Genetic and Phenotypic Aspects of Body Weights in Local Large Beladi Chicken Raised Under Two Different Dietary Constituents

BY

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Dedication

To the souls, of my father and my mother from whom I learned patience.

To my little family, my wife Zeinab and my dearest twins Mohamed and Ahmed, who felt loneliness while I was busy with this study.

To my brothers and sister, who encouraged me.

To my employers and my colleagues.

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ABSTRACTS

The foundation stock was primarily established by purchasing 50 cockerels and 160 pullets of the indigenous fowl from the Blue Nile area (Sinar state). This work was conducted to compare the genetic and phenotypic parameters estimates for body weights of large Beladi chicken under two different feeding regimes and proposing outlines of a strategy for improving body weights at different ages. Each cockerel was randomly assigned to mate with three pullets in a rotational pattern. Eggs for incubation purpose were collected from the individual breeding pens three times a day and recorded on daily basis. Eggs were weighed, graded and pedigreed and then incubated to obtain 13 consecutive hatches at weekly intervals. The total number of birds used in the experiment was 1718. According to the experimental protocol, which based on feeding regime, chicks were divided into two groups (A) and (B). Birds in group (A) were fed on broiler-formulated rations, whereas birds in group (B) were fed on layer-formulated rations. For group (A) individual body weights were taken at biweekly interval up to 12 weeks. However, for group (B) individual body weights were taken at monthly interval up to 3 month.

The overall average body weights for birds at hatch, 4, 8 and 12 weeks in group (A), were 26.78±2.91, 147.16±30.87, 393.51±64.12 and 800.93±155.97g, respectively, whereas, the corresponding weights in group (B), were 29.31±2.66, 170.80±49.27, 353.43±102.70 and 512.75±116.11.

Mean body weights of birds in group (B) were significantly ($P < 0.05$) higher than those in group (A) at hatch and 4 weeks of age, however, the reverse was true for body weights at 8 and 12 weeks of age. Growth pattern revealed an increasing trend with advanced ages. On the

other hand, the monthly weight gain showed marked decline at 8 weeks of age for birds in group (B). Comparing growth of birds in A and B groups revealed that, increasing dietary protein and metabolizable energy (ME), resulted in increase body weights at 8 and 12 weeks of age by 11.3 and 56.2 percents, respectively. In group (A), the mean body weights of males were significantly ($P < 0.05$) higher than those of females at 4, 6, 8 and 12 weeks of age. This may express the presence of heterogeneity between sexes at these ages. Sire and dam effects on body weights were found to be significant at various ages. Hatch had significant effect ($P < 0.01$) on body weight at all ages.

Heritability estimates for body weights at different ages from sire, dam and sire plus dam components of variance were obtained for both groups. The estimates in group (A) and (B) ranged from low (0.02) to high (0.97) and low (0.06) to moderate (0.25), respectively. In group (A), heritability estimates from dam component were higher than those from sire component, whereas the reverse was true for the estimates in group (B). Heritability estimates for body weights in group (A) were slightly higher than those in group (B). This may reveal the tendency for increasing heritability magnitudes with improved levels of dietary protein and metabolizable energy (ME).

For both groups (A) and (B), the genetic and phenotypic correlation estimates ranged from low (0.16) to high (0.97) and followed similar trends. However, the magnitudes were relatively higher in group (A) than those in group (B). The environmental correlation estimates were also positive, ranged from low (0.08) to high (0.99), and followed similar trend.

Based on sire component of variance, the highest heritability estimate in group (A) was at 4 weeks of age, whereas the corresponding estimate in group (B) was at 8^{th} week. Generally, it may be concluded that mass or individual selection for body weight is better to be conducted at 4th week, when birds are fed on diet with high protein and metabolizable energy (Broiler ration) and at 8th week, when birds are fed on diet with low protein and metabolizable energy (Layer ration).

CHAPTER ONE

INTRODUCTION

Africa has a proximately 9.6% of the total human population and 9.4% of the world domestic fowl (FAO, 1984). While the ratio of fowl to people is similar to that of the rest of the world, yet it produces only 4.7% and 3.4% of the world poultry meat and eggs, respectively (Wilson, 1986). Sudan is considered as a vast agricultural country occupying about one million squire miles (about 2.5 million km^2) in an area extending over 18 degrees of latitude between 4° and 22°N, falling entirely in the tropics with a distinct dry and wet season and a rain fall that increase gradually from (zero) in the north to (52) inches in its extreme south; as such, it represents a wide variation of climate and vegetation. The indigenous animal genetic resources in the country therefore vary to a great deal from one part to another. Sudan has a large livestock population; that estimated at 39 million heads of cattle, 47million heads of sheep, 42 million heads of goats, 3.3 million heads of camel and 85 millions poultry (Exotics breeds), (FAO, 2004). The Country ranks among the top African and Arab countries owning livestock. This rich animal potential represents a high source of animal protein. The production of red meat in Sudan has been estimated at 1146,000 ton beef, 401,000 ton mutton and 81.000 ton camel meat, while the total production of white meat is 32,000 ton (FAO, 2004). Despite these high animal protein resources, large sectors of Sudanese people are suffering from protein deficiency as an outcome of the low intake of animal protein. This could partly be attributed to the very low consumption of poultry products, which estimated at a range of 0.7 to 1.0 kg poultry meat and 13 to 16 eggs per person per year, compared to 3 kg of poultry meat and 34 eggs, for Africa, (FAO, 1986). The annual per capita consumption of poultry meat in other parts of the world was further higher, varied from 4 kg in Philippines to 12 kg in Eastern Europe, 16 kg in Western Europe, 17 kg in United Kingdom and 28 kg in Saudi Arabia, and in the developed countries more than 200 eggs per person per year (Gyles, 1989).

The native fowl of the Sudan is found in the rural areas and in villages along the river banks where numerous water pumping schemes exist. They are reared mainly under free range system by women and children as a source of additional income by selling the produced eggs, pullets and cockerels. Moreover, the birds feed on forage, seeds, insects, worms and human food residues, and provided with poor shelters at night to protect them from predation and theft. The commonest types of indigenous chicken in Sudan (collectively called Beladi), vary in their shape, size, color, production characteristics and. Desai (1962) classified the Beladi breed as follows:-

1- Large Beladi: It is the commonest type in the country, characterized by good body size. The adult size range from 2.5 to 3.0 Ibs, with wide variety of feather colors and small crushed comb.

2- Bare neck: it is the predominant type in southern Sudan, with small size and featherless neck. The average body weight is 1.5 lb and it is the best layer, however the hen is broody.

3- Betwil: It is the smallest type; found in the Nuba Mountain in Kordofan region. It is characterized by compact body. The adult body weight averages 1.5 – 2.0 lb, and they possess tiny black legs. Betwil and Bare neck types are more uniform in feather color than the large Beladi.The local bird on an average lays 40 to 50 eggs a year, whereas under controlled test conditions the average egg production of Bare neck, large Beladi and Betwill were 106, 78 and 86 respectively, (Osman, 1988). Although, the production performance of the indigenous fowl of Africa is quite low, (Nwosu, 1979), they are well adapted to poor management, feed restriction and common endemic diseases; in addition, they are characterized by good fitness traits (Oluyemi et al, 1979 and Trial, 1962). Moreover the traditional poultry production system can, partly help to satisfy the increase demand for animal protein in a cheap price, particularly in the rural areas.

Exotic breeds have been introduced to Sudan and other developing countries in an attempt to improve the local breeds potentiality. The earliest importation of exotic breeds into Sudan is dated to 1926, when a British veterinarian introduced a stock of Yandotte breed and distributed the fertilized eggs to be used for incubation. This was followed in 1949 by the introduction of another breed, Black Australorp to improve the chicken of southern Sudan. In 1951, the government established the Khartoum North Poultry Farm to serve as a research centre for the local breed and its improvement; however later in 1963, the first proper Poultry Research Unit was established at the Animal Production Research Centre at Kuku village. This Centre began actively to import foreign breeds and to evaluate their performance under Sudan conditions. Such breeds were White Leghorn, Egyptian Fayoumi, Rhode Island Red, New Hampshire and High Sussex. Although, these foreign breeds are characterized by high productivity, their performance under Sudan conditions was relatively fluctuated, due to reduction in feed intake resulting from loss of appetite due to heat stress, (Nasir, 1988). However in the beginning of 1980s, poultry industry in Sudan entered a new era of modernization, by the introduction of a large scale investment and establishment of many big companies that imported a hundred millions of fertilized eggs and broiler stocks to meet the increasing demands for meat and eggs. In general, the major constraint of poultry production in the Sudan is feeding. This includes the occasional unavailability and high price of some feed ingredients such as animal protein sources, vitamins and minerals. In addition, to the seasonal shortage of some local row materials such as grains, beside the high cost of transportation of the feed stuff from the production areas to the poultry farms.

There is a great need to improve the local poultry breeds performance. Research on genetic improvement using selection and crossbreeding has been conducted successfully for several indigenous breeds in other developing countries such as Egypt, Iran, India and Malaysia, (Growford, 1992). In Sudan, several attempts for improvement of the local breed have been conducted, however with limited success. This may be due to paucity of information about production and reproduction performance of the local breed which considered essential for primary evaluation. On the other hand estimation of genetic and phenotypic parameters for the production traits in indigenous fowl are pre- requisites for setting a strategy for genetic improvement; therefore the present work aims at the following: -

1- Studying growth performance of large Beladi chicken under two different dietary protein and energy levels.

2- Estimating and comparing the genetic and phenotypic parameters for body weights at different ages under two different feeding regimes.

3-Suggesting a strategy outlines for improving body weights at different ages.

CHATER TWO

Literature review

General Growth

Growth is a complex biological process resulting from genetic factors and environmental circumstances. Growth rate in poultry differ between breeds, strains, lines and within one line according to their genetic composition even when they were reared under similar environmental conditions or age. Yousif and Osman, (1994) reported that the average body weight of the Sudanese local chicken at 8 weeks of age was 476 and 402g for males and females, respectively. Suleiman, (1996) studied some traits including body weights at various ages in Sudanese Beladi chicken raised under relatively improved conditions. He reported body weight at 2, 4, 6 and 8 weeks of age were 53.4, 107.0, 180.2, and 290 g., respectively. Yousif et al. (2006) studied the growth pattern of the Large Beladi type from hatch up to 18^{th} week for males and up to 22^{nd} week for females; they found that body weights at 8, 10, and 12 weeks of age were 310.1, 424.6 and 554.7g.for males and 271.8, 373.7 and 484.7g. for females. Nwosu et al. (1979) reported that the local Nigerian chicken reached their major point of inflection of growth at 13 weeks of age. Nwosu, (1979) reported that the hatch, 4, and 8 weeks body weights of local Nigerian fowl were 26.78, 110.07 and 278.10 g, respectively. Several studies confirmed tropical and sub tropical breeds are poor in their body weight performance compared to the exotic breeds. Tibin and Mohamed, (1990) stated that the body weight of Sudanese indigenous fowl as compared to exotic breeds was significantly lower. Oluyemi and Oyenugo, (1974) stated that the local Nigerian chicken grew faster than the exotic at the start but slower later on. In India, Thakur et al. (2006) studied growth performance of two hybrids of Kadaknath breed (Meghnager and Jobat). They reported average body weights at hatch, 8^{th}, 10^{th} and 12^{th} weeks to be 28, 239, 319 and 411 g., respectively. Jain and Chaudhry, (1985) found that the two month body weight for White Leghorn, Rhode Island Red and Desi averaged 481, 458 and 334g., respectively, with differences being significant between groups. Kait et al. (1986) and Wilson et al. (1987) stated that in rural areas of central Mali, the mean body weight of cocks and hens were 1.6 and 1.02 kg, respectively. Coligado et al. (1985) found that the mean mature body weight of native fowl in Philippine was 1461g. Dhoubbadel, (1992), studied four groups of indigenous Sqkini birds in Nepal under intensive management, he found that the adult body weight of the hen was 1.88 kg. Nayak, (1994) reported that body weight of Desi hen at 30 weeks was 1-2 kg. Sharma et al. (1971) reported that body weight gain of the Indian native fowl (Desi) and Rhode Island Red at 4, 8 and 12 weeks of age were 147.27, 328.01 and 573.25g. and 171.27, 427.85 and 713.31g., respectively. The Rhode Island Red gave significantly higher body weight than Desi fowl at all ages. Chabard and Sapra, (1973) found the exotic breeds, White Leghorn, Rhode Island Red and White Cornish were significantly ($P< 0.01$) better in body weight at 12 weeks of age than the Indian native pure breeds (Naked Neck, Aseel and Bengal). Harvey et al. (1979) stated that broiler chicks were significantly heavier and remained so up to 9 weeks of age than the laying strain chicks. Mahaptra et al. (1985) reared four strains of broilers to 8 weeks of age, they found a significant strain differences in final live weight. Bigili et al. (1992) studied the response of strain-cross of heavy male broilers to dietary lysine in the finisher diet using 8 commercial strains-crosses they found that the strain crosses differed significantly ($P< 0.05$) in body weight at one, 21, 42 and 53 days of age. Marks et al. (1972) found significant differences in body weight of six meat – type strains at 1, 5 and 8 weeks of age.

For sire effect on body weight performance; Yousif et al. (2006) conducted experiment to study the growth curves and factors affecting body weight in Sudanese indigenous chicken prior to age at sexual maturity, they reported that sire and dam effects on body weight were variable and sire effect was highly significant ($P < 0.01$) at 8 weeks of age only; however, the reverse was true for dam effect. On the other hand, sire effect was prominent when the analysis of variance was obtained from data on male progeny, whereas dam effect was prominent when the analysis of variance was obtained from data on female progeny. Barbaro, (1991) studied individual body weight data on fowls from a sire breeding line, a broiler type line, and unselected line of Gersy Giants and F1 crosses among these lines. After fitting growth curves, he found the instantaneous growth rate exhibited significant heterosis (0.1424 for parental lines versus 0.1447 for crossbreds). He also found significant sex x heterosis interaction for instantaneous growth rate and degree of heterosis being higher in females than in males.

