CHAPTER ONE

INTRODCTION

Protein is an important constituents of a balanced diets for healthy human individual. The highest quality protein sources are found in animal products. Protein from poultry origin rich in all essential amino acids, free from toxic materials and easily assimilated in body.

Scientific and balanced feeding is one of the major items of economic poultry production, as feed accounts for about 60-70 % of the total cost of poultry industry. Sudan is a rich country in conventional plant protein sources such as cakes of oil seeds and legumes, but the need for exportation of the whole seeds as a hard currency cash crop and competion between different animal species, make the cereal and animal protein supplements usually fed to poultry rather expensive. Gaur meal is easily available and economical feed ingredient and may be useful in alleviating this problem.

Guar (*Cyamopsis Tetragonoloba*) is drout resistant annual legume prominently produced in India and Pakistan, but due to strong demand as a cash crop for gum, the plant is being introduced into new areas **(Pathak *et al.*, 2010)**. In the Sudan, the main area of guar farming and industrial, processing is Sinnar province (Sinnar state 490 km, South of Khartoum).

Guar meal is a low cost by-product of guar gum extraction that has protein content ranges between 36-60% which is high in lysine and methionine **(Larhang and Torki, 2011)**. Guar meal results from combination of two fractions, the germ and hull and contains approximately 60 and 35% protein, respectively **(Conner, 2002)**. The germ and hull compose approximately 44 and 21% of the guar meal, respectively.

Although guar meal can be used as source of vegetable proteins in poultry diets, but inclusion of guar meal into broiler diets deleteriously affects growth rate and feed efficiency of broiler chicks when added in high concentration **(Lee *et al*., 2003b and Kamran *et al*., 2002)**. These anti-nutritive effect have been a attributed to trypsin inhibitor activity and residual gum that remain in the guar meal after gum extraction. Although some evidence suggests that trypsin inhibitor activity is an ant-intuitive factor in guar, other researchers show that trypsin inhibitor concentration are not high enough to depress growth **(Lee *et al*., 2003 a).** Therefore, the major anti-nutritional factor in guar meal is guar gum **(Lee *et al*., 2005).**

Guar gum is a highly viscous galactomanna polysaccharide consisting of a 1-4 β-mannose backbone with glactose bound at six on alternative mannose sugars. Guar gum is sticky in nature and reduces the nitrogen retention, energy utilization and fat absorption from the gut thus depresses the growth and increases mortality in broilers **(Maisonnier *et al*., 2003).** Also, gum residues increases intestinal viscosity, which decreases nutrients absorption and decreases the rate of passage of digesta through the intestine. High intestinal viscosity also decreases digestibility coefficient of all macronutrients and decreases digestive enzyme activity throughout small intestine **(Salih *et al*., 1991 and Smits *et al*., 1997).**

Isolation and use of enzymes for degradation of indigestible substrates occurs frequently in scientific literature. Enzymes supplementation of diets containing guar meal and other highly viscous ingredients such as barley and wheat improve growth and feed utilization in chickens **(Choct *et al*., 1995, Steenfeidt *et al*., 1998 and Lee *et al*., 2003b)**. Improvement of nutrients availability from feed ingredients such as wheat and barley by enzyme addition is attributed to a decrease in intestinal viscosity **(Adeola and Bedford, 2004; Plander *et al*., 2005; Juapere *et al*., 2005 and Cowieson, 2005).** Effective enzyme hydrolyzes poly-saccharides from these ingredients and reduces viscosity, thereby improving digestibility, coefficients, growth and feed efficiency. Therefore, this study was conducted to evaluate effects of dietary inclusion of guar meal supplemented with xylanase enzyme on performance and carcass characteristics of broiler chicks.

CHAPTER TWO

LITERATURE REVIEW

2. Guar:

2.1 Scientific classification of guar :

- Kingdom: plantae . – Order : Fables – Family :
- Fabaceae - Genus : Cyamopsis - Species :
- C. tetragonoloba-Binomial name: Cyamopsis tetragonoloba – Synonyms : Cyamopsis psoralioides
- **(Wikipedia, 2013).**

2.2 Guar production

The Gauar/Guar/Guwar/Guvar bean or cluster bean (*Cyamopsis tetragonoloba*) is an annual legume and the source of guar gum. It is known as gawaar in Punjabi, Urdu, Hindi and Marathi, goruchikkuda kaya or gokarakaya in Telugu, (gorikayi), Javalikaayi, (chavalikayi) in Kannada, and kottliavarai in Tamil. the origin of *Cyamopsis tetragonoloba* is unknown, since it has never been found in the wild **(Whistler and Hymowitz, 1979).** It is assumed to have developed from the African species *C. Senegalese's*. It was further domesticated in India and Pakistan, where it has been cultivated for many centuries **(Mudgil *et al.*, 2011)**. Guar grows well in arid to semi arid areas, but frequent rainfall is necessary. This legume is a very avaluable plant within a crop rotation cycle, as it lives in symbiosis with nitrogen-fixing bacteria **(Undersander *et al.*, 1991).** Guar as a plant has a multitude of different functions for human and animal nutrition but it,s gelling agent containing seeds (guar gum) are today the most important use **(Mudgil *et al.*, 2011)**. Demand is rising rapidly due to industrial use of guar gum in hydraulic fracturing (oil shale gas). About 80%

world production occurs in India and Pakistan, but, due to strong demand, the plant is being introduce into new areas.

In the Sudan, first experimental guar planting was conducted at the Gezira research station in the early thirty's until (1982) when other research stations followed. The average yield at these research station during (1965-1985) exceed 1000kg/ha **(Flower, 1987)**. Cultivation of guar now expanding in this country and the main area of guar farming and industrial processing is Singa province, Sennar state, 390 km, south Khartoum and the amounts of the by-product (guar meal) will soon parallel those of wheat bran and sorghum gluten meal **(ELobied et *al*., 1998).**

2.3 Biology of guar plant:

Guar plant can access soil moisture in low soil **(Undersander *et al*., 1991).** Additionally, this legume develops root nodules with nitrogen-fixing soil bacteria rhizobia in the surface part of it's rooting system. it's leaves and stem are mostly hairy, dependent on the cultivar. it's fine leaves have an elongated oval shape (5 to 10 cm length) and of alternate. Position Clusters of flowers grow in the plant axil and are of white to blueish colour. The developing pods are rather flat and slim containing 5 to 12 small oval seeds of 5mm length. Usually, mature seeds are white or gray, but in case of excess moisture they can turn black and loose germination capacity. The chromosome number of guar seed is 2n = 14 **(Guar bohne, 2012).** The seeds of guar beans have very remarkable characteristics. Its kernel consists of protein rich germ (43-46%) and a relatively large endosperm (34-40%), containing big amounts of the galacto-mannan **(Mudgil *et al*., 2011).** Latter is polysaccharide containing polymers of mannose and glactose in ratio of 2:1 with many branches **(Garti and Leser 2001).** exhibits a great hydrogen bonding activity **(Undersander *et al.*,1991).** having a viscosifying effect in liquids.

2.4 Uses of guar:

2.4.1 Guar Plant:

In Agriculture: Guar plants can be used as cattle feed, but due to hydrocyanic acid in its bean, only mature beans can be used. Also guar plantings increase the yield of subsequent crops as this legume conserves soil nutrients content **(Whistler and Hymowitz, 1979).**

2.4.2 Domestic use:

Guar leaves can be used like spinach vegetables. Its beans very nutritious but the guar protein is not usable by humans unless toasted to destroy trypsin inhibiter**. (Guar bohne, 2012).**

2.5 Guar gum:

Guar gum has a multitude of different application:

2.5.1 Food:

in several food and beverages (baked goods, cheese, icecream and fried products) guar gum is used as additives in order to change its viscosity or as fiber source **(Klis1966, Sutton and Wilox, 1998 and Sakhale *et al.*, 2011).**

2.5.2 Industry:

Derivatives of guar gum that been further reacted is also used in industrial applications such as the paper and textile industry, orefolation, the manufacture of explosives hydraulic fracturing (fracking) of oil and gas formation **(Gardiner, 2012 and Times, 2012).** Guar gum has also proven a useful substitute of locust bean gum (made from carob seeds).

2.6 Guar meal as plant protein source for poultry:

2.6.1 Guar meal:-

Guar meal is a relatively inexpensive high protein meal produced as a by-product of guar manufacture. Guar meal result from combinations of two fraction, the germ and hull fractions, the germ and hull fractions contains approximately 60 and 35% protein, respectively. **(Conner 2002).** The germ and hull compose 44 and 21% of the guar bean, respectively. **(Larhang and Torki, 2011).**

2.6.2 Chemical composition of guar meal:-

Ramakrihnan, (1957) reported that guar meal contains 12% moisture, 4% fat, 45% crude protein, 6% crude fiber and 4,5% ash. It is source of a well balanced protein rich in lysine and sulpher amino acids.

Smith *et al*. (1959) and Bhatia and Sial (1971) found that GM after the removal of most the gum contain about 51% protein, 31.8% gum, 4.6% fat, 6.8% methionine and 5.7% ash. They calculated in protein (16% nitrogen bases). The amounts of different amino acids to be for lysine 12.2% methionine 4.25%, methionine-cystine 6.07%, pheny lalanine 11.2% argnine 37%, glycine 15.4%, histidine7.59%, isoleucine 9.7%, leucine 17.9%, threonine 8.49%, tryptophan 5.76%, valine 12.72%, alanine 12.72%, aspartic acid 30.9%, glutamic acid 6.6% , proline 9.49% and serine 14.85%.

