Plant Archives Vol. 20, Supplement 2, 2020 pp. 1584-1591 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

EFFECTS OF COMBINING *IN OVO* INJECTION BY NUTRITIVE SOLUTIONS AND EARLY POST-HATCH NUTRITION ON PRODUCTIVE PERFORMANCE OF BROILER

Ola Mahdi Alsultan, Fadhel Rasoul Abbas Al-Khafaji* and Hashim Naji Gmash
Animal production Department, Agriculture College, Al- Qasim Green University, Iraq
*Email: dr-fadhilkafaji@uoqasim.edu.iq

Abstract

This experiment was conducted in hatchery and fields of Al-Anwar Poultry Company in Babylon province in two-stage, where the first stage was within the period from 14/9/2019 to 18/9/2019 and included the use of two types of early feeding and its impact on the productive traits of broiler chickens. The first type included hatching eggs injected with a nutrient solution into the amniotic sac at 17.5 days from the incubation period. As for the second type of early feeding, it includes feeding the hatching chicks in the hatchery. And 450 eggs were fertilized from the broiler-type Ross 308, where 225 eggs were injected and distributed to six treatments, with 75 eggs per treatment. The treatments are divided as follows: T1 control group without injection and without early feeding in the hatching, T2: Injecting eggs with a nutrient solution (Maxifort at a concentration of 1% and at a dose of 0.2 ml/egg), T3: Injection of hatching eggs with a nutrient solution (Maxifort at a concentration of 1% and at a dose of 0.2 ml/egg) and feeding by drinking water (contains a nutrient solution at a concentration of 3%), T4: injecting the hatching eggs with a nutrient solution (Maxifort at a concentration of 1% and a dose of 0.2 ml/egg) and feeding it by drinking water (containing a nutrient solution at a concentration of 3%) and feed. T5: the provision of drinking water (containing a nutrient solution with a concentration of 3%) inside the hatching and T6: provision of feed and drinking water (containing a nutrient solution with a concentration of 3%) inside the hatching. As for the second stage of the experiment, the 360 Hatching chicks were raised for five weeks, starting from 18/9/2019 to 23/10/2019, and were distributed to six treatments shown above, at the rate of 60 birds per treatment, and each treatment contained three replicates and each replicate contains 20 chicks. The most important results indicated a significant excelled P <0.01 in weight at hatching, weekly body weight rate, total weight gain rate and total feed conversion efficiency for early feeding treatments in comparison with the control treatment.
***Keywords*:** *In ovo* injection, broiler chickens, feed in hatching.

Introduction

Poultry meat production increased at a faster rate than any other livestock animal production in the world (Jha *et al.*, 2019) due to that the poultry industry is of great importance in agricultural production, including the production of white meat and eggs. Researchers have shown that early access to feed and water is of obvious importance in the performance of hatched chicks. Where delayed water consumption and nutrients for chicks can lower its overall growth performance. Early feeding strategies have been proposed and developed to reduce or possibly reverse the negative effects of delayed feeding. These strategies include early feeding by egg injection as well as early feeding after hatching (Willesmen *et al.*, 2010). The productive traits of broiler chickens can be influenced by many factors related to determining development and vitality during the different stages of the embryo age and during the hatching process. and because the growth and development of embryo tissue until the hatching process depends radically on the contents of the egg, Because these contents represent one of the most important of these factors. In addition to the chicks ability to take advantage of the remaining nutrients in the yolk sac during the days following the hatching process, Also, the gut ability to digest and absorb nutrients from the external diet source. These factors have an impact on the vitality of the chicks, their growth rate, their efficiency in feed consumption and disease resistance (Al-Asadi and Al-Hassani, 2007). Moreover, the hatching process requires energy and the hatching chicks may suffer from food stress, so the use of early feeding in the egg by injection with nutrients *In Ovo* Feeding (IOF) (IOF) or early feeding by provided feed-in hatching directly Early Feeding (EF It has great importance in the growth and development of its digestive system and enhances the ability to digest and absorb nutrients. Also, early nutrition leads to enhanced glycogen reserves, intestines development, and muscle growth (Al-Khafaji, 2012). Ensuring that these reinforcements are achieved through early feeding ensures that the marketing age is reached with a lesser period compared to the usual situation (Uni and Ferket, 2011). The embryonic development of birds, unlike mammals, depends on the nutrients in the egg. And because the present chicken strains have an accelerated growth rate, they have higher metabolism requirements, which makes the post-hatching period a very important factor in productive efficiency. As for the post-hatching stage, which is a period of severe pressure on the chicks as a result of the main changes in the environment in addition to transportation and fasting for long periods, the chicks resort to using proteins in the muscles to obtain energy through the introduction of sugar. Muscle protein loss can be reduced by providing nutrients in eggs, such as amino acids and carbohydrates, which allow birds to achieve higher production performance. Vitamin and mineral injections mainly help improve the antioxidant and immune system (Bello *et al.*, 2013). Amino acids are also mainly injected to reduce the sugar formation of protein (Johri 2004; Bhanja *et al.* 2014; Salmanzadeh *et al.*, 2016). Carbohydrate injections generally serve as an additional source of energy to meet the high energy requirement at the end of the incubation period (Zhai *et al.*, 2011). In addition, the egg can be injected with other substances that help improve productive performance and health. Therefore, the current study aims to know the effect of early feeding on some productive traits of broiler chicken and determine the best method for early feeding by comparing the effect of injecting hatching eggs with nutrient solutions at the age of 17.5 days with the feeding of hatching chicks inside the hatching as well as the combined effect of these two methods.