It has been reported that growth performance is influenced by many genetic and non-genetic factors as following: -

1-Genetic factors

1-1 Breed &strain

Several investigators found that breed and strain affected body weight significantly. Tibin and Mohamed, (1990) Found significant difference in body weight ($P <0.01$) between indigenous chicken and two exotic breeds (Lohman and Hypro) from hatching to 10 week of age. Oluyemi et al. (1979) studied the performance of the local Nigerian Fowl and White Rock under conditions of disease and nutritional stress. They found that White Rock grew significantly faster ($P < 0.05$) and consumed more food than the indigenous fowl. Singh et al. (1992) studied data over two years on 5372 pullets of two strains of White Leghorn and reciprocal crosses. They found significant effects for strains and interaction among strains for body weight at different ages. Mohammadian and Jaab, (1972) reported a reduction of 32 gm in body weight at 8 week of age in progeny from Dwarf dams when compared to progeny from normal dam, and they concluded that the reduction effect could be attributed either to small egg size or to depression of growth due to dwarf (dw) gene in heterozygous offspring.

Genotype had been reported to have a significant effect on body weight. Ludrovsky et al. (1986) maintained a commercial line of broilers fowl with normal feathers and Transyvarian black line homozygous for the nacked neck gene, in a normal environment at 35 C° and at 90% relative humidity. They found that all genotype and environmental effects and genotype-environmental interaction were significant. Sazzad et al. (1989) and Nayak, (1974) reported that the growth of crossbred and indigenous fowl under scavenging condition did not differ significantly. Benea and Howlider, (1990) investigated the body weight and yield of indigenous of naked- neck (Nana) and full feather (Nana) birds of Bangladesh, reared in traditional scavenging system. The average live weight of Nana cockerels and hens were 0.97±0.124, 0.97±0.112, 1.02±0.119 and 1.0 ±0.109kg, respectively.

1-2 Breeding methods

Different breeding methods were applied in poultry in order to induce alteration in gene frequency of the progeny compared to that of parental generations, or to attain fixation of particular genes of parents in their progeny. For cross breeding between exotic and indigenous breds, Sharma et al. (1971) found that Desi x Rhode Island Red crossbred were heavier than Rhode Island Red x Desi up to 8 week but at 12 week of age R. I. R x Desi were superior to their corresponding Desi x R. I. R, and he indicated this to the existence of maternal effect up to 8-week of age. In Sudan; Mekki et al. (2005) reported that the average body weights measured at biweekly intervals from hatch to 18 weeks of age showed significant differences ($P<0.01$) between the nine groups obtained from crossing Rhode Island Red, Bovans and Egyptian Fayoumi cockerels with Large Beladi, Bare–neck and Betwil Sudanese chicken types. Several reports compared the performance of pure bred and crossbred progenies. Nahanson and Brides, (1990) conducted a study to determine the effect of cross breeding under a high-energy diet on female progeny of commercial broiler breeder males and selected White Plymouth Rock (WPR) females. They found that body weight was significantly ($P < 0.05$) larger in the crossbred than in the purebred. Mohammadian and Jaap, (1972) working with normal and dwarf chickens reported a reduction in body weight of 30 % and 20 % at 26 week of age for the first and third back crossing, respectively. Singh et al. (1974) studied different breeding systems in two inbred lines of Rhode Island Red and one line of White Leghorn. They found highly significant ($P < 0.01$) breeding effect on body weight at 12 week of age from incross-bred system with average body weight of 717.0 and 472.8g. for male and female, respectively. Katule, (1990) evaluated the imported meat and egg type strains and their crosses with the local fowl in Tanzania; he observed that the local x meat type strain and local x egg type crosses showed heterosis in body weight at 4, 8, 14 and 16 weeks of age, and he concluded that synthetic genotypes can be developed to suit local production conditions.

As selection for growth rate has proved to be successful, it has been found practically feasible to reduce the age at slaughter from about 12 weeks down to 9 weeks or less. Selection as a tool has been successfully utilized by worker to improve growth in poultry. Hartman, (1988) stated that selection for increase body weight in broilers had created a highly omnivore capable of a attaining more than a 2.0 kg. body weight in 42 to 46 days, with an over all feed conversion of less than 2.kg. Kataria et al. (1986) carried out two generations of selection for 8-week body weight of both New Hampshire (NH), White Play mouth Rock (WPR), and White Cornish (WC) broilers. They found that the average response per generation was greater in males than in females, and attributed this to sex-linked effects in the NH and WC breeds. Sohail and Brides, (1990) conducted study to determine the effect of selection on body weight at 28 and 58 days of age to progeny of commercial broilers males and females and White Plymouth Rock (WPR) by feeding a high-energy diet (3256 kcal/kg). They found that body weight was significantly greater ($P < 0.05$) in crosses than the WPR at 58 day.

2- Non - genetic factors: -

2-1 Age effect

The effect of parental age was also studied, Mohamed, (1985) reported that in White Leghorn layer strain that hatched and reared at Kuku Research Centre, 8 week body weights and subsequent ages to maturity stages showed highly significant ($P < 0.01$) differences. Rao, (1970) reported body correlation between hatch weight and

12 week of age in White Leghorn females to be insignificant (0.19), but there was a high correlation ($P < 0.01$) between 8 and 12 weeks body weight (0.8) in males. Horn et al. (1982) reported that age of dam had no significant effect on live weight of the chicks, but from another experiment, they pointed that there was a highly significant sex x parental age interaction. Sinclair et al. (1990) stated that, chicks from older breeder flocks had significant heavier body weight and greater growth rate at 6 weeks. Tufft and Jansen, (1990) concluded that body weight gain to 3 weeks of age was higher for progeny from older dams than those from younger ones. Tufft and Jansen, (1991) found that as hen age and egg size increased, body weight gain for chicks also increased. According to Jaap, (1970) broilers, under full feeding reached 50% of their adult size at about 10 weeks of age. Age of the parental breeds was effect on chick growth; Teserveni- Gousi, (1998) studied the relationship between egg weight, age of the breed quails (Colurnes Japonica) and one- day old chick weight; he found that hatching weight was influenced more by the age of the breeder quails than by the egg weight as such.

2-2 Egg weight

There is a high phenotypic correlation between the weight of one day old-chicks and the weight of the eggs from which they hatched. Willey, (1950) studied the effect of egg size on hatch and subsequent body weight of White Wayndottes and Barred Plymouth Rock breeds, he reported that chicks from large eggs were heavier than those from small eggs, and this effect continued to 12^{th} week of age. The effect of egg weight on chick weight has been found up to 10 weeks of age; but the proportion of variation accounted for this and other maternal effects is usually very small (Bowmann, 1968). Birth weight is an economically important production trait that is mostly influenced by additive and non-additive gene action. The author also reported that birth weight determines the future performance of individuals engaged in prevailing environment. Mohamed, (1985) reported that in White Leghorn layer strain that hatched and reared in Kuku Research Centre, the initial egg weight was negatively correlated with early body weight during the pre- mature stage. Shanwany, (1987), Sinclair et al., (1989) and Pinchasov, (1991); pointed out that chick weight had been recorded to range from about 62 to 71 % of the fresh egg weight. Sinclair et al. (1989) and Pinchasov, (1991) indicated that there was a decline in the magnitude of correlation between egg and chick weight with the advanced age of the chick.

2 -3 Sex effect:-

In poultry, males chick are generally known to be heavier than females of the same age and breed or strain; but the reverse could be seen in some other species such as Japanese quail. Sex differences have been investigated by several workers. Rao, (1970) stated that the difference between the two sexes in White Leghorn were not significant at 4 and 8 weeks; but males showed a significant larger body weight than females at 12 weeks of age. Singh et al. (1974) stated that sex influenced 12th week body weight significantly in Rohde Island Red, and the average body weight was 553.3 and 427.6 g. for males and females, respectively. In slow and rapid feathering birds, Verma and Prasad, (1981) found that males at 10 weeks of age obtained significant body weight than females. Sefton and Seigel, (1974) stated that many Avain species, like chicken showed marked dimorphism in body weight, with males being substantially heavier than females due to the effective male growth hormones compared with females hormones. Yousif et al. (2006), found same results for Sudanese local chicken; they reported that sexual dimorphism was evident at all ages except at hatch, with males being significantly ($P < 0.01$) heavier than females. Khan, et al. (1975) referred this marked dimorphism to better utilization of energy by males than females inside the egg. Singh et al. (1988) found that the effect due to sex was significant on body weight at 6, 8 and 10 weeks of age. Khan et al., 1975, Whiting and Pesti, 1983 and Bruke, 1992 found significant sex differences at hatching with males being heavier than females. Havensetin et al. (1988) reported that sex difference may emphasize the importance of testing variance heterogeneity between sexes as evidence for sexual dimorphism. Singh et al. (1990) in another study found significant sex difference ($P < 0.05$) at day old, 4 and 8 weeks body weight. However, Singh et al (1974) and Singh et al. (1988) found no sex effect at hatching. Mostageer et al. (1978) found the same result for Fayoumi and Rhode Island Red.

2-4 Dietary effect:-

2-4-1 Protein and energy levels

Several researchers have studied the effect of varying levels of dietary protein, energy and their interaction on development and growth performance of chicken. Tibin and Mohamed, (1990) conducted a comparative study between indigenous Sudanese chicken and exotic breeds (Lohman and Hypro) using two levels of dietary protein (20-22%), they found that body weights from hatching to 5 weeks of age, and from 5 weeks to 10 weeks and the final body weight at 10 weeks of age of the indigenous chicken were significantly lower ($P < 0.01$) than those of exotic breeds.

According to Waldroup et al. (1966), low protein and low energy, diets had no effect on feed consumption and feed utilization in broilers. However, Chillar et al. (1971) stated that, chicks fed on animal protein diets exhibited higher growth rate ($P < 0.05$) and better efficiency than those fed on a vegetable protein diets. Jalora and Sharma, (1975) studied the growth response of chicks reared in winter and spring to varying protein and energy levels in starting diets. Two experiments were conducted, in winter and spring with 3 levels of protein (18, 20, and 22%) and 4 levels of energy (2340, 2550, 2860 and 3150 kcal). The results revealed that, differences between rations were highly significant ($P < 0.01$) for protein effect in the two experiments, but was only so for the energy effect for experiment in winter, where reared chicks showed higher body weight gain and feed intake. Efficiency of utilization of energy varied with energy content of ration; Hassan et al. (1974) studied the effect of increasing dietary protein on broiler performance. They concluded that, the overall broiler performance was progressively improved by raising the dietary protein level from 18% to 24%. Pesti and Smith, (1984) found a significant correlation between dietary protein and dietary metabolizable energy. They stated that growth was found to be dependent on the linear and quadratic effect of dietary metabolizable energy as well as the linear and quadratic effect of dietary protein. Lilburn et al. (1987) studied the effect of two nutritional treatments on male and female broiler breeders performance, starter treatment consisted of 19.5% crude protein, 2970 kcal/kg ME, from 0-2 weeks, and 15.5% C.P, 2950 kcal/kg ME from 2-10 weeks, while the other treatment consisted of the 15.5% C.P , 2950 kcal/kg ME from 0-10 weeks of age. They found that the starter treatment resulted in significantly heavier body weight at 3 weeks of age but disappeared at later ages. Harms et al. (1987) conducted a comparative study among Giminish, Sinani and Lohman hybrid fowls which were fed two diets varying in metabolizable energy (3100 and 2800 kcal/kg) and crude protein content (23 and 20%), respectively, until they reached approximately 1.0 kg live weight. They found that the age at 1 kg live weight for these hybrid fowls was 10, 14 and 6 weeks, respectively and there were no significant differences between strains for body weight, growth rate, feed consumption, feed conversion and carcass traits. Walter et al. (1986) studied the effect of 4 dietary treatments (12, 14, 16 and 18% crude protein) on growth and production performance of dwarf broiler from 3 up to 58 weeks of age. They found that dietary treatment had significant effect on body weight ($P < 0.05$) at 12 weeks of age, but by week 17th the differences were no longer significant.

Ameenudden et al. (1977) reported significant increase on average body weight gain of Dwarf broiler pullets when the protein levels increased from 13 to 17%. Abdel hamid et al. (1978) compared the performance of white leghorn with Dandrawi form one-day to 16 weeks of age. The birds were fed diets containing 17, 20, 23 and 26% crude protein (CP) and 2770, 2766, 2734 and 2708 kcal/kg ME, respectively. Their results indicated that diets contained 17 and 20% C.P maintained the greatest growth rate of both strains up to 12 weeks of age; then after 12 weeks of age the growth rate was in favor of 26% CP. Verma and Hassan et al. (1978) fed a commercial broiler chicks diet, with 18.2, 20.3, 22.2 and 24.1% C.P with 2984, 2915, 2853 and 2792 kcal ME/kg, respectively from hatch up to 12 weeks of age. Diet with 22.2% and 2853 kcal/ME was found to give a better body weight than the three other levels. Frabs, (1943) showed that a manipulation of the dietary protein could have a various effects on broiler performance. He pointed out that differences occurred in the body weights, feed intake, and especially the carcass composition of birds fed different level of the dietary Protein.

