EFFECT OF *IN OVO* INJECTION OF ACETIC ACID ON HATCHING CHARACTERISTICS AND PRODUCTION PERFORMANCE OF BROILER CHICKENS

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ABSTRACT

This study included two experiments, in order to investigate the effect of *In ovo* injecting of different levels of Acetic acid solution on hatchability, chicks characteristics and production performance of broiler chickens.

The first experiment: In this experiment, 720 fertilized eggs were used from breeders of the broiler (Ross 308), distributed into six treatments, 120 egg per treatment by three replicates per treatment (40 eggs rep.$^{-1}$), at the 18th day of incubation when the eggs are transferred from the setter to the hatcher, they were injected into the amniotic sac according to the experimental treatments, T1 (Negative control) hatching eggs without injection, T2 (Positive control) hatching eggs are injected 0.2 ml egg^{-1} distilled water only, and T3, T4, T5, T6 hatching eggs are injected 0.2 ml egg^{-1} of different concentrations of Acetic acid solutions achieves 1, 2, 3, 4 µl egg^{-1} respectively, after injection, the eggs were returned to the hatcher.

The results showed a significant improvement (P≤0.05) in the Hatching Characteristics, body weight, body length, relative weight of the yolk sac, relative weight of the small intestine, length of the small intestine and humoral immunity in chicks of Acetic acid injection treatments compared with both control treatments (T1, T2).

The second experiment: In this experiment, 255 broiler chicks Ross 308 were used, their took from the chicks in the first experiment of the best two treatments in the results that's means the fifth and sixth treatments (T5, T6) as well as the treatment of control (T1) form randomly and an equal number of 75 chicks of each treatment, they were raised in standard conditions up to the age of 35 days.

The results showed an improvement in the production performance of broiler chicks from the *In ovo* injection of Acetic acid treatments, which improved significantly (P≤0.05) each of the live weight, weight gain, feed intake, feed conversion ratio, mortality, production index, body fullness degree and the dressing percentage in broiler of both treatment which injected of acid (T2, T3) compared to birds of control treatment.

In conclusion indicated that the process of coupling the *In ovo* injection technique with feeding Acetic acid solution to the chick embryos at 18th days of incubation, improve the hatchability, quality characteristics of the chicks and the production performance of broiler chickens.

Key words: *In ovo* Injection, Acetic acid, Broiler, Hatchability, Production performance.

INTRODUCTION

The early feeding of embryos in eggs using the technique of *In ovo* injection of a nutrient solutions in the amniotic fluid surrounding the embryos, through the embryo consumption of this fluid during oral intake in the egg will supplement its needs for growth and development of its vital tissue in the recent period of fetal growth, as well as the needs of hatching process. Uni and Smith (2017) found that *In ovo* injection will be of great importance in the recent period of embryo development and supporting the development of critical organs of the digestive system, skeletal and immune system, (Uni, 2014) detected that by this way of injection the chicks will be improved productivity, Zhang *et al*., (2016) found that injection of glucose and L-carnitine solution during the final phase of the growth of broiler embryos has an effect in improving the hatchability, chick's weight and their production performance in later phase. Gao *et al*., (2017) also noted that the injection of broiler embryos of L-arginine in the amniotic fluid at the age of 17.5 days of incubation leads to the development of small intestine through the increase in the width and length of the villus and surface area at the age of three days post hatching, which is positively reflected on the increase in digestibility and absorption in early ages, whereas Abbasi *et al*., (2017) observed that injecting vitamins D3 and K3 on day 18 from the incubation had beneficial effects on growth performance, immune system, and bone development in broiler chicks.

Organic acids are natural products of microbial fermentation of carbohydrate nutrients (Diba *et al*., 2015), in recent years, scientists have confirmed that the use of these organic acids as promoter for the production of poultry rather than antibiotics, which improves growth, production and immunity against diseases when added to feed and drinking water (Bagal, 2016 ; Ragaa and Korany, 2016 ; Sheoran and Tewatia, 2017), without leaving negative effects or residues harmful to birds, humans and the environment, It is absorbed by the cells of the digestive system and decompose into water and carbon to be a source of energy for these absorbed cells (Bolton and Dewar, 1965). Acetic acid is one of the most important types of organic acids, called vinegar with a concentration of 4% (Diba *et al*., 2015), acetic acid (CH_3COOH) is a major product in the biotrophic processes within living cells of which Acetyl-coenzyme A is produced to produce energy ATP (Lehninger *et al*., 2012). The absence of a previous study on early feeding of Acetic acid using *In ovo* injection technique.

Aim of study was designed to determine the effect of *In ovo* injection of different levels of Acetic acid at 18th days of incubation on hatchability and quality characteristics of broiler chicks (Ross 308) at hatching and follow up the effect of the injection of acid on post-hatched chicks on their productive performance.