According to **Van Etten *et al*., (1961)** Guar meal contains amino acids (gm /16 gm of nitrogen) to use for lysine 4.0, methionine 1.4, methionine-cystine 2.0, phenylalanine 3.7, arginine,12.5 glycine 5.1, histiding 2.5, isoleucnine 3.2, leucine 5.9, threonine 2.8, tryptophan 1.9, valine 4.3, alanine 4.2, aspartic acid 10.2 glutamic acid 20.1, proline 3.1, and serine 4.9. The amino acid content of the guar meal makes guar meal a useful protein supplement for chicks and hens.

Couch *et al.* (1966) reported that guar meal contains high protein 35-45%, which is high in lysine and methionine.

According to **Nagpal *et al.* (1971)** the percent chemical composition of guar meal shows. the crude protein 38.78%, dry matter 10.25%, crude fiber 11.25%, ether extract 7.19%, ash 5.47%, insoluble ash 0.38% non-nitrogenous extract 36.81% and the amino acid lysine 6.95%, tryptophan 1.05%, methionine 1.05%, argnine 15.91%, and histidine 5.9%. The guar meal then contains a high amount of lysine, and histidine though methionine content was poor.

Duke (1983) showed that guar seed consists of 14-17% hulls ,43-47% germ and 35-42% endosperm. The chemical composition revealed that germ contained high protein (55%) and fat (5.2%). Also he observed that the seed meal contained (gm/16 gm N), lysine 4.0, methionine 1.4, methionine-cystine 2.0, phenylalanine 3.7, argnine 12.5, glycine 5.1, histidine 2.5, isoleucine 3.2, leucine 5.9, threonine 2.8, tryptophan 1.9, valine 4.9, alanine 4.2 , aspartic acid 10.2 , glutamic acid 20.1 proline 3.1 and serine 4.9.

Ambegaokar *et al.*(1969) found that crude protein content of guar meal various from 35 to 47.51, on dry matter basis and suggested that tryptophan, methionine and threonine were the first three deficient amino acid of guar meal when compared to whole egg proteins.

Nagpal *et al.* (1971) showed that the gross energy of raw and autoclaved GM were 4.83, and 4.86, kcal/g, while the N-corrected M E values of raw and autoclaved GM were 2.005 and 2.069 kcal/g, respectively.

Verma and McNab. (1984 b) reported that about 88% crude protein of G M was found to be present as true protein and rich in argnine, but methionine and lysine concentrations were comparatively lower than concentrations typically found in soybean.

Rajput *et al.*(1987). Gave ranges for chemical composition of germ meal from different varieties of guar meal seeds as moisture 5.2-7.97, crude fat 4.5-5.7 and the protein nearly the same in all meals except with variety HG-75 which had 58% protein.

According to **ELobied. (1998)** the percent chemical composition on dry matter basis of heat-treated guar meal shows the dry-matter 96.04, crude protein 47.20, ether extract 5.16, crude fiber 10.40, Nitrogen free extracts 27.2, ash 5.56, and the metabolizable energy 2.76 Mcal/kg.

2.6.3 anti-nutritive factors in GM.

Extraction of guar gum from guar beans yield a mixture of germ and hull fractions as a by-product. The germ and hull compose about 44 and 21% of the guar bean, respectively **(Larhang and Torki, 2011).** However, the germ and hull proportions of the guar bean are not consistent with the relative amounts of the fractions mixed in guar meal. Also, the degree of contamination of germ and hull fraction with guar gum is not equivalent within these proportions where mixed into commercial guar meal **(Lee *et al*., 2003 b).**

A nutritional value of vegetable protein sources depends on their chemical composition as well as on the extent to which nutrients are digested and absorbed in the body. Lack of appropriate enzymes in the gastro intestinal tract and presence of anti-nutritional factors are hampering the digestion, absorption and utilization of nutriecnts **(Kamran *et al*., 2002).** Although guar meal can used as a source of vegetable proteins in poultry diets, but inclusion of guar meal into broiler diets deleteriously affects measures of growth rate and feed efficiency when fed in high concentrations **(Lee *et al*., 2003b; Lee *et al*., 2005 and Larhang and Torki, 2011)**. These antinutritive effects have been attributed to two deleterious factors in guar meal. The first is the residual guar gum, which is about 18% of the guar meal **(Lee *et al*., 2009).** The other is the trypsine inhibitor, which inactivates the pancreatic photolytic enzymes i.e trypsin and chymotrypisn in the gut **(Brik, 1989).** ALthough several research reports have speculated that trypsin inhibitor activity is antinutritive factor in guar, others show that trypsin inhibitor concentrations are not high enough to depress growth **(Lee *et al*., 2003a).** Decreases in measure of growth are reported drawbacks to the use of guar meal in poultry rations **(Sathe and Bose, 1962, Vogt and Penner, 1963, Anderson and Warink, 1964, Couch *et al*., 1967, Thakur and Pradhan,1975).** These authors speculated that the legume guar contained a trypsin inhibitor. Heating of GM reduced the level of trypsin inhibitor when measured by the trypsin hemoglobin digestion procedure **(Couch *et al*., 1966)** and improved growth **(Couch *et al*.,1967).** However, **Brochers and Ackerson (1950)** were notable to detect significant concentration of trypsin inhibitor in sources of guar seeds, and autoclaving guar did not improve growth performance when guar was feed to rats. These researchers suggested that guar gum residues in GM could be the cause of negative effect in poultry. More recently, trypsin inhibitor activity has been quantified and shown not to differ from that of commercially processed soybean meal **(Lee *et al*., 2004).** However the major anti-nutritional factor in guar meal is guar gum which increases intestinal viscosity in chicken and reduces growth rate **(Lee *et al*., 2005).**

Guar gum is galactomannan polysaccharide consisting of a 1-4 – ß-mannose back bone with glucose bound at position six at ultimate mannose sugars. Guar gum contains 8-14% moisture, 75-85% galactomannan, 5-6% protein 2-3% fiber and 0.5-1.0 ash **(Kamran *et al*., 2002)** Mixing the gum with water produces a highly viscous solution which increases the viscosity of ingesta in the gut of chicks. **(Lee *et al*., 2009).**

Excessive intestinal viscosity detrimentally affects growth rate and feed efficiency. Increased viscosity severely compromises the ability of the gut to physically mixdigesta **(Edward *et al*., 1988).** Impaired mixing has severe implications for fat digestion since fat emulsification requires vigorous intestinal mixing and excessive viscosity impairs diffusion and convective transport of digestive enzymes within the gastrointestinal tract of young chicks **(Almirall *et al*., 1995 and Langhout *et al*., 2000**. **Edward *et al.* 1988)**. demonstrated in vitro that convective transport of glucose and sodium declines in a viscous environment: Increased viscosity also may reduce contact in tensely between potential nutrients and their respective digestive secretions , thereby reducing diffusion to epithelial surface **(Choct and Annison, 1992. Rainbird *et al.* (1984).** using isolated porcine jejunal loops demonstrated that guar gum significantly reduced net absorption of glucose and maltose solution form 74.2-41.4% and 71.1-36.0% respectively. A significant increase in intestinal viscosity leads to increase weight and length of intestinal segments and decreases digestibility of lipids, starch and nitrogen **(Smits *et al.* 1997).** Highly viscous diet cause pasty feces and leads to depress growth performance of broiler and to an increase incidence of disease and management problems associated with sticky and wet litter conditions **(Steenfieldt 1995; Lee *et al.*, 2009 and Santos *et al.*, 2004) .**

2.7 Effects of dietary inclusion of guar meal on broiler performance:

Voget and Penner (1963). Suggested that Guar meal when included at levels of 5,10 and 15% in broiler diets, their growth and feed conversion values were reduced particularly at the levels of 10 and 15%.

Vohara and Kratzer (1964 a,b). reported that the substitution of 7.5% guar meal caused a depression in growth rate, a major portion of which was attributed to the presence of residual polysaccharide (gum) in the meal in chick diet .

Anderson and Warnick (1964). Suggested that the substitution of 10% guar meal in chicks diets, had an unfavourable effect on growth rate and efficiency of feed conversion and that the dropping of the chicks were sticky. **Couch *et al*., (1967)** reported that the substitution with 10 or 20% raw guar for soybean meal reduced the growth significantly in broiler cross chicks and growth of the chicks was improved when guar meal was heated for half an hour at 110ċ with the injection of super-heated steam for 15 minutes had significantly improved efficiency and feed utilization when compared to the above diets. They also noticed that the substitution with 20 and 30% commercially processed guar meal for soya bean meal in the diets produced a significant decrease in the weight and feed utilization of broiler cross chicks at 25 days of age.

Nagpal *et al*. (1971). reported that guar meal when fed to chicks at 40% as the source of protein in the diets , caused aloss in body weight ,depression of feed intake with high mortality rate as compared with 40% groundnut cake. **Verma and McNab (1982)** reported that birds fed on diets containing 100 or 50 gm guar meal /kg gained significantly less weight and consumed significantly less feed than those fed on control diets. They noticed that birds fed on diets containing guar meal with supplemented 0.5% methionine weight significantly at four weeks of age than those fed on similar diets without extra added free methionine. The feed intake of birds fed on diets with10 and 15% guar meal were less than those fed on diets containing 5% guar meal.

Nagra (1984) reported that both toasted and autoclaved guar meal at 24 and 32 levels in broiler rations replacing respectively 75 and 100%

groundnut cake significantly lowered gain in weight, feed efficiency and protein efficiency ratio with 15-20 mortality rate.

Patel and McGinnis (1985) noted that addition of 10% raw guar meal to the control diet depressed body weight gain and feed efficiency and increased faecal acrean score (Fss) and increasing guar meal to 15% caused a further decrease in body weight gain but did not change the Fss.

