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EFFECT OF L- ARGININE SUPPLEMENTATION ON PRODUCTIVE, REPRODUCTIVE PERFORMANCE, IMMUNE RESPONSE AND GENE EXPRESSION IN TWO LOCAL CHICKEN STRAINS: 1- EGG PRODUCTION, REPRODUCTION PERFORMANCE AND IMMUNE RESPONSE.

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ABSTRACT: The present study aimed to evaluate the effect of dietary supplementation with different levels of L-arginine (L-Arg) above the levels recommended by NRC (1994) on egg production, reproduction performance, egg quality and some physiological and immunological parameters. The experimental period started when the hens were 40 week old, and ended to three months. Two local strains Fayoumi(Fa) and Golden Montazah(GM) were used with a total number of 180 laying hens and 18 males (90 females and 9 males from each strain). Selected male and female of each strain were divided randomly into 3 groups/strain, each group consisted of 3 replicates (10 female and 1 male /replicate). Control diet (contain recommended level of L-Arg0.700% L-Arg). Crystalline amino acid (L-Arg) was supplemented by 2% and 4% as a percentage of dietary L-Arg to achieve 0.714% L-Arg and 0.728% L-Arg respectively (treatment groups).During the experimental period thirty six cockerels (18 from each strain) were housed in individual cage; each 6 cockerels fed one of the experimental diets to determine semen quality. During the experimental period, feed consumption and egg number were recorded daily. Eggs were weighed daily and egg mass per hen per day were calculated. Feed conversion ratio and crude protein conversion were calculated. During the last month of the experiment three hatches were conducted weekly to determine hatchability parameters. At the end of the experiment random samples of eggs representing controls and treatments (10 eggs /replicate) for each strain examined for egg quality parameters. Two blood samples were collected from each replicate within each strain in all groups to estimate physiological and immunological parameters. Experimental results showed that: Arginine supplementation above NRC caused significant increase in egg production percent and egg mass during the whole experimental period. There was at least 6% of extra egg production over the control.

Key Words: Arginine, Egg Production, ReproductionAnd Immune Response..

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Feed conversion ratio and crude protein conversion improved significantly, as the dietary L-Arg level increased. Most incubation and semen parameters improved and female ratio decreased significantly by L-Arg supplementation. Arginine supplementation had no adverse effect on physiological parameters. Arginine supplementation was associated with a reduction in heterophilus percent and heterophilus/lymphocytes ratio and was associated with increase in white blood cells count and lymphocytes percent. On the other hand egg quality was not affected significantly by any of the dietary L-Arg levels.

INTRODUCTION

L-arginine a basic amino acid, is an important amino acid for chickens because they, like other birds, are unable to obtain L-Argfrom endogenous sources since they lack almost all the enzymes that are involved in the urea cycle. L-Arginine is a substrate for biosynthesis of many molecules, including protein, nitric oxide, creatine, ornithine, glutamate, polyamines, proline, glutamine, agmatine and dimethylargininesa, thereby it serves a number of important biological and physiological functions in poultry (Khajali and Wideman, 2010).A remarkable variation can be found in the L-Arg requirements among different species because they have different capacities for endogenous L-Arg synthesis. Interspecies differences in the L-Arg requirements have been reviewed by Ball et al. (2007). The L-Arg requirement of the chick has been of considerable interest because the magnitude of the requirement is highly variable under different dietary conditions. The requirement for L-Arg is influenced by the source of dietary protein. The L-Arg requirement varied from lower than 0.70% of the diet for practical diets to nearly 1.8% for purified diets in which casein was the source of protein (Khajaliand Wideman, 2010).

It is well known that nitric oxide is the most putative metabolite of L-Arg (Jobgen et al., 2006). Nitric oxide, a highly reactive and short-lived radical, is implicated in regulating the reproductive functions in poultry (Sundaresan et al., 2007 and Kumar and Chaturvedi, 2008).Manwar et al. (2003) noticed that level of nitric oxide in serum is linked to high egg production. Arginine is also known for stimulating ovulation by increasing the release of luteinizing hormone (LH) (Basiouni et al., 2006). Basiouni (2009) conducted his experiment to explore why dietary L-Arg supplementation improved egg production and egg weight. He demonstrated that inclusion of L-Arg in laying hens diet elevated significantly luteinizing hormone concentration compared with the control. Carvalho et al.(2012) demonstrated that L-Arg supplementation up to NRC(1994) improved egg performance. Manwar et al. (2006) reported that increasing dietary L-Arg level led to a significant improve in egg production. Therefore, L-Arg plays a pivotal role in poultry nutrition under different conditions. Increasing L-Arg level to 1.5% over that required for the Leghorn breed requirements was found to improve hen-day egg production (Najib and Basiouni, 2004 and Basiouni et al., 2006). The supplementation of broiler breeder diets with L-Arg improved egg production and egg weight (Silva et al., 2012). Arginine is also considered a powerful secretagogue, increasing the release of insulin, growth hormone, and IGF-A in the blood stream. It is part of the hormone vasotocin, which is involved in uterine contraction and oviposition (Rueda et al., 2003). Arginine plays a role in augmenting the cellular inflammatory response by providing protection against oxidative damage. Arginine is essential for sperm motility, metabolism, capacitation, acrosome reaction, and is a precursor for producing putrescine, spermine, and spermidine(Ko and Sabangh, 2014)Spermidine is synthesized from putrescine and is a precursor of spermine. Daily L-Arg supplementation improves sperm concentration and motility (Scibona et al., 1994).Al-Daraji and Salih (2012)