2-4-2 Feed intake and feed efficiency

Mohamed, (1985) reported that feed intake of white leghorn hatched and reared in Sudan was 113.8 and 89.9 g/hen/day in winter and summer hatches, respectively. Sulieman, (1996) reported that the average daily feed intake of adult large baladi to be 89.4 gm/hen/day. Elfaki, (2000) in feed intake comparison study between Large Beladi and exotic breed (White Hisex); revealed that Large Beladi has the highest feed intake (506.27±70 g/ bird/ week) while the exotic breed recorded the lowest feed intake (442.66±277.38 g/bird/ week). Contrast between 5 Large Baladi groups (Black color, Red color, Yellow color, Variegated and spotted color) and White Hisex, revealed a significant difference at ($P < 0.05$) level, whereas there is no significant difference among the Large Beladi groups. Waldroup and Kenny, (1975) reported that Indian River Dwarf breeder hens consumed 269 kcal/Kg/day, which could be 65 % of that consumed by normal sized broiler breeder hen. Daeton et al. (1988) reported that pelleted diet did not improve 12 – 20 weeks body weight gain of summer reared egg- type pullets under cyclic temperature of 24 -35-24 C° when compared with those pullets fed in mash form; however the same authors, (1988) in another experiment reported a significant increase in body weight of broiler fed pelleted feed than those fed mash form when beak trimming was practiced. Proudfoot and Gowe, (1974), Huartiz and Palvink, (1989) and Summer, (1990) reported a lower body weight for restricted fed pullets than *adlibitum* fed group (control) throughout the growth period; but pullets under restricted regime attained further body weight gain which exceeded that of the control and the differences in body weight diminished when feed restriction was ceased.

2-5 Managerial factors effect:-

Numerous investigators studied the environmental factors effect on growth rate. In order to achieve their genetic potential for growth, chicken must be provided with optimal environmental conditions. The affect of temperature could be the most important factor affected body weight in tropical and sub tropical. The reducing effect of high ambient temperature on production and energy metabolism of poultry had been reported with respect mainly to laying hens and other mature fowls. Mohamed, (1985) and Ismail, (1997) reported lower body weight gain in summer hatched chicks that exposed to temperature range of 37 – 40 C°. Campos, (1960) found body weight reduction in some birds survived this ambient temperature when they exposed either to faster or slow rises in temperature, the average body weight loss correspondent with the two situation was found to be 17 and 10 gm/kg body weight respectively, under 21C°, Deaton et al. (1988) observed a significant improvement in body weight from 12 to 20 weeks of age, however this advantage was not found under cyclic (24 – 35 – 24C°) temperature. Many workers had addressed the affect of seasonality on chick body weight increasing. Mohamed, (1985) reported that the effect of the rearing season upon growth of White Leghorn that hatched and grown in Sudan was quite marked. Winter hatched chicks were found to grow faster (1255g) than summer hatched chicks (905.25g). Rao, (1970) and Abdou et al. (1980) reported higher body weight in Winter hatch than that in summer hatch for Fayomi and White Leghorn at 12, 16 and 24 weeks of age. Singh et al. (1988) conducted an experiment, which extended between 1st February and the end of March; they concluded that middle hatch showed a better performance than the earlier and the latter hatches in terms of body weight.

The effect of housing systems on the production performance of chickens and other species of poultry have been adequately reported (Chemelinca 1980, Terabek and Machal, 1981, Kling et al, 1985 and Bandopadhya, 1987). Oluyemi and Roberts, (1975) reported significant differences in body weight of wire cage versus deep litter reared Rohde Islanded Red (R. I. R) and White Rock (W.R) breeds. Deaton et al.

(1973) and Stock land and Play lock (1974), reported that caged birds were significantly heavier than floor reared pullets at 20 weeks of Age.

3 - Genetic and Phenotypic parameters estimates for body weight:-

3 -1 Heritability estimates: -

Heritability estimates for body weight at various ages in poultry have been extensively reported in the literature. Yousif and Osman, (1994) estimated heritability for 8th week body weight of local Sudanese chicken; they found higher heritability estimates (0.79) from sire component of variance than that from dam component (0.52) for males. However, they found higher heritability estimates (0.73) from dam component of variance than that from sire component (0.38) for females. They attributed these results to the absence or minor effect of sex-linked genes on such estimates. Suleiman, (1996) reported that heritability estimates for body weight at various ages from hatching to 8 week of age ranged from low (0.04) to high (0.97) and the estimates from paternal half–sibs for females and males at 6 weeks of age were 0.31 and 0.04, respectively; whereas the corresponding estimates at 8 week of age were 0.31 and 0.19, respectively. On the other hand, Ismail, (1997) found low heritability for body weight at 10 and 12 weeks of age in local chicken of Sudan; estimates from sire component of variance for males were 0.05 and 0.14, respectively, while those for females from dam component of variance were 0.25 and 0.14, respectively. Oluyemi and Oyenugo, (1974) estimated heritability for body weight at 12 weeks of age from paternal half–sib (H.S) analysis in indigenous Nigerian chicken to be 0.31. Akiokum, (1971) found an estimate of 0.44 for the same breed and age but from full – sib (F.S) analysis. Abdel latif, (1989) employed 314 males from 33 sires and 157 dam Dandrawi fowl breed; he found (0.83) heritability estimate from full–sibs component of variance for body weight 12 week of age. Salahud–din et al. (1992) estimated heritability for body weight at 16 weeks of age for Layllpur Silver strain broiler from sire, dam and sire plus dam components of variance; the heritability estimates from the three methods were 0.21, 0.6 and 0.43, respectively . Aksoy, (1982) and Tripathy et al. (1986) at hatching and up to two weeks of age followed by domination of sire component effect. Similar conclusion was reported by Reddy and Patro, (1983) for 8- weeks body weight in male progeny, but with lesser magnitude in female; they reported the inheritance of biweekly body in New Hampshire chicken to be higher (0.58) from dam component than that of sire component (0.22) at 8-weeks of age .Tripathy *et al*. (1984) concluded that heritability estimates for body weight from dam components of variance were higher than those from sire components at hatching and at 2 week, but lower at 4, 6 and 8 weeks of age. Kumar and Acharya, (1980) reported that the heritability estimates from full sib components for Desi chicken at 0, 2, 4, 6, 8 and 12-week body weight were 0.920, 0.435, 0.447, 0.465 and 0.414, respectively. Kosba and Eid, (1983) studied data on 21 groups of chicken, each comprising one male and six females of Fayoumi breed (group one), Alexandria strain selected for high or low body weight at 8 week of age (group two and three). They found that in group one the heritability estimates at hatching, 4 and 8 week were 0.17, 0.01 and 0.44, respectively from sire component and 0.41, 0.02 and 0.48, respectively from dam component. Chung and Cheong, (1985) reported that heritability of chick hatch weight was 0.88. Asuquo and Nwosu, (1987) for Nigerian local fowl found that heritability estimates at 4-week body weight from sire, dam and sire plus dam components of variance were 0.32, 0.36 and 0.34, respectively. Singh and Singh, (1979) found that heritability estimates for body weight at 8 and 10 week of age after correcting sex and hatch effects, were 0.014 and 0.15, respectively. Singh and Singh, (1981) found that heritability for 8-week body weight estimated by paternal half sib correlation was higher ($P < 0.01$) than for 10 weeks of age. Sing *et al*., (1988) estimated heritability from adjusted data of synthetic broiler strain by half-sib correlation. They found that heritability estimates for body weight at 6, 8 and 10 weeks of age were very high indicating that almost the variability in the flock was due to additive genetic variance. Considering sex, Yousif, (1987) found higher heritability estimates from sire component of variance for male progeny, and higher estimates from dam component for females at 8-week body weight.

The non-additive portion of the hereditary variation of a quantitative character may be due to dominance or epitasis. Shimzu *et al*. (1968) reported that heritability estimates for body weight at various early ages were generally high ranging from 0.65 to 0.45 for males and in females the estimates from sire components of variance were considerably higher. They suggested that this might be due to the maternal effect and/or gene interaction affecting body weight at those various early ages. McCarthy, (1977) suggested that the proportion of genetic to non-genetic variation might increase slightly with age as maternal effects on growth are damped by compensatory growth. McCarthy, C. and Siegel, P. B. (1983) stated that there was a tendency for estimates of immature body weights based on maternal half-sib correlation to be higher than those based on paternal half-sib correlation. They attributed this difference to maternal effects and/or non-additive genetic variation. Oluyemi, (1979) studied the potentialities of the indigenous Nigerian chicken for meat production; he found that the heritability estimates for 12-week body weight as determined by half-sib analysis was 0.31. He concluded that these estimates were relatively low, suggesting that only a moderate improvement could be obtained by individual selection for broiler weight.

Selection could also influence genetic variance and hence heritability estimates. Continuous selection for increased body weight in a closed population of a limited size resulted in a declining of heritability estimates as reported by Siegel (1962), Nesbeth (1979), Kuruvilla, (1982). Taran et al. (1972) said that heritability of various traits estimated on the basis of crossbred offspring were higher than the estimates on the basis of purebred offspring derived either from sire or dam components of variance. On the other hand, Holcman, (1986) carried out a two-way selection for body weight on Perolux-Bro chicks from a population selected over 7 generations for high and low body weight at 56 days of age. The sire-component, dam-component and mid-parent heritability estimates of body weight at 56 days were 0.27, 0.25and 0.26, respectively in the line selected for high body weight, and 0.21, 0.19and 0.20in the line selected for low body weight. Thompson, (1978) used 837 pullets selected for 4 generations and reported higher heritability estimates from sire component than those from the dam components and the estimates were ranged from 0.5 – 0.7 and 0.33 – 0.47, respectively.

The effect of inbreeding on heritability estimates had been demonstrated by Rai *et al*. (1992), they found that in progeny from the 5th generation of in inbred population, maintained by full-sib mating, heritability of body weight was low in general (<0.2) due to inbreeding except for 8 and 12 week body weight. The breeds, strains and their crosses could influence the estimation of heritability. Singh and Singh, (1983) studied the inheritance of 8-week body weight of New Hampshire (NH), White Cornish (WC) and their crosses. They reported higher heritability estimates for NH x NH (0.54), followed by WC x NH (0.15), NH x WC (0.10) and WC x WC (0.014). Kataria *et al* (1986) estimated heritability for body weight at 8 weeks of age for three breeds; New Hampshire (NH), White Playmouth Rock (WPR) and White Cornish (WC) selected for two generations. They found that the higher estimates in the base population were for NH followed by WPR and WC, respectively, and in the first generation of selection were for WPR, WC and NH, respectively, and in the second generation were for WC, WPR and NH, respectively and the pooled heritability estimates were 0.18, 0.25 and 0.30 in NH, WPR and WC, respectively. Mukherjee and Frair, (1970) observed that the estimates of heritability from analysis of variance component to be higher than those from intra – sire regression of off – spring on parent.

For environmental effect on heritability estimate, Abplanalp and Martin, (1961) maintained White Leghorn line under different environments for ten weeks. They obtained a variable heritability estimates for same body weight; also, they found low heritability for body weight in flocks grown under field conditions than those grown in confined house. Several authors studied the effect of different dietary constituents on heritability estimates for body weight. Sorenson, (1977) studied the effect of different protein levels on heritability estimates for body weight; he concluded that, there was a possibility of tendency towards higher heritability estimates for low protein concentration in diet. Marks and Briton, (1978) used three protein levels (14%, 18% 22%) to study their effect on genetic parameters of random bred broiler stock .They found that the heritability (0.42 – 0.44) for 8 weeks body weight from sire components were similar for 18 and 22% dietary proteins, but differ from that of the 14% dietary protein (0.14) . For the feed intake effect on heritability; Marks, (1980) fed two different metabolizable energies (3124 and 2902 kcal/kg) to broiler chicks; he obtained a smaller heritability (0.33vs 0.38) at 6 weeks of marketing age for the birds received the lower ME level.

3 - 2 Genetic and Phenotypic correlations

Many researchers have discussed phenotypic and genetic correlations between body weights at different ages. Sefton and Siegel, (1974) stated that in most cases of body weight correlations, both genetic and phenotypic correlations might follow the same trend. However, Singh and Singh, (1981) stated that the importance of genetic correlation between body weight at various ages rely on possibility of selection at early ages which in turn had a large economic benefit. They reported higher genetic correlation than phenotypic correlation at 8 and 10 week of age in New Hampshire chicks. Suleiman, (1996) studied the genetic and phenotypic correlations for body weights between 6 and 8 weeks of age from sire component of variance for sexes combined, females and males indigenous Sudanese breed; he found that the genetic correlations estimates were 0.98, 0.86 and 1.75, respectively; whereas the phenotypic correlation estimates were 0.64, 0.64 and 0.63, respectively. Ismail, (1997) studied the genetic parameters of the indigenous fowl of Sudan. He reported a high and positive (0.77 to 0.98) genetic correlations between body weight at different ages from dam and sire plus dam components of variance; and the phenotypic correlations were ranged from 0.5 to 0.88 and 0.29 to 0.84 for males and females, respectively. Sefton and Siegel, (1974) found that the magnitude of phenotypic correlation decreased in general as the time interval between weightings increase. Kumar and Acharya, (1980) observed in Desi chicken a decline trend in correlation of day-old weight with later body weights. In the same study, they also found that the genetic correlations of 2, 6 and 8 weeks body weight with 12-week body weight averaged about 0.8 and the phenotypic correlations between body weights increased with the advancement of age. Reddy and Patro, (1983) found that in New Hampshire chicken, the genetic and phenotypic correlations between bodyweight at 6 and 8 weeks of age were positive and high, and the genetic correlations between all ages except from day-old were positive and high in both males and females. Kosba and Eid, (1982) studied the genetic correlation of Fayoumi and New Alexandria strains; they reported positive genetic correlations for hatching weight with 2, 4, 6 and 8-week body weight. Aman and Becker, (1983) studied the genetic correlations between body weight at 6 and 7 week for 216 male broilers from 42 sires and 100 dams with 2 full-sibs per dam. They found that the genetic correlations between 6 and 7 week live weight was 0.58. Tripathy *et al*. (1984) reported higher genetic correlations of 8 week weight with weights at hatching and at 2, 4 and 6 weeks for females than for males. Singh and Singh, (1988) in a synthetic broilers strain found that the genetic correlations of 6 week body weight with 8 and 10 weeks body weight were positive and high, and also the phenotypic correlations. They pointed that the high genetic and phenotypic correlations of 6 weeks body weight with 8 and 10 weeks body weight indicated that instead of waiting until 10 weeks, broilers might be selected on the basis of 6 weeks body weights. Kosba et al. (1984) reported that phenotypic correlation in a population of 5277 pullets from 35 sires and 240 dams was found to be 0.23 in both sets of lines, which were selected for 8 weeks males body weight and females at sexual maturity.