MATERIALS AND METHODS

The hatchery experiment was carried out in Petersime hatchery, 800 hatching eggs were used from one herd of broiler breeders (Ross 308) at the age of 46 weeks, a stored for two days and a weight average of 61±1 g egg^{-1}, incubation of eggs in the Setter at 99.8 ºF and relative humidity 60%, on the 18th day of the incubation, before the transfer of eggs from the Setter to the hatcher, candled eggs were scanned for detection of fertilized eggs, and used 720 fertilized eggs divided into six treatments by three replicates per treatment (40 eggs rep.$^{-1}$) post *In ovo* injection according experiment treatments, T1 (Negative control) hatching eggs without injection, T2 (Positive control) hatching eggs injected 0.2 ml egg^{-1} distilled water only, T5, T4, T3, T6 hatching eggs were injected by 0.2 mL egg^{-1} of different concentrations of Acetic acid solutions 0.5, 1, 1.5, 2% achieves 1, 2, 3, 4 µl egg^{-1} respectively, and the incubation of eggs in the hatcher was repeated at 98.6 °F and a relative humidity 65% until hatching.

The injection solution was prepared using pure Acetic acid Glacial from India- kanoria chemicals company with sterilized distilled water, In the process of injecting eggs automatic syringe (Self-Refilling Syringe) processed by Socorex Swiss with a valume of 1 ml, a length of 1 inch and measuring Gauge 22, the blunt end of each egg was disinfected by cotton immersed in ethanol, which was followed by the process of injecting each egg with a solution treatment by the automatic medical syringe to connecting the needle in the aminion fluid level surrounding the embryo post the piercing of the shell with the drill and closed the injection hole post completion by the paraffin wax (Zhai *et al*., 2008), then put the eggs in plastic boxes and returned the process of incubation in the hatcher until the date of hatching.

When hatching, the hatching results were calculated according to Desha *et al*., (2015):

$$\text{Total hatchability} = \frac{\text{Number of hatched chicks}}{\text{Number of fertilized eggs}} \times 100$$

$$\text{Good chicks hatchability} = \frac{\text{Number of good hatched chicks}}{\text{Number of fertilized eggs}} \times 100$$

$$\text{Distorted chicks hatchability} = \frac{\text{Number of distorted hatched chicks}}{\text{Number of fertilized eggs}} \times 100$$

$$\text{Embryos motality post inj.} = \frac{\text{Number of dead embryos}}{\text{Number of fertilized eggs}} \times 100$$

After taking the live weight of the newly chicks using a thermometer sensitive to two decimal order of type HD-KE1200, and calculate the length of the body chicks using the measurement ruler. Five chicks were slaughtered from each treatment to estimate the measurements of the small intestine and the weight of the yolk sac and its humoral immunity. Calculated the relative weight of both the small intestine and the remaining yolk sac according to the equation referred to by Seifi *et al*., (2015): -

$$\text{Relative weight of the organ} = \frac{\text{Weight of organ (g)}}{\text{Live body weight}} \times 100$$

The length of the small intestine was measured by a metric scale as stated in method of Salahi (2015). Blood samples were collected at slaughter directly from the jugular Vein and humoral immunity was measured as mentioned Al-Mayah (2009).

The farm experiment was conducted to monitor the effect of *In ovo* injection of Acetic acid post-hatching on productive performance of broiler chickens, used 225 resulting chicks from the best two treatments for the first experiment, which were both treatment of the eggs treated with acetic acid 3, 4 µl egg^{-1} respectively, as well as resulting chicks from control treatment, which were treatment the eggs without injections, rate weight chicks were 42.77, 42.10 and 40.73 g respectively, which transferred to the raising farm after dividing they into three replicates per treatment (25 chick rep.$^{-1}$) as follows: first treatment T1chicks from hatching eggs without injection, second treatment T2 chicks produced from *In ovo* injected of acetic acid 3 µl egg^{-1}, third treatment T3 chicks produced from *In ovo* injected of acetic acid 4 µl egg^{-1}.

The chicks were raised in standard conditions until 35 days According to Ross Broiler Management Manual Guide, Aviagen (2014), and fed on diets containing chemical analysis as in table (1).

