds (dry matter basis)

Item	Percent
Moisture	4.1
Dry matter	95.9
Crude protein	25.68
Ether Extract	27.6
Crude Fiber	0.4
N. Free Extract	34.83
Ash	7.39
ME (Mcal/Kg)	2.3896

Lodhi et al., (1976)

Table2. Percent inclusion rates of dietary ingredients used in the experiment

Ingredient	Control	1% Fs	2% Fs	4% Fs
Sorghum	65.75	65.50	64.68	64.16
Groundnut cake	13.00	12.00	12.00	10.70
Sesame cake	15.00	14.00	14.00	15.00
Super concentrate	05.00	05.00	05.00	05.00
Oyster shell	1.00	0.58	0.57	0.53
Salt	0.25	0.25	0.25	0.25
Fenugreek seed	-	1.00	2.00	3.00
lysine	-	0.13	0.07	0.02
Methionine	-	0.08	0.07	0.05
Vitamin	-	0.2	0.2	0.2
Vegetable oil	-	1.26	0.98	1.09
Calculated composition				
Crude Protein	22.04	22.19	22.54	22.05
ME	3133.11	3110.5	3121.37	3175.0
lysine	1.148	1.300	1.250	1.3
Methionine	0.467	0.540	0.640	0.540
Ca	1.18	1.0	1.18	1.0
Phosphorus	0.65	0.63	0.63	0.63

*ME (Metabolizable energy): calculated by the following equation by (Lodhi et al., 1976)

$$ME_p : 1.549 + 0.0102 (CP) + 0.0275 (EE) - 0.0148 (NFE) - 0.0034 (CF).$$

*Super concencte: crude protein 40%, ME 2000 Kcal/kg, crude fiber 3% ; calcium 8%, lysine 12 %, Methionine 3% , available phosphorus 8%,

*Vitamins: vit. A 2500 I.U/Kg ; D3 2500 I.U/Kg ; E 25 mg/Kg ; C 400 mg/Kg ; B2 100 mg/Kg .

*Iron 800mg/ kg, folic acid 30 mg/Kg, choline 1000 mg/Kg, Carcass 21%.

3.5 Data collection:

Chicks of each replicate were group weighted at weekly interval and feed consumption was recorded at the time of weighing. Mean body weight gain and feed conversion ratio (FCR) were calculated weekly. Mortality was recorded daily throughout the experimental period,

Blood samples were collected from the wing of birds (one from each replicate) before slaughter in heparinized tubes. The blood samples were centrifuged at 3000 rpm for 15 min. and plasma obtained was stored at -20C° until analysis. Plasma total protein(total protein kit (Biuret method)), albumin, total lipids, total cholesterol(cholestoxidase, peroxidase (CHOD - POD) method), creatine and triglycerides were determined using spectrophotometry., Ca⁺⁺ = total colorimetric method.

3.6 Carcass Preparation:

At the end of the experiment, the chicks were fasted overnight except from water, one chick from each replicate was randomly selected, individually weighted and slaughtered.

After bleeding the slaughtered chicks were scaled in hot water, feathers plucked manually then washed and drained, after evisceration .The hot carcass and the individual organs, the liver, heart, gizzard and legs were separately weighted and they expressed as a percentage of live weight.

The carcasses were chilled at 4C° for 24 hours for carcass characteristics and meat yield, and then they were sawed into two halves. The left side then divided into the commercial cuts (breast, thigh and drumstick). Each cut was weighted individually then deboned. The meat was frozen for panel taste.

3.7 Panel taste:

The stored meat samples were cut into small pieces, wrapped individually in aluminum foil and roasted at 190 C° for 70 minutes with average internal temperature of 88C° and served warm. Ten well-trained taste panel were used to score color, flavor, tenderness and juiciness of meat (Cross et al., 1978) on scale of 1-8 (Appendix I). The samples were served randomly to each judge and at room temperature. Water was provided for the panelists to rinse their mouth after tasting each sample.

3.8 statistical analysis:

The data collected were subjected to analysis of variance (one-way ANOVA), and where significant differences were observed, means were further subjected to Duncan's multiple range test (Duncan, 1955).

Chapter four

Results

4.1 Performance:

Data concerned the growth performance of different experimental treatments was displayed in Table (3). Results showed that broiler chicks fed on diets containing fenugreek seeds flour (FSF) recorded significantly ($P < 0.05$) higher values for growth performance.

