# COMPARISONS OF PRODUCTION TRAITS IN WHITE LEGHORN, EGYPTIAN BALADI AND FAYOUMI CHICKENS

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Comparisons of Production Traits Among Chickens

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ABSTRACT

Three experiments were conducted at the Agricultural Research and Education Center of the American University of Beirut, to study and compare production traits of the White Leghorn, Egyptian Baladi and Fayoumi breeds of chickens.

The results of the first growing period experiment indicated that the White Leghorn chicks had the highest live weight gains and were most efficient in feed utilization. The Egyptian Baladi chicks had the higher live weight gains and better feed efficiency as compared to the Fayoumi chicks.

The results of the second growing period experiment substantiated the information obtained from the first experiment. Best live weight gains and feed efficiency were attained by the White Leghorn chicks. The Fayoumi chicks made higher body weight gains in this experiment than the first experiment and were slightly more efficient than the Egyptian Baladi. No difference in mortality was observed.

Data from the production period experiment indicated that the White Leghorn pullets had higher mean egg production, lower feed consumption per dozen eggs and higher mean egg weight than the Egyptian Baladi and Fayoumi pullets. The two Egyptian breeds had higher percent yolk and shell, lower percent albumen, better albumen quality and thicker egg shells than the White Leghorn. The eggs from the Egyptian Baladi

showed least number of blood and meat spots.

The laying house mortality was highest for the White Leghorn, intermediate for the Egyptian Baladi and least for the Fayoumi pullets. The Fayoumi eggs showed the highest percent fertility while the eggs from Egyptian Baladi had the least percent fertility. The White Leghorn eggs had the higher percent hatchability than the other two breeds.

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# INTRODUCTION

The chicken has a higher reproductive rate and produces eggs and meat more economically than any of the other domesticated animals. In addition, relatively more progress has been made in the last two decades in increasing the reproductive efficiency of chickens than any other class of livestock. Advances in genetics, nutrition and disease control which resulted from years of research, brought about economies in production and were responsible for the rapid growth of the broiler industry. Egg production is more important than broiler production due to the fact that chicken as meat competes with beef, lamb and pork for a market, whereas eggs in a class by themselves does not have any direct competition.

Lebanon has great potentialities for the development of a poultry industry because of its location, climatic conditions and research and educational opportunities. Prior to 1952 the people of Lebanon did not know poultry production in its modern perspective. Poultry and egg production were neither recognized as an important phase of the annual agricultural income on farms nor as a dependable source of food for the family. Before this time, the flocks were degenerated with an average egg production of 50 to 60 eggs per annum per bird (Ward and Fuleihan, 1962). However rapid changes have taken place in the poultry production program in the last ten years

and today Lebanon is recognized in the Middle East as an important poultry center in the production of breeding stock, baby chicks and hatching or market eggs. Poultry production in Lebanon has obtained a place of national significance as a business in the scheme of human food production.

Egg production, egg size, fertility, hatchability, growth rate and feed efficiency are some of the most important economic traits influencing profits made from a poultry enterprise. Diseases, on the contrary, quite often mask the true production potential of a flock of birds. Disease and consequent high mortality in poultry is a direct result of the increase in the size of the flock causing a too large a number of fowls to be concentrated on a limited area, and the widespread interchange of chicks and breeding stock between different parts of the country. Disease has also resulted partly through the intensive application of improved methods of selection, housing, feeding and management, with little emphasis placed on vitality and inherent vigor, in order to attain the one objective, better egg production.

Lebanese poultry producers, like their counter parts in any other country, are losing money because of excessive mortality in their growing chickens and laying flocks. These losses are of great importance from the standpoint of those birds that die after consuming various amounts of feed and with respect to the monetary losses resulting from retarded growth, poorly finished market birds and decreased egg production by

many of the birds that survive the attack of the disease. Jull (1957), emphasized that any attempt to reduce losses from disease will render great service to the poultry industry in Lebanon.

It has been recognized that there is no substitute for good management in lowering the incidence of disease in poultry flocks. Jull (1952) reviewing a paper by Hutt, however, observed that the major portion of the laying pullet mortality that normally occurs is due to diseases that are not amenable to sanitation, immunization and elimination of carriers and exposed birds. It seems, therefore, that if along with good management one could develop a strain of chickens that has some genetic resistance to diseases, it will be of help in augmenting the development of the poultry industry and will have economic implications in any part of the world. Two Egyptian breeds of chicken (Fayoumi and Egyptian Baladi) are reportedly more resistant to diseases which are prevalent in Egypt than other commercial breeds of chicken. The traits of economic importance, on the other hand, are at a significantly lower level in these two breeds than other breeds used for egg production under Egyptian conditions.

The present study was undertaken with the idea of comparing a locally adapted Babcock strain of Single Comb White Leghorn chicken with two reportedly disease resistant Egyptian breeds of chicken in production traits under Lebanese environmental and managerial conditions. Another purpose of

the present investigation was to determine if the production level of Egyptian Baladi and Fayoumi was high enough to justify their use in crosses for disease resistance with the White Leghorn without lowering the production of this breed to an uneconomical level. Data were obtained on growth rate, feed efficiency and mortality of the chicks during the first 12 weeks of age. Data were also obtained on egg production, average age at 50% production, feed conversion, egg quality, fertility, hatchability and mortality during the first year of production.

## REVIEW OF LITERATURE

Profits from poultry depend largely upon the superior performance of the birds and the production of good quality products. Therefore, extensive studies have been made to increase the inherent capacity of the birds to produce a good quality product with better efficiency. The factors, other than inherent capacity, affecting the production level and the quality of the product have also been studied at different research stations. The purpose of this section is to review the available information pertaining to the production traits and the factors affecting these characters in poultry.

### Body Weights, Growth Rate and Feed Efficiency

Growth is one of the most important factors affecting the efficiency of feed utilization in chickens. The faster growing chickens are more efficient in feed utilization. The fact that rate of growth is inherited has been demonstrated by many workers. Schnetzler (1936) showed that rate of growth is inherited and suggested the possibility of selecting chickens at 8 or 9 weeks of age. Hazel and Lamoreux (1947) showed that phenotypic selection of the prospective breeders should be quite effective in increasing body size in most strains of birds. It was recommended that cockerels and pullets for future breeding purposes should be selected at 4-6

weeks and again at 10-12 weeks of age. No evidence of sex-linked gene influencing body weights was found from the results of this study. According to Jull (1952), however, several genes, a few of major importance, including at least one sex-linked gene are involved in the inheritance of body size.

A number of workers have studied the influence of egg size, age at sexual maturity and mature body weights on the growth of chicks. Halbersleben and Mussehl (1921) noted a consistant relationship between the weight of the egg used and the weight of the chick at hatching. The chick weight averaged 64% of the egg weight. The data also indicated that during the first few weeks smaller chicks at hatching time grew somewhat slower than larger chicks hatched from the same dams. However, a compensatory growth was observed in the case of smaller chicks and at 5 weeks of age the chicks from small eggs averaged approximately the same weight as those from the large eggs. Upp (1928) also found a high degree of association between egg weight and day old chick weight but showed that rate of growth in most cases was independent of chick size at hatching and indirectly independent of size of eggs set. The results of this study suggested that day old chick weight is an unreliable index of the chicks growth rate. Wiley (1950) reported that the smaller chicks at hatching time grew somewhat slower than larger chicks hatched from the same hens and observed that this slower growth in case of smaller chicks was made up from the third to the twelfth week of age.

Waters (1937) indicated that inherent differences in rate of growth operate independently of maximum adult weight at 10 months of age but the growth rate manifested seems to be associated with age at sexual maturity. Hays (1952) observed that very early maturing pullets remained significantly smaller than medium or late maturing birds until the age of 12 months. At the age of 14 months all age groups showed about the same body weight. Godfrey et al. (1953) studied the relative influence of egg size, age at sexual maturity and mature body weights on growth to 12 weeks of age. The results indicated that the weight of the egg exerted the major influence on body weight at hatching and until approximately 2 weeks of age, then mature body size and age at sexual maturity began to exert increasingly greater influence. Conversely to the finding of Waters (1937), the work of Godfrey showed that the influence of mature body size on body weight was greater than the effect of age at sexual maturity. The combined influence of egg weight, age at sexual maturity and adult body weight accounted for about 36 percent of the variation observed in body weight at 12 weeks of age but accounted for less from 2-10 weeks of age. At hatching, however, these three factors (egg weight, age at sexual maturity and adult body weight) accounted for about 74 percent of the observed variation in body weight. The difference in the influence of egg weight, age at sexual maturity and adult body weight on body weight at hatching and at 12 weeks of age

was attributed to relatively large influence of egg size on body weight at hatching.

The influence of summer temperatures on growth rate in chickens was studied by Kempster (1938). This work indicated that a decrease in growth during the summer could be attributed to high temperatures which explains the weight differences between early and late hatched chicks during the growing season. The study also revealed that the greatest weight increases occurred during the third 4-week period, that is 9-12 weeks of age.

Hafez and Kamar (1955) reported that the hatching weight for Fayoumi chicks ranged from 28 gms. in September to 31 gms. during December. The hatching weight of chicks was low in the months of July, September and October than during winter months. The body weights were heavier in chicks hatched during summer months than those hatched during spring months while those hatched in autumn and winter showed intermediate body weights throughout the experimental period.

The fact that male chicks grew relatively faster than female chicks has been demonstrated by several investigators. Lerner and Asmundson (1938) reported that within a given strain of birds the difference in rate of growth between the sexes is greater in a rapid growing strain than a slow growing strain. Jull and Titus (1928) interestingly noted that for the first 6 or 8 weeks the female chicks weighed practically the same as the male chicks. After ten weeks of age, the male

chicks increased in weight more rapidly than the female chicks. The results indicated proportionately smaller increase in live weight for each successive 1000 gms. of feed consumed. Asmundson and Lerner (1933) indicated that the male chicks grew more rapidly than the female chicks and the earlier hatched chicks grew faster than the later hatched chicks. The same research workers in 1934 compared the rates of growth of Leghorn and Barred Plymouth Rock considering each sex separately. Male and female White Leghorn chicks weighed 99 and 98 percent of the weights of the respective sexes of Barred Plymouth Rock when one day old. These breed differences increased with age and White Leghorn male and female chicks weighed 79 and 81 percent and 75 and 74 percent of the weights of the respective sex of the Barred Plymouth Rock at 12 and 24 weeks of age, respectively. The greatest differences in rate of growth were noted during 2-6, 2-8, 6-16 and 8-16 week periods. These researchers suggested that the period from 2-8 weeks was the most suitable for studying the genetic differences in rate of growth.

The growth rates of male and female New Hampshire, Barred Plymouth Rock and White Leghorn chicks raised on floor and batteries were compared by Le Masurier and Branion (1939). The results indicated that the male chicks were heavier than the female chicks of the respective breeds both in the batteries and on the floor. Jull (1952), reviewing the work of Kempster and Parker observed that White Leghorn female chicks

weighed 98, 93, 87, 81, 79 and 77 percent of the weights of White Leghorn male chicks at 0, 4, 8, 12, 16 and 20 weeks of age, respectively. Titus (1955) stated that for chickens, the males tend to grow faster than the females. The absolute rate of growth increased with age for a time and then decreased, while the relative growth rate decreased with age, at first slowly and then more rapidly. It was further noted that the more feed a growing chicken consumed the more rapidly it gained in weight. Badreldin et al. (1961) studied growth rate and body weights in 545 chicks hatched from seven matings using three breeds: Fayoumi x Fayoumi, White Leghorn x White Leghorn, Rhode Island Red x Rhode Island Red and reciprocal crosses of Fayoumi with the other two breeds. At hatching the pure Fayoumi, White Leghorn and Rhode Island Red chicks were 25.8, 33.8 and 37.8 grams, respectively. The crossbreds of Fayoumi dams were lighter than those of White Leghorn and Rhode Island Red dams at hatching. The Rhode Island Red chicks were heavier than White Leghorn chicks until the fourth week of age, when the weight of the White Leghorn exceeded those of Rhode Island Red and remained heavier until 12 weeks of age. Pure Fayoumi chicks had the lowest body weights throughout the study period. The Fayoumi x Rhode Island Red chicks were the heaviest, while the White Leghorn x Fayoumi were the lightest among the crossbreds during the first 12 weeks. The highest relative growth rate was observed for Fayoumi chicks during the first two weeks and from the 6-10 weeks;

the White Leghorn chicks grew fastest from 2-6 weeks. Fayoumi and White Leghorn chicks showed faster growth rate than the Rhode Island Red chicks until 12 weeks of age which was due to a difference in the age of sexual maturity. The average weight of Fayoumi chicks was 460 gms. as compared with 503 gms. for the White Leghorn chicks and 480 gms. for the Rhode Island Red chicks at the end of 12 weeks. The reciprocal crosses of Fayoumi and Rhode Island Red showed higher weights at 12 weeks of age than the chicks of both parental breeds. This was not true in the case of the crosses between the White Leghorn and Fayoumi breeds. Kamar and Sami (1964) conducted an experiment to observe the effect of wing cutting on growth in Fayoumi and Baladi chicks. The data indicated that the Fayoumi chicks were heavier than Baladi chicks in both groups throughout the experimental period. The breed differences in body weights were slight at early age but as the birds grew older the differences became more marked. Average values of 58 and 117 gms. were reported for the wingless and the control group of chicks, respectively. The final weights of the control group at 12 weeks of age were 407 gms. for Baladi and 524 gms. for Fayoumi chicks.

The efficiency of feed utilization is a very complexed phenomenon that is influenced by a great number of physiological, environmental and individual differences. Rate of growth, sex, capacity to consume large quantities of feed, activity and general health of the individual are some of the factors

that may affect this characteristic. The importance of feed efficiency is stressed because of the cost of feed which accounts for above 50 percent of the total expense of production.

In feed efficiency studies in poultry, Hess et al. (1941) presented evidence that efficiency of feed utilization is inherited. These data demonstrated that efficiency varies greatly among different strains and crosses. The least efficient Barred Plymouth Rock chick required 21 percent more feed per pound of gain than the most efficient chick until 8 weeks of age. This work showed that the efficiency was better in crossbred (Barred Plymouth Rock x New Hampshire) than in the purebred chicks of the two parental breeds. The data of McCartney and Jull (1948) revealed differences in feed efficiency between two strains of New Hampshire chicks to 12 weeks of age. Extensive studies were also conducted by Hess and Jull (1948) to determine whether the efficiency of feed utilization is inherited and whether or not it is possible to develop strains of chickens that will excell others in their ability to utilize feed efficiently. The following results were reported:

(i) There is a definite inherent difference in feed efficiency between individuals that cannot be explained on the basis of body weight, rate of gain or time.

(ii) The male chicks were slightly more efficient than the female chicks in utilizing feed. These diffe-

rences were not very marked at 500 gms. and lower body weights but increased progressively with age in favor of male chicks.

(iii) The faster growing individuals utilized their feed more efficiently than the slower growing individuals.

(iv) Crossbred chicks were more efficient in feed utilization than purebred chicks sired by the same male.

Fox and Bohren (1952) studied feed efficiency in four breeds of chicks from 4-10 weeks of age. The results of this study indicated that much of the differences in feed efficiency among breeds could be attributed to differences in gains. Similarly the differences in efficiency between sexes appeared to be largely due to differences in growth rate. These results suggested that the growth rate provides a reliable and easy measure of feed efficiency.

Carver and Haugan (1935) sexed White Leghorn chicks to find the sexual differences in growth and efficiency of feed utilization. The average weights of male and female chicks for the first three weeks were practically the same but after the third week, the males showed more rapid growth each week than the female chicks. In general, the males made greater gains than the female chicks during each week with the exception of the first week. The males were slightly better feed utilizers but both male and female chicks showed slightly

decreasing feed efficiency from the first to eight weeks of age. Glazner and Jull (1946) studied efficiency of feed utilization in two strains of Barred Plymouth Rock and New Hampshire chicks and showed that the progeny of the long shanked strains grew faster and utilized feed more efficiently than the progeny of the short shanked strains. Within a strain, the slower growing birds showed poorer feed efficiency than the more rapid growing birds. O'Neil (1950) designed an experiment to test the effect of percentage size of chicks on growth characteristics and mortality to 8 weeks of age. The results indicated that those chicks hatching with the highest percentage of the original weight of the egg are heavier at 8 weeks and more efficient in feed utilization. Fox and Bohren (1954) obtained highly significant differences in average body weight due to breed and sex differences. These results indicated that sex differences in gross efficiency may be considered as an expression of sexual dimorphism in growth. Breed differences in gross feed efficiency were also predominantly a reflection of differences in growth rate. Titus (1955) stated that young actively growing chickens normally make larger gain in live weight per unit of feed consumed than older chicks. This phenomenon was explained on the basis of relatively less increase in daily feed consumption as compared to live weight increase and more feed requirement for maintenance in older ages. Male chicks were more efficient than female chicks of the same breed and strain. The chickens of some

breeds utilize feed more efficiently than those of other breeds.

Trail (1963), in Uganda, observed great improvement in growth rates of indigenous birds when crossed with Light Sussex, Rhode Island Red and Black Australorps cockerels. The Ligh Sussex cross gave the best results while the White Leghorn did not improve the growth rate of the indigenous birds to any significant level. Crossing with Light Sussex and Rhode Island Red cockerels greatly improved the feed conversion of indigenous poultry of Uganda but crossing with Black Australorps and White Leghorn cockerels did not improve the feed efficiency. Kamar and Mostageer (1963) compared Rhode Island Red, White Leghorn, Fayoumi and the reciprocal crosses of Fayoumi with two other breeds for growth rate and efficiency of feed utilization. At hatching, the pure Fayoumi and crossbreds of Fayoumi dams were lighter than pure White Leghorn and Rhode Island Red or cross of White Leghorn or Rhode Island Red dams; this was attributed to a smaller egg size, but this influence decreased rapidly after two weeks of age. The gain in weight at 2 week intervals showed a progressive increase until 4-6 weeks of age but thereafter, the gains were not consistant. Pure White Leghorn and reciprocal crosses with Fayoumi had the heaviest live weights and made the greatest gains. Pure Fayoumi showed the lightest weights and the slowest gains. Rhode Island Red and reciprocal crosses showed intermediate weights and gains. Generally male chicks were

heavier than female chicks and as the birds grew older the differences increased. The average live weights noticed at 12 weeks of age were 1.16, 1.35, 1.66, 0.99, 1.29, 1.50, 1.50 and 1.46 pounds for Rhode Island Red x Fayoumi, Rhode Island Red, Fayoumi x Rhode Island Red, Fayoumi, Fayoumi x White Leghorn, White Leghorn, and White Leghorn x Fayoumi, respectively. These research workers noticed a decrease in feed efficiency with increasing age and explained it on the basis of decreased growth rate in later ages. Fayoumi and White Leghorn were less efficient in utilizing feed than Rhode Island Red chicks. White Leghorn and Fayoumi crossbred chicks showed a slightly higher level of efficiency in comparison with both parental breeds. However, crossing Fayoumi with Rhode Island Red produced chicks with intermediate efficiency (between those of their parents). From the findings of this study, the workers suggested the possibility of crossing Fayoumi with Rhode Island Red for broiler production in Egypt.

Age and Body Weight at Sexual Maturity

The study of the age at sexual maturity is of practical importance because of its influence on subsequent egg production (Jull, 1924; Hays, 1952). According to Gutteridge and O'Neil (1941) age at sexual maturity is affected by the environment to a great degree and by heredity only to a limited extent. Body weight at sexual maturity is affected equally by both environment and heredity.

