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BROILER PERFORMANCE RESPONSE TO BREEDER AGE, EGG STORAGE PERIOD, EGG STORAGE TYPE AND SUMAC POWDER

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Abstract

The study was carried out to investigate the effect of broiler breeder ages (35 and 50 weeks), storage periods (2 and 6 days) and storage types (cooling, hot room 30 ºC and partially oil covered at hot room 30 ºC) combined with utilization of sumac powder (0 and 1%) on productive characteristics of hatched Ross-308 broiler chicks. The results obtained from this experiment were summarized as the following: Broiler breeder ages had significant ($p \leq 0.05$) effects on some of the improved the post hatch broiler performances such as: live body weight, weekly weight gain, feed intake, mortality percentage, production index and carcass weight. Storage periods had significant ($p \leq 0.05$) effects on some of the post hatch broiler performances also such as: live body weight, weekly weight gain, feed intake, mortality percentage, production index and carcass weight. Storage types (conditions) had significant ($p \leq 0.05$) effects on some of the post hatch broiler performances also such as: live body weight, weekly weight gain, feed intake, mortality percentage, production index and carcass weight. Addition of 1% sumac powder to the diet had significant ($p \leq 0.05$) effects on some of the improved the post hatch broiler performance such as: live body weight, weekly weight gain, feed intake, mortality percentage, production index and carcass weight.

***Keywords*:** broiler performance, Sumac Powder, carcass weight, Breeder age, egg storage.

Introduction

High broiler weight at slaughter is the main goal of the farmer and the factors that influence broiler flock performance, such as nutritional and environmental conditions are well documented (Acamovic, 2001 and Veldkamp *et al.,* 2002). Some other factors, such as age of the breeder and egg storage before incubation, may also affect embryonic life of the chick and thereafter the quality of the hatched chick and the growth potential post hatch (Tona *et al.,* 2004).

Breeder age could be also a contributing factor to post-hatch performance of broilers, smaller yolk proportions of eggs from a young flock may be associated with low final body weight of their offspring (Ulmer-Franco *et al.,* 2010). Hulet *et al.* (2007) reported that broilers from old breeders had higher body weight until 35 d compared with broilers from the young breeders.

A storage duration beyond 7 d increases incubation duration (Tona *et al.,* 2003) and has a negative effect on hatchability (Fasenko *et al.,* 2001; Tona *et al.,* 2004; Yassin *et al.,* 2008) and chick quality (Tona *et al.,* 2003, 2004). The negative effects of prolonged egg storage may be caused by changes in egg characteristics, embryo quality or by both (Reijrink *et al.,* 2008). Some authors found chick weight to be an accurate predictor of final body weight (Sklan *et al.,* 2003). Pre-incubation of hatching eggs before or during storage was reported to reduce the detrimental effects of periods of storage more than 7 d (Fasenko *et al.,* 2001a; Reijrink *et al.,* 2009). The effect of preincubation on hatchability was found to be influenced by the length of egg storage period and the developmental stage of the embryo before (Reijrink *et al.,* 2009) or after (Fasenko *et al.,* 2001a) the heating. Sumac (*Rhus coriaria* L) is a plant species belong to the anacardiaceous family that is used as a spice and herbal medicine. Sumac is found in hot, temperate, and tropical regions worldwide (Kurucu *et al.,* 1993). It has a long history of use by indigenous people for medicinal and other applications (Rayne and Mazza, 2007). The sumac fruit contain flavonols, phenolic acids, hydrolysable tannins, anthocyanins, and organic acids such as malic, citric and tartaric acids (Ozcan and Haciseferogullari, 2004; Greathead, 2003; Jung, 1998). Sumac is used as an herbal remedy in traditional medicine because of its assumed analgesic, antidiarrheal, antiseptic, anorectic, and anti-hyperglycemic properties (Rayne and Mazza, 2007).

Kheiri *et al.* (2015) showed that feed intake of chicks increased significantly in Sumac powder in comparison without using sumac powder in diet ($P < 0.05$), body weight gain was also significantly higher when used sumac powder in diet. Navid, (2011) showed that The improvement of body weight gain and feed conversion are due to the active materials (Cinnamaldehyde and ugenol) found in sumac, causing greater efficiency in the utilization of feed, resulting in enhanced growth, the results could be attributed to the effect of sumac powder on improving feed utilization probably due to its anti-bacterial effect on gut micro flora (Ahmadian *et al.,* 2007). The aim of this study was response of broiler chicks to the effects of broiler breeder ages, egg storage periods, egg storage types and utilization of sumac powder on broiler performance and carcass traits.