Chicks fed on diet containing 1% FSF recorded significantly ($P < 0.05$) the heaviest body weight compared to other tested groups, while those fed on control diet recorded significantly ($P > 0.05$) the lowest body weight. For body weight gain there was no significant ($P > 0.05$) difference between groups fed on diets containing FSF, although they recorded significantly ($P < 0.05$) high weight gains compared to the control group which recorded significantly ($P > 0.05$) the lowest weight gain.

Chicks fed on diets containing FSF showed significantly ($P < 0.05$) more feed consumption compared to control group. Chicks fed on diet containing 2% FSF consumed significantly ($P < 0.05$) more feed compared to control group.

It was cleared that chicks fed on diets containing FSF have had significantly ($P < 0.05$) the best feed conversion ratio (FCR) than those on control group. However, the best FCR values were for chicks fed on 1% and 3% respectively.

The results indicated no affect on the health of the chicks due to addition of FSF in broiler chicks diet, however, there was no mortality recorded throughout the experimental period.

4.2 Carcass Traits;

Data obtained for carcass traits were presented in Table (4), results revealed carcass traits as a percentage of pre –slaughter weights were significantly affected by the level of FSF to some extent. In general dressing percentage of chicks fed on 1% and 2% FSF recorded significantly ($P < 0.05$) high values compared to those on control group, for gizzard chicks fed on control group recorded significantly ($P < 0.05$) heavy weight, while the gizzard weights decreased significantly ($P > 0.05$) with the addition of FSF in the diets, also there was no significant ($P > 0.05$) differences in the intestine weights of chicks fed on diets containing FSF, the chicks fed on control diet recorded significantly ($P > 0.05$) decrease in intestine weight compared to those chicks fed diets containing FSF.

No significant ($P < 0.05$) differences were found between the treatments with regard to the percentages of commercial cuts (breast, thigh and drumstick), their meat yield, non-carcass components (liver, heart) ,Table (5), and the average subjective meat quality scores (color, flavor, tenderness and juiciness), however, scores given for all attributes of meat quality were above moderate acceptability level ,Table (6).

4.3 Blood Parameters:

Effects of FSF on blood parameters shown in Table (7), addition of FSF in the broiler chicks diets significantly ($P > 0.05$) decreased plasma cholesterol, total protein, albumin and calcium, while there was a reduced in the level of phosphorus and triglyceride compared to control group.

4.4 Economic Appraisal:

The economic calculation for broiler chicks fed on diets containing raw FSF were shown in table (8), Chicks purchase and feed cost values were the main inputs considered while, the total selling value of meat was the total revenue. Chicks fed on diets containing FSF recorded the highest profit compared to control group which recorded the lowest profit. However chicks fed on diet containing 1% FSF recorded the highest profit (25.643) followed by those fed on diet containing 3% FSF (24.27) compared to control group (9.193), on the same trend chicks fed on 1% FSF recorded the highest profitability ratio followed by chicks fed on 3% and 2% respectively.

Table 3. The average performance of chicks fed fenugreek seeds

Items	Groups				SEM ±	LSD
	Control	1% Fs	2% Fs	3% Fs		
Initial weight g/bird	150 ^a	150.25 ^a	150.25 ^a	150.5 ^a	2.13	6.56
Final Weight g/bird	1382.25 ^a	2578 ^b	2328.5 ^c	2192.25 ^a	93.42	287.87
Weight Gain g/bird	1238.75 ^b	2365.25 ^a	2178.25 ^a	2042.00 ^a	93.14	287.02
Feed Intake g/bird	3132 ^c	4627 ^{a,b}	4809 ^a	4382.5 ^b	89.31	275.22
Feed Conversion Ratio (FI/ WG)	2.54 ^a	1.96 ^b	2.23 ^c	2.145 ^a	0.07	0.22

a, b, c means with the same letters on the same column are in not significantly difference ($p>0.05$).

