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THE EFFECTS OF STOCKING DENSITY DURING PRODUCTION PHASE ON PHYSIOLOGICAL AND IMMUNOLOGICAL CHARACTERISTICS IN RELATION TO PRODUCTIVE PERFORMANCE OF DEVELOPED NATIVE LAYING HENS

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Abstract

The present study was conducted to evaluate some physiological, immunological and productive responses of two developed native laying hens to three stocking densities. A total of 450 hens and 50 cocks of Matrouh and Inshas strains (225 hens and 24 cocks of each) before sexual maturity (20 WK) were randomly chosen. Birds of both strains were allocated into three groups and reared on deep litter under natural light, environmental temperature, fed the same diets. Water was provided ad-lib (Free). The 1ST, 2nd and 3rd groups were placed in 10, 15 and 20 birds / m^2 (floor area unit) to achieve hen densities of 1000, 667 and 500 cm^2/ bird, respectively. The physiological and immunological effects were taken into consideration and assessed for improving productive performance. The experiment lasted for 4 months. The obtained results were as following:

(1) High stocking density group had significantly reduced body weight, feed consumption, egg production, fertility and hatchability in both strains compared with other groups.

(2) Humidity, litter pH, ammonia in house, body temperature and respiration rate increased as stocking density increased.

(3) The birds in 1st and 2nd groups gave the highest levels of plasma calcium, glucose, total protein, albumen, T4 hormone and Alkaline phosphatase, ALT and AST enzymes in both strains compared with the 3rd group.

(4) The birds in 1st group gave the highest levels of plasma, yolk and liver cholesterol LDL, HDL, total lipids and triglycerides in two strains compared with other groups.

(5) The birds in 1st and 2nd groups gave the highest levels of primary immuno- response against sheep red plod cells and Newcastle disease, high level of plasma globuline and high relative weights of thymus gland and spleen , as immune-related organs, in both strains compared with the 3rd group.

(6) Matrouh strain gave the best physiological, immunological and productive performance compared with Inshas in 1st and 2nd groups; but Inshas strain gave the highest levels of primary immuno response against sheep red plod cells compared with Matrouh strain.

The results suggest that increasing the number of birds to 15 birds /m^2 may give comparable physiological and immunological effects to 10 birds / m^2. The new aspect caused sharp decreases from 10 to 15 hens in the housing wages, labour and equipment costs per hen subsequently maximizing profits and increasing economic returns and give good biosecurity for rearing some native or local strains in the Egyptian villages.

INTRODUCTION

In the past, the number of birds in a given area was recognized as the sole method of expressing stocking density. Body weight appears to be a better indicator of bird performance and well- being / welfare than number of birds in a given space (Feddes *et al.,* 2002). Welfare concerns are influencing sales of poultry products, and stocking density is a major welfare concern (Food Marketing Institute and National Council of Chain Restaurants, 2003).

Maintaining a high stocking density is a common practice for the poultry industry because it allows for an increase of economic returns per unit floor space. Moreover, increases in hen density have been a trend in the commercial layer corporations to minimize the housing, wages, equipment costs, and subsequently maximizing profits. In the past few years, few investigators have examined the effects of stocking density during production phase on physiological and immunological characteristics, subsequently productive performance of laying hens. Early reports have shown that when hen densities are increased, egg production, egg weight, feed consumption and body weight gain were declined, while mortality rate increases. Reports of Anderson *et al.* (2004) generally support these conclusions.

Nowadays breeder investigators had selected small layer body weight besides the technological equipment become using in layer farms and the technicians become dexterity and more sensitive to layer corporations trade (Hester *et al.*; 2006). Tollba and El-Nagar (2008) studied the effect of housing two strains of developing Egyptian laying hens at three stocking density 8, 12 and 16 hens /m^2 floor space on productive performance, physiological stress and egg quality. They found that increasing stocking density decreased productive performance, egg quality and increasing physiological stress.

Most researches have shown that as cage density increases, body weight, feed consumption, egg production, egg weight decreased and feed efficiency reduced (Sohail *et al.,* 2001).

Also, Hester *et al.* (2006) reported that egg quality was better when hens were housed at low densities. They claimed that as the population and cage density increases, a physiological stress, may be the consequence, hence the performance of birds declined.

Tollba *et al.* (2006) and Tollba and El-Nagar (2008)suggested that the increasing social tension as crowding increases besides the wet litter and high ammonia levels are density – dependent and may , therefore , be an additional causal factor for lower performance fear in broilers and developing Egyptian laying hens , respectively .

Also, El-Sheikh and Ahmed (2006) observed that the high stocking density significantly decreased serum levels of T3 and T4 which might indicate that the lowering stocking density (8 birds/m^2) during summer improved thyroid function, liver function and decrease oxidative stress condition. However, Tollba *et al.* (2006) showed that the concentration of T3 was not influenced by maintaining the hens at different stocking densities (8, 12 and 16 bird/m^2). Patterson and Siegel (1998) reported no significant effect of cage density on antibody titer responses to SRBC's and heterophils to lymphocytes ratio. It is of interest to know and understand of what occurs as the number of birds per unit of floor space increased. This will help to increase our awareness of potential problems and may give the opportunity to take appropriate preventive actions.

Therefore, the objective of this study was to further investigate the effects of three stocking density 10, 15, and 20/ m^2 floor space during production phase on physiological and immunological characteristics in relation to productive performance of two developing native laying strains (Matrouh and Inshas) .

MATERIALS AND METHODS

The present study was carried out at Inshas Poultry Breeding Research Station ,Animal Production Institute, Agricultural Research Center ,Ministry of Agriculture ,Sharkia Governorate from June to September (2008).

A total of 450 pullets and 50 cocks (20 wk old) of Matrouh (Mat) and Inshas (Insh) strains (225 Matrouh strain and 225 Inshas strains) were used in this study.

The experiment (each strain) consisted of three treatment groups having nearly similar body weight. Male to female mating ratio was 1:10 and the groups were arranged as follows:

The 1st group included 55 birds in five replicates (10 pullets and one cock each) housed as 11 bird/ m^2.

The 2nd group included 85 birds in five replicates (15 pullets and 2 cocks each) housed as 17 bird/ m^2.

The 3rd group included 110 birds in five replicates (20 pullets and 2 cocks each) housed as 22 birds/ m^2.

In each treatment, the fifth replicate in each strain was housed in open system floor pens and fed the same basal diet (Table 1). Birds of both strains were allocated into three groups and reared on deep litter, under natural light, environmental temperature, fed the same diets and water.

The birds were submitted to the same conditions of management throughout the experimental period. Similar alive birds substituted the dead birds on day of death from a reserve stock to maintain constant densities.

Data collected (Measurements)

1. Productive traits

(a) Individual body weight was recorded every two weeks (to the nearest g) and total body gain was calculated during production phase (24 until 36 weeks of age).

Total Body weight gain: The average total body weight gain (TBG) was calculated biweekly and globally for each replicate according to the following equation: $TBG = W_2 - W_1$

Whereas: W_1= Body weight at the beginning of the period, W2= Body weight at the end of the period.

(b) Feed intake for hens per day was calculated every 2 weeks through the experimental period and total feed conversion was calculated during production phase (24 until 36 weeks of age).

Feed intake: Feed intake (FI) was calculated biweekly for each replicate according to the following equation:

Average feed intake per replicate = Feed intake in grams per pen / Number of hens in the same pen

Total Feed conversion (TFC) was calculated using the following formula:

Total Feed conversion = Average daily feed intake (g/hen) / Average daily egg mass (g/hen)

(c) Egg production

Egg number and egg weight (to the nearest 1g) for each hen were recorded daily and both egg production rate and egg mass were calculated.

Egg production rate = Egg number per pen / Number of hens in the same pen

Egg mass = Egg weight (g) X Egg number (egg) on the same day/hen.

Egg quality: ten eggs from each of the three groups were collected at 28, 32 and 36 weeks of age to determine egg quality traits. Eggs from each group were weighed, broken out and separated into shells, yolks and albumens, the weights of yolk, albumen and shell (with membranes) were recorded.