Hafez and Kamar (1955) conducted extensive studies to investigate the age and the body weight at sexual maturity in Fayoumi fowl and reported that the average age at sexual maturity was 155 days for August hatched pullets and 200 days for those hatched in February. Autumn, Summer and Winter hatches reached sexual maturity at the age of 159, 165 and 183 days, respectively. The average age at sexual maturity for all pullets was 169 days. The results further indicated that the Summer and Winter hatched chickens attained sexual maturity at heavier body weights than those hatched in the Autumn. The average body weight at sexual maturity was 1093, 1124 and 1023 grams for Winter, Summer and Autumn hatched pullets, respectively. From these results, these workers concluded that the effect of temperature was greater than that of day length on growth rate and age of pullets at sexual maturity.

Nordskoj and Phillips (1960) reported differences in age at sexual maturity between light and heavy breeds of chicken. White Leghorn matured earliest at 187 days of age; Fayoumi matured slightly later than White Leghorn at 190 days of age, and the heavy breeds attained sexual maturity at about 206 days of age. Badreldin et al. (1961) observed breed differences in body weights at sexual maturity. The body weights at sexual maturity were 1043, 1477 and 1891 grams for Fayoumi, White Leghorn and Rhode Island Red pullets, respectively.

Egg Production and Feed Efficiency

The level of egg production is the most important factor that influences the economics of producing eggs. The main objective in breeding for high egg production is to increase the efficiency of the flock, since feed cost accounts for about two-thirds of the total cost of producing eggs. Joshi et al. (1949) reported that those hens laying at the rate of 72 percent used 71 percent of the feed consumed for body maintenance, 27 percent for the production of eggs and 2 percent for the increase in body weight. The study also revealed that when the feed used for body maintenance and increase in body weight is deducted, the lower producing birds used their feed as efficiently as the higher producing birds.

Many researchers have shown that the ability to lay well is inherited and at the same time is influenced by environmental factors. Gutteridge and O'Neil (1941) studying the relative effect of environment and heredity upon production characteristics in pullets found that egg production was influenced by environment to a much greater degree than by heredity and thus emphasized the importance of improvement of the environment for increasing the level of egg production.

Hays (1952), with Rhode Island Red, observed that early maturing pullets averaged a significantly greater number of eggs than late maturing pullets. No differences were observed in egg production between early and medium maturing pullets.

Pepper et al. (1957) observed that egg production and feed efficiency of range birds were significantly superior to the birds reared in confinement during a 10 months laying period. Nordskoj and Phillips (1960) observed breed differences in egg production. Among pure breeds, the White Leghorns produced at the highest rate (65%), the Fayoumi pullets produced at the lowest rate (51%), while the heavy breeds produced eggs at an intermediate rate (57%). Crosses, between Fayoumi chickens with White Leghorns and the heavy breeds, produced at a higher rate than their parental breeds.

A number of investigators have shown that the temperature is a main cause of the seasonal variation in egg production. Atwood (1928), with White Leghorn pullets hatched in June observed that the average production for the first year was 170.2 eggs. The minimum rate of production was noticed in November when the pullets started laying and the maximum was reached in May when pullets laid at a rate of 78.6 percent.. Bennion and Warren (1933) reported a decline in egg production following extremely high or low temperatures. The birds were more sensitive to sudden changes than gradual changes upward or downward and consumed 12 percent less feed during high temperatures than during low temperatures. Bruckner (1936) indicated that the use of temporary sources of heat during cold weather gave promise of being a practical method of preventing production slumps during sudden cold waves. The results showed that sudden and extreme drops in temperature

affected mash consumption materially, grain consumption showed a slight increase but total feed intake was slightly lowered. Less feed per dozen eggs was required by birds in heated pens than those in unheated pens.

Rajab and Assem (1953) investigated the effect of atmospheric temperature and day light on egg production in Fayoumi and Baladi birds and reported that maximum egg yield was reached in December and January and the minimum production occurred in September. A tendency for high egg production was noticed during the period from December to May, followed by a decline which reached its lowest between August and October. The data showed a decrease in monthly egg yield with an increase in temperature. The period of increase in day length was preceded by an increase in egg production (December, January and February). Although the day light increased after these months, a corresponding increase in egg yield did not take place because of the high temperatures of the Summer months. Fayoumi produced an average of 156.4 eggs while the Baladi hens produced an average of 154.6 eggs during the first laying year. Hafez (1954) classified the Fayoumi chickens after completion of the first laying year according to the intensity of egg laying as high, medium and low producers. The average number of eggs laid per day during the laying year was reported as 0.50, 0.42 and 0.40 eggs for high, medium and low classes, respectively. Assem and Rajab (1955) observed that the average clutch size in

Fayoumi and Baladi pullets was 1.87 and 1.74 eggs, respectively. The average egg production in August and September was 19.0 for Baladi and 18.7 eggs for Fayoumi hens. The average length of pauses throughout the year was 15.84 days for Baladi and 17.18 days for Fayoumi hens. The longest pause, occurred during the Autumn months in both breeds,was 21.85 days for the Fayoumi as compared to 18.64 days for the Baladi hens. These long Autumn pauses were attributed to the effect of moulting.

Egg Shape Index

An individual bird lays eggs that have a more or less uniform shape index but enormous variations may occur within a breed of birds. The problem of variation in egg shape was investigated by Asmundson (1931) who reported that the general shape of the egg is determined by the amount of albumen secreted in the oviduct, the calibre of the lumen of the albumen-secreting part and isthmus and the muscular activity of the walls of these parts. It was further observed that the general shape may be altered in the uterus. The isthmus and the uterine alteration give the egg its particular shape. Romanoff and Romanoff (1949) reported great differences in the average shape index of flocks of the same breed. These researchers noted enormous variation in the shape index of eggs laid by a single flock of 262 White Leghorn hens. Shape index values varied from 63.1 to 81.7. According to Romanoff

and Romanoff (1949), the standard egg, weighing about 58 grams, should have a shape index of 74. King and Hall (1955) reported that the eggs between breeds did not differ significantly in shape index while the differences among strains within breeds were significant. Mueller et al. (1960) reported that shape indices of the eggs produced during the pullet year were significantly higher than those produced during the second laying year. No seasonal effect was observed in the shape index of the eggs.

Egg Size and Egg Components

The value of an egg is determined by its size and its interior quality. Birds with very high production records may produce eggs of a relatively low market value because of a high proportion of small eggs. Large size is also desirable from a breeding standpoint since it is well established that large eggs produce large chicks. The size of the egg is influenced by domestication, the environment and genetical factors. The inheritance of egg weight in the domestic fowl was studied by Hays (1929) who reported that large eggs are produced by the effect of a dominant autosomal gene B, while the small eggs are due to an autosomal gene A, epistatic to B. The eggs of standard size are produced by birds with a B genotype. According to this worker, breeding for egg size alone, without giving any consideration to egg production level, is a simple procedure.

The effect of age and body weight at sexual maturity on egg weight has been studied by many workers. Jull (1924) reported that earlier maturing birds produce a greater number of eggs with a lower mean egg weight. Pullets that attain greatest maximum body weight tend to lay eggs of the greatest mean weight for the total production. The increase in egg weight was analogous to the increase in body weight. The data showed that the earlier maturing birds attained maximum body weight and egg weight later than the later maturing birds. Similar results of the effect of age and body weight at sexual maturity on egg weight were reported by Callenbach (1934); Waters (1937); and Hays (1952).

Atwood (1928), with the White Leghorn breed observed that during the pullet year the egg weight increased from a minimum of 39.4 gms. in November to a maximum of 57.3 gms. in the following October, with a weight increase of 45.4 percent. The average weight of the eggs during the pullet year was 53.0 gms. The results of this study indicated a tendency for eggs to become heavier with increasing age of the pullets. Similar trends in egg weight were also noticed by Maw and Maw (1931) and Mueller et al. (1960).

Strain and Johnson (1957) reported an increase in egg weight from October to June. Nordskoj and Phillips (1960) observed breed differences among White Leghorn, Rhode Island Red, New Hampshire, White Rock and Fayoumi chickens in egg weight. The heavy breeds produced the heaviest eggs

(62 gms.) while the smallest eggs (49 gms.) were produced by the Fayoumi chickens. The White Leghorn hens produced eggs of intermediate size (58 gms.). Crossbreds, between Fayoumi with White Leghorn and the heavy breeds, laid eggs with sizes intermediate between the two parental breeds.

The fact that high summer temperatures tend to reduce the egg weight has been pointed out by Bennion and Warren (1933), and Warren (1939). Warren (1939) observed a rapid increase in egg size for the first few months which was attributed to the birds reaching physiological maturity. These workers also indicated that egg size showed a close relationship to the prevailing temperature. In areas where the temperature seldom exceeded 70°F., a gradual increase in egg size was noticed throughout the pullet year. Similar variations in weight of eggs laid by caged and floor layers were noticed by Froning and Funk (1958). Cunningham et al. (1960) observed a continuous increase in egg weight from August to December which levelled off during the spring months of February to May and after a slight decrease in June tended to increase again from July to August.

Rajab and Assem (1953) studied the effect of atmospheric temperatures and day light on the egg weight of Fayoumi and Baladi chickens. These research workers reported that the egg weight reached its maximum weight during January and its minimum weight during August. A gradual increase in egg size occurred from the first month of laying to the eighth

month. The Baladi began with a minimum egg weight of 30.8 grams for the first month and reached 40.0 grams by the end of first laying year, with an increase of 30.5 percent. The Fayoumi started with an average egg weight of 33.3 grams and reached 45.3 grams at the 12th month of laying with an increase of 36 percent. The average egg weight did not increase considerably after the 8th and 9th month for Baladi and Fayoumi fowls, respectively. The average egg weight for the first laying year was 41.0 grams for Fayoumi and 36.5 grams in the Baladi chickens. The workers further noted that the high egg production is accompanied by a small egg size in Baladi but no such relation existed among Fayoumi eggs.

The egg of domestic fowl is composed of a shell with its two closely adhering membranes, the white or albumen consisting of four layers and the yolk. These three main parts can be readily separated and their respective proportions determined.

Bennion and Warren (1933), with Rhode Island Red and White Leghorn hens, noted a decrease in all components of the eggs under high temperatures. The shell and the albumen decreased considerably more than the yolk. The average percentage of albumen, yolk and shell were 58.57, 31.50 and 9.91, respectively. Romanoff and Romanoff (1949) stated that the albumen showed the greatest seasonal variation. During winter, the albumen increased in weight more rapidly than the yolk. It was further reported that the amount of albumen and shell

decreased but the yolk either remained the same size or decreased slightly in weight during the summer season. Of all the components of the egg, the shell showed the greatest variability in weight. Cunningham et al. (1960) found that the total volume of albumen and yolk varied with the season and the age of the bird. The relative amount of albumen to yolk per egg was not influenced by the seasons of the year but as the birds advanced in age the percent yolk per egg increased.

Hall (1939) investigated the breed differences in the egg characteristics of the White Wyandottes, the Barred Plymouth Rock, the Rhode Island Red and the White Leghorn breeds. The data showed no significant breed differences in weight of egg, yolk and total white. The shell weight of the Barred Plymouth Rock hens was significantly lower than the shell weights of White Wyandottes and White Leghorns. The percent shell, yolk and albumen for the White Leghorn eggs was 12.11, 30.25 and 57.06, respectively. It was concluded that when breed, variety or strain differences in egg weight occurred, it is likely to be associated with the amount of shell.

Hafez et al. (1955) studied the developmental changes in the Fayoumi fowl eggs. A gradual increase in egg weight was observed throughout the first laying year but the relative increment in weight declined with age. The average egg weight at the end of first laying year was 45.6 grams. A

marked developmental increase in weight of egg components was noticed throughout the experimental period. A high variability in the egg and in the weight of its components was observed. The albumen percent decreased while the percent yolk increased throughout the first laying year. The percent shell decreased gradually in the first half until it reached a minimum of 11.72 percent of the egg weight. During the second half of the study, the percent shell increased until by the end of the experiment it was 12.7 percent of the total weight of the egg. The albumen was 51.9 percent while the yolk was 35.37 percent at the end of the experiment.

Shell Thickness

King and Hall (1955) and Trail (1962) observed breed differences in egg shell thickness. Trail (1962) reported that the indigenous breed of Uganda produced eggs with shells significantly thicker than all of the imported breeds and crosses. It has been pointed out by Brant et al. (1955), however, that purebreds and crosses have a very similar shell thickness. The average shell thickness was 0.0146 inches in March which decreased to 0.0138 inches in August. In March, 20.5 percent of the egg shells measured 0.0130 inches or below but 41.1 percent egg shells (eggs produced in August) measured 0.0130 inches or below. These data confirmed the widely accepted fact that during the summer shell quality is considerably below the desirable level of 0.0130 inches.

Dawson et al. (1954) observed a flock variation in shell thickness from 0.0121 to 0.0143 inches. Froning and Funk (1958) reported that warmer temperatures had an adverse effect on egg shell thickness and the recovery in fall was not sufficient to bring the thickness back to the original level observed in May. Mueller et al. (1960) observed that the shell thickness during the second year of production was significantly greater than that during the pullet year. These researchers suggested that this increase in shell thickness was probably caused by environmental factors and not by the increase in age.

Albumen Quality

Hunter et al. (1936) noticed a seasonal trend in the albumen quality of eggs produced by White Leghorns. The quality of the eggs began to decrease in March and April and continued through the Summer. The eggs of the highest quality were produced in the period between November and March. Brant et al. (1953) reported remarkable similarity among breeds for albumen quality in March. The largest difference was 2.7 Haugh Units between eggs from Barred Plymouth Rocks (77.4) and those from Rhode Island Reds (74.7). During August the variation was somewhat greater with a 5.2 Haugh Units difference between White Leghorn (71.5) and White Plymouth Rock (66.3) eggs. The White Leghorn eggs differed least in quality. The White Leghorn eggs produced in Spring had a

Haugh Unit Score of 75.8 and those produced in Summer had a Haugh Unit Score of 71.5. A Summer decline in albumen quality was observed in all breeds. These workers also reported that in high producing birds the decrease in albumen quality is greater than in low producing birds as the laying year advances. Breed and seasonal differences in egg quality were also noted by King and Hall (1955) and Trail (1962). Strain and Johnson (1957) also reported a seasonal decline in albumen quality. The average decline was greater during the period from October to February than from February to June. These workers suggested that the decline in albumen quality is due to a physiological change taking place as egg production progresses than to changes in environmental temperatures. The results also indicated significant hatch and strain differences in albumen quality. Froning and Funk (1958) observed the sharpest decline in egg quality from November to May. The results indicated that pullets have greatest decrease in egg quality during the first six or seven months of laying.

Mueller et al. (1960) and Cunningham et al. (1960) observed a continuous decline in albumen quality. Cunningham et al. (1960) suggested that this decline in Haugh Unit Score was entirely due to the aging of the birds. No seasonal differences in Haugh Unit values were observed by Cunningham et al. (1960). Harms et al. (1962) observed a significant correlation between rate of egg production and Haugh Unit Score. The data indicated a decline in Haugh Unit Score with the increase in

egg production.

Blood and Meat Spots

Nalbandov and Card (1944) proposed that haemorrhages causing the formation of blood spots in eggs occur before ovulation. Meat spots result from the transformation of blood clots under the influence of changes in pH and high environmental temperatures either prior to or during egg formation or even after the egg is laid.

The fact that the management of the laying flock has some effect on the incidence of blood spots was observed by Jeffrey and Pino (1943). Confinement was noted to reduce the incidence of blood spots. These workers, however, observed that frightening chickens at different hours of the day did not increase the incidence of blood spots in eggs. These researchers also indicated that the incidence of blood spots is dependent primarily on genetic factors.

Several investigators have shown that the incidence of blood spots is influenced to some extent by season. One of the first demonstrations of the seasonal influence on the incidence of blood spots was reported by Lerner and Smith (1942). These workers noted seasonal differences in the incidence of blood spots and suggested that both seasonal and hereditary differences between birds contributed to the variation in the incidence of blood spots. Following this work,

several workers (Jeffrey, 1945; Strain and Johnson, 1957; and Froning and Funk, 1958) have shown seasonal differences in the incidence of blood and meat spots.

With regard to the breed differences in the occurrence of blood and meat spots, the observations vary somewhat. Brant et al. (1953) and Dawson et al. (1954) observed that the percentage of blood spots was much less in White Leghorn hens as compared with the heavy breeds. King and Hall (1955), however, observed that the White Leghorn hens have a higher incidence of blood spots than the heavier breeds. Amer (1961) noted breed differences in the incidence of both blood and meat spots. The Fayoumi breed had a higher incidence of blood and meat spots than the Rhode Island Red; and the Rhode Island Red a higher incidence of blood and meat spots than the White Leghorn hens.

Fertility and Hatchability

Lamoreux (1940) reported that the hens which laid at a more rapid rate produced a lesser number of infertile eggs than the hens producing at a lower rate. The fertility was significantly lower in hens laying in clutches of one to three eggs than those having larger clutch sizes. This worker suggested that this high level of infertility in low producing hens was due to less frequent copulation.

Jull and Hynes (1925) concluded that the egg shape and egg weight, when normal eggs are involved, do not affect the

hatching quality. Thus the selection of eggs for incubation purposes according to shape and egg weight cannot be expected to affect the hatching results. Funk (1934) reported that eggs laid in the afternoon had significantly higher hatchability than the eggs laid in the morning. Byerly (1938) observed that the hatchability at 97°F., 99¾°F. and 102½°F. was 49.4, 85.3 and 24.3 percent, respectively. The relative decrease in hatchability due to abnormal temperature was only slightly less for eggs from females whose eggs showed low hatchability at normal temperature. The lower hatchability at both of the abnormal temperatures of 97°F. and 102½°F. was reported to cause excessive mortality at different stages of embryonic development. A large incidence of malposition was observed in both low and high temperature groups. Rajab et al. (1955) reported a higher hatchability for crossbreds between White Leghorn and Baladi than both purebred hens. The average hatchability percent was 58.4 for Baladi, 46.5 for White Leghorn and 61.7 for a cross between the two breeds. A continuous decrease in hatchability of White Leghorn eggs was observed year after year.

Heywang (1944) obtained data on the fertility and hatchability of eggs of White Leghorn pullets kept under normal environmental temperatures. A decline in both fertility and hatchability was noticed with the increase in environmental temperatures. The fertility and hatchability of the eggs laid at 101.8° and 106.8°F. was significantly lower than the

fertility and hatchability of the eggs laid at the average maximum temperatures of 82.8, 86.2 and 93.0°F. Hafez and Kamar (1955) conducted extensive studies to observe seasonal variations in fertility, mortality and hatchability of Fayoumi eggs. These workers reported the following results.

(i) Minimum fertility was observed in August while the maximum fertility occurred during April.

(ii) The average fertility during Spring, Summer, Autumn and Winter was 87, 72, 80 and 91 percent, respectively.

(iii) Minimum hatchability was observed in June and maximum during July and December.

(iv) Minimum seasonal hatchability was noticed during the Summer and maximum during the Winter.

(v) The percent embryo mortality was low during September and high during June.

(vi) The atmospheric temperature had more effect on fertility than the relative humidity while the hatchability was affected by relative humidity independent of the atmospheric temperature.

Mortality

Carver and Hougan (1935), sexed White Leghorn chicks to study the sexual differences in mortality, observed that the total mortality, all of which occurred in the first week

of life, for the females was one percent while in males it was two percent. O'Neil (1950) reported those chicks hatching with the highest percentage of the original weight of the egg had a lower rate of mortality than the smaller chicks.