SEM±: standard error means

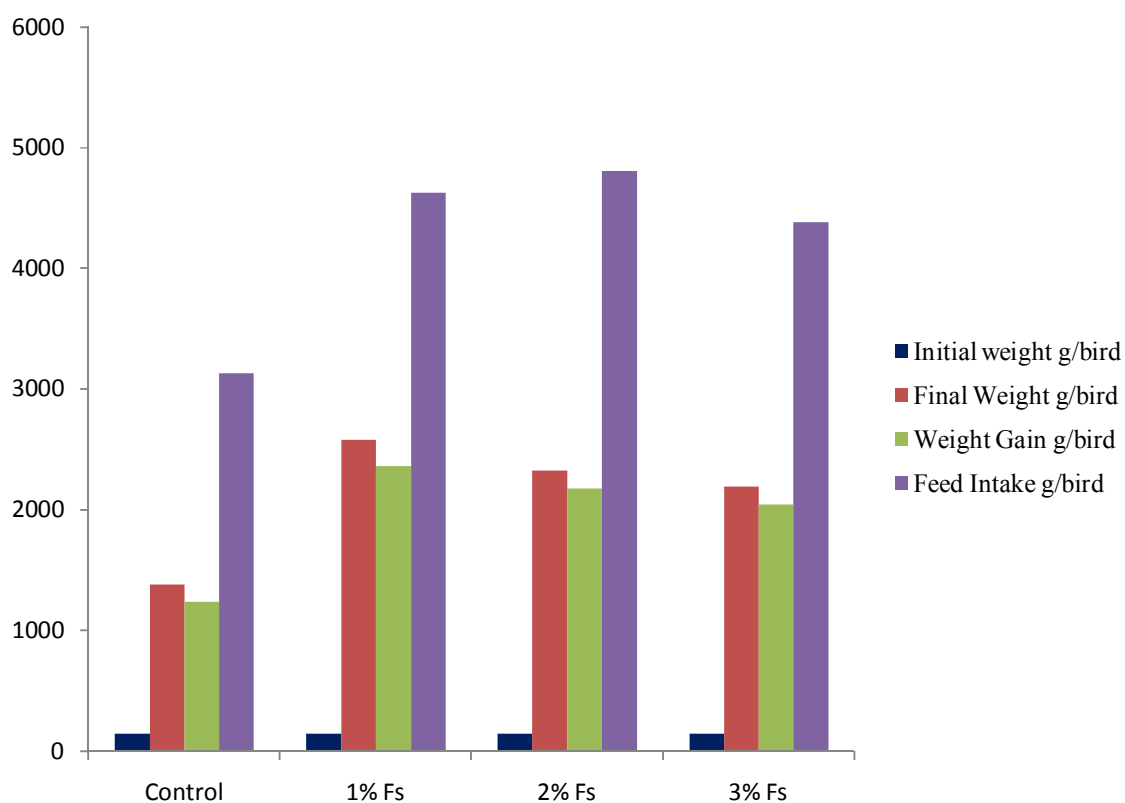


Table 4. Effect of feeding broiler chicks on diets containing FS on non-carcass compounds as % of final body weight

Items	Groups				SEM±	LSD
	Control	1% Fs	2% Fs	3% Fs		
Live body weight	1801.67 ^a	2971.67 ^b	2661.67 ^c	2665.00 ^c	227.39	741.54
Liver%	2.24 ^a	2.08 ^a	2.22 ^a	2.05 ^a	0.22	0.498
Heart	0.53 ^a	0.47 ^a	0.50 ^a	0.50 ^a	0.073	0.238
Gizzard	1.87 ^a	1.39 ^{b c}	1.31 ^b	1.57 ^c	0.17	0.55
Dressing%	70.39 ^a	77.06 ^b	73.14 ^c	68.85 ^a	2.18	7.13
Intestine (wt)	207.67 ^b	228.00 ^a	225.67 ^a	234.67 ^a	15.62	50.92
Legs	4.31 ^a	3.77 ^b	3.82 ^{bc}	4.00 ^a	0.113	0.37

a, b, c means with the same letters on the same column are in not significantly difference (p>0.05).

SEM±: standard error means

Table 5. Effect of feeding broiler chicks on diets contained FS on the hot carcass weight and yield of commercial cuts percentages

Items	Groups				SEM±	LSD
	Control	1% Fs	2% Fs	3% Fs		
Hot eviscerated carcass wt (kg/bird)	1266.67 ^a	2266.67 ^b	1943.33 ^c	1836.67 ^c	141.3	460.8
Breast as % of hot carcass	28.22 ^a	30.31 ^a	29.13 ^a	29.76 ^a	1.62	5.29
Thigh	13.55 ^a	14.60 ^a	14.61 ^a	14.28 ^a	0.86	2.80
Drumstick	15.31 ^a	14.17 ^a	14.45 ^a	14.98 ^a	0.54	1.76
wing	11.06 ^a	10.46 ^a	10.48 ^a	10.76 ^a	0.72	2.33
Back	11.29 ^a	11.28 ^a	11.31 ^a	11.22 ^a	0.72	2.35

-Values are the means of 12 chicks per dietary treatment

-**a, b, c** means with the same letters on the same column are in not significantly difference ($p>0.05$).

SEM±: standard error means

Table 6. Average subject of meat quality values of chicks fed on different levels of Fs

Items	Groups			
	Control	1% Fs	2% Fs	3% Fs
Tenderness	5.6	5.7	6.4	5.6
Flavor	5.6	5.6	5.9	5.2
Color	6.1	6.7	6.7	6.1
Juiciness	5.6	6.0	5.4	5.6

a, b, c means with the same letters on the same column are in not significantly difference ($p>0.05$).

