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EFFECT OFINTERACTION BETWEEN FEED RESTRICTION AND DIETARY ENERGY LEVELS ON PRODUCTIVE, PHYSIOLOGICAL, IMMUNOLOGICAL PERFORMANCE AND ECONOMIC EFFICIENCY OF TWO STRAINS OF LAYING HENS.

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ABSTRACT: This study was conducted to determine the effect of interaction between feed restriction and dietary energy levels on productive, physiological and immunological performance as well as economic efficiency of Matrouh and Silver Montazah chickens (females and males).A total number of 240 females and 24 males 24 weeks old from each of Matrouh (MAT) and Silver Montazah (SM) layer strains (120 females and 12 males from each strain) were used, Birds of each strain were randomly divided into 4 equal groups with 3 replicates each of 10 females and one male. The first and second groups fed diet contained 2800 and 2600 kcal ME /kg diet, respectively at a rate of 120g/ hen/day. The third and fourth groups fed diet contained 2800 and 2600 kcal ME /kg diet, respectively at a rate of 100g/ hen/day. Theobtained results showed that Silver Montazah hens recorded higher values for egg production%, egg weight,egg mass and feed efficiency, hatchability % and post hatch chick weight as well as T3, LH and FSH hormones as compared with Matrouh (MAT) hens.Reducing the amount of feed provided to hens (100 g/hen/ day) significantly improved feed efficiency and increased blood levels of T3 and LH hormones, fertility and hatchability percentages, chick weight at hatch and weight of abdominal fat were significantly decreased. the best results of egg production%, egg weight and egg mass, as well as chick weight at hatch, fertility and hatchability percentages were recorded for SM hens which received diet containing 2800 kcal ME at a rate of 120g/hen/day, the lowest results were recorded for MAT hens which fed diet contained 2600 kcal ME at a rate of 100g /hen/day. However, the best feed efficiency was recorded for hens of both strains which received diet contained 2800 kcal at rate of 100 g/hen/day. T3 and LH hormones, chick weight at hatch as well as fertility and hatchability percentages were increased for SM hens either those received low or high dietary energy content at a rate of 120 or 100g/hen/day comparing with MAT hens which received the same experimental diets. Semen quality traits were found to be improved for SM cocks under the two levels of energy and feeding.The highest economic efficiency values were exhibited by SM hens fed high or low dietary energy levels at a rate of 100 g / hen / day. It could be concluded that the best feed efficiency and economic efficiency were recorded for hens of both strains which received diet contained 2800 kcal at rate of 100 g / hen/ day.

Key Words: Feed restriction, Dietary energy, Egg production, Fertility, Developed strains.

INTRODUCTION

Feed management practices aiming to improve poultry industry without increasing production cost (Mateos*et al.*, 2012).Quantitative feed restriction is one of the possible ways to control body weight of hens during laying period and metabolic rate to some extent as well as improving feed conversion and reducing feed cost. Therefore, hatching egg producers use feed restriction programs to prevent birds from getting over weighed, to delay sexual maturity, to avoid reproductive dysfunction, and to increase the production of settable eggs (Renema and Robinson, 2004).Recently, published results have reported that the 4/3 feed restriction program employed during the rearing stage provides the best performance and reproductive traits response of broiler breeder hens reared on floor pens (Carneiro*et al*., 2019).Moreover, Moreira *et al.* (2012) observed that laying hens can be submitted to 5% feed restriction with the supply of hay *ad -libitum* without significant changes on the performance of the hens and egg quality.

Energy is an expensive component of poultry diets with lipids providing a concentrated energy source to meet these needs. So energy represents the component of greatest cost in poultry diets (Murugesan*et al*., 2017). Energy represents at least 60% of total cost in poultry feed. It is important to accurately estimate the available energy content of feed ingredients. Corn is considered commonly used energy source in the poultry feed industry (Liu *et al.*, 2020).Research over time has demonstrated that laying hens can change feed intakepatterns to meet energy requirement; thus, feed intake and subsequent hen productivity change with dietary energy content (Murugesan and Persia, 2013). Laying rate increased at an energy content of 2,753 kcalof ME/kg of feed (Jiang *et al.* 2013). Optimizing the energy in the breeder male diet for semen production will help in saving feed cost of production (Shanmugam*et al.,* 2016).The percentage of males producing semen, semen weight and total sperm per ejaculate was reduced in birds fed less than 2400 kcal ME/kg feed (Sexton *et al.,* 1989).Semen quality is an important factor affecting fertility, since a semen quality factor has been proposed as a predictor of male semen fertilizing ability (Łukaszewicz and Kruszynski, 2003).

The aim of this study was to evaluate the effect of the interaction between the strains, feed restriction and dietary energy levels on productive, physiological, immunological performance and economic efficiency of two strains of laying hens.

MATERIALS AND METHODS

The present study was carried out at Inshas Poultry Research Station, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Giza, Egypt.

Birds management and experimental design:

A total number of 240 females + 24 males from each of Matrouh and Silver Montazah laying strains, (120 females + 12 males from each strain). At 24 weeks of age, birds of each strain were randomly assigned to four equal groups of 30 females + 3maleseach with three replicates, (10 females + 1 male each). The birds were housed in floor pens and kept under similar managerial and hygienic conditions. Water was offered *ad-libitum* during the whole experimental period.

The four experimental treatments for each strain were the first and second groups fed diet contained 2800 and 2600 kcal ME /kg diet, respectively at a rate of 120 g/ hen / day. The third and fourth groups fed diet contained 2800 and 2600 kcal ME /kg diet, respectively at a rate of 100 g/ hen / day.