Materials and Methods

The 450 hatching eggs were used in this experiment from the hatchery of Al-Anwar Poultry Company in Al-Mouradia Babylon province, imported from a Turkish company. The experiment was conducted in two stages. The first stage was the use of early nutrition, which was two types, where in the first type was the use of early nutrition by injecting eggs with the nutrient solution on 9/14/2019, And included the injection of 225 eggs suitable for hatching at the age of 17.5 days (after the process of photosynthesis to exclude the unfertilized eggs that contain dead embryos) and then the eggs were transferred to the hatching with flat-base boxes where the eggs were distributed to three boxes with 75 eggs per box. The temperature in the hatching machine was 37 ° C and relative humidity of 80-85%. As for the second type, the chicks are fed directly after hatching inside the hatchery, where two-store mesh boxes were used. The eggs on the upper floor were laid for hatching, and the lower floor included the feed solution and feed. Where the nutrient solution was placed in small fountains fixed to the four sides of the box. As for the second stage (the field part), it was conducted in the fields belonging to the Anwar Poultry Company, and 360 birds of the Ross 308 type for broiler chickens were raised for broiler chickens with One day age unsexed for 35 days from 18/9/2019 to 23/10/2019. The experiment included the following six treatments: The first treatment: a control group without injection and without early feeding in the hatching, the second treatment: Injecting eggs with a nutrient solution) (Maxifort at a concentration of 1% and at a dose of 0.2 ml/egg), the third treatment: Injection of hatching eggs with a nutrient solution (Maxifort at a concentration of 1% and at a dose of 0.2 ml/egg) and feeding by drinking water (contains a nutrient solution at a concentration of 3%), The fourth treatment: injecting the hatching eggs with a nutrient solution (Maxifort at a concentration of 1% and a dose of 0.2 ml/egg) and feeding it by drinking water (containing a nutrient solution at a concentration of 3%) and feed. The fifth treatment: the provision of drinking water (containing a nutrient solution with a concentration of 3%) inside the hatching machine and the sixth treatment: provision of feed and drinking water (containing a nutrient solution with a concentration of 3%) inside the hatching. On 09/18/2019, the hatching chicks from the hatchery were transferred to a field belonging to the Anwar Poultry Company - Al-Mouradia- Babylon and the chicks were raised for a period of 35 days from 09/18/2019 to 23/10/2019. The chicks were distributed to six treatments, each treatment contains three randomly distributed replicates, and each replicate contains 20 chicks placed in pens, the dimensions of each being 1 *1.5 m. The feed used was as shown in the following table:

Table 1 : The percentages of diet components used in the study and their chemical composition

Final diet% (22-35 day)	**Starter diet% (1-21 day)**	**Feeding Materials**
40	30	yellow corn
24	28.25	wheat
24.8	31.75	Soybean meal (48% protein)
5	5	Protein center *
4.4	2.9	Sunflower oil
0.6	0.9	limestone
0.9	0.7	DCP Calcium Diphosphate
0.1	0.3	salt
0.2	0.2	Mix vitamins and minerals
100	100	Total
20.6	23.6	Crude protein (%)
3140	2954	Calculated energy represented (kilo calories / kg feed)
0.451 mg/kg	0.457 mg/kg	Selenium
102.66 mg/kg	101.225 mg/kg	Vitamin E
1.1	1.2	Lysine (%)
0.46	0.49	Methionine (%)
0.32	0.36	Cystine (%)
0.76	0.85	Methaionine + cysteine (%)
0.49	0.45	Available phosphorus (%)
159.77	131.61	C / P Energy Ratio: Protein%

* BROCON-5 SPECIAL W protein concentrate : Chinese origin, each kg contains: 40% crude protein, 3.5% fat, 1% fiber, 6% calcium, 3% phosphorous available, 3.25% lysine, 3.90% methionine + cysteine 2.2% sodium, 2100 kcal / kg energy represented, 20,000 IU vitamin A, 40000 IU vitamin D3, 500 mg vitamin E, 30 mg vitamin K3, 15 mg vitamin B1 + B2, 150 mg B3, 20 mg B6, 300 B12 mg, 10 mg folic acid, 100 mcg biotin, 1 mg iron, 100 mg copper, 1.2 mg manganese, 800 mg zinc, 15 mg iodine, 2 mg selenium, 6 mg cobalt, 900 mg antioxidant (BHT).According to the chemical analysis of the diet according to NRC (1994).

Studied traits

(i) Chicks weight at hatching

The weight of the chicks at hatching was measured for each treatment by weighing the chicks with the box whose weight was previously measured and is empty. Then the weight of the empty box was extracted from this weight. Where the result represents the sum of the weights of the whole treatment. Then, the average weight of chicks was calculated for each treatment by dividing the total net weight by the number of chicks per treatment.

(ii) Average live body weight

The average live body weight for each replicate was calculated at the end of each week (after the weight of the chicks was calculated at the one day age) and for weeks (1-

5) by weight of the whole replicate birds using a sensitive balance. Thus, the calculation of the average live weight of the bird according to the following equation (Al-Fayyad and Naji, 1989):

Average live weight (g /bird)=

$$\frac{\text{Total weights for replicate birds at the end of the week (g)}}{\text{The number of birds per replicate}}$$

(iii) Weight gain rate (g / bird).