indicated that RBC, PCV, Hb, MCV, MCH, MCHC, WBC, and H/L ratio were improved significantly as a result of dietary supplementation with L-Arg. Arginine has been reported to play an important role as a potent immunological modulator through production of nitric oxide, and has been shown to directly influence the immune system of birds under several experimental models (Kidd et al., 2001).Abdukalykova and Ruiz-Feria (2006) demonstrated that high level of L-Arg can accelerate antibody production in broiler chickens. Furthermore L-Arg helps to prevent bacterial and viral diseases and enhance immune system functions and increases the size of the thymus. Arginine also stimulates the production of helper T-cells by the thymus and restores the production of thymic hormones (Al-Daraji and Salih, 2012). Kidd et al.(2001) reported that dietary L-Arg level near the NRC (1994) recommendation should support proper immune system functions in healthy chicks.AI-Daraji and Salih (2012) reported that chickens fed 0.06% L-Arg achieved a significant increase in white blood cell number than 0.02% and 0.04% L-Arg Therefore, L-Arg directly or indirectly by its metabolites can improve the immune response of poultry challenged with infectious diseases. Supplementing L-Arg significantly decreased H/L ratio Al-Daraji and Salih (2012).

Therefore, the present study were conducted to evaluate the effect of dietary supplementation with different levels of L-Arg above the levels recommended by NRC (1994) on egg production, reproduction, egg quality and some physiological and immunological parameters.

MATERIAL AND METHODS

The present investigation was conducted at El-Azab Poultry Research Station, Fayoum, Egypt. The study aimed to evaluate the effect of dietary supplementation with different levels of L-Arg above the levels recommended by NRC (1994) on egg production, reproduction performance, egg quality and some physiological and immunological parameters in two local strains during winter months(November, December and January). The experimental period started when the hens were 40 week old, and ended to three months. Two local strains Fayoumi (Fa) and Golden Montazah (GM) were used with a total number of 180 laying hensand18males (90 females and 9 males from each strain) had passed a visual health inspection. Selected male and female divided randomly into 3 groups /strain each group consisted of 3 replicates (10femaleand 1 male/replicate). Each replicate housed in 1.2 × 1.2 m floor pens. Management procedures (temperature and lighting program) were similar during the experimental period. Hens were maintained on a 16 h light:8 h darkness. Daily high and low ambient temperatures were recorded using digital thermometer. Relative humidity recorded daily at 12 p.m. Mean monthly values of temperatures and relative humidity were summarized in Table2.

Diets were formulated based on expected feed consumption and age of hens. Recommendations for dietary nutrients were based on NRC (1994) except for L-Arg. Water and feed were available for ad-libitum consumption throughout the experiment. A basal diet(Table, 1) mainly based on corn, corn gluten meal, Wheat bran and soybean meal was used and served as the control group(T_1)(contain 0.700% L-Arg). Crystalline amino acid L-Arg was supplemented by 2% and 4% as a percentage of dietary L-Arg to achieve 0.714% L-Arg (T_2) and 0.728% L-Arg (T_3) respectively. During the experimental period, feed consumption and egg numbers were recorded daily. Eggs were weighed daily, egg mass per hen per day were calculated. Egg mass production per hen per day was calculated as laying percentage multiplied by average egg weight of the hen (daily egg mass production, g/hen per d) according to Bonekamp et al., (2010). Feed intake was determined per replicate. Feed conversion ratio was calculated as

gram feed consumption per hen per day divided by gram egg mass per hen per day according to EL-Husseiny et al. (2008).Crude protein conversion calculated according to (Bunchasak et al., 2005) from the following equation.

$$\text{Crude protein conversion} = \frac{\text{Daily Protein intake}}{\text{Daily Egg mass}}$$

At the last month of the experiment three hatches were conducted weekly to determine hatchability parameters. Sixty eggs collected weekly from each replicate (180 eggs from each treatment) and stored at 18°C and then set in a chick master incubator at 37.5°C and 55% RH. Eggs were candled at day 7 and 14 of incubation and transferred for hatching on d 18 of incubation. During candling, eggs were characterized as being infertile or containing early dead embryos (less than 7 d) or late dead embryos (more than 7d and less than 14 d). At the end of incubation period un-hatched eggs were broken to determine deformed (Abnormalities) embryos. Hatched chicks were sexed immediately after incubation and female sex ratio was determined. Thirty six cockerels (18 from each strain) were housed in individual cages, each 6 cockerels fed one of the experimental diets. All males received 16 h of light daily throughout the experiment Semen volume, pH, and color were determined immediately after the collection. Semen volume was measured with the use of a graduated collection tube. Semen pH was determined with the aid of a highly sensitive p-Hydrion test paper (pH value ranges from 6.4 to 8.0) Motility scored (from 1 to 10 grades) using light microscope at 100 magnification where Eosin-Nigrosine stain was used to determine the percent of morphologically abnormal sperm cells. Sperm concentration was determined by using haemocytometer.