Productive performance:

Body weight was recorded and body weight change was calculated (final body weight – initial body weight) every 4 weeks intervals. Feed intake was recorded per 4 weeks, the first and second treatments groups fed diet contained 2800 and 2600 kcal ME /kg diet, respectively at a rate of 120 g/ hen / day and the third and fourth treatments groups fed diet contained 2800 and 2600 kcal ME /kg diet, respectively at a rate of 100 g/ hen / day, and feed efficiency was calculated every 4 weeks(g feed/1 g eggs).Egg number and egg weight were recorded daily throughout the experimental period and egg mass was calculated every 4 weeks, Egg number x egg weight = egg mass. Also, Egg production rate was calculated every4 weeks intervals period.

Hatchability measurements:

The incubated eggs were handled on the seventh day of incubation to determine fertility percent (number of fertile eggs / number of eggs set × 100), total hatchability percent (number of hatched chicks/ number of total eggs set× 100) and fertile hatchability percent (number of hatched chicks/ number of fertile eggs × 100) , the body weight of newly hatched chicks was recorded gm.

Semen quality:

Four weeks before the end the experimental period (at 36 weeks of age), the males were separated from the females in special rooms; six sperm samples were drawn from each group for assessment semen quality to study the effect of the treatments on them. At 40 weeks of age semen was collected from 4 well trained cooks (3 cooks from each experimental group × 2 strains) by massage method. Semen samples wake examined for the following characteristics: Ejaculate volume, percentage of sperm motility, dead spermatozoa, sperm abnormality, acrosomal damage and sperm cell concentration.

Internal body organs:

At the end of the experiment (40 wks. of age)5 hens/treatment were randomly chosen, individually weighted and slaughtered. Hens were manually eviscerated, liver, heart, abdominal fat, spleen and thymus were removed and their percentages to live body weight were calculated.

Blood parameters

At the end of the experiment (40 wks. of age).Forty blood samples (5 ml/ hen) were collected from the previously slaughtered hens during exsanguinations into non-heparinized test tubs. Serum was obtained by centrifuging blood at 3000 r.p.m. for 10 minutes and stored at – 20 ^{o}c until assayed forT3 ,T4,LH and FSH hormones which determined by ELISA method using commercial kits. The ratio of T3:T4 was calculated.

Economical efficiency:

The economic parameters of production including feeding and fixed costs, income and returns per hen were calculated. Economic efficiency is defined as the net revenue per unit feed cost which calculated from input- output analysis.

Statistical analysis:

The data were statistically analyzed usingSAS (2003) from all the response variable were subjected to factorial analysis (2×2×2) of variance. Variables having a significant F-test (P≤0.05) were compared using Duncan, sMultiple Range Test (Duncan, 1955).

To test the effect of feeding rate, energy levels and strain of bird as following Model:

Xijl = µ + Ti +Fj+Sl (TFS) ijl+ Eijl

whereX_{ijl} = Any observation

µ = The overall mean.

T_i = The effect of feed levels (i= 1and2).

F_j = Energy levels (j= 1 and 2)

Sl= Type of strain (l= 1 and 2)

(TFS)ijl= Interaction between feed restriction, energy levels and type of strain,

Eijl = Experimental error.

RESULTS AND DISCUSSION

1-Productive performance

The present results in Table (2). shows that there were no significant differences between the two laying hen strains (Matrouh and Silver Montazah) for in egg production %, egg weight and egg mass due to strain or feed restriction rate. On the other hand , feed efficiency was significantly better for Silver Montazah hens than Matrouh ones, Also, it was significantly improved for hens received 100 g feed/ day compared to those fed 120 g feed/ day . Body weight change was found to be significantly ($p \leq 0.01$) higher for S.M hens over than MT hens, meanwhile, feed rest restriction did not significantly affect body weight change. Concerning the effect of dietary energy level, hens fed diet containing 2800 kcal ME/ kg had significantly ($p \leq 0.01$) better feed efficiency and significantly higher egg production % and egg mass than those fed diet containing 2600 kcal ME/ kg. Meanwhile, egg weight and body weight change were not significantly differed between both energy levels.

Regarding the interaction it could be observed that Silver Montazah fed 120 g/ hen/day +2800 ME kcal / Kg diet exhibited the highest egg production % , egg mass and body weight change compared with other experimental groups, while the best feed conversion was recorded for Silver Montazah and Matrouh hens received100 g /hen/day + 2800 Me kcal / kg diet. The lowest egg production and egg mass was recorded for Matrouh hens which fed diet containing 2600 kcal Meat a rate of 100 g / hen / day. On the other hand, there were no significant differences in egg weight among the experimental groups due to the interaction between strain, feed restriction and dietary energy levels.

Results in this research agreed with Golian and Maurice (1992) and Leeson *et al*. (1993) who reported that birds consume feed to meet their energy requirement.

Moreover, Ding *et al.* (2016) concluded that by increasing metabolizable energy level from 2650 to 2750 ME kcal / Kg diet in laying hen diets, their feed intake decreased by 3.45%.Also, egg production % was improved by increasing ME level without any change in FCR.

These results agreed with Souza *et al.*(2008) who found that the poultry production in the free-range system to be feasible should be directed to the use of alternative feeding and pastures, in the free-range system, the feeding of birds with exclusively commercial diet may cause losses, even selling the eggs with price higher than the recommended for eggs produced industrially, the consumption of forage by birds is low, and the balanced, supplementary diet is undoubtedly necessary to maintain a good health and high levels of poultry production. On the other hand, Irandoust *et al.* (2012) indicate that laying hens performance did not differ with the use of the different soy oil sources and consequently, well processed recycled soy oil from the refining of soy oil can be used successfully in commercial diets. However, there were no references on the interaction between effect of strain, feed restriction and dietary energy levels on egg production, egg weight, egg mass, feed conversation and body weight change.

2- Semen quality

Data of semen quality are presented in Table (3). It could be noted that SM cocks had significantly ($p \leq 0.01$) higher values for ejaculate volume and sperm (motility and concentration) and the lower percentages for dead spermatozoa and acrosomal damage than those of MAT cocks. On the other hand, sperm abnormality percent was not significantly differed between the two strains.