Fertility and hatchability percentages at 28, 32 and 36 wk were measured by collecting 100 eggs for all groups during 4 weeks, and then replicated for three patches.

2. Environmental traits

The following measurements were taken with frequency of data collection and include: house humidity, litter pH and litter ammonia (twice a day) at 32 and 36 weeks of age.

3. Physiological traits

Body temperature and respiration rate were recorded at 32 and 36 wk of age.

A. Plasma contents

Blood samples were collected at 32and 36 weeks of age to evaluate the blood chemical constituents.

Five blood samples were randomly obtained from 5 hens / treatment /strain, with of number 30 samples for all groups.

For each sample, 3 ml blood was collected by brachial vein puncture in heparinized tubes. The tubes were centrifuged at 4000 rpm for 15 minutes; clear plasma was separated, and then stored in a deep freezer at -20$^{o c}$ until biochemical analysis.

Plasma calcium, phosphorus, glucose, total protein, albumin, and calculate globulin , T3, T4 hormones and activities of Alkaline phosphatase , Alanine transaminase (ALT) and Aspartate transaminase (AST) enzymes, cholesterol, high density lipoprotein (HDL) and low density lipoprotein (LDL), total lipids and triglycerides were determined by chemical analysis.

Sample of 0.5 ml plasma was transferred into sterile tube containing 6 ml glacial acetic acid, mixed, and then 4 ml ferric chloride reagent was added, shaken and cooling. The color was measured at 550 nm wave length by using the spectrophotometer.

The cholesterol value (mg) was calculated as the sample /standard x200. The standard solution was obtained from the kit. Determination of plasma total lipids determined using commercial kits. Sample of plasma was mixed with sulfophosopho-vanillic mixture and measured at wave length 525 nm by spectrophotometer.

Total lipids (mg) were calculated as sample/ standard x600 which the standard solution was obtained from the kits.

HDL, LDL, total lipids, triglycerides, total protein, albumin, calcium, phosphorus, glucose. Triiodothyronine (T3) and thyroxine (T4) hormones were determined using RIA by commercial kits, and T3 /T4 ratio was calculated. Blood analysis was done by using available commercial kits.

B. yolk cholesterol and lipids contents

After measuring the egg quality, yolk for ten samples from each treatment from the two strains were taken, separated from the broken eggs, was calculated and extracted to determine cholesterol, LDL HDL, triglycerides and total lipids by using commercial kits.

C. Liver cholesterol and total lipids contents

Liver samples were prepared to determine the cholesterol, LDL HDL, triglycerides and total lipids. Liver was rapidly dissected out, and chilled in ice tank. One gram of liver was put in glass containing 0.1 ml phosphate buffer solution (pH 7.4) and homogenized with an electric homogenizer. The homogenized solution was centrifuged at 2000 rpm for 5 minutes; clear homogenized solution was separated, stored in deep- freezer at -20 ^{oc} until analysis. Cholesterol, LDL HDL, triglycerides and total lipids were determined using commercial kits.

D. Immune responses (humoral immunity)

1. Antibody titer against SRBC

To study the effect of stocking density on immune response, 10 pullets /treatment at 36 weeks of age, were injected intravenously with 1ml of SRBC suspension (0.07ml packed SRBC mixed with 0.93 ml physiological saline, 0.9% Nacl). The SRBC were obtained from Texel sheep and washed three times in a physiological saline.

Other 10 pullets were injected with 1 ml physiological saline (0.68% Nacl) and served as control group.

To measure the secondary response, the same antigens were injected 4 weeks following the first challenge to the same treated pullets. Seven days following the antigen challenge, blood samples were collected and frozen until the measurement of primary and secondary responses.

2. Antibody titer against avian Newcastle disease virus (NDV)

At 36weeks of age, hemagglutination-inhibition (HI) test was applied for determination of antibody response in plasma samples by manual of diagnostic tests after 30 days of immunization of the flock by lasota vaccine against Newcastle disease virus (NDV) and commercial ELISA kits were used for detection of antibodies against nucleoprotein and matrix of NDV (biochek b. v, gouda ,Holland).

E. Carcass and internal organs weights

At 32 and 36 weeks of age ,five hens per group were weighed , sacrificed and some internal organs were removed (heart ,liver ,gizzard ,stomach ,gallbladder , kidneys ,intestine ,pancreas ,ovary , oviduct and abdominal fat) and some immune organs (spleen and thymus gland) were weighed to nearest 0.1gm .The oviduct length , number of large and small ovarian follicles and the percentage of carcass and the relative weight of these organs were calculated relative to body weight .

Statistical analysis

All data of Matrouh or Inshas hens were subjected to computerize two -way analysis of variance, and Duncan's multiple range test procedures using (SAS software, 2000). The percentage values were transferred to percentage angle using arcsine equation before due statistical analysis.

RESULTS AND DISCUSSION

1 - Productive performance

1. 1 -Total body gain

Almost high stoking densities were associated with significantly (P<0.05) lower total body weight gain. Birds reared at the highest stocking density (20 birds/ m^2) gained significantly less weight compared to the other two treatments as shown in Table 2 . In this regard, there was a tendency for the hens to be heavier as density decreased. These results were more profound in birds reared at the highest stocking density and observed in both strains. Also Matrouh strain was higher in total body weight gain compared with Inshas strain. The same results were reported with Carey (1987) and with commercial laying hens and Tollba and El-Nagar (2008) with developed native laying hens.

1. 2 - Feed intake and total feed conversion

Feed intake was significantly (P<0.05) decreased as stocking densities increased, while total feed conversion was significantly (P<0.05) increased as stocking densities increased (Table 2). Matrouh strain was higher in feed intake and total feed conversion compared with Inshas strain. These results were observed in both strains and are agree with previous finding of (El-Deek and Al-Harthi, 2004) who reported that greater stoking densities were associated with significant lower feed consumption and attributed that to increased competition for feeding space. However, Sohail *et al,* (2001) reported that increasing density resulted in reduction of feed usage, and feed conversion was not affected.

1. 3 - Egg Production, egg weight and egg mass

Data in Table 2 pointed out that, high stocking densities resulted in a significant (P<0.05) reduction in egg production rate and egg mass. It is obvious that egg production rate and egg mass tended to reduce as floor area per hen reduced or number of hens per unit of area increased.

However, high stocking densities were not significantly influencing egg weights in either strain. Also, Matrouh strain was higher in egg production percentage and egg mass compared with Inshas strain, but these is no significant difference in egg weight between the two strains.

The present results of feed consumption may explain the results of egg production and egg mass. Similarly, Sohail *et al,* (2001) concluded that cage density had no effect on egg weight. Also, Sohail *et al,* (2001) reported that higher density had a significant ($P<0.05$) effect on hen-day egg production and ($P<0.05$) egg mass. Moreover, Sohail *et al.* (2001), observed the same results with laying hens. They reported that a significant ($P<0.05$) decline in egg production and egg mass was noticed when floor space per hen was reduced and increasing the number of birds per unit of area. This result may be attributed to the fact that hens in low density were allowed to more movement, which may have resulted in a less stressful environment.

1. 4 - Fertility and hatchability percentage

Percent fertility and hatchability (of fertile eggs) were ($P<0.01$) decreased due to keeping the hens at high stocking density compared to the other two densities in both strains, (Table 2).Also , Matrouh strain was higher in percent fertility and hatchability compared with Inshas strain.

Similarly, Christmas *et al,* (1993) showed that fertility and hatchability were decreased due to keeping the hens at highest stocking density. Also Tollba and El-Nagar (2008) reported that fertility and hatchability were decreased by increasing stocking density from 8 to 12 birds/m^2 (1250 to 834cm^2/ bird) of Dandarawy hens at 20 wks of age.

1. 5 – Egg Quality

Table 3 demonstrates that, no significant differences were noted in egg components (weights of yolk and albumen) or egg quality (yolk index, Shape index, and albumen index) of eggs produced by hens maintained in the different stocking densities. No significant difference in egg quality between the two strains was observed.