For environmental correlations effect on body weight; Kosba et al. (1984) reported that environmental correlation in a population of 5277 pullets from 35 sires and 240 dams was found to be 0.17, 0.17 and 0.18 in parental lines and 0.2, 0.2 and 0.4 in maternal lines. Suleiman, (1996) reported the environmental correlations estimated from paternal half – sibs between 6 and 8 weeks calculated from data on sexes combined for females and males in Sudanese indigenous breed were 0.55 and 0.61, respectively; further study were conducted by Ismail, (1997) in the indigenous fowl of Sudan. He found the environmental correlations between body weights at 10 and 12 weeks of age from dam and sire plus dam components of variance on sexes combined data were 0.80 and 0.82, respectively. For environmental correlation between hatching weight and subsequent body weights; Rao, (1970) found positive environmental correlation between body weight at hatch and body weight at 4, 8, and 12 weeks of age, in White Leghorn males. On the other hand, the same study showed a higher correlation between 8 and 12 week body weight for females. However there was no significant correlation between 8 and 20 weeks body weight in both sexes.

GHAPTER THREE

MATERIALS & METHODS

3-1The foundation stock:-

The foundation stock was primarily established by purchasing 50 cockerels and 160 pullets of the indigenous fowl from the Blue Nile area (Sinar state). This stock was collected from different parts of the rural areas where the local breed is expected to be pure. Considerable effort was exerted to select birds according to characteristics of Beladi type as described by Desai, (1962).

The stock was kept at the poultry house of the Faculty of Agricultural Sciences, University of Sinar at Abu Niama province for 30 days adaptation period during which the birds received prophylactic doses of antibiotics, enthelemintics, vitamins and minerals and vaccinated against New-Castle disease. Thereafter, the stock was transported by truck to the Poultry Research Unit, at Animal Production Research Centre at Kuku district -Khartoum North. For safe transportation the truck was bedded by hay and each five birds were grouped together and allocated separately in the truck with open sided bars to offer better ventilation. Furthermore the transportation was carried out during the night to avoid stress from the excessive heat. Before, the starting of the experiment, the cockerels and pullets were housed separately for one month to assure that female reproductive tracts were free from astray sperms; further more the stock was also provided with relatively improved management (feed, light, ect) which aimed to initiate good performance and to induce synchronization of egg production. Feed and water were available *adlibitum*.

3-2 Experimental procedure:-

3-2-1 Housing

The experiment started in August 2005 and continued until May 2006. The stock was kept in an open–sided poultry house, with dimensions, of 23x6x3 m^3. The house was made of corrugated iron roof, and two walls with 6x3 meters square dimensions, on east and west orientation to prevent the direct sun shine effect. The north and south sides were made of iron posts and wire nettings. Accacia trees were grown along the north side to prevent cold, drought and wind. The floor of the house was made of bricks and covered by 4 inches depth wooden shavings litter. The house was internally divided into 5 pens, each with dimensions, of 6x3x4.6 m^3 and separate door. Each of the first three pens contained two rows of double decks; each one was divided into seven small breeding pens with 0.8x1.0x0.9 m^3, dimensions. Moreover eight single breeding pens, each with 0.8x1.0x0.8 m^3 were constructed. These breeding pens were made of metal bars and covered by iron tin sheets. In the fourth pen, a raw with eight single breeding pens was added; whereas the fifth one was left for quarantine measures. Feeders and waterers were hanged by rubber to the front and back of every breeding pen to facilitate feeding and drinking. These breeding pens were made of Iron frames and tin sheets, while the floor of the upper rows was made of heavy cartoon and covered with 2 inches depth wooden shaves litter.

3-2-2 Management

Before the arrival of the stock the house and the equipment were thoroughly cleaned by detergent and disinfected using a mixture of 0.05 % formalin and 0.01% iodine. The entrance of the house was also covered by sacs dipped in potassium permanganate solution. The male and female birds were initially weighted and randomly distributed to single breeding pens. Each cockerel was randomly assigned to mate with three pullets in a rotational manner. In order to assure successful mating and high fertility, each cockerel used to be kept with assigned pullet for the whole day, before being rotated to the next one. Lighting system was made of five bulb lambs each with 100 watt which were fixed to the roof of the house to provide extra five- hours light daily. Layer ration which were prepared by Poultry Research Unit, at Animal Production Research Centre, was provided *adlibitum*. Fresh water was available through out the day and prophylactic doses of antibiotics, enthelemintics, vitamins and minerals were added to the drinking water every month. Attention was paid to represent all the families in the experiment.

3-3 Eggs production and Incubation.

Egg collection for incubation purpose had started after the females being rotated to the males at least twice to assure good fertility. Eggs were collected three times a day (at 6 a.m., 1 p.m. and 5 p.m.) and recorded on daily basis. Eggs were weighed, graded and pedigreed using an insoluble marker. The cracked, dirty, misshapened, rounded, blood spotted and very small eggs (30g) were excluded. Normal eggs were setted in plastic trays and stored in a cold room with temperature ranging between 20-39 °C for 7-10 days before incubation. Eggs were allotted individually in small boxes ($7x7x7cm^3$) within wooden trays which were divided internally by thick carton sheets. The tray was tightly covered by metallic wire to avoid intermingling of chicks after hatching and before the process of identification has been completed. An automatic turning device Western type incubator with capacity of 9000 eggs was used for eggs setting. The incubator was cleaned and disinfected using Potassium Permanganate and Formaldehyde solution at a ratio of 1g: 2 ml. The temperature inside the incubator was adjusted to 99-100°F, and the relative humidity was also kept in a range of (70%) using moisture trays allocated at the bottom and middle of the hatchery; however during hatching time the relative humidity was elevated to the optimum level by putting wet sacs on the base of the incubator and added extra moisture trays. On the eighteenth day of incubation the eggs were candled to detect the fertility and late embryonic deaths. The fertile eggs were fumigated and transferred to the hatching unit in the lower side of the same incubator. In the early morning of the twenty second day of incubation, the trays were pulled out carefully one by one and the hatched chicks were released, graded (to cull the weak and deformed ones), weighed and wing-banded. The hatched chicks were then transferred in covered plastic containers to pens which were modified to serve as brooders.

3-4 Brooding and Rearing

The range of higher and lower temperature during the course of experiment was 34 °c and 10°c, respectively. Because of unavailability of proper brooders, an open–sided poultry house containing five pens was modified to serve as brooders. Each pen with dimensions, of 3x3x3 m^3, was covered with plastic bags from out side for further insulation; while a circle cartoony bout with 2.5 meter diameter and 0.5 meter height was constructed in the centre of each pen and the floor was covered with sands as litter. The capacity of each circle carton brooder was about 250 chicks. For lightining and heating, two bulb lambs each with 100 watt were hanged from the roof and extended with electric wires down wards to the centre of the circle carton brooder. During the first few days chicks were fed *adlibitum* with chicker mash spreaded on sacs which covered the floor and then gradually shifted to small feeders. Fresh water was provided in waterers *adlibitum*. Antibiotics, vitamins and minerals were given in a regular program and New- Castle vaccine was practiced at the twenty–eight day of age. After 4 weeks of age chicks were transferred to deep litter rearing pens with dimensions, of 4x3x3 m^3.

3- 5 Data recorded:-

The total number of birds used in this study was 1718, which were obtained from 13 consecutive hatches at weekly interval. According to the research objectives, chicks from the first 6 hatches (represented group A), were fed on broiler rations (Table 1 and 2), aiming at measuring the carcass characteristics at 12 weeks of age, therefore, body weight was taken at weekly interval. On the other hand, chicks from the last 7 hatches (represented group B), were fed on layer rations (Table 3), aiming at measuring egg production traits, thus, body weight was taken at monthly interval. However, due to prevalence of Avian Influenza in the country, the veterinary authority decided to eliminate all the birds in the region, including those of the group (B). Therefore, the experiment was deliberately terminated while the birds were 12 weeks old. Feed consumption was measured for the two groups; this was done by subtracting the remaining feed weight from the initial weight given to the stock at the end of each week. Mortality rate was regularly recorded on daily basis during the whole experimental period.

Table (1): Composition of the experimental chick pre starter ration for birds in group (A).

Constituents	
Crude protein (%)	22.50
Crude fat (%)	7.00
Crude fiber (%)	2.50
Ash (%)	5.30
Starch (%)	35.00
AME (Kcal/kg)	3075
Vitamin A (IU/kg)	17.500
Vitamin D_3 (IU/kg)	3500
Vitamin E (IU/kg)	90
Copper (Mg/Kg)	22.50

Source: Nascor Broiler Feed, LNB International Feed B.V. Nistelrode-Holland

Table (2): Composition of the experimental broiler rations (starter and finisher) for birds in group (A).

Ingredients	Starter %	Finisher %
Grain sorghum	60.00	65.00
Wheat bran	5.00	4.50
Groundnut cake	28.00	23.00
Animal protein concentrate	5.00	5.00
Calcium Bicarbonate	1.50	2.00
Common salt	0.25	0.25
Premix-Vitamins and Minerals	0.25	0.25
Duration (weeks of age)	2nd to 8th	8th to 12th
TOTAL	**100**	**100**

Chemical composition of broiler ration.

Constituents	Starter	Finisher
Crude protein %	22.80	20.13
ME(Kcal/kg)	3000	3010
Calcium %	1.17	1.57
Phosphorus %	0.65	0.72
Lysine (IU %)	1.28	1.12
Methionine (IU %)	0.41	0.48

Source: Animal Research Laboratory, Kuku, Khartoum North.
ME = Metabolizable Energy

Table (3): Composition of the experimental layer rations (chicks and grower) for birds in group (B).

Type	Chicks	Grower

Ingredients (%)		
Grain sorghum	56.4	60.0
Groundnut cakes	17.4	9.86
Wheat bran	19.0	22.4
Animal concentrate	5.0	5.0
Limestone	1.62	2.31
Nacl	0.25	0.1
Methionine	0.08	0.07
Lysine	0.25	0.26
Total	100	100
Duration (weeks of age)	1st to 8th	8th – to 20th

Chemical composition of chicks and grower diets.

Type	Chicks	Grower
Constituents		
Crude protein	18.49	16.38
ME (K cal /kg)	2799.4	2753.68
Calcium	0.91	1.09
Phosphorus	0.78	0.53
Lysine	0.69	0.73
Methionine	0.34	0.36
Total	100	100

Source: Animal Research Laboratory, Kuku, Khartoum North.
ME = Metabolizable Energy

3-6 statistical analysis

Data sets consisted of 434 observations for the experiment (A) and 604 observations for experiment (B) were analyzed by Harvey (1990) LSMLMSW Programme (Least Squares and Maximum Likelihood

Procedure) to estimate variance and covariance components. The model used in the analysis of data in experiment (A) was:

$\mathbf{Y_{ijklm} = \mu + Si + D/S_{ij} + H_k + SX_l + (H\,xSX)_{kl} + e_{ijklm}}.$

Where:

Y_{ijklm} = the individual observation for triat Y_{ijklm}.

μ = overall mean for trait Y.

S_i = Random effect of the i^{th} sire.

D/S_{ij} =Random effect of the j^{th} dam mated to the i^{th} sire.

H_k = Fixed effect of the k^{th} hatch.

SX_l = Fixed effect of the l^{th} sex.

$(HxSX)_{kl}$ = Fixed effect of the interaction between hatch and sex.

e_{ijklm} = the random error associated with the measurement of each individual which assumed to be randomly and independently distributed with a mean of **zero** and a variance of **δ^2.**

The data in experiment (A) and (B) were also analyzed separately using the same model above with exception that sex effect had been dropped from the model. The analysis of variance and the expected mean squares for the random effects are shown in the following table as described by (Falconer, 1981): -

Source of variation	**D.F**	**Mean squares (MS)**	**Excepected mean squares (EMS)**
Sires (s)	**S-1**	**SSs/S-1**	$\delta^2 w + K_2 \delta^2_{d/s} + K_3 \delta^2_S$
Dam within sires (d/s)	**D-1**	**SS_D/ D- 1**	$\delta^2_W + K_1 \delta^2_{d/s}$

Error	**N-D**	**SSw / N - D**	δ^2_w

Where:

δ^2_S = Parental half–sib covariance. This component is due to differences between sire groups.

$\delta^2_{d/s}$ = Maternal half – sib covariance . This is the covariance of full – sibs minus the covariance of half–sibs; it is due to the difference between dam groups.

δ^2_w = within – progeny covariance.

Heritability estimates for body weight from sire and dam components of variance and from full–sibs analyses were calculated as follow:

$$h^2_s = 4\,\delta^2_S / \delta^2_S + \delta^2_{d/s} + \alpha^2_w$$

$$h^2_D = 4\,\delta^2_{d/s} / \delta^2_S + \delta^2_{d/s} + \delta^2_w$$

$$h^2_{S+D} = 2[\delta^2_S + \delta^2_{d/s}] / \delta^2_S + \delta^2_{d/s} + \delta^2_w$$

CHAPTER FOUR

RESULTS

According to the experimental protocol, which was based on feeding regime, chicks were divided into two groups at hatch. In the first group, which represented group (A), chicks were fed with a broiler-formulated ration, whereas in the 2nd group, which represented group (B) chicks were fed with a layer- formulated ration.

