Egypt.Poult.Sci.Vol (38)(II): (657-678)(2018) **(1804-1021)**

Egyptian Poultry Science Journal

http://www.epsj.journals.ekb.eg/

ISSN: **1110-5623** (**Print**) **– 2090-0570** (**Online**)

EFFECT OF SUPPLEMENTING THE DIET WITH CAROTENOIDS-ENRICHED SPIRULINA ALGAE 2- ON EMBRYOGENESIS AND PHYSIOLOGICAL RESPONSE FOR DEVELOPED CHICKENS

Ebtsam E.E.Iraqi; Mona M.Ahmed; Wesam A.Fares;A.A.El-Prollosy and R.E.Rizk

Anim.Prod.Res.Inst., Agric.Res.Center, Egypt

Corresponding author: Ebtsam E.E.Iraqi Email:ibtisam.iraqi.h@gmail.com

Received: 05/05/2018 Accepted: 03/06/2018

ABSTRACT: The present experiment was conducted to study the effect of dietary supplementation with carotenoids- enriched Spirulina platensis algae (SA), flock age on egg weight loss% ,embryonic weight and mortalities %, hatching traits and blood constituent of Bandarah chicks. One hundred and thirty five females with fifteen males from Bandarah chicken strain at 30-week of age (YA) besides the same numbers at 56-week of age (OA) were housed in floor pens. Five experimental bird groups for each age were fed as follows : basal diet without supplementation of SA (T1) , basal diets supplemented with 40 mg (T2), 80 mg (T3), 120 mg (T4) , 160 mg (T5) SA / Kg diet. The obtained results showed that eggs of elder flock significantly lost greater percentage of weight compared to the younger one. Elder flock age had greater ($p \leq 0.05$) embryonic mortality percentage compared with those for younger one and supplementation the diet with SA reduced embryonic mortality. Supplementation the diets with 40 mg for younger flock or 160 mg SA/Kg diet for elder flock , represented significant improvement of macroscopic fertility, hatchability of fertile eggs and hatched chick body weight. Lowest concentrations($p \leq 0.05$) of β-carotene and Zeaxanthin were detected in the liver of control chicks compared to those for all other groups. The elder flock represented significantly higher Zeaxanthin carotenoid concentration in the chick liver compared to those for younger one. Irrespective to flock age, baby chicks of T2 and T5 groups represented the highest significant values of total antioxidants and lowest LDL compared with the others. Regarding flock age, chicks produced from elder flock had higher significant values of cholesterol, LDL and malondialdhide, while chicks produced from younger one had higher values ($p \leq 0.05$) of total antioxidants and HDL. In conclusion, supplementing the diet of parental younger flock age with 40 mg SA/Kg diet and 160 mg SA/Kg diet for the elder one could be a good tool for realizing the best improvement results of fertility, hatchability and hatched chick body weight, besides highest concentration of total antioxidants in the blood of hatched chicks.

Key words: Spirulina algae – flock age – carotenoids – embryos – hatchability – blood.

INTRODUCTION

Spirulina is a blue-green microalgae with a spiral cellular structure and contains large amounts of protein (70% dry weight), carotenoid (4000 mg/kg), omega-3 and omega-6 polyunsaturated fatty acids ,gamma linolenic acid, sulfolipids, glycolipids, polysaccharides, provitamins; vitamin A, vitamin E, various B vitamins; and minerals, including calcium, iron, magnesium, manganese, potassium, zinc and selenium (Khan et al., 2005).

Carotenoids are notable as the pigments responsible for the typical yellow-orange colors of the egg yolks of birds and the functions of the carotenoids during the development of the avian embryo are unclear (Surai, 2002). These pigments may prove to be essential for successful avian development, or at least may confer some degree of benefits to the embryo(Karadas et al., 2005). Also,Surai (2012) reported that canthaxanthin as the main carotenoid provide a great deal of benefits for animals, including chicken eggs, embryos and chickens during early postnatal development.

Carotenoids are natural lipid-soluble antioxidants that could enhance the overall antioxidant capacity available to the embryo, thereby protecting the developing tissues from the damaging effects of reactive oxygen and free radicals (Stahl and Sies, 2003). Such protection is likely to be important because several tissues of the avian embryo are rich in highly polyunsaturated lipids that are very susceptible to peroxidative attack (Speake et al., 1998).

Supplementing the diet with antioxidants increased their transfer to eggs, which had beneficial consequences for specific offspring traits (Biard et al., 2005). Therefore, during incubation, the incorporation of these compounds from egg yolk into the developing embryo and chick tissuemay substantially contribute to the antioxidant defenses of the offspring (Karadas et al., 2005). Mariey et al. (2012) showed that no significant differences among different dietary treatments (Spirulina platensis algae) in egg weight loss percentages.Fertility and hatchability percentages of eggs produced by birds fed the Spirulina-containing diets were significantly superior compared to those of the control (Inborr, 1998).

Old breeders have a significant reduction in fertility and sperm number trapped in fertile eggs (Brillard, 1993 and Bramwell et al., 1996).The possible causes for the decline in fertility of old hens include problems in the ability to store sperm in their reproductive tract or a decline in the ability to transport the sperm to the fertilization site(Santos et al., 2015).Also, Javid et al.(2016)reported that egg weight loss percent was significantly affected by breeder's age.

Regarding the effect of flock age on hatch time, Rizk et al. (2006) and Mona et al.(2016) reported that time of hatch for chicks from elder flock age was significantly delayed compared to those from younger one. Also, chick weight was increased with advancing age of broilersbreeders as reported by Yildirim (2005).

This study was undertaken to assess the role of using small doses of Spirulina algae as main source of natural carotenoids in layers diet on egg weight loss , embryonic weight and mortalities, hatching traits , liver carotenoids in hatched chicks and some blood parametersfocusing on the effect of

chicken age on the previous mentioned parameters.

MATERIALS AND METHODS

The present experiment was conducted at El-Sabahia Poultry Research Station (Alexandria), Animal Production Research Institute, Agriculture Research Center, throughout the period from 1st of January up to 1st of may 2016. One hundred and thirty five females with fifteen males for Bandarah chicken strain at 30-week of age (YA), besides the same numbers of birds from the same chicken strain at 56-week of age (OA) were housed in floor pens. The birds were weighed and randomly divided into five groups representing the dietary supplementations within each experimental age and kept in 15 floor pens for each age with three replicates for each treatment.Sex ratio comprised 1 male for 9 females for each pen were used as replicate. The five experimental bird groups for each age were fed diets supplemented with Spirulina Platensis algae (SA) powder as follows :

1. basal diet without supplementation of SA (control, T1)
2. basal diet supplemented with 40 mg SA / Kg diet (T2)
3. basal diet supplemented with 80 mg SA / Kg diet (T3)
4. basal diet supplemented with 120 mg SA / Kg diet (T4)
5. basal diet supplemented with 160 mg SA / Kg diet (T5)

The ingredient profiles and nutrient composition of the basal diets areshown in (Table 1) according to the Feed composition for Animal and Poultry Feedstuffs in Egypt (2001).Chemical composition of SA was detected and puplished in the first part of this research by Ebtsam et al.(2017).