EL-Faki(1995). studied the nutritive replacement values of guar meal for conventional protein sources. Five groups of broiler chicks were fed guar meal replacing groundnut cake at 0% (group A), 33.3% (group B), 66.7% (group C), 100% (group D and E). The guar meal supplied in ration E was heat treated (Toasted). The feeding trails was extended for 6 weeks. The results indicated that body weight gain, feed intake and feed efficiency values for all test groups were significantly different from control group. Body weight gain, feed intake and feed efficiency of groups B,C and D decreased in descending order, with toasted guar meal of group (E) showing remarkable improvement in all performance parameters, but still below the recorded of the control group.

Kamran *et al.*(2002). Investigated the influence of dietary inclusion of guar meal at the level of 0,5,10 and 15% on the performance of broiler chicks and reported that as the level of dietary guar meal increased there was decrease in the body weight gain, feed intake and feed efficiency of the broiler chicks.

In factorial experiment **Lee *et al.* (2003a)** investigated the impacts of two guar meal fractions (germ and hull) at 5 inclusion levels (0, 2.5, 5, 7.5 and 10%) on intestinal viscosity, measures of growth and feed efficiency in broiler chicks fed to 42 days of age . The results indicated that growth rate and feed efficiency were not affected by inclusion as much as 7.5% of the germ fraction into poultry diets, while inclusion of the hull fraction reduced growth at all concentrations. The hull fraction increased intestinal viscosity at all inclusion levels fed, although feed efficiency was not affected until inclusion rate exceed 5%. The germ fraction significantly increased intestinal viscosity at 7.5% and 10% inclusion level. They concluded that the guar meal germ fraction constituting as much as 7.5% of the diet supported growth and feed efficiency measures similar to those observed with a typical corn – soybean broiler ration.

Lee *et al.*(2005) studied the effect of guar meal by-products on broiler performance,factorial design (3x4) was used to feed broiler chicks diets containing guar germ, guar hull or guar meal at 4 levels (2.5, 5,7.5 and 10%) compared with control died . Results showed that average body weight was decreased incrementally as the level of guar inclusion increased. Average weight was significantly greater for broiler receiving the germ fraction versus the hull fraction and guar meal. Also broiler receiving 2.5% of any meal by-products weighted significantly more than those receiving higher levels. They also noticed that the level of guar meal significantly depressed feed intake with birds receiving 10% guar consuming significantly less than chicks fed 2.5,5 and 7.5% , the result also showed that broiler chicks fed on germ fraction demonstrated significantly better feed conversion ratio than those fed hull fraction or guar meal. Feed conversion ratio significantly increased from 1.93 to 2.66 as the level of guar increased from 2.5% to 10%, whereas the bird fed 2.5% guar fraction had feed conversion similar to those fed control diet. They suggested that any of three guar meal by-products could be fed at 2.5% dietary inclusion rate without adversely affected chicks growth to 6 week of age.

Turki *et al* (2011) investigated on the effect of feeding various levels 0%, 5%, 15% and 25% of guar germ in broiler chickes performance. The results indicated that chicks received 5% guar germ had significantly ($P<0.01$) higher body weight gain, feed intake and improved feed efficiency compared to controls or other dietary treatments, while chicks fed on 25% guar germ diets; significantly showed decreased values of all such parameters.

2.8 The role of dietary non- starch polysaccharide (NSP) degrading enzymes in broiler nutrition:

Enzymes use are well documented across different types of poultry diets. Example papers on amylase **(Jiang *et al.* 2008)**, protease **(Ghazi *et al.* 2003 and Wang *et al.* 2008)**, Xylanase **(Mathlouthi *et al.* 2002, Cowleson *et al.* 2005 and Bin- Baraik 2010)**, beta-mannanase (**Mathlouthi *et al.*, 2002, Lee *et al.*, 2005, Lee *et al.*, 2009, Shahbazi, 2012),** mixes of two or more of the aforementioned activities **(Meng *et al.*, 2005; Cowieson and Ravindran 2008b Mathlouthi *et al.*, 2002; Kamran *et al.*, 2002** and **Lorhang Torki 2011)** are among the many that can be found in the scientific Literature.

The use of NSP degrading enzyme can be categorized into five areas, firstly removal of antinutritional factors, secondly be increasing the digestibility of existing nutrients, thirdly by making ascertain nutrients more available for absorption in intestine, fourthly supplementing host endogens enzymes, for example at young ages, fifthly affecting the micro-flora in the gastro-intestinal tract **(Classen and Richard, 1999, Bin-Baraik,2010).**

Numerous researchers **(White *et al.*, 1983 Edney *et al.*, 1989 and Friesen *et al.*, 1992)** found that addition of NSP degrading enzymes improved significantly protein and energy of wheat, rye and oat based diets of the broiler chicks. Response to enzymes addition probable due to their ability to hydrolysis of NSP components present in the cereal grains. This includes an efficient reduction in viscosity of the gut content, liberation of entrapped nutrieints, thereby allowing more nutrients available or digestion in intestinal tract of broiler chicks. **Smulikowsk and Mieczkoska (2000)** showed that 62-90 of increase in AME value was due to better fat digestibility when broiler fed wheat based diet supplemented with enzymes. **Adeola and Bedford (2004)** found that addition of xylanase enzyme improved AME more in high viscosity than low viscosity wheat when fed to duck. **Juapere *et al.* (2005) and Choct (2001)** reported that dietary xylanase and beta glucanase enzymes improved nutritive value of wheat and barely basal diets for broiler by reducing the effect of NSP in these cereals. **Ratharfurd *et al.* (2006)** found that addition cocktail of enzymes contain xylanase, beta-glucanase and alfa-amylase, to the corn-soybean diet containing wheat bran and canola meal increased the AME values as well as apparent and true ileal amino acids digestibility for all amino acids, but had no effect on endogenous ileal lysine flow**. Pourreza *et al.* (2007)** reported a significant improvement of protein and energy digestibility due to the addition of xylanase enzyme to basal diet containing 65% triticale diet for broilers. **Meng *et al.* (2005)** reported

2.3% and 5.5% increased in dietary apparent metabolizable energy and crude protein content respectively upon supplementing acorn-soybean diet with xylanse, glucanase, pectinase, cellulase, amannanase and gluctanase enzymes. **Mathlouthi *et al.* (2002)** found that addition of xylanase and beta-glucanase to ray-based diet improved nutrient digestibility for broiler probably by improved the absorption capacity of the small intestine through increased villus surface and intestinal concentration of conjugated bile acids.

In contrast, other researchers have shown no effect of supplementation of some enzyme preparation to poultry diets on AME **(Scheideler *et al.*, 2005).** ileal digestible energy and nitrogen **(Cowiesen and Adola 2005)** and protein and starch **(Meng and Slominski 2005)** and fat digestibility **(Zanella *et al.*, 1999).**

Patel and McGinnis (1985) noted that autocalving or hemicellulases enzyme supplementation of guar meal increased ($p<0.05$) weight gain and feed efficiency ($p<0.05$) of chicks fed diet containing 10 or 15% guar meal in replacement of corn-soybean meals at 2 and 4 weeks, but inapparent at 7 weeks of age.

Kamran *et al.* (2002) conducted study to determine the effect of commercial enzyme (Natugrain) addition on the nutritive value of guar meal in broiler diets. The experimental broiler chicks devided into two groups (i) and (ii). Group (i) was further devided in 4 sub-groups A, B, C and D which were fed enzyme supplemented diets containing 0, 5, 10 and 15 guar meal, respectively. The dose of enzyme was 100gm/ton of feed. Group (ii) was also devided into 4 sub-groups E, F, G and H which were fed diets without enzymes supplementation containing 0, 5, 10 and 15% guar meal, respectively. The results indicated that guar meal reduced weight gain, feed intake, dressing percentage and deteriorates feed conversion ratio of the chicks. Further, addition of enzyme did not result in significant improvement in feed intake, weight gain and dressing percentage.

Lee *et al.* (2003b) studied the effect of two guar meal fractions at three different concentrations, germ (0,5 and 7.5 %) and hull (0, 2.5 and 5%) and the effectiveness of beta-mannanase at three levels (0, 1 and 4 times the manufactures recommended level of 1.9x10 units / kg) on broiler performance. The results showed that addition of the germ fraction to rations did not reduced body weight although the feed efficiency was reduced at 7.5 of the diet. Inclusion of the hull fraction significantly reduced body weight at both levels of inclusion and decrease the feed efficiency at 5% inclusion. A ddition of the enzyme significantly increased body weight and improved feed utilization in diets containing guar hull fractions. Also the result of this study showed that addition of beta-mannanase to feed containing either fraction of guar meal reduced intestinal viscosity and alleviated the deleterious effects associated with guar meal feeding.

Lee *et al.* (2005) evaluated the effect of guar meal by products (guar germ, guar hull and guar meal with and without beta-mannanase hemicell on broiler performance. A 4x2 factorial design was utilized consisting of the corn-soy bean meal control diets and each of guar by-products fed at 5% with and without addition of hemicell which contains significant amount of beta-mannanase (720x106 units/L). The results showed that the average bird weight produced at 6/wk by germ fraction was similar to the control, whereas bird weight produced by the hull fraction and guar meal were significantly lower. The inclusion of Hemicell at the recommended level did not significantly affect average body weight. Cumulative 6-wk feed intake was not affected by addition of guar germ fraction or guar meal when compared with the control diet, whereas feed intake was significantly reduced by addition of hull fraction or Hemicell. Also the results showed that feed conversion ratio for each of the treatment were significantly improved with addition of Hemicell to the level comparable with the control diets.