The weekly weight gain rate (g / bird) was calculated according to the following formula (Al-Fayyad and Naji, 1989):

Weight gain rate (g / bird) = average live body weight at the end of the week (g) - average live body weight at the beginning of the week (g).

(iv) Feed Consumption rate (g) per week

The weekly feed consumption rate was calculated for each replicate and for weeks (1 - 5). The weight of the feed provided to the birds was measured at the beginning of the week and the remaining feed weight was subtracted from it at the end of the week.

(v) Feed conversion ratio (g feed / g weight gain)

The following equation was used for the purpose of calculating the feed conversion rate (Al-Zubaidi, 1986).

Feed conversion ratio (g feed / g weight gain)=

$$\frac{\text{Average amount of feed consumed (gm) per week}}{\text{Average weight gain (g) per week}}$$

The statistical program SAS, (2012) was used in the statistical analysis for the purpose of studying the effect of the studied treatments on different traits, and the significant differences between the averages were compared by using the Duncan test (1955) polynomial

Results and Discussion

Weight at hatching (g)

For the weight ratio at hatching, the T4 and T3 treatments were highly significant (P <0.01) on the other treatments followed by the T1, The T6 and T5 treatments excelled on the T2 treatment, which recorded the lowest average live body weight at hatching where it recorded 50.74, 49.67, 49.99 and 50.33 g, respectively as shown in Table (2). The reason for the increase in the weight of the chicks when hatching in the treatments that were injected with the nutrient solutions in the last period of embryonic development may be due to the enhancement of the liver content of Glycogen which kept the muscle protein from demolishing by the process of gluconeogenesis to induce sugar in the last period of embryo development. (Uni *et al*., 2005).

The average Weekly live body weight (g)

The results of the statistical analysis in Table (2) indicated the effect of injecting fertilized eggs with the nutrient solution and early feeding into the incubator in the live body weight for the five-week experiment period, Where we note that the trait of live weight in the first week was significantly affected by injections and early feeding treatments in the hatching, where it was noticed that a significant difference (p <0.01) for the T4 treatment in the trait of live body weight was on all the treatments of the experiment followed by the T3 treatment, which excelled with a high significance (p <0.01) On T5, T2, T1 T6, treatments. No significant differences emerged between T6, T5, and T1 treatments, which in turn excelled T2 (injection treatment only). As for the second week, the results showed that there was a significant excelled (p <0.01) for the two treatments T4, T3 on the rest of the treatments, then came the two treatments T6, T5 excelled" (p <0.01) on the treatments T2, T1 and it is worth noting that no Significant differences appeared between T6 and T5 treatments, as well as between T2 and T1 treatments. The third week witnessed the continuation of a highly significant (p <0.01) excelled of the T4 treatment on the rest of the treatments, where it recorded the highest weight which reached 1123.05 g, followed by the T6 treatment, which significantly excelled the level (p <0.01) on the T5, T3, T2, T1 treatments, Also, the T3 treatment was significantly excelled to the T5, T2, T1 treatments. In turn, the T1 treatment recorded a significant excelled (p <0.01) on the T2 and T5 treatments. The T5 treatment was also significantly excelled to the T2 treatment which recorded the lowest weight of this trait, which was 1040.16 g.

As for the fourth week, the treatment T3 recorded the highest average body weight, followed by the T4 treatment, which was significantly excelled (p <0.01) on the T6, T5, T2, T1 treatments. In addition, the excelled of the T6 treatment was observed on the T5, T2, T1 treatments, where the same table also indicated that the T1 control treatment was significantly excelled to the T5 and T2 treatments, which showed no significant differences between them. As for the fifth week of the bird's age, significantly excelled (p <0.01) for T4 treatment continued on all treatments, where it recorded weight of 2253.90 g, followed by significantly excelled, treatment T6, recording a weight of 2242.59 g.

Also, in the same table, there were significant differences between T1, T2, T3, T5 treatments, where T3 treatment weighed 2185.70 g on T1, T2, and T5 treatments, and T1 treatment excelled with a weight of 2152.68 g on T5 and T2 treatments, and T5 (at a weight rate) 2143.16 g), in turn, excelled the T2 treatment, which recorded the lowest average weight of 2105.26 g,

Weight gain rate (g)