Birds were subjected to 16 hours light and 8 hours dark during the experimental period. Feed and water were provided ad libituim. Eggs produced from Bandarah hens were collected daily after 4 weeks from the beginning of the experiment at 34-week for younger age and 60-week for elder age. Prior incubation, hatching eggs were culled for removing cracked, misshapen, dirty or extreme size of eggs. One thousand and four hundred hatching eggs were collected throughout six days of production and stored in room temperature supplied with fans. All eggs were numbered and weighed prior incubation and replicated in three trays for each previously mentioned group. Eggs were set and randomly distributed at different places in the same trolley of the incubator to reduce possible position effect. The eggs were incubated in Egyptian-made incubator at 99.5 F° temperature and 55% relative humidity (RH) from days 1 to 18 of incubation. On th 18th days of incubation the eggs were transferred singly into pedigree hatching nests and then placed into hatcher for the remainder of period at 98.6°F and 65% RH for 3 days till the hatch.

Collected data

All eggs were individually weighed again during incubation on the 7th ,14th days and at pipping in order to obtain egg weight loss percentages for each incubation time interval.

At days 7, 14 and 18 during incubation, nine eggs were randomly chosen from each experimental group (total 90 eggs) weighed and opened then the embryos were separated from the remaining egg contents. Embryos were rinsed in saline and blotted dry on an absorbent paper andthe dried embryos were weighed to the nearest 0.001 g .

Eggs that failed to hatch and having full opportunity to hatch were broken out and examined macroscopically to estimate the embryonic development and assigned according to their times of death by dayas possible. Embryonic mortality percentage expressed as a percentage of fertile eggs set was recorded every day of incubation and classified into three periods (0-6 ,7-12 and 13-20days).

Macroscopic fertility was estimated as a percentage of fertile eggs out of the number of eggs set. Hatchability of fertile eggs was estimated as a percentage of sound chicks out of the fertile eggs. All percentages data of fertility and hatchability were subjected to arcsine square root transformation prior to analysis. Hatch time was monitored every 6 hours after the hatch of first chick by hours. Baby chicks at hatch were weighed by gram. For detection the carotenoids in the hatched chick's liver, a small portion of the lower right lobe of the liver was excised, weighed and stored at −20 °C prior to biochemical analysis. Carotenoid profile was determined with HPLC by normal phase isocratic elution on Rocket Platinum column (Alltech Inc.) preceding direct extraction (Kerti and Bárdos, 2006).

Sixty blood samples were randomly taken from 6 hatched chicks for each treatment group representing each age. The blood samples were collected immediately in heparenized tubes for measuring plasma cholesterol (mg/dl), high density lipoprotein (HDL-cholesterol) (mg / dl) , low density lipoprotein (LDL-cholesterol) (mg/dl), total antioxidant (mg/dl) and lipid peroxide (malondialdehyde) (nmol/ml) using available commercial kits. Half of the blood sample was taken to determine red blood cells (RBC_S), hemoglobin (Hb) content,packed cell volume (PCV) ,white blood cells (WBC_S) counts , Lymphocyte (L) and Heterophil (H).

Statistical analyses

Data were analyzed using GLM procedure of SAS (2000) to study the effect of treatment, age and their interactions. The model was as follows:

$Y_{ijk} = \mu + Ti + A_j + TA_{ij} + e_{ijk}$

where:

Y_{ijk} = an observation on the k^{th} individual,

μ = the overall mean,

T_i = the fixed effect of the i^{th} treatment.

A_j = the fixed effect of the j^{th} age.

TA_{ij} = the interaction between treatment and age

e_{ijk} = random error assumed to be independent normally distributed with mean = 0 and variance $\sigma^2 e$.

Significance among means was detected using Duncan's Multiple Range Test (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Egg weight loss percentages during different incubation periods as affected by dietary SA and flock age and their interactions are shown in Table 2. Generally, SA supplementation significantly affected egg weight loss % and eggs of T1 group as control represented the highest ($p \leq 0.05$) weight loss among the experimental incubation periods (0-7 d,8-14 d and 0-pipped) with no statistical change with T3 and T5 groups during 0-7 days of incubation. Moreover, eggs of T2 group represented the lowest numerical loss among all experimental periods except for the period between Day 15 to pipping. In addition, data of Table 2 showed that eggs of elder flock significantly lost greater percentage of weight compared to the younger one. The interaction between T1 × OA

represented the highest ($p \leq 0.05$) eggs loss during the whole incubation period (0-pipped) compared with all studied interactions. While, the lowest loss for this period is detected for interaction of T2 × YA .

The variables in egg weight loss during the incubation intervals due to SA supplementation could be due to two main factors, the first one is shell thickness as reported by Englmaierová et al.(2013) who found that all carotenoids significantly increased shell thickness. Also, Molenaar et al.(2010) mentioned that egg weight loss is variable in egg size as second factor. Therefore, the first part of research on SA (Ebtsam et al.,2017) proved that both factors of eggshell thickness and egg weight could be the reasons of variation in egg weight loss with SA supplementation in the diet. The present results of accumulated egg weight loss (0-pipped) clarified that the increase of shell with membrane thickness for T2 group could be the reason for decreasing the egg weight loss of this group. Moreover, the significant increase of egg weight loss for elder flock could be interpreted on the light of shell thickness data as main reason with aging advance of chickens as documented by Rizk et al. (2008) and Mona et al. (2016). Egg weight loss is critical and very sensitive criterion and should be within the normal range of loss. The interaction data in Table 2 revealed that the optimum loss for eggs of younger age could be obtained with supplementation the diet with 40 mg SA/Kg diet, while for elder age 160 mg SA/Kg could be recommended.

It is clear from data of Table 3 that embryonic weight at Day 18 was significantly largest for T2 group compared with those for other treatments , while, embryonic weight at Days 7 and 14 represented the same significant increase of embryonic weight compared with control (T1) and no significant differences with the other experimental groups. Furthermore, the embryos of elder flock age had larger ($p \leq 0.05$) weight compared with those for younger one at Days 7,14 and 18 of incubation. The interaction between T and Age revealed that there are significant differences among all interactions of embryonic weights at studied days focusing on the increase of embryonic weight for interaction of T5 × OA at all studied days sharing with T2 × OA at Day 18. Whereas, T1 × YA interaction represented the smallest embryonic weight among the detected interactions.