It has been established that certain breeds differ from others in their ability to withstand unfavorable environmental conditions. Rajab et al. (1955) observed differences in mortality of White Leghorn, Baladi and cross of these two breeds until six months of age. The results of this study revealed the lowest mortality rate for Baladi and the highest mortality rate for pure White Leghorn. Nordskoj and Phillips (1960) obtained reciprocal crosses from matings of Leghorns, Rhode Island Red, New Hampshire, White Rock and Fayoumi. These research workers reported that pure Fayoumi had less mortality as compared with the Leghorn, and the heavier breed crosses. The total adult mortality of the Fayoumi breed was 15 percent from all causes as compared with 19 and 22 percent for the White Leghorn strain crosses and the heavy breed crosses, respectively. About two-thirds of the Fayoumi adult mortality was due to prolapse.

## MATERIALS AND METHODS

Three experiments were conducted at the Agricultural Research and Education Center of the American University of Beirut between July, 1963 and July, 1964. The Center is located in the Bekaa Valley of Lebanon about 80 kilometers from Beirut at an elevation of about 1000 meters. The Valley is one of the major poultry production areas in Lebanon.

To start this study, one hundred eggs of each of the Egyptian Baladi and Fayoumi breeds were imported from the Faculty of Agriculture, Cairo University, U.A.R. Another one hundred eggs of an adapted Babcock strain of White Leghorn were purchased from a local hatchery. The eggs of the three breeds were incubated on January 4, 1963, and chicks hatched on January 25, 1963 were raised to maturity under identical conditions of feeding and management. These pullets were used for the production period trial and the chicks hatched from the eggs of these pullets were used for the growing period trials.

### Growing Period Experiments

Chicks from the three breeds (White Leghorn, Egyptian Baladi and Fayoumi) were used for two trials conducted during

the growing period. All chicks were started in wire-floored thermostatically-controlled 5-deck brooder batteries. The temperature of the brooding batteries was maintained at 95°F during the first week of the experiment and subsequently lowered by 5°F weekly until the end of the brooding period. At this time, the chicks were transferred to wire-floored nonheated 4-deck growing batteries for the remaining 8 weeks of the experiment. Light was distributed uniformly among the different decks by the use of side wall bulbs. All chicks were vaccinated with a Newcastle disease water-vaccine at 4 days of age and with a wing-web vaccine at 5 weeks of age.

The ration was formulated according to the analysis table for feed ingredients compiled by Hubbell (1963). The ration used in Experiment 1 was mixed in a locally built 50-pound batch mixer, while the ration used in the second trial was mixed in 100-pound batches in a Brower Whirl-Wind feed mixer. Feed and water were supplied ad libitum. Feeders were kept half-full to avoid wastage. Any bird showing signs of illness was isolated, but was fed from the respective feed can. Deaths were recorded and dead chicks examined to determine possible causes.

The chicks of the three breeds were wing banded and weighed at the start of the trials and subsequently at 2-week intervals. All chicks were raised to 12 weeks of age. Prior to the weighing of each chick, all feed uneaten was removed and weighed. The average feed consumption per bird

for each period was calculated from the total amount of feed supplied to the group minus the weight of the unconsumed feed, corrected to allow for the estimated weight of the feed consumed by any chick which had died during the period. The sex was recorded for each bird as soon as it could be distinguished morphologically to enable average weights and weight gains to be calculated for each sex. The efficiency of feed utilization was calculated by dividing the average corrected weight of feed consumed by the average live weight gain during the same period. The total efficiency of feed utilization to the end of the experiment was calculated by dividing the average feed consumed by the average live weight gains made throughout the experimental period.

Production Period Experiment

Single Comb White Leghorn, Egyptian Baladi and Fayoumi pullets and cockerels reared under identical conditions of feeding and management were available at the start of this trial. These birds were used to determine and to compare the production traits of the three breeds.

The birds were weighed and leg banded at the start of the experiment and were kept in adjoining deep litter pens of the same poultry house. The ration was formulated and mixed in a similar way as mentioned for chicks of Experiment 2. The feeding and management were kept as uniform as possible for the three breeds throughout the experimental period. The

birds were fed ad libitum a balanced ration and were provided with fresh water at all times. Light was provided 14 hours a day. Tin floor nests with clean nesting material were provided in each pen. Any death occurring during the study period was recorded and a post-mortem examination was performed to determine the cause of death.

The experimental period was divided into thirteen 28-day periods. Daily egg production records were kept for each breed and percent egg production on a hen day basis was calculated. As individual egg production records were not obtained, the average age at reaching 50% production was recorded for making comparison among the three breeds. The average feed consumption was calculated from the total amount of feed consumed after correcting for the estimated weight of the feed consumed by any bird that died during the period. Feed required per dozen of eggs was calculated by dividing the corrected weight of feed consumed by the dozens of eggs produced during the period.

The eggs were collected three times a day at 4-hour intervals and held at 50-55°F in a holding room until the following day when quality measurements were made. Quality measurements were made for three consecutive days during each 28-day period. The length and width of the eggs were measured to the nearest 0.1 cm. for shape index determination. Shape index was calculated as follows:

$$\frac{\text{Greatest width}}{\text{Greatest length}} \times 100$$

Egg weights were obtained to the nearest of 0.1 of a gram on a torsion balance. Subsequently the eggs were broken with a sharp edged spoon and contents were placed on a glass plate supported by a wooden stand with a mirror underneath to observe the underside of the eggs for blood and meat spots. A spot was considered as a "blood spot" only when they were bright red in color. All other spots were recorded as "meat spot".

The albumen height was taken with a tripod "Ames" micrometer to the nearest 0.1 mm. and recorded. Albumen height and egg weight in grams were used to compute Haugh Units. A circular calculator described by Kilpatrick, Brant and Shrader (1958) was used for computing the Haugh Unit Score.

The yolk was freed from the different layers of the albumen and two chalazae without breakage of the yolk sac and weighed to the nearest 0.1 gram in a dry basin which was cleaned after weighing each yolk. The shell was carefully cleaned to remove the remains of the albumen using a paper towel, and weighed with the shell membranes intact. The weight of the albumen was calculated by subtracting the weight of the yolk and the shell from the total egg weight. Percentages were calculated for each component of the eggs for the three breeds. Shell thickness was measured with a paper gauge having rounded contact points, accurate to 1/1000 inches.

For fertility and hatchability data, the eggs of the three breeds were collected for seven days during each 28-day period. The eggs were placed in an egg holding room at a temperature of 50-55°F. Before incubating, the eggs were examined and those showing cracks or other defects were removed. The eggs were set in a 6000 total eggs capacity Petersime incubator operated at a temperature of 100°F and a wet bulb reading of 85°F humidity. The eggs were tested for fertility on the 18th day of incubation by an electric candling device fixed on a table in the incubator room. Hatchability was determined from the number of chicks hatched on the 21st day of incubation. The fertility and hatchability percentages were determined for each breed and comparisons were made on a seasonal basis. The seasons were considered as follows: Winter, from December to February; Spring, from March to May; Summer, from June to August; and Autumn from September to November.

The birds of the three breeds were finally weighed on the last day of the study to observe the gains or losses made in body weights during the experimental period.

To analyse the data, appropriate statistical methods were employed. The 12 week body weight gains, feed consumption and feed efficiency, egg weight, egg shape index, percentages of various egg components, Haugh Unit Score and shell thickness were analysed by employing the analysis of variance. The Chi-square method was used for the statistical analysis of

fertility, hatchability, chick and adult mortality, and blood and meat spot data. Simple correlation coefficients were calculated for certain production and egg quality traits. The regression equation of feed per unit gain on age was calculated from the general equation as follows:

$$\hat{y} = a + bx$$

where,

$a = \bar{y} - b\bar{x}$

y = dependent variable - feed per unit gain

b = partial regression of feed per unit gain on age

x = independent variable - age.

## RESULTS AND DISCUSSION

### Growing Period

#### Experiment 1

This experiment was conducted to study and compare growth rate, feed consumption, feed efficiency and mortality among White Leghorn, Egyptian Baladi and Fayoumi chicks raised to 12 weeks of age. The study was made from November 15, 1963 to February 7, 1964.

Thirty, one-day old, chicks from each breed were randomly assigned to two groups of approximately equal weights. The composition of the ration fed to chicks throughout the experimental period is shown in Table 1.

The production data reported are based upon observations from twenty-nine (14 males and 15 females) White Leghorn, thirty (16 males and 14 females) Egyptian Baladi and twenty-nine (14 males and 15 females) Fayoumi chicks. The results of growth rate, feed consumption, feed efficiency and mortality are presented in Tables 2-4 and 7. The analysis of variance for body weight gains, feed consumption and feed efficiency are given in Tables 5 and 6.

Simple correlations have been computed between body weights at one day of age and body weights at 12 weeks of age and between feed required per unit gain and age for the three

Table 1 - Composition of the chick ration - Experiments 1 and 2.

| Ingredients | % |
|---|---|
| Yellow corn | 67 |
| Soybean oil meal (44% protein) | 16 |
| Peanut oil meal (47% protein) | 5 |
| Alfalfa meal (17% protein) | 1 |
| Bone meal | 1 |
| Chick concentrate[1] | 10 |
| Calculated analysis* (%) | |
| Protein | 21.26 |
| Fat | 3.00 |
| Fiber | 3.96 |
| Calcium | 0.95 |
| Phosphorus | 0.79 |
| Productive energy (Cal/lb) | 974 |

* Calculated from the analysis table for feed ingredients compiled by C.H. Hubbell, 1963.

[1] Chick concentrate furnishes the following nutrients according to the specifications of the manufacturers: Protein, 58.0% (both from animal and vegetable sources); oil, 3.0%; fiber, 2.5%; calcium, 6.4%; phosphorus, 3.7%; sodium chloride, 4.0%; and productive energy, 1650 Cal./kilo.
It also supplies the following vitamins and minerals per kilogram:
Vitamin A, 60,000 I.U.; vitamin $D_3$, 15,000 I.U.; riboflavin, 44 mg.; nicotinic acid, 242 mg.; pantothenic acid, 55 mg.; choline, 5390 mg.; vitamin $B_{12}$, 110 mcg.; iron, 200 mg.; copper, 20 mg.; manganese, 500 mg.; iodine, 20 mg.; cobalt, 10 mg.; and zinc, 500 mg.

breeds (Appendix). The regression equation of feed required per unit gain on age was calculated and the regression line is shown in Figure 1.

Body Weights

Body weights at 2-week intervals are presented in Table 2. The mean body weight of the White Leghorn birds at hatching was 36.0 grams while those of the Egyptian Baladi and Fayoumi chicks were 29.5 and 29.0 grams, respectively. The lighter weights of the Egyptian Baladi and Fayoumi chicks at hatching were mainly due to smaller egg size. The influence of egg size on body weights decreased rapidly after about 2 weeks of age. Similar results of the influence of egg size on hatching weight have been reported by many earlier investigators (Halbersleben and Mussehl, 1921; Upp, 1928; Godfrey et al., 1953; Kamal and Mostageer, 1963).

At 2 weeks of age the Egyptian Baladi males were heavier than the White Leghorn and Fayoumi male chicks and this superiority in body weight was maintained until 8 weeks of age. The White Leghorn female chicks, however, were heavier than the female chicks of the other two breeds until the 4th week of age after which the Egyptian Baladi females had heavier body weights. After 8 weeks of age both male and female White Leghorn chicks were heavier than the male and female chicks of the other two breeds. The Fayoumi chicks had the lightest weight during the entire 12-week period.

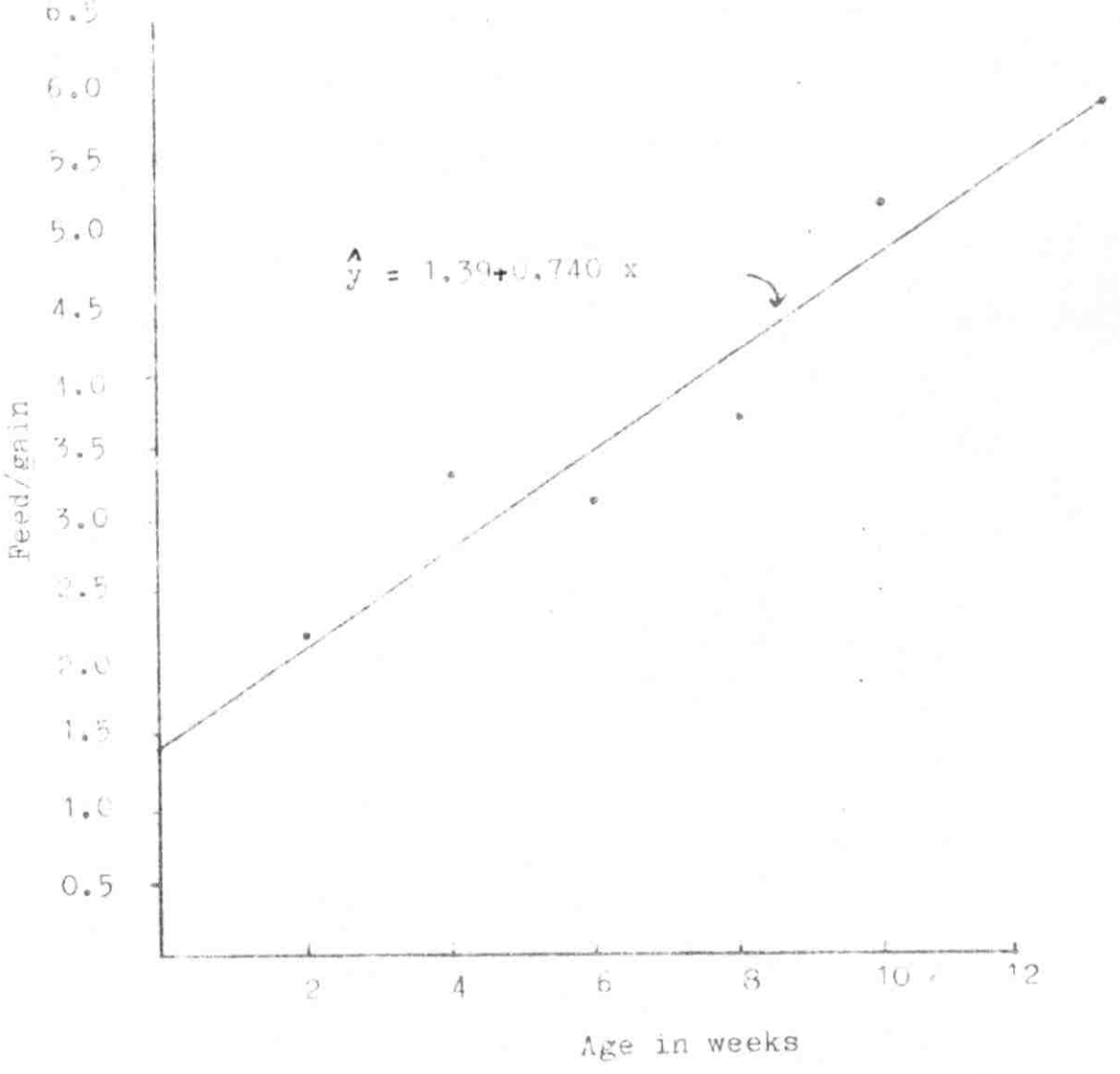


Figure 1 - Regression of feed/gain on age - Experiment 1.

Table 2 - Comparison of body weights (gms.) at 2-week intervals among White Leghorn, Egyptian Baladi and Fayoumi chickens - Experiment 1.

| Age | White Leghorn | | | Egyptian Baladi | | | Fayoumi | | |
|---|---|---|---|---|---|---|---|---|---|
| | Males | Females | Average | Males | Females | Average | Males | Females | Average |
| One day | 37.2 | 35.0 | 36.0 | 29.6 | 29.3 | 29.5 | 29.0 | 28.9 | 29.0 |
| 2 weeks | 105.6 | 102.1 | 103.8 | 106.9 | 99.4 | 103.4 | 92.7 | 86.7 | 89.5 |
| 4 weeks | 259.5 | 244.6 | 251.8 | 260.4 | 232.8 | 247.5 | 223.8 | 199.9 | 211.0 |
| 6 weeks | 464.1 | 403.6 | 432.8 | 469.9 | 409.9 | 441.9 | 392.1 | 348.7 | 368.9 |
| 8 weeks | 730.7 | 621.3 | 674.1 | 733.3 | 625.3 | 682.9 | 621.4 | 517.7 | 567.8 |
| 10 weeks | 978.7 | 808.5 | 890.7 | 951.1 | 770.6 | 866.9 | 788.9 | 655.2 | 719.7 |
| 12 weeks | 1230.3 | 1023.0 | 1123.1 | 1176.9 | 973.6 | 1082.1 | 996.7 | 796.3 | 893.0 |

In general, the male chicks were heavier than the female chicks of the respective breeds and these differences in body weights between two sexes increased as the birds grew older. The female chicks of the White Leghorn, Egyptian Baladi and Fayoumi breeds weighed 83.1, 82.7 and 79.8 percent of the weights of the male chicks of the respective breeds at 12 weeks of age. The average body weight of the White Leghorn, Egyptian Baladi and Fayoumi chicks at 12 weeks of age was 1123.1, 1082.1 and 893.0 grams, respectively. Furthermore, no significant relationship was found between body weights at one day of age and body weights at 12 weeks of age for the chicks of the three breeds (Appendix).

The body weights obtained in this study are considerably higher than those reported by many workers under Egyptian conditions (Badreldin et al., 1961; Kamal and Mostageer, 1963; Kamar and Sami, 1964). Another point of interest revealed by this study is the superiority of the Egyptian Baladi over the Fayoumi chicks in body weights at all stages of the experiment. Badreldin et al. (1961) and Kamar and Sami (1964), however, reported that the Fayoumi chicks were heavier than the Baladi chicks at all stages from 0-12 weeks of age. These differences in body weights may be attributed to differences in locality, managerial conditions or to the nutritive value of the feed. Moreover, these results together with the findings of the Egyptian workers could possibly suggest differences in responses to different environmental

conditions.

Relative Growth Rate

During the first half of the experiment, no breed continuously had the highest relative growth rate. The highest relative growth rate during the first two weeks was manifested by the Egyptian Baladi chicks, during the second 2-week period by the White Leghorn and during the third 2-week period again the Egyptian Baladi had the highest relative growth rate. However, after the third 2-week period, the White Leghorn chicks consistantly had the highest relative growth rate (Table 3). The Fayoumi chicks had the slowest relative growth rate during all of the age intervals with the exception of the first when the White Leghorn chicks exhibited a slower growth rate. However, during the entire 12-week period, the Egyptian Baladi had the highest relative growth rate (189.4) followed by the White Leghorn (187.6) and Fayoumi (187.4) chicks (Table 3).

During the first weeks of life, the growth rate is affected by the nutrients obtained from the egg. The higher growth rate observed in the Egyptian Baladi and Fayoumi chicks during the first few weeks could be due to higher percentage of yolk in the egg of these breeds. These results are in agreement with the findings of Kamar and Mostageer (1963) who also observed a faster growth rate during the first two weeks of life by Fayoumi chicks than by White Leghorn chicks.