Larhang and Torki (2011). Studied the effect of different levels of guar meal (0,4 and 8%) and commercial enzyme (0 and 0.05%) Natuzyme which containing a cocktail of enzymes (cellulose, xylanase, beta-glucanase, amylase. pectinase, phytase, protease, lipase, amyloglycos, hemicellulase and pentosanase) on broiler performance. The results showed that guar meal had significant effect on all the measured parameters, but enzyme had no significant effect. Interaction between diets inclusion guar meal and enzyme was significant on performance parameter except for feed intake. The highest body weight gain was seen in birds fed control diets with enzyme and lowest body weight gain was observed in bird fed diet containing 8% guar meal with Natuzymes enzymes.

Mohayayee and Karimi (2012) studied the effect of β- mannanase enzyme on growth performance of broiler fed with different levels of guar meal germ fraction (GM). The experimental diets included, low level of GM (2,4 and 6% in starter, grower and finisher diets), respectively, intermediate GM+enzyme high level of GM (6, 9 and 12% in starter, grower and finisher respectively) and high GM + enzyme. The results indicated in control, low GM and intermediate GM + enzyme groups, body weight gain, feed intake and conversion ratio were better than other treatment. High GM in broiler diet deleteriously affected growth performance. They concluded that the optimal levels of guar meal are low level without β-mannanase enzyme and intermediate level with β-mannanase enzyme without adverse effect on performance of broiler chicks .**Gharaei *et al.* (2012)** studied the effects of guar meal (0,3,6 and 9%) and β-mannanase enzyme (0 and 0.05%) on performance of broiler chicks. The results showed that daily weight gain and body weight gain (42 d) significantly reduced and feed conversion ratio increased in chicks fed diets containing 9% guar meal. Feed intake was lower in chicks fed 9% guar meal than other groups only at starter period. In spite of trend to improved feed conversion ratio and body weight gain with B-mannanase enzyme addition, feed intake was not affected by enzyme supplementation. They concluded that the use of guar meal up to 6% have no negative effect on performance of broiler chicks and supplementation of β-mannanase enzyme to guar meal diets improves the performance of broilers.

CHAPTER THREE

MAETERIALS AND METHODS

This experiment was conducted during winter season (3 January 2012 to 15th Februry 2012). The ambient temperature averaged (15.8 - 31.8 ċ) (Appendix .1) during the experimental period.

3-1 Experimental chicks:

A total number of day- old commercial unsexed broiler chicks of Ross - 308 were purchased from Arab poultry Breeders Company, Ommat-Sudan and transported to the Student Poultry Premises College of Agricultural Studies Sudan University of Science and Technology, Shambat. The chicks were adapted to the premises and feed over 7 days before start the experiment. At the end of adaptation period, all chicks were weighed with an average intail weight of (40) gms. The chicks were then assigned randomly into 8 dietary groups A, B, C, D, A_+, B_+, C_+ and D_+ in completely randomized block design each group was devided into 4 replicates each of (7) chicks. Ground brooding/rearing system was adopted for 6 weeks experimental period. Chicks were bought vaccinated against Marek,s disease with on farm vaccinated against Gumboro disease at 11 days through drinking water and Newcastle disease at 22 days of age using lasota strain. Soluble multi-vitamins Combound (Pantominovit-Holland BV. 5525ZG Duizel-Holland) and antibiotic (Neomycin Avico, Jordan) were given during the first 3 days of age and 4 days before and after vaccination to guard against stress.

3. 2. Housing:

Open wire mesh-side poultry house was used. The house was constructed on a concrete floor, with a corrugated metal sheets roof and a solid brick western - Easter wall up to 3 meters the eaves and 4-5 meters for apex. 32 Pens, $1m^2$ each, inside the house, were prepared using wire mesh partitioning. Each pen was equipped with one feeder and drinker to allow ad libitum consumption of feed and water. light was provided approximately 14 hours /day allowing one hour before sunset and one after dawn. Four bulb (60 watt) lamps were used for this purposes. The house was cleaned and disinfected before commencement of the experiment.

3.3. Preparation of guar meal:

The guar seed used in this experiment to as a Sudanese variety HFG grown at Eldamazine area and kindly supplied by the Sudanese Guar company L.td. Khartoum. The processing of the guar meal was carried out as described by **EL-Faki *et al*. (1992 a).**

3.4. Experimental Diets:

Eight diets were formulated to be iso-nitrogenous (23%) CP and iso-caloric (1.18 Mcal /Kg.) being adequate in all nutrients (Table1), matching broiler chick requirements according to (NRC, 1994). levels of guar meal in replacement of groundnut cake were set at 0, 33, 66, and 100% for diets A, B, C and D respectively. Diets A_+, B_+ , C_+ and D_+ were similar to diets A, B, C and D respectively, but were supplemented with commercial microbial enzyme (xylam 500) at level ½kg/Ton : Diets A, B, C and D . A_+, B_+ , C_+ and D_+ were fed to respective groups with diet A and A_+ serving as the negative and positive control diets respectively.

Microbial xylam 500 used in this experiment is mixed enzymes preparation made from bacteria Bacillus subtilis which composed of Endo-1,4 B. xylanase 1260 u/g and Alpha-amylase 8000 u/g. This produced by Nutrex Company for Feed Enzymes Production, A chterstenhoek 5, 2275 Lille , Belgium.

3.5 Data collected:

3.5.1 performance data:

Average body weight gain and feed consumption (g) for each group were determined weekly throughout experimental period. Health of the experimental stock and mortality data were closely observed and recorded daily.

3.5.2 Slaughter procedure and data:

At the end of the experimental period birds were fasted overnight with only water allowed. Birds were weighed individually before slaughter by severing the right and left carotid and jugular vessels, trachea and esophagus. After bleeding they were scalded in hot water, hand plucked and washed. The head was removed at the hock joint. Evisceration was accomplished by a posterior ventral cut to completely remove the visceral organs. Hot carcass and each evisceration have the liver, heart and gizzard was separately weighed.

3.5.3 Carcass data:

The hot carcass was prepared for analysis by removal of the skin and neck near to the body and each was weighed separately. The carcass was then divided into right and left sides by mid sawing along the vertebral column and each side was weighed. The left side was devided into three commercial cuts, breast, drumstick and thigh **(Mohammed, 1996),** each cut was weighed separately, then they were debonded, the meat was frozen and stored for chemical analysis.

3.6 Meat quality assessment:

3.6.1 Meat chemical analysis :

The samples were stored for 24 hours in refrigerator and duplicated samples were sending to the Veterinary Research Central Laboratories-Soba for chemical analysis of protein, moisture fat and ash contents according to the A.O.A.C. (1988).

3.6.2 The panel taste:

Frozen deboned breast, drumstick and thigh cuts of the right side were thawed at 5-7ċ before cooking for sensory evaluation. The meat was trapped in aluminum foil, placed in roast pan and cooked at 176.7ċ in conventional preheated electrical oven to about 80ċ internal muscle temperature. The cooked meat was allowed to cool to room temperature in about 10 minutes. The samples were kept warm until served. Trained panelists were instructed to eat crackers drink water between sample testing to clear the palate and pause for 20 seconds between all samples evaluated, following recommended procedure **(Hawrysh *et al.*, 1980).** The sensory panel evaluated the chops for flavour, colour, tenderness and juiciness using an eight point scale (Appendix 2).

3.7 Statistical analysis:

Complete randomized block design (CRBD) was used in this experiment. Data in performance, slaughter, carcass yield and quality were all analyzed using One-way Analysis of variance (ANOVA). Frequency distribution were set and treatment means were compared for significance using the statistic test at the 5% level of probability (Obi, 1990).

Table(1): Percent inclusion rates(as fed basis)and calculated analysis (dry matter basis)of experimental diets fed to broiler chicks for 42 days .

Ingredient	**Ration (A)**	**Ration (A_+)**	**Ration (B)**	**Ration (B_+)**	**Ration (C)**	**Ration (C_+)**	**Ration (D)**	**Ration (D_+)**
Sorghum	68.39	68.39	68.28	68.28	68.17	68.17	68.03	68.03
Oil	0.11	0.11	0.22	0.22	0.33	0.33	0.44	0.44
Ground Nut Cake	25	25	16.7	16.7	8.3	8.3	-	-
Guar Meal	-	-	8.3	8.3	16.7	16.7	25	25
Concentrate *	5	5	5	5	5	5	5	5
Limestone	1	1	1	1	1	1	1	1
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Di calcium phosphate	.125	.125	.125	.125	.125	.125	.125	.125
Methionine	.125	.125	.125	.125	.125	.125	.125	.125
Total	100	100	100	100	100	100	100	100
Enzyme as feed additive ,5 kg/Ton								
Calculated analysis:								
Dry matter %	95.47	95.47	95.24	95.24	94.96	94.96	94.21	94.21
Crude protein%	23.01	23.01	23.06	23.06	23.14	23.14	23.19	23.19
Ether extract %	4.10	4.10	3.90	3.90	3.80	3.80	3.70	3.70
Crude fibre%	4.32	4.32	4.38	4.38	4.45	4.45	4.49	4.49
Ash %	4.30	4.30	4.27	4.27	4.08	4.08	3.96	3.96
N-Free Extract %	59.74	59.74	59.63	59.63	59.49	59.49	58.89	58.89
Calcium %	1.08	1.08	1.06	1.06	1.03	1.03	1.01	1.01
Total phosphorus %	0.82	0.82	0.83	0.83	0.84	0.84	0.85	0.85
Available phosphorus %	0.53	0.53	0.54	0.54	0.55	0.55	0.56	0.56
ME.,Mcal/kg	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18

Broiler concentrate * : crude protein 40% crude fat 3% crude fiber 1.5% lysine 13.5% methionin 5.9% meth + cystine 60.25%, calcium 6.8%, phosphorus 7% , sodium 1.5%, me 2.122 cal/kg . Added vitamins and minerals per kg : vitamin A250,000 I U , vitamin D3 60.000IU, V.E 800ppm, V.K3 60ppm, V.B12 40ppm, B2 100ppm, pantothenic acid 200ppm, niacin 800ppm, V.B6 50ppm, V.B12 300ppm, V,C 4.000ppm, Biotin 2000ppm, Folic acid 3oppm, choline chloride 10,000ppm, iron (fe) 1.000ppm, copper (cu) 300ppm, zinc (zn) 1.000ppm, Manganese (mn) 1.600ppm, iodine 20ppm, cobalt 12ppm, Antioxidant added.