The increase of egg weight in group T2 as observed in the first part of research on SA as reported by Ebtsam et al.(2017) could be the main reason for increasing ($p \leq 0.05$) embryonic weight for this group compared with the other ones. The obtained results of increasing embryonic weight for elder flock age compared to younger one could be related with the increase of egg weight and this conclusion is in harmony with that reported by ÓSullivan et al.(1991) who mentioned that weight of embryos increased with parental age and heavier embryos have been attributed to heavier egg weight. Moreover, egg weight loss may be involved in embryonic weight and development (Roque and Soares, 1994).

With respect to embryonic mortality, T2 and T5 groups represented the lowest percentages compared with other groups during the early (0-6 d) and mid (7-12 d) stages of embryonic development, T5 group represented only the same lowest ($p \leq 0.05$) embryonic mortality compared

with the others except that for T2 group. During the late stage of embryonic mortality (13-20 d), T5 group showed the lowest numerical percentage of embryonic mortality compared with others. Whereas, control group (T1) had the highest numerical embryonic mortality compared with the others. Moreover, elder flock age had greater ($p \leq 0.05$) embryonic mortality percentage compared with those for younger one. The interaction between T and Age represented the significant differences among the studied stages. Regarding the early stage (0-6 d), highest values of interactions for embryonic mortality were recorded with T1 × OA and T3 × OA. While, the lowest numerical one was detected for T2 × YA. The embryonic mortality % in the middle stage of incubation showed the same trend of interactions between T and age. With respect to late stage of embryonic mortality, the highest interaction was detected in T1 × OA, while the lowest ones were detected in interactions of T2 × YA, T4 × YA and T5 × OA.

Regarding embryonic mortality, different authors confirmed our conclusion that supplementation the diet with carotenoids reduced embryonic mortality (Surai, 2012 and Duarte et al., 2015). Peebles and Marks (1991) mentioned that increased egg shell permeability which related to egg weight loss has been associated with increased early and late embryonic mortality . Also, Rizk et al.(2008) showed that rate of egg weight loss during incubation might be related to embryonic mortality. Besides parent flock age influences daily embryonic metabolism which coincides with the incidence of greater embryonic mortality during the late period of incubation (Hamidu et al.,2007). In addition, the increase of embryonic mortality among the experimental stages for elder age compared with the younger one is in line with those previously reported by Mona et al. (2016). In conclusion from the forementioned results that supplementing the younger age with 40 mg SA/Kg diet and 160 mg SA/Kg diet for elder flocks could be recommended for diminishing embryonic mortality.

Data of macroscopic fertility and hatchability of fertile eggs percentages beside hatch time (hrs) and hatched chick weight (g) are shown in Table 4. Groups of T2 and T5 with SA supplementations recorded the highest significant percentages of macroscopic fertility and hatchability of fertile eggs compared to control and no statistical change was observed with T3 and T4 groups with respect to hatchability %. Moreover, the chicks of T2 and T5 groups were hatched ($p \leq 0.05$) earlier than those for other groups. Hatched chick weight represented the same trend of significant increase of hatchability % as chicks for T2 and T5 groups realized the same significant increase compared to other experimental groups. Regarding flock age, younger chickens had a significant increase of macroscopic fertility (%) and hatchability of fertile eggs (%)compared with those for elder ones. Moreover, no significant difference was reported between both ages regarding hatch time.Furthermore, hatched chick weight produced from elder flock age had been increased ($p \leq 0.05$) compared with those for younger one. Also, there are significant differences between the interactions of T × Age with respect to all studied traits (Table 4). It is evident from this data that the highest interactions of macroscopic

fertility and hatchability of fertile eggs % are observed for groups of T2 × YA and T5 × OA. In addition to , hatch time had been significantly delayed for chicks of interaction groups of T1 × YA, T4 × YA , T1 × OA and T3 × OA compared with the other interactions. The interaction of hatched chick body weight represented the highest significantvalues in T5 × OA and T2 × YA compared with the other interactions.

The increase of macroscopic fertility for eggs of T2 and T5 groups was reflected on the improvement of hatchability for these groups. Different authors came to the conclusion that supplementing the diet with either carotenoids or SA significantly increased both fertility and hatchability percentages as El-Khimsawy (1985) who reported that tocopherols had a vital role in fertility and hatchabiliy of poultry. Also, Mariey et al. (2012) reported that Spirulina algae inclusion in hen diet improved fertility and hatchability. Besides Duarte et al.(2015) observed that the inclusion of canthaxanthin and 25-(OH)-D_3 in the diet increased hatching percentage, and number of viable chicks produced per bird. While, Zhang et al. (2011) found no effect of canthaxanthin on the fertility and hatchability of fertile eggs. Moreover, the reduction of fertility percentage for eggs of elder flock age compared to younger one is explained by including the old hens some problems in the ability of storing sperms in reproductive tract or a decline in the ability to transport the sperm to the fertilization site (Santos et al.,2015). Also, Brillared (1993) reported that old females have reduction in the quantity of sperm stored over time. Also, the numerical decrease of hatchability percentage for elder flock age could be explained with the decrease of eggshell thickness (Tsarenko,1998), the change in the physical and functional qualities of eggs as the hens aged (Christensen et al.,1996),larger egg size (Leeson and Summers,2000), albumen quality deterioration (Tona et al.,2004), and the increase of embryonic mortality (Rizk et al.,2008).

There is a little collaborative data on the response of hatch time due to SA supplementation. With respect to the results herein of hatch time as affected by flock age, Bruzual et al.(2000) confirmed present results that hatching time was not affected by hen age, while others mentioned that hatch time was delayed for elder chickens compared with those for younger ones (Rizk et al., 2006). The trend result of SA concentration which influenced hatched chick body weight resembles the results of hatchability for T2 and T5 groups as they recorded the best significant results. Also, the increase of chick body weight for older parental age comparedtoyounger one is supported by different authors (Rizk et al. 2006 and Mona et al., 2016). Contradicted results were observed by Mariey et al. (2012) who showed no significant differences among different dietary treatments of Spirulina platensis algae in chicks weight at hatch.In conclusion, the results of interactions revealed that supplementation young flock with 40 mg SA/Kg diet and supplementation the elder flock with 160 mg SA/Kg diet could be a good tool for improving fertility , hatchability and hatched chick body weight.