These results are related to genotype, age and environmental factors that affected the semen quality. As well as large variation existed in semen quantity and quality traits in cocks (Peter *et al.,* 2008). In this connection, Shanmugam*et al*., (2016) stated that Dahlem Red roosters breeder males fed diet contained high energy (2950 kcal/kg ME) and high protein (16% CP)had no effect ($P>0.05$) on the semen parameters. However, in the current study, there were insignificant differences in all studied semen quality parameters due to feeding rate or dietary energy level, except for ejaculate volume which was significantly ($p \leq 0.05$) increased in cocks fed diet contained 2800 kcal ME/ kg. Regarding the effect dietary levels on the semen quality, Tadondjou*et al.,* (2013) examined the effects of dietary energy levels on reproductive parameters of local barred chickens in Cameroon and found that semen volume and mass motility of cocks fed on a starter diets contained 2800 or 2900 kcal/ kg and a grower diets contained 3000 or 3100 kcal/kg were significantly ($P<0.05$) higher. It was concluded that dietary energy was more suitable for growth and reproduction of local barred cocks. The differences in sperm density could be associated with dietary energy level. Moreover, Ghonim*et al.,* (2010) indicated that a diet containing 2950 Kcal ME/kg and 15% CP could be used to improve the reproductive performance and fertility of Domyati drakes without adverse effects during laying period.

Concerning the effect of interaction, Table(3). illustrates that the highest values for ejaculate volume and sperm (motility and concentration) were recorded for cocks of SM strain which fed the high dietary energy diet at a rate of 120 g / hen/ day. Whereas, the worst values for all semen quality parameters such as ejaculate volume, sperm motility and concentration, dead spermatozoa and acrosomal damage percentages were recorded for MAT cocks which received the low dietary energy diet at a rate of 100 g/ bird/ day. These results revealed that dietary energy level (2800 kcal/kg) affected testicular development suggesting that high energy intake leads to precocious testicular development. During prepubertal period, testicular development is highly correlated to the number and size of Sertoli cells while during pubertal period; it is rather correlated to the number of germinal cells (Brière*et al.*,2011).In birds, Brière *et al*.,(2011) reported that intratesticular hyperthermia resulting from high dietary energy intake may lead to reduction of sperm production. Intratesticular hyperthermia acts by altering the functional state of spermatogonia stock. On the other hand, there were no significant differences in sperm abnormality % due to the interaction effect. Generally, SM cocks those received 120 g or 100 g / bird / day was found to be exhibited the best values for most semen quality parameters under low or high energy content diets as compared with MAT cocks experimental groups. The present findings showed an improvement in semen quality due to the feed restriction. These results are confirmed by Crouch *et al.*,(2002) who demonstrated that age of breeder, season of implementation and length of physical feed restriction have significant effects on the reproductive performance of turkey breeder hens. In addition, Kabir*et al* (2007) revealed that providing Rhode Island red and white cocks with one-half to three-quarter (i.e., 50-70%) of their normal daily diet did not affected adversely semen quality of Rhode Island chickens.

3-Fertility and hatchability

The results of fertility and hatchability traits are presented in Table (4). It is clear that fertility and hatchability of total eggs percentages as well as chick weight at hatch of eggs produced by hens inseminated with SM semen cocks were significantly ($p \leq 0.05$) higher than that of those produced by hens inseminated with MAT semen cocks, while, hatchability of fertile eggs (%) did not significantly effect .In laying hen flocks, declining fertilization and hatching rates are observed as correlated response to intensive selection for laying performance, due to negative relationship between laying and hatching (Rozempolska-Rucińska*et al.,* 2007).

Irrespective of strain effect, fertility and hatchability of total eggs percentages as well as post-hatch chick weight of eggs produced by hens received high dietary energy diet (2800 kcal) at a rate of 120 g / hen/ day were significantly ($p \leq 0.05$) higher than that those produced by hens fed low energy diet at a rate of 100 g/ hen/ day, whereas, hatchability of fertile eggs (%) did not significantly affect (Table 4).The interaction between strain, feed restriction and the level of dietary energy had a significant effect on fertility , hatchability percentages and post-hatch chick weight (Table 4).Where , eggs produced by SM hens fed high energy diet at a rate of 120 g/ hen / day exhibited the superiority values for fertility , hatchability(%) and chick weight at hatch, while the worst results were recorded for eggs of MAT hens received low energy diet (2600 kcal) at a rate of 100 g/ hen/ day .However, eggs of SM hens attained higher values for fertility , hatchability and newly hatched chick weight traits than MAT eggs under the two levels of dietary energy and feeding rate. On the other hand, the percentage of hatchability of fertile eggs was not significantly differed due to the interaction. The previous results demonstrated a relationship between semen quality traits and fertility and hatchability (%), where, as semen traits improved fertility and hatchability percentages increased, However, these observations were confirmed by the findings of Kamar and Razik (1972) who found highly significant positive correlation between sperm motility and fertility. The authors interpreted this correlation in which high motile spermatozoa may have higher fertilizing ability because the high motile sperms are of higher viability. Also , they found that sperm concentration and live sperm are positively correlated with fertility where, the increase in the previous parameters provide more numbers of live sperms around the ova to insure high fertility results.

These results are similar with those reported by Leson and Lopez (1994) who observed that low hatchability is associated with low dietary energy intake.

Also, Leeson *et al. (*1993) who observed thatby low energy intake, the hatchability is lowered. Carneiro*et al.,* (2019) evaluated the effect of different feed restriction programs applied during rearing on the performance and reproductive traits of broiler breeder pullets reared on floor pens and found that 4/3 program could be more efficient than 5/2 program in fertility and hatchability. Romero-Sanchez *et al.,* (2004) observed that low-density male broiler breeder diets, that is, with low crude protein and metabolizable energy levels, promoted good fertility.