Table 3 - *Comparison of the relative growth rate at 2-week intervals among White Leghorn, Egyptian Baladi and Fayoumi chickens - Experiment 1.

| Age (weeks) | White Leghorn | | | Egyptian Baladi | | | Fayoumi | | |
|---|---|---|---|---|---|---|---|---|---|
| | Males | Females | Average | Males | Females | Average | Males | Females | Average |
| 0-2 | 95.8 | 97.9 | 97.0 | 113.3 | 108.9 | 111.2 | 104.7 | 100.0 | 102.1 |
| 2-4 | 84.3 | 82.2 | 83.2 | 83.5 | 80.3 | 82.1 | 82.8 | 79.0 | 80.9 |
| 4-6 | 56.6 | 49.1 | 52.9 | 57.4 | 55.1 | 56.4 | 54.6 | 54.2 | 54.5 |
| 6-8 | 44.6 | 42.5 | 43.6 | 43.8 | 41.6 | 42.8 | 45.2 | 39.0 | 42.5 |
| 8-10 | 29.0 | 26.2 | 27.7 | 25.9 | 20.8 | 23.7 | 23.7 | 23.4 | 23.6 |
| 10-12 | 22.8 | 23.4 | 23.1 | 21.2 | 23.3 | 22.1 | 23.3 | 19.4 | 21.5 |
| 0-12 | 188.3 | 186.6 | 187.6 | 190.2 | 188.3 | 189.4 | 188.7 | 186.0 | 187.4 |

* $\frac{W_2-W_1}{\frac{1}{2}(W_1+W_2)}$ (Brody, 1949)

Where, $W_1$ = initial weight

$W_2$ = final weight.

The faster growth rate in White Leghorn chicks during the latter half of the study could be attributed to differences in body weights at sexual maturity. Godfrey et al. (1953) reported that the influence of mature body size on body weight was stronger than the effect of age at sexual maturity.

In general, the male chicks grew faster than the female chicks of the respective breeds. Similar sex differences in relative growth rate have also been observed by many earlier investigators (Asmundson and Lerner, 1933; Lemasurier and Branion, 1939; Titus, 1955; Kamal and Mostageer, 1963). These sex differences could be due to hormonal differences between the two sexes. It is also evident from these data that the relative growth rate decreased as the birds grew older and that the decrease was faster in the latter half than in the earlier half of the experimental period.

Weight Gains

For all breeds, rapid and steady increases occurred in body weights during all age intervals (Table 4). The gains in weight at 2-week intervals showed a progressive increase until the fourth 2-week period. Thereafter, the increase in successive gains was not consistant. The total gain during the entire experimental period was greatest for the White Leghorn (1087.1 gms.), intermediate for the Egyptian Baladi (1052.6 gms.) and least for the Fayoumi (864.0 gms.) chicks. Male chicks of the White Leghorn, Egyptian Baladi and Fayoumi

Table 4 - Comparison of the live weight gains and the feed per unit of gain at 2-week intervals among White Leghorn, Egyptian Baladi and Fayoumi chickens - Experiment 1.

| Period (weeks) | Breeds | Average live weight gain (gms.) | | | Average feed consumption (gms.) | Feed/ gain |
|---|---|---|---|---|---|---|
| | | Males | Females | Average | | |
| 0-2 | W.L.[1] | 68.4 | 67.1 | 67.8 | 148.4 | 2.19 |
| | E.B.[2] | 77.3 | 70.1 | 73.9 | 155.1 | 2.10 |
| | F[3] | 63.7 | 57.8 | 60.5 | 136.2 | 2.25 |
| 2-4 | W.L. | 153.9 | 142.5 | 148.0 | 469.6 | 3.17 |
| | E.B. | 153.5 | 133.4 | 144.1 | 506.9 | 3.52 |
| | F | 131.1 | 113.2 | 121.5 | 401.0 | 3.30 |
| 4-6 | W.L. | 204.6 | 159.0 | 181.0 | 547.9 | 3.03 |
| | E.B. | 209.5 | 177.1 | 194.3 | 643.2 | 3.31 |
| | F | 168.3 | 148.8 | 157.9 | 484.3 | 3.07 |
| 6-8 | W.L. | 266.6 | 217.7 | 241.3 | 829.7 | 3.44 |
| | E.B. | 263.4 | 215.4 | 241.0 | 892.9 | 3.70 |
| | F | 229.3 | 169.0 | 198.9 | 782.8 | 3.94 |
| 8-10 | W.L. | 248.0 | 187.2 | 216.6 | 1088.0 | 5.02 |
| | E.B. | 217.8 | 145.3 | 184.0 | 1082.0 | 5.88 |
| | F | 167.3 | 137.5 | 151.9 | 931.5 | 6.13 |
| 10-12 | W.L. | 251.6 | 214.5 | 232.4 | 1295.4 | 5.57 |
| | E.B. | 225.8 | 203.0 | 215.2 | 1278.8 | 5.94 |
| | F | 207.8 | 141.1 | 173.3 | 1038.5 | 5.99 |
| 0-12 | W.L. | 1193.1 | 988.0 | 1087.1 | 4379.1 | 4.03 |
| | E.B. | 1147.3 | 944.3 | 1052.6 | 4558.9 | 4.32 |
| | F | 967.7 | 767.4 | 864.0 | 3774.2 | 4.37 |

1 White Leghorn.

2 Egyptian Baladi.

3 Fayoumi.

breeds gained more weight than the female counterparts during each 2-week interval (Table 4).

These data on live weight gains were analysed statistically and the results are shown in Table 5. Significant differences were found among live weight gains of chicks of the three breeds (P = .01). Significant differences in body weight gains were also found between sexes (Table 5). Male chicks made significantly higher body weight gains than female chicks during the entire experimental period (P = .01).

Feed Consumption and Feed Efficiency

Average feed consumption and feed efficiency was calculated for each breed and the results summarized (Table 4). It is apparent from these data that feed consumption increased as the birds grew older. The Egyptian Baladi chicks consumed the largest amount of feed during the first eight weeks while the White Leghorn chicks had the highest feed consumption during the last four weeks of the experimental period. However, for the entire 12-week period, the Egyptian Baladi consumed 279.8 and 784.7 grams more feed than the White Leghorn and Fayoumi chicks, respectively. The average feed consumption values obtained in this study are higher than those reported by Kamal and Mostageer (1963). These differences in feed consumption may be attributed to differences in locality, growth rates and palatability of the rations.

The feed efficiency data suggested that the chicks

were very efficient in feed utilization during the early weeks of life. As the birds grew older, more feed was required per unit of increase in body weight. This can be explained on the basis of higher growth rate and less feed required for body maintenance during earlier ages. An exception to the above generalization was found in this study during the second 2-week interval when all chicks had poorer feed efficiencies than during the third 2-week period, which was probably due to loss of feed from the feeders. At four weeks of age, the birds were moved to growing batteries, where no further feed wastage occurred, and with an increase in age more feed was required per unit increase in body weight.

Statistically significant correlations ($P = .01$) were found between age and feed required per unit of gain for the White Leghorn ($r = 0.948$), Egyptian Baladi ($r = 0.934$) and Fayoumi ($r = 0.935$) chicks. These high correlation values substantiate the previous observation that as age increases feed required per unit gain increases. The regression equation of feed per unit gain on age was also calculated and the regression line is shown in Figure 1. The results indicated that for each 2-week increase in the age of the birds an additional 0.740 pounds of feed was required per pound of gain.

The White Leghorn chicks were most efficient in feed utilization except during the first 2-week period when the

Table 5 - Analysis of variance of the live weight gains at 12 weeks of age - Experiment 1.

| Source of variation | d.f. | M.S. |
|---|---|---|
| Between breeds within sex | 4 | 202121* |
| Between sexes within breed | 3 | 301213* |
| Within breeds within sex | 82 | 7478 |

* Significant at 0.01 level of probability.

Table 6 - Analysis of variance of the average feed consumption and feed/gain - Experiment 1.

| Source of variation | d.f. | M.S. | |
|---|---|---|---|
| | | Feed consumption | Feed/ gain |
| Breeds | 2 | 341547* | 0.04020 |
| Replication | 1 | 34202 | 0.01700 |
| Error | 2 | 8750 | 0.02585 |

* Significant at 0.05 level of probability.

Egyptian Baladi chicks were more efficient. The Fayoumi chicks were least efficient in feed utilization which was probably associated with their slower growth rates. On an average for the entire experimental period, the White Leghorn, Egyptian Baladi and Fayoumi chicks required 4.03, 4.32 and 4.37 pounds of feed for each one pound increase in body weight, respectively. These results are in agreement with the findings of Fox and Bohren (1954) and Kamal and Mostageer (1963) who also observed breed differences in feed efficiency and explained these differences in terms of differences in growth rates.

These data on feed consumption and feed efficiency for the entire 12-week period were analysed statistically and results are reported in Table 6. A significant difference ($P = .05$) in feed consumption was found among the breeds while no such difference was found in feed efficiency of chicks of the three breeds. The nonsignificance in feed efficiency was probably due to the fact that the Fayoumi chicks consumed less feed than the faster growing White Leghorn and Egyptian Baladi chicks.

Mortality

Percent viability figures are presented in Table 7. Only two chicks, one White Leghorn and one Fayoumi, died during the course of the experiment. The White Leghorn chick died on the second day of the experiment without showing any observable symptoms of the disease. No lesions were found on

Table 7 - Comparison of the percent viability (0-12 weeks) among White Leghorn, Egyptian Baladi and Fayoumi chicks - Experiments 1 and 2.

| Breeds | Percent viability | |
|---|---|---|
| | Experiment 1 | Experiment 2 |
| White Leghorn | 96.7 | 95.8 |
| Egyptian Baladi | 100.0 | 91.7 |
| Fayoumi | 96.7 | 95.8 |

post-mortem examination. The Fayoumi chick died during the fourth 2-week interval after showing signs of respiratory affection. Congestion of the respiratory tract was observed upon autopsy. The White Leghorn, Egyptian Baladi and Fayoumi chicks showed 96.7, 100.0 and 96.7 percent viability, respectively. The differences in mortality among White Leghorn, Egyptian Baladi and Fayoumi chicks (0-12 weeks of age) were not significant.

Experiment 2

This experiment was conducted to substantiate the information obtained from the first experiment. The experimental period was from February 24, 1964 to May 18, 1964.

Twenty-four, one-day old, chicks from each breed were weighed individually at the start of the experiment and were divided into two groups of approximately equal weights. A completely randomized design was used for this experiment. The composition of the ration fed during this 12-week experimental period was the same as for experiment 1 (Table 1).

The results obtained on the production traits are based on observations from twenty-three (4 males and 19 females) White Leghorn, twenty-two (11 males and 11 females) Egyptian Baladi and twenty-three (15 males and 8 females) Fayoumi chicks. The results of mortality, growth rate, feed consumption and feed efficiency are summarized in Tables 7-10. The analysis of variance for body weight gains is given in Table 11.

Simple correlations have been computed between body weights at one day of age and body weights at 12 weeks of age and between feed required per unit gain and age (Appendix). The regression equation of feed required per unit gain on age was calculated and the regression line is shown in Figure 2.

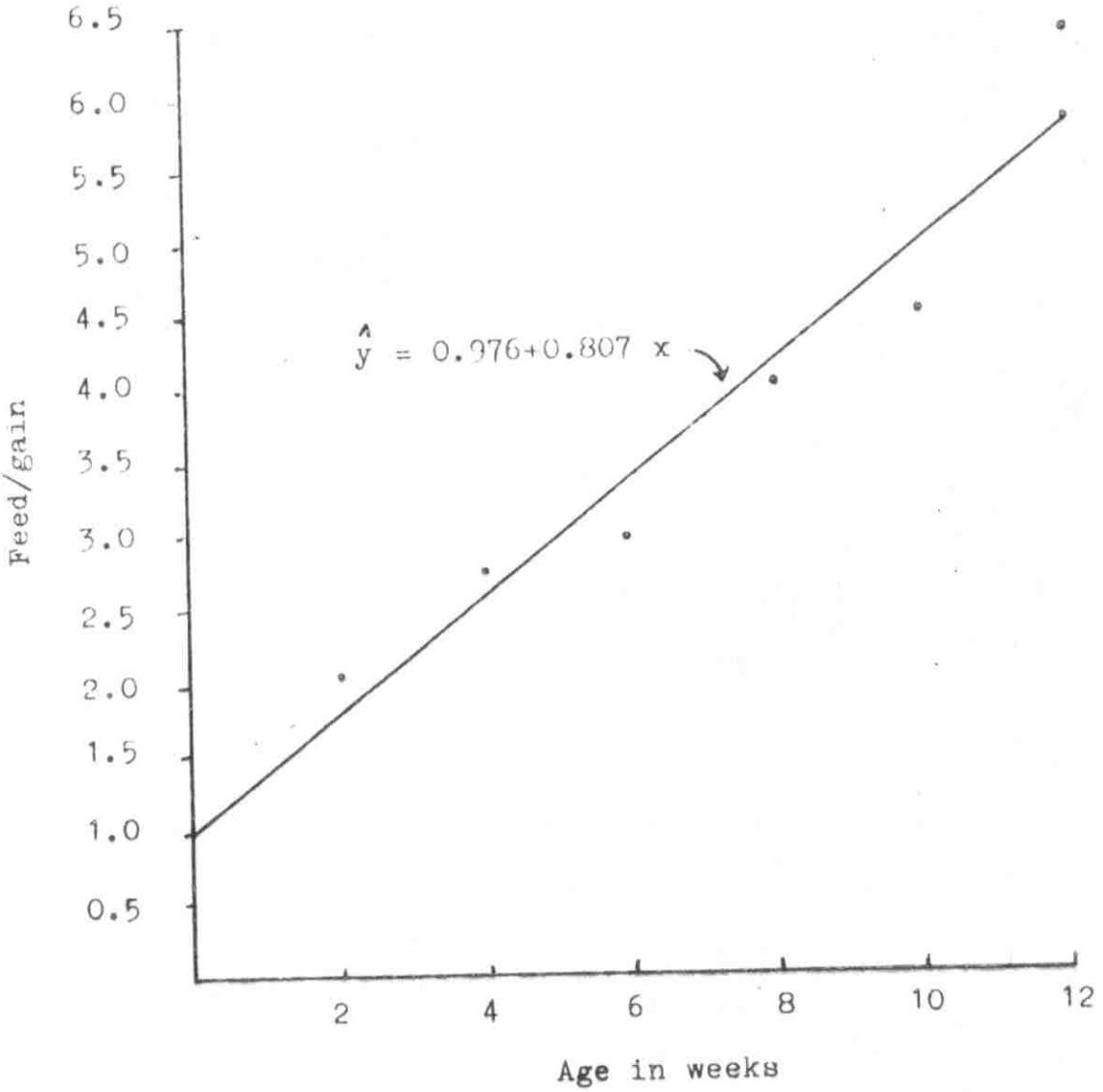


Figure 2 - Regression of feed/gain on age - Experiment 2.

Body Weights

The mean body weights of the White Leghorn, Egyptian Baladi and Fayoumi chicks at hatching were 37.8, 34.1 and 31.8 grams, respectively (Table 8). These live weights at hatching for the three breeds of chicks were heavier than those reported in the first experiment and can be attributed to comparatively larger egg size during this experiment. The difference in egg size between the first and second experiment was mainly due to difference in the age of the hens. The eggs for the first experiment were taken from pullets while those for the second experiment were taken from mature birds. However, the general trend in hatching weight of the chicks was the same as observed in Experiment 1.

Contrary to the findings of the first experiment, the White Leghorn chicks had the heaviest weights during all intervals followed by Egyptian Baladi and Fayoumi chicks (Table 8). The males were heavier than the female chicks of the respective breeds throughout the 12 weeks experimental period. However there was a deviation from the above generalization. The White Leghorn and Fayoumi female chicks were slightly heavier than the male chicks at hatching. The female chicks of the White Leghorn, Egyptian Baladi and Fayoumi breeds weighed 82.6, 77.1 and 79.2 percent of the weight of the male chicks at 12 weeks of age, respectively.

In this experiment, the body weights of male and female

Table 8 - Comparison of body weights (gms.) at 2-week intervals among White Leghorn, Egyptian Baladi and Fayoumi chickens - Experiment 2.

| Age | White Leghorn | | | Egyptian Baladi | | | Fayoumi | | |
|---|---|---|---|---|---|---|---|---|---|
| | Males | Females | Average | Males | Females | Average | Males | Females | Average |
| One day | 36.4 | 38.1 | 37.8 | 35.0 | 33.2 | 34.1 | 31.7 | 32.0 | 31.8 |
| 2 weeks | 121.8 | 111.9 | 114.0 | 113.5 | 101.9 | 107.7 | 98.1 | 100.0 | 98.8 |
| 4 weeks | 287.2 | 259.3 | 265.1 | 271.8 | 238.0 | 254.9 | 229.5 | 225.4 | 228.0 |
| 6 weeks | 538.2 | 482.4 | 494.0 | 500.3 | 430.1 | 466.7 | 436.2 | 404.1 | 424.2 |
| 8 weeks | 838.0 | 700.7 | 724.6 | 731.1 | 601.2 | 668.9 | 659.5 | 585.7 | 631.8 |
| 10 weeks | 1107.0 | 917.6 | 950.5 | 980.4 | 759.2 | 869.8 | 880.7 | 746.6 | 830.4 |
| 12 weeks | 1309.8 | 1082.0 | 1121.6 | 1167.4 | 899.9 | 1033.6 | 1081.0 | 856.4 | 1002.8 |

chicks of the White Leghorn and Fayoumi breeds were heavier than those reported in the first experiment. The Egyptian Baladi chicks had heavier body weights until six weeks of age than in the first experiment, but were lighter in weight at 12 weeks of age (Table 8). These data suggested a difference in seasonal responses by chicks of different breeds.

At 12 weeks of age, the average live weight of White Leghorn, Egyptian Baladi and Fayoumi chicks was 1121.6, 1033.6 and 1002.8 grams, respectively. No significant relationship was found between body weights at one day of age and body weights at 12 weeks of age (Appendix). The average body weights of the White Leghorn, Egyptian Baladi and Fayoumi chicks were considerably higher than those reported by the Egyptian workers (Badreldin et al., 1961; Kamal and Mostageer, 1963; Kamar and Sami, 1964). The weight superiority of the Egyptian Baladi over the Fayoumi chicks as reported in Experiment 1 was maintained. The average body weight of the Fayoumi chicks at 12 weeks of age during this experiment was higher than those reported for the first experiment. The average weight of the White Leghorn and the Egyptian Baladi chicks were slightly lower than those of the first experiment. This difference in average weight at 12 weeks for the Fayoumi and White Leghorn chicks could possibly be attributed to a disproportion of males to females during this experiment and to a seasonal effect. Since there were equal numbers of males and females in the Egyptian Baladi breed, the most likely explana-

tion for the lower weight during this experiment was a difference in season.

Relative Growth Rate

The fastest relative growth rate was noticed in the Egyptian Baladi chicks during the first four weeks of life and in the White Leghorn chicks during the third 2-week period. However after six weeks of age, the Fayoumi chicks consistantly had the highest relative growth rate (Table 9). During the entire 12 weeks period, the Fayoumi chicks had the highest (187.7) relative growth rate followed by the Egyptian Baladi (187.2) and White Leghorn (187.0) chicks. When each sex is considered separately, both male and female White Leghorn chicks had faster growth rates than the male and female of the Egyptian Baladi and the Fayoumi breeds for the entire 12 weeks period. These results indicated that the slower growth rate of the White Leghorn chicks in this experiment was due to a disproportion of males to females (19 females to 4 males). In general, the growth rate decreased as the birds grew older and the male chicks grew faster than female chicks.