Results of Table 5 showed carotenoids in the liver of the day old progeny representing two flock ages supplemented with dietary SA. Liver of

hatched chicks represented the lowest concentrations of Zeaxanthin for control group (T1). Also, increase of SA concentration in the diet represented linear increase of carotenoid concentrations as liver for T4 and T5 chicks recorded the highest concentrations. Moreover, regarding the flock age, there was no significant difference between both ages with respect to β-carotene. Whereas, the elder flock represented significantly higher Zeaxanthin concentration in the chick liver compared to those for younger one. Furthermore, with respect to β-carotene, the interactions represented highest significant records of concentrations for all dietary supplementations with T3 ,T4 and T5 either with YA or OA compared to other interactions. While regarding Zeaxanthin, T3,T4 and T5 represented highest significant interactions with OA compared to other interactions except that for T5 × YA and T2 × OA.

The interactions data revealed that carotenoids concentrations (β-carotene and Zeaxanthin) in chick liver are significantly increased due to all supplementation concentrations of SA with both flock ages compared to control. Aforementioned results proved that carotenoids in the diet of laying hens are strictly limited to the embryos and persisted to the progeny after hatching. The reason of choosing the chick liver for analysis that Surai and Speake (1998) mentioned that carotenoids concentration in the liver at hatch exceeds that of any other tissues and they added that liver carotenoids content is very sensitive to change in yolk carotenoid levels whereas, the other tissues of the embryo are much less responsive . Also, Galvan et al.(2012) stated that liver is considered the main storage site for fat soluble antioxidants (carotenoids , vitamin A, E and coenzyme Q10). The results herein regarding the deposit of carotenoids in the yolk and liver which derived from the maternal diet through egg yolk and embryos as apparent in the data of Table 5 are in accordance with those reported by Surai et al.(2003) .

Therefore, maternal dietary supplementation with the small doses of carotenoids as done in this study is quite enough and no obvious advantage to be gained from extra supplementation for transmission via the egg to the embryo and finally to the liver of the subsequently hatched chicks. Also, maternal supplementation of Spirulina algae not only enhance the carotenoid provision during embryonic life but also continues to influence the chick' s carotenoid status after hatching and could be used as effective way to boost the antioxidant defenses of the offspring.

Data of Table 6 represent blood constituent of hatched Bandarah chicks as affected by dietary SA. Highest significant values of cholesterol and malondialdhide were detected for control chicks compared with those for other experimental groups. All SA supplementations had significant influence on HDL values compared with control. Also, baby chicks of T2 and T5 represented the highest significant values of total antioxidant compared with the others, while the same previous supplementations had the lowest values of LDL. Regarding of flock age, chicks produced from elder flock age had higher significant values of cholesterol, LDL and malondialdhide, while chicks produced from younger one had higher ($p \leq 0.05$) value of total antioxidant and HDL.The interaction between T2 × YA represented highest values of HDL and

total antioxidant besides lowest values of cholesterol, LDL and malondialdhide compared to other interactions .

The apparent effects of SA supplementations and flock age on some blood parameters of hatched chicks are similar to that detected in the blood of their parents as reported in the first part of research of this series (Ebtsam et al.,2017). This similarity between blood parameters of parental flock and their offspring could be due to maternal effect as documented by Dixon et al. (2016). The current results of decreasing plasma cholesterol for chickens fed dietary SA are in line with that detected by Mariey et al. (2014) and Ebtsam et al. (2017). Moreover, the decreasing of plasma cholesterol and LDL and increasing of HDL may be due to that beta-carotene has a hypocholesterolemic effect and seems to displace cholesterol in the transport of lipoproteins (Yeum and Russell, 2002) and released into circulation (Salma et al., 2007). Also, the present results of the significant increase of total antioxidant and decrease of malondialdhide due to SA are coincided with the results of Surai (2012) who mentioned that canthaxanthin has a special place as a carotenoids and may be considered as an important element of the integrated antioxidant system of various tissue in the body including chicken embryo development. Also, Karadas et al. (2016) reported that carotenoids are natural lipid – soluble antioxidants that could enhance the overall antioxidant capacity available to the embryo and baby chicks. With respect to age effect, Latour et al. (1998) showed that serum cholesterol tended to be higher in elder hens than younger ones. Moreover Ebtsam et al. (2017) found that younger chickens had higher levels of plasma antioxidant and lower levels of malondialdhide compared to elder ones.

Effects of dietary supplementation with SA, flock age and their interactions on some blood parameters of hatched Bandarah chicks are shown in Table 7. It appears from data of this table that supplementation the diet with SA by 40 (T2), 120 (T4) and 160 (T5) mg /Kg diet represented significant increase of RBC_scount compared to control group. Also, values of Hb , PCV %, WBC_s countand lymphocyte % (L) were significantly increased for all treated groups than those for control one. Whereas, Heterophil % (H) and H/ L % were significantly decreased among all treated groups compared to control.

Irrespective of SA supplementation, chicks produced from younger age had the higher values ($p \leq 0.05$) of RBC_s count, Hb, PCV %, WBC_s countand L % compared with those for elder one. Opposite trends were observed for H and H/L %. The interactions between experimental treatment groups and flock age represented the highest values of RBC_s , Hb , PCV %, WBC_s count and L % and lowest ones of H% and H/ L % for T2 × YA group .

The improvement of blood parameters for newly hatched chicke either for supplemented groups with SA or those for younger flock could be interpreted with the maternal influence for both dietary supplementation or parental flock age. Supported to this notion, Khawaja et al. (2012) showed that hematological parameters in birds have been influenced by various factors such as age and nutrition. Spolaore et al. (2006) indicated that SA is rich in macro and microminerals, especially Fe, Cu, Zn (Babah et al., 2004). Iron plays an

important role in Hb, PCV % and RBC_s biosynthesis and is essential for metabolic enzymes biosynthesis such as cytochromes superoxide (Badway, 1998). An increase in Hb, PCV % and RBC_s concentration augment the blood oxygen carrying capacity (Snyder et al., 1982) and in turn on body weight and health status of chicks. Also, the increases ofWBC_s count and lymphocyte % by adding SA to the diet are in harmony with those reported by Khan et al.(2005) who showed that these increase because SA has immune-stimulatory effects and enhance immune function. Moreover, the previous mentioned parameters increase for chicks produced from younger flock age are in harmony with the results of Luguetti et al. (2004). Also, Farahat et al. (2009) mentioned that highest values of Hb, PCV % , RBC_s count and some white blood cell differentiation were recorded at the period of the highest egg production.Also, Peebles et al.(2007) revealed that younger age had the highest record of PCV % compared to older one. In addition, Talebi et al. (2005) detected the increase in H/ L ratios caused by heterophilice as indicator of chronic stress and biomarkers relevant to immune function and related to bird's age.