Sohail *et al.* (2001) reported that there were no significant effects of the stocking density on egg quality traits such as average egg weight, specific gravity, shell weight, shell percentage, shell thickness, shell weight per surface area and Haugh units at 40 weeks of age for laying hens. Moreover, Tollba and El-Nagar (2008) reported that all egg quality factors were not affected by increasing stocking density from 8 to 12 birds/m^2 (1250 to 834cm^2/ bird) of Dandarawy hens at 20 wks of age.

2 - The physiological and environmental traits:

2.1 -Some physiological characteristics:

Statistically, a significant effect on body temperature was observed where body temperature decreased at lower density. Respiratory rate of hens maintained at the high stoking densities in both strains was not affected (Table 4). No significant difference in body temperature and respiratory rate between two strains was observed.

Gharib *et al.* (2005) showed that no significant effect in body temperature in the different stocking densities of 750, 600, 500, 428, 375 and 333 cm2 /bird (4, 5, 6, 7, 8 and 9 per cage). Also, Tollba et al. (2006) found that no significant effect in body temperature and respiratory rate of hens maintained at the different stoking densities (8, 12, 16 bird/m2).

2.2 -Some environmental characteristics

Table 4 clearly shows that, litter pH was not significantly affected, while, litter ammonia and house humidity showed a significant (P<0.01) increase due to high stocking densities. Litter ammonia and house humidity were increased as stocking density increased in both strains. Also, a significant effect on house humidity was recorded due to maintaining the hens at the high stoking densities. No significant difference in litter pH and litter ammonia between two strains, but house humidity was

Higher in Matrouh strain compared with Inshas strain. Thxton *et al.* (2003) reported that allowing litter to build up in broiler houses is accompanied by increases in ammonia emissions and litter pH.

Tollba *et al.* (2006) and Tollba and El-Nagar .(2008) suggested that the increasing social tension as crowding increases wet litter and high ammonia levels are density – dependent and may , therefore , be an additional causal factor for low performance in broilers and developing Egyptian laying hens , respectively .

3-Blood biochemical parameters

3.1 - Plasma calcium, phosphorus, glucose and proteins

Plasma calcium, glucose, total protein, albumin and globulin as affected by the stocking densities are shown in Table 5. High stocking densities (20 birds/ m^2) resulted in a significant (P<0.05) lower level of Plasma calcium, glucose, total protein, albumin and globuline compared with low stocking densities (10 and 15 birds/ m^2), but no effect on plasma phosphorus. No significant difference was observed in plasma calcium, glucose, total protein, albumin and globulin between the two strains.

Stocking density had no effect on plasma constituents of broiler chicks. El-Deek and Al-Harthi, (2004) reported that in this respect, a significant (P<0.05) decline in plasma glucose was detected due to maintaining the hens in highest stocking density (Table 5). Lower feed intake and higher energy expenses or social stress may be responsible for the reduced glucose level seen in birds housed in the highest density.

No relevant references on glucose levels in the blood could be found; so, the significance of this result could not be assessed or discussed. Tollba and El-Nagar (2008) found an equal effect (P<0.05) of density on the blood calcium and phosphorus in hens at 26 weeks of age.

3.2 - Plasma hormones

Inspection of data in Table 6 shows that, high stocking densities (20 bird/m^2) resulted in a significant (P<0.05) lower level of plasma T4. However, normal or mediator stocking densities (10 and 15 bird/m^2) had no significant effect on the plasma T3. The concentrations of T3 and T3 / T4 ratio were not significantly influenced due to maintaining the hens at different stocking densities.

No significant difference in plasma T3 and T4 hormones or T3 / T4 ratio between the two strains was observed.

High stocking density may have resulted in a stress environment. Similar findings were obtained by Qota (2007) who reported a positive relationship between number of birds and T4 concentration. Low level of T4 can be an indicator of stress as density increases. Stress and thyroid hormones may exert powerful influences over the immune system.

Also, El-Sheikh and Ahmed (2006) observed that the stocking density has effect (P<0.05) on serum levels of T3 and T4. The high stocking density led to decreaseT3 and T4 levels. Their results might indicate that the lowering stocking density (10 birds/m^2) during summer improved thyroid function, liver function and decreasing oxidative stress condition. Tollba *et al.* (2006) showed that the concentration of T3 was not influenced due to maintaining the hens at different stocking densities (8, 12 and 16 bird/m^2).

3.3 – Plasma enzymes

Statistically, stocking density has significant effect on plasma Alanine transaminase (ALT) and Aspartate transaminase (AST) values (Table 7). High stocking densities resulted in a significant (P<0.05) lower level of Alkaline phosphatase, ALT and AST. The reduction of feed consumption may improve the liver functions and that may explain the results of ALT and AST. Stocking density had an effect on chemical composition of liver of broiler chicks as well as liver functions as judged by plasma ALT and AST activity (El-Deek and Al-Harthi, 2004). Also, El-Sheikh and Ahmed (2006) observed that the stocking density has effect (P<0.05) on serum levels of ALT and AST. The high stocking density led to decreasing AST level. These results might indicate that the lowering stocking density (8 birds /m^2) during summer improved liver function and decreased oxidative stress condition.

3.4 – Plasma cholesterol and total lipids

High stocking densities (20 bird/m^2) resulted in a significant (P<0.05) lower level of plasma cholesterol, HDL, LDL, total lipids and triglycerides compared with low stocking densities(10 and 15 bird/m^2). Matrouh strain was higher than Inshas strain in plasma cholesterol, HDL, LDL, total lipids and triglycerides.

This is in close agreement with results obtained by El-Sheikh and Ahmed (2006) who observed that the high stocking density decreased cholesterol level. Also, Ozbey and Esen (2007) found that increasing stocking density (from 15, 20 to 25 bird/m^2) of rock partridges decreased the levels of total cholesterol.

Regarding the effect of strain on cholesterol, high density lipoprotein (HDL) and low density lipoprotein (LDL) results showed that Matrouh hens had higher plasma HDL cholesterol than Inshas ones with no differences in total and LDL cholesterol. These results are in agreement with Ali *et al.* (2006) who reported that levels of serum parameters of Matrouh hens at 44 wks of age were 125.17 mg cholesterol/dl, 84.02 mg LDL/dl, 41.15 mg HDL/dl. In Inshas hens, Qota (2007) reported that serum cholesterol level of Inshas from 30 to 42 wks of age was 160.1 mg/100 ml. No interaction effects were observed between strain and density in all these traits.

Plasma total lipids (TL) and triglycerides (TG) of Matrouh and Inshas laying hens under different stocking densities at 32 and 36 wks of age are presented in Table 8. Results indicate that increasing stocking density adversely affects plasma total lipids and triglycerides, whereas, El-Sheikh and Ahmed (2006) observed that high stocking density led to increase total lipid. Also, Ozbey and Esen (2007) found that increasing stocking density (15, 20 and 25 bird/m^2) of Rock Partridges increased the levels of triglyceride.

Regarding the effect of strain on plasma total lipids (TL) and triglycerides (TG), it can be observed from Table 8 that Matrouh hens had higher TL (P=0.0007) and TG (P=0.0159) than Inshas ones. Ali *et al.* (2006) reported that levels of serum total lipids and triglycerides of Matrouh hens at 44 wks of age were 16.31 g/l and 515.50 mg/dl, respectively. No interaction effect was obtained in these traits between strain and density.

4– Yolk and liver cholesterol, HDL, LDL, total lipids and triglycerides

Yolk and liver cholesterol and triglyceride of Matrouh and Inshas laying hens under stocking densities at 32 and 36 wks of age are presented in Tables 9 and 10. Results indicate that higher stocking densities resulted in a significant (P<0.05) lower level of yolk and liver cholesterol, HDL, LDL, total lipids and triglycerides. Differences were observed in yolk cholesterol, yolk and liver triglycerides under the three stocking densities. However, liver cholesterol was higher in hens housed under 10 birds/m^2

than in hens housed less than 20 birds/m^2. Regarding the effect of strain on yolk cholesterol, yolk and liver triglycerides data in Tables 9 and 10 shows that Matrouh was higher than Inshas hens in yolk and liver cholesterol, HDL, LDL, total lipids and triglycerides.