Table (3) shows the effect of early feeding (fertilized egg injection and feeding inside the incubator) on the trait of the weight gain during the weeks of the experiment, where significant differences were observed between the different treatments during the first week where the fourth treatment was significantly excelled to the level (p <0.01) on the rest of the treatments followed by the treatment T3 significant excelled on T1, T2, T5, T6. We also notice a significant excelled (p <0.01) for the T5 treatment on the T1, T2, T6 treatments, and then came the T6 and T1 treatments, which significantly excelled the T2 treatment and no significant differences emerged between the T6 treatments T1. As for the second week, all early feeding treatments highly significant excelled (p <0.01) in the weight increase rate on the T1 control treatment, which recorded the lowest weight gain for this week, which amounted to 271.49 g while the T6 treatment recorded the highest weight gain amounted to 279.17 g. No significant differences were recorded between T2, T3 and T6 treatments followed by T5 treatment, by weight gain on the T1 and T4 treatments, and there were no significant differences between T4 and T5 treatments. As for the third week, the results showed that highly significant excelled ($p < 0.01$) for T4 treatment was obtained on other treatments, followed by T6 treatment, which significantly excelled T1, T2, T3, and T5, and then the T1 control treatment was significantly excelled to T5, T3, and T2. Significant differences were recorded between T3 and T5, which in turn excelled T2. The fourth week witnessed a significant weight gain ($p < 0.01$) for the T3 treatment, followed by the T6 treatment that showed significantly excelled ($p < 0.01$) on the T1, T2, T4, T5 treatments. We also notice a significant excelled of the T1 control treatment on the T2, T4, T5 followed by the T4 treatment, excelled to the T5 and T2 treatments, and the T2 treatment excelled the T5 treatment, which recorded the smallest weight gain for this week. As for the last (fifth) week, the results of the statistical analysis indicated a significant improvement ($p < 0.01$) in the weight gain rate of the T6 treatment on the rest of the experiments treatments. The T1, T2, T3, T4, T5 treatments differed significantly between them, whereby the T4 treatment was significant ($p < 0.01$) on the T1, T2, T3, T5 treatments, and then the T5 treatment was significantly excelled to the T1, T2, T3 treatments, and in turn the control treatment was excelled. T1 on the T2 and T3 treatments and the T2 treatment was significantly better than the T3 treatment. As for the total weight gain, the results shown in this table showed a significantly excelled ($p < 0.01$) for the treatment T4 on rest treatments recorded, a total weight gain amounted to 2201.57 g followed by the T6 treatment with significantly excelled ($p < 0.01$) and a weight gain amounted to 2192.26 g, The T3 treatment in which the total weight gain reached 2133.95 g was significantly better than the control treatment, which recorded a total weight gain amounted to 2101.93 g. After that, the T5 treatment came with a total weight gain amounted to 2093.16 g, significantly excelled to the T2 treatment, whose weight gain was 2055.60 g.

Average feed consumption (g)

Table (4) shows the results of the statistical analysis of the effect of injecting eggs with the nutrient solution and early feeding inside the incubator on the weekly and total feed consumption of the broilers. Where the results indicated in the first week the high significantly excelled ($p < 0.01$) for the two treatments T3, T4 in the feed consumption rate on the rest of the treatments, followed by the T5 treatment, which was significantly excelled to the T1, T2, and T6 treatments, then the T1 and T2 treatments (without significant differences between them) Significantly excelled ($p < 0.01$) on T6 treatment recorded the lowest feed consumption rate. In the second week, a significant difference ($p < 0.01$) of the T1, T4, T5 treatments birds (without significant differences between them) was observed in the feed consumption rate on the T2, T3, T6 treatment birds for the same trait, which also showed no significant differences between them. During the third week of the experiment, the T4 treatment birds continued to record the highest feed consumption rate with a highly significant difference ($p < 0.01$) compared to the rest of the treatments followed by the T6 treatment which in turn significantly ($p < 0.01$) on the T1, T2, T3, T5 treatments and No significant differences were seen between T1 and T5, which showed significant improvement on T2 and T3 treatments, The T3 treatments were excelled to treatment T2. The fourth week of the experiment treatments a significantly excelled ($p < 0.01$) for the T3, T4 treatments in the amount of feed consumption followed by the T1 and T5 treatments and without significant differences between them, which in turn excelled the feed consumption on the T2 and T6 treatments and the T6 treatment also recorded a higher feed consumption compared to the T2 treatment. As for the fifth week, there was a significantly excelled($p < 0.01$) for the treatment T6 compared to the rest of the treatments followed by the amount of feed consumption, the treatment T4, which was significantly excelled to the treatments T1, T2, T3, and T5, and then the T5 treatment came after consuming a higher quantity of feed of treatments T1, T2, T3. The treatment T3 was more feed consumption rate than the two treatments T1 and T2 and the treatment T2 excelled the treatment T1 significantly in the amount of feed consumption for this week. This table also showed details of the total feed consumption for treatments during the total experiment period. Where the treatments T4 recorded a significantly excelled at the level ($p < 0.01$) on rest treatments, amounted to 3313.45 g, followed by the T6 treatment, with a significantly excelled on the treatments T1, T2, T3, T4, T5. As for the T3 and T5 treatments, no significant differences occurred between them, T1 and T2. The control treatment recorded a significant increase in feed consumption, which amounted to 3196.70 g compared to the treatment T2.