Table (4) presents the total number of birds in the two groups (A) and (B). The number of birds in group (A), which were reared and provided full records for statistical analysis was 1114 (420 males and 694 females). The total number of females was greater than that of males. There were significant differences ($P < 0.05$) in the number of birds reared per hatch; the highest was in the 6th hatch (308) and the lowest was in the 2nd hatch (78); while the average number per hatch was 185.6. The total number of birds, which were reared in group (B), was 604. This was considerably lower than that of group (A). Birds in group (B), were not differentiated by sexes because their existence had been terminated due to prevalence of Fowl Influenza in the region.

Table (5) shows the overall least squares means, standard deviations (S.D) and coefficients of variation (C.V %) for body weight of birds in group (A) and (B). The coefficients of variation (C.V %) in group (A) ranged from 10.87 to %24.71, and exhibited linear increase up to week 4, and then slightly dropped; while The coefficients of variation (C.V%) in group (B) ranged from 9.08 to %29.06 %, and exhibited linear increase up to week 8, and then dropped. The average (C.V %) for overall body weight in group (B) was higher than that in group (A).

Table (6) shows the comparison between body weights at different ages in the two groups (A) and (B). The results showed significant differences ($P < 0.001$) among body weights of birds in the two groups. Further illustration was shown in figures (1 and 2), which present the growth patterns of chicks in both groups (A) and (B). The figures revealed an increasing trend in body weights with advanced ages. The growth of birds in group (B) was slightly higher than that in group (A) between hatch and 5 weeks of age. Thereafter the growth of birds in group (A) started to exceed that in group (B) and exhibited differentiation up to week 8; and continued to show a sharp increase until reached the maximum weight (800.93g.) at 12 weeks of age. At this point growth of birds in group (A) was higher than that in group (B) by 278 g. On the other hand, figure 2. revealed a declining trend in weight gain of birds in group B between 8 and 12 weeks of age.

Table 4. The number of chicks per hatch in group (A) and (B).

Group (A)				**Group (B)**
Hatch No.	Number of chicks per hatch	Number of chicks per/sex/hatch		Number of chicks per hatch
		Females	Males	
HATCH 1	147	80	67	107
HATCH 2	78	53	25	67
HATCH 3	209	127	82	135
HATCH4	163	120	43	179
HATCH5	209	113	96	116
HATCH6	308	201	107	-
TOTAL	1114	694	420	604

* Chicks in group (A), were fed with broiler rations (Table 1 and 2).

* Chicks in group (B), were fed with layer rations (Table 3).

Table 5. Overall least squares means (g.) and standard deviations (S.D.) for chicks body weights at various ages in group (A) and (B).

Group (A)				**Group (B)**		
Trait	Means	SD	C.V %	Means	SD	C.V %
BWO	26.78	2.91	10.87	29.31	2.66	9.08
BW2	75.34	11.86	15.74	-	-	-
BW4	147.16	30.87	20.98	170.80	49.27	28.85
BW6	256.89	43.18	16.81	-	-	-
BW8	393.50	64.12	16.29	353.43	102.70	29.06
BW10	631.09	124.47	19.72	-	-	-
BW12	800.93	155.97	19.47	512.75	116.11	22.64

**BW0, BW2, BW4, BW6, BW8, BW10 and BW12= Body weight at hatch, 2, 4, 6, 8, 10 and 12 weeks of ages.

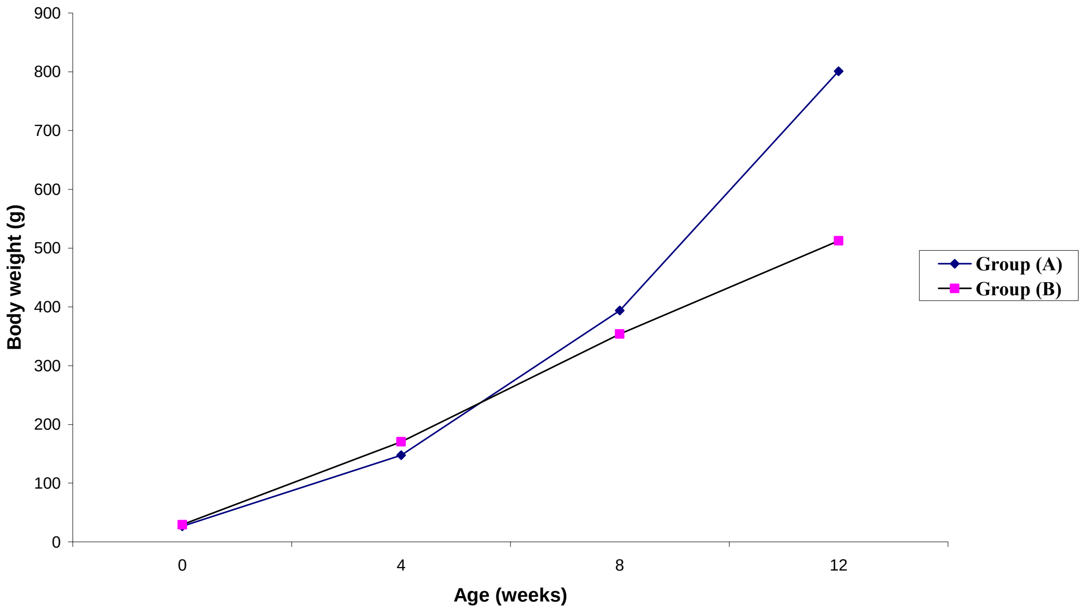
Table 6. Comparison of body weights at different ages for birds in group (A) and (B).

	Mean ± S.D		
Trait	**Group (A)**	**Group (B)**	**Significance**
BW0	26.78±2.91	29.31±2.66	**
BW4	147.16±30.87	170.80±49.27	**
BW8	393.50±64.12	353.43±102.70	**
BW12	800.93±155.97	512.75±116.11	**

**BW0, BW4, BW8, and BW12= Body weight at hatch, 4, 8 and 12 weeks of ages, respectively.

** = Significant at ($P< 0.01$)

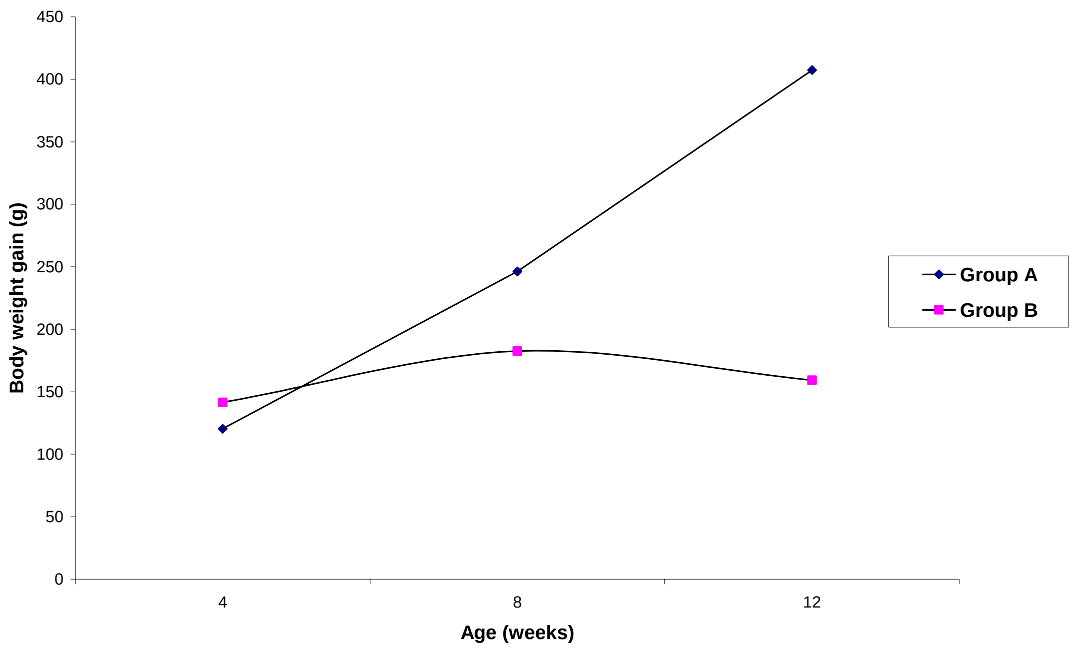
Figure (1). Comparative growth between Large Beladi chicken in group (A) and (B).



* Chicks in group (A), were fed with broiler ration (Table 1 and 2).

* Chicks in group (B), were fed with layer ration (Table 3).

Figure (2). A monthly body weights gain of chicks in group (A) and (B).



* Chicks in group (A), were fed with broiler ration (Table 1 and 2).

* Chicks in group (B), were fed with layer ration (Table 3).

Table (7) shows the males and females least squares means, standard deviations (S.D) and coefficients of variation (C.V %) for body weight of birds in group (A). The coefficients of variation (C.V %) ranged from 9.96 to %18.14. The (C.V %) of females were slightly higher than those of the males. With exception of body weight at hatch and 2 weeks of age, males were significantly heavier than females, and showed higher growth rates at biweekly interval (Figure 3). The cumulative weight gain was 15.47, 18.73 and 19.83 percent higher in males than in females at 8, 10 and 12 weeks of ages, respectively. The figures revealed an increasing trend in body weight gain with advanced ages. Body weight gain increased sharply between 8 and 10 weeks of age in both males and females, thereafter, they started to decline.

Table (8) and (9) show the combined least squares analysis of variance for various random and fixed factors affecting body weight at different ages in group (A) and (B). The results indicated that hatch had significant ($P <0.001$) and ($P <0.05$) effects on body weight at all ages in both groups. Sire was found to have significant effect ($P <0.05$) on body weight at 4 and 8 weeks of age in group (A) and at 8 and 12 weeks in group (B), whereas dam revealed significant effect ($P <0.001$) on body weight at hatch, 8, and 12 weeks of age in group (A) and only at hatch in group (B).

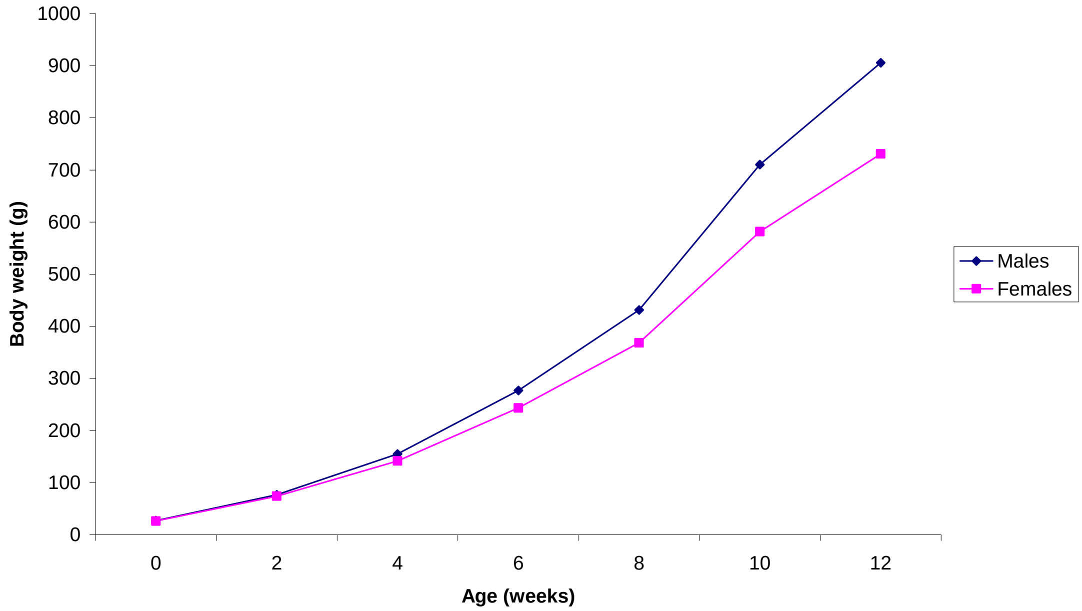
Table 7.The males and females least square means, standard deviations (S.D) and coefficients of variation (C.V %) for body weights in group (A).

Trait	Males			Females		
	Means	SD	C.V %	Means	SD	C.V %
BWO	27.11[a]	3.095	9.89	26.56[a]	2.77	9.10
BW2	76.94[a]	11.095	12.02	74.37[a]	9.16	13.42
BW4	155.24[b]	30.141	16.87	141.76[a]	20.25	18.14
BW6	276.87[b]	42.324	15.81	243.52[a]	32.12	17.07
BW8	431.28[b]	59.046	15.79	368.22[a]	47.33	16.44
BW10	710.12[b]	113.642	16.00	581.66[a]	89.65	16.13
BW12	905.61[b]	137.444	15.84	730.88[a]	106.57	16.06

* Means with the same letter for comparison between males and females are not significantly different (P <0.05).