In agreement with these results, Ali *et al.* (2006) reported that liver and yolk were the following levels of cholesterol (156.72 and 17.39 mg/dl) and triglycerides (502.07 and 277.05 mg /dl), respectively of Matrouh hens at 44 wks of age. Also, in Inshas hens, Qota (2007) reported that cholesterol levels in the liver and yolk were 105.2 mg/100g and 16.36 mg/g, respectively from 30 to 42 wks of age.

5-immune responses (humoral immunity)

Antibody production and antibody titer against avian Newcastle disease virus (NDV)

Enzyme linked immuno-sorbent assay (ELISA) titer against Newcastle disease virus (NDV) and hemagglutination inhibition (HI) titer against sheep red blood cells (SRBC'S) of Matrouh and Inshas laying hens under stocking densities at 36 wks of age are presented in Table 11. Results show that NDV titer of hens under stocking densities of 10 and 15 birds/ m^2 was higher than those under 20 birds/ m^2 ones, whereas, SRBC'S titer of hens under stocking density of 10 and 15 birds/ m^2 were higher than hens under 20 birds/ m^2. However, data show that there were no significant differences between Matrouh and Inshas hens in antibody titer against (NDV) and secondary immune response, but Inshas hens were higher in primary immune response compared with Matrouh hens. In agreement with these results, Hester *et al.* (1996 found that birds housed in multiple-bird cages (362 cm2/birds had lower hemagglutinins to SRBC's than those reared in single cages (1085cm/ bird). However, Gharib *et al.* (2005) reported that no differences were observed in antibody titers against SRBC's among the different cage densities at 3-day post-immunization, whereas, at 5-day post-immunization, they noted that birds housed at low cage density (C4) produced higher antibody titers against SRBC's than those housed at the higher cage densities (C8 and C9). At 7 days post immunization, birds housed at high cage density (C9) had lower antibody titers against SRBC's than any of the other cage densities (4, 5, 6, 7 or 8 birds per cage). Also, in pullets, Patterson and Siegel (1998) compared two commercial White Leghorn strains housed at 38, 32, 26, and 20 birds per cage from one day to 6 weeks of age, and 19, 16, 13, and 10 birds per cage from 6 to 18 week and found no effect of cage density on antibody titer in response to SRBC'S antigen. No interaction was detected between strain and density for NDV and SRBC'S titers.

6 – Relative weight of some organs

6-1. Lymphoid organs

A significant (P<0.05) increase was detected in relative weighs of thymus and spleen due to maintaining the hens at low stocking densities. (10 and 15 birds/ m^2). Relative weights were increased as stocking density decreased (Table12). No Significant differences (P<0.01) were detected in relative weights of spleen and thymus between two strains of developed native laying hens.

Weights of thymus and spleen were increased probably due to the immune stimulation as affected by stocking density stress. Also, liver weight was not influenced by increasing stocking densities in both strains, as reported by Bishop and Dhaliwal (1994).

Also, Tollba *et al.* (2006) found a significant decrease in relative weighs of thymus and spleen due to maintaining the hens at high stocking densities (16 bird /m^2).

6-2. Some physiological organs

No significant differences (P<0.01) were detected in relative weights of liver, gizzard, proventriculus, gallbladder, ovary oviduct, kidney and pancreas between all groups and between two strains. Significant differences (P<0.01) was detected in weights of heart and gallbladder which may be due to maintaining the hens in higher stocking densities(20 birds/ m^2) compared to 10 and 15 birds/ m^2 (Table 12). This result may reflect the possibility mentioned above that, at lower densities the hens were fatter and so, if weight of heart remains constant across density treatments, the ratio will decrease because of increasing body weight (Bishop and Dhaliwal, 1994).

6-3. Some carcass characteristics

Dressing percent was significantly (P<0.01) lower as affected by high stoking densities in either strain (Table 13). The reduction was great as stocking density increased. Birds reared at the higher stocking density weighed significantly (P<0.01) less compared to other treatments. However, stocking densities in either strain did not significantly affect giblets (Table13). As in review, the excessive reduction in the available cage area perbird, may have negative effects on growth and consequently, muscular and bone development (Anderson and Adams, 1992).

CONCLUSION

It is concluded that 10 and 15 birds / m^2 gave the best results as observed in productive performance, immunological and physiological responses of developed native laying hens.

Table 1. Composition and calculated analysis of the basal diet.

Ingredients	%
Yellow corn	63.50
Soybean meal (44%)	24.57
Wheat bran	2.00
Lime stone	7.77
Premix*	0.30
Salt (Na cl)	0.30
Di-calcium phosphate	1.50
DL- methionine	0.06
Total	**100**
Calculated analysis**	
CP%	16.00
Kcal ME /kg	2703.34
Crude fiber%	3.47
Crude fat %	2.86
Calcium %	3.32
Available phosphorus %	0.406
Lysine %	0.889
Methionine %	0.350
Methionine + Cystine %	0.620
Sodium%	0.135

* Premix contains 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, Manganese 80000mg, Zinc 80000mg, Iodine 2000mg, Cobalt 250 mg and $CaCO_3$ to 3000g.

** According to Egyptian Feed Composition Tables for Animal and Poultry Feedstuffs (2001)

Table 2. Effect of stocking density on productive performance at the 36 weeks of the experimental period of two strains of developed native laying hens.

Item	TBG (g)	FI (g)	TFC	EP %	EW (g)	EM (g)	Fertility %	Hatchability %
Strain effect								
Matrouh	525.60 a ± 38.02	124.5 a ± 3.09	3.48 a ±0.17	60.47 a ±0.36	44.46 a ±0.26	403.47 a ±16.66	91.82 a ±3.22	87.34 a ±2.61
Inshas	451.00 b ± 23.37	121.5 b ±2.34	3.18 b ±0.11	51.53 b ±0.23	43.62 a ±0.42	344.72 b ±9.93	89.78 b ±2.95	83.84 b ±2.55
Density effect								
D20/m^2	355.60 c ± 31.71	118.6 b ±3.93	3.86 a ±0.17	48.50 c ±0.42	42.22 b ±0.41	300.86 c ±20.91	89.17 c ±2.72	84.83 c ±2.83
D15/m^2	493.60 b ± 21.31	122.2 a ±3.14	3.26 b ±0.10	53.33 b ±0.26	44.35 a ±0.42	330.96 b ±11.34	90.71 b ±2.91	85.24 b ±2.67
D10/m^2	544.70 a ± 55.19	124.0 a ±5.28	2.86 c ±0.09	75.00 a ±0.17	45.05 a ±0.42	473.02 a ±8.16	92.35 a ±3.04	87.08 a ±2.56
Source of Variation	.... P value							
Strain	0.0006	0.0011	0.0301	0.0001	0.7435	0.0001	0.0432	0.0355
Density	0.0098	0.0054	0.0001	0.0001	0.0131	0.0001	0.0022	0.0001
Strain* Density	0.0099	0.1453	0.1934	0.0164	0.1108	0.0071	0.0002	0.0004

a-b Means in a column within main or interaction effects not sharing a common superscript are significantly different.

TBG = Total body gain FI = Feed intake

TFC = Total feed conversation EP % = Egg production percentage

EW = Egg weight EM = Egg mass

Table 3. Effect of stocking density on egg quality at the 32 and 36 weeks of the experimental period of two strains of developed native laying hens.