Table 1. Chemical analysis of the diets used in the experiment

Structure	Starter 1-10 d.	Grower 11-24 d.	Finisher 25-35 d.
Crude protein (%)	22.50	20	18
ME (kcal kg^{-1} feed)	3069	3185	3250
Ratio of energy to protein(C:P)	1:136.4	1:159.25	1:180.56
Crude fat (%)	4.45	5.61	5.95
Lysine (%)	1.33	1.21	1.21
Methionine (%)	0.64	0.56	0.50
Calcium (%)	0.98	0.95	0.90
Available phosphorus (%)	0.45	0.43	0.41

The birds and the feed intake were weighed weekly, as well the weight gain, mortality and feed conversion ratio, according to Diarra *et al.*, (2014). Production index was calculated according to the equation indicated by Koreleski *et al.*, (2010):

$$\text{Production index (PI)} = \frac{\text{Live weight (kg)} \times \text{ Liveability}}{\text{Age, day} \times \text{Feed convertion ratio}} \times 100$$

Note that Liveability = 100 - Mortality

At the end of the fifth week, four birds of each treatment of both sexes were slaughtered equally then after slaughtering and cleaning, taking the weight of each carcass and calculated the proportion of each of the dressing and the degree of fullness of the body as stated by Diarra *et al*., (2014) and Ripoll (2016) respectively:

$$\text{Dressing percentage (\%)} = \frac{\text{Weight of cleaned carcass (g)}}{\text{Live body weight(g)}} \times 100$$

$$\text{Dressing percentage (\%)} = \frac{\text{Weight of cleaned carcass (g)}}{\text{Length of living body (cm)}} \times 100$$

Statistical analysis was performed using Complete Randomized Design (CRD), to test the differences between the averages, the Duncan (1955) test was used at a significant level of 0.05. SPSS (2011) was used to analyze the data.

RESULTS AND DISCUSSION

Table 2 shows the result of effect of *In ovo* injecting of different levels of Acetic acid solution at 18th days on hatchability, it's noted from the table a significant effect ($P \leq 0.05$) obtained on hatchability of the good hatched chicks for the treatment of Acetic acid injection T4, T5, T6 compared to control T1, T2. Also, the injection of Acetic acid for hatching eggs had led to significant effect ($P \leq 0.01$) on the hatchability of the distorted chicks in all injected treatment of acid compared to the control treatment of without injected T1. As well the injection of Acetic acid at the highest levels in T5, T6, led to a significant effect (P≤0.01) on the embryos mortality compared to the other treatments remainder, in the same table, the improvement in the values of the previous traits due to Acetic acid injection was reversed in the same direction, with a significant improvement in the total hatchability to all acid injection treatments T3, T4, T5 and T6 compared to T1 and T2.

Table 2. Effect of *In ovo* injection of different levels of Acetic acid at 18 days of incubation on hatchability (%) of broiler chicks (Mean ± S.E.)

Treatment	Good hicks hatchability	Distorted chicks hatchability	Embryos mortality after inj.	Total hatchability
T_1	86.67± 0.06 [c]	3.33± 0.58 [b]	4.28± 0.21 [b]	90.00± 2.00 [b]
T_2	88.33± 0.44 [bc]	2.50± 0.47 [ab]	4.17± 0.58 [b]	90.83± 1.61 [b]
T_3	93.33±0.33 [ab]	1.67± 0.11 [a]	3.33± 0.11 [b]	95.00± 1.32 [a]
T_4	94.17±0.60 [a]	0.00±0.00 [a]	3.33± 0.28 [b]	94.17± 2.11 [a]
T_5	95.00±0.58 [a]	0.00±0.00 [a]	1.73± 0.11 [a]	95.00± 0.00 [a]
T_6	94.66±3.73 [a]	1.67± 0.46 [a]	1.67± 0.12 [a]	96.33± 2.65 [a]
Sig.	*	**	**	**

T1 (Negative control) Hatching eggs without injection, T2 (Positive control) eggs hatching injected 0.2 ml egg^{-1} distilled water only, T5, T4, T3, T6 hatching eggs were injected 0.2 ml egg^{-1} of solution achieves 1, 2, 3, 4 µl $eggs^{-1}$ acetic acid respectively.

The different letters within a single column indicate that there are significant differences among the methods of the treatments at the probability level P≤0.05.

* Mean significant effects found of treatment at P≤0.05 in variance analysis table.

** Mean significant effects found of treatment at the probability level P≤0.01 in the variance analysis table.

Improvement of hatchability and reduction of embryos mortality in Acetic acid injection treatments, may be due to the fact that the process of injection of acid is an early feeding process, provides the embryo energy, organic acids as a direct source of energy for intestinal cells (Blank *et al*., 1999), Acetic acid is also an intermediate compound in cellular metabolism, where it turns into the compound Acetyl Co-enzyme A, which enters the Kreb's Cycle to production of energy ATP (Lehninger *et al*., 2012 ; Edan, 2018), Applegate (2002) confirmed that providing embryos with energy by injecting the egg during incubation leads to increased hatching, because hatching is a stress on the embryo, so it needs extra energy to complete it. Another studies by Uni *et al*., (2005) showed that *in ovo* injecting at 17.5 days of incubation in the amniotic sac with food solutions resulted in improved hatching rate, because the embryo in the final phase of embryonic development when hatching almost depletes the stored Glycogen in the liver, the body to get extra energy to pip the egg shell and exit when hatching. It may be the reason for the superiority of acid injection treatments in the rate of hatching to the role of Acetic acid in facilitating the process of breaking the shell during hatching through its interaction with calcium carbonate, which leads to the lack of calcification of the crust and weak cohesion, facilitating the process of breaking (Anonymous, 2017).