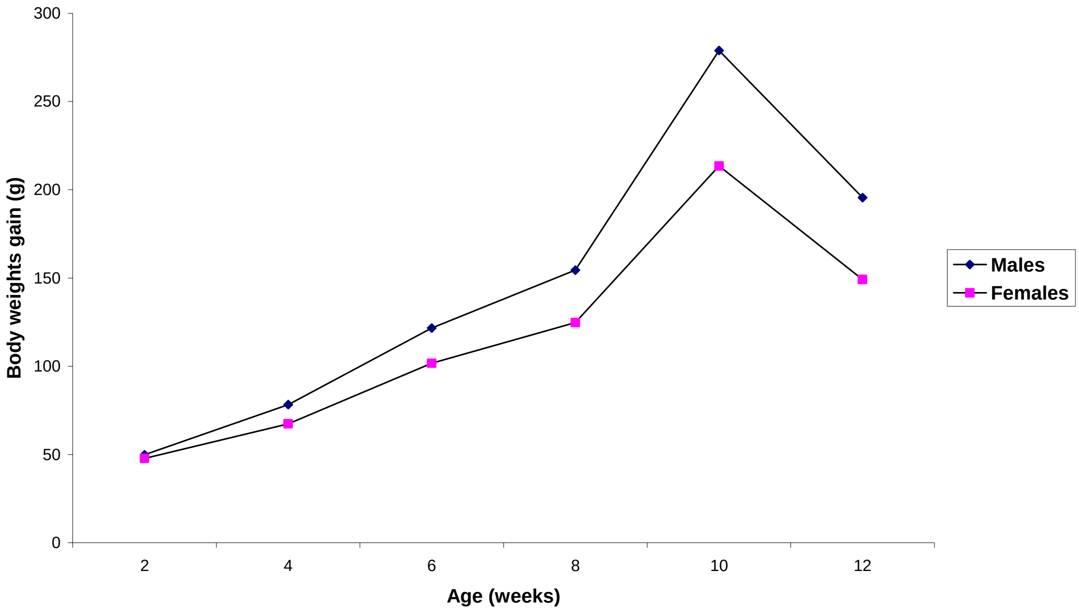
**BW0, BW2, BW4, BW6, BW8, BW10 and BW12= Body weight at hatch, 2, 4, 6, 8, 10 and 12 weeks of ages.

Figure (3). General growth curves for body weights of experimental birds (males and females) of Large Beladi type in group (A)



* Chicks in group (A), were fed with broiler ration (Table 1 and 2).

Figure (4). Acumulative body weight gains of male and female chicken in group (A).



* Chicks in group (A), were fed with broiler ration (Table 1 and 2).

Table 8. Combined least squares analysis of variance for random and fixed factors affecting body weight at different ages in group (A).

Source of variation	D.F	Mean squares of body weight						
		BW0	BW2	BW4	BW6	BW8	BW10	BW12
Sire (R)	46	21.727	101.950*	899.665*	2146.450	5727.040*	18847.108	29406.376
Dam within sire(R)	82	14.446**	61.155	533.008	1545.149*	3752.452**	14541.456**	19418.527**
Hatch(F)	2	56.624**	8207.934**	47430.710**	30128.738**	10526.431*	234050.253**	208104.447**
Sex (F)	1	2.967	297.760*	10150.794**	68519.803**	246132.613**	1013167.813**	1849608.176**
Sex x Hatch (F)	2	0.457	94.101	181.678	706.452	2759.838	8104.683	8598.530
Error	300	1247.651	18625.002	129484.382	331739.993	727610.657	2045919.303	3361508.964

**BW0, BW2, BW4, BW6, BW8, BW10 and BW12= Body weight at hatch , 2, 4, 6, 8, 10 and 12 weeks of ages, respectively.

* = Significant at (P< 0.05).
** = Significant at (P <0.01).

Table 9. Combined least squares analysis of variance for random and fixed factors affecting body weight at different ages in group (B).

		Means of squares			
Source of variance	Degree of freedom	BWO	BW4	BW8	BW12
Sire (S)	51	16.750457	2929.478802	15371.190280 *	18828.51617 7*
Dam within Sire	93	17.757034**	2445.384907	8885.490360	11287.20628 8
Hatches	4	32.492791**	13474.367250 **	233172.25575 3**	279945.9778 56**
Reminder	455	3.667935	2178.501173	7671.308908	9931.588660

**BW0, BW2, BW4, BW6, BW8, BW10 and BW12= Body weight at hatch, 2, 4, 6, 8, 10 and 12 weeks of ages, respectively.

* = Significant at (P< 0.05).
** = Significant at (P <0.01).

Table (10) shows the heritability estimates and standard errors (S.E) for body weights at different ages from sire, dam and sire plus dam components of variance calculated from data on sexes combined in group (A) and (B). For group (A), the results showed that the heritability estimates ranged from low (0.08) to high (0.97). The heritability estimates from dam component of variance were higher than those from sire component of variance. The highest estimates from sire and dam components of variance were 0.29 and 0.75 at 4 and 12 weeks of age, respectively. For group (B), the heritability estimates for body weights ranged from low (0.06) to moderate (0.25). The highest estimate from sire and dam components of variance were 0.25 and 0.16, respectively, both at 8 weeks of age. Heritability estimates for body weights from sire and dam components of variance at hatch were non- estimable and over estimated, respectively. Heritability estimates from sire and dam components of variance at 12 weeks of age were 0.23 and 0.14, respectively. Heritability estimates from sire component of variance at 4 weeks of age was higher in group A than that in group B. However, the corresponding estimates at 8 and 12 weeks were slightly higher in group B than those in group A. On the other hand estimates from dam component were substantially higher in group (A) than those of group (B).

Table (11) shows the heritability estimates and standard error (S.E) for body weights at different ages from sire, dam and sire plus dam components of variance calculated from data on females and males in group (A). The results showed that the heritability estimates ranged from low (0.02) to high (0.53). The highest estimates from dam component of variance were 0.33 and 0.53, for females and males, respectively, both at hatch. The heritability estimates from sire component of variance on females were higher than those on males at 4 and 8 weeks of age. The estimates from dam component of variance on males were higher than those on females only at hatch; whereas the estimates at subsequent ages were non- estimable on both females and males.

Table (12) shows the genetic correlations between body weights from hatch up to 12 weeks of age from sire and dam components of variance calculated from data on sexes combined in group (A) and (B). Genetic correlations between various ages obtained from sire and dam components of variance ranged from 0.17 to 0.95. Generally, several genetic correlations were positive and high in magnitude, with some cases being negative and greater than unity. The genetic correlations between body weights at various ages obtained from sire component of variance were relatively higher than those from dam component of variance in group (A). The highest estimate (0.95) from sire component of variance was obtained for the correlation between body weight at 8 and 12 weeks of age, whereas the lowest one (0.17) was obtained for the correlation between body weight at hatch and 8 weeks of age. On the other hand the corresponding higher and lower estimates from dam component of variance was (0.63) for the correlation between body weight at hatch and 4 weeks, of age and (0.54) for the correlation between body weight at hatch and 12 weeks of age, respectively. For group (B), the genetic correlations between body weights at various ages from sire and dam components of variance were either non- estimable or exceeding unity. The general trend indicated that genetic correlation estimates in group (A) were reliable than the estimates in group (B).

Table 10. Heritability estimates and standard error (SE) from sire, dam and sire plus dam components of variance calculated from data on sexes combined in group (A) and (B).

Group (A)				**Group (B)**		
Trait	Sire component	Dam component	Sire +Dam component	Sire component	Dam component	Sire +Dam component
BW0	0.22±0.15	1.72±0.20	0.97±0.11	NE	2.06±0.16	1.03±0.10
BW2	0.26±0.16	NE	0.13±0.09	-	-	-
BW4	0.29±0.16	0.27±0.20	0.28±0.10	0.06±0.09	0.13±0.15	0.09±0.06
BW6	0.15±0.14	0.46±0.21	0.31±0.10	-	-	-
BW8	0.22±0.16	0.59±0.21	0.41±0.11	0.25±0.12	0.16±0.15	0.20±0.07
BW10	0.08±0.12	1.09±0.21	0.58±0.11	-	-	-
BW12	0.22±0.14	0.75±0.21	0.48±0.11	0.23±0.12	0.14±0.15	0.18±0.07

*NE = Non-estimable due to negative variance.

**BW0, BW2, BW4, BW6, BW8, BW10 and BW12= Body weight at hatch, 2, 4, 6, 8, 10 and 12 weeks of ages, respectively.

* Chicks in group (A), were fed with broiler rations (Table 1 and 2).

* Chicks in group (B), were fed with layer ration (Table 3)

Table 11. Heritability estimates and standard error (SE) from sire, dam and sire plus dam components of variance calculated from data on females and males in group (A).

Trait	Females			Males		
	Sire component	Dam component	Sire +Dam component	Sire component	Dam component	Sire +Dam component
BWO	NE	0.33±0.31	0.17±0.13	NE	0.53±0.46	0.27±0.21
BW4	0.32±0.24	NE	0.16±0.13	0.27±0.37	NE	0.13±0.20
BW8	0.33±0.25	NE	0.17±0.13	0.03±0.33	NE	0.02±0.20
BW12	0.11±21	NE	0.11±0.13	0.11±0.35	NE	0.06±0.20

* NE = Non-estimable due to negative variance.

**BW0, BW4, BW8 and BW12= Body weight at hatch, 4, 8 and 12 weeks of ages, respectively.

Table 12. Genetic correlations ± standard errors (SE) estimates between body weights at various ages obtained from sire and dam components of variance calculated from data on sexes combined in group (A) and (B).

Group (A)			**Group (B)**	
Trait	Sire component	Dam component	Sire component	Dam component
BW0 X BW4	0.56±0.32	0.63±0.32	NE	NE
BW0 X BW8	0.17±0.42	0.55±0.19	NE	NE
BW0 X BW12	- 0.29±0.41	0.54±0.18	NE	NE
BW4 X BW8	0.76±0.17	1.27±0.29	1.20	1.20
BW4 X BW12	0.59±0.25	1.19±0.31	1.19	1.19
BW8 X BW12	0.95±0.06	1.01±0.04	1.07	1.07

* NE = Non-estimable due to negative variance.

**BW0, BW4, BW8 and BW12= Body weight at hatch and, 4, 8 and 12 weeks of ages, respectively.

* Chicks in group (A), were fed with broiler rations (Table 1 and 2).

* Chicks in group (B), were fed with layer rations (Table 3).

Table (13) shows the phenotypic correlations between body weights from hatch up to 12 weeks of age from sire and dam components of variance calculated from data on sexes combined in group (A) and (B). The phenotypic correlations were relatively high and positive; and ranged from (0.32) to (0.91).The highest estimate (0.91) from sire component of variance was obtained for the correlation between body weight at 8 and 12 weeks of age, and the lowest one was (0.32) for the correlation between body weight at hatch and 4 weeks of age. The corresponding estimates for dam component of variance was (0.91) for the correlation between body weight at 8 and 12 weeks of age, and the lowest one was (0.32) for the correlation between body weight at hatch and 4 weeks of age. For group (B), the phenotypic correlations estimates ranged from (0.16) to (0.81). The highest estimate (0.81) from sire component of variance was obtained for the correlation between body weight at 8 and 12 weeks of age; and the lowest one (0.16) was for the correlation between body weight at hatch and 8 weeks of age. The corresponding estimates from dam component of variance (0.81) was for the correlation between body weight at 8 and 12 weeks of age, and the lowest one (0.16) was for the correlation between body weights at hatch and 8 weeks of age. In general the phenotypic correlation estimates in group (A) were higher than the estimates in group (B).

Table (14) presents the environmental correlations between body weights from hatch up to 12 weeks of age from sire and dam components of variance calculated from data on sexes combined for group (A) and (B). The results indicated that environmental correlations ranged from low (0.16) to high (0.90). In group (A), the highest estimate (0.90) from sire component of variance was obtained for the correlation between body weight at 8 and 12 weeks of age, whereas the lowest one (0.24) was obtained for the correlation between body weight at hatch and 4 weeks of age. On the other hand the corresponding highest and lowest estimates, from dam component of variance (0.70) and (0.19) were obtained for the correlation between body weight at (hatch and 12) and (hatch and 4) weeks of age, respectively. For group (B), the results showed that the highest estimate (0.72) from sire component of variance was obtained for the correlation between body weight at 8 and 12 weeks of age, whereas the lowest one (0.56) was obtained for the correlation between body weight at 4 and 12 weeks of age. On the other hand the corresponding highest and lowest estimates, from dam component of variance (0.77) and (0.16) were obtained for the correlation between body weight at (8 and 12) and (hatch and 8), weeks of age, respectively. The general trend indicated that environmental correlations estimates in group (A) were relatively higher than the estimates in group (B).

Table 13. Phenotypic correlations between body weights at various ages obtained from sire and dam components of variance calculated from data on sexes combined in groups (A) and (B).

Trait	**Group A**		**Group B**	
	Sire component	Dam component	Sire component	Dam component
BWO X BW4	0.32	0.32	0.25	0.25
BWO X BW8	0.34	0.34	0.16	0.16
BWO X BW12	0.32	0.32	0.17	0.17
BW4 X BW8	0.75	0.75	0.63	0.63
BW4 X BW12	0.66	0.66	0.61	0.61
BW8 X BW12	0.91	0.91	0.81	0.81

**BW0, BW4, BW8 and BW12= Body weight at hatch and, 4, 8 and 12 weeks of ages, respectively.

Table 14. Environmental correlations estimates between body weights at various ages obtained from sire and dam components of variance calculated from data on sexes combined in group (A) and (B).

Group (A)			**Group (B)**	
Trait	Sire component	Dam component	Sire component	Dam component
BW0 X BW4	0.24	0.19	NE	0.39
BW0 X BW8	0.38	0.40	NE	0.16
BW0 X BW12	0.49	0.70	NE	0.29
BW4 X BW8	0.76	NE	0.58	0.68
BW4 X BW12	0.69	NE	0.56	0.58
BW8 X BW12	0.90	NE	0.72	0.77

* NE =Non estimable due to negative co variance.