Weight Gains

The gains in weight at 2-week intervals showed a progressive increase until the fourth 2-week period for the White Leghorn and Fayoumi chicks, but only to the third 2-week period for the Egyptian Baladi chicks (Table 10). The results of this

Table 9 - Comparison of the relative growth rate at 2-week intervals among White Leghorn, Egyptian Baladi and Fayoumi chickens - Experiment 2.

| Age (weeks) | White Leghorn | | | Egyptian Baladi | | | Fayoumi | | |
|---|---|---|---|---|---|---|---|---|---|
| | Males | Females | Average | Males | Females | Average | Males | Females | Average |
| 0-2 | 108.0 | 98.4 | 100.4 | 105.7 | 101.7 | 103.8 | 102.3 | 103.0 | 102.6 |
| 2-4 | 80.9 | 79.6 | 79.7 | 82.2 | 80.1 | 81.2 | 80.2 | 77.1 | 79.1 |
| 4-6 | 60.9 | 60.2 | 60.3 | 59.2 | 57.5 | 58.7 | 62.1 | 56.8 | 60.2 |
| 6-8 | 43.6 | 36.9 | 37.8 | 37.5 | 33.2 | 35.6 | 40.8 | 36.7 | 39.3 |
| 8-10 | 27.7 | 26.8 | 27.0 | 29.1 | 23.2 | 26.1 | 28.7 | 24.2 | 27.2 |
| 10-12 | 16.8 | 16.4 | 16.5 | 17.4 | 17.0 | 17.2 | 20.4 | 13.7 | 18.8 |
| 0-12 | 189.2 | 186.4 | 187.0 | 188.4 | 185.8 | 187.2 | 188.6 | 185.6 | 187.7 |

Table 10 - Comparison of the live weight gains and the feed per unit of gain at 2-week intervals among White Leghorn, Egyptian Baladi and Fayoumi chickens - Experiment 2.

| Period (weeks) | Breeds | Average live weight gain (gms.) | | | Average feed consumption (gms.) | Feed/ gain |
|---|---|---|---|---|---|---|
| | | Males | Females | Average | | |
| 0-2 | W.L.[1] | 85.4 | 73.8 | 76.2 | 179.7 | 2.36 |
| | E.B.[2] | 78.5 | 68.7 | 73.6 | 189.2 | 2.57 |
| | F[3] | 66.4 | 68.0 | 67.0 | 160.8 | 2.40 |
| 2-4 | W.L. | 165.4 | 147.4 | 151.1 | 378.3 | 2.50 |
| | E.B. | 158.3 | 136.1 | 147.2 | 439.8 | 2.95 |
| | F | 131.4 | 125.4 | 129.2 | 359.4 | 2.78 |
| 4-6 | W.L. | 251.4 | 223.1 | 228.9 | 633.7 | 2.77 |
| | E.B. | 228.5 | 192.1 | 211.8 | 616.8 | 2.91 |
| | F | 206.7 | 178.7 | 196.2 | 624.2 | 3.18 |
| 6-8 | W.L. | 299.8 | 218.3 | 230.6 | 814.1 | 3.53 |
| | E.B. | 230.7 | 171.1 | 202.2 | 888.3 | 4.39 |
| | F | 223.3 | 181.6 | 207.7 | 865.4 | 4.17 |
| 8-10 | W.L. | 269.0 | 216.9 | 225.9 | 917.9 | 4.06 |
| | E.B. | 249.4 | 158.0 | 200.9 | 969.5 | 4.82 |
| | F | 221.2 | 160.9 | 198.6 | 931.6 | 4.69 |
| 10-12 | W.L. | 202.8 | 164.4 | 171.1 | 1046.2 | 6.11 |
| | E.B. | 187.0 | 140.7 | 163.8 | 1140.1 | 6.96 |
| | F | 200.3 | 109.8 | 172.4 | 1041.0 | 6.19 |
| 0-12 | W.L. | 1273.4 | 1043.9 | 1083.8 | 3969.9 | 3.66 |
| | E.B. | 1132.4 | 866.7 | 999.5 | 4243.7 | 4.25 |
| | F | 1049.3 | 824.4 | 971.0 | 3982.5 | 4.10 |

1 White Leghorn.

2 Egyptian Baladi.

3 Fayoumi.

experiment followed the same general trends as that of the first experiment. However the difference in body weight gains between Egyptian Baladi and Fayoumi chicks decreased considerably during this experiment due to reasons already explained. Significant differences (P = .01) were found in live weight gains between breeds and sexes (Table 11).

Feed Consumption and Feed Efficiency

Feed consumption and feed efficiency data are presented in Table 10. It is evident from these data that the average feed consumption increased as the birds grew older. The Egyptian Baladi chicks consumed the largest amount of feed during each 2-week interval with the exception of third 2-week period when the White Leghorn chicks consumed slightly more feed. However, for the entire experimental period, the Egyptian Baladi chicks consumed the largest amount (4243.7 gms.) of feed followed by Fayoumi (3982.5 gms.) and White Leghorn (3969.9 gms.) chicks (Table 10). The average feed consumption values obtained in this experiment were lower for the Egyptian Baladi but higher for Fayoumi chicks than those reported in the first experiment. This decrease in feed consumption by the White Leghorn and Egyptian Baladi chicks in the present study can be attributed to seasonal differences in feed consumption and to a smaller number of male chicks. During the first experiment, comparatively more feed was required to meet the energy requirement of the chicks due to the severe cold

Table 11 - Analysis of variance of live weight gains at 12 weeks of age - Experiment 2.

| Source of variation | d.f. | M.S. |
|---|---|---|
| Between breeds within sex | 4 | 134495* |
| Between sexes within breed | 3 | 275577* |
| Within breeds within sex | 62 | 9091 |

* Significant at 0.01 level of probability.

weather. The average feed consumption of the Fayoumi chicks was higher in the present study which was probably due to a larger number of males and larger gains made both by male and female chicks than those reported for the first experiment. The differences in feed consumption among the three breeds were not significant.

The feed efficiency data in this experiment followed the same general trend as during the first experiment. The chicks were most efficient in feed utilization during the first two weeks of life and as the birds grew older, more feed was required per unit of increase in body weight (Table 10). These results conform with those of Titus (1955) that the young actively growing chicks normally make a larger gain in live weight per unit weight of feed consumed than older chicks.

Significant (P = .01) correlations were found between age and feed required per unit of gain for the White Leghorn (r = 0.917), Egyptian Baladi (r = 0.933) and Fayoumi (r = 0.973) chicks. The regression equation of feed per unit gain on age was calculated and the regression line is shown in Figure 2. The results indicate that for each 2 weeks increase in age of the birds an additional 0.807 pounds of feed is required per pound of gain in body weight.

The White Leghorn birds were the most efficient in feed utilization during each 2-week interval of the experimental period. The Fayoumi chicks were intermediate with the exception of third 2-week period when the Egyptian Baladi chicks

were more efficient in feed utilization. This superiority of Fayoumi over Egyptian Baladi chicks in feed efficiency in this experiment may be due to comparatively higher growth rate and less feed requirement for body maintenance. On an average for the entire experimental period, the White Leghorn, Egyptian Baladi and Fayoumi chicks required 3.66, 4.25 and 4.10 pounds of feed for each pound increase in body weight, respectively. These data indicated that the efficiency of feed utilization of the three breeds was better in this experiment than in the first experiment and can be perhaps attributed to differences in energy requirements for heat during the two experiments.

Mortality

A total of four chicks, one White Leghorn, two Egyptian Baladi and one Fayoumi, died during the experimental period. The percent viability in the White Leghorn, Egyptian Baladi and Fayoumi chicks was 95.8, 91.7 and 95.8, respectively (Table 7). No significant difference was found in mortality among the three breeds.

## Production Period Experiment

This experiment was conducted to study and compare egg production, age at 50 percent production, feed consumption, feed required per dozen eggs, egg quality, fertility, hatchability and laying house mortality among White Leghorn, Egyptian Baladi and Fayoumi breeds of fowls. The study was made for one year from July 3, 1963 to July 2, 1964.

Twenty White Leghorn, twenty-one Egyptian Baladi and twenty-eight Fayoumi pullets were used for this study. The pullets of each breed were housed with five cockerels at the start of the experiment. The composition of the ration fed to the experimental birds is shown in Table 12.

## Egg Production

The comparison of egg production for the three breeds at 28-day intervals is shown in Figure 3. The maximum egg production for the Egyptian Baladi and Fayoumi pullets was reached during the second 28-day period (August) followed by large fluctuations throughout the rest of the year. The White Leghorn pullets, however, reached the maximum rate of egg production during the fifth 28-day laying period (Oct. 23 - Nov. 19). The maximum rate of egg production in White Leghorn, Egyptian Baladi and Fayoumi pullets was 83.2, 68.6 and 52.8 percent, respectively. The minimum egg production rates of 52.1, 26.1 and 25.0 percent for the White Leghorn,

Table 12 - Composition of the laying ration.

| Ingredients | % |
|---|---|
| Yellow corn | 51 |
| Barley | 20 |
| Soybean oil meal (44% protein) | 7 |
| Peanut oil meal (47% protein) | 7 |
| Limestone | 4 |
| Bone meal | 1 |
| Breeder concentrate[1] | 10 |
| **Calculated analysis* (%)** | |
| Protein | 17.16 |
| Fat | 2.71 |
| Fiber | 4.53 |
| Calcium | 2.88 |
| Phosphorus | 0.72 |
| Productive energy (Cal/lb) | 897 |

* Calculated from the analysis table for feed ingredients compiled by C.H. Hubbell, 1963.

[1] Breeder concentrate furnishes the following nutrients according to the specifications of the manufacturer: Protein, 40.0% (both from animal and vegetable sources); oil, 3.0%; fiber, 2.5%; calcium, 10.7%; phosphorus, 3.1%; sodium chloride, 3.5%; and productive energy, 1320 Cal./kilo.
It also supplies the following vitamins and minerals per kilogram:
Vitamin A, 80,000 I.U.; vitamin $D_3$, 10,000 I.U.; riboflavin, 28 mg.; nicotinic acid, 220 mg.; pantothenic acid, 35 mg.; choline, 1900 mg.; vitamin $B_{12}$, 22 mcg.; iron, 200 mg.; copper, 20 mg.; manganese, 500 mg.; iodine, 20 mg.; and cobalt, 10 mg.

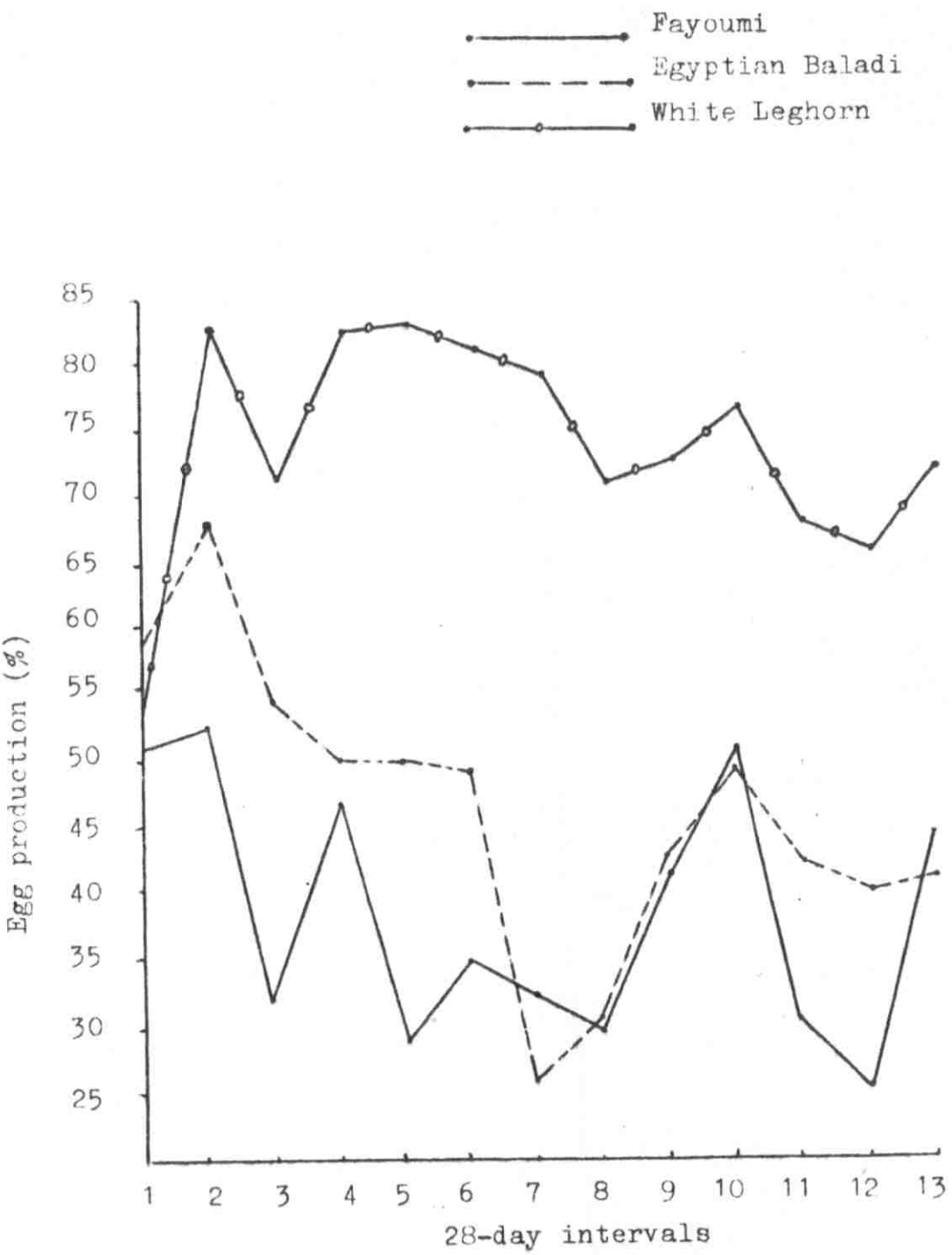


Figure 3 - Comparison of egg production (%) among three breeds of chickens at 28-day intervals.

Egyptian Baladi and Fayoumi pullets were noticed during the first (July), seventh (Dec. 18 - Jan. 14) and twelfth (May 6 - June 2) 28-day period, respectively. Sudden slumps in production were noticed in the Egyptian Baladi and Fayoumi pullets during severe cold weather. The egg production of the Fayoumi pullets was more adversely affected by the cold waves than that of the Egyptian Baladi pullets. These production slumps in the Egyptian Baladi and Fayoumi pullets may be attributed to long winter pauses resulting from the inability of these breeds to withstand the severe cold weather. Another period of decline in egg production for the Egyptian Baladi and Fayoumi pullets was noticed during the eleventh and twelfth periods (April 8 - June 2). The White Leghorn pullets showed high production rate with slight fluctuations during the entire experimental period.

These results do not agree with the findings of Rajab and Assem (1953) who reported that the maximum egg production rate was reached in December and January and minimum in September for the Egyptian Baladi and Fayoumi pullets. The slumps and peaks in egg production during different times of the year could be attributed to differences in climatic conditions between the locality of the present study and those of the Egyptian workers. These results were, however, in agreement with the findings of Bennion and Warren (1933) who reported a decline in egg production following high or low temperatures. Bruckner (1936) also noticed production slumps during sudden

cold waves and indicated that the use of temporary sources of heat gave promise of being a practical method for preventing production slumps.

The average egg production during the experimental period was 271 eggs for the White Leghorn, 170 eggs for the Egyptian Baladi and 141 eggs for the Fayoumi pullets. The average egg production calculated on a hen-day basis for the entire year was 74.0, 46.4 and 38.5 percent for White Leghorn, Egyptian Baladi and Fayoumi pullets, respectively (Table 13). These egg production levels were higher for the Egyptian Baladi and lower for the Fayoumi pullets than those reported by Rajab and Assem (1953) under Egyptian conditions. Moreover, the egg production of the Egyptian Baladi pullets was higher than the Fayoumi in this study as contrasted to a higher egg production of the Fayoumi than the Egyptian Baladi (Rajab and Assem, 1953). These differences may be attributed to differences in strain, locality, nutritive value of the rations and differences in response to climate by the two breeds.

Age at 50 Percent Production

The Fayoumi pullets reached 50 percent production at 165 days of age; the Egyptian Baladi reached 50 percent production slightly later at 166 days of age; and the White Leghorn pullets reached 50 percent production the latest at 172 days of age (Table 13). The average age at 50 percent production observed for Fayoumi pullets in this study is less than that

Table 13 - Comparison of production data among White Leghorn, Egyptian Baladi and Fayoumi breeds during the first laying year.

| Characters studied | Breeds | | |
|---|---|---|---|
| | White Leghorn | Egyptian Baladi | Fayoumi |
| Av. egg production/hen (hen day basis) | 271 | 170 | 141 |
| Av. egg production/hen (%) | 74.0 | 46.4 | 38.5 |
| Av. age at 50% production (days) | 172 | 166 | 165 |
| Feed consumed/day/hen (gms.) | 114.6 | 99.1 | 84.5 |
| Total feed consumed/hen (lbs.) | 92.39 | 79.91 | 68.15 |
| Feed consumed/dozen eggs (lbs.) | 4.10 | 5.63 | 5.80 |
| Av. body weight/hen at 160 days of age (gms.) | 1463.5 | 1388.2 | 1150.4 |
| Av. body weight/hen at 525 days of age (gms.) | 1818.3 | 1631.9 | 1381.2 |
| Av. body weight increase/hen (gms.) | 354.8 | 243.7 | 230.8 |
| Mortality (%) | 15.0 | 14.3 | 3.6 |

reported by Hafez and Kamar (1955). These differences may be due to differences in locality, nutritive value of the feed and growth rate.