Therefore, Potential benefits of maternal carotenoid diet may span the generations for immunity and viability of the progeny and could be a useful area for future study.

IN CONCLUSION,

using Spirulina algae as a good source of carotenoides with 40 mg SA/Kg diet for young chicken flocks and 160 mg SA/Kg diet of elder one could be a good tool for improving different items of performance such as fertility, hatchability, chick body weight besides increasing liver carotenoides and antioxidant concentrations in the chick blood. Therefore carotenoids could be considered as key substances for impacting reproductive strategies in an age-dependent way and can potentially ameliorate the cost of reproduction.

Table (1): Composition and the nutritive value of the basal diets

Ingredients	**%**
Yellow corn	66.33
Soybean meal (44%)	24.2
Dicalcium phosphate	1.32
Limestone	7.5
Salt (Nacl)	0.25
DL – methionine	0.15
Vit & Min mix.*	0.25
Total **Calculated analysis:**	**100.00**
Metabolizable energy (Kcal/kg)	2777
Crude protein %	16.97
Calcium %	3. 1
Available phosphate %	0.37
Methionine % + cyctine %	0.67
Lysine %	0. 8

*Composition of premix in 3 kg is : Vit. A, 10.000 IU ; Vit . D3, 2.000 IU ; Vit E , 10.000 mg ; Vit. K3,1.000 mg; Vit . B1 , 1 mg ; Vit . B2 , 4 mg ; Vit B6 ,1.5 mg ; Vit . B12 , 10 mcg ; Niacin , 20.000 mg ; Pantothenic acid 10.000 mg ; Folic acid , 1 mg ; Biotin , 50 mg ; Choline chloride , 500 mg ; Copper , 4 mg ; Iron , 30 mg ; Manganese , 40.000 mg ; Zinc , 45.000 mg ; Cu , 3.000 mg ; Iodine , 300 µg ; Selenium , 0.1 mg ; Cobalt , 0.1 mg ,carrier caco3 add to 3 Kg.

Table (2): Effect of dietary supplementation with carotenoids-enriched Spirulina algae (SA), flock age and their interactions on egg weight loss during incubation ($\bar{X}$± S.E)

Main effect	**Egg weight loss %**			
	(0-7 days)	**(8-14 days)**	**(15days-pipped)**	**(0-pipped)**
Treatment(T)				
T1(Control)	4. 49^{a}±0.08	4.48^{a}± 0.08	3.44^{b}± 0.06	12.30^{a}±0.11
T2 (40mg SA/Kg diet)	3.80^{b}± 0.07	3.65^{c}± 0.06	3.11^{c}± 0.05	10.55^{c}± 0.10
T3(80mg SA/Kg diet)	4.13^{ab}±0.06	3.93^{b}± 0.11	3.58^{b}±0.07	11.64^{b}± 0.13
T4(120mg SA/Kg diet)	3.89^{b}± 0.08	3.95^{b}± 0.11	3.92^{a}± 0.09	11.76^{b}± 0.13
T5(160mg SA/Kg diet)	4.38^{a}± 0.08	4.10^{b}± 0.08	2.94^{c}±0.06	11.53^{b}±0.11
Age				
Young (YA) 30 - wk	3.87^{b}±0.05	3.80^{b}±0.05	3.10^{b}±0.04	10.77^{b}±0.07
Old (OA) 56 - wk	4.40^{a}±0.05	4.24^{a}±0.05	3.67^{a}±0.04	12.32^{a}±0.07
Interaction (T*Age)				
T1*YA	4.19^{c}± 0.12	3.93^{ab}±0.10	2.73^{d}± 0.08	10.48^{d}±0.16
T2*YA	3.19^{f}±0.09	3.33^{c}±0.08	3.01^{cd}± 0.07	9.53^{f}± 0.15
T3*YA	3.19^{f}± 0.09	3.87^{b}± 0.14	3.23^{c}± 0.09	10.29^{e}± 0.17
T4*YA	3.71^{e}± 0.11	3.91^{ab}± 0.16	3.76^{b}± 0.14	11.38^{cd}± 0.18
T5*YA	5.08^{a}± 0.12	3.98^{ab}±0.12	2.98^{cd}± 0.08	12.04^{c}± 0.16
T1*OA	4.61^{b} ± 0.10	5.03^{a}± 0.13	4.15^{a}±0.10	13.79^{a}± 0.15
T2*OA	4.42^{bc}± 0.09	3.94^{ab}±0.10	3.22^{c}± 0.08	11.58^{c}± 0.13
T3*OA	5.08^{a}± 0.11	4.01^{ab}± 0.18	4.02^{a}± 0.11	13.11^{b} ±0.22
T4*OA	4.11^{cd}± 0.13	4.01^{ab}± 0.14	4.08^{a}±0.09	12.21^{c}± 0.19
T5*OA	3.82^{de}± 0.10	4.24^{ab}±0.11	2.91^{cd}±0.08	10.97^{d}± 0.14

a , b ….. f means in the same column within the same trait with different superscripts are significantly different ($p \leq 0.05$) .

Table (3): Effect of dietary supplementation with carotenoids-enriched Spirulina algae (SA), flock age and their interactions on embryonic weight and mortalities ($\bar{X}$ ± S.E)