4-Blood constituents

Table (5) showed that Silver Montazah hens attained higher concentrations of LH and FSH hormones and T3:T4 ratio compared with Matrouh hens. On the other hand, no significant differences in T4 hormone level was found between tow the strains. The groups take 100 g / hen L day gave the high T3, T3: T4 ratio and LH hormones compared with the groups take 120 g/ hen/ day and no significant differences in T4 and FSH hormones levels between all groups of feed restriction. The groups take 2600 kcal / diet gave higher T3, T3: T4 ratio and FSH hormone compared with groups take 2800 kcal / diet, but no significant differences in T4 and LH hormones levels between all groups of different energy in diets. The groups of Silver Montazah strain take 100 g/ hen / day + 2600 ME kcal / kg diet gave high levels of T3, LH hormones and T3 : T4 ratio compared with other groups in two developed strains, but no significant differences in T4 and FSH hormones levels between all interaction groups for feed restriction and different energy levels in diets.No references on interaction between effect of feed restriction, dietary energy levels on T3, T4, T3: T4 ratio and LH and FSH hormones. Concerning the effect of feed restriction, it could be observed that feeding 100 g/ hen / day significantly ($p \leq 0.01$) increased blood concentrations of T3 and LH hormones as well as T3: T4 ratio as compared with feeding 120 g /hen/day. On the other hand, the levels of both T4 and FSH hormones were not significantly affected by different feeding rates, Similarly, feeding the low level of dietary energy was found to be increased the blood concentrations of T3 and FSH hormones and the ratio of T3:T4 comparing with the high energy diet, while the levels of T4 and LH hormones were not significantly differed. These results were confirmed by those reported by Liu et al., (2019) who observed that dietary energy modifies laying possibly through regulating reproductive hormone secretion and gene expression in hypothalamus pituitary gonad axis in laying geese. It was also observed that FSH releases are necessary to induce follicular maturation and ovulation in the hen, which can facilitate follicle selection and increase the number of follicles. Also, the deficient energy inhibited FSH secretion and possibly impaired follicle development (Palmer and Bahr, 1992).On the other hand, Hadlnia *et al.* (2020) concluded that higher ME advanced the activation of the hypothalamic–pituitary–gonadal axis and also, increased body lipid deposition, and moreover, stimulated reproductive hormones (LH and FSH) levels which overall accelerated puberty in broiler breeder pullets. Regarding the effect of interaction, Table (5). Showed there was a significant ($p \leq 0.05$) interaction effect on serum blood concentrations of T3 and LH hormones and T3: T4 ratio. However, within the same strain, feeding 100g /hen /day with the low level of dietary energy significantly ($p \leq 0.05$) increased serum concentrations of T3 and LH hormones comparing with the other experimental groups. However, in both strains serum concentrations of T3 and LH hormones and T3: T4 ratio were higher in SM hens either received 120 or 100 g/hen / day with high or low energy levels content (Table5).Conversely, serum concentration of T4 and FSH hormones did not significantly change due to strain × feed restriction ×dietary energy level interaction. Generally, SM hens which received 2600 kcal ME diet at a rate of 100 g/hen/ day showed the highest values for all the studied blood parameters, meanwhile, the lowest values were recorded for MAT hens which fed high energy diet (2800 kcal ME) at a rate of 120 g/ hen / day.

5-Internal body organs

The results of some body organs relative weights are presented in Table (6) .Irrespective the effect of interaction it is obvious that liver, heart and spleen relative weights were not significantly differed due to the effect of strain, feed restriction or dietary energy levels except for heart relative weight which was significantly ($p \leq 0.05$) higher for SM hens than MAT ones and spleen % which was significantly ($p \leq 0.05$) higher for the hens fed 120 g/ hen /day compared with those fed 100 g /hen / day. On the other hand, abdominal fat percentage was found to be significantly ($p \leq 0.01$) decreased either by feeding hens on 100 g diet / hen / day or low dietary energy diet (2600 kcal ME) , whereas, the relative weight of abdominal fat did not significantly differ between the two strains of hens .This finding is similar to that of Tesfaye*et al.* (2011) who reported that there was no difference in the slaughter weight and dressing weight between feed restricted and the control group but an influence on the carcass with abdominal fat. The interaction between the previously main effects was found to be significantly ($p \leq 0.01$) affect each of abdominal fat and thymus relative weights. It could be noticed that the relative weight of abdominal fat was significantly ($p \leq 0.01$) reduced by feeding low energy diet at a rate of 100 g / hen /day for the two strain of hens, MAT and SM. Meanwhile the highest percent was recorded for hens of both strains which received high energy diet at a rate of 120 g/ hen / day. However, the differences between the rest of interaction treatments in abdominal fat percent were not significant. These results were confirmed by those reported by Hadlnia*et al.*(2020) who concluded that higher ME advanced the activation of the hypothalamic–Pituitary–gonadal axis and also increased body lipid deposition, tissues and abdominal fats, and moreover, stimulated reproductive hormones (LH and FSH)levels which overall accelerated puberty in broiler breeder pullets. On the other hand, there were no significant differences in liver, heart and spleen relative weights between all of the interaction treatments were detected.