At the end of the experiment random samples of eggs representing controls and treatments (10eggs/replicate) for each strain were taken to estimate egg quality parameters as albumin weight %, yolk weight% and shell weight%. Albumin height was measured in millimeters by using tripod micrometers. Haugh unit was calculated according to(Haught, 1937). Yolk index and color were estimated. Shell thickness was measured to nearest 0.01mm accuracy with a micrometer. Shell surface area (Sa) calculated according to Hamilton (1978). Shell weight per unit of surface area (Sw/Sa)was calculated by divided shell weight/surface area

Two blood samples were taken from each replicate within each strain in all groups. Blood samples were collected from wing vein in heparinized test tubes. Fresh blood samples were taken to determine hemoglobin (Hb), hematocrit (Ht), total count of red blood cells (RBCs), total count of white blood cells (WBCs) and their differentiations (Heterophils%, lymphocytes%, and H/L ratio).All measurements conducted according to Clark et al. (2009)

The following parameters were calculated:-

Mean Corpuscular Volume (MCV) (µm3) = Ht × 10/ RBC's

Mean Corpuscular Hemoglobin (MCH) (picograms "10^{-12}gms"/cell) = Hb × 10/ RBC's

Mean Corpuscular Hemoglobin Concentration (MCHC) (g/dl) = HbX100/ Ht

Statistical analyses:General linear model: general factorial design procedure of SPSS. (2007) procedure was used to detect the effect of strain, arginine levels and its interaction. Along with Duncan's multiple range test to separate means (Duncan, 1955). All statements of significance were based on a probability level of (0.05).

RESULTS AND DISCUSSION

Egg production performance: As shown in table 3 L-Arg supplementation caused significant increase in egg production percent and egg mass during the whole experimental period. There was at least 6% of extra production over the control. These results are consistent with those obtained by Silva et al (2012), who found increasing egg production percentage and egg mass as a function of L-Arg dietary supplementation. According to Najib and Basiouni (2004), this effect suggests that the increase in egg production may have been due to the specific stimulating effect of L-Arg on the secretion of LH (luteinizing hormone), which acts directly on the ovary and the follicles (Basiouni, 2009). Through experimental period L-Arg levels didn't influence average egg weight. This result agrees well with that of Basiouni et al. (2006).

Strain differences of overall egg production percent were not significant. This results disagree with findings of Osman et al. (2010) who reported that GM had higher significantly egg production than Fa. This may be due to this experiment was conducted during winter months, where Fa attained their maximum egg weight during winter, while the heavy breed GM reached its maximum egg weight later on during spring (Amer, 1965). Nevertheless GM had higher significantly egg mass than Fa. This is due to average egg weight of GM was higher significantly than Fa (Table, 3).

Except for first month feed intake did not generally differ significantly due to L-Arg supplementation (Table, 4). Wu et al. (2011) showed that the addition of L-Arg had no significant effect on feed intake. Feed conversion and crude protein conversion significantly improved, as the dietary L-Arg level increased (Table, 4). These results agree with those obtained by Basiouni et al. (2006). Improving in feed parameters may be due to L-Arg is considered a potent secretagogue of insulin, growth hormone, and the insulin-like growth factor I (IGF-I) in the blood stream (Fernandes and Murakami 2010). Moreover exclusively vegetarian diets may not provide an adequate supply of L-Arg, which is required for maximum production. Arginine will spare the utilization of energy and nitrogen for L-Arg synthesis (Ball et al., 2007).

Egg quality: The data in Table 5 indicated that L-Arg level did not affect significantly on egg quality. These results agree with the findings of Silva et al. (2012) who reported that egg quality parameters were not influenced by different L-Arg levels. Significant strain effect was observed in all parameters except for yolk color and shape index. , the eggs from GM hens were heavier than those from Fa hens, with more albumen% but less shell thickness, shell%, yolk index, shape index% and haugh unit. These results also supported with similar findings of (Osman et al., 2010). In this respect Silversides and Scott (2001) found that major influences on albumen quality are the strain and age of a laying hen.

Reproduction performance:

Incubation parameters: Hatching results are shown in Table 6. Arginine supplementation caused significant increase in fertility% and hatchability%, conversely female% and early dead % decreased significantly. Results of hatching parameters can be demonstrated by Al-Asadi (2013) who reported that in ovo administration of L-Arg at 18 d of age increased fertility and hatchability. Similar results found in ovo administration of L-Arg into Japanese quail embryos (Al-Daraji et al., 2012). Dead embryos decreased significantly during the first week and insignificantly during the second week of incubation. This may be due to L-Arg was critical for the growth of chicken embryo (Toghyani et al., 2012). Hatching parameters found in present study agree with the values of the genetic strain manual and did not differ between the two experimental strains.

One of the most important observations in this study was female ratio. Female ratio decreased significantly by L-Arg supplementation. This finding support L-Arg supplementation especially with broiler breeder hens. Since the males grow faster than females. We have no available explanation demonstrated this finding.