Main effect	Embryonic weight(gm)			Embryonic mortality %		
	Day 7	Day 14	Day 18	Early stage (0-6 d)	Mid stage (7-12 d)	Late stage (13-20 d)
Treatment (T)						
T1(Control)	0.78^{b}± 0.03	9.33^{c}±0.55	21.83^{c}± 0.60	5.74^{a}± 1.29	3.32^{a}± 0.43	4.35^{a}± 0.51
T2(40mg SA/Kg diet)	1.05^{a}± 0.12	12.33^{a}± 0.42	29.33^{a}± 1.22	2.10^{c}± 0.93	1.90^{ab}± 0.47	3.41^{ab}± 0.34
T3(80mg SA/Kg diet)	0.88^{ab}± 0.04	11.83^{ab}± 0.47	23.83^{cb}± 0.40	5.80^{a}± 2.39	2.39^{a}±0.67	4.10^{a}± 0.57
T4(120m SAg/Kg diet)	0.96^{ab}± 0.09	10.50^{bc}± 0.56	22.00^{c}±0.93	3.75^{b}± 0.75	2.18^{a}± 0.52	3.33^{ab}±0.56
T5(160mg SA/Kg diet)	1.03^{a}± 0.13	11.83^{ab}± 1.13	26.16^{b} ± 1.66	2.29^{c}± 1.43	0.89^{b}± 0.92	3.19^{ab}± 0.76
Age						
Young (YA) 30- wk	0.84^{b}± 0.06	10.59^{b}±0.44	23.46^{b}±0.62	3.20^{b}± 1.15	1.01^{b}± 0.39	3.02^{b}± 0.42
Old (OA) 56- wk	1.04^{a}± 0.05	11.73^{a}± 0.54	25.79^{a} ± 1.18	5.23^{a}± 0.80	2.72^{a}± 0.35	4.17^{a}± 0.32
(Interaction T*Age)						
T1*YA	0.70^{c}±0.03	8.66^{e}±0.88	20.00^{b}± 1.00	4.32^{ab}± 1.92	2.90^{ab}± 0.64	3.33^{abc}±0.71
T2*YA	1.10^{ab}± 0.14	13.00^{ab}± 0.57	28.66^{a}±0.88	1.07^{b}± 0.68	0.52^{c}± 0.83	2.22^{c}±0.28
T3*YA	0.81^{bc} ± 0.03	11.33^{bcd}±0.66	23.66^{b}± 0.88	4.23^{ab}± 2.14	1.34^{b}± 1.15	3.36^{abc}± 0.86
T4*YA	0.80^{bc}± 0.06	10.33^{cde}± 0.88	21.33^{b}±1.76	3.19^{ab}± 1.14	1.09^{b}± 0.85	2.56^{c}± 0.62
T5*YA	0.80^{bc} ± 0.10	9.66^{de}± 1.20	23.66^{b}± 0.88	3.12^{ab}± 1.08	1.18^{b}± 1.42	3.64^{abc}± 0.87
T1*OA	0.86^{bc}± 0.06	10.00^{cde} ± 0.57	23.66^{b} ± 0.33	7.17^{a}± 1.38	3.75^{a} ± 0.48	5.38^{a} ±1.13
T2*OA	1.01^{ab} ±0.08	11.66^{abcd}± 0.33	30.00^{a}± 2.51	4.86^{ab}± 0.79	2.28^{ab}± 0.55	4.61^{ab} ±0.62
T3*OA	0.96^{abc}± 0.08	12.33^{abc} ±0.66	24.00^{b}± 0.01	7.37^{a}± 4.38	3.70^{a}± 0.96	4.61^{ab}± 0.65
T4*OA	1.13^{ab}± 0.18	10.66^{bcde}± 0.88	22.66^{b} ± 0.88	4.32^{ab}± 0.76	3.27^{a}± 0.73	4.11^{ab}± 0.73
T5*OA	1.26^{a}± 0.14	14.00^{a}± 0.57	28.66^{a}± 2.60	1.46^{b}± 0.77	0.60^{c}± 0.25	2.15^{c}± 0.31

a , b …..e means in the same column within the same trait with different superscripts are significantly different ($p \leq 0.05$) .

Table (4): Effect of dietary supplementation with carotenoids- enriched Spirulina algae (SA), flock age and their interactions on some hatching traits ($\bar{X}$ ± S.E)

Traits / Main effect	Macroscopic fertility(%)	Hatchability of fertileeggs (%)	Hatch time (hrs)	hatched chick weight(gm)
Treatment(T)				
T1(Control)	84.30^{b}± 2.22	74.98^{b}± 1.73	496.00^{a}±1.71	36.17^{b}±0.16
T2 (40mg SA/Kg diet)	90.58^{a}± 0.68	82.01^{a}± 1.78	482.00^{c}±1.46	37.58^{a}± 0.16
T3 (80mg SA/Kg diet)	88.96^{ab}± 1.74	75.97^{b} ± 2.87	490.00^{b}±2.30	36.09^{b}± 0.19
T4 (120mg SA/Kg diet)	87.95^{ab}± 2.63	76.7^{b}± 2.31	489.00^{b}±2.67	36.10^{b}± 0.19
T5 (160mg SA/Kg diet)	91.80^{a}±0.56	84.42^{a} ± 1.97	484.00^{c}±1.46	37.79^{a}± 0.17
Age				
Young (YA) 30 - wk	91.48^{a}± 1.29	83.78^{a}±1.78	488.00^{a}±1.60	36.36^{b}± 0.09
Old (OA) 56 - wk	85.95^{b}± 1.28	74.03^{b}± 1.46	488.40^{a}±1.91	37.44^{a}± 0.13
Interaction (T*Age)				
T1*YA	88.55^{abc}± 2.80	81.12^{b} ± 1.62	494.00^{a}±2.30	35.99^{de}± 0.21
T2*YA	94.52^{a}± 0.67	90.79^{a} ± 2.30	482.00^{b}±2.30	38.28^{b}±0.15
T3*YA	92.44^{abc}± 1.85	81.56^{b}± 2.94	486.00^{b}±2.30	35.56^{e}± 0.23
T4*YA	91.57^{abc}± 3.89	81.67^{b}± 1.41	494.00^{a}±2.30	35.79^{de} ± 0.21
T5*YA	90.33^{abc}± 1.29	83.79^{b}±1.75	484.00^{b}±2.30	35.57^{e}± 0.20
T1*OA	80.06^{d}± 3.90	68.85^{d}± 1.75	498.00^{a}±2.30	36.37^{cd} ±0.25
T2*OA	86.63^{bc}±3.90	72.74^{c}± 3.47	482.00^{b}±2.30	36.90^{c}± 0.27
T3*OA	85.48^{abc}± 1.85	70.39^{d}± 2.90	494.00^{a}±2.30	36.73^{c}± 0.32
T4*OA	84.34^{c}± 3.89	71.74^{c}± 2.94	484.00^{b}±2.30	36.53^{cd}± 0.35
T5*OA	93.28^{ab}±0.68	86.43^{a} ± 1.78	484.00^{b}±2.30	39.76^{a}± 0.20

a , b ….e means in the same column within the same trait with different superscripts are significantly different ($p \leq 0.05$)

Table (5): Carotenoids in the day old progeny liver representing two flock ages supplemented with dietary Spirulina algae (X^{-}± S.E)