Materials and Methods

Experimental design

A total of 1248 broilers chicks at one-day old was used in the experiment; Broilers were reared in the same environmental conditions, the area of each replicate (cage) was ($1.5 \times 1 \times 3$) m^3 and 13 birds reared from each replicate (24 groups × 4 replications × 13 broilers), also, feed and water were given *adlibitum* during the experiment (1 to 42 days). The studied factors were broiler breeder ages (35 and 50 weeks), storage periods (2 and 6 days) and storage types (cooling, hot room 30 ºC and particially oil covered at hot room 30 ºC) combined with utilization of sumac powder (0

and 1%) on productive characteristics of Ross-308 broiler chicks. The chicks were treated by sumac powder to study the effect of adding sumac powder to the diet on broiler performance.

Feeding

During the experiment periods; starter (1-10 days), grower (11-22 days) and finisher (23-42 days), birds were fed on the following ration, also, diets composition and chemical composition were shown in table (1).

Table 1 : Ingredient diet composition and chemical composition provided to the broilers.

Feed stuff	Starter (1-10 days)	Grower (11-22 days)	Finisher (23-42 days)
	(%)		
Wheat	18	22	30
Yellow corn	40	37	37
Soya bean meal	30	30	22
Protein concentrate	10	8	8
Corn oil	1	2	2
Limestone	0.7	0.7	0.7
Salt	0.3	0.3	0.3
Calculated chemical component			
Crude protein (%)	23	22.1	19.6
Metabolized energy (kcal/kg)	2900	2985	3100

Statistical analysis

The present experiment was conducted using Completely Randomized Design (C.R.D) with four factors namely broiler breeder ages, storage periods, storage types and added sumac powder to study the effect of these factors on the broiler growth performances. Statistical analysis was accomplished using (Xlstat-2017 Program for Windows version 19.6). Duncan's multiple range tests were used to determine the significance of differences among treatments means. Level of significance used in all results was ($P \leq 0.05$).

Results and Discussions

Productive characteristics (Growth performance)

Live body weight (g)

Effect of broiler breeder ages, egg storage periods, egg storage types and sumac powder on live body weight (LBW) g

There was a significant ($p \leq 0.05$) effect of broiler breeder ages, storage periods, storage types and sumac powder on live body weight for all rearing periods and at the end of the experiment (42 days old) (Table 2), the highest value (2400.33 g) of LBW (g) was recorded by broiler breeder 50 weeks of age but the lowest value (2335.46 g) was recorded by broiler breeder 35 weeks of age. Moreover, the highest value (2392.59g) was recorded by 2 day of storage period and the lowest value (2343.2g) was recorded by 6 day of storage period, the highest value (2413.95g) was recorded by cooling condition of storage type and the lowest value (2302.98 g) was recorded by hot room condition of storage type. However, there was no significant difference between cooling condition and oil covered of storage type (2386.75 g) for oil covered condition, and the highest value (2371.56 g) was recorded by treated that added sumac powder and the lowest value (2364.22 g) was recorded by without sumac powder.

The interactions for all rearing periods and at the end of the experiment between broiler breeder ages, storage periods, storage types and sumac powder had significant ($p \leq 0.05$) effect on live body weight (continued table 2), the highest value (2543.58 g) of LBW(g) was recorded by broiler breeder 50 weeks of age with 2 day of storage period with cooling condition of storage type and added sumac powder and the lowest value (2151.67 g) was recorded by broiler breeder 35 weeks of age with 6 day of storage period with hot room condition of storage type and without sumac powder.