Table 7: Serum analysis of experimental chicks fed on diets containing Fs

Items	Ca ⁺⁺ mg/dl	Posp mg/dl	Chol mg/dl	TP mg/dl	Glucose mg/dl	TP g/Levels	Tri mg/dl
Control	11.3	5.5	122.1	2.2	203.8	1.1	81.0
1% Fs	10.4	7.6	98.3	2.1	181.3	2.4	119.5
2% Fs	0.9	8.1	104.6	1.0	171.3	0.2	96.2
3% Fs	8.8	8.9	102.2	1.7	185.5	0.7	91.2

a, b, c means with the same letters on the same column are in not significantly difference ($p>0.05$).

Posp=phosphorus, **Chol**= cholesterol, **TP**= total protein,

TP= total protein

Tri= triglyceride

AL= albumin

Table 8. Economic appraisal of fenugreek seeds in broiler chicks

Item	Control	1% Fs	2% Fs	3% Fs
Cost:				
Chicks	3.000	3.000	3.000	3.000
Feed	7.292	7.817	7.398	4.365
Elect., Management	1.250	1.250	1.250	1.250
Total cost	11.542	12.067	11.648	8615
Revenues:				
Average weight/bird	1.3823	2.518	2.3285	2.1923
Meat Price/ Kg	15.30	15.30	15.30	15.30
Total Revenues	20.735	37.71	34.928	32.885
Profit	9.193	25.643	23.28	24.27
Profitability Ratio	1	2.79	2.53	2.64

Discussion:

Fenugreek seed powder addition at various levels to broiler diets in this study improved the performance of the experimental chicks compared to un supplemented group.

The apparent health of the experimental chicks was good throughout the experimental period and in all treatments. Environmental temperature during the experimental period fell within thermo neutral zone, no mortality was recorded. This might be due to good sanitation or that supplementation of fenugreek did affect on mortality rate. The result was in a agreement with findings of Guler *et al.*, (2007) and Bin-Hafeez *et al.*, (2003) who reported that the pharmacological properties of fenugreek have been explored to identify a role in cardiovascular health (Petit *et al.*, 1995b; Sauvaire *et al.*, 1996; Hannan *et al.*, 2003; Marinho *et al.*, 2007 and Rayes *et al.*, 2009).

Result showed that supplementation of fenugreek seed powder in various levels improved significantly ($P > 0.05$) live body weight. This might be due to the presence of the fatty acids (Murray *et al.*, 1991) or due to stimulating effect on the digestive system of broilers (Hernandez *et al.*, 2004). These findings were also in agreement with those of Nadir Alloui *et al.*, (2012) and Azoua (2001) who noted that addition of fenugreek seed in broiler diets increased live body weight.

Results also revealed a significant improvement in body weight gain of the chicks on treated groups compared to those fed on the basal diet. This might be attributed to the increase of feed intake or to the fenugreek contents of active compounds such as anti bacterial, antifungal, anti-inflammatory, carminative and antioxidant activities. The result was in line with findings of Morsy (1995); Pandian *et al.*, (2002); Kaviarasan *et al.*, (2004 and 2007); Balaraman *et al.*, (2006); Hamden *et al.*, (2010) and Abou-EL-Wafa *et al.*, (2003).

Results appeared that addition of fenugreek seed powder in different levels in broiler diets significantly ($P > 0.05$) improved feed consumption. This positive effect of fenugreek seeds in feed consumption can be evaluated on the basis of different perspectives, that fenugreek as natural feed additives improved diet palatability and could be attributed the carbohydrates and their main components (galactomannan) which stimulating the appetizing and digestive process (Steiner, 2009), this result was comparable with that of Micheal and Kumawat, (2003); AL-Habori and Roman, (2002) and Nadir Alloui *et al.*, (2012), on contrast Moustafa (2006) indicated that fenugreek seeds at level of 0.05% revealed insignificant effect on feed consumption compared to the control group. Also in this respect, El-Kaiaty *et al.*, (2002) and Radwan (2003) reported that there were no effects of supplemented fenugreek on feed consumption for laying hens and broilers respectively.

Fenugreek seeds supplementation improved significantly ($P > 0.05$) feed conversion ratio of broiler chicks, this might be related to the development of the broiler chicks gut morphological changes of gastrointestinal tissues can be induced by differences in gut load of microbial content including their metabolites (Xue *et al.*, 2003). The result was in line with findings of (Nadir *et al.*, 2012); Mukhtar *et al.*, (2013) and Amal *et al.*, (2013) who reported improvement in feed conversion ratio of broiler chicks fed on diets supplemented with lemon grass oil and Halfa bar essential oil respectively.