Main effect	Carotenoids (µg100 gr^{-1})	
	β.carotene	**Zeaxanthin**
Treatment(T)		
T1 (Control)	4.11^{b}±0.13	8.95^{c}±0.98
T2 (40mg SA/Kg diet)	4.93^{ab}±0.14	10.11^{b}±1.11
T3 (80mg SA/Kg diet)	5.15^{a}±0.09	10.66^{b}±1.20
T4 (120mg SA/Kg diet)	5.35^{a}±0.14	11.35^{a}±1.29
T5 (160 mg SA/Kg diet)	5.61^{a}±0.15	11.90^{a}±1.43
Age (wk)		
Young (YA) 30 – wk	4.94±0.11	10.11^{b}±1.31
Old (OA) 56 – wk	4.98±0.19	11.93^{a}±1.54
Interaction(TRT*Age)		
T1*YA	4.00^{c}±0.13	8.85^{c}±1.00
T2*YA	4.96^{b}±0.10	9.79^{b}±1.03
T3*YA	5.20^{a}±0.18	10.00^{b}±0.93
T4*YA	5.25^{a}±0.15	10.11^{b}±1.09
T5*YA	5.33^{a}±0.12	10.77^{ab}±1.21
T1*OA	4.11^{c}±0.08	9.73^{c}±1.29
T2*OA	4.43^{b}±0.19	10.83^{ab}±1.49
T3*OA	5.36^{a}±0.15	11.00^{a}±1.22
T4*OA	5.55^{a}±0.19	10.95^{a}±1.18
T5*OA	5.49^{a}±0.17	11.30^{a}±1.26

a , b and c means in the same column within the same trait with different superscripts are significantly different ($p \leq 0.05$) .

Table (6): Effect of dietary supplementation with carotenoids-enriched Spirulina algae (SA), flock age and their interactions blood on constituent of hatched Bandarah chicks (X^{-}± S.E)

Traits / Main effect	Cholesterol (mg/dl)	high density lipoprotein (mg / dl)	Low density lipoprotein (mg/dl)	Total antioxidant (mg/dl)	Malondialdhide (nmol/ml)
Treatment (T)					
T1(Control)	145.57^{a}±3.04	43.14^{b}±1.21	74.95^{a}±1.12	350.3^{c}±25.7	2.16^{a}±0.34
T2 (40mg SA/Kg diet)	124.71^{c}±5.99	52.38^{a}±1.98	61.01^{bc}±5.32	405.0^{b}±38.68	1.43^{b}±0.27
T3 (80mg SA/Kg diet)	128.84^{b}±4.09	52.00^{a}±0.71	67.91^{ab}±2.54	369.3^{c}±18.58	1.58^{b}±0.21
T4(120mg SA/Kg diet)	127.33^{bc}±3.03	49.99^{a}±1.24	66.71^{abc}±1.29	375.0^{c}±20.74	1.55^{b}±0.23
T5(160mg SA/Kg diet)	127.46^{bc}±0.92	51.83^{a}±1.53	57.78^{c}±3.39	435.0^{a}±8.45	1.11^{c}±0.03
Age					
Young (YA) 30 - wk	124.06^{b}±2.67	52.08^{a}±1.11	62.77^{b}±2.11	428.0^{a}±10.0	1.11^{b}±0.05
Old (OA) 56 - wk	137.51^{a}±2.17	48.33^{b}±1.32	68.59^{a}±2.58	345.9^{b}±14.6	2.02^{a}±0.16
(Interaction T*Age)					
T1*YA	138.83^{b}±1.58	45.25^{d}±1.52	72.8^{ab}±1.21	400.0^{c}±28.86	1.40^{c}±0.05
T2*YA	114.37^{f}±1.12	56.67^{a}±1.01	49.2^{d}±1.27	490.0^{a}±5.77	0.83^{e}±0.03
T3*YA	120.15^{e}±1.81	55.11^{ab}±0.58	62.73^{c}±228	410.0^{c}±5.77	1.13^{d}±0.08
T4*YA	120.60^{e}±0.57	53.41^{bc}±1.15	64.30^{c}±0.64	420.0^{bc}±5.77	1.03^{de}±0.06
T5*YA	126.36^{d}±1.20	49.94^{bc}±2.60	64.80^{c}±1.73	420.0^{bc}±5.77	1.16^{cd} ±0.03
T1*OA	152.32^{a}±0.60	41.03^{e}±0.06	77.1^{a}±0.45	300.6^{d}±0.87	2.93^{a}±0.08
T2*OA	135.06^{c}±1.18	48.10^{cd}±0.58	72.83^{ab}±0.58	320.1^{d}±15.3	2.03^{b}±0.12
T3*OA	137.54^{bc}±2.25	48.21^{cd}±1.15	73.10^{ab}±0.57	328.6^{d}±6.26	2.03^{b}±0.12
T4*OA	134.07^{c}±0.58	50.59^{bc}±2.45	69.13^{b}±1.47	330.1^{d}±9.90	2.06^{b}±0.12
T5*OA	128.56^{d}±1.27	53.74^{bc}±1.21	50.77^{d}±2.33	450.0^{b}±9.96	1.06^{de}±0.03

a , b ….. f means in the same column within the same trait with different superscripts are significantly different ($p \leq 0.05$) .

Table (7): Effects of dietary supplementation with carotenoids- enriched Spirulina algae(SA), flock age and their interactions on some blood parameters of hatched Bandarah chicks (X^{-}± S.E)