Item	EW (g)	SI (%)	SW (%)	YW (%)	AW (%)	YI (%)	AI (%)	ST (mm)	YC (degree)	HU (%)
Strain effect										
Matrouh	44.96^a ±0.51	65.14^a ±0.83	14.17^a ±0.25	38.66^a ±0.54	47.17^a ±0.63	50.19^a ±0.78	13.80^a ±0.25	30.80^a ±0.25	7.04^a ±0.11	79.24^a ±0.18
Inshas	43.55^a ±0.54	66.05^a ±0.84	14.58^a ±0.24	38.83^a ±0.53	46.59^a ±0.64	50.31^a ±0.78	14.02^a ±0.26	31.02^a ±0.26	7.16^a ±0.12	77.89^b ±0.20
Density effect										
D20/m²	43.70^b ±0.52	65.56^a ±0.83	13.85^b ±0.25	38.37^a ±0.53	47.43^a ±0.64	50.30^a ±0.77	14.27^a ±0.19	28.27^c ±0.19	6.20^c ±0.12	76.87^b ±0.25
D15/m²	44.85^a ±0.74	65.43^a ±0.85	14.31^{ab} ±0.26	38.81^a ±0.54	46.80^a ±0.65	49.89^a ±0.70	14.23^a ±0.24	31.23^b ±0.24	7.00^b ±0.13	78.43^a ±0.24
D10/m²	45.22^a ±0.62	65.89^a ±0.84	14.97^a ±0.25	39.05^a ±0.54	46.98^a ±0.64	50.50^a ±0.78	13.93^a ±0.22	32.23^a ±0.22	7.70^a ±0.10	79.90^a ±0.22
Age effect										
WK28	43.72^b ±0.63	67.63^{ab} ±0.83	14.04^a ±0.23	37.74^b ±0.53	48.22^a ±0.65	49.68^b ±0.78	13.97^a ±0.20	30.97^a ±0.20	6.97^a ±0.13	79.00^a ±0.19
WK32	43.23^b ±0.64	69.14^a ±0.84	14.85^a ±0.23	40.23^a ±0.54	44.92^b ±0.64	49.99^{ab} ±0.72	14.33^b ±0.26	29.33^b ±0.26	7.13^a ±0.13	79.17^a ±0.19
WK36	45.82^a ±0.16	66.89^b ±0.85	14.27^a ±0.24	38.30^b ±0.54	47.43^a ±0.64	51.02^a ±0.79	14.43^a ±0.41	31.43^a ±0.41	7.20^a ±0.16	79.03^a ±0.32
Source of Variation	……………… P value………………									
Strain	0.0358	0.0556	0.4357	0.2445	0.0667	0.8062	0.1582	0.2582	0.4200	0.0202
Density	0.0114	0.2266	0.0903	0.5431	0.7407	0.0661	0.3331	0.0001	0.0001	0.0384
Strain* Density	0.5936	0.6492	0.8281	0.5279	0.6033	0.0723	0.2056	0.1482	0.9740	0.9347
Age	0.0046	0.7989	0.0661	0.0041	0.0536	0.0610	0.0634	0.0001	0.3635	0.8168
Strain* Age	0.7707	0.0623	0.0732	0.0444	0.0620	0.2488	0.0844	0.2495	0.6086	0.0003
Density* Age	0.3717	0.9925	0.9015	0.0085	0.0602	0.5611	0.0555	0.0001	0.1789	0.0001
Density*Strain*Age	0.0147	0.1196	0.4152	0.0008	0.0645	0.0624	0.0877	0.0850	0.7644	0.5159

a-b Means in a column within main or interaction effects not sharing a common superscript are significantly different.
EW= Egg weight, SI= Shape index, SW =Shell weight, YW =Yolk weight, AW= Albumen weight,
YI= Yolk index, AI= Albumen index, ST= Shell thickness, YC= Yolk color and HU= Haugh units.

Table 4. Effect of stocking density on some physiological and environmental parameters of two strains of developed native laying hens.

Item	Body Temperature (C °)	Respiratory rate (count/min)	House humidity (%)	Litter PH (degree)	Litter ammonia (PPm)
Strain effect					
Matrouh	41.82 [a] ±0.10	103.78 [a] ±1.98	57.12 [a] ±0.81	8.05 [a] ±0.22	41.54 [a] ±2.03
Inshas	41.92 [a] ±0.09	104.56 [a] ±1.89	56.03 [b] ±0.96	8.42 [a] ±0.05	40.13 [a] ±2.31
Density effect					
D20/m^2	42.12 [a] ±0.11	106.92 [a] ±2.196	59.96 [a] ±0.74	8.38 [a] ±0.05	50.08 [a] ±1.45
D15/m^2	41.86 [ab] ±0.13	103.83 [a] ±2.39	56.82 [b] ±0.67	8.17 [a] ±0.34	41.30 [b] ±1.28
D10/m^2	41.43 [b] ±0.08	101.75 [a] ±2.39	52.96 [c] ±0.69	8.16 [a] ±0.07	31.13 [c] ±1.39
Age effect					
WK32	41.85 [a] ±0.15	102.35 [a] ± 232	54.67 [b] ±0.76	7.98 [b] ±0.21	36.88 [b] ±1.92
WK36	41.32 [a] ± 0.14	108.72 [a] ±2.65	58.49 [a] ±0.78	8.49 [a] ±0.04	44.79 [a] ±1.99
Source of Variation		.... P value.............			
Strain	0.4091	0.7822	0.0216	0.1082	0.0762
Density	0.0143	0.3275	0.0001	0.6619	0.0001
Strain* Density	0.8684	0.7409	0.5358	0.5325	0.4052
Age	0.7325	0.6223	0.0001	0.0268	0.0001
Strain* Age	0.1742	0.1533	0.0752	0.3847	0.6385
Density* Age	0.6053	0.7422	0.8375	0.4068	0.9321
Density*Strain*Age	0.0866	0.1421	0.8425	0.4820	0.0905

[a-b] Means in a column within main or interaction effects not sharing a common superscript are significantly different.

Table 5. Effect of stocking density on some blood parameters of two strains of developed native laying hens.

Item	Plasma Calcium (mg/dl)	Plasma phosphorus (mg/100ml)	Plasma Glucose (mg/dl)	Total protein (mg/dl)	Albumin (mg/dl)	Globulin (mg/dl)
Strain effect						
Matrouh	14.47 [a] ±0.56	7.26 [a] ±0.66	231.26 [a] ±3.12	9.55 [a] ±0.46	4.78 [a] ±0.20	4.77 [a] ±0.40
Inshas	13.65 [a] ±0.52	7.19 [a] ±0.62	234.05 [a] ±3.79	8.80 [a] ±0.55	4.96 [a] ±0.19	3.84 [a] ±0.62
Density effect						
D20/m^2	13.07 [b] ±0.65	7.11 [a] ±0.53	225.37 [b] ±3.79	6.81 [b] ±0.64	3.91 [b] ±0.26	2.90 [b] ±0.74
D15/m^2	13.75 [ab] ±0.63	7.45 [a] ±0.53	230.56 [ab] ±4.44	9.11 [ab] ±0.55	5.58 [ab] ±0.23	3.53 [ab] ±0.58
D10/m^2	15.31 [a] ±0.67	7.11 [a] ±0.55	237.05 [a] ±4.15	10.12 [a] ±0.64	6.14 [a] ±0.22	3.98 [a] ±0.61
Age effect						
WK32	14.11 [a] ±0.63	8.49 [a] ±0.42	227.82 [b] ±3.64	10.17 [a] ±0.45	4.32 [b] ±0.17	5.85 [a] ±0.40
WK36	14.10 [a] ±0.45	5.95 [b] ±0.34	237.49 [a] ±3.06	8.18 [b] ±0.51	5.42 [a] ±0.17	2.76 [b] ±0.49
Source of Variation			.... P value			
Strain	0.1997	0.2112	0.5322	0.2068	0.4139	0.0926
Density	0.0569	0.0665	0.0050	0.0058	0.0013	0.0096
Strain* Density	0.1423	0.2001	0.2775	0.0086	0.0047	0.0099
Age	0.9925	0.0412	0.0343	0.0014	0.0001	0.0001
Strain* Age	0.6198	0.6270	0.5740	0.0024	0.2252	0.0002
Density* Age	0.1059	0.1262	0.0124	0.7431	0.0136	0.5767
Density*Strain*Age	0.0847	0.0942	0.9098	0.0191	0.0573	0.0959

[a-b] Means in a column within main or interaction effects not sharing a common superscript are significantly different.