According to the results presented in this study broiler breeder ages was a main factor that significantly affected chick body weight at hatch and the growth rate of chicks produced from the old breeders was significantly higher than those produced from the young breeders, chick body weight at hatch was higher for chicks produced from broiler breeder 50 weeks compared to those at 35 weeks, irrespective of other main studied factors. In support to this outcome, different authors reported that the breeder age had significant effect on the chick body weight at hatch (Javid *et al.,* 2016; Ipek and Sozcu 2015; Alsobayel *et al.,* 2013; Ulmer-Franco *et al.,* 2010; Mustafa and Al-Sardary, 2009; El-Sheikh, 2007). Age of broiler breeders and egg storage before incubation were fundamental factors that may affect poultry production parameters such as hatchability, chick quality, and broiler growth up to slaughter at 42 d of age (Tona *et al.,* 2003). Gualhanone, *et al.* (2011) also, showed that heavier eggs resulted in heavier chicks, as expected, corroborating several authors that reported a positive correlation between egg weight and chick weight, older breeders with heavier eggs produced heavier chicks, irrespective of incubation temperature, chick weight is an important factor in broiler growth, since it was reported that there is a positive and strong correlation between chick weight at hatch and broiler market weight (42 to 45 days of age). Similar results were reported by several investigators with respect to egg weight increase with advancing age of breeders (Yildirim, 2005; Vieira *et al.,* 2005; Zakaria *et al.,* 2009). This severe effect of older breeders may be considered as a method of

improving the percentage of high quality chicks obtained from older breeders.

The results in the present study demonstrated that the decrease in body weight at hatching and at the marketing with increase of storage period, this was may be due to the effect of prolonged storage period on egg quality. This change in body weight, due to the effect of many genetically and environmentally factors like differences in (yolk sac size) and disease could greatly influence the weight of broiler for different ages and at market age (Mustafa and Al-Sardary, 2009). The results in the present study regarding the effect of storage period agred with those of (Hassan *et al.,* 2005; Reijrink *et al.* 2010; Gonzalez, 2010; Alsobayel and Albadry, 2011; Muhammad *et al.,* 2013; Michael *et al.,* 2015 and Muhammad *et al.,* 2014) whom indicated that egg and chick weight and chick weight percent of fresh egg decreased with prolonged storage period. The decrease of chick weight that hatched from eggs stored in hot room compared with cooling and oil covered storage type may be due to decrease of egg quality during storage periods.

These results demonstrated that the adding of sumac powder to the diet was beneficial for broiler chicks growth in agreement with the results of (Mohammad *et al.,* 2014) who reported that this improvement may be due to the active materials like cinnamaldehyde and ugenol found in sumac, causing greater efficiency in the utilization of feed, resulting in enhanced growth. Rayne and Mazza (2007) showed that sumac extracts have been found to have antimicrobial, hypoglycemic and antioxidant activities and had led to better growth and performance for broilers. Reza *et al.* (2014) observed that using sumac extract enhance the performance of broilers, and the improvement of health and growth may be due to some biological functions to improve growth or that may be due to their role as stimulating, enhancing digestibility, anti-oxidant antimicrobial and properties for inhibition of gastric toxicity. The effect of interactions between all main factors in the present study on increasing live body weight may be explained by the major effect of egg weight from old breeders (breeder ages) followed by other factors like addition of sumac powder to the diet.

Weight gain (g)

Effect of broiler breeder ages, egg storage periods, egg storage types and sumac powder on Weight gain (WG) g

Table (3) showed significant ($p \leq 0.05$) effects of broiler breeder ages, storage periods, storage types and sumac powder on weight gain (g) for all rearing periods and at the end of the experiment, the highest value (2362.10 g) of WG(g) was recorded by broiler breeder 50 weeks of age and the lowest value (2298.74 g) was recorded by broiler breeder 35 weeks of age. Moreover, the highest value (2354.29g) was recorded by 2 day of storage period and the lowest value (2306.55g) was recorded by 6 day of storage period, the highest value (2374.58g) was recorded by cooling condition of storage type and the lowest value (2268.28 g) was recorded by hot room condition of storage type and the highest value (2334.21 g) was recorded by treated that added sumac powder and the lowest value (2326.63 g) was recorded by without sumac powder.

The interactions for all rearing periods and at the end of the experiment between broiler breeder ages, storage periods, storage types and sumac powder had significant ($p \leq 0.05$) effect on WG(g) (continued table 3), the highest value (2502.46 g) of WG(g) was recorded by broiler breeder 35 weeks of age with 2 day of storage period with cooling condition of storage type and without sumac powder and the lowest value (2118.81 g) was recorded by broiler breeder 35 weeks of age with 6 day of storage period with hot room condition of storage type and without sumac powder.