Feed Consumption and Feed per Dozen of Eggs

The comparison of the average daily feed consumption and feed required per dozen of eggs for the White Leghorn, Egyptian Baladi and Fayoumi pullets during each period is shown in Figure 4. The feed consumption showed a tendency to increase until the ninth 28-day period followed by a slight decrease. The highest average daily feed consumption occurred during the eighth 28-day period for the White Leghorn (130.4 gms.) and during the ninth 28-day period for the Egyptian Baladi (112.5 gms.) and Fayoumi (99.9 gms.) pullets. In general, there was a tendency for higher feed consumption during the winter months which was probably due to a higher feed requirement for heat production. A slight decrease in feed consumption was noticed after the ninth 28-day period in all breeds due to the advent of warmer weather. These results were in agreement with the findings of Bennion and Warren (1933) who reported 12 percent less feed consumption during high temperatures than during moderate temperatures. The White Leghorn birds consumed the highest amounts of feed during all periods with the exception of the fourth period when the Egyptian Baladi consumed more feed. The Egyptian Baladi showed intermediate feed consumption while the Fayoumi pullets

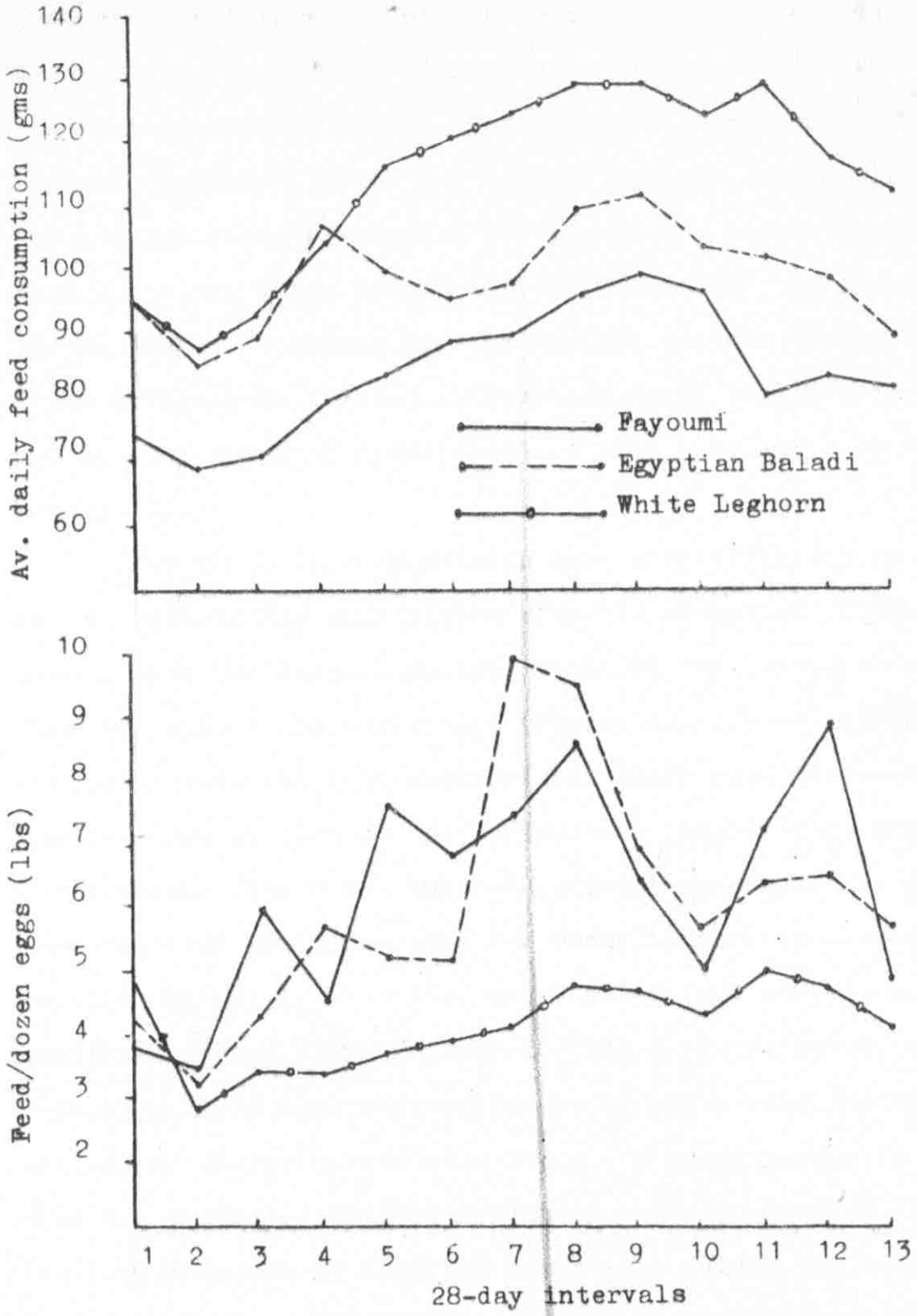


Figure 4 - Comparison of average daily feed consumption and feed/dozen eggs among three breeds of chickens at 28-day intervals.

consumed the lowest amounts of feed during all periods (Figure 4). The average daily feed consumption for the experimental period was 114.6, 99.1 and 84.5 grams for the White Leghorn, Egyptian Baladi and Fayoumi pullets, respectively. The average feed consumption for the entire period was 92.39 pounds for the White Leghorn, 79.91 pounds for the Egyptian Baladi and 68.15 pounds for the Fayoumi pullets (Table 13). These differences in feed consumption among the three breeds may be attributed to differences in body size and rate of egg production.

The White Leghorn pullets were most efficient in producing eggs during each period with the exception of the first period when the Fayoumi pullets required the lowest amount of feed to produce one dozen eggs (Figure 4). These data also indicated that the feed required per dozen eggs decreased with the increase in rate of egg production. Significant negative correlations ($P = 0.01$) between percent egg production and feed required per dozen eggs for White Leghorn ($r = -0.695$), Egyptian Baladi ($r = -0.950$) and Fayoumi ($r = -0.971$) pullets substantiate the above statement. The Egyptian Baladi and Fayoumi pullets were most efficient in egg production during the second 28-day period when their egg production rate was also the highest. The White Leghorn pullets, however, required the lowest amount of feed per dozen eggs during the second period although the production rate was slightly higher during the fifth period. This was probably due to more feed requi-

rement for maintenance during the fifth period as compared with the second period. The Egyptian Baladi and Fayoumi pullets required the largest amount of feed to produce one dozen eggs when the egg production rate was the lowest. The White Leghorn pullets, however, were least efficient in egg production during the eleventh period although the lowest egg production was exhibited during the first period. This could be attributed to larger feed requirement for body maintenance during the eleventh period than the first period due to larger body size.

For the entire experimental period, the White Leghorn pullets were most efficient while the Fayoumi pullets were least efficient in producing eggs. The White Leghorn, Egyptian Baladi and the Fayoumi pullets required an average of 4.10, 5.63 and 5.80 pounds of feed to produce one dozen eggs, respectively (Table 13). These differences in feed efficiency may be attributed to differences in rate of egg production of the three breeds.

Body Weights

The body weights at the start of this experiment were 1463.5, 1388.2 and 1150.2 grams for the White Leghorn, Egyptian Baladi and Fayoumi pullets, respectively (Table 13). These differences could be due to differences in growth rate and age at sexual maturity of the three breeds. The earlier maturing breeds attained sexual maturity at lower weights.

The average weight of the Fayoumi pullets attained in this study was higher than that reported by Hafez and Kamar (1955) and Badreldin et al. (1961) which could be due to differences in locality and nutritive value of the feed.

The average increase in weight was highest for the White Leghorn, intermediate for the Egyptian Baladi and lowest for the Fayoumi pullets during the experimental year. The final weights at the end of the experimental period were 1818.3 grams for the White Leghorn, 1631.9 for the Egyptian Baladi and 1381.2 grams for the Fayoumi pullets (Table 13).

Laying House Mortality

The results indicated that mortality in the Fayoumi pullets was less than in the Egyptian Baladi and the White Leghorn pullets. A total of seven pullets, three White Leghorn, three Egyptian Baladi and one Fayoumi, died during the first laying year. All deaths were due to non specific disorders. The mortality rate was 15.0 percent for the White Leghorn, 14.3 percent for the Egyptian Baladi and 3.6 percent for the Fayoumi pullets. These results are in agreement with the work of Nordskoj and Phillips (1960) who reported that the Fayoumi breed had a lower mortality rate than the White Leghorn and the heavier breeds. However, in this study, the differences in mortality among the three breeds were not significant.

Egg Quality Characteristics

During the experimental period, 526 White Leghorn, 296 Egyptian Baladi and 354 Fayoumi eggs were used to study and compare the egg quality characters of the three breeds (Table 14).

1. Egg Weight

The comparison of the egg weights of the three breeds during each period is shown in Figure 5. The White Leghorn eggs were heaviest, Egyptian Baladi eggs intermediate and the Fayoumi eggs were the lightest in weight during each period. These differences in egg weights were attributed to breed differences in body weights at sexual maturity and inherited capacity of the three breeds

The eggs of the three breeds showed a tendency for rapid increase in weight for the first few periods followed by a gradual increase until the eleventh period (Figure 5). The average egg weight of the White Leghorn pullets increased from a minimum of 47.5 grams during the first period to a maximum of 59.8 grams during the ninth period. The Egyptian Baladi eggs showed an increase from a minimum of 39.5 grams during the first period to a maximum of 52.2 grams egg weight during the tenth period. The egg weight of the Fayoumi pullets increased from a mini-

Table 14 - Comparison of egg quality characters among White Leghorn, Egyptian Baladi and Fayoumi breeds during the first laying year.

| Measurements | Breeds | | |
|---|---|---|---|
| | White Leghorn | Egyptian Baladi | Fayoumi |
| No. of eggs studied | 526 | 296 | 354 |
| Egg weight (gms.) | | | |
| Range | 41.5-72.0 | 34.0-64.6 | 31.4-58.9 |
| Mean | 56.59 | 47.60 | 46.69 |
| Egg components | | | |
| Yolk weight (gms.) | 17.17 | 15.31 | 14.92 |
| Yolk (%) | 30.34 | 32.16 | 31.96 |
| Shell weight (gms.) | 5.88 | 5.53 | 5.51 |
| Shell (%) | 10.39 | 11.62 | 11.80 |
| Albumen weight (gms.) | 33.54 | 26.76 | 26.26 |
| Albumen (%) | 59.27 | 56.22 | 56.24 |
| Shape index | 73.30 | 77.06 | 76.45 |
| Haugh unit score | 75.34 | 77.55 | 81.28 |
| Shell thickness (inches) | 0.0128 | 0.0134 | 0.0138 |
| Blood spots (%) | 6.08 | 0.68 | 5.37 |
| Meat spots (%) | 0.39 | 0.34 | 1.13 |

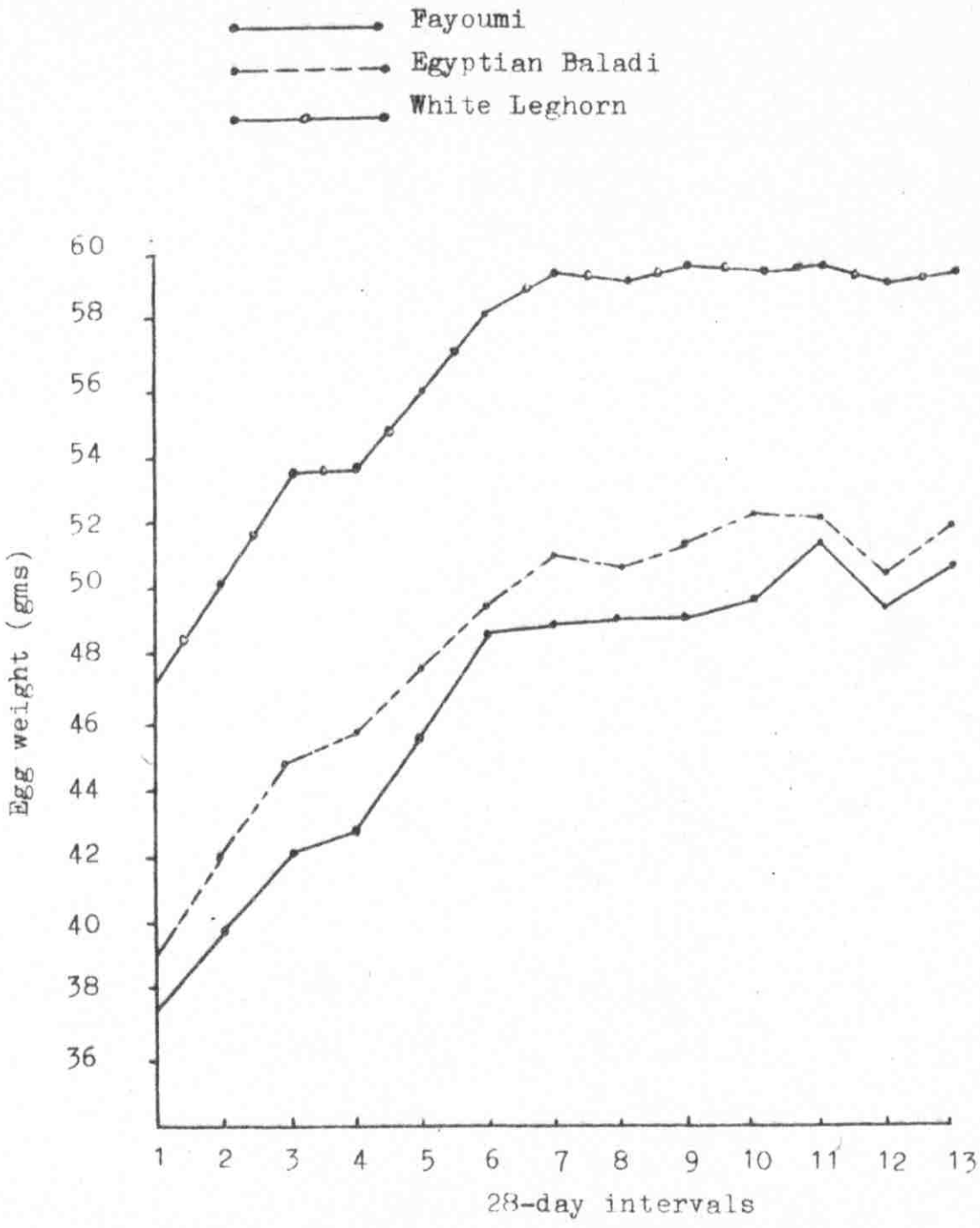


Figure 5 - Comparison of egg weight among three breeds of chickens at 28-day intervals.

mum of 37.5 grams during the first period to a maximum of 51.5 grams during the eleventh period. These results were in agreement with the work of Jull (1924) who reported that earlier maturing birds attained their maximum body and egg weights later than the later maturing birds. The average egg weight did not increase after the ninth, tenth and eleventh period for the White Leghorn, Egyptian Baladi and Fayoumi pullets, respectively. This was probably due to the fact that the birds attained their maximum body weights at these periods, although no data were available to support this explanation. The egg weights of the three breeds showed a slight decrease during the twelfth period (May) but tended to increase again during the thirteenth period (June). These results suggested that the egg weights increased as the birds grew older.

The average egg weight for the entire experimental period was 56.6 grams for the White Leghorn, 47.6 grams for the Egyptian Baladi and 46.7 grams for Fayoumi pullets (Table 14). These differences in egg weight for the White Leghorn, Egyptian Baladi and Fayoumi pullets were significant ($P = 0.01$) (Table 15). The egg weights of the Egyptian Baladi and Fayoumi breeds obtained in this study were higher than those reported by Rajab and Assem (1953). This was expected because of the heavier body weights attained by these breeds under the environmental condition

of this study.

2. Egg Shape

Egg shape was measured by determining the shape index. The comparison of the shape index of the three breeds during each 28-day period is shown in Figure 6. The shape index of the eggs of the three breeds showed slight fluctuations throughout the study period. Great variations were noticed in the shape index of eggs laid by different birds within each breed during each period. This finding agreed with Romanoff and Romanoff (1949) who reported enormous variations in the shape index of eggs laid by a single flock of White Leghorn eggs. The shape index of the three breeds showed a tendency to decrease as the birds grew older. The average shape index for the entire period was 73.30, 76.45 and 77.06 for the White Leghorn, Egyptian Baladi and Fayoumi eggs, respectively (Table 14). These results indicated that the average shape index of the eggs of the White Leghorn pullets was approaching the shape index for a standard egg reported by Romanoff and Romanoff (1949). Significant differences (P = 0.01) were found in the shape index of the three breeds (Table 16). This does not agree with the results of King and Hall (1955) who observed no significant difference in the shape index of the eggs of different breeds.

Table 15 - Analysis of variance of egg weight and egg component percentages during the first laying year.

| Source of variation | d.f. | M. S. | | | |
|---|---|---|---|---|---|
| | | Egg weight | % Yolk | % Shell | % Albumen |
| Between breeds | 2 | 13155.71* | 442.15* | 268.30* | 1353.85* |
| Within breeds | 1173 | 30.14 | 3.57 | 1.13 | 6.03 |

* Significant at 0.01 level of probability.

Table 16 - Analysis of variance of shape index, haugh unit score and shell thickness during the first laying year.

| Source of variation | d.f. | M. S. | | |
|---|---|---|---|---|
| | | Shape index | Haugh unit score | Shell thickness |
| Between breeds | 2 | 1744.60* | 3744.10* | .000116500* |
| Within breeds | 1173 | 13.70 | 61.86 | .000000861 |

* Significant at 0.01 level of probability.

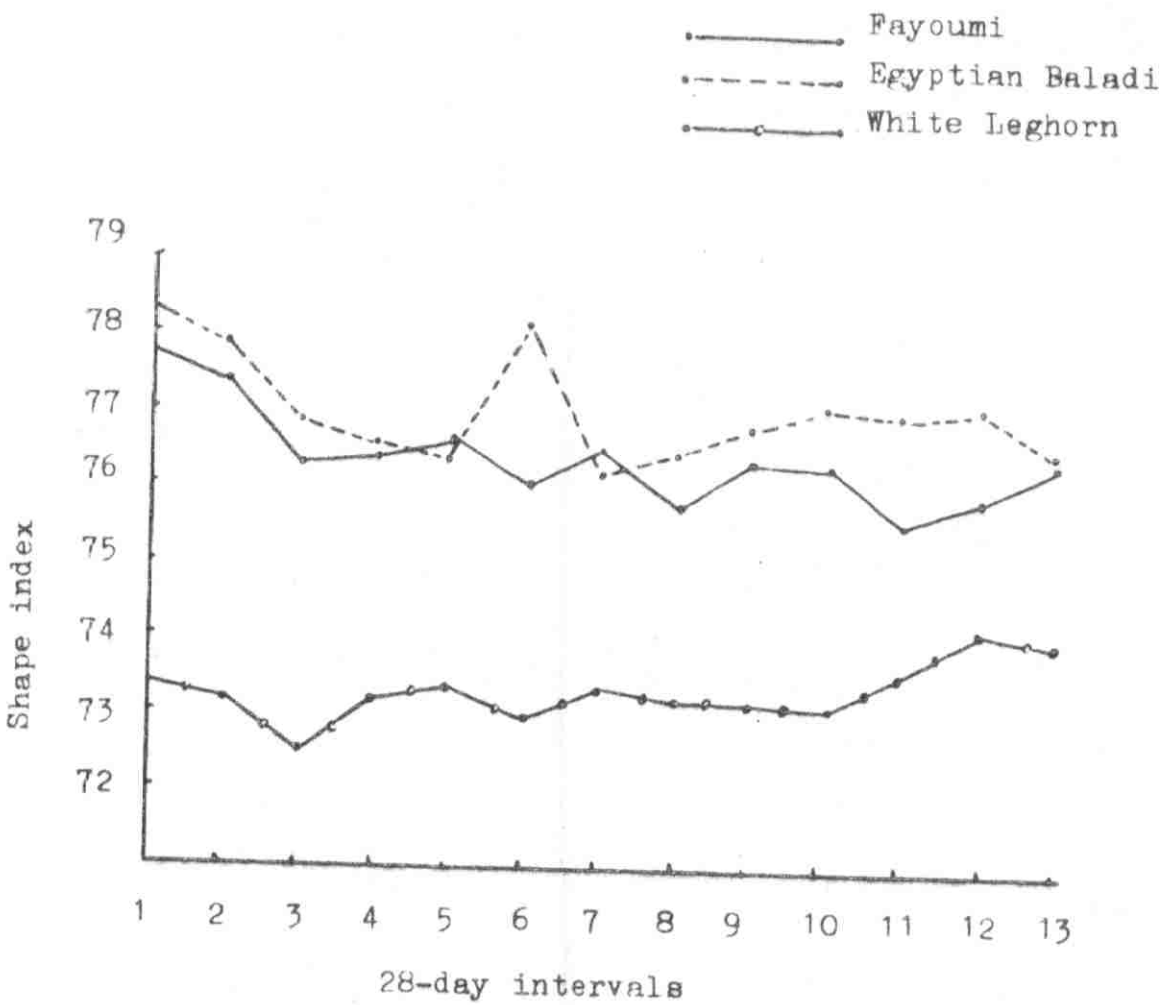


Figure 6 - Comparison of shape index among three breeds of chickens at 28-day intervals.