6-Economic efficiency

Results of economic efficiency are summarized in Table (7) . It was clear that SM hens had the higher revenue per hen compared with MAT ones. Regardless strain of hen feeding of 120 g/ hen / day increased the net revenue by about 32.7 % over than feeding 100 g/ hen / day. Whereas, reducing the dietary energy to 2600 kcal, increased the net revenue per hen by 5.2 % over than the high energy diet (2800 kcal).With regard to feed restriction levels, Olawumi, (2014) found that 90% ad libitum was better and feed efficient than ad libitum and 80% *ad libitum* recorded higher net returns and economic efficiency. Also, from Table(7) it could be noticed that all groups of feed restriction(100 g/ hen /day) either with high or low dietary energy content for both strains of hens had better economic efficiency values compared with those fed 120 g / hen / day with the two levels of dietary energy. However, the highest economic efficiency was exhibited by SM strain hens which fed either low or high energy diet at a rate of 1oo g / hen / day followed by MAT hens which received both dietary energy levels and the same feeding rate (100g /hen /day). On the other hand, the least economic efficiency was recorded for experimental groups of both strains which received 120 g / hen / day either with high or low dietary energy levels. It could be concluded that reducing the quantity of feed provided for hen caused appreciable improvement in economic efficiency and net revenue.On the other hand, Fattori *et al.* (1991) reported that severe reduction of energy intake during the growing period of broiler breeder hens did not affect subsequent fertility or hatchability.The results of the present study suggest that the quantitative feedrestriction (100 or 200g /hen /day) is employed to control growth by feedinga predetermined amount of balanced diet in order toachieve a good production during laying period as well enhanced the economic efficiency.

CONCLUSION

It could be concluded that the best feed efficiency and economic efficiency were recorded for hens of both strains which received diet contained 2800 kcal at rate of 100 g / hen/ day.

Table (1):Composition and calculated analysis of the experimental diets.

Ingredients	**Control diet Percentage (%)**	**Tested diet Percentage (%)**
Yellow corn	57.65	65.85
Soya bean meal (44%)	16.60	17.20
Wheat bran	11.30	1.60
Corn gluten (60%)	4.22	5.12
Di- Calciumphosphate	1.39	1.39
Limestone	8.16	8.16
Salt	0.37	0.37
*Minerals and vitamins mix	0.30	0.30
DL Methionine	0.01	0.01
Total	100.00	100.00
**Calculated values ** **		
Crude protein%	16.05	16.06
Metabolizableenergy (ME) Kcal/kg	2604	2800
Crude fiber (CF) %	3.86	3.05
Ether extract%	2.98	2.94
Calcium %	3.40	3.39
Available Phosphorous%	0.41	0.38
Sodium%	0.16	0.16
Lysine%	0.74	0.73
Methionine%	0.33	0.34
Methionine & cysteine%	0.62	0.62

*Mineral and vitamin mix added to the 1 kg of diet including Vit.A 10000 IU; Vit. D3 2000 I.U; Vit.E 15 mg; Vit.K3 1 mg; Vit B1 1mg; Vit.B2 5 mg; vit. B12 10 µg; Vit B6 1.5mg; Niacin 30mg; Pantothenic acid 10mg; folic acid 1mg; Biotin 50 µg; choline 300 mg; zinc 50mg; copper 4mg; iodine 0.3 mg; iron 30mg; selenium 0.1mg; manganese 60mg; cobalt 0.1mg and carrier CaCo3 up to 1kg.

* According to CLFF, (2001).

Table (2): Effect of strain, feed restriction, dietary energy levels and their interaction on productive performance traits of Matrouh and Silver Montazah laying hens .

Productive traits			Egg Production %	Egg weight (g)	Egg mass (g/hen/day)	Feed conversation (g feed /g egg)	Body weight change (g)
Main effects Strain(S)			NS	NS	NS	*	**
Matrouh			62.10	46.20	28.69	3.87^{a}	244.68^{b}
Silver Montazah			62.90	46.24	29.08	3.80^{b}	270.34^{a}
MSE			±0.40	±0.02	±0.20	±0.03	±12.83
Feed restriction(FR)			NS	NS	NS	**	NS
120 gm			62.90	46.26	29.10	4.15^{a}	262.98
100 gm			62.10	46.18	28.68	3.52^{b}	252.04
MSE			±0.40	±0.04	±0.21	±0.32	±5.47
Dietary energy(ME)			**	NS	**	**	NS
2800 ME kcal/ K g diet			63.24^{a}	46.25	29.25^{a}	3.79^{b}	263.22
2600 ME kcal/ K g diet			61.76^{b}	46.19	28.53^{b}	3.88^{a}	251.81
MSE			±0.74	±0.03	±0.36	±0.05	±5.70
Interaction(S×FR×ME)							
Strain	Feed restriction	ME	*	NS	*	**	*
Matrouh	120 gm	2800	63.23^{a}	46.28	29.26^{ab}	4.10^{ab}	253.30^{b}
		2600	61.79^{ab}	46.18	28.53^{abc}	4.21^{a}	246.17^{bc}
	100 gm	2800	62.74^{a}	46.24	29.01^{ab}	3.45^{d}	244.34^{bc}
		2600	60.63^{b}	46.12	27.96^{c}	3.58^{c}	234.92^{c}
Silver Montazah	120 gm	2800	63.58^{a}	46.34	29.46^{a}	4.07^{b}	281.58^{a}
		2600	63.00^{a}	46.26	29.14^{ab}	4.12^{ab}	270.88^{a}
	100 gm	2800	63.42^{a}	46.16	29.27^{ab}	3.42^{d}	273.64^{a}
		2600	61.61^{ab}	46.21	28.47^{bc}	3.51^{cd}	255.28^{b}
MSE			±0.37	±0.03	±0.18	±0.12	±5.75

* a , b and c Means within the column for each main effect had different superscripts are significantly differ ($P \leq 0.05$).

** a , b, c and dMeans within a column with different superscripts are significantly differ ($P \leq 0.01$).

Table (3): Effect of strain, feed restriction, dietary energy levels and their interaction on semen quality of Matrouh and Silver Montazah cocks at 40 weeks of age.