Traits / Main effect	$RBC_s \times 10^6$	HB	PCV%	$WBC_s \times 10^3$	Lymphocyte% (L)	Heterophil % (H)	H/L
Treatment(T)							
T1(Control)	2.29^{b}±0.05	9.26^{b}±0.42	29.55^{b}±0.66	6.13^{b}±0.15	64.45^{b}±0.46	32.33^{a}±0.80	50.19^{a}±1.39
T2(40mgSA/Kgdiet)	2.47^{a}±0.08	11.18^{a}±0.45	31.96^{a}±1.07	6.95^{a}±0.40	67.33^{a}±0.60	29.43^{b}±1.21	43.81^{b}±2.19
T3(80mg SA/Kg diet)	2.41^{ab}±0.06	11.04^{a}±0.17	31.86^{a}±0.58	6.87^{a}±0.26	67.36^{a}±0.47	30.00^{b}±1.04	44.59^{b}±1.84
T4(120mgSA/Kgdiet)	2.46^{a}±0.03	11.01^{a}±0.17	31.85^{a}±0.28	6.60^{a}±0.13	66.96^{a}±0.16	30.33^{b}±0.83	45.30^{b}±1.33
T5(160mgSA/Kgdiet)	2.48^{a}±0.04	11.17^{a}±0.26	32.00^{a}±0.25	6.74^{a}±0.15	67.23^{a}±0.05	29.91^{b}±0.36	44.49^{b}±0.53
Age							
Young (YA) 30 -wk	2.49^{a}±0.03	11.15^{a}±0.24	32.44^{a}±0.32	6.98^{a}±0.16	67.40^{a}±0.31	28.71^{b}±0.45	42.65^{b}±0.85
Old (OA) 56 - wk	2.35^{b}±0.03	10.31^{b}±0.26	30.45^{b}±0.42	6.33^{b}±0.10	65.94^{b}±0.34	32.09^{a}±0.33	48.71^{a}±0.68
Interaction (T*Age)							
T1*YA	2.37^{bcde}±0.08	9.83^{d}±0.68	30.90^{de}±0.43	6.30^{def}±0.23	65.33^{f}±0.24	31.10^{bc}±0.96	47.59^{bc}±1.42
T2*YA	2.63^{a}±0.09	12.16^{a}±0.16	34.26^{a}±0.033	7.83^{a}±0.10	68.66^{a}±0.06	26.76^{e}±0.53	38.98^{g}±0.80
T3*YA	2.52^{abc}±0.03	11.41^{ab}±0.06	33.00^{b}±0.10	7.40^{ab}±0.05	68.43^{a}±0.08	27.83^{de}±0.60	40.67^{fg}±0.83
T4*YA	2.50^{abcd}±0.05	11.39^{ab}±0.03	32.36^{bc}±0.18	6.83^{cd}±0.12	67.30^{b}±0.10	28.56^{de}±0.57	42.44^{ef}±0.81
T5*YA	2.43^{abcd}±0.03	10.97^{bc}±0.29	31.66^{cd}±0.33	6.56^{cde}±0.28	67.26^{b}±0.03	29.30^{cd}±0.05	43.55^{de}±0.06
T1*OA	2.21^{e}±0.03	8.70^{e}±0.34	28.20^{f}±0.41	5.96^{f}±0.17	63.56^{g}±0.47	33.56^{a}±0.88	52.79^{a}±0.99
T2*OA	2.30^{de}±0.06	10.19^{cd}±0.21	29.66^{e}±0.66	6.06^{ef}±0.09	66.00^{e}±0.26	32.10^{ab}±0.15	48.63^{b}±0.35
T3*OA	2.31^{cde}±0.10	10.67^{bcd}±0.08	30.73^{de}±0.63	6.33^{def}±0.24	66.30^{de}±0.05	32.16^{ab}±0.66	48.51^{b}±0.95
T4*OA	2.43^{abcd}±0.01	10.64^{bcd}±0.11	31.33^{cd}±0.33	6.38^{cdef}±0.16	66.63^{cd}±0.12	32.10^{ab}±0.05	48.17^{b}±0.13
T5*OA	2.53^{ab}±0.07	11.36^{ab}±0.47	32.33^{bc}±0.33	6.93^{bc}±0.08	67.20^{bc}±0.11	30.53^{bc}±0.54	45.43^{cd}±0.75

a , b ….. g means in the same column within the same trait with different superscripts are significantly different ($p \leq 0.05$) .

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الملخص العربي
تأثيرإضافة طحلب الإسبيرولينا الغنى بالكاروتينات للعليقة 2.على النمو الجنينى و الإستجابة الفسيولوجية للدجاج المستنبط

إبتسام السيد إبراهيم عراقى – منى محمود أحمد – وسام أديب فارس – على عبد الهادى سعد – رءوف ادوارد رزق

معهد بحوث الانتاج الحيواني - مركزالبحوث الزراعية– الجيزة – مصر

أجريت هذه التجربة لدراسة تأثير إضافة طحلب الإسبيرولينا الغنى بالكاروتينات و كذلك عمر القطيع على الفاقد فى وزن البيض % و وزن الأجنة و النفوق الجنينى % و صفات الفقس و صفات الدم لدجاج البندرة . و اجريت التجربة على مائة و خمسة و ثلاثون أنثى مع خمسة عشر ذكر من سلالة دجاج البندرة عند عمر 30 اسبوع (YA) إلى جانب عدد مماثل عند عمر 56 اسبوع (OA) فى بيوت تربية ارضية . و قسمت عشوائيا إلى خمس مجموعات تمثل الإضافات الغذائية لكل عمر كما يلى: العليقة المقارنة بدون اى اضافة طحلب الإسبيرولينا (T1) ، العليقة المقارنة مضاف إليها 40 ملجم (T2) ، 80 ملجم (T3) ، 120 ملجم (T4) ، 160 ملجم (T5) طحلب الإسبيرولينا / كجم علف . و أظهرت النتائج أن نسبة الفقد فى وزن بيض القطيع الأكبر كانت أعلى معنويا مقارنة بالأصغر عمرا . هناك زيادة ($p\leq0.05$) فى نسبة النفوق الجنينى للقطيع الأكبر عمرا مقارنة بالقطيع الأصغر و الإضافة الغذائية بطحلب الإسبيرولينا للعليقة خفضت النفوق الجنينى . أظهرت الإضافة الغذائية بتركيز 40 ملجم للقطيع الأصغر أو160 ملجم طحلب الإسبيرولينا / كجم علف للقطيع الأكبر تحسين معنوى لنسبة الخصوبة و الفقس للبيض المخصب ووزن الكتاكيت الفاقسة. يلاحظ أقل تركيز ($p\leq0.05$) للبيتا كاروتين و الزاكسانثين فى الكبد للكتاكيت الكنترول بالمقارنة لكل المجموعات الأخرى . العمر الأكبر أعلى معنويا لتركيز الزاكسانثين فى كبد الكتكوت مقارنة بالأصغر . بغض النظر عن عمر القطيع، الكتاكيت الفاقسة لمجموعات T2 و T5 سجلت أعلى قيم معنوية لمضادات الأكسدة الكلية و أقل للكوليسترول المنخفض الكثافة LDL مقارنة بالمجموعات الأخرى. بالنسبة إلى عمر القطيع ،سجلت الكتاكيت الناتجة من القطيع الأكبر عمرا أعلى قيم معنوية للكوليسترول و الكوليسترول المنخفض الكثافة و المالونالدهيد، بينما سجلت الكتاكيت الناتجة من القطيع الأصغر عمرا أعلى قيم معنوية للمضادات الأكسدة الكلية و للكوليسترول المرتفع الكثافة . و نستخلص من نتائج هذه الدراسة إلى أن الإضافة الغذائية لعليقة القطيع الأصغر عمرا بتركيز 40 ملجم طحلب الإسبيرولينا / كجم علف ، و لعليقة القطيع الأكبر عمرا بتركيز 160 ملجم طحلب الإسبيرولينا / كجم علف يمكن أن تكون أداة جيدة للحصول على أفضل تحسين لنتائج الخصوبة و الفقس ووزن الكتاكيت الفاقسة، إلى جانب أعلى تركيز لمضادات الأكسدة الكلية فى دم الكتاكيت الفاقسة .