It was noted from table 3 that the body weight of hatched chicks was improved by injection of Acetic acid to the eggs from which it was hatched, the injection treatments for Acetic acid at the highest levels T5 and T6 were significantly higher ($P \leq 0.05$) in this Characteristic compared to control treatments T1, T2. The current study also noted that the body length of the hatched chicks was significantly higher ($P \leq 0.01$) in the T4, T5 and T6 acid injections compared to T1 and T2.

Table 3. Effect of *In ovo* injection of different levels of acetic acid at 18 days of incubation on the body weight and body length chicks at hatch of broilers (Mean ± S.E.)

Treatment	BW hatched chicks (g)	BL hatched chicks (cm)
T_1	40.73±0.04 ^{b}	18.16± 0.31 ^{c}
T_2	41.15± 0.50 ^{ab}	18.23± 0.11 ^{c}
T_3	41.82±0.12 ^{ab}	18.80±0.27 ^{bc}
T_4	41.64±0.25 ^{ab}	19.22± 0.15 ^{ab}
T_5	42.77±0.40 ^{a}	19.78±0.21 ^{a}
T_6	42.10±0.59 ^{a}	19.60± 0.22 ^{a}
Sig.	*	**

T1 (Negative control) Hatching eggs without injection, T2 (Positive control) eggs hatching injected 0.2 ml egg^{-1} distilled water only, T5, T4, T3, T6 hatching eggs were injected 0.2 ml egg^{-1} of solution achieves 1, 2, 3, 4 µl $eggs^{-1}$ acetic acid respectively.

The different letters within a single column indicate that there are significant differences among the methods of the treatments at the probability level $P \leq 0.05$.

* Mean significant effects found of treatment at $P \leq 0.05$ in variance analysis table.

** Mean significant effects found of treatment at the probability level $P \leq 0.01$ in the variance analysis table.

The results of table 4 showed a significant increase ($P \leq 0.01$) in the length of the small intestine of the hatching chicks from the eggs of acid injection, the treatment of acid T6 recorded a highest values in the length of the small intestine compared to the rest of the experimental parameters, and the acid injection treatments resulted a significant increase ($P \leq 0.05$) in the relative weight of the small intestines in chicks, compared to control treatments T1, T2. Asignificant decrease ($P \leq 0.01$) was observed in the relative weight of the yolk sac weight in the chick from T4, T5 and T6 acid injection eggs compared to T1 and T2.

The improvement in the characteristics of the broiler chicks, whose length and weight in acid injection treatments may be due to the effect of acetic acid on embryos by improving the growth, development and activity of her gut and stimulating nutrient uptake from the yolk sac, Uni and Smith (2017) indicated that chicks embryos have the ability to digest and absorb nutrients before hatching but the intestinal function begins only at the time the embryo intake the fluid that surrounds it through the mouth at the age of 17-19 days of incubation, so the growth of intestinal tissue, maturation and metabolism become of great importance in the recent period on the growth and development of the embryo, the feeding of embryos *In ovo* feeding (IOF) with acetic acid in the amniotic fluid during this period will be absorbed by the enterocytes and will be a direct source of energy for these cells (Scheppach *et al*., 1995).

Table 4. Effect of *In ovo* injection of different levels of acetic acid at 18 days of incubation on length and relative weight of the small intestine, yolk sac at hatch of broilers (Mean ± S.E.)

Treatment	Small intestine length (cm)	Relative weight of Small intestine (%)	Relative weight of yolk sac (%)
T_1	45.20±2.95 ^{b}	4.25±0.23 ^{b}	10.01± 1.41 ^{c}
T_2	49.20±0.84 ^{b}	4.12±0.12 ^{b}	9.15± 0.21 ^{c}
T_3	49.90±1.87 ^{b}	5.70±0.20 ^{a}	7.63± 0.93 ^{bc}
T_4	48.00±2.28 ^{b}	5.54±0.13 ^{a}	6.53± 0.59 ^{ab}
T_5	47.47±2.05 ^{b}	5.64±0.51 ^{a}	5.14± 0.57 ^{a}
T_6	56.75±1.86 ^{a}	5.77±0.25 ^{a}	5.01± 0.53 ^{a}
Sig.	**	*	**

T1 (Negative control) Hatching eggs without injection, T2 (Positive control) eggs hatching injected 0.2 ml egg^{-1} distilled water only, T5, T4, T3, T6 hatching eggs were injected 0.2 ml egg^{-1} of solution achieves 1, 2, 3, 4 µl eggs^{-1} acetic acid respectively.