Traits			Ejaculate Volume (ml)	Sperm motility (%)	Dead spermatozoa (%)	Sperm abnormalities (%)	Acrosomal damage (%)	Spermcell concentration(((10^8 /ml)
Main effects of Strain			**	**	**	NS	**	**
Matrouh			0.57 ^{b}	78.75 ^{b}	17.50 ^{a}	14.83	12.75 ^{a}	4.26^b
Silver Montazah			0.68 ^{a}	85.42 ^{a}	13.25^b	12.58	11.00^b	4.94 ^{a}
MSE			0.06	3.33	2.13	1.13	0.88	0.34
Feed restriction			NS	NS	NS	NS	NS	NS
120 gm			0.64	83.75	15.42	13.75	11.83	4.68
100 gm			0.61	80.42	15.33	13.67	11.92	4.53
MSE			0.01	1.67	0.04	0.04	0.04	0.08
Dietary energy			*	NS	NS	NS	NS	NS
2800 ME kcal/ K g diet			0.66 ^{a}	83.75	14.50	13.25	11.83	4.73
2600 ME kcal/ K g diet			0.59 ^{b}	80.42	16.25	14.17	11.92	4.47
MSE			0.04	1.67	0.88	0.46	0.04	0.13
Interaction			*	**	*	NS	**	**
Strain	Feed	ME						
Matrouh	120 gm	2800	0.63^{ab}	81.67^{abcd}	15.67^{ab}	15.00	13.33 ^{a}	4.33^{bcd}
		2600	0.54 ^{b}	78.33^{cd}	19.67 ^{a}	14.67	13.00 ^{a}	4.17 ^{cd}
	100 gm	2800	0.58^{ab}	80.00^{bcd}	15.67^{ab}	13.33	11.33^{ab}	4.53^{bcd}
		2600	0.53^b	75.00^d	19.00 ^{a}	16.33	13.33 ^{a}	4.00^d
Silver Montazah	120 gm	2800	0.73^a	88.33 ^{a}	14.00 ^{b}	13.00	11.33^{ab}	5.23 ^{a}
		2600	0.66^{ab}	86.67^{ab}	12.33 ^{b}	12.33	9.67 ^{b}	4.97^{ab}
	100 gm	2800	0.71 ^{a}	85.00^{abc}	12.67 ^{b}	11.67	11.33^{ab}	4.83^{ab}
		2600	0.62^{ab}	81.67^{abcd}	14.00 ^{b}	13.33	11.67^{ab}	4.73^{abc}
MSE			0.03	1.57	0.96	0.54	0.45	0.15

* a , b and c Means within the column for each main effect had different superscripts are significantly differ ($P \leq 0.05$).

** a , b, c and d Means within a column with different superscripts are significantly differ ($P \leq 0.01$).

Table (4): Effect of strain, feed restriction, dietary energy levels and their interaction on hatchability traits and chick weight at hatch of Matrouh and Silver Montazah of chickens.

Traits / **Main effects**			**Fertility (%)**	**Hatchability of total eggs sets (%)**	**Hatchability of fertile eggs (%)**	**Chick weight at hatch (g)**
Effect of Strain			*	*	NS	**
Matrouh			87.50^{b}	76.11^{b}	86.98	32.21^{b}
Silver Montazah			89.44^{a}	78.06^{a}	87.28	33.07^{a}
MSE			0.97	0.97	0.15	0.43
Effect of feed restriction			*	**	NS	*
120 gm			89.44^{a}	78.61^{a}	87.89	32.87^{a}
100 gm			87.50^{b}	75.56^{b}	86.38	32.40^{b}
MSE			0.97	1.53	0.76	0.23
Effect of dietary energy			*	*	NS	*
2800 ME kcal/ K g diet			89.44^{a}	78.06^{a}	87.28	32.85^{a}
2600 ME kcal/ K g diet			87.50^{b}	76.11^{b}	86.99	32.42^{b}
MSE			0.97	0.97	0.15	0.22
Interaction			*	*	**NS**	**
Strain	Feed	ME				
Matrouh	120 gm	2800	90.00^{ab}	78.89^{ab}	87.65	32.80^{abc}
		2600	87.78^{abc}	75.56^{bc}	86.09	32.00^{c}
	100 gm	2800	86.67^{bc}	75.56^{bc}	87.22	32.07^{c}
		2600	85.56^{c}	74.44^{c}	86.97	31.95^{c}
Silver Montazah	120 gm	2800	91.11^{a}	81.11^{a}	89.07	33.54^{a}
		2600	88.89^{abc}	78.89^{ab}	88.75	33.14^{ab}
	100 gm	2800	90.00^{ab}	76.67^{bc}	85.19	33.00^{ab}
		2600	87.78^{abc}	75.56^{bc}	86.13	32.60^{bc}
MSE			0.66	0.81	0.47	0.21

* a , b and c Means within the column for each main effect had different superscripts are significantly differ ($P \leq 0.05$).
** a , b, c and d Means within a column with different superscripts are significantly differ ($P \leq 0.01$).

Table (5): Effect of strain, feed restriction, dietary energy levels and their interaction on some blood parameters of Matrouh and Silver Montazah laying hens .

Parameters			T3 (ng/ml)	T4 (ng/ml)	Ratio T3:T4	LH (IU/ml)	FSH (IU/ml)
Strain effect			**	NS	**	**	*
Matrouh			162.67^{b}	470.42	0.346^{b}	0.376^{b}	1.817^{b}
Silver Montazah			173.33^{a}	473.58	0.366^{a}	0.412^{a}	1.964^{a}
MSE			5.33	1.58	0.010	0.018	0.074
Feed restriction effect			**	NS	**	**	NS
120 gm			163.33^{b}	471.75	0.346^{b}	0.379^{b}	1.845
100 gm			172.67^{a}	472.25	0.366^{a}	0.408^{a}	1.936
MSE			4.67	0.25	0.010	0.015	0.045
Dietary energy effect			**	NS	**	NS	*
2800 ME kcal/ K g diet			164.50^{b}	470.58	0.350^{b}	0.389	1.818^{b}
2600 ME kcal/ K g diet			171.50^{a}	473.42	0.362^{a}	0.399	1.963^{a}
MSE			3.50	1.42	0.006	0.005	0.072
Interaction effect			**	NS	**	**	NS
S ×	FR	ME					
Matrouh	120 gm	2800	155.67^{e}	469.00	0.332^{c}	0.357^{e}	1.717
		2600	160.33^{d}	472.33	0.340^{c}	0.368^{de}	1.853
	100 gm	2800	164.33^{cd}	468.33	0.351^{bc}	0.386^{cd}	1.830
		2600	170.33^{bc}	472.00	0.361^{ab}	0.392^{bcd}	1.867
Silver Montazah	120 gm	2800	161.33^{de}	471.67	0.342^{bc}	0.395^{bcd}	1.783
		2600	176.00^{ab}	474.00	0.371^{a}	0.398^{bc}	2.027
	100 gm	2800	176.67^{ab}	473.33	0.373^{a}	0.419^{ab}	1.943
		2600	179.33^{a}	475.33	0.377^{a}	0.436^{a}	2.103
MSE			3.11	0.84	0.006	0.009	0.045