Semen parameters: Supplementation of L-Arg improved significantly semen quality. Semen volume, motility and sperm concentration increased significantly by L-Arg supplementation. On the other hand abnormality reduced significantly by L-Arg supplementation. Our results agree with the findings of Perez Garcia and Cuellar (1970) who reported that semen quality (ejaculate volume, sperm concentration, motility and abnormal spermatozoa) of group given 50 mg supplementary L-Arg /day for 60 days markedly improved between days 30 and 40 of treatment.

Improving semen quality via L-Arg may be due to a positive effect of nitric oxide (NO)-donating amino acids like L-Arg, attributed to improve blood circulation and alleged reduction of oxidative stress (Ciftci et al., 2009). Nitric oxide has a dual function, being both a cytotoxic and necessary molecule for normal sperm production. Moreover another metabolic pathway that involves L-Arg is the synthesis of polyamines. Polyamines (putrescine, spermine and spermidine) function in membrane transport (Schaefer and Seidenfeld, 1987) cell growth, cell proliferation and cell differentiation (Schuber 1989). Spermidine and spermine are highly concentrated in cell types that have a high demand on oxidant protection, such as sperm (El-Taieb et al., 2009). Polyamines are essential for sperm motility (Steven, 2000) and serve as natural acceptor amines for seminal transglutaminase action, thus attenuating protein cross-linking and premature clotting of the ejaculate (Rubinstein and Breitbart, 1991). Spermine showed positive correlation with spermatozoa motility (Valsa et al., 2013)

Physiological and immunological parameters: Table 7 showed that adding L-Arg to the diet of laying hens at levels higher than the levels recommended by the NRC (1994) did not have a negative effect on physiological performance of birds, as indicated by the non significant differences between treatment groups as regards RBC, PCV, Hb, MCV, MCH and MCHC. These results are in agreement with Atakisi et al. (2009), Emadi et al. (2010 and 2011) and Al-Hassani, (2011). Atakisi et al. (2009) found that increasing the L-Arg level in the diet had improved some blood traits and did not have a negative impact on those characters.

Supplementing L-Arg to the diet of laying hens resulted in enhancement of immune response as indicated by significant increase in WBC in comparison with control group. On the other hand, adding L-Arg to laying hens ration didn't cause any stress on birds as indicate by the significant decrease in H/L ratio as compared with control group. It was shown from Table 7 that dietary supplementation with different levels of L-Arg resulted in significant increase in WBC and percentage of lymphocyte cells and significant decrease in percentages of heterophilus cells as compared with control group. These results also supported with findings of Al-Hassani, (2011) dietary supplementation with different levels of L-Arg resulted in significant increase in WBC as compared with control group. In the current experiment, the L-Arg treated groups recorded low values of H/L ratio compared to the control group which may be refers to the role of L-Arg in alleviating the impact of stress (Tong and Barbul, 2004). Since this experiment was conducted during winter months and the recorded subsequence temperature degree during the whole experiment period was less than recommended. The H/L ratio should be a better measure of long-term changes in the

environment and the concentration of corticosteroids in the blood should be a better measure of short-term changes. Therefore, the H/L ratio is a good measure of the chicken's perception in its environment and increasing H/L ratio indicated that the birds were under stress. Mendes et al. (1997) indicated that L-Arg alleviate the effects of heat stress in broiler that was raised in hot climate. Therefore, the reason of low H/L ratio in the L-Arg supplemented groups compared to control group, may be explained by the effects of L-Arg in alleviating the influence of heat stress.

Improving cellular immunity by L-Arg supplementation observed via many authors. D'Amato, and Humphrey, (2010) identified markers of L-Arg utilization in different leukocyte populations that is responsive to dietary L-Arg levels. Jahanian, (2009) indicates that the immunomodulatory action of L-Arg in the sophisticated immune system is mediated mainly through cellular immune responses rather than humoral ones.

In summary, this study demonstrates that dietary supplementation of L-arginine above NRC (1994) improved egg production, reproduction performance and enhanced cellular immunity.

Table(1): Composition and calculated analysis diets.

Ingredients	**%**	**Calculated analysis**	
Yellow corn	65.00	CP	15.14
Soybean meal (44% CP)	5.30	ME.	2786.49
Corn gluten (60% CP)	9.00	Ca	3.45
Wheat bran	12.00	Av.P	0.37
Di-calcium phosphate	2.39	Lys.	0.70
Lime stone	5.63	Met.	0.31
Salt	0.37	SAA	0.61
Premix	0.30	Na	0.17
DL- methionine	0.01	L-Arg	0.70
		L-Arg 2%	0.014
		L-Arg 4%	0.028
		Total L-Arg2%	0.714
Total	100	Total L-Arg 4%	0.728

Premix contain per 3kg vit A 12 000 000, vit D3 3000 000 IU, vit E 50000mg, vit K3 3000mg , vit B1 2000mg, vit B2 7500mg, vit B6 3500 mg, vit B12 15mg, Pantothenic acid 12000mg, Niacin 30000mg, Biotin 150mg, Folic acid 1500mg, Choline 300gm, Selenium 300mg, Copper 10000mg, Iron 40000mg, Manganess 80000mg, Zinc 80000mg, Iodine 2000mg, Cobalt 250 mg and CaCO3 to 3000g.