The different letters within a single column indicate that there are significant differences among the methods of the treatments at the probability level P≤0.05.

* Mean significant effects found of treatment at P≤0.05 in variance analysis table.

** Mean significant effects found of treatment at the probability level P≤0.01 in the variance analysis table.

As well as the role of acetic acid in reducing the pH of the intestines in the intestine stimulates and activates and stimulates and activates the pancreas also the secretion of digestive enzymes to promote the absorption of nutrients from the sac of yolk (which weighs less) and supports the development of vital organs of the embryo (Salahi *et al*., 2011), this is consistent with Ur Rehman *et al*., (2016) who found that feeding the acetic acid broiler led to the growth of epithelial cells and increased length and area of the small intestinal flora, Lourens *et al*., (2006) also confirmed that there is a strong correlation between the length of the newly hatched chick with its zero yolk mass and the negative association between the remaining yolk and its yolk-free mass. Also the consumption of yolks at an early time gives better results to the broiler chicks because the remaining yolk contains all the nutrients of fat, amino acids, vitamins and minerals needed by the embryo for its growth and development (Meijerhof, 2009).

Table 5 shows an improvement in humoral immunity response against both diseases of Newcastle and Infectious Bronchitis in chicks treatments of acid injection compared to both control treatments, as the titter of antibodies against Newcastle Disease was significantly increased in the acid injection treatments compared to T1 and T2, titter of antibodies against Infectious Bronchitis was also significantly increased in all acid injection treatments compared with control treatments.

Table 5. Effect of *In ovo* injection of different levels of acetic acid at 18 days of incubation on humoral immunity at hatch of broilers (Mean ± S.E.)

Treatment	Titer of antibodies against Newcastle Disease	Titer of antibodies against Infectious Bronchitis
T_1	8378.00±313.91 [c]	4163.67±32.11 [b]
T_2	8570.00±213.80 [c]	4315.00±16.21 [b]
T_3	10809.67±193.82 [b]	4985.67±27.73 [a]
T_4	11025.00±552.53 [ab]	4919.33±25.55 [a]
T_5	11936.00±311.92 [a]	4831.33±18.78 [a]
T_6	11954.67±189.48 [a]	5056.00±30.95 [a]
Sig.	**	**

T1 (Negative control) Hatching eggs without injection, T2 (Positive control) eggs hatching injected 0.2 ml egg^{-1} distilled water only, T5, T4, T3, T6 hatching eggs were injected 0.2 ml egg^{-1} of solution achieves 1, 2, 3, 4 µl eggs^{-1} acetic acid respectively.

The different letters within a single column indicate that there are significant differences among the methods of the treatments at the probability level P≤0.05.

** Mean significant effects found of treatment at the probability level P≤0.01 in the variance analysis table.

Noted from the results of humoral immunity that the process of feeding eggs with acetic acid significantly affected the improvement of humoral immunity which may be due to the effect of acetic acid on the embryos by improving the growth and development of her intestines as confirmed by the results of this study (Table 4), the immune system accounts for 3% of the body's weight, and 75% of the body is present in the digestive system which is the Gut-Associated Lymphoid Tissue (GALT) tissue, which includes the lymphatic tissue under the mucous layer extending from the pharynx to the pool, Patchess Peyer, Cecal Tonsils, and Bursa of Fabricius. These tissues are inherently sensitive to the growth and development of the small intestine (Alkhalf *et al.*, 2010), Improved growth and development of lymphatic tissues and organs is reflected in increased B lymphocytes, which produce antibodies in the blood (Abdel-Razek and Tony, 2013 ; Abdel-Tawab *et al.*, 2015 ; Talebi *et al*., 2015).

Table 6 shows that the improvement in chicks' characteristics which hatched from hatching eggs injected with acetic acid at 18^{th} days of incubation significantly affected the production characteristics of broilers at marketing, as the superiority of both treatments of acetic acid T2 and T3 significantly ($P \leq 0.01$) in the live body weight compared with the control treatment T1, also the T2 and T3 of acid injection treatments were significantly higher in the weight gain compared with the control treatment. The T3 acid injection significantly improved the feed consumption during the trial period. Feed conversion ratio was significantly improved ($P \leq 0.01$) in treatment of acetic injections T2, T3 compared with T1 control treatment. A significant decrease was observed in the mortality in the both treatments of acetic acid compared with the control treatment. The production index, which is one of the best measurements of production efficiency of meat breeds, It takes into account of all live body weight, mortality, feed conversion ratio and duration of raising, It was noted from the table that the values of the production index were improved in the acid injection treatments which took the same improving path of live body weight, feed conversion ratio and mortality, it was significantly increased in T2 and T3 acid injection compared to T1 control. It was also shown from the same table that the degree of body fullness of chicken carcasses in acid injection treatments had improved significantly at the age of marketing. The T2 and T3 acid injections showed significant increases in body fullness compared to T1. As well as noted from the table that the dressing percentage of the T2 and T3 acid injection treatments were significantly higher than the control treatment.