* a , b and c Means within the column for each main effect had different superscripts are significantly differ ($P \leq 0.05$).
** a , b, c and d Means within a column with different superscripts are significantly differ ($P \leq 0.01$).

Table (6): Effect of strain, feed restriction, dietary energy levels and their interactionon some internal organs weights of Matrouh and Silver Montazah laying hens at 40 week of age**.**

Traits **Main effects**	Body weight (g)	Carcass (%)	Liver (%)	Heart (%)	Abdominal fat (%)	Spleen (%)	Thymus (%)
Effect of Strain	NS	NS	NS	*	NS	NS	NS
Matrouh	1537.29	61.18	2.60	0.478[b]	1.909	0.280	0.334
Silver Montazah	1541.50	60.84	2.63	0.489[a]	1.925	0.286	0.343
MSE	2.11	0.17	0.02	0.006	0.008	0.003	0.005
Effect of feed restriction	NS	*	NS	NS	**	*	**
120 gm	1545.42	60.61 [b]	2.60	0.480	2.018 [a]	0.289 [a]	0.329 [b]
100 gm	1533.38	61.42 [a]	2.64	0.487	1.815 [b]	0.278 [b]	0.347 [a]
Mse	6.02	0.40	0.02	0.004	0.101	0.005	0.009
Effect of dietary energy	NS	NS	NS	NS	**	NS	*
2800 ME kcal/ K g diet	1543.68	61.13	2.61	0.480	2.015 [a]	0.280	0.333 [b]
2600 ME kcal/ K g diet	1535.12	60.90	2.63	0.488	1.819 [b]	0.286	0.343 [a]
MSE	4.28	0.12	0.01	0.004	0.098	0.003	0.005
Interaction	NS	*	NS	NS	**	NS	

Content Table (6): Effect of strain, feed restriction, dietary energy levels and their interaction on some internal organs weights of Matrouh and Silver Montazah laying hens at 40 week of age.

Traits **Main effects**			Body weight (g)	Carcass (%)	Liver (%)	Heart (%)	Abdominal fat (%)	Spleen (%)	Thymus (%)
Strain	Feed	ME							*
Matrouh	120g	2800	1540.91	61.21^{abc}	2.55	0.474	2.100^{a}	0.273	0.314^{c}
		2600	1543.97	59.87^{c}	2.62	0.484	1.924^{b}	0.298	0.335^{ab}
	100g	2800	1537.41	61.29^{abc}	2.64	0.471	1.887^{bc}	0.284	0.340^{ab}
		2600	1526.89	62.35^{a}	2.60	0.483	1.724^{c}	0.267	0.345^{ab}
Silver Montazah	120 g	2800	1553.73	60.42^{bc}	2.58	0.476	2.146^{a}	0.286	0.328^{bc}
		2600	1543.07	60.94^{abc}	2.64	0.486	1.904^{b}	0.298	0.339^{ab}
	100 g	2800	1542.64	61.59^{ab}	2.66	0.497	1.925^{b}	0.279	0.350^{ab}
		2600	1526.57	60.43^{bc}	2.67	0.498	1.725^{c}	0.282	0.354^{a}
MSE			3.21	0.28	0.01	0.004	0.054	0.004	0.005

* a , b and c Means within the column for each main effect had different superscripts are significantly differ ($P \leq 0.05$).
** a , b, c and d Means within a column with different superscripts are significantly differ ($P \leq 0.01$).

Table (7): Economical efficiency as affected by feed restriction and dietary energy levels of two developed strains of laying hens.

Main effects \ Economic Parameters	Feed	ME	Eggs number Per hen	Price/ egg (LE)	Total revenue hen (LE/hen)	Total feed intake/ (kg/hen)	Price/ Kg feed (LE)	Total feed cost (LE/ hen)	Fixed costs (LE/ hen)	Total cost (LE/ hen)	Net revenue/ (LE/ hen)	Economic efficiency (EE)
Effect of Strain												
Matrouh			69.55	1.20	83.46	12.32	5.900	72.69	2.00	74.69	8.77	11.74
Silver Montazah			70.45	1.20	84.54	12.32	5.900	72.69	2.00	74.69	9.85	13.19
Effect of feed restriction												
120 gm			70.45	1.20	84.54	13.44	6.000	80.64	2.00	82.64	21.90	22.30
100 gm			69.55	1.20	83.46	11.20	5.800	64.96	2.00	66.96	16.50	24.65
Effect dietary energy												
2800 ME kcal/ K g diet			70.83	1.20	85.00	12.32	6.000	73.92	2.00	75.92	9.08	11.95
2600 ME kcal/ K g diet			69.17	1.20	83.00	12.32	5.800	71.46	2.00	73.46	9.55	13.00
Effect of interaction												
Strain	Feed	ME										
Matrouh	120 gm	2800	70.82	1.20	84.98	13.44	6.000	80.64	2.00	82.64	2.34	2.83
		2600	69.21	1.20	83.05	13.44	5.800	77.95	2.00	79.95	3.10	3.87
	100 gm	2800	70.27	1.20	84.32	11.20	6.000	67.20	2.00	69.20	15.12	21.85
		2600	67.91	1.20	81.49	11.20	5.800	64.96	2.00	66.96	14.53	21.70
Silver Montazah	120 gm	2800	71.21	1.20	85.45	13.44	6.000	80.64	2.00	82.64	2.81	3.40
		2600	70.56	1.20	84.67	13.44	5.800	77.95	2.00	79.95	4.72	5.91
	100 gm	2800	71.03	1.20	85.23	11.20	6.000	67.20	2.00	69.20	16.03	23.17
		2600	69.01	1.20	82.81	11.20	5.800	64.96	2.00	66.96	15.85	23.67