Table 6. Effect of stocking density on some blood hormones of two strains of developed native laying hens.

Item	T3 hormone (mg/ml)	T4 hormone (mg/ml)	T3/T4
Strain effect			
Matrouh	3.61 [a] ±0.50	14.39 [a] ±0.39	0.25 [a] ±003
Inshas	3.31 [a] ±0.32	14.51 [a] ±0.41	0.23 [a] ±0.03
Density effect			
D20/m²	3.90 [a] ±0.66	13.82 [b] ±0.44	0.28 [a] ±0.03
D15/m²	3.83 [a] ± 0.41	14.66 [ab] ±0.50	0.26 [a] ±0.03
D10/m²	3.96 [a] ±0.52	14.93 [a] ±0.48	0.27 [a] ±0.03
Age effect			
WK32	3.32 [a] ±0.35	13.99 [b] ± 0.38	0.24 [a] ±0.03
WK36	3.59 [a] ± 0.49	14.22 [a] ±0.39	0.25 [a] ±0.03
Source of Variation	-----P value-----		
Strain	0.0606	0.4251	0.1317
Density	0.6913	0.0453	0.3045
Strain* Density	0.0643	0.0615	0.1077
Age	0.0620	0.0236	0.3998
Strain* Age	0.0635	0.9322	0.1371
Density* Age	0.0648	0.8309	0.0848
Density*Strain*Age	0.0607	0.9398	0.2638

[a-b] Means in a column within main or interaction effects not sharing a common superscript are significantly different.

Table 7. Effect of stocking density on some blood enzymes of two strains of developed native laying hens.

Item	Alkaline phosphatase (U/L)	ALT (IU/L)	AST (IU/L)
Strain effect			
Matrouh	13.93[a] ±0.69	10.16[a] ±0.48	115.75[a] ±2.99
Inshas	13.58[a] ±0.63	8.16[b] ±0.27	107.59[b] ±2.39
Density effect			
D20/m^2	12.34[c] ±0.86	8.33[b] ±0.42	100.14[c] ±1.24
D15/m^2	13.52[b] ±0.79	8.96[b] ±0.49	114.09[b] ±2.16
D10/m^2	15.68[a] ±0.73	10.18[a] ±0.62	120.78[a] ±3.48
Age effect			
WK32	12.16[b] ±0.52	8.39[b] ±0.37	106.93[b] ±2.43
WK36	14.86[a] ±0.65	9.92[a] ±0.46	116.41[a] ±2.84
Source of Variation	... P value....		
Strain	0.3391	0.0002	0.0002
Density	0.0091	0.0104	0.0001
Strain* Density	0.0038	0.9940	0.1568
Age	0.0048	0.0031	0.0001
Strain* Age	0.3911	0.1828	0.2493
Density* Age	0.7332	0.7598	0.1556
Density*Strain*Age	0.9201	0.8371	0.8648

[a-b] Means in a column within main or interaction effects not sharing a common superscript are significantly different.

Table 8. Effect of stocking density on some blood parameters of two strains of developed native laying hens.

Item	Plasma cholesterol (mg/dl)	Plasma LDL (mg/dl)	Plasma HDL (mg/dl)	Plasma total lipids (mg/dl)	Plasma Triglycerides (mg/dl)
Strain effect					
Matrouh	157.28 ^{a} ±7.88	87.60 ^{a} ±7.09	69.68 ^{a} ±7.48	543.54 ^{a} ±7.50	239.91 ^{a} ±8.06
Inshas	130.21 ^{b} ±7.84	100.53 ^{a} ±6.68	49.68 ^{b} ±7.26	522.65 ^{b} ±6.67	221.59 ^{b} ±6.73
Density effect					
D20/m ^{2}	129.04 ^{b} ±8.48 ^{b}	85.15 ^{b} ±7.69	43.89 ^{b} ±8.08	512.63 ^{b} ±8.41	204.85 ^{c} ±5.46
D15/m ^{2}	154.94 ^{a} ±9.68	110.58 ^{a} ±6.83	48.36 ^{b} ±8.26	528.60 ^{b} ±7.53	232.24 ^{b} ±7.89
D10/m ^{2}	162.25 ^{a} ±9.82	86.47 ^{b} ±9.82	75.78 ^{a} ±9.82	558.06 ^{a} ±6.28	255.15 ^{a} ±8.43
Age effect					
WK32	150.09 ^{a} ±6.91	82.80 ^{b} ±6.71	67.29 ^{a} ±6.81	518.37 ^{b} ±6.43	217.17 ^{b} ±5.14
WK36	147.39 ^{a} ±8.98	105.33 ^{a} ±6.63	42.06 ^{b} ±7.81	547.83 ^{a} ±6.84	244.32 ^{a} ±8.48
Source of Variation	.... P value				
Strain	0.1001	0.1583	0.0242	0.0041	0.0081
Density	0.0265	0.0432	0.0352	0.0001	0.0001
Strain* Density	0.5223	0.4338	0.4521	0.9196	0.8835
Age	0.7913	0.0160	0.0243	0.0002	0.0003
Strain* Age	0.5252	0.0965	0.4321	0.3817	0.0414
Density* Age	0.9149	0.6841	0.7352	0.7306	0.1846
Density*Strain*Age	0.0063	0.5312	0.0624	0.6764	0.8980

$^{a-b}$ Means in a column within main or interaction effects not sharing a common superscript are significantly different.

Table 9. Effect of stocking density on some yolk parameters of two strains of developed native laying hens.

Item	Yolk Cholesterol (mg/g)	Yolk LDL (mg/g)	Yolk HDL (mg/g)	Yolk Total Lipids (mg/g)	Yolk Triglycerides (mg/g)
Strain effect					
Matrouh	11.64 [a] ±0.45	7.56 [a] ±0.31	4.08 [a] ±0.17	277.69 [a] ±4.64	308.26 [a] ±4.83
Inshas	10.92 [a] ±0.42	7.10 [a] ±0.29	3.82 [a] ±0.15	268.99 [a] ±4.26	290.45 [b] ±6.05
Density effect					
D20/m^2	10.02 [b] ±0.42	6.49 [b] ±0.29	3.53 [b] ±0.16	263.54 [b] ±5.40	290.51 [b] ±6.24
D15/m^2	10.67 [b] ±0.37	6.94 [b] ±0.26	3.73 [b] ±0.15	272.82 [ab] ±5.07	295.93 [ab] ±7.46
D10/m^2	13.16 [a] ±0.54	8.57 [a] ±0.37	4.59 [a] ±0.19	283.68 [a] ±5.33	311.63 [a] ±6.52
Age effect					
WK32	10.25 [b] ±0.39	6.77 [a] ±0.26	3.48 [b] ±0.13	260.31 [b] ±4.05	283.95 [b] ±4.49
WK36	12.31 [a] ±0.41	7.89 [a] ±0.28	4.42 [a] ±0.14	286.37 [a] ±5.59	314.77 [a] ±5.37
Source of Variation		.... P value..............			
Strain	0.1319	0.1215	0.1149	0.1043	0.0079
Density	0.0001	0.0001	0.0001	0.0115	0.0274
Strain* Density	0.9637	0.9462	0.9587	0.7832	0.4065
Age	0.0001	0.0001	0.0001	0.0001	0.0001
Strain* Age	0.9659	0.7254	0.8195	0.5010	0.1113
Density* Age	0.9622	0.9622	0.9612	0.9646	0.8134
Density*Strain*Age	0.9925	0.9731	0.9662	0.9390	0.7584

[a-b] Means in a column within main or interaction effects not sharing a common superscript are significantly different.

Table 10. Effect of stocking density on some liver parameters of two strains of developed native laying hens.