** Vitamins and minerals supplement per kg product : V.A300.000IU, V.D3 100.000IU, V.E 4.00ppm, V.K 98ppm, V.B21.320ppm, V.B12 4.00ppm, pantothenate 2.0ppm, Niacin20.0ppm, Folic acid 100ppm, coline 50.0ppm, Copper 15.0ppm, iodine 250ppm, Selenium 50ppm, Manganese 24ppm, Zink 20ppm, lron 10ppm, Coccide 25ppm, Antioxidant b125ppm.

CHAPTER FOUR

RESULTS

4.1 Performance :

Table (2) shows the effect of dietary inclusion of guar meal and enzyme supplementation on the performance of broiler chicks. Initially all groups started at similar (P>0.05) body weight. Weight gain and feed intake and FCR values for all test group were significantly (P<0.05) different from the control group. Body weight gain and feed intake were decreased significantly (P<0.05) in descending order as the level of guar meal increased in the broiler diet.

The feed conversion ratio was deteriorated significantly (P<0.05) as the dietary level of guar meal increased during all experimental period.

The results showed that the addition of enzymes had no significant effect on the body weight gain and fed conversion ratio in all the dietary treatments, whereas the feed intake was increased significantly (P<0.05) in the birds fed with the enzymes supplemented diets, but the groups of the chicks fed on guar meal still significantly (P<0.05) below the control group in feed intake values. The treatment had no significant effect on the mortality rate throughout the experimental period.

Table (2): Effect of dietary inclusion of guar meal and enzyme supplementation on performance of broiler chicks.

Replacement of groundnut cake meal by Guar meal	Wight gain (g/bird)	Feed intake (g/ bird)	Feed conversation ratio (Feed intake/weight gain)/ bird	Mortalit%
A (0%) (Control)	1794.00±116.75[a]	3239.00±81.68[b]	1.80±0.22[a]	0.00
A_+(0%) + Enzyme	1801.00±46.77[a]	3261.00±72.44[a]	1.80±0.08[a]	0.45
B (33%)	1398.00±167.77[b]	2981.00±178.12[d]	2.12±1.02[b]	o.45
B_+ (33%) Enzyme	1405.00±75.42[b]	2998.00±210.68[c]	2.13±0.76[b]	0.00
C (66 %)	1209.00±78.26[c]	2750.00±357.87[f]	2.31±1.38[c]	0.45
C_+ (66 %) Enzyme	1218.00±27.45[c]	2781.00±248.23[e]	2.24±0.82[c]	0.45
D (100 %)	822.00±40.59[d]	2201.00±486.49[h]	2.68±1.3[d]	0.45
D_+ (100%) Enzyme	831.10±16.07[d]	2234.00±308.73[g]	2.68±1.52[d]	0.00
Lsd 0.05	128.4[*]	13.00[*]	1.569[*]	0.349[ns]
SE±	43.67	4.42	0.5334	0.175

Any two means ±SD value(s) bearing same superscript(s) within columns are not differ significantly (P < 0.05).

* : Denote mean values significant at (P < 0.05)

ns : not significant at (P > 0.05)

SE ± : Standard Error

4.2 Carcass Measurements:

4.2.1 Carcass and non-carcass yield:

Table (3) shows the average percent of carcass dressing and giblets (gizzard, heart and liver) were not affected significantly by either different levels of guar meal inclusion or enzyme supplementation.

Table (3): Effect of dietary inclusion of guar meal and enzyme supplementation on percent of carcass dressing and giblets (Gizzard, Liver and Heart) of broiler chicks.

Replacement of groundnut cake meal by Guar meal	Dressing %	Gizzard %	Liver %	Heart %
A (Control)	71.20±3.80[a]	2.12±0.20[a]	2.15±0.41[a]	0.60±0.00[a]
A_+ (0%) Enzyme	71.27±3.25[a]	2.11±0.32[a]	2.16±0.12[a]	0.63±0.11[a]
B (33%)	68.31±4.34[a]	2.30±0.14[a]	2.15±0.23[a]	0.63±0.04[a]
B_+ (33%) Enzyme	68.34±5.64[a]	2.35±0.13[a]	2.27±0.32[a]	0.65±0.20[a]
C (66%)	67.11±6.62[a]	2.23±0.52[a]	2.17±0.10[a]	0.62±0.23[a]
C_+ (66%) Enzyme	67.18±14.30[a]	2.43±0.17[a]	2.17±0.17[a]	0.63±0.11[a]
D (100%)	65.60±3.57[a]	2.61±0.34[a]	2.17±0.34[a]	0.62±0.06[a]
D_+(100%) Enzyme	65.66±24.76[a]	2.61±0.10[a]	2.18±0.10[a]	0.63±0.09[a]
Lsd0.05	18.54[ns]	0.5045[ns]	0.4069[ns]	0.1997[ns]
SE±	6.113	0.1663	0.1342	0.06583

Any two means ±SD value(s) bearing same superscript(s) within columns are not differ significantly ($P < 0.05$).

*: Denote mean values significant at ($P < 0.05$)

ns: not significant at ($P > 0.05$)

SE ±: Standard Error.

4.2.2 Commercial cut:

Commercial cut (drumstick, thigh and breast) are given in Table (4). The inclusion level of guar meal had no significant effect on the commercial cuts and all treatment groups mean values were similar. There was no significant difference among different experimental groups as far as enzyme supplementation was concerned.

Table(4): Effect of dietary inclusion of guar meal and enzyme supplementation on percentage of commercial cuts (Drumstick, Thigh and Breast) values of broiler chicks.

Replacement of groundnut cake meal by Guar meal	**Drumstick %**	**Thigh %**	**Breast %**
A (Control)	19.11±1.13[a]	19.35±1.56[a]	24.49±2.77[a]
A_+ Enzyme	19.13±1.20[a]	19.38±3.35[a]	24.49±2.60[a]
B (33%)	19.11±1.74[a]	19.33±2.90[a]	24.46±1.19[a]
B_+ Enzyme	19.14±1.66[a]	19.35±1.94[a]	24.48±3.30[a]
C (66%)	19.09±0.37[a]	19.30±4.46[a]	24.43±2.35[a]
C_+ Enzyme	19.10±2.69[a]	19.32±4.61[a]	24.45±4.21[a]
D (100%)	19.06±3.17[a]	19.31±3.36[a]	23.41±3.12[a]
D_+ Enzyme	19.09±0.37[a]	18.98±1.19[a]	23.43±2.37[a]
Lsd0.05	3.296[ns]	5.897[ns]	4.622[ns]
SE±	1.087	1.944	1.524

Any two means ±SD value(s) bearing same superscript(s) within columns are not differ significantly ($P < 0.05$).

*: Denote mean values significant at ($P < 0.05$)

ns: not significant at ($P > 0.05$)

SE ±: Standard Error

The treatment of meat expressed as percentage from total weight of selected commercial cuts are given in Table (5). No significant effect was observed between all treatment groups in meat percentage of breast, thigh and drumsticks.

Table(5): Effect of dietary inclusion of guar meal and enzyme. supplementation on the values of meat expressed as percentages form total weight of commercial cuts of broiler chicks.

Replacement of groundnut cake meal by Guar meal	Drumstick meat %	Thigh meat %	Breast meat %
A (Control)	70.40±2.22[a]	83.27±1.35[a]	81.87±3.33[a]
A_+ (0%) Enzyme	70.44±1.65[a]	83.30±0.70[a]	81.87±4.14[a]
B (33%)	70.36±6.09[a]	83.25±4.85[a]	81.84±3.76[a]
B_+ (33%) Enzyme	70.38±1.56[a]	83.27±1.96[a]	80.88±6.82[a]
C (66%)	70.32±4.82[a]	83.25±9.58[a]	81.82±6.77[a]
C_+ (66%) Enzyme	70.37±8.33[a]	83.28±15.03[a]	81.85±4.23[a]
D (100%)	70.30±2.89[a]	83.24±12.72[a]	81.21±2.86[a]
D_+(100%) Enzyme	70.34±3.28[a]	83.27±5.07[a]	81.84±3.07[a]
Lsd0.05	7.366[ns]	13.97[ns]	8.085[ns]
SE±	2.428	4.605	2.666

Any two means ±SD value(s) bearing same superscript(s) within columns are not differ significantly ($P < 0.05$).

*: Denote mean values significant at ($P < 0.05$).

ns : not significant at ($P > 0.05$).

SE ±: Standard Error.

4.3 Meat quality parameters :

4.3.1 Meat chemical composition:

Table (6) shows meat chemical composition aspects (crude protein, ether, ash and moisture) were not affected significantly by different dietary levels of guar meal. furthermore addition of enzyme did not have any effect on meat chemical composition aspects at all inclusion level of guar meal.

Table(6): Effect of dietary inclusion of guar meal and enzyme supplementation on chemical meat composition of broiler chicks.