Feed conversion ratio and total mortality rate%

Table (5) shows the effect of early feeding (egg injection for hatching and early feeding in hatching) on the Feed conversion efficiency of broilers at the age of 1-5 weeks. As it was evident during the first week, a significant improvement in the treatment of T6 in comparison with the other treatments followed by the two treatments T1 and T4 (they did not differ significantly), which showed a significant improvement in the feed conversion efficiency on the T2 and T5 treatments for the same trait. Treatment T5 was more improved than treatment T2 in food conversion efficiency. In the second week, the results indicated a significant improvement in the level ($p < 0.01$) of the T2, T3, T3 treatments (without significant differences between them) compared to the T1, T4, and T5 treatments, and the T5 treatment was more improved than the T4 and T1 treatments. T4 treatment followed while the control treatment recorded the lowest rate of food conversion efficiency. At the third week of the bird's age, the best feed conversion efficiency was recorded by the T4 treatment birds, followed by the T1 and T6 treatments (they did not differ significantly). Then there were the two treatments, T2 and T3, which also had no significant differences between the two treatments, which were excelled to the T5 treatment, which recorded the lowest food conversion efficiency this week. The treatments that included injection and early feeding in the hatching together continued to improve by recording the best feed conversion efficiency in the fourth week of the experiment where treatment T3 recorded the best feed conversion efficiency and a significant difference ($p < 0.01$) when compared with other treatments followed by T6 treatment and then a treatment followed T1 control was excelled to T4 treatment. T2 showed a significant improvement on T5 treatment which was the lowest in this trait. As for the results of the fifth week, it indicated a significant increase in the treatment of T4, T5, T6 on T1, T2, T3, where the T5 treatment recorded the best significant improvement ($p < 0.01$) in the food conversion efficiency followed by the T6 treatment and then the T4 treatment and then the control treatment followed T1 was significantly superior to T3 , T2, The T2 treatment was better than the T3 treatment for the same trait. As for the feed conversion ratio, significant differences were found between the experiment treatment. The injection and feeding inside the incubator together resulted in a highly significant improvement (p <0.01) for the T4 and T6 treatments (by 1.504 and 1.502, respectively) compared to the control treatment T1 which 1.520 recorded for the same trait. followed by treatment T3 recorded 1.512 and there were no significant differences between the T2 and T5 treatments, which recorded an average food conversion efficiency of 1.543 and 1.542, respectively. The results of productive performance in early feeding by injecting eggs prepared for hatching with a nutrient solution into an Amniotic sac at the age of 17.5 days from incubation and early feeding of the chicks immediately after hatching (inside the incubator) were good and may be due to the injection of nutrients (such as amino acids, minerals, Vitamins, carbohydrates) had an effect on the development of the intestine, its ability to digest, increase the size of villi, the speed of digestion, absorption and utilization of food, and thus led to an increase in body weight. This is what was observed in the results of treatment T4, T6, which agree with Ohta *et al*., 2001, who indicated the process of injecting embryo with amino acids leads to an increase in their concentration in the incubators, which have a positive effect on body weight. or, the reason for the excelled in the chicks weight treatment T6 fed directly after hatching may be due to a positive association between intestinal enzyme activity and feed intake (which is stimulated by early feeding immediately after hatching) that leads to the development of the gastrointestinal tract and thus promotes growth and an increase in weight (Sklan *et al*., 2000), while the surface area of villi in the duodenum and fasting are not prominent and compressed in the absence of early feeding, which may reach its normal level of performance after four days of hatching. In addition to that, delaying the provision of feed after hatching leads to the inhibition of the mitosis division of breast muscles cells, which reduces the size of the chest muscles and thus reduces body weight. (Halevy *et al*., 2000), and this was shown by the results of the treatment of control T1. Also, the injection of amino acids such as L-Arginine has a great role in increasing body weight, as L-Arginine works to stimulate the secretion of growth hormone from the frontal lobe of the pituitary gland by inhibiting the secretion of somatostatin that is secreted from Under the hypothalamus, which has a role in inhibiting the growth hormone secretion Alba-Roth (*et al*., 1988 and Campbell *et al*., 2004).

This is also confirmed by Al-Daraji *et al.* in 2012 that injecting Japanese quail eggs with L Arginine solution leads to an increase in body weight at the age of 7 and 42 days compared to the control group, and that l-arginine plays a role in creatine creativity which in turn leads to increased muscle growth (Vandenberghe *et al*., 1997) and an increase in the size of muscle fibers (Volek *et al*., 1999). The process of injecting nutrient solutions shortens the time required for marketing where the embryo consumes additional food by taking the amniotic fluid orally before hatching, and this leads to the development of the intestine and its maturity, and thus positively affects the growth process, increased body weight and high weight increase during the subsequent weeks (Sklan *et al*., 2000). Ohta *et al*., 1999, indicated that chicks had a high weight when hatching had a high weight at the age of marketing, and the results of the experiment were consistent with the findings of these researchers. As for feed consumption, the results of the experiment agreed with the findings of Peebles *et al.* (2006) that injecting eggs with nutrient solutions did not have an important effect on feed consumption, and it also agrees with what reached by Al-Daraji *et al.* (2012) in that injecting Japanese quail eggs with a solution Arginine had no significant effect on feed consumption. As for the efficiency of feed conversion ratio, the injection process led to a significant improvement in the Feed conversion efficiency, and this is what was observed in the treatment T4, which was consistent with the findings of researchers Uni and Ferket, 2004; Mousavi *et al*., 2009 that injecting nutrient solutions into eggs (vitamins, carbohydrates, amino acids) It has improved feed consumption efficiency. The results of treatment T6 also agreed with what (Uni *et al*., b 1998) indicated, that early feeding after hatching had improved feed consumption efficiency. This is the result agree with Noy and Sklan, 1999 found, that early nutrition did not affect the feed consumption efficiency. It is worth noting that during all the weeks of the experiment, no mortality was recorded for any of the birds, and thus the total mortality for all treatments is zero.