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الملخص العربى

تأثير التداخل بين تحديد كمية الغذاء ومستوى طاقة العليقة على الاداء الانتاجى والفسيولوجى و المناعى والكفاءة الإقتصادية لسلالتين من الدجاج البياض .

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اجريت الدراسة لتقدير تأثير التداخل بين تحديد كميه الغذاء المأكول و مستوى طاقه العليقه على الصفات الانتاجيه والفسيولوجيه والمناعيه بالاضافة إلى الكفاءه الاقتصاديه للدجاج البياض لسلاله مطروح والمنتزه الفضي. أستخدم فى هذة الدراسه عدد240 دجاجه +24ديك (120 دجاجه + 12 ديك من كل سلاله) عمر 24 أسبوع. تم تقسيم طيور كل سلاله الى 4 مجموعات متساويه (30 دجاجه + 3 ديوك) بكل مجموعه ثلاث مكررات بكل مكرره 10 دجاجات + ديك، المجموعتين الأولى والثانيه تم تغذيه الطيور على عليقه تحتوى على 2800 و 2600 كيلو كاللورى طاقه ممثله / كيلو جرام على الترتيب بمعدل 120 جرام / طائر / اليوم ، المجموعتين الثالثه والرابعه تم تغذيه الطيور على عليقه تحتوى على عليقه تحتوى على 2800 و 2600 كيلو كاللورى طاقه ممثله / كيلو جرام على الترتيب بمعدل 100 جرام / طائر / اليوم . حيث أستمرت المعاملات من عمر 24 حتى 40 أسبوع.

و كانت النتائج المتحصل عليها كما يلى:

سجل دجاج المنتزه الفضى أعلى قيم نسبه انتاج البيض و وزن البيض وكتله البيض والكفاءه الغذائيهوالنسبه المئويه للفقس ووزن الكتكوت عند الفقس، و هرمونات FSH, LH , T3. كانت مستوياتها أعلى بالمقارنه بدجاج المطروح . وحدث تحسن معنوى فى الكفاءه الغذائيه وكذلك زياده مستويات هرمونات LH , T3بالدم مع تحديد العليقه وأعطاء 100 جم / دجاجه/ يوم ، فى حين انخفضت نسب الخصوبه والفقس لحد كبير وايضا وزن الكتاكيت عند الفقس وايضا وزن دهن البطن . ومع ذلك لم تكن هناك اى اثار سلبيه للحد من تقليل كميه العلف على مقاييس الانتاج وتركيزات هرمونات FSH, T4 بالدم ولا على النسبه المئويه للبيض الفاقس كنسبه من البيض المخصب الكلى،وبالنسبه لتأثير التداخل بين المعاملات ، وجد أنه تم تسجيل أفضل النتائج لنسب انتاج البيض ووزن البيض وكتله البيض وكذلك وزن الكتاكيت عند الفقس لدجاج المنتزه الفضى الذى حصل على عليقه تحتوى على 2800 كيلو كالورى طاقه ممثله بمعدل 120 جم / دجاجه / يوم ، بينما تم تسجيل أقل قيم للنتائج لدجاج مطروح والذى تغذى على عليقه تحتوى على 2600 كيلو كالورى طاقه ممثله بمعدل 100 جم / دجاجه / يوم . ومع ذلك تم تسجيل أفضل كفاءه غذائيه لدجاج السلالتين المنتزه الفضى والمطروح عندما تغذت على علائق تحتوى على 2800 كيلو كالورى طاقه ممثله بمعدل 100 جم / دجاجه / يوم.تم تسجيل زياده فى مستويات هرمونات LH , T3 بالدم وكذلك وزن الكتكوت عند الفقس ونسب الخصوبه والفقس لدجاج المنتزه الفضى عندما تعذى على علائق تحتوى على مستويات منخفضه او مرتفعه من الطاقه الممثله سواء بمعدل 120 او 100 جم / دجاجه / يوم بالمقارنه بدجاج المطروح الذى اخذ نفس العلائق العذذائيه التجريبيه.فقد وجد انه حدث تحسن فى صفات جوده السائل المنوى لديوك المنتزة الفضى والتى تغذت على المستويين المنخفض والمرتع من الطاقه الممثله بالعلائق مع وضع معدلات عليقه 120 او 100 جم/ دجاجه / يوم بالمقارنه بديوك المطروح التى اخذت نفس العلائق العذائيه التجريبيه. تم الحصول على أعلى قيم للكفاءه الاقتصاديه لدجاج المنتزه الفضى والذى تغذى على علائق تحتوى على مستويات مرتفعه او منخفضة من طاقه العليقه بمعدل 100 جم / دجاجه / يوم .

الخلاصة: توصى هذه الدراسة أنه من النتائج السابقة يتضح أنه تم تسجيل أفضل كفاءه غذائيه وكفاءه اقتصاديه للدجاج البياض من السلالتين المنتزه الفضى والمطروح عندما تغذت على علائق تحتوى على 2800 كيلو كالورى طاقه ممثله بمعدل 100 جم / دجاجه / يوم.