** BW0, BW4, BW8 and BW12= Body weight at hatch, 4, 8 and 12 weeks of ages, respectively.

CHAPTER FIVE
DISCUSSION

The study was conducted to compare the performance and genetic parameter estimates for body weights in two groups of Large Beladi chicks reared under relatively improved management. The first group (A) was fed with a broiler ration (Table 1 and 2), whereas the second group (B) was fed with a layer ration (Table 3). Growth rate of the indigenous chickens is generally low compared to that of exotic breeds; a resultant of genetical and environmental factors (climate, nutritional and parasitic infestations) at different ages. In the present study, the average body weights for birds at hatch 4, 8 and 12 weeks of age were 26.78±2.91, 147.16±30.87, 393.51±64.12 and 800.93±155.97g, respectively, in group (A), whereas the corresponding results were 29.31±2.66, 170.80±49.27, 353.43±102.70 and 512.75±116.11, in (group B). As illustrated by the figures (1) and (2), comparison of growth performance resulted from group (A) and (B) indicated that, there was significant variation in body weights at different ages. Growth rate for birds in (group B) was higher than that in (group A) for the period between hatch and 4 weeks. However, the reverse was true for the rest of the period (4 and 8 weeks and 8 and 12 weeks), where the birds in (group A) expressed higher performance than that in (group B). The relatively better start of growth for birds in (group B) might be due to the difference in average egg weight and other managerial factors; such as rising temperature in the beginning of the study and some diseases problems, which were in favor of birds in group (B) at the beginning of the experiment. It has been reported that body weight at hatch indirectly affected by egg weight (Willy, 1950; Bowman, 1968; Hafez and Dayer, 1969; Sinclair et al.

1989 and Pinchasov, 1991). Dietary levels of protein and energy are known to have direct effect on growth performance. Birds in group (A), were fed with a broiler rations, which contained higher levels of protein (20.13 to %22.8) and ME (3000 to 3075 kcal/kg) and birds in group (B) were fed with a layer rations, which contained low levels of protein (16.38 to %18.49) and ME (2750 to 2800 kcal/kg). These results are in agreement with those obtained by Hewang et al. (1965), who found that the average body weights of chicks increased by increasing protein level of the diet from 20 to % 23; and when they increased the crude protein level to % 24 the birds increased significantly (P< 0.01) in the average weight. Salmon et al. (1983), obtained similar results, and concluded that there was a positive effect on growth performance, and feed conversion ratio due to increasing protein levels. Ameenudden et al. (1977) reported significant increase on average body weight gain of Dwarf broiler pullets when the protein levels increased from 13 to 17%. Hassan et al. (1974), who reported increasing broiler performance by increasing the dietary protein level, obtained similar results. Pesti and Smith, (1984) found a significant correlation between dietary protein and dietary metabolizable energy. They stated that growth was found to be dependent on the linear and quadratic effect of dietary metabolizable energy as well as the linear and quadratic effect of dietary protein. On the other hand, the present results are different from those of Danaldson; Combs and Romoser (1965); Robel and Combs and Romoser, (1956), who they indicated that lowering the protein level in relation to the energy level (CP/ME ratio), in diets fed *adlibitum* to chicks resulted in increase feed intake. The present results are also different from those of Waldroup et al. (1966), who reported that low protein and low energy, diets had no effect on feed consumption and feed utilization in broilers.

Several authors Grossman and Koops, (1988), Yousif et al. (2006) and Yang et al. (2006) studied growth patterns of indigenous chicken. As illustrated by figure 4, in the present study both males and females exhibited linear increase in growth rate until reached the climax at 10 weeks, then after that, they declined sharply. This result is different than that of Nwosu et al. (1979), who reported that the local Nigerian chicken reached their major point of inflection of growth at 13 weeks of age; and Yousif et al. (2006) for the Sudanese Large Beladi chicken, who reported that the maximum growth could be attained at 12 weeks of age. In general, body weights at 4, 8 and 12 weeks of age in the present study were higher than those obtained by Yousif et al. (2006); Tibin and Mohamed, (1990); Yousif and Osman, (1994) for Large Beladi; Thomas and Rao, (1988) for Kadaknath India breed and Sazzad et al. (1988), for Desi breed of Bangladesh. The present results are within the range of that obtained by Jain and Chaudhary, (1985) for the native chicken of Bengladish. For (group A), the male body weight at 12 weeks of age (905.50g) is higher than that obtained by Singh et al. (1974), for Rhode Island Red cock (553 g) at 12 weeks of age. These discrepancies could be attributed to the variation in rearing seasons, management and genetic variation between flocks.

In the present study, the mean body weights of males at 4, 6, 8 and 12 weeks of age were significantly ($P < 0.05$) higher than those of females in (group A); however, they were slightly but not significantly higher at hatch and 2nd weeks of age. Several authors (Yousif et al. 2006; Singh et al. 1974; Mostageer et al. 1978; Singh et al. 1979 and Singh et al. 1988) have discussed the phenomenon of sexual dimorphism in chicken. They reported that sexual dimorphism was evident at all ages except at hatch, with males being significantly (P <0.001) heavier than females. Singh *et al.* (1979) attributed the sex differences in body weight to the male sex hormones being more effective in the increase of body weight compared to those responsible for females. The clear evidence of sexual dimorphism may necessitate that each sex should be considered differently. In the present study, for both groups (A) and (B), the results showed significant effects of sire and dam on body weights at different ages. This is consistent with the findings reported by Yousif et al. (2006). Hatch effect was significant (P <0.001) at all ages in the two groups (A) and (B). This is in agreement with the results reported by Reddy and Patro (1983), Singh *et al.* (1988), Suleiman, (1996) and Ismail, (1997). There was no-significant effect of hatch x sex interaction on body weight at all ages in (group A); however, Suleiman, (1996) found significant effect (P <0.01) of sex x hatch at 4 and 8 weeks of age.

The coefficient of variation (C.V %) of body weight at hatch in (group A) was 10.87%.and exhibited increasing trends with advanced ages. These results are similar to those findings obtained by Suleiman, (1996); Berman, (1973) and Boa- Amponsem et al. (1992). The low (C.V %) at hatch weight may be due to suitable managerial conditions during incubation period. The possible reasons for general increase in (C.V %) at later ages may be due to exposure of the chicks to variable external environment during growing period; also, some inherited genetic factors could be involved. However, all the coefficient of variations exhibited a slight increase with age; this may be due to the effect of the greater dispersion in the values of the data analyzed as well as the use of unsexed individuals.

Heritability estimates for body weight at different ages calculated from sire and dam components of variance ranged from low (0.08) to high

(0.75) in (group A) and from low (0.06) to moerte (0.25) in (group B). These results agreed with those obtained by Marks and Briton, (1978), who used three protein levels (14, 18, and % 18). They found that the heritability estimates at 18 and %22 protein levels were higher than the estimate at %14 protein level. However, different results were obtained by Sorenson, (1977), who concluded that, there was a possibility of tendency towards higher heritability estimates for low protein concentration in diet. The heritability estimates in the present study are relatively lower than those reported by Yousif and Osman, (1994), Suleiman, (1996) and Ismail, (1997) for the indigenous breed in Sudan. On the other hand, the estimates are in general agreement with those reported by Kinney and Shoffner (1965); Siegel (1983); Havenstein et al. (1988) and Zerehdaran et al. (2005). The discrepancies in heritability estimates for body weights could be due to the different methods used for the estimates, genetic variations between the populations (presence of different additive, epistatic and dominant effects), different ages and environmental factors including maternal effects (Falconer, 1981). Heritability estimates from dam component were relatively higher than those from sire component in (group A); however, the reverse was true for the estimates in (group B). Higher estimates from sire component indicate the presence of high additive genetic effect, whereas the higher estimates from dam component may be due to non- additive genetic and/or maternal effects. Even though the heritability estimates for body weights from sire and dam components of variance in group A (0.08 to 0.75) were higher than those in group B (0.06 to 0.25), there is no clear evidence about the effect of dietary protein and ME on variance components (i.e sire and dam components). Heritability estimates for body weight at hatch from maternal half-sib on sexes combined data in groups (A) and (B) were overestimated. This is in agreement with the results reported by Moyer *et al*. (1962), Sefton and Siegel, (1974) and Pym, and Nicholls, (1979).

For (group B), the heritability estimates for body weight at hatch from paternal half sibs were non-estimable due to negative covariances. Heritability estimates for body weight from paternal and maternal half-sibs at 8 weeks of age, were higher than the corresponding estimates at 4 and 12 weeks. Similar results were obtained by Moyer *et al*. (1962) who, reported higher heritability estimates from paternal half-sibs at 8 weeks than that at 4-week body weight. Heritability estimates from sire component of variance at 8 and 12 weeks of age, were higher than those of the corresponding estimates from dam component of variance. These results are similar of those obtained by Yousif and Osman, (1994); who found higher heritability estimate (0.79) from sire component than that from dam component (0.52) in males. However, the estimates at 8- weeks of age is lower than that obtained by Oluyemi and Oyenugo, (1974), who estimated heritability for body weight from paternal half–sib (H.S) at 12 weeks of age in indigenous Nigerian chicken to be 0.31; also, Akiokum, (1971) found an estimate of 0.44 for the same breed at similar age but from full–sib (F.S) analysis.

Heritability estimates, for body weights calculated from data on males and females in (group A), were relatively low to moderate. Heritability estimates for body weight from paternal half sibs at hatch for males and females were non-estimable due to negative covariance. Many authors (Pirchnr and Vonkrosigh, 1973; Vonkrosigh and Pirchnr, 1974, Sefton and Siegel, 1974, Suleiman, 1996 and Ismail, 1997), also reported similar phenomenon. This could be attributed to maternal effects, intangible factors and/or non-additive genetic variation. These results are not consistent with those reported by Chung and Cheong, (1985), who reported that heritability of chicks hatch weight was 0.88 and Kumar and A charya, (1980), reported that the heritability estimates from full sib component for Desi chicken at hatch, was 0.92. In general, the effect of dominance and common environment mostly (maternal effect), tend to magnify the estimates from maternal half-sibs compared to the corresponding estimates from paternal half-sibs. Maternal effect is considerably high at hatch and tends to decline with increased age. Heritability estimates from dam component for females were non- estimable except at hatch. Heritability estimates from dam component for males were non- estimable except at hatch and 2 week of age. The heritability estimates for 8-week body weight from paternal half-sibs for females and males were (0.33) and (0.03), respectively. These results are agreed with those obtained by Reddy and Patro, (1983), for 8- weeks body weight in male progeny, but with lesser magnitude in females. They also, reported that, the inheritance of biweekly body in New Hampshire chicken to be higher (0.58) from dam component than that from sire component (0.22) at 8-weeks of age. Heritability estimates from paternal half-sibs for 12-week body weight for males and females were similar (0.11). This result is in agreement with the findings of Moyer *et al*. (1962), and Kataria *et al*. (1986). The relatively low heritability estimates for males and females may indicate selection for high body weight within sex might not be as efficient as with sex combined. These low results of heritability estimates may be due to small data set or sample size (Prado - Gonzalez et al., 2003).

Generally, sex-linked genes in chicken tend to contribute to the sire component estimate for female progeny; whereas for males the effect tends to make the dam component higher than the sire component estimate. In the present study, heritability estimates for females were higher than the corresponding estimates for males. These are in agreement with those reported by Kinney and Shoffner, (1965), who concluded that in all cases where comparison is possible the heritabilities of females were higher than those of males. Moreover, heritability estimates from dam component of variance for males and females were higher than those from sire component of variance. This result agreed with those reported by Kinney and Shoffner (1965), Reddy and Patro, (1983) and Suleiman, (1996). Such agreements indicate the existence of some non-additive genetic and/or maternal effects.

In (group A), heritability estimates from sire component for sexes combined data at 4 weeks of age was higher than the heritability estimates for other ages, it may be concluded that, when chicks fed with high level of protein and ME, mass or individual selection for 4-week body weight could result in improvement of body weight of the chicks at this age. However, in (group B), the corresponding estimate at 8 weeks of age was higher than the heritability estimates for other ages, it may be concluded that, when chicks fed with lower levels of protein and ME, mass or individual selection for 8-week body weight could result in improvement of body weight of the chicks at this age. In general, the present study showed that, heritability estimates in (group A) were higher than those in (group B).

Estimates of genetic correlations are subject to bias in the same manner as heritability estimates and usually reflect large sampling errors; thus, the estimates may range widely. In (group A) the genetic correlations ranged from low (0.17) to high (0.95), these results are in agreement with those reported by Chambers, (1991), who concluded that most of the reported genetic correlations among body weights at various ages were very high (> 0.90). Even though some estimates were greater than unity, the genetic correlations in the present study are in good agreement with those concluded by Chambers, (1991). In term of estimates being greater than unity; the above author, concluded that it could be attributed to the effect of common environment, particularly the estimates obtained from dam component of variance. The effect of sampling should also be considered. In the present study (group A) several genetic correlations of body weights from dam component of variance were overestimated. These are consistent with the estimates obtained by Singh and Singh, (1979) and Chambers *et al.* (1984). The genetic correlations from dam component of variance for 2, and 4, 6, 8, 10 and 12 weeks body weights could not be calculated because of the negative covariances, which assumed to be zero. This could be interpreted from the results, which revealed that the effect of sire on body weight was significant only at 2, 4 and 8 weeks of age, while the effect of dam within sire was significant at hatch, 6, 8, 10 and 12 weeks of age. Non-estimable results in this study agreed with those reported by Sefton and Siegel, (1974) who, reported negative covariance component for female body weight at one day of age. The phenotypic correlations from sire and dam component in the present study (group A) were relatively high and positive in magnitude and ranged from 0.32 to 0.91 for sexes combined. Sefton and Siegel, (1974) reported similar results; they found that the genetic and phenotypic correlations for body weight were following similar trend. However, many phenotypic correlations were negative and exceeding unity. These results are similar to those found by Sefton and Siegel, (1974), Suleiman, (1996) and Ismail, (1997). In the present study (group A), the phenotypic correlations from sire and dam component were relatively high and positive in magnitude and showed increased trend with the subsequent ages for sexes combined. In consistent results were obtained by Clayton and Alan (1966), Buran et al. (1969) and Vonkrosigh and Pirchner, (1974), who reported that the phenotypic correlations were high and positive in magnitude from males and females and exhibited decline trend with subsequent ages, which is similar to that of genetic correlations. On the other hand, Renganthan et al. (1979) and Miginelshivit, (1989) reported significantly low phenotypic correlations for body weight of sons and daughters off- spring. In (group B), the genetic correlations between body weights at various ages from sire plus dam component of variance were ranged from low (0.37) for the correlation between body weights at hatch and 8 weeks of age to high (0.93) for the correlation between body weights at 4 and 12 weeks of age**.** The phenotypic correlations were positive and ranged from low to high (0.16 to 0.81). These results are similar to that found by Sefton and Siegel, (1974), Suleiman, (1996) and Ismail, (1997). The genetic correlations between body weights at various ages from sire component of variance were non- estimable due to negative covariance and the other genetic correlations estimates between body weights were exceeding unity, similar results were obtained for dam component of variance. In general, genetic and phenotypic correlations, estimates for body weight in (group A) were higher than those in (group B).The environmental correlation between two traits is the correlation of environmental deviations together with the non-additive genetic deviations. In (group A), the environmental correlations in most of cases were positive and ranged from low to high (0.19 to 0.90), with little exceptions, which were negative and exceeding unity. The environmental correlations followed the same trend as phenotypic correlation. The environmental correlation between 8 and 10-week body weight was (0.8); this result was inconsistence with result obtained by Singh and Singh, (1981) in studying the inheritance of body weight in New Hampshire chicks. Reddy and Patro, (1983) obtained similar results also in studying the inheritance of biweekly body weights in New Hampshire chickens from one day old up to 10 weeks of age. In (group B), the environmental correlations between body weights from hatch 4, 8 and 12 weeks of age from sire and dam component of variance were relatively high and ranged from low (0.16) to high (0.77). Environmental correlations from dam component between body weights at 8 and 12 weeks of age were (0.77). These results are in agreement of those estimated by Suleiman, (1996), Ismail, (1997), Singh and Singh, (1981) and Reddy and Patro, (1983).