Table 2 : Effect of studied treatments on average body weight for different weeks

(Average ± standard error (g))						Treatments
The fifth week	**The fourth week**	**The third week**	**The second week**	**The first week**	**Weight at hatching (g)**	
d 0.88± 2152.68	d 0.71 ± 1529.47	d 0.51±1056.39	c 0.21± 485.57	c 0.16± 214.08	b 0.22± 50.74	T1
f 0.356± 2105.26	e 0.47± 1483.51	f 0.72 ±1040.16	c 0.33± 487.42	d 0.41± 209.25	c 0.32± 49.67	T2
c 1.17± 2185.70	a 0.42± 1590.62	c 0.69± 1062.79	a 1.36± 502.16	b 0.22± 224.00	a 0.23± 51.75	T3
a 1.14± 2253.90	b 1.61± 1579.47	a 0.37± 1123.05	a 0.26± 503.22	a 0.77± 227.41	a 0.31± 52.33	T4
e 0.46± 2143.16	e 0.28± 1485.00	e 0.67± 1053.33	b 0.32± 491.18	c 0.59± 214.33	bc 0.2± 49.99	T5
b 1.37± 2242.59	c 0.74± 1548.07	b 0.42± 1066.19	b 0.22± 492.42	c 0.27± 213.25	bc 0.18± 50.33	T6
**	**	**	**	**	**	Level of significance

(1) The averages that have different letters within one column differ significantly among themselves * (P <0.05). ** (P <0.01).

(2) Treatments : T1: control group without injection and without injection feeding in the incubator, T2: injection of eggs with a nutrient solution ((Maxifort at a concentration of 1% and at a dose of 0.2 ml / egg, T3: injection of hatching eggs with a nutrient solution) (Maxifort at a concentration of 1% and at a dose of 0.2 ml / egg and feeding by drinking water (containing a nutrient solution at a concentration of 3%), T4: injection of hatching eggs with a nutrient solution) (Maxifort at a concentration of 1% and at a dose of 0.2 ml / egg and feeding by drinking water (container On a nutrient solution with a concentration of 3%) and forage, T5: Provide drinking water (containing a nutrient solution with a concentration of 3%) inside the hatching and T6: Provide feed and drinking water (contain a nutrient solution with a concentration of 3%) inside the hatching.

Table 3: Effect of studied treatments on weight gain rate for different weeks

Average treatment ± Standard error (g)						Treatments
Total weight gain	**The fifth week**	**The fourth week**	**The third week**	**The second week**	**The first week**	
d 0.69± 2101.93	d 0.17± 623.20	c 0.20± 473.08	c 0.30± 570.81	d 0.34± 271.49	d 0.32± 163.33	T1
f 0.16± 2055.60	e 0.11± 621.75	e 0.24± 443.35	f 0.39± 552.73	ab 0.08± 278.17	e 0.19± 159.58	T2
c 0.94± 2133.95	f 0.75± 595.08	a 0.27± 527.83	e 0.66± 560.62	ab 1.14± 278.16	b 0.02± 172.25	T3
a 0.84± 2201.57	b 0.46± 674.42	d 1.23± 456.43	a 0.10± 619.82	c 0.51± 275.80	a 0.47± 175.08	T4
e 0.32± 2093.16	c 0.18± 658.15	f 0.39± 431.67	0.34± 562.14	bc 0.25± 276.86	c 0.44± 164.33	T5
b 1.15± 2192.26	a 0.57± 694.51	b 0.31± 481.88	b 0.21± 573.76	a 0.05± 279.17	d 0.13± 162.91	T6
**	**	**	**	**	**	Level of significance

(1) The averages that have different letters within one column differ significantly among themselves. ** (P <0.01).
(2) Treatments : T1: control group without injection and without injection feeding in the incubator, T2: injection of eggs with a nutrient solution ((Maxifort at a concentration of 1% and at a dose of 0.2 ml / egg, T3: injection of hatching eggs with a nutrient solution) (Maxifort at a concentration of 1% and at a dose of 0.2 ml / egg and feeding by drinking water (containing a nutrient solution at a concentration of 3%), T4: injection of hatching eggs with a nutrient solution) (Maxifort at a concentration of 1% and at a dose of 0.2 ml / egg and feeding by drinking water (container On a nutrient solution with a concentration of 3%) and forage, T5: Provide drinking water (containing a nutrient solution with a concentration of 3%) inside the hatching and T6: Provide feed and drinking water (contain a nutrient solution with a concentration of 3%) inside the hatching.

Table 4 : Effect of studied treatments on feed consumption /bird for different weeks

Average treatment ± Standard error (g / bird)						Treatments
Total feed consumption	**The fifth week**	**The fourth week**	**The third week**	**The second week**	**The first week**	
d 2.72± 3196.70	f 0.71± 1042.93	b 0.91± 909.95	c 0.36± 715.61	a 0.46± 359.03	c 0.29± 169.16	T1
e 2.98± 3171.03	e 0.82± 1048.18	d 0.32± 897.64	e 1.19± 700.08	b 0.1± 354.78	c 0.39± 170.33	T2
c 1.74± 3228.52	d 0.44± 1065.20	a 0.46± 915.98	d 0.76± 710.61	b 0.62± 356.14	a 0.23± 180.58	T3
a 2.67± 3313.45	b 1.01± 1124.82	a 0.25± 915.13	a 0.45± 732.35	a 0.26± 360.06	a 0.75± 181.08	T4
c 2.45± 3231.07	c 1.51± 1073.36	b 0.46± 909.65	c 0.35± 717.02	a 0.67± 359.03	b 0.31± 172.00	T5
b 0.98± 3294.13	a 0.28± 1145.38	c 0.97± 906.40	b 0.42± 720.61	b 0.44± 350.31	d 0.41± 165.41	T6
**	**	**	**	**	**	Level of significance