Item	Liver cholesterol (mg/g)	Liver LDL (mg/g)	Liver HDL (mg/g)	Liver total lipids (mg/g)	Liver Triglycerides (mg/g)
Strain effect					
Matrouh	142.78 [a] ±3.24	92.04 [a] ±2.04	52.22 [a] ±1.65	247.44 [a] ±3.73	434.26 [a] ±6.17
Inshas	139.84 [a] ±3.17	88.06 [a] ±2.50	49.68 [a] ±1.27	224.69 [b] ±4.25	407.15 [b] ±5.82
Density effect					
D20/m^2	133.91 [b] ±3.18	86.35 [b] ±1.99	48.47 [a] ±1.45	229.39 [b] ±5.06	408.60 [b] ±8.69
D15/m^2	140.65 [b] ±3.90	88.83 [b] ±3.22	51.80 [a] ±2.17	233.19 [b] ±5.39	416.04 [b] ±7.81
D10/m^2	149.38 [a] ±3.97	94.98 [a] ±2.84	52.59 [a] ±1.68	245.62 [a] ±5.59	437.47 [a] ±5.78
Age effect					
WK32	134.83 [b] ±2.66	86.42 [b] ±2.17	49.01 [a] ±1.65	228.49 [b] ±4.53	407.03 [b] ±6.32
WK36	147.79 [a] ±3.28	93.68 [a] ±2.26	52.89 [a] ±1.20	243.63 [a] ±4.05	434.37 [a] ±5.64
Source of Variation		.... P value			
Strain	0.4806	0.1976	0.2257	0.0001	0.0009
Density	0.0138	0.0686	0.2355	0.0453	0.0096
Strain* Density	0.7242	0.7857	0.9385	0.8460	0.9140
Age	0.0030	0.0213	0.0664	0.0072	0.0008
Strain* Age	0.6072	0.7245	0.9527	0.7210	0.8442
Density* Age	0.6826	0.3110	0.9381	0.9931	0.9192
Density*Strain*Age	0.6226	0.2556	0.1491	0.6819	0.9978

[a-b] Means in a column within main or interaction effects not sharing a common superscript are significantly different.

Table 11. Effect of stocking density on primary and secondary immune response against SRBC and NDV of two strains of developed native laying hens.

Item	Primary Immune Response	Secondary Immune Response	NDV
Strain effect			
Matrouh	65.1 [b] ±4.26	259.37[a] ±7.14	150.57[a] ±5.05
Inshas	75.3 [a] ±3.41	264.30[a] ±7.35	155.13[a] ±5.12
Density effect			
D20/m^2	61.7 0[c] ±3.04	248.15[c] ±6.37	133.53[c] ±4.17
D15/m^2	69.55[b] ±4.76	264.36[b] ±7.65	152.35[b] ±5.02
D10/m^2	79.50[a] ±5.34	273.00[a] ±8.11	162.67[a] ±4.18
Source of Variation	--- p value ---		
Strain	0.0550	0.1322	0.3920
Density	0.0274	0.0025	0.0001
Strain* Density	0.7790	0.6426	0.4477

a-b Means in a column within main or interaction effects not sharing a common superscript are significantly different.

Table 12. Effect of stocking density on the relative weights (%) of some internal organs of two strains of developed native laying hens.

Item	Carcass weight %	Heart weight %	Liver weight %	Gizzard weight %	Proventriculus weight %	Gallbladder weight %	Intestine weight %	Spleen weight %	Thymus weight %	Ovary weight %
Strain effect										
Matrouh	64.18^{a} ±1.24	0.42^{a} ±0.01	2.35^{a} ±0.05	1.93^{a} ±0.05	0.47^{b} ±0.01	0.10^{b} ±0.01	5.70^{a} ±0.12	0.17^{a} ±0.01	0.14^{a} ±0.01	2.64^{a} ±0.11
Inshas	63.26^{a} ±0.72	0.44^{a} ±0.01	2.23^{a} ±0.07	1.99^{a} ±0.05	0.50^{a} ±0.02	0.14^{a} ±0.01	5.93^{a} ±0.14	0.19^{a} ±0.01	0.14^{a} ±0.01	2.37^{b} ±0.08
Density effect										
D20/m^2	64.52^{a} ±1.01	0.40^{b} ±0.01	2.22^{a} ±0.07	2.02^{a} ±0.08	0.49^{a} ±0.02	0.09^{b} ±0.01	6.09^{a} ±0.13	0.15^{b} ±0.01	0.12^{b} ±0.01	2.39^{a} ±0.12
D15/m^2	64.19^{a} ±1.14	0.44^{a} ±0.01	2.29^{a} ±0.09	1.98^{a} ± 0.06	0.48^{a} ±0.02	0.13^{a} ±0.01	5.90^{a} ±0.16	0.19^{a} ±0.01	0.15^{a} ±0.01	2.49^{a} ±0.09
D10/m^2	62.45^{a} ±1.49	0.44^{a} ±0.01	2.34^{a} ±0.07	1.88^{a} ± 0.06	0.48^{a} ±0.02	0.13^{a} ±0.01	5.45^{b} ±0.14	0.19^{a} ±0.01	0.15^{a} ±0.01	2.61^{a} ±0.14
Age effect										
WK32	64.09^{a} ±1.28	0.42^{a} ±0.01	2.19^{b} ±0.06	1.85^{b} ±0.05	0.44^{b} ±0.01	0.09^{b} ±0.01	5.54^{b} ±0.12	0.17^{a} ±0.01	0.12^{b} ±0.01	2.56^{a} ±0.11
WK36	63.35^{a} ±0.64	0.44^{a} ±0.01	2.38^{a} ±0.06	2.07^{a} ±0.05	0.53^{a} ±0.01	0.14^{a} ±0.01	6.09^{a} ±0.12	0.19^{a} ±0.01	0.17^{a} ±0.01	2.44^{a} ±0.08
Source of Variation				--------p value-------						
Strain	0.4929	0.2193	0.1771	0.4267	0.0270	0.0006	0.1498	0.0717	0.9684	0.0456
Density	0.4023	0.0508	0.5319	0.3050	0.8484	0.0059	0.0047	0.0099	0.0047	0.4427
Strain* Density	0.0020	0.6981	0.2334	0.4074	0.3745	0.1810	0.2025	0.1413	0.9928	0.6491
Age	0.5815	0.3366	0.0355	0.0045	0.0001	0.0001	0.0009	0.1334	0.0004	0.3689
Strain* Age	0.6446	0.0823	0.4461	0.4120	0.1896	0.1975	0.3123	0.4976	0.2316	0.9430
Density* Age	0.6520	0.2360	0.5771	0.5106	0.2085	0.2217	0.3802	0.3051	0.0709	0.0624
Density*Strain*Age	0.6383	0.1849	0.7542	0.7286	0.1988	0.0275	0.6076	0.2711	0.7814	0.1750

a-b Means in a column within main or interaction effects not sharing a common superscript are significantly different.

Table 13. Effect of stocking density on the relative weights (%) of some internal organs and number of big and small ovarian follicle of two strains of developed native laying hens.