The improvement in the production characteristics of the both birds treatments of acetic acid injection may be a reflection of the superiority of the characteristics of chicks at hatching, which was ideals by improved all of their weight, length, internal organs and immunity (Table 3, 4 and 5), which were great benefit to birds by increasing their ability to digestion, absorption and disease resistance. This is consistent with Tona *et al*., (2003) who conclude that the quality of a one-day-old broiler is a good indicator of the future production performance of broilers. Willemsen *et al*., (2008) further confirm that the improved weight and length of broiler chickens during hatching are positively reflected on production performance when marketing.

Table 6. Effect of *In ovo* injection of different levels of acetic acid solution at age 18 days of incubation on production performance of broiler chickens at age 35 days (Mean± S.E.)

Characteristics	Treatments			Sig.
	T_1	T_2	T_3	
Live body weight (g)	2012.67±21.60 [b]	2134.72±16.07 [a]	2120.67±9.65 [a]	**
Weight gain (g bird^{-1})	1971.97±18.74 [b]	2091.95±23.13 [a]	2078.57±17.59 [a]	**
Feed intake (g bird^{-1})	3160.85±12.01 [b]	3178.14±11.78 [b]	3203.76±3.50 [a]	*
Feed conversion ratio	1.60±0.01 [b]	1.52±0.02 [a]	1.54±0.01 [a]	**
Mortality (%)	5.33±0.33 [b]	1.33±0.69 [a]	0.00±0.00 [a]	**
production index	362.00±16.36 [b]	424.67±13.98 [a]	452.99±35.98 [a]	**
Body fullness degree (%)	37.68±1.00 [b]	42.73±1.23 [a]	41.61±0.99 [a]	*
Dressing percentage (%)	69.62±0.82 [b]	72.55±0.49 [a]	70.19 ±0.47 [b]	*

T1 Hatching eggs without injection, T2, T3 eggs hatching injected of acetic acid of 3, 4 µl eggs^{-1} in order.

The different letters within a single row indicate that there are significant differences among the methods of the treatments at the probability level P≤0.05.

* Mean significant effects found of treatment at P≤0.05in variance analysis table.

** Mean significant effects found of treatment at the probability level P≤0.01in the variance analysis table.

REFERENCE

Abbasi, T., M. Shakeri, M. Zaghari and H. Kohram. 2017. Growth performance parameters, bone calcification and immune response of *In ovo* injection of 25-hydroxycholecalciferol and vitamin k3 in male Ross 308 broilers. *Theriogenology*, 1(90): 260- 265.

Abdel-Razek, A. H. and M. A. Tony. 2013. Effects of dietary supplementation of a mixture of Synbiotic and some digestive enzymes on performance, behavior and immune status of broiler chickens. *International Journal of Animal and Veterinary Advances*, 5(2): 75-81.

Abdel-Tawab, A. A., F. I. El-Hofy, K. I. El-Eknawy and H. E. El-Shora. 2015. Effect of Synbiotic on immune response of experimentally infected broiler chickens with *E. coli* and salmonella. *Benha Veterinary Meedical Journal*, 28(2): 188-194.

Alkhalf, A., M. Alhaj and I. Al-Homidan. 2010. Influence of probiotic supplementation on immune response of broiler chicks. *Egypt. Poultry Science*, 30: 271-280.

Al-Mayah, A. A. S. 2009. Effect of fish oil immune response in broiler chicks vaccinated against IBD. *International Journal of Poultry Science,* 8: 1156-1161.

Anonymous. 2017. Available from: http://www.edinformatics.com/mathscience/science_of_cooking/naked_egg_experiment.htm

Applegate, T. J. 2002. Reproductive maturity of turkey hens: egg composition, embryonic growth and hatchability transition. *Avian and Poultry Biology Reviews*, 13(1): 31- 41.

Aviagen. 2014. Ross Broiler Management Manual Guide: 1- 16. Available from: http://www.aviagen.com/.

Bagal, V. L., K. V. Kumar, T. B. Singh, S. S. Kumar and R. S. Shamrao. 2016. Relative efficacy of organic acids and antibiotics as growth promoters in broiler chicken. *Vet. World*, 9(4): 377-382.

Blank, R., R. Mosenthin, Wc. Sauer, S. Huang. 1999. Effect of fumaric acid and dietary buffering capacity on heal and fecal amino acid digestibilities in early weaned pigs. *Journal of Animal Science*, 77: 2974-84.

Bolton, W. And W. A. Dewar. 1965. The digestibility of acetic, propionic and butyric acids by the fowl. *British Poultry Science*, 6: 103-105.