Table (2): Experimental design (Arginine levels and strain types), ambient temperature and relative humidity.

Strain	**Fa**		**GM**
Treatment	1 2 3		4 5 6
Basal diet (L-Argof basal diet)	0.700		0.700
L-Argof basal diet+(2%L-Argof basal diet)	0.714		0.714
L-Argof basal diet+ (4%L-Argof basal diet)	0.728		0.728
Temperature and Relative humidity	Temperature		Relative humidity
Experiment months	High	Low	
First month	26	16	45%
Second month	20	15	40%
Third month	18	13	30%

Table(3): Effect of strain, arginine levels and its interaction on egg production performance.

Parameters	Egg production percent				Egg mass per hen per day (gm)				Average egg weight (gm)			
Main Factors	Month			Over-all	Month			Over-all	Month			Over-all
	1st	2nd	3rd		1st	2nd	3rd		1st	2nd	3rd	
Arg level												
Arg 0%	35.31b*	49.76b	52.59b	45.93b	16.95b	24.14	25.59b	22.25b	47.07	48.36	48.44	47.95
Arg 2%	36.63b	55.01a	64.87a	52.17a	17.42b	26.22	31.11a	24.92a	46.73	47.77	48.87	47.79
Arg 4%	45.47a	54.07a	62.66a	54.07a	21.44a	25.73	30.62a	25.93a	47.10	47.73	48.70	47.85
SE.	±0.01	±0.01	±0.01	±0.01	±0.59	±0.65	±0.70	±0.43	±0.17	±0.16	±0.14	±0.10
P value	0.001	0.015	0.001	0.001	0.001	N.S.**	0.001	0.001	N.S.	N.S.	N.S.	N.S.
Strain												
Fa	33.63b	53.87	62.26a	49.92	15.07b	24.67	28.96	22.90b	44.65b	45.94b	46.37 b	45.65b
GM	44.64a	52.02	57.81b	51.53	22.14a	26.06	29.26	25.84a	49.29a	49.97a	50.98 a	50.08a
SE.	±0.01	±0.01	±0.01	±0.01	±0.48	±0.53	±0.57	±0.35	±0.14	±0.13	±0.11	±0.80
P value	0.001	N.S.	0.007	N.S.	0.001	N.S.	N.S.	0.001	0.001	0.001	0.001	0.001
Treatments												
Fa + Arg 0%	29.96c	52.84	57.96b	46.92bc	13.52d	24.46b	27.11cd	21.70c	44.96b	46.46c	46.55c	45.99c
Fa + Arg 2%	27.64c	53.52	67.30a	49.49b	12.24d	24.22b	31.10ab	22.52c	43.88c	45.32d	46.07c	45.09d
Fa + Arg 4%	43.28ab	55.26	61.53ab	53.36a	19.44c	25.32b	28.66bc	24.48b	45.11b	46.03c	46.48c	45.87c
GM+Arg 0%	40.66b	46.68	47.23c	44.95c	20.38bc	23.83b	24.08d	22.81c	49.18a	50.25a	50.33b	49.91b
GM+Arg 2%	45.62ab	56.50	62.43ab	54.85a	22.60ab	28.22a	31.13ab	27.32a	49.59a	50.23a	51.67a	50.50a
GM+Arg 4%	47.66a	52.89	63.78ab	54.85a	23.44a	26.13ab	32.58a	27.39a	49.10a	49.43b	50.92b	49.82b
SE.	±0.02	±0.02	±0.02	±0.01	±0.83	±0.92	±0.99	±0.61	±0.25	±0.23	±0.20	±0.14
P value	0.001	N.S.	0.005	0.012	0.001	0.036	0.002	0.009	0.001	0.003	0.001	0.001

*a,b,...= Means in the same column with different superscripts, differ significantly (P<0.05);
** N.S. = Not Significant (P>0.05).

Table(4): Effect of strain, arginine levels and its interaction on feed intake, conversion and crude protein conversion.