3. Egg Components

The comparisons of the weights and percentages of the egg components for the White Leghorn, Egyptian Baladi and Fayoumi breeds during each period are shown in Figures 7-9.

a. Yolk

The weight of the yolk was highest for the White Leghorn, intermediate for the Egyptian Baladi and lowest for the Fayoumi pullets during each period (Figure 7). Rapid increases were noticed in the weight of the yolk during the first few periods. In general, the changes in yolk weight corresponded to the changes in the egg weight. The average yolk weight for the White Leghorn, Egyptian Baladi and the Fayoumi pullets was 17.17, 15.31 and 14.92 grams, respectively (Table 14). These differences in yolk weight could be due to differences in egg size of the three breeds. Significant correlation ($P = 0.01$) between egg weight and the weight of the yolk for the White Leghorn ($r = 0.996$), Egyptian Baladi ($r = 0.995$) and Fayoumi ($r = 0.998$) breeds substantiated this opinion. The yolk percentage also showed a tendency to increase throughout the experimental period (Figure 7). These results are in conformity with the work of Cunningham *et al.* (1960) who reported an increase in percent yolk with an increase in age of the birds. The Egyptian Baladi

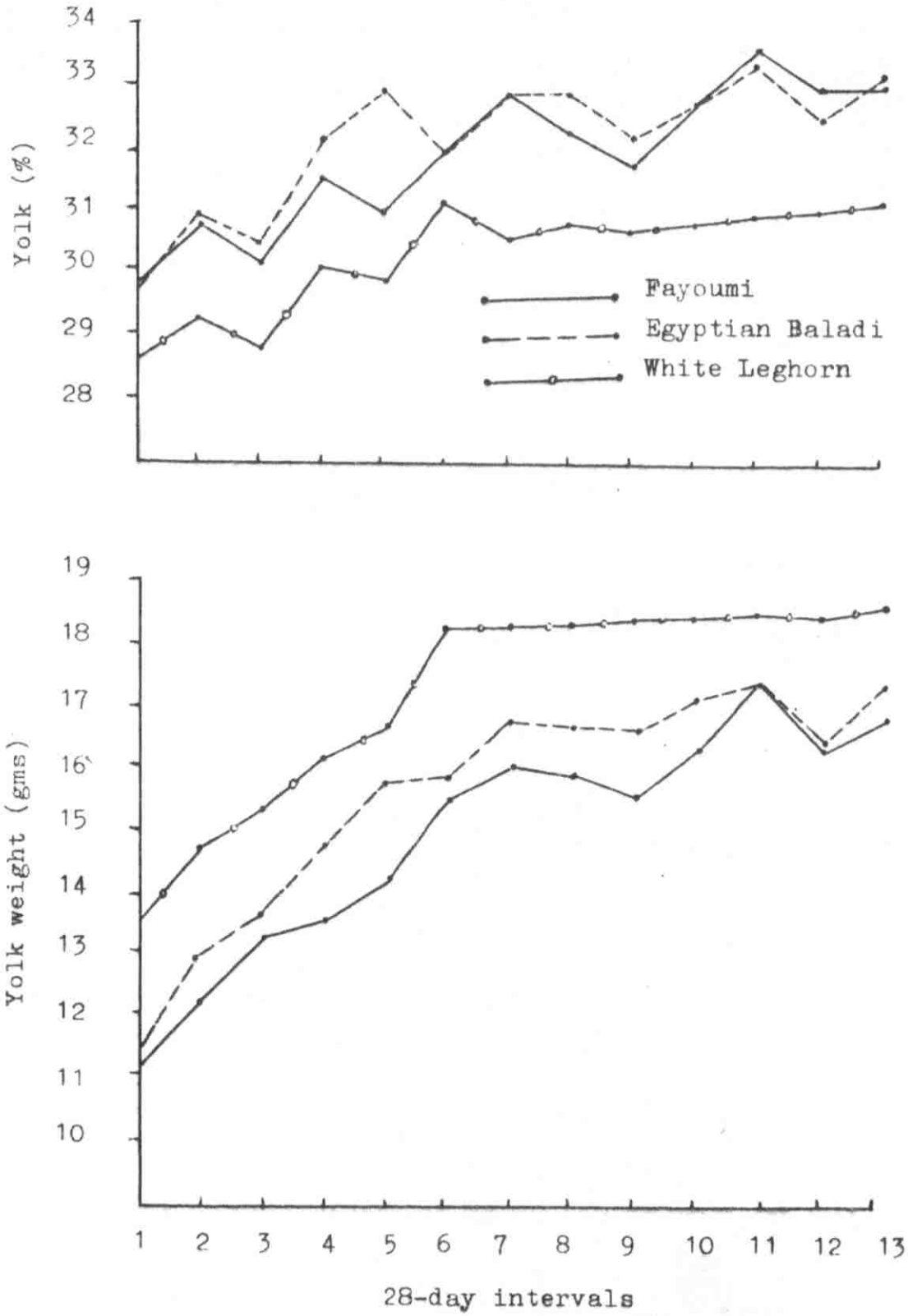


Figure 7 - Comparison of yolk weight and percent yolk among three breeds of chickens at 28-day intervals.

and Fayoumi pullets had a higher percentage of yolk than the White Leghorn pullets during each 28-day period (Figure 7). The average percent yolk was 30.34 for the White Leghorn, 31.96 for the Fayoumi and 32.16 for the Egyptian Baladi eggs (Table 14). These differences in percent yolk were significant among breeds (P = 0.01). The percent yolk observed in this study for the Fayoumi breed was somewhat lower than that reported by Hafez et al. (1955).

b. Albumen

In general, the albumen weights of the three breeds tended to increase during the experimental period. The albumen weight was highest for the White Leghorn, intermediate for the Egyptian Baladi and lowest for the Fayoumi pullets during each period (Figure 8). The average albumen weight for the Fayoumi, Egyptian Baladi and the White Leghorn pullets was 26.26, 26.76 and 33.54 grams, respectively (Table 14). Significant correlation (P = 0.01) was found between egg weight and the weight of the albumen for the White Leghorn (r = 0.984) and Fayoumi (r = 0.986) breeds (Appendix). These high correlation coefficients indicated an association between egg weight and the weight of the albumen. The percent albumen was higher in the eggs of the White Leghorn pullets than in the eggs of the Egyptian Baladi and Fayoumi pullets during each

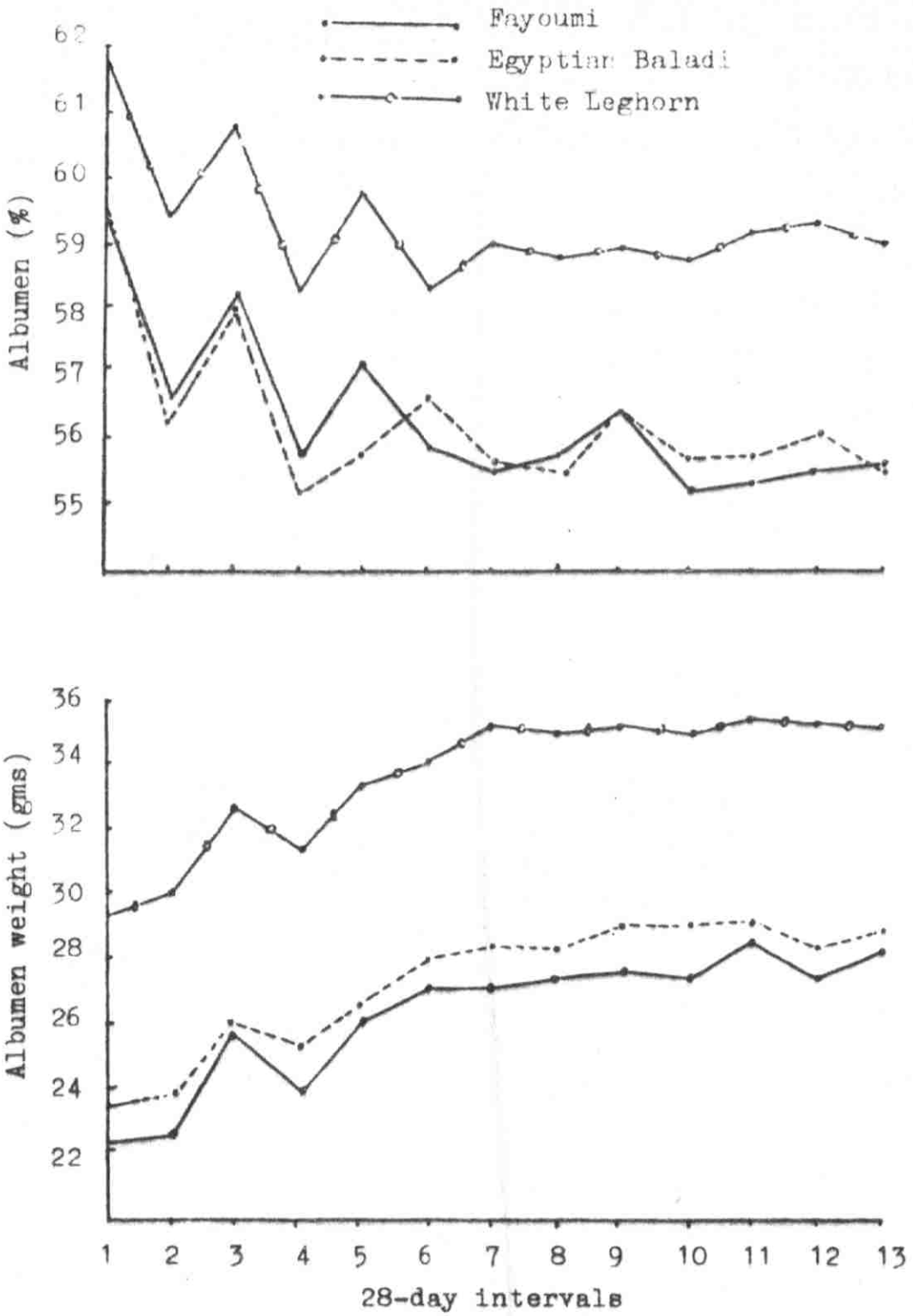


Figure 8 - Comparison of albumen weight and albumen percent among three breeds of chickens at 28-day intervals.

period (Figure 8). The albumen percentage tended to decrease as the experiment progressed. This finding was in conformity with the results of Hafez et al. (1955) who also found that percent albumen tended to decrease during the first laying year. The average albumen percent for the White Leghorn, Egyptian Baladi and Fayoumi pullets was 59.27, 56.22 and 56.24, respectively (Table 14). Significant difference was found in the albumen percent among the three breeds ($P = 0.01$) (Table 15). The albumen percent for the Fayoumi eggs in this study was higher than that reported by Hafez et al. (1955).

c. Shell

The shell weight increased during the first ten periods followed by a slight decline which was more marked in the White Leghorn than in the Egyptian Baladi and Fayoumi breeds (Figure 9). The decline in shell weight during the last three periods was probably due to the season. The Egyptian Baladi and Fayoumi breeds being more adapted to higher summer temperatures were less affected. The shell weight of the White Leghorn was higher than the Egyptian Baladi and Fayoumi breeds during each period which was probably due to larger egg size. The average shell weight was 5.51, 5.53 and 5.88 grams for the Fayoumi, Egyptian Baladi and the White Leghorn breeds,

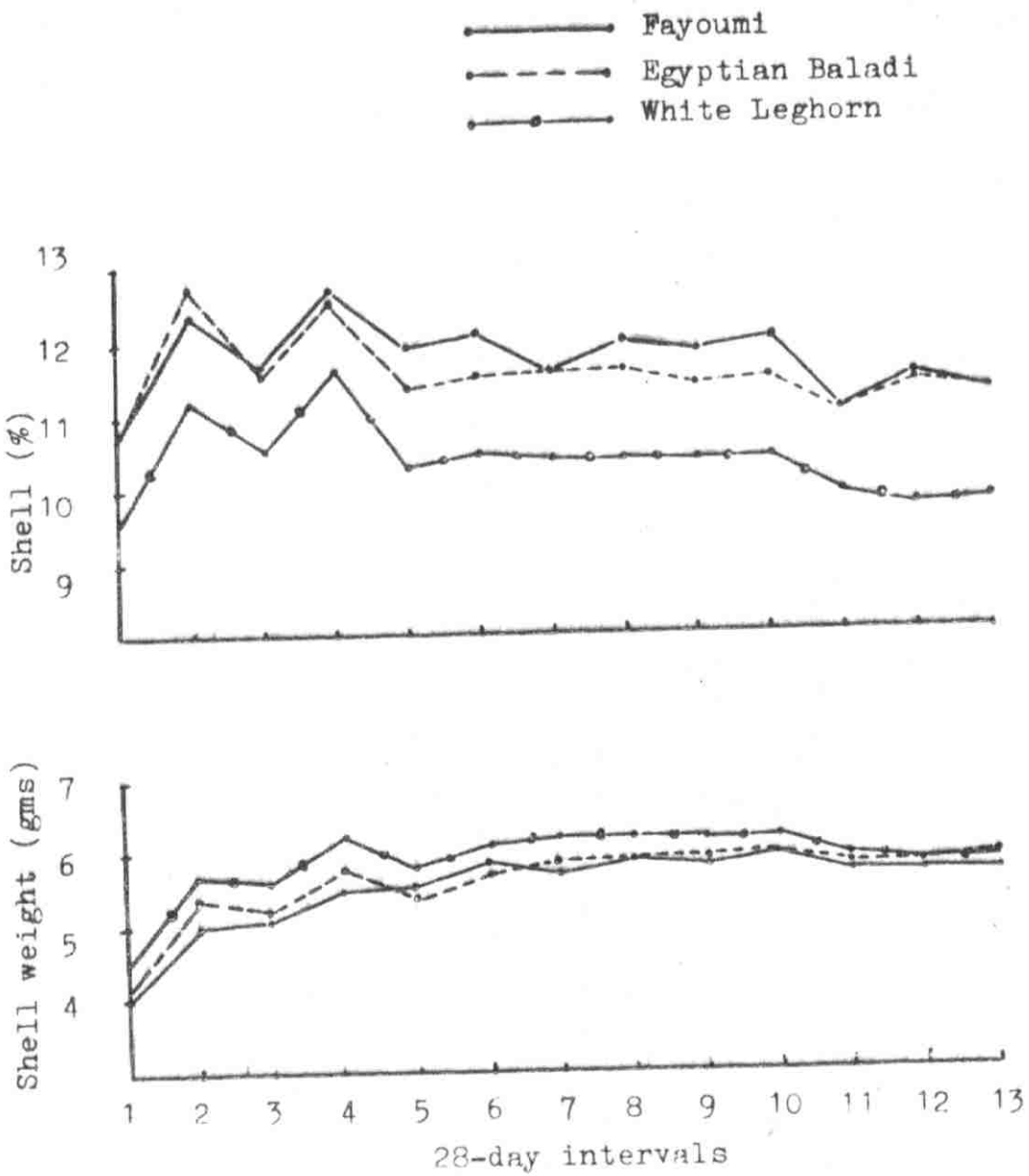


Figure 9 - Comparison of shell weight and percent shell among three breeds of chickens at 28-day intervals.

respectively (Table 14). Significant correlation between the weight of the egg and the weight of the shell for the White Leghorn (r = 0.767), Egyptian Baladi (r = 0.842) and Fayoumi (r = 0.814) breeds indicated a relationship between these two variables. The percent shell was higher in the Egyptian Baladi and Fayoumi eggs than in the White Leghorn eggs during each period (Figure 9). A decline in percent shell was noticed during the last three periods (April 8 - July 2). However the lowest percent shell was observed during the first period (July). These results indicated a seasonal influence on the percent shell which was more marked in the White Leghorn than in the other two breeds. The average percent shell was 10.39, 11.62 and 11.80 for the White Leghorn, Egyptian Baladi and Fayoumi breeds, respectively (Table 14). These differences in percent shell among the three breeds were significant (P = 0.01). In general, all egg components tended to increase in weight during the experimental period. The increase in the weight of egg components was more pronounced during the earlier periods. The White Leghorn pullets had highest average weight of all egg components followed by Egyptian Baladi and Fayoumi pullets. The percent yolk tended to increase while the percent albumen decreased during the study period. The percent shell

showed fluctuations and tended to decrease during the Summer months. The Egyptian Baladi and Fayoumi breeds had higher percent yolk and shell than the White Leghorn. The percent albumen was higher in the White Leghorn than for the other two breeds.

4. Shell Thickness

Comparison of the shell thickness of the White Leghorn, Egyptian Baladi and Fayoumi breeds during each period is reported in Figure 10. The Egyptian Baladi and Fayoumi eggs had thicker shells than the White Leghorn eggs during each period. The thickest shells for the three breeds were observed during the sixth period (Nov.20 - Dec.17). This peak was followed by a decrease in shell thickness which continued, with slight fluctuations, to the end of the experiment. The decline in shell thickness was more marked in the eggs of the White Leghorn pullets during the last two periods and was probably due to a seasonal influence. The average shell thickness was 0.0128, 0.0134 and 0.0138 inches for the White Leghorn, Egyptian Baladi and Fayoumi breeds, respectively (Table 14). The difference in shell thickness among the breeds was significant ($P = 0.01$) (Table 16). The differences in shell thickness among the breeds may be attributed to hereditary factors which cause a difference in the relative efficiency of assimilating and secreting calcium and other minerals

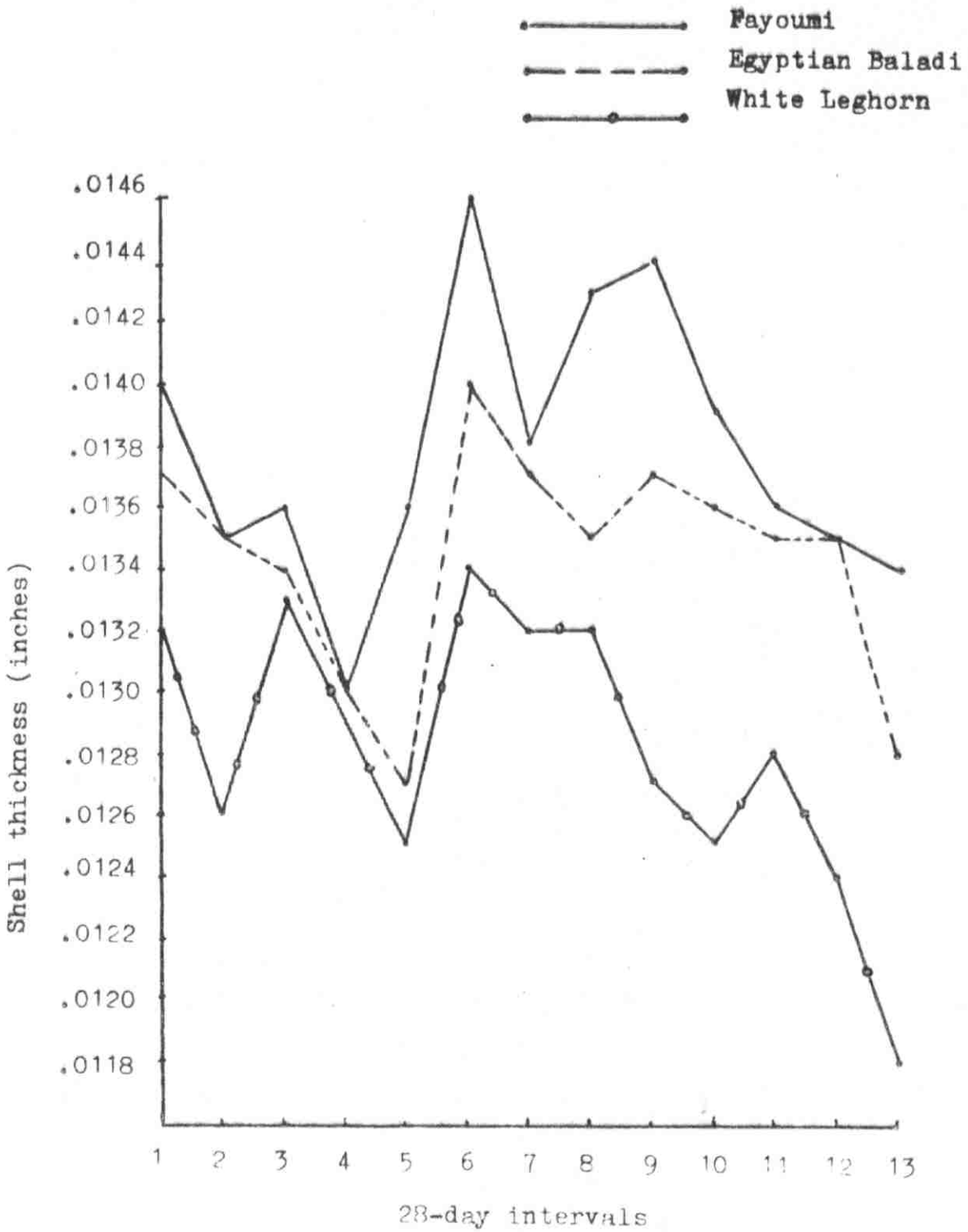


Figure 10 - Comparison of shell thickness among three breeds of chickens at 28-day intervals.

needed for shell formation. These differences may also be due to a difference in level of egg production among the three breeds. It was also evident from these data that the White Leghorn birds produced eggs with thinner shells than is desirable (.0130 inches) as reported by Brant et al. (1955). The shell thickness of the Egyptian Baladi and Fayoumi breeds was higher than this standard.