(1) The averages that have different letters within one column differ significantly among themselves. ** (P <0.01).
(1) (2) treatments : T1: control group without injection and without injection feeding in the incubator, T2: injection of eggs with a nutrient solution ((Maxifort at a concentration of 1% and at a dose of 0.2 ml / egg, T3: injection of hatching eggs with a nutrient solution) (Maxifort at a concentration of 1% and at a dose of 0.2 ml / egg and feeding by drinking water (containing a nutrient solution at a concentration of 3%), T4: injection of hatching eggs with a nutrient solution) (Maxifort at a concentration of 1% and at a dose of 0.2 ml / egg and feeding by drinking water (container On a nutrient solution with a concentration of 3%) and forage, T5: Provide drinking water (containing a nutrient solution with a concentration of 3%) inside the hatching and T6: Provide feed and drinking water (contain a nutrient solution with a concentration of 3%) inside the hatching.

Table 5 : The effect of the studied treatments on the Feed conversion ratio for the different weeks

Average ± standard error (kg feed / kg meat / bird)						Treatments
Average	**The fifth week**	**The fourth week**	**The third week**	**The second week**	**The first week**	
b 0.001± 1.520	c 0.001± 1.673	d 0.001± 1.923	c 0.00± 1.254	a 0.001± 1.322	c 0.003± 1.035	T1
a 0.001± 1.542	b 0.001± 1.686	b 0.002± 2.024	b 0.001± 1.266	d 0.001± 1.275	a 0.002± 1.067	T2
c 0.001± 1.512	a 0.003± 1.790	f 0.002± 1.735	b 0.003± 1.267	d 0.003± 1.280	b 0.002± 1.048	T3
d 0.001± 1.504	d 0.003± 1.667	c 0.005± 2.004	d 0.001± 1.181	b 0.003± 1.305	c 0.002± 1.034	T4
a 0.001± 1.543	f 0.002± 1.630	a 0.002± 2.107	a 0.003± 1.275	c 0.003± 1.297	b 0.001± 1.046	T5
d 0.001± 1.502	e 0.001± 1.649	e 0.002± 1.881	c 0.001± 1.256	d 0.002± 1.276	d 0.002± 1.015	T6
**	**	**	**	**	**	Level of significance

(1) The averages that have different letters within one column differ significantly among themselves ** (P <0.01).
(2) treatments : T1: control group without injection and without injection feeding in the incubator, T2: injection of eggs with a nutrient solution ((Maxifort at a concentration of 1% and at a dose of 0.2 ml / egg, T3: injection of hatching eggs with a nutrient solution) (Maxifort at a concentration of 1% and at a dose of 0.2 ml / egg and feeding by drinking water (containing a nutrient solution at a concentration of 3%), T4: injection of hatching eggs with a nutrient solution) (Maxifort at a concentration of 1% and at a dose of 0.2 ml / egg and feeding by drinking water (container On a nutrient solution with a concentration of 3%) and forage, T5: Provide drinking water (containing a nutrient solution with a concentration of 3%) inside the hatching and T6: Provide feed and drinking water (contain a nutrient solution with a concentration of 3%) inside the hatching.

Conclusions

It was noted that the best results were obtained from the combining of the technique of injecting eggs with the nutrient solution and early feeding inside the incubator (treatment T4). Also, the use of early feeding in the incubator by feeding the hatching chicks with a nutrient solution and feed (treatment T6) also led to an improvement in the productive performance of the broiler chickens.

References

Al-Asadi, A.N. and Al-Hassani, D.H. (2007). Effect of 18-day-old egg injection from incubation with nutrient solutions and early feeding on some productive traits of broilers. Iraqi Journal of Poultry Science, 2(2): 102-114.

Alba-Roth, J.; Müller, O.; Schopohl, J. and Werder, K. (1988). Arginine Stimulates Growth Hormone Secretion by Suppressing Endogenous Somatostatin Secretion. The Journal of Clinical Endocrinology & Metabolism, 67(6): 1186–1189

Al-Daraji, H.J.; Al-Mashadani, A.A.; Al-Hayani, W.K.; Al-Hassani, A.S. and Mirza, H.A. (2012). Effect of *in ovo* injection with L-arginine on productive and physiological traits of Japanese quail. S. Afr. J. Anim. Sci., 42: 139-145.

Al-Fayadh, Hamdi Abdul-Aziz, Saad Abdul-Hussein Naji, Poultry Products Technology (1989). Higher Education Press - University of Baghdad.

Al-Khafaji, F.R. (2012). The effect of treatments feeding of hatching eggs with ascorbic acid, arginine, maltose sugar and in hatchery in some productive, physiological, microbial and histological characteristics of broiler meat. Ph.D. thesis. College of Agriculture, Baghdad University.

Al-Zubaidi, S.S.A. (1986). Poultry Administration. Basra University Press – Basra.

Bello, A.; Zhai, W.; Gerard, P. and Peebles, E. (2013). Effects of the commercial *in ovo* injection of 25-hydroxycholecalciferol on the hatchability and hatching chick quality of broilers. Poultry science. 92. 2551-9.