Parameters	Feed intake (gm)				Feed conversion ratio				Crude protein conversion			
Main Factors	Month			Over -all	Month			Over-all	Month			Over -all
	1st	2nd	3rd		1st	2nd	3rd		1st	2nd	3rd	
Arg level												
Arg 0%	93.30^{ab}*	101.78	105.32	100.13	5.57^{a}	4.23^{a}	4.13^{a}	4.64^{a}	0.84^{a}	0.64^{a}	0.62^{a}	0.70^{a}
Arg 2%	85.89^{b}	100.85	112.25	99.66	5.09^{b}	3.86^{b}	3.61^{b}	4.19^{b}	0.77^{b}	0.58^{b}	0.54^{b}	0.63^{b}
Arg 4%	101.69^{a}	96.19	107.00	101.63	4.78^{c}	3.74^{c}	3.48^{c}	4.00^{c}	0.72^{c}	0.56^{c}	0.52^{c}	0.60^{c}
SE.	±3.07	±2.57	±2.64	±1.65	±0.02	±0.02	±0.01	±0.03	±0.01	±0.01	±0.01	±0.01
P value	0.001	N.S.**	N.S.	N.S.	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Strain												
Fa	83.76^{b}	97.92	104.71^{b}	95.47^{a}	5.59^{a}	3.98^{a}	3.63^{b}	4.40^{a}	0.84^{a}	0.60^{a}	0.55^{b}	0.66^{a}
GM	103.49^{a}	101.29	111.66^{a}	105.48^{b}	4.69^{b}	3.91^{b}	3.85^{a}	4.15^{b}	0.71^{b}	0.59^{b}	0.58^{a}	0.63^{b}
SE.	±2.51	±2.09	±2.16	±1.35	±0.02	±0.02	±0.01	±0.03	±0.01	±0.01	±0.01	±0.01
P value	0.001	N.S.	0.023	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Treatments												
Fa + Arg 0%	80.73^{b}	101.48	111.54^{ab}	97.92^{b}	5.95^{a}	4.17^{a}	4.12^{a}	4.74^{a}	0.90^{a}	0.63^{a}	0.62^{a}	0.71^{a}
Fa + Arg 2%	68.93^{b}	95.96	107.89^{bc}	90.93^{c}	5.62^{b}	3.97^{c}	3.47^{d}	4.35^{c}	0.85^{b}	0.60^{c}	0.52^{d}	0.65^{c}
Fa + Arg 4%	101.63^{a}	96.33	94.72^{d}	97.56^{b}	5.22^{c}	3.82^{d}	3.30^{e}	4.11^{d}	0.79^{c}	0.58^{d}	0.50^{e}	0.62^{d}
GM+Arg 0%	105.87^{a}	102.09	99.09^{cd}	102.35^{ab}	5.18^{c}	4.30^{b}	4.13^{a}	4.54^{b}	0.78^{c}	0.65^{b}	0.62^{a}	0.68^{b}
GM+Arg 2%	102.86^{a}	105.74	116.60^{ab}	108.40^{a}	4.57^{d}	3.75^{d}	3.75^{b}	4.02^{d}	0.69^{d}	0.57^{d}	0.57^{b}	0.61^{d}
GM+Arg 4%	101.75^{a}	96.05	119.28^{a}	105.69^{a}	4.33^{e}	3.67^{e}	3.67^{c}	3.89^{e}	0.65^{e}	0.55^{e}	0.55^{c}	0.59^{e}
SE.	±4.35	±3.63	±3.73	±2.33	±0.03	±0.03	±0.02	±0.04	±0.01	±0.01	±0.01	±0.01
P value	0.001	N.S.	0.001	0.016	0.001	0.001	0.001	0.031	0.005	0.001	0.001	0.036

*a,b,...= Means in the same column with different superscripts, differ significantly (P<0.05);
** N.S. = Not Significant (P>0.05).

Table(5): Effect of strain, arginine levels and its interaction on egg quality.

Parameters / Main Factors	Yolk color	Shape index	Yolk index	Haugh unit	Albumin%	Yolk %	Shell %	Shell thickness	SA	SW/SA
Arg level										
Arg 0%	8.20	76.39	36.89	86.35	59.54	30.65	9.81	4.14	62.07	75.97
Arg 2%	8.14	75.19	36.39	83.63	58.98	31.09	9.93	4.18	61.11	76.35
Arg 4%	8.27	77.06	36.93	81.81	60.37	29.84	9.79	4.00	60.82	75.94
SE.	0.23	0.77	0.70	1.71	0.64	0.51	0.34	0.06	0.69	2.57
P value	N.S.**	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Strain										
Fa	8.40	77.09	37.64^{a}*	77.70^{b}	57.45^{b}	31.76^{a}	10.80^{a}	3.87^{b}	59.03^{b}	82.07^{a}
GM	7.99	75.33	35.84^{b}	90.17^{a}	61.81^{a}	29.30^{b}	8.89^{b}	4.34^{a}	63.63^{a}	70.11^{b}
SE.	0.18	0.63	0.57	1.39	0.53	0.42	0.28	0.05	0.56	2.09
P value	N.S.	N.S.	0.030	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Treatments										
Fa + Arg 0%	8.34	77.35	37.95	83.59^{bc}	57.30	31.94	10.77	3.85	59.89	81.96
Fa + Arg 2%	8.47	75.99	36.29	78.64^{c}	56.66	32.32	11.03	3.90	57.83	82.97
Fa + Arg 4%	8.40	77.95	38.67	70.86^{d}	58.39	31.02	10.59	3.87	59.38	81.27
GM+Arg 0%	8.05	75.42	35.84	89.11^{ab}	61.78	29.36	8.86	4.43	64.24	69.97
GM+Arg 2%	7.80	74.40	36.50	88.62^{ab}	61.30	29.87	8.84	4.46	64.40	69.73
GM+Arg 4%	8.13	76.18	35.19	92.76^{a}	62.36	28.67	8.98	4.12	62.26	70.61
SE.	0.32	0.73	0.99	2.42	0.91	0.73	0.48	0.09	0.97	3.63
P value	N.S.	N.S.	N.S.	0.004	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

SA: Surface area – SW/SA: shell weight/unit of Surface area

*a,b,...= Means in the same column with different superscripts, differ significantly ($P<0.05$); ** N.S. = Not Significant ($P>0.05$).