Desha, N. H., F. Islam, M. N. M. Ibrahim, M. Okeyo, H. Jianlin and A. K. F. H. Bhuiyan. 2015. Fertility and hatchability of eggs and growth performance of mini-incubator hatched indigenous chicken in rural areas of Bangladesh. *Tropical Agricultural Research*, 26(3): 528-536.

Diarra, S. S., D. Sandakabatu, D. Perera, P. Tabuaciri and U. Mohammed. 2014. Growth performance and carcass yield of broiler chickens fed commercial finisher and cassava copra meal-based diets. *Journal of Applied Animal Research,* 3: 352-356.

Diba, F., F. Alam, and A. A. Talukder. 2015. Screening of acetic acid producing microorganisms from decomposed fruits for vinegar production. *Advances in Microbiology,* 5(05): 291-29.

Duncan, B. D. 1955. Multiple range and multiple f test. *Biometrics*, 11: 1- 24.

Edan, R. 2018. Glycolysis, Krebs cycle, and other Energy Releasing Pathways. Available From: http://www.uobabylon.edu.iq/uobColeges/ad_ downloads/4_21336_963.pdf

Gao, T., M. M. Zhao, Y. J. Li, L. Zhang, J. L. Li, L. L. Yu, F. Gao and G. H. Zhou. 2017. Effects of *In ovo* feeding of l-arginine on the development of digestive organs, intestinal function and post-hatch performance of broiler embryos and hatchlings. *Journal of Animal Physiology and Animal Nutrition,* 12(1): 166-175.

Koreleski, J., S. Świątkiewicz, and A. Arczewska. 2010. The effect of dietary potassium and sodium on performance, carcass traits, and nitrogen balance and excreta moisture in broiler chicken. *Journal of Animal and Feed Sciences*, 19(2): 244-256.

Lehninger, A. L., D. L. Nelson and M. C. Michael. 2012. Principles of Biochemistry. 6th ed. USA.

Lourens, A., R. Molenaar, H. V. D. Brand, M. J. W. Heetkamp, R. Meijerhof', and B. Kemp. 2006. Effect of egg size on heat production and the transition of energy from egg to hatchling. *Poultry Science*, 85: 770-776.

Meijerhof, R. 2009. Incubation principles: What does the embryo expect from us? Proceedings of the 20th *Australian Poultry Science Symposium*: 106-110, Sydney, Australia.

Ragaa, M. N. and R. M. S. Koranyg. 2016. Studying the effect of formic acid and potassium diformate on performance, immunity and gut health of broiler chickens. *Animal Nutrition*, 2: 296-302.

Ripoll, G., Pere Albertí, Javier Álvarez-Rodríguez, Isabel Blasco and Albina Sanz. 2016. Body size, carcass and meat quality of three commercial beef categories of 'Serrana de Teruel' breed. *Spanish Journal of Agricultural Research,* 14(3): e0604.

Salahi, A. 2015. Effect of *In ovo* administration of butyric acid into broiler breeder eggs on chicken small intestine ph and morphology. *Slovak Journal of Animal Science*, 48(1): 8-15.

Salahi, A., S. N. Mousavi, F. Foroudi, M. M. Khabisi, M. Norozi. 2011. Effects of *In ovo* injection of butyric acid in broiler breeder eggs on hatching parameters, Chick quality and performance. *Global Veterinaria*, 7(5): 468-477.

Scheppach, W., H. P. Bartram and F. Richter. 1995. Role of short-chain fatty acids in the prevention of colorectal cancer. *Eur. J. Cancer,* 31: 1077-1080.

Seifi, S., R. Sayrafi, R. Khoshbakht and A. Gilani. 2015. Effects of dietary acetic acid on intestinal microbiota, serum components, internal organs and performance of broilers. *Global Journal of Animal Scientific Research,* 3(2): 536-543.

Sheoran, N. and B. S. Tewatia. 2017. Organic acids as alternatives to antibiotic growth promoters in poultry. *The Pharma Innovation Journal*, 6(11): 164-169.

SPSS. 2011. Statistical Package for Social Science version 20 for window LEAD Technologies. Inc. USA.

Talebi, A., A. Amani, M. Pourmahmod, P. Saghaei and R. Rezaie. 2015. Synbiotic enhances immune responses against infectious bronchitis, infectious bursa disease, Newcastle disease and avian influenza in broiler chickens. *Vet. Res. Furum*, 2(6): 191-197.

Tona, K., F. Bamelis, B. D. Ketelaere, V. Bruggeman, V. M. B. Moraes, J. Buyse, O. Onagbesan and E. Decuypere. 2003. Effects of egg storage time on spread of hatch, chick quality, and chick juvenile growth. *Poultry Science*, 82: 736-741.