Replacement of groundnut cake meal by Guar meal	Crude protein %	Ash %	Moisture%	Ether extract %
A (Control)	17.47	1.34	70.54	4.56
A_+ (0 %) Enzyme	17.48	1.35	70.55	4.57
B (33%)	17.49	1.30	70.51	4.55
B_+ (33%) Enzyme	17.47	1.32	70.52	4.55
C (66%)	17.46	1.30	70.50	4.53
C_+ (66%) Enzyme	17.48	1.33	70.51	4.54
D (100%)	17.42	1.29	70.50	4.53
D_+ (100%) Enzyme	17.44	1.31	70.51	4.52
Lsd0.05	0.5782^{ns}	0.1909^{ns}	0.1909^{ns}	0.414^{ns}
SE±	0.1835	0.060	0.0224	0.13117

Any two means ±SD value(s) bearing same superscript(s) within columns are not differ significantly (P<0.05).

*: Denote mean values significant at (P < 0.05)

ns: not significant at (P > 0.05)

SE ±: Standard Error.

4.3.2 Panel test (subjective meat attributes):

The effect treatment on subjective attributes is shown in table (7). The average of subjective meat quality score for colour, tenderness, juiciness and flavour and over all acceptability of leg cuts (thigh and drumstick) did not differ significantly among the experimental dietary groups and score given for all attributes are above moderate acceptability.

Table (7): Effect of dietary inclusion of guar meal and enzyme supplementation on Subjective attribute of broiler chicks.

Replacement of groundnut cake meal by Guar meal	Tenderness	Juiciness	Color	Flavor
A (Control)	6.65±0.30[a]	6.33±0.30[a]	6.10±0.61[a]	6.40±0.06[a]
A_+ (0%) Enzyme	6.91±0.43[a]	6.35±0.35[a]	6.18±0.12[a]	6.44±0.74[a]
B (33%)	6.63±0.31[a]	6.26±1.53[a]	6.03±0.92[a]	6.35±0.56[a]
B_+ (33%) Enzyme	6.69±1.96[a]	6.33±1.49[a]	5.50±0.95[a]	6.35±1.44[a]
C (66%)	6.58±0.93[a]	6.25±0.15[a]	5.97±0.45[a]	6.33±0.35[a]
C_+ (66%) Enzyme	5.97±1.71[a]	6.29±1.23[a]	5.97±1.42[a]	6.37±1.08[a]
D (100%)	6.52±0.93[a]	6.26±0.59[a]	5.96±0.87[a]	6.30±0.62[a]
D_+ (100%) Enzyme	6.57±1.86[a]	6.25±0.75[a]	5.98±0.36[a]	6.34±0.75[a]
Lsd0.05	2.13[ns]	1.677[n.s]	1.212[ns]	1.494[ns]
SE±	0.7024	0.5529	0.3996	0.4926

Any two means ±SD value(s) bearing same superscript(s) within columns are not differ significantly (P < 0.05).

*: Denote mean values significant at (P < 0.05)

ns: not significant at (P > 0.05)

SE ±: Standard Error.

4.4 Economic appraisal:

Appraisal of the total cost, reverences, net profit and profitability ratio of the broiler chicks fed different levels of guar meal with or without enzyme supplementation for 6 weeks is shown in Table (8). Chicks purchase, management and feed cost values were the major inputs considered. The total selling values of the meat is the total income obtained. the results indicated that as the level of guar meal with or without enzyme increased in the diet the cost of feed decreased , but as the same time the profitability ratio/bird decreased linearly profitability ratio (0.13) of the test group D_+ (100% replacement of GNC by GM + Enzyme) was the lowest of the test groups.

Table (8): Total cost, revenues, net profit and profitability ratio of broiler chick fed different levels of guar meal with or without enzyme.

Items / Treatment groups	**A**	**A+**	**B**	**B+**	**C**	**C+**	**D**	**D+**
Chicks price	3	3	3	3	3	3	3	3
Management /chick	1	1	1	1	1	1	1	1
Feed cost/chick	6.097	6.129	4.274	5.522	3.969	3.170	2.589	3.040
Carcass w,g/chick	1277	1283	954.8	960.03	811.91	818.25	539.23	545.63
Price / kg	15	15	15	15	15	15	15	15
Total Revenue/ chick	19.155	19.245	14.322	14.400	12.179	12.274	8.088	8.184
Total cost /chick	10.097	10.129	8.274	9.522	7.969	7,170	6.589	7.040
Profit /chick	9.058	9.116	6.048	4.878	4.21	5.104	1.499	1.144
Profitability/chick	1	1.006	0.67	0.54	0.46	0.56	0.17	0.13

Total cost calculated according to January 2012 price

Price kilogram of bird calculated according to March 2012.

CHAPTER FIVE

DISCUSSION

The novel feedstuffs group consists of those that less commonly used in hot region. It is observed that in general recommended level of inclusion of the novel feedstuffs are low in poultry diets because of problems with either the palatability of those feedstuffs or the presence of anti-nutritional factors. As pointed out by **Farrell (2005),** many countries in the hot regions of the world may not able to continues importing maize and soybean as their industry grows and there may have depend more on the locally produced ingredients. Therefore, research on methods of improving the palatability and reducing anti-nutritional factors in those feedstuffs is needed. This type of research can lead to more extensive of these novel feedstuffs in hot region of the worlds.

Guar meal is the one of those novel feedstuffs which contain 35-45 % crude protein and a good sources of essential amino acids (**Mohayayee and Karimi, 2012**). Although, guar meal can be used as a source of protein in poultry diets but some of the anti-nutritional agents such as guar gum, tripsin inhibitor, saponins, polyphenols and hemagelotenins in guar meal limit the usage of high levels of this meal in broiler diets **(Verma and McNab, 1982, Conner, 2002 and Lee *et al.*, 2003a)**. High content of galactomannan gum residues the main anti-nutritionial agent in guar meal can increase intestinal viscosity, suppress growth and reduce feed efficiency in broilers **(Gutierrez, *et al.*, 2007 and Lee *et al.*, 2003, a,b)**. The guar plant recently introduced to Sudan, its industrial by-products is also new to animal feeders experiences. Few experiments were run utilizing guar meal for other classes of animals including broiler chicks.

Experimental diets in this study were formulated to be iso nitrogenous (23% CP) and iso-caloric (1.18 Mcal/kg) according to the recommended dietary requirement for broilers **(NRC, 1994)**, with groundnut cake replaced by guar meal at levels 0, 33, 66 and 100% without and with commercial microbial enzyme (xylam500) supplementation.

The apparent health of the experimental stock was good in all treatment groups. Environmental temperature during the experimental period fell within thermoneutral zone, exerting no heat stress on the experimental birds.

Throughout the experimental period, mortality rate was normal among all treatment groups. Dietary guar meal with or without enzyme supplementation had no significant effect on mortality rate and that was disagreed with the findings of **Thakur and Pardhan (1975 a,b), Sagar *et al* (1978) and Kamran, (2002)** who reported that mortality rate has an increasing trend at 15% guar meal in diet.

The result of this experiment indicated that the body weight gain was decreased significantly ($P<0.05$) in descending order as the level of guar meal increased in broiler diets, this may be due to the residual gum in guar meal increases intestinal viscosity in chickens, which reduces growth rate **(Lee *et al.*, 2005, Gharaei *et al.*, 2012 and Mohayayee and Karimi, 2012**), Increased viscosity severely decreases nutrient, absorption and decreases the rate of passage through intestine

(Maisonnier, 2003). Also decreases digestibility coefficient of all macronutrients and decreases digestive enzymes activity throughout the small intestine **(Smits *et al.*, 1997).**In present study, a remarkable increase in the viscosity of the faces was observed when the level of guar meal increased in the diets. This results are in line with those obtained by **EL-Faki (1995)** who found that body weight gain of broiler chicks was decreased significantly in descending order as the level of replacement of groundnut cake by guar meal increased. Similarly, Rajput *et al.* (1998) **Lee *et al.* (2003 a); Lee *et al.* (2005) Larhang and Torki (2011) and Turki *et al.* (2011).** They all reported significant decrease in body weight gain of broilers consuming higher levels of guar meal. The enzyme addition had no significant effect on body weight gain in all dietary treatment groups. This results agreed with the findings of **Patel and McGinnis (1985), Kamran *et al.* (2002), Larhang and Torki (2011)** who found that addition of enzymes to diets containg different levels of guar meal did not result in significant improvement in weight gain of broiler chicks. These results were disagreed with **Lee *et al.* (2003a,b); Gharaei *et al.*(2012); Mohayayee and Karimi, (2012)** who found that addition of β-mannanase enzymes to guar meal diets had elevated amounts of guar gum and deleterious effects related to intestinal viscosity and improved chicks body weight.

Feed intake by the chicks was decreased significantly ($P<0.05$) in linearly trend as level of guar meal increased in the diet. Deterioration effects of using guar meal on feed intake can be attributed to its viscosity causing properties. The increase in viscosity reduces the gastric-emptying time that can cause reduced feed intake. (**Faris and**

Sgarbieri, 1998). These results are in accordance with findings of **Khan (1996) Kamran *et al.* (2002); Lee *et al.* (2003a); Mohayayee and Karimi (2012); Gharaei *et al.* (2012);** who observed that feed consumption in broilers was significantly reduced as the guar meal content increased. The results of the present study do not agree with the findings of **Larhang and Torki (2011)** who found that feed intake of broiler chicks was not influenced significantly by the increasing dietary level of guar meal up 15%. In contrast **Thakur and Pradhan (1975a), Sagar *et al.* (1978)** reported that feed intake was increased with the increased level of guar meal and rations containing raw guar meal were consumed more than rations containing treated guar meal. Further, addition of enzyme had improved the feed intake significantly ($P<0.05$) at all dietary treatment groups in this study, but still the groups fed on guar meal significantly below the control groups. This result was in line with **Lee *et al.* (2003 b) Lee *et al.* (2005) Mohayee and Karimi (2012)** who reported that inclusion of β-mannanase Hemicell in broiler diet containg guar meal reduces viscosity and increases feed intake. These results were disagreed with **Kamran *et al.* (2002) and Larhang Torki (2011).** who stated that addition of enzyme to diet containing various level of guar meal did not have any significant effect on feed intake of broiler chicks.