Bhanja, S.K.; Sudhagar, M.; Goel, A.; Pandey, N.; Mehra, M. and Agarwal, S.K. (2014). Differential expression of growth and immunity related genes influenced by *in ovo* supplementation of amino acids in broiler chickens. Czech Journal of Animal Science, 59: 399-408.

Campbell, B.I.; LaBounty, P.M. and Roberts, M. (2004). The Ergogenic Potential of Arginine. J. Int. Soc. Sports Nutr. 1: 35-38.

Duncan, D.B. (1955). Multiple Rang and Multiple F-test. Biometrics, 11: 4-42.

Halevy, O.; Geyra, A.; Barak, M.; Uni, Z. and Sklan, D. (2000). Early Posthatch Starvation Decreases Satellite Cell Proliferation and Skeletal Muscle Growth in Chicks, The Journal of Nutrition, 130(4): 858–864.

Jha, R.; Singh, A.K.; Yadav, S.; Berrocoso, J.F.D. and Mishra, B. (2019). Early Nutrition Programming (*in ovo* and Post-hatch Feeding) as a Strategy to Modulate Gut Health of Poultry. Front. Vet. Sci., 6: 82.

Johri, T.S. (2004). Feasibility of in ovo amino acid injection for embryonic growth and optimizing total and digestibl*e* amino acid requirements for meat production and immunocompetence of broiler chickens. Poultry nutrition in India.

Mousavi, S.; Foroudi, F.; Baghi, F.; Shivazad, M. and Ghahri, H. (2009). The effects of *in ovo* feeding of threonine and carbohydrates on growth performance of broiler chickens. Proceedings of the British Society of Animal Science, 198-198.

National Research Council (1994). Nutrient Requirements of Poultry: Ninth Revised Edition, 1994. Washington, DC: The National Academies Press.

Noy, Y. and Sklan, D. (1999). Energy utilization in newly hatched chicks. Poult. Sci., 78: 1750–1756.

Ohta, Y. and Kidd, M.T. (2001). Optimum Site for In Ovo Amino Acid Injection in Broiler Breeder Eggs. Poult Sci.; 80(10): 1425-9.

Ohta, Y.; Tsushima, N.; Koide, K.; Kidd, M.T. and Ishibashi, T. (1999). Effect of amino acid injection in broiler breeder eggs on embryonic growth and hatchability of chicks. Poultry Science, 78(11): 1493-1498.

Peebles, E.D.; Berry, W.D.; Keirs, R.W.; Bennett, L.W. and Gerard, P.D. (2006). Effects of injected gluconeogenic supplementation on the performance of broilers from young breeders. Poultry Science, 85(3): 371-376.

Salmanzadeh, M.; Ebrahimnezhad, Y.; Shahryar, H.A. and Kandi, J.G.G. (2016). The effects of *in ovo* feeding of glutamine in broiler breeder eggs on hatchability, development of the gastrointestinal tract, growth performance and carcass characteristics of broiler chickens. Archives Animal Breeding, 59: 235–242.

SAS (2012). Statistical Analysis System, User's Guide. Statistical. Version 9.1th ed. SAS. Inst. Inc. Cary. N.C. USA.

Sklan, D.; Noy, Y.; Hoyzman, A. and Rozenboim, I. (2000). Decreasing weight loss in the hatchery by feeding chicks and poults in hatching trays. J Appl Poult. Res.; 9: 142–148.

Uni, Z. and Ferket, P.R. (2011). In ovo feeding impact on intestinal development, energetic status and growth L' Associazione Italiana di Avico Hura Scientifica WPSA-Italian Branch.

Uni, Z. and Ferket, R. (2004). Methods for early nutrition and their potential. World's Poultry Science Journal, 60(1): 101-111.

Uni, Z.; Platin, R. and Sklan, D. (1998b). Cell proliferation in chicken intestinal epithelium occurs both in the crypt and along the villus. J. Comp. Physiol. B, 168: 241-247.

Uni, Z.; Ferket, P.R.; Tako, E. and Kedar, O. (2005). *In ovo* feeding improves energy status of late-term chicken embryos. Poult. Sci., 84: 764-770.

Vandenberghe, K.; Goris, M.; Van Hecke, P.; Van Leemputte, M.; Vangerven, L. and Hespel, P. (1997). Long-term creatine intake is beneficial to muscle performance during resistance training. Journal of Applied Physiology, 83(6): 2055-2063.

Volek, J.S.; Duncan, N.D.; Mazzetti, S.A.; Staron, R.S.; Putukian, M.; Gómez, A.L.; Pearson, D.R.; Fink, W.J. and Kraemer, W.J. (1999). Performance and muscle fiber adaptations to creatine supplementation and heavy resistance training. Med Sci Sports Exerc. 31(8): 1147-56.

Willesmen, H.; Debonne, M.; Swennen, Q.; Everaert, N.; Careghi, C.; Han, H.; Bruggeman,V.; Tona K. and Decuypere, E. (2010). Delay in feed access and spread of hatch: Importance of early nutrition. World's Poultry Science Journal, 66(2): 177-188.

Zhai, W.; Bennett, L.W.; Gerard, P.D.; Pulikanti, R. and Peebles, E.D. (2011). Effects of *in ovo* injection of carbohydrates on somatic characteristics and liver nutrient profiles of broiler embryos and hatchlings. Poultry Science, 90(12): 2681-2688.