Uni, Z. and Robert H. Smith. 2017. The effects of *In ovo* feeding. Available from: http://zootecnicainternational.com/featured/ effects-ovo-feeding/

Uni, Z. 2014. The effects of *In ovo* feeding. 2014. Arkansas Nutrition Conference, Rogers, Arkansas. P: 9 Available From: www.thepoultryfederation.com/public/userfiles/files/Zehava%20Uni%20Presentation.pdf

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

Ur Rehman, Z. U., A. U. Haq, N. Akram, M. E. A. El-Hack, M. Saeed, S. U. Rehman, C. Meng, M. Alagawany, Sayab, M. Dhama, K. and C. Ding, 2016. Growth performance, intestinal histomorphology, blood hematology and serum metabolites of broilers chickens fed diet supplemented with graded levels of acetic acid. *Pharmacology*, 12(8): 874-883.

Willemsen, H., K. Tona, V. Bruggeman, O. Onagbesan, E. Decuypere. 2008. Effects of high CO_2 level during early incubation and late incubation *In ovo* dexamethasone injection on perinatal embryonic parameters and post-hatch growth of broilers. *British Poultry Science*, 49(2): 222- 231.

Zhai, W., S. Neuman, M. A. Latour and P. Y. Hester. 2008. The Effect of *In ovo* injection of L-carnitine on hatchability of white leghorns. *Poultry Science*, 87: 569-572.

Zhang, L., X. D. Zhu, X. F. Wang, J. L. Li, F. Gao, G. H. Zhou. 2016. Individual and combined effects of *In ovo* injection of creation monohydrate and glucose on somatic characteristics, energy status, and post-hatch performance of broiler embryos and hatchlings. *Poultry Science*, 1: 95(10): 2352- 2359.

تأثير حقن بيض التفقيس بحامض الخليك على صفات الفقس والاداء الانتاجي لفروج اللحم

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المستخلص

تضمنت هذه الدراسة اجراء تجربتين، وذلك بهدف بحث تأثير حقن بيض التفقيس بمستويات مختلفة من محلول حامض الخليك في نسبة الفقس وصفات افراخ فروج اللحم الفاقسة واداءها الانتاجي.

التجربة الاولى: استخدمت فيها 720 بيضة مخصبة من أمهات فروج اللحم Ross308، وزعت على ست معاملات بيضة لكل معاملة وبواقع ثلاثة مكررات لكل معاملة (40 بيضة مكرر$^{-1}$)، في اليوم 18 من الحضن عند تحويل البيض من الحاضنة الى المفقسة تم حقنه في كيس الامنيون حسب معاملات التجربة، T1 (السيطرة السالبة) بيض تفقيس بدون حقن، وT2 (السيطرة الموجبة) بيض تفقيس حُقِنَ 0.2 مل بيضة$^{-1}$ ماء مقطر فقط وT5، T4، T3، T6 بيض تفقيس حُقِنَ 0.2 مل بيضة$^{-1}$ من تراكيز مختلفة من محاليل حامض الخليك يحقق 1، 2، 3، 4 ميكرولتر بيضة$^{-1}$ بالترتيب، وبعد اجراء عملية الحقن تم إعادة البيض إلى المفقسة. أظهرت النتائج تحسن معنوي ($P\leq0.05$) في صفات الفقس، وزن الأفراخ، طول الافراخ، الوزن النسبي للصفار المتبقي، الوزن النسبي للأمعاء الدقيقة، طول الامعاء الدقيقة والمناعة الخلطية في أفراخ معاملات الحقن بحامض الخليك مقارنة بمعاملتي السيطرة (T1 و T2).

التجربة الثانية: استخدمت فيها 225 فرخ فروج لحم Ross 308، اخذت من الافراخ الفاقسة في التجربة الاولى من افضل معاملتين في النتائج التي هي المعاملة الخامسة والسادسة (T5، T6) فضلا عن معاملة السيطرة (T1) وبشكل عشوائي وبعدد متساوٍ، 75 فرخا من كل معاملة، وتم تربيتها في ظروف قياسية لغاية عمر 35 يوما. أظهرت النتائج تحسن الاداء الانتاجي للفروج الفاقس من بيض معاملتي الحقن بحامض الخليك، إذ تحسن معنوياً ($P\leq0.05$) كل من وزن الجسم الحي والزيادة الوزنية واستهلاك العلف وكفاءة التحويل الغذائي ونسبة الهلاكات والدليل الانتاجي لفروج معاملتي حقن الحامض (T2، T3) مقارنة مع طيور من معاملة السيطرة.

نستنتج ان اجراء عملية اقتران تقنية حقن البيض بتغذية محلول حامض الخليك لأجنة فروج اللحم عند 18 يوما من الحضن، تُحسن من نسبة الفقس وصفات نوعية وصحة الافراخ الفاقسة والاداء الانتاجي لفروج اللحم.

الكلمات المفتاحية: حقن بيض تفقيس، حامض الخليك، فروج لحم، نسبة الفقس، الاداء الانتاجي.