The result of the present study indicated that as the level of guar meal increased in the diet, there was significant deteriorate in feed conversion ratio. In this study the guar gum residues in guar meal also responsible for poor feed conversion ratio of broiler fed diets containing guar meal. Guar gum is sticky in nature and reduces the digestibility, absorption and utilization of the macronutrient, thereby depresses the feed efficiency in broilers **(Smits *et al.*, 1997; Lee *et al.*, 2009; Lee *et al.*, 2003 a,b).** These results were agreed with the findings of **EL-Faki (1995); Kamran, *et al*; (2002); Lee *et al.* (2005); Gharaei *et al.* (2012)** who reported that as the level of guar meal increased in broilers diets the feed efficiency was reduced significantly. However there was non-significant differences in feed conversion ratio among different experimental groups, as far as enzyme addition was concerned in this study. This findings co-relate with **Kamran *et al.* (2002)** and disagrees with **Lee *et al.* (2003 b); Mohayayee and Karimi (2012) and Gharaei *et al.* (2012)** who found that inclusion of β-mannanase to diet containing guar meal reduced intestinal viscosity and improved the feed efficiency of the broilers.

The results cited in the literature are a highly variable about the degree of improvement obtained in performance of broilers by adding non-starch-polysaccharides degrading enzymes to poultry diets. This may be due to the variation in the efficacy of the enzyme additives which depend on many factors , including the type of ingredients used in the diet, the level of NSP in the ingredient, the type, sources and concentration of enzyme used, type, age and diseases status of animal **(Jaroni *et al.,* 1999, and Sreenivasaiah, 2006) .**

The results showed that inclusion of guar meal to broiler diets had no significant effect on carcass yield and internal organs (gizzard, liver and heart) percentages. This result agree with **Lee *et al.* (2003a), and Mohayayee and Karimi (2012)** and disagrees with **EL-Faki (1995),** who found that the liver% was increased significantly at the level 66% of replacement groundnut cake by guar meal whereas, the gizzard%

increased significantly at level of replacement 66% and 100% and the dressing % was decreased significantly at all level of replacement. compared to control group. The supplementation experimental diets with enzyme did not have any significant effect on carcass dressing and internal organs percentages in the present study. Similar result were obtained by **Lee *et al.* (2003a), and Mohayayee and Karimi (2012)**. who reported that addition of β-mannanase had no significant effect on relative weight of carcass and giblets of broilers fed different level of guar meal.

Treatment effect in this study was not significant on commercial cut (thigh, breast and drumstick) percentage and their percent of separable tissue. Confirmation of these findings obtained by **EL-Faki (1995).** who reported that the commercial cuts and their percent of separable meat were not affected significantly by the replacement groundnut cake by guar meal at level (33, 66 and 100) in broiler diet.

The result of the present study showed that feeding guar meal with or without enzyme had no significant effect on broiler meat chemical composition (moisture, fat, protein and ash). These results were confirmed by the subjective meat quality values in broiler (tenderness, juiciness, flavor and colour), all being at moderate values in this study. This findings disagreed with **EL-Faki (1995)** who reported that increasing guar meal level in broiler diet significantly affected muscle moisture and ether extract but in an irregular pattern and effect on crude protein and ash was variable.

The result of economical evaluation of experimental diets showed that as the level of guar meal increased in the ration the cost of feed decreases, but at the same time cost per bird increased. Similar result was obtained by **Kamran *et al*. (2002).** The addition of enzyme to the all treatment groups did not have any economical benefits in this study. **Kamran *et al*.(2002).** reported that economic was improved with enzyme addition to diet containing guar meal but 15% guar meal with enzyme was least efficient.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion:

- It is clear from the results that as the guar meal increased to replace the groundnut cake meal in the diets the performance of broiler decreases.
- Addition of commercial enzyme to the diet containing different levels of guar meal did not result in significant improvement in weight gain and feed conversion ratio, whereas the feed intake was increased by enzyme supplementation , but still significantly below the control values.
- Using guar meal with or without enzyme in the diets made no changes in carcass yield and meat quality.
- Adding guar meal with or without enzyme to broiler diets economically not feasible.

Recommendation:

1- Based on the results of this study, the inclusion of guar meal to replace groundnut cake in diet had a negative effects on the performance of the broiler chicks.

2- The level of dietary commercial enzyme (xylam 500) used in this study is inadequate enough to remove the anti-nutritional effect of guar gum in guar meal on the performance of broiler.

3- All levels of dietary guar meal used with or without enzyme supplementation economically are less profitable compared with groundnut cake meal values.

4- Higher inclusion of guar meal in broiler ration requires effective inactivation of antinutritional factors to avoid depression in performance.

Suggestition for future research:-

1- Based on the findings of preset study, it may be worthwhile to investigate further, whether or not higher levels of commercial dietary xylam 500, above (1/2 kg/Ton) with dietary guar meal could give beneficial effect.

2- Further experimentations are needed to test the synergistic effect of different polysaccharides degrading enzymes on guar gum anti-nutritional agent in guar meal.

3- Furthely, guar meal with and without enzyme supplementation can be evaluated as well in laying hen diets checking its effect on egg yield and quality.

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Appendix1: Weekly average minimum and maximum air temperature during the experimental period (3[ed] January 13[rd] February 2012).

weeks	**Min. temp c^0**	**Mix. Temp c^0**
1	15.4	28.9
2	13.2	26.2
3	11.0	29.9
4	16.4	33.2
5	17.3	35.9
6	21.6	36.8
Average	15.8	31.8

Source: Khartoum Meteorological Office

Appendix2: SENSORY EVALUATION CARD

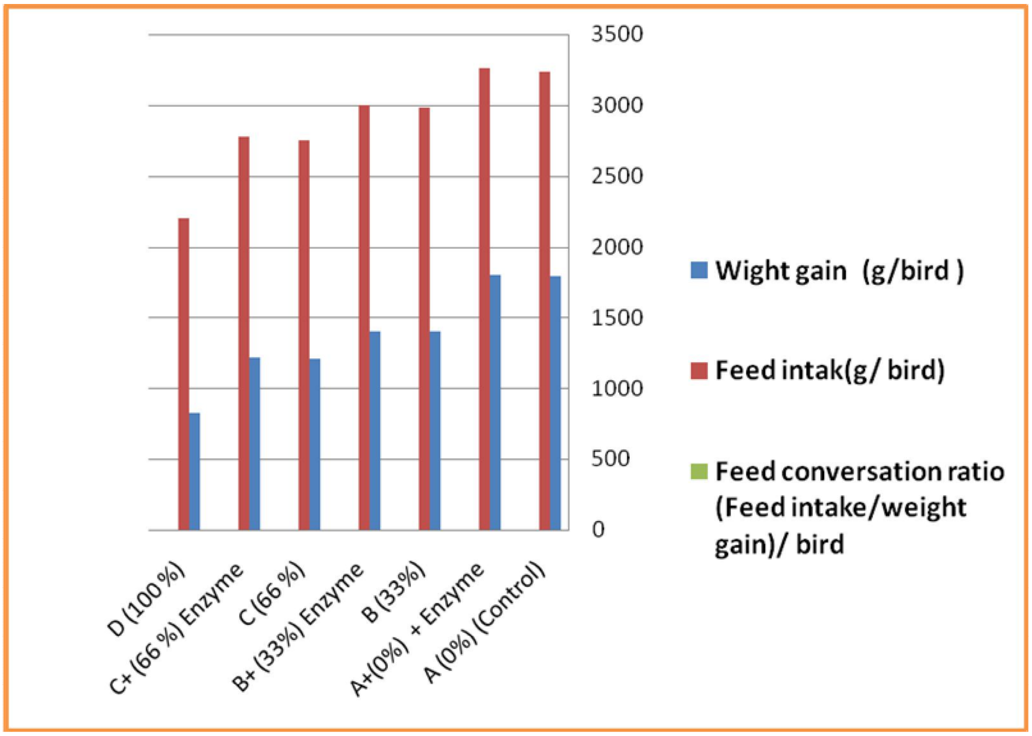
Evaluate these sample for colour , flavor juiciness and tenderness , for each sample , use the appropriate scale to show your attitude by checking at the point that best describes your feeling about the sample , if you have any quation please ask , thanks for your cooperation.

Name : …………………………………. Date : ……………………………………….