Item	Oviduct weight %	Oviduct Length %	Edible giblets %	Total edible part %	Kidney weight %	Abdominal fat weights %	Pancreas weight %	Number of big ovarian follicle	Number of small ovarian follicle
Strain effect									
Matrouh	3.03^a ±0.10	3.64^a ±0.11	4.69^a ±0.08	68.88^a ±1.24	0.48^a ±0.02	1.75^a ±0.15	0.25^a ±0.01	5.33^a ±0.21	14.87^a ±0.44
Inshas	3.12^a ±0.12	3.52^a ±0.07	4.66^a ±0.11	67.92^a ±0.75	0.45^a ±0.02	1.76^a ±0.16	0.24^a ±0.01	5.40^a ±0.19	15.27^a ±0.34
Density effect									
D20/m^2	2.94^a ±0.12	3.51^a ±0.14	4.64^b ±0.13	67.17^b ±0.99	0.47^a ±0.02	1.59^b ±0.20	0.24^a ±0.01	3.65^b ±0.19	10.55^b ±0.41
D15/m^2	3.14^a ±0.12	3.60^a ±0.09	5.72^{ab} ±0.14	68.92^{ab} ±1.20	0.45^a ±0.02	1.69^{ab} ±0.16	0.25^a ±0.01	5.70^a ±0.19	15.35^a ±0.45
D10/m^2	3.15^a ±0.17	3.63^a ±0.11	6.67^a ±0.09	69.82^a ±1.51	0.47^a ±0.02	1.97^a ±0.22	0.25^a ±0.01	6.75^a ±0.27	16.30^a ±0.38
Age effect									
WK32	2.97^a ±0.14	3.81^a ±0.10	4.47^b ±0.08	68.56^a ±1.30	0.46^a ±0.02	1.64^b ±0.16	0.24^a ±0.01	5.30^a ±0.19	14.83^a ±0.41
WK36	3.18^a ±0.07	3.35^b ±0.06	4.89^a ±0.09	68.24^a ±0.64	0.48^a ±0.01	1.86^a ±0.15	0.25^a ±0.01	5.43^a ±0.21	15.30^a ±0.38
Source of Variation			--p value--						
Strain	0.5657	0.2729	0.7564	0.4823	0.2254	0.9594	0.2495	0.7922	0.3736
Density	0.5213	0.6675	0.0062	0.0125	0.6905	0.0201	0.5632	0.0009	0.0001
Strain* Density	0.9149	0.6575	0.1848	0.0023	0.0449	0.6536	0.1291	0.9826	0.2200
Age	0.2035	0.0001	0.0020	0.8164	0.3396	0.0348	0.4183	0.5987	0.2999
Strain* Age	0.1782	0.0207	0.2379	0.7339	0.0870	0.2934	0.8716	0.2946	0.0142
Density* Age	0.2991	0.1794	0.0060	0.6648	0.1779	0.0080	0.9709	0.0156	0.0630
Density*Strain*Age	0.9814	0.0641	0.5534	0.5953	0.2908	0.3647	0.2764	0.6475	0.8135

a-b Means in a column within main or interaction effects not sharing a common superscript are significantly different.

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تأثيرات الكثافة العددية أثناء مرحلة الأنتاج على الصفات الفسيولوجية والمناعية وعلاقتها بالآداء الانتاجى للدجاج البياض المحلى المستنبط

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تم أستخدام عدد ٤٥٠ دجاجة و ٥٠ ديك من سلالتين من الدجاج المستنبط هما مطروح وأنشاص ، كل سلالة ٢٢٥ دجاجة و٢٥ ديك من عمر ٢٠ أسبوع وحتى ٣٦ أسبوع وقسمت عشوائيا الى ٣ مجاميع طبقا للكثافة العددية فى المتر المربع من المساحة الأرضية كما يلى :

- المجموعة الاولى تم وضع عدد ٢٠ دجاجة +٢ديك /م٢.
- المجموعة الثانية تم وضع عدد ١٥ دجاجة +٢ديك /م٢.
- المجموعة الثالثة تم وضع عدد ١٠ دجاجة +١ديك /م٢.

وتم تقسيم كل مجموعة عشوائيا الى ٥ مكررات حيث ربيت على الفرشة ، وتم تغذيتها على نفس العليقة وتحت نفس الظروف من حرارة واضاءة وتهوية وماء ، وخلال فترة التجربة تم أخذ عدد من القياسات الانتاجية والبيئية والفسيولوجية والمناعية

وكانت اهم النتائج المتحصل عليها كالآتى:

- المجاميع ذات الكثافة العددية ١٠ دجاجة ، ١٥ دجاجة /م٢ اعطت اعلى وزن جسم نهائى واستهلاك علف واعلى نسبة انتاج بيض ووزن بيض وكتلة بيض وافضل كفاءة تحويلية وجودة بيض وسمك قشرة واعلى نسب خصوبة وفقس ، بينما كانت المجموعة ذات الكثافة العددية ٢٠دجاجة /م ٢الأقل فى هذة الصفات ، وكانت سلالة مطروح هى الافضل فى معظم الصفات الانتاجية بالمقارنة بسلالة أنشاص .
- المجاميع ذات الكثافة العددية ١٠ دجاجة ، ١٥ دجاجة /م٢ سجلت أقل درجة حرارة جسم ومعدل تنفس واقل نسبة رطوبة بالمسكن واقل درجة حموضة ونسبة امونيا بالفرشة مقارنة بالمجموعة ذات الكثافة العددية ٢٠دجاجة /م ٢.
- المجاميع ذات الكثافة العددية ١٠ دجاجة ، ١٥ دجاجة / م٢ أعطت اعلى مستوى لكلا من الكالسيوم والجلوكوز والبروتين الكلى والالبيومين والجلوبيولين وانزيمات الكبد و الالكالين فوسفاتيز مقارنة بالمجموعة ذات الكثافة العددية ٢٠دجاجة /م ٢، لم يتاثر مستوى كلا من الكالسيوم والجلوكوز

والبروتين الكلى والالبيومين والجلوبيولين وانزيمات الكبد و الالكالين فوسفاتيز بنوعية السلالة المرباة.

– المجاميع ذات الكثافة العددية ١٠ دجاجة ، ١٥ دجاجة / م٢ أعطت اعلى مستوى لكلا من الكوليستيرول والدهون الكلية والجليسريدات الثلاثية بالدم و البيض والكبد مقارنة بالمجموعة ذات الكثافة العددية ٢٠دجاجة /م ٢على اعمار ٣٦،٣٢ أسبوع ، وكانت سلالة مطروح هى الأعلى فى مستوى لكلا من الكوليستيرول والدهون الكلية والجليسريدات الثلاثية بالدم و البيض والكبد مقارنة بسلالة أنشاص.

– لم يتاثر كلا من مستوى الفوسفور وهرمون T3 بالدم بالكثافة العددية ولا بنوعية السلالة المرباة.

– المجاميع ذات الكثافة العددية ١٠ دجاجة ، ١٥ دجاجة / م٢ أعطت اعلى مستوى لكلا من مستوى الاستجابة المناعية الاولية والثانوية ضد الحقن بكرات الدم الحمراء لدم الغنم وضد مرض النيوكاسيل مقارنة بالمجموعة ذات الكثافة العددية ٢٠دجاجة / م ٢ على اعمار ٣٦،٣٢ أسبوع ، وزادت الاستجابة المناعية الاولية فى سلالة أنشاص عن سلالة مطروح فى كل المجاميع الثلاثة.

– لم يظهر اى تاثير معنوى واضح على معظم الاوزان النسبية لأعضاء القلب والكبد والقونصة والمعدة الغدية و الحوصلة المرارية والامعاء والمبيض وقناة المبيض والبنكرياس والكلية ولكن اتضح زيادة معنوية فى الاوزان النسبية للاعضاء المناعية كالطحال والغدة التيموثية ووزن الذبيحة ووزن الأجزاء الكلية المأكولةووزن الأعضاء المأكولة ووزن دهن البطن وعدد الحويصلات المبيضية الكبيرة والصغيرة فى المجاميع ذات الكثافة العددية ١٠ دجاجة ، ١٥ دجاجة / م ٢بالمقارنة بالمجموعة ذات الكثافة العددية ٢٠ دجاجة /م ٢ على اعمار ٣٢ ،٣٦ أسبوع.

– كان لاختلاف السلالة تاثير معنوى على بعض الصفات الانتاجية والفسيولوجية والمناعية حيث كانت سلالة مطروح الأفضل فى معظم الصفات السابقة بينما زادت الاستجابة المناعية الاولية فى سلالة أنشاص عن سلالة مطروح فى المجاميع الثلاثة.

ومن كل ما سبق يتضح اهمية تربية العدد المناسب من الدجاج المحلى المستنبط فى المتر المربع ويفضل ١٠ دجاجة ، ١٥ دجاجة / م٢ أثناء مرحلة الأنتاج لانها اعطت افضل نتائج للاداء الانتاجى والفسيولوجى والمناعى مما يعود على المربى لهذة السلالات بزيادة العائد الاقتصادى من تربية مثل هذة السلالات .