CONCLUSIONS AND RECOMENDATIONS

This study was conducted at the Animal Production Research Centre, Kuku district. The main objective was to compare growth performance, genetic and phenotypic parameters estimates of Large Beladi native fowl under two different dietary regimes (Broiler and Layer formulated ration).

The foundation stock was primarily established by purchasing 50 cockerels and 150 pullets from the rural areas of Blue Nile state. After short adaptation period in which the cockerels were separated from pullets to ensure the clearance of the oviducts of any sperms; the birds were randomly distributed to the breeding pens and pedigreed by wing bands. Each cockerel was assigned to mate with three pullets in a rotational form every 48 hours. Eggs were collected daily, weighed, stored in relatively cold room for 10 days and then incubated to obtain 1718 chicks from 13 consecutive hatches. The hatched chicks were pedigreed using the wing bands and reared in a circle cartoon containers used as brooders until 8 weeks of age and then transferred to the rearing house. The birds received several prophylactic dose of antibiotic and vitamins throughout the rearing period and vaccinated against New-Castle disease. Individual body weight measurements were taken at biweekly interval for (group A) and at monthly interval for (group B).

Results in (group A), showed that the average body weights for birds at hatch, 4, 8 and 12 weeks were 26.78±2.91, 147.16±30.87, 393.51±64.12 and 800.93±155.97g, respectively, whereas the corresponding results in (group B) were 29.31±2.66, 170.80±49.27, 353.43±102.70 and

512.75±116.11, respectively. In the present study, mean body weights in (group B) at hatch and 4 weeks were higher than the corresponding results in (group A). However, the reverse was true for body weights at 8 and 12 weeks of age. These results were within the range of those obtained for indigenous chicken (Tibin and Mohamed 1990, Yousif and Osman, 1994 and Ismail, 1997) but higher than those obtained by Yousif et al. (2006).

Heritability estimates for the (group A), ranged from low (0.08) to high (0.97) and higher than those in (group B).

Genetic, phenotypic and environmental correlations in (group A) were positive, ranged from low to high and higher in magnitude than those in (group B).

The following conclusions could be drawn from this work:

1- Different protein and energy levels affected body weight performance significantly.

2- Genetic and phenotypic parameters estimates were considerably higher; this permits setting a strategy for genetic improvement of the local breed using selection and crossbreeding methods.

3- It seemed that increasing dietary protein and ME affected genetic parameters estimates positively. However, these findings may need to be further verified using more than two levels of protein and ME.

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Appendices

Appendix 1. Genetic correlations ± standard error (SE) estimates between body weights at various ages obtained from sire +dam component of variance calculated from data on sexes combined in group (A).

Trait	BW0	BW4	BW4	BW6	BW8	BW10	BW12
BW0	-	0.97±0.11	0.94±0.24	0.54±0.16	0.17±0.15	0.40±0.14	0.40±0.15
BW2		-	1.06±0.09	1.23±0.19	1.19±0.21	0.88±0.20	1.01±0.21
BW4			-	1.05±0.03	1.04±0.06	0.73±0.12	0.93±0.09
BW6				-	1.00±0.01	0.67±0.11	1.01±0.04
BW8					-	0.65±0.11	0.99±0.02
BW10						-	0.64±0.10
BW12							-

****BW0, BW2, BW4, BW6, BW8, BW10 and BW12= Body weight at hatch and 2, 4, 6, 8, 10 and 12 weeks of ages, respectively.**

Appendix 2. Phenotypic correlations between body weights at various ages obtained from sire+ dam component of variance calculated from data on sexes combined in group (A).

Trait	BW0	BW2	BW4	BW6	BW8	BW10	BW12
BW0	-	0.368	0.316	0.321	0.336	0.336	0.321
BW2		-	0.860	0.724	0.622	0.525	0.512
BW4			-	0.848	0.753	0.639	0.658
BW6				-	0.950	0.796	0.816
BW8					-	0.862	0.908
BW10						-	0.877
							-

****BW0, BW2, BW4, BW6, BW8, BW10 and BW12= Body weight at hatch and 2, 4, 6, 8, 10 and 12 weeks of ages, respectively.**

Appendix 3. Environmental correlations estimates between body weights at various ages obtained from sire + dam component of variance (full- sibs) calculated from data on sexes combined in group (A).

Trait	BW0	BW2	BW4	BW6	BW8	BW10	BW12
BW0	-	0.191	0.124	0.208	0.306	0.292	0.351
BW2		-	0.832	0.613	0.482	0.467	0.385
BW4			-	0.763	0.615	0.627	0.519
BW6				-	0.929	0.956	0.718
BW8					-	1.098	0.845
BW10						-	1.158
BW12							-

****BW0, BW2, BW4, BW6, BW8, BW10 and BW12= Body weight at hatch and 2, 4, 6, 8, 10 and 12 weeks of ages, respectively.**

Appendix 4. Genetic correlations estimates between body weights at various ages obtained from sire +dam component of variance calculated from data on sexes combined in group (B).

Trait	BW0	BW4	BW8	BW12
BWO	-	0.84	0.37	0.48
BW1		-	0.71	0.93
BW2			-	1.06
BW3				-

****BW0, BW4, BW8 and BW12 = Body weight at hatch, 4, 8 and 12 weeks of age, respectively.**

Appendix 5. Phenotypic correlations between body weights at various ages obtained from sire, dam component of variance calculated from data on sexes combined in group (B).

Trait	BWO	BW4	BW8	BW12
BWO	-	0.25	0.16	0.17
BW4		-	0.63	0.61
BW8			-	0.81
BW12				-

*** BW0, BW4, BW8 and BW12 = Body weight at hatch, 4, 8 and 12 weeks of age, respectively.**

Appendix 6. Environmental correlations estimates between body weights at various ages obtained from sire + dam component of variance (full-sibs) calculated from data on sexes combined in group (B).

Trait	BW0	BW4	BW8	BW12
BW0	-	0.08	0.03	0.25
BW4		-	0.63	0.57
BW8			-	0.75
BW12				-

*** BW0, BW4, BW8 and BW12 = Body weight at hatch, 4, 8 and 12 weeks of age, respectively.**

ملخص الاطروحة

بسم ا الرحمن الرحيم

أجرى هذا البحث لتقييم المعالم الوراثية لوزن الجسم للدجاج المحلى السودانى تحت تأثير نظامين مختلفين من الغذاء .

تم استعمال 50 ديك و160 دجاجة فى مرحلة البيض(فروج) تم إختيارها عشوائيا من عدة مناطق وتم التزاوج عشوائيا. تم أسستخدام ديك لكل ثلاثه دجاجات بطريقه دورية. تم جمع البيض وتنسيبه ووزنه وتخزينه ومن ثم تحضينه لأنتاج 13 فقسة متتالية بين كل فقسة وتاليتها اسبوعا. العدد الكلى الذى تم الحصول عليه من الكتاكيت 1718.

نسبة للنظام الذى أتبع فى هذه الدراسه، تم تقسيم الدراسة الى مجموعتين (أ) و(ب) ،في المجموعة (أ) تم استخدام عليقة دجاج لاحم فى تغذية الكتاكيت وفى المجموعة(ب) استخدمت عليقة دجاج بياض. بالنسبه للمجموعه (أ)، تم أخذ الأوزان المبدئية للكتاكيت كل على حده ومن ثم تم رعايتها لاسبوعين وترحيلها لأقفاص الرعاية حتى عمر 12 أسبوعا. تم أخذ أوزان الكتاكيت اسبوعيا وحتى عمر12 اسبوع.

بالنسبه للمجموعه (ب) والتى بدأت عقب نهاية المجموعة الأولى ،تم أجراء نفس الأجرأت التى اتبعت فى المجموعة(أ) عند الفقس والرعايه، ما عدا أخذ أوزان الجسم كان يتم شهريا.

تم تحليل المعلومات أحصائيا وعلى ضوء هذه الدراسه تم الحصول على النتائج التالية:-

1- عند المجموعة(أ)، متوسط وزن الجسم الكلى عند الفقس وعند أعمار4، 8 و12 اسبوعا يساوى2,91±26,78، 30.87±147.16،64.1±393.50 و 155.97±800.93 على التوالى. بينما القيم المقابله في المجموعة (ب) ،يساوى، 2.66±29.31 ،49.27±170.80، 102.700±353.43 و 116.11±512.75. متوسط أوزان الكتاكيت فى المجموعة (ب)، كان أعلى معنويا (P<0.05)، من أوزان المجموعة (ا)، عند عمرالفقس و4 إسبوع، بينما العكس هو الصحيح عند أعمار 8 و 12 إسبوع.

2- عند المجموعة (أ)، كان هنالك أثرا معنويا (p < 0.05) للأباء على وزن الجسم عند عمر 4 و 8 أسبوع بينما فى المجموعة (ب) كان هنالك أثرا معنويا (p < 0.05) للأباء على وزن الجسم عند عمر8 و12 اسبوع.

3- منحنى النمو أظهر زياده واضحه مع تقدم العمر فى المجموعتين.

4- تأثير الأمهات كان معنويا($p < 0.01$) عند المجموعة (أ)، عند عمرالفقس،10,8,6و12 أسبوعا، بينما فى المجموعة (ب) لم يكن هنالك أثرا معنويا للأمهات على وزن الجسم فى كل الأعمار.

5- وجد أن الفقس يوثر معنويا($p < 0.01$) على وزن الجسم فى كل الأعمار فى كلا المجموعتين عدا عند عمر 8 اسبوع حيث يوثر معنويا ($p < 0.05$)عند (أ).

6- وجد أن الجنس يوثر معنويا($p < 0.01$) على وزن الجسم فى كل الأعمارعدا عند عمر 2 أسبوع حيث يوثرمعنويا ($p < 0.05$) وليس له تأثيرمعنوى عند الفقس فى المجموعة (أ) وأن الذكور أعلى وزنا من ألأناث.

7- المكافئ الوراثي لوزن الجسم عند الأعمار المختلفة للمجموعة (أ)، الذى يتراوح ما بين المنخفض (0,08) والمرتفع (0,97)، كان أعلى من المكافئ الوراثى للمجموعة (ب)، الذى يتراوح ما بين المنخفض (0,06) والمعتدل (0,25).

8- الأرتباطات الوراثية والمظهرية لأوزان الجسم المختلفة عند الأعمار المختلفة عند المجموعة (أ)، والتى تتراوح ما بين المنخفض (0,25) والمرتفع (0,95)، كانت أعلى من الأرتباطات الوراثية والمظهرية للمجموعة (ب)، التى تتراوح ما بين المنخفض (0,37) والمرتفع (0,93) من تحليل مجموع المكون الوراثى للأباء والأمهات لأوزان الجسم بينما لم يتم تقديره من المكون الوراثى للأباء والأمهات لوجود تغايرسلبى وفى بعض الحالات كان يفوق القياس.

9- الأرتباطات البيئة فى كلا المجموعتين كانت عالية نسبيا وموجبة القيمة.

10- تشير هذه الدراسة الى أن المكافئ الوراثى لوزن الجسم من مكون الأباء عند عمر 4 اسبوع في المجموعة (أ) كان عاليا عند تغذية الكتاكيت مستويات عاليه من البروتين والطاقه وهذا ربما يكون العمر المثالى لتحسين الوزن فى الدجاج المحلى، بينما فى المجموعة (ب)، كان المكافئ الوراثى لوزن الجسم عند عمر 8 اسبوع ، أعلى عند تغذية الكتاكيت مستويات منخفضه من البروتين والطاقه وهذا ربما يكون العمر المثالى لإنتاج البيض فى ا لدجاج المحلى.

(ألم يروا إلى الطير مسخراتٍ في جو السماء ما يمسكهن إلا الله
إن في ذلك لآياتٍ لقومٍ يؤمنون)
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المعالم الوراثية والمظهرية لوزن الجسم فى الدجاج البلدي الكبير المحلى تحت تأثير نظامين مختلفين من الغذاء

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