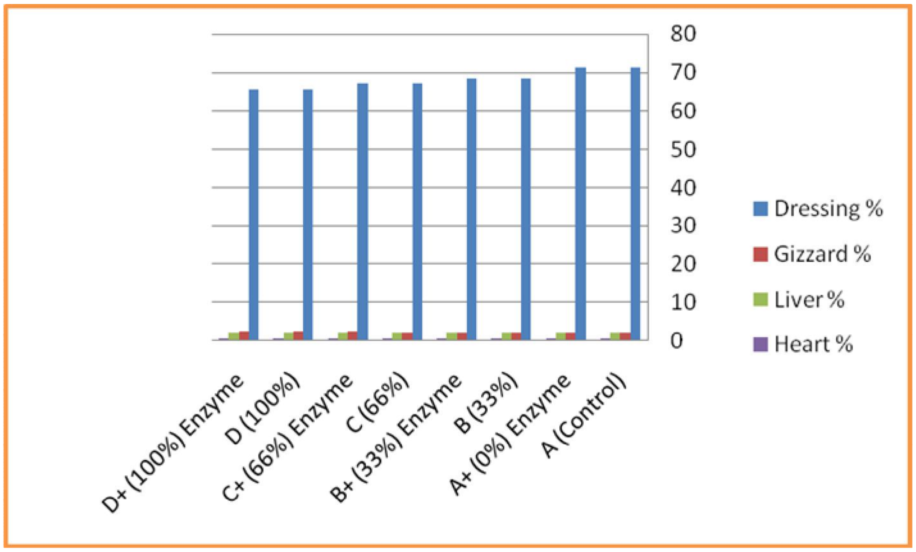
1- Tenderness	2- Flavor	3- Colour	4- Juiciness
8- Extemely tender 7- Very tender6- Moderately 5- Slightly tender 4- Slightly tough 3- Moderately tough 2- Very tough 1-Extemely tough	8- Extemelyintense 7- Very intense 6- Moderatelyintense 5- Slightly intense 4- Slightly bland 3- Moderately bland 2- Very bland 1-Extemely bland	8- Extemelydesiralbe 7- Very desirable 6- Moderately desirable 5- Slightly desirable 4- Slightly undesirable 3- Moderately undesirable 2- Very undesirable 1-Extemely undesirable	8- Extemelyjuicy 7- Very juicy 6- Moderately juicy 5- Slightly juicy 4- Slightly dry 3- Moderately dry 2- Very dry 1-Extemely dry

Serial	Sample code	(1)	(2)	(3)	(4)	Comments
1-	A					
2-	A_+					
3-	B					
4-	B_+					
5-	C					
6-	C_+					
7-	D					
8-	D_+					

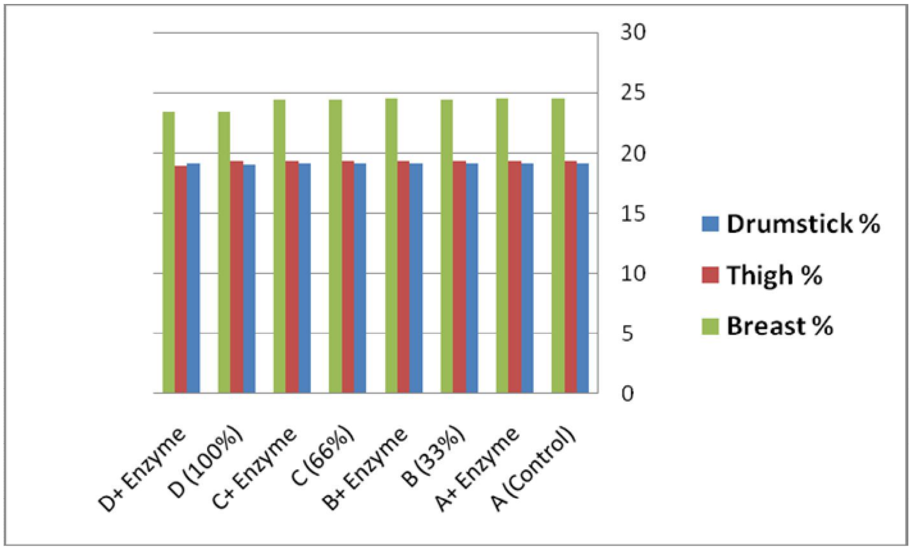
Appendix3 : Figure (2). Effect of dietary inclusion of guar meal and enzyme supplementation on performance of broiler chicks.



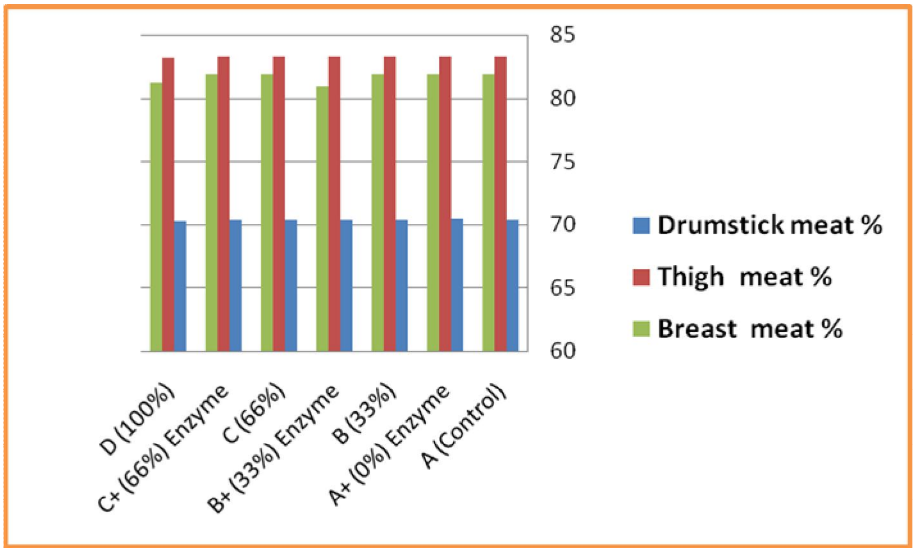
Appendix 4: Figure (3). Effect of dietary inclusion of guar meal and enzyme supplementation an percent of carcass dressing and giblets (Dressing, Gizzard, Liver and Heart) broiler chicks.



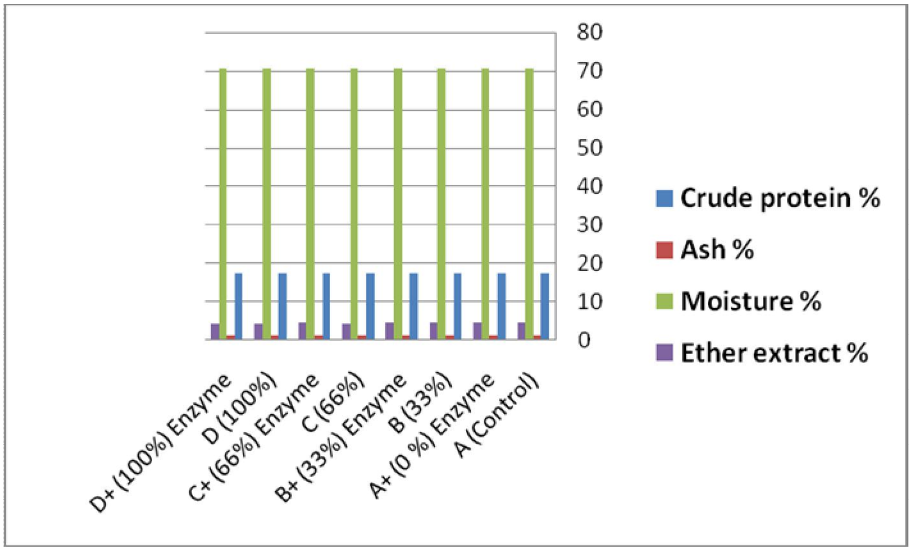
Appendix 5 : Figure (4). Effect of dietary inclusion of guar meal and enzyme supplementation on percentage of commercial cuts (Drumstick, Thigh and Breast) percentage values of broiler chicks.



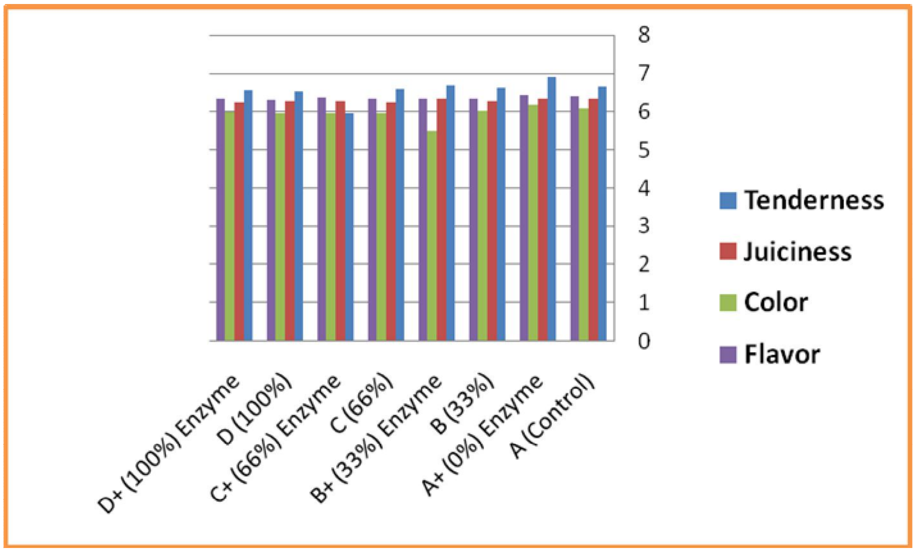
Appendix 6 : Figure (5): Effect of dietary inclusion of guar meal and enzyme. supplementation on the values of meat expressed as percentages form total weight of commercial cuts of broiler chicks.



Appendix 7 : Figure (6). Effect of dietary inclusion of guar meal and enzyme supplementation on chemical meat composition of broiler chicks for 6 weeks.



Appendix 8 : Figure (7): Effect of dietary inclusion of guar meal and enzyme supplementation on subjective attribute of broiler chicks.



Appendix 9: Figure (8).c Total cost, revenues, net profit and profitability ratio of broiler chick fed different levels of guar meal with or without enzyme.