Table (6): Effect of strain, arginine levels and its interaction on reproductive performance.

Parameters	Hatchability parameters							Semen quality				
Main Factors	**Fertility%**	**Hatch. t. egg%**	**Hatch. f. egg%**	**Female ratio%**	**dead1**	**dead2**	**deformed**	**Volume mm^3**	**Mot**	**Ph**	**Conc. $10^9/cm^3$**	**Abn**
Arg level												
Arg 0%	90.97^{b}*	81.25^{b}	89.21^{b}	51.39^{a}	4.86^{a}	2.50	2.36	0.35^{c}	6.67^{b}	7.34	2.13^{b}	17.75^{a}
Arg 2%	93.20^{ab}	86.25^{a}	92.47^{a}	42.75^{b}	3.33^{b}	2.09	1.53	0.43^{b}	7.42^{a}	7.37	2.38^{a}	16.92^{ab}
Arg 4%	94.72^{a}	88.33^{a}	93.23^{a}	40.87^{b}	3.06^{b}	1.67	1.67	0.51^{a}	8.00^{a}	7.43	2.38^{a}	15.50^{b}
SE.	±0.79	±1.60	±1.10	±1.96	±0.53	±0.31	±0.26	±0.02	±0.03	0.03±	±0.06	±0.60
P value	0.008	0.012	0.035	0.001	0.046	N.S.**	N.S.	0.001	0.003	N.S.	0.010	0.038
Strain												
Fa	93.15	85.65	91.89	45.19	3.70	2.13	1.67	0.37^{b}	8.06^{a}	7.37	2.63^{a}	14.78^{b}
GM	92.78	84.91	91.39	44.81	3.70	2.04	2.04	0.49^{a}	6.67^{b}	7.38	1.97^{b}	18.67^{a}
SE.	±0.64	±1.304	±0.90	±1.60	±0.43	±0.26	±0.22	±0.02	±0.02	0.03±	±0.05	±0.49
P value	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	0.001	0.001	N.S.	0.001	0.001
Treatments												
Fa + Arg 0%	91.95	82.50	89.67	51.37	4.72	2.50	2.22	0.27	7.83^{a}	7.32	2.33^{b}	15.33
Fa + Arg 2%	94.17	87.22	92.60	38.81	3.06	1.95	1.11	0.38	8.17^{a}	7.37	2.77^{a}	14.67
Fa + Arg 4%	93.06	85.28	91.55	40.10	3.33	1.95	1.67	0.45	8.17^{a}	7.43	2.80^{a}	14.33
GM+Arg 0%	93.33	87.22	93.39	45.40	5.00	2.50	2.50	0.43	5.50^{c}	7.37	1.93^{c}	20.17
GM+Arg 2%	90.00	80.00	88.75	51.41	3.61	2.22	1.95	0.48	6.67^{b}	7.37	2.00^{c}	19.17
GM+Arg 4%	95.28	89.45	93.86	42.92	2.78	1.39	1.67	0.57	7.83^{a}	7.42	1.97^{c}	16.67
SE.	±1.11	±2.26	±1.56	±2.77	±0.74	±0.44	±0.372	±0.03	±0.04	0.05±	±0.09	±0.89
P value	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	0.027	N.S.	0.042	N.S.

Hatch. t. egg%: hatchability per total eggs – Hatch. f. egg%: hatchability per fertile eggs
dead1: early dead embryos (less than 7 d) – dead2: late dead embryos (7d : 14 d)
Mot.:Motility Degree 1:10 – Conc. : Concentration $\times 10^9$ – Abn.: abnormality
*a,b,...= Means in the same column with different superscripts, differ significantly ($P<0.05$); ** N.S. = Not Significant ($P>0.05$).

Table (7): Effect of strain, arginine levels and its interaction on red blood cell indices and cellular immunity.

Parameters	Red blood cell indices						Cellular immunity			
Main Factors	**R.B.C ×10^6**	**Hb mg/dl**	**Ht %**	**MCV µm3**	**MCH picograms**	**MCHC g/dl**	**WBC ×10^3**	**H%**	**L%**	**H/L**
Arg level										
Arg 0%	3.10	11.92	30.13	97.41	38.66	39.94	15.83^{b}*	30.90^{a}	60.87^{b}	0.51^{a}
Arg 2%	3.14	12.13	31.15	100.07	39.00	39.14	16.86^{a}	29.00^{ab}	63.32^{ab}	0.46^{ab}
Arg 4%	3.19	12.150	32.41	102.14	38.46	37.73	16.98^{a}	27.78^{b}	64.55^{a}	0.43^{b}
SE.	±0.06	±0.30	±0.71	±3.00	±1.11	±1.261	±0.23	±0.86	±0.86	±0.02
P value	N.S.**	N.S.	N.S.	N.S.	N.S.	N.S.	0.003	0.041	0.016	0.028
strain										
Fa	3.39^{a}	12.09	32.83^{a}	97.28	35.86^{b}	36.97^{b}	16.63	29.39	62.54	0.47
GM	2.90^{b}	12.03	29.63^{b}	102.47	41.55^{a}	40.90^{a}	16.48	29.06	63.28	0.46
SE.	±0.05	±0.24	±0.58	±2.45	±0.91	±1.030	±0.19	±0.70	±0.70	±0.02
P value	0.001	N.S.	0.001	N.S.	0.001	0.011	N.S.	N.S.	N.S.	N.S.
Treatments										
Treatments	3.32	11.93	31.95	96.39	36.13	37.46	15.98	30.25	61.48	0.50
Fa + Arg 0%	3.38	12.17	32.73	97.73	36.20	37.34	16.88	29.70	62.40	0.48
Fa + Arg 2%	3.47	12.18	33.80	97.72	35.25	36.12	17.03	28.23	63.75	0.45
Fa + Arg 4%	2.88	11.90	28.30	98.44	41.19	42.42	15.68	31.55	60.25	0.53
GM+Arg 0%	2.90	12.08	29.57	102.41	41.80	40.95	16.83	28.30	64.23	0.45
GM+Arg 2%	2.92	12.12	31.02	106.56	41.66	39.34	16.93	27.33	65.35	0.42
GM+Arg 4%	±0.09	±0.42	±1.004	±4.24	±1.57	±1.78	±0.33	±1.21	±1.22	±0.03
SE.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