5. Albumen Quality

Albumen quality was measured by determining the Haugh Unit Score of the eggs. Comparison of the Haugh Unit Score of the three breeds during each period is shown in Figure 11. The Haugh Unit Score was highest for the Fayoumi, intermediate for the Egyptian Baladi and lowest for the White Leghorn during each period with the exception of first period when the White Leghorn had a higher Haugh Unit Score than the Egyptian Baladi. The highest Haugh Unit Score for the three breeds was observed during the first period followed by a decline during the rest of the experimental period. However the decline in albumen quality was more marked during the first six periods than the latter half of the experiment. These results suggested that the decline in quality was due to a physiological change taking place as the egg production progressed and as the birds grew older. These results are in agreement with the work of Froning and Funk (1958)

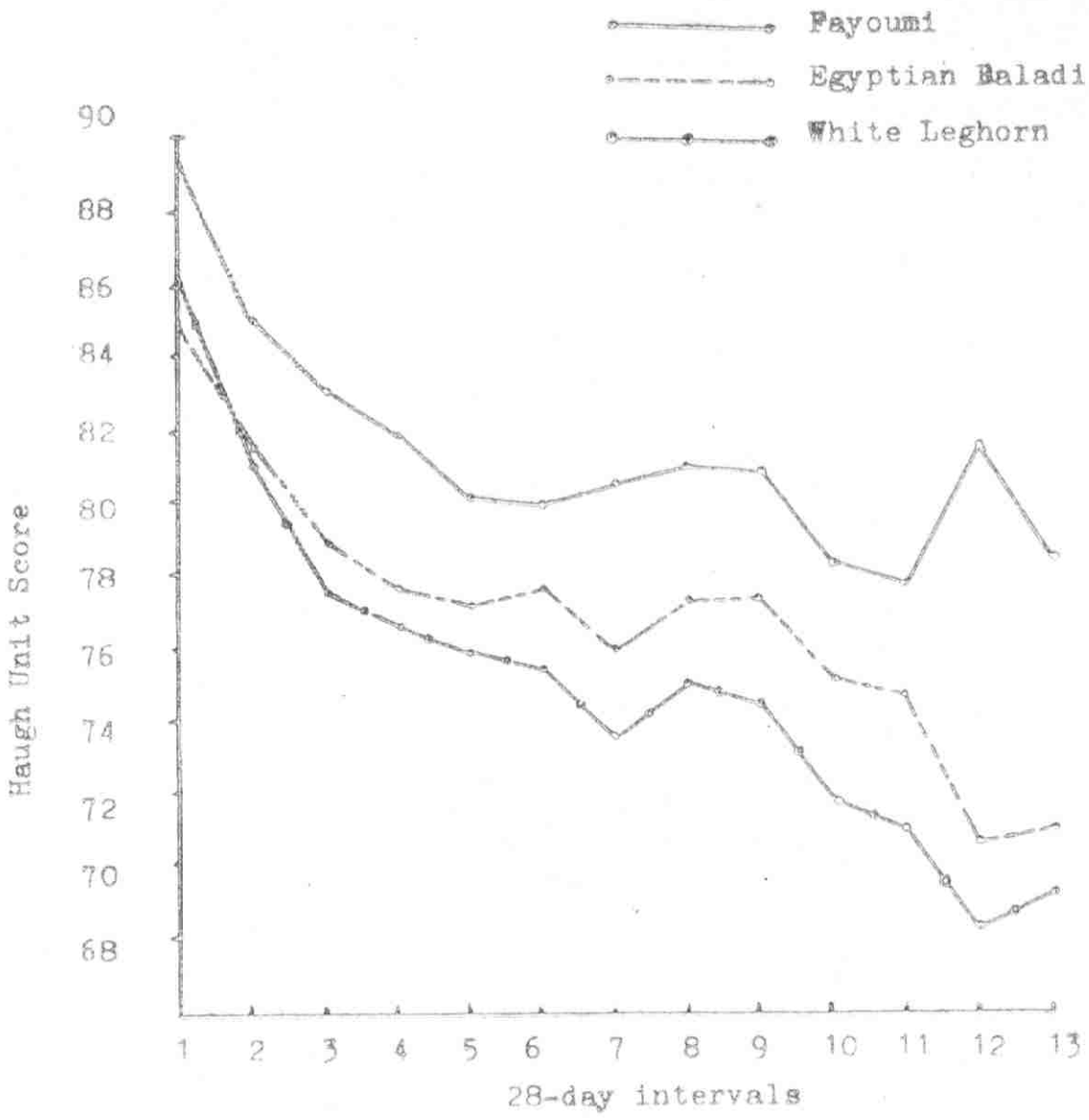


Figure 11 - Comparison of Haugh Unit Score among three breeds of chickens at 28-day intervals.

who reported that the greatest decrease in egg quality occurred during the first six or seven months and with the work of Cunningham et al. (1960) who suggested that the decline in Haugh Unit Score was entirely due to aging of the birds. Significant negative correlation between egg weight and Haugh Unit Score for the White Leghorn (r = -0.865), Egyptian Baladi (r = -0.835) and Fayoumi (r = -0.894) breeds further support this opinion. The decrease in albumen quality was greater for the White Leghorn pullets than for the Egyptian Baladi and Fayoumi pullets which could be attributed to a comparatively higher egg production for the White Leghorn birds. The average Haugh Unit Score for the entire experimental period was 75.34, 77.55 and 81.28 for the White Leghorn, Egyptian Baladi and Fayoumi breeds, respectively (Table 14). The differences in Haugh Unit Score among breeds were significant (Table 16).

6. Blood and Meat Spots

A total of sixty eggs, thirty-four for the White Leghorn, three for the Egyptian Baladi and twenty-three for the Fayoumi, showed blood and meat spots. The blood spot incidence was 6.08, 5.37 and 0.68 for the White Leghorn, Fayoumi and Egyptian Baladi breeds, respectively (Table 14). The meat spot incidence was 0.34 percent for Egyptian Baladi, 0.39 percent for the White Leghorn and 1.13

percent for the Fayoumi birds (Table 14). No definite seasonal trend was noticed in blood and meat spot incidence. The incidence of blood spots was significantly higher in the White Leghorn and Fayoumi eggs than in the Egyptian Baladi eggs. These results are in agreement with the work of Brant et al. (1953) and Dawson et al. (1954) who also observed breed differences in the incidence of blood and meat spot.

Fertility and Hatchability

During the experimental period 1129 White Leghorn, 773 Egyptian Baladi and 952 Fayoumi eggs were used to determine and compare the percent fertility and hatchability.

1. Percent Fertility

These data on egg fertility for the White Leghorn, Egyptian Baladi and Fayoumi pullets are presented in Table 17. These data revealed that the eggs from the White Leghorn and Egyptian Baladi pullets showed maximum fertility during the autumn and minimum during the spring. The eggs from the Fayoumi pullets showed maximum fertility during the spring and minimum during the summer. The maximum fertility obtained during a season from the Egyptian Baladi, Fayoumi and White Leghorn pullets was 91.3, 91.5, and 94.2 percent, respectively (Table 17). The minimum fertility (seasonal) noticed was 76.4 percent

Table 17 - Comparison of the fertility and the hatchability by seasons among White Leghorn, Egyptian Baladi and Fayoumi chickens.

| Season | No. of eggs set | | | No. of eggs fertile | | | No. of chicks hatched | | | Fertility (%) | | | Hatchability (%) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | W.L.[1] | E.B.[2] | F[3] | W.L. | E.B. | F | W.L. | E.B. | F | W.L. | E.B. | F | W.L. | E.B. | F |
| Spring | 373 | 305 | 354 | 285 | 234 | 324 | 179 | 74 | 216 | 76.4 | 76.7 | 91.5 | 62.8 | 31.6 | 66.7 |
| Summer | 186 | 157 | 177 | 155 | 135 | 153 | 92 | 78 | 74 | 83.3 | 86.0 | 86.4 | 59.4 | 57.8 | 48.4 |
| Autumn | 259 | 161 | 194 | 244 | 147 | 175 | 176 | 127 | 111 | 94.2 | 91.3 | 90.2 | 72.1 | 86.4 | 63.4 |
| Winter | 311 | 150 | 227 | 278 | 127 | 204 | 236 | 101 | 158 | 89.4 | 84.7 | 89.9 | 84.9 | 79.5 | 77.4 |
| Total or average | 1129 | 773 | 952 | 962 | 643 | 856 | 683 | 380 | 559 | 85.2 | 83.2 | 89.9 | 71.0 | 59.1 | 65.3 |

[1] White Leghorn.

[2] Egyptian Baladi.

[3] Fayoumi.

for eggs from the White Leghorn, 76.7 percent for eggs from the Egyptian Baladi and 86.4 percent for eggs from the Fayoumi pullets. These data further showed that the seasonal difference in percent fertility was highest for eggs from the White Leghorn, intermediate for the Egyptian Baladi and lowest for eggs from the Fayoumi pullets. The lower fertility levels observed during Summer months may be attributed to deaths of embryos in the early stages of development as a result of unfavorable environment, particularly the advent of the dry season. The lower fertility level during Summer could also possibly be due to low semen production of the males.

The average fertility for the whole experimental period was 83.2 percent for the Egyptian Baladi, 85.2 percent for the White Leghorn and 89.9 percent for the Fayoumi breed (Table 17). The average percent fertility for the eggs of the Fayoumi pullets found in this study was higher than that reported by Hafez and Kamar (1955).

The $x^2$ test revealed significant differences between fertility levels of the three breeds ($P = 0.01$). The eggs from the Fayoumi pullets exhibited significantly higher fertility than those from the White Leghorn and the Egyptian Baladi pullets. However, no significant difference was found between fertility of eggs from the White Leghorn and the Egyptian Baladi pullets.

2. Percent Hatchability

The hatchability data for eggs from the White Leghorn, Egyptian Baladi and Fayoumi breeds are shown in Table 17. The White Leghorn and Fayoumi breeds had maximum hatchability during the Winter and minimum during the Summer. The Egyptian Baladi showed maximum hatchability during the Autumn and minimum during the Spring. These results suggested seasonal differences in percent hatchability of the three breeds. These seasonal differences as expected followed the same general trend as fertility. These results are in agreement with the work of Hafez and Kamar (1955) who reported maximum hatchability during the Winter and minimum during the Summer for the Fayoumi eggs.

The maximum seasonal percent hatchability observed for the eggs of the Fayoumi, White Leghorn and the Egyptian Baladi breeds was 77.4, 84.9 and 86.9, respectively. The minimum seasonal percent hatchability was 31.6 for the Egyptian Baladi, 48.4 for the Fayoumi and 59.4 for the White Leghorn (Table 17). The seasonal difference in percent hatchability was highest for the Egyptian Baladi, intermediate for the Fayoumi and lowest for the White Leghorn. The percent hatchability was lower during April, July and September for the White Leghorn, from April to July for the Egyptian Baladi and for July and September

for the Fayoumi breed. The lower percent hatchability during these months was due to high embryonic mortality during the last few days of incubation which could have resulted from low humidity.

The average hatchability of eggs for the entire experimental period was 59.1 percent for the Egyptian Baladi, 65.3 percent for Fayoumi and 71.0 percent for the White Leghorn (Table 17). The percent hatchability of the eggs from the Fayoumi pullets in this study was higher than that reported by Hafez and Kamar (1955). These differences were probably due to differences in the environments.

The $X^2$ test showed significant ($P = 0.01$) differences in percent hatchability among the three breeds. The White Leghorn pullets produced eggs with a significantly ($P = 0.01$) higher percent hatchability than the pullets of the other two breeds. The difference in hatchability of eggs between the Fayoumi and Egyptian Baladi breed was also significant ($P = 0.05$). The lower percent hatchability in the eggs of Egyptian Baladi and Fayoumi pullets could be probably due to a thicker egg shell of these two breeds.

## SUMMARY AND CONCLUSIONS

Three experiments with the White Leghorn, Egyptian Baladi and Fayoumi breeds of chickens were conducted at the Agricultural Research and Education Center of the American University of Beirut during 1963-64. Two growing period experiments evaluated and compared the three breeds for growth rate, feed consumption, feed efficiency and mortality to 12 weeks of age. The production period experiment was designed to study and compare egg production, age at 50 percent production, feed consumption, feed required per dozen eggs, egg quality, fertility, hatchability and laying house mortality among the three breeds.

The results of the first growing period experiment indicated that the White Leghorn chicks had the highest live weight gains as compared to the Egyptian Baladi and Fayoumi chicks. The Egyptian Baladi chicks gained more weight than the Fayoumi chicks. The male chicks of each breed gained significantly more weight than the female chicks during the experimental period. The average body weight of the White Leghorn, Egyptian Baladi and Fayoumi chicks at 12 weeks of age was 1123.1, 1082 and 893.0 grams, respectively.

The Egyptian Baladi chicks consumed the largest amount of feed and the Fayoumi chicks the least. For the entire period, the Fayoumi chicks consumed significantly less feed

than the Egyptian Baladi. The White Leghorn chicks were the most efficient in feed utilization; the Egyptian Baladi chicks were slightly more efficient than the Fayoumi chicks. The differences in efficiency of feed utilization among breeds were nonsignificant.

The findings of the second growing period experiment, in general, substantiated the information obtained during the first experiment. The results indicated a superiority of the White Leghorn chicks in body weight gains and efficiency of feed utilization over the other two breeds. However, the Fayoumi chicks gained more weight during this experiment than during the first and consumed slightly more feed than the White Leghorn chicks. The Fayoumi chicks were more efficient feed utilizers than the Egyptian Baladi chicks. No difference in mortality was observed among the breeds.

The results of the production period revealed that the White Leghorn pullets had the highest rate of egg production followed by the Egyptian Baladi and Fayoumi pullets. The average egg production during the first laying year was 271, 170 and 141 eggs for the White Leghorn, Egyptian Baladi and Fayoumi pullets, respectively. The Egyptian Baladi and Fayoumi pullets reached 50 percent production slightly earlier than the White Leghorn pullets.

The average daily feed consumption was the highest for the White Leghorn, intermediate for Egyptian Baladi and lowest for the Fayoumi pullets. The differences in feed

consumption among three breeds were attributed to differences in body size and rate of egg production.

The White Leghorn pullets were most efficient in egg production while the Fayoumi pullets were the least efficient egg producers. The White Leghorn, Egyptian Baladi and Fayoumi pullets required an average of 4.10, 5.63 and 5.80 pounds of feed to produce one dozen eggs, respectively.

The White Leghorn pullets, because of their larger body size, produced the largest eggs as compared with pullets of the other two breeds. The average egg weight was 56.6 grams for the White Leghorn, 47.6 grams for the Egyptian Baladi and 46.7 grams for the Fayoumi pullets. The eggs of the White Leghorn pullets (on a weight basis) had the largest absolute amount of all of the egg components, the Egyptian Baladi were intermediate, and the Fayoumi had the smallest. However, the percent yolk and shell was higher in the eggs of the two Egyptian breeds then in the White Leghorn. The highest percent albumen was observed in the eggs of the White Leghorn pullets.

The Fayoumi pullets produced eggs having the best albumen quality followed by the Egyptian Baladi and the White Leghorn. The eggs with the thickest shells were produced by the Fayoumi pullets while the White Leghorn produced eggs with the thinnest shells. The eggs from the White Leghorn pullets had the highest incidence of blood and meat spots while the eggs from the Egyptian Baladi showed the least percent blood

and meat spots.

The eggs from the Fayoumi pullets had the highest percent fertility while the eggs from the Egyptian Baladi showed the least percent fertility. The average percent fertility for the entire study period was 83.2 for the Egyptian Baladi, 85.2 for the White Leghorn and 89.9 for the Fayoumi eggs.

The eggs of the White Leghorn had the highest hatchability while the eggs having the least percent hatchability were produced by the Egyptian Baladi pullets. The lower hatchability of the eggs of two Egyptian breeds was attributed to thicker egg shells.

Laying house mortality was the highest for the White Leghorn, intermediate for the Egyptian Baladi and least for the Fayoumi pullets. The mortality rate was 3.6 percent for the Fayoumi, 14.3 percent for the Egyptian Baladi and 15.0 percent for the White Leghorn pullets. However, no significant difference in mortality was found among breeds.

Under conditions of this experiment, the White Leghorn breed performed the best during the growing and the production period; the Egyptian Baladi was second; and the Fayoumi breed performed the poorest.

The results of this study indicated that in order to obtain a strain of Egyptian Baladi or Fayoumi chicks that could be crossed with the White Leghorn chicks without causing a too great a sacrifice in production, individual performance

testing should be done. The individuals with the highest performance could be used in breed crosses with the White Leghorn chicks, perhaps, enabling the development of a breed that possess many of the outstanding characteristics of both breeds.

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# A P P E N D I X

Table 18 - Correlation coefficients among production traits in White Leghorn, Egyptian Baladi and Fayoumi breeds.

| Characters | White Leghorn | Egyptian Baladi | Fayoumi |
|---|---|---|---|
| Body weight at one day of age vs. body weight at 12 weeks of age - Experiment 1 | +0.355 | +0.111 | +0.174 |
| Body weight at one day of age vs. body weight at 12 weeks of age - Experiment 2 | -0.215 | +0.041 | +0.114 |
| Feed required per unit gain vs. age - Experiment 1 | +0.948* | +0.934* | +0.935* |
| Feed required per unit gain vs. age - Experiment 2 | +0.917* | +0.933* | +0.973* |
| Egg production (%) vs. feed/dozen eggs | -0.695* | -0.950* | -0.971* |
| Egg weight vs. yolk weight | +0.996* | +0.995* | +0.998* |
| Egg weight vs. shell weight | +0.767* | +0.842* | +0.814* |
| Egg weight vs. albumen weight | +0.985* | +0.984 | +0.986* |
| Egg weight vs. Haugh Unit Score | -0.865* | -0.835* | -0.894* |

* Significant at 0.01 level of probability.