The dressing percentages of chicks fed on 1% and 2% FSP showed significantly ($P > 0.05$) heavy weights compared to un-supplemented group. The result was agreed with the findings of Abaza (2001); Guo *et al.*, (2004); Farman Ullah *et al.*, (2009) and Alloui *et al.*, (2012). Feeding fenugreek seed powder significantly decreased gizzard weight, no significant affect on intestine weights and non carcass components (liver, heart), these results were in line with reports of Guo *et al.*, (2004); Mukhtar *et al.*, (2013).

The results of the study showed that meat yield and the average of subjective meat quality scores (color, flavor, juiciness and tenderness) were not affected by dietary treatment at different levels, all being at moderate values. These results were in line with the findings of Abaza (2007); Abou EL-Wafa *et al.*, (2003) and Mukhtar *et al.*, (2013) in broiler chicks; Waibel *et al.*, (1974) and Kidd *et al.*, (1994) in turkeys and Fraker *et al.*, (1977) in mouse.

The results of serum metabolite showed lower of plasma total protein, total cholesterol and calcium in groups of chicks fed on FSP compared to control group. The hypocholesterolemic effect of FSP might be due to its active ingredients such as saponins, hemicelluloses, mucilage, tannin and pectin and these compounds help lower blood LDL-cholesterol levels by inhibiting bile salts. Re-absorption in the colon, they also bind the toxins in the food and help to protect the colon mucus membrane from cancers. These results confirmed by reports of Azoua, (2001), Mukhtar *et al.*, (2013), and Ahmed *et al.*, (2013) who supplemented broiler diets with gum Arabic as natural prebiotic and reported reduction in serum cholesterol.

The results of economical evaluations of the experimental diets showed that the supplementation of FSP to broiler diets improved the performance of chicks and resulted economically benefits. Profitability ratio (2.79) for 1% FSP was the highest although all chicks fed on different levels recorded high ratio of profits compared to control group ,these results were in agreement with findings of Mukhtar *et al.*, (2013); Mariam *et al.*, (2013) in broilers, and Seleem *et al.*, (2008) in rabbit fed 0.3% fenugreek seed powder.

Conclusion and Recommendations

Based on the results of this study it can be concluded that:

Supplementation of fenugreek seed powder at various levels in broiler diets significantly improved the performance of chicks. The supplementation of FSP raised the appetite of chicks so they consumed more feed and simultaneously gain significantly more weight compared to untreated group.

Supplementing of FSP also resulted in lower levels of serum cholesterol, total protein, and calcium and ALP enzyme activity. Adding of FSP to broiler diets is economically feasible.

Recommendations:

According to the results obtained, FSP could be considered as a potential natural growth promoter that may replace antibiotics.

All levels of FSP added in broiler diets in this study were recommended economic-wise but the level 1% was more profitable.

Future experiments on the possibility of using FSP raw or treated in layers as well as testing it for egg production and quality.

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APPENDIXES

Appendix (1):

Weekly temperature monitoring during the period

10th November to 15th December 2012

Weeks	Medium temperature °C
1	26
2	27
3	24
4	21
5	22
6	24

www.wunderground.com (2012)

Appendix (2):

Card used for judgment of subjective meat Quality attributes.

Sensory evaluation card

Evaluate these sample for color, flavor juiciness tend mess. For each sample, use the appropriate scale to show your attitude by checking at the point that dest describes your felling about the sample. If you have any question please ask. Thanks your cooperation.

Name: **Date:**

Tenderness	Flavor	colour	Juiciness
8-Extremely tender	8-Extremely intense	8-Extremely desirable	8-Extremely juicy
7-Very tender	7-Very intense	7-Very desirable	7-Very juicy
6-Moderatly tender	6-Moderately intense	6-Moderatly desirable	6-Moderatly juicy
5-Slightly tender	5- slightly bland	5-Slightly desirable	5-Slightly juicy
4- Slightly tough	4- slightly bland	4-Slightly desirable	4-Slightly dry
3-Moderatly tough	3-Moderatly bland	3-Moderatly desirable	3-Moderatly dry
2-Very tough	2-Very bland	2-Very undesirable	2-Very dry
1-Extremely tough	1-Extremely bland	Extremely undesirable	1-Extremely dry

Serial	Sample cod	Tenderness	Flavor	Colour	Juiciness	Comments
1						
2						
3						
4						
5						