R.B.C: Red blood cell count – Hb: hemoglobin concentration – Ht: hematocrit %
H%: heterophilus% – L%: lymphocytes% –H/L: heterophilus/lymphocytes ratio
MCV: Mean Corpuscular Volume – MCH: Mean Corpuscular Hemoglobin
MCHC: Mean Corpuscular Hemoglobin Concentration
*a,b,..= Means in the same column with different superscripts, differ significantly (P<0.05)
** N.S. = Not Significant (P>0.05).

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الملخص العربي

تأثيرإضافة إلـارجينين على الأداءالإنتاجي والتناسلي والاستجابة المناعية والتعبيرالجيني في سلالتين منا لدجاج المحلي: ١- الأداء الإنتاجى و التناسلى و الأستجابه المناعيه

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الملخص العربي: اجريت هذه الدراسة بمحطة بحوث الدواجن بالفيوم بهدف تقييم اضافة الحامض الاميني إلـ ارجينين بكميات اعلى من توصيات (NRC, 1994) على الاداء الانتاجي والتناسلي للدجاج البياض وصفات جودة البيض وبعض القياسات الفسيولوجية والمناعية خلال فصل الشتاء. تم البدء في هذه التجربة عند عندما وصل الدجاج الى عمر ٤٠ اسبوع واستمرت لمدة ٣ شهور. وقد استخدم لذلك ٩٠ دجاجة و٩ ديوك من كل من دجاج الفيومي والمنتزه الذهبي. قسمت الديوك والدجاجات الى ٣ مجموعات بحيث تحتوي كل معاملة على ثلاث مكررات، يحتوي كل مكرر على ديك و١٠ دجاجات. تم تسكين كل مكرر في بيوت مساحة البيت الواحد ١،٢×١،٢ م تحت نفس ظروف الرعاية ودرجات الحرارة وبرنامج الإضاءة. تم تكوين عليقة المقارنة كمعاملة اولى بحيث تحتوي على ٠،٧ ٪ إلـ ارجينين (طبقاً لاحتياجات(NRC, 1994) وتم اضافة الحامض الأميني إلـ ارجينين بمعدل ٢٪ ، ٤٪ من محتوى ارجينين العليقة لتكوين المعامل الثانية والثالثة بحيث تحتوي العليقة الثانية والثالثة على ٠،٧١٤ ، ٠،٧٢٨٪ ارجينين على الترتيب. تم تسكين ١٨ ديك من كل سلالة في اقفاص فردية. وتم تغذية كل ٦ديوك بعليقة من العلائق الثلاثة وذلك لدراسة جودة السائل المنوي. خلال فترة التجربة تم تقدير الغذاء المستهلك وعد البيض المنتج يوميا. تم وزن البيض يوميًا وتم حساب كتلة البيض/الفرخة/اليوم. تم حساب معامل تحويل الغذاء والبروتين. تم تفريخ ثلاث تفريخات خلال الشهر الثالث من التجربة. في نهاية التحربة تم تكسير ١٠ بيضات من كل مكرر لدراسات صفات جودة البيض. تم سحب عينتين من كل مكرر لدراسة القياسات المناعية والفسيولوجية.

هذا وقد تم الحصول على النتائج التالية:-

ادى اضافة الـ ارجنين بمستوى اعلى من (NRC, 1994)الى زيادة في النسبة المئوية لانتاج البيض بما لا يقل عن ٦٪ وزيادة كتلة البيض خلال فترة التجربة عن عليقة المقارنة. تحسن معنوياً معامل التحويل الغذائي ومعامل تحويل البروتين الخام. تحسنت صفات التفريخ و السائل المنوي باضافةالأرجينين بينما انخفضت نسبة الاناث للذكور. ولم يكن هناك اي تأثير عكسي للارجينين على الصفات الفسيولوجية. بينما تحسنت المناعة الخلوية باضافةالأرجينين. ولم يكن هناك اي تاثير معنوي للمعاملات على صفات جودة البيض.