Breeder age had significant effect on chick weight; the results revealed that chick weight was improved with advancing age of broiler breeder. The results of the present experiment were agreed with (Javid *et al.,* 2016) who showed that chicks hatched from older breeder flocks were usually heavier and of higher quality because they were naturally more resistant to dehydration upon hatching as compared to smaller chicks from young breeder. Mustafa and Al-Sardary, (2009) showed that the high weight gain of hatched chicks from older breeder eggs due to higher weight at hatching and at 6 weeks because of the positive correlation between day-old chicks weight and weight of chicks at 42 days.

Mustafa and Al-Sardary, (2009) also, revealed the reason of higher weight gain of chicks produced from egg stored for 3 days at 42 and 49 days was due to positive correlation between live body weight and weight gain.

The results found in the present study demonstrated that addition of sumac powder was beneficial to increase body weight gain in broilers. The improvement of body weight gain was due to the active materials (cinnamaldehyde and ugenol) found in sumac, causing greater efficiency in the utilization of feed, resulting in enhanced growth (Lee *et al.,* 2003). Phenolic compounds that are found in sumac inhibit lipid peroxidation, scavenge the superoxide anion and hydroxyl radical (Khalaf *et al*., 2008) and enhance the activities of detoxifying enzymes such as glutathione-S-transferase (Mazloom, 2011).D-limonene (l-methyl-4-(1-methylethenyl)-cyclohexane) is a monocyclic monoterpene component of sumac that has hypocholesterolemic effects (Kurucu *et al*., 1993). Ahmadian *et al.* (2007) showed that use of sumac extract can improve growth and have beneficial effect on broilers. (Mohammad *et al.,* 2014; Mansoub, 2012) showed that using different levels of sumac had significant effects on body weight gain in broiler. Mansoub, (2012) found that antimicrobial substances present in sumac can reduce the harmful bacteria populations in the gastrointestinal tract and improve the levels of absorbed amino acids.

Feed intake (g)

Effect of broiler breeder ages, egg storage periods, egg storage types and sumac powder on feed intake (FI) g

There was significant ($p \leq 0.05$) effects of broiler breeder ages, storage periods, storage types and sumac powder on feed intake (g) for all rearing periods and at the end of the experiment (Table 4). The highest value (4486.26 g) of FI(g) was recorded by broiler breeder 50 weeks of age and the lowest value (4291.57 g) was recorded by broiler breeder 35 weeks of age, the highest value (4448.18 g) was recorded by 2 day of storage period and the lowest value (4329.66 g) was recorded by 6 day of storage period, the highest value (4517.81 g) was recorded by cooling condition of storage type and the lowest value (4291.46 g) was recorded by oil covered condition of storage type and the highest value (4459.82 g) was recorded by treated that added

sumac powder and the lowest value (4318.01 g) was recorded by without sumac powder.

The interactions for all rearing periods and at the end of the experiment between broiler breeder ages, storage periods, storage types and sumac powder had significant ($p \leq 0.05$) effects on feed intake (g) (continued table 4), the highest value (4936.51 g) of FI(g) was recorded by broiler breeder 50 weeks of age with 2 day of storage period with hot room condition of storage type and added sumac powder and the lowest value (3938.47 g) was recorded by broiler breeder 50 weeks of age with 2 day of storage period with oil covered condition of storage type and without sumac powder.

The results in the present study demonstrated that broiler breeder age had significant effect on feed intake in broiler chicks; this was may be due to the positive correlation between body weight and feed intake. These results were in agreement with (Hulet *et al.,* 2007) reported that the chicks produced from young breeders had significantly greater cumulative feed compared with chicks from the younger breeder.

The effect of storage period had significant effect on feed intake of chicks at 42 days. These results were in agreement with finding of (Mustafa and Al-Sardary, 2009 and Talabane, 2006) whom reported that feed intake at 42 days of age was significantly affected by storage periods.

According to the results in the present study addition of sumac powder had significantly affected the feed intake. These results were in agreement with (Kheiri *et al.,* 2015; Golzadeh *et al.,* 2012; Mansoub, 2012) whom showed that using different levels of sumac had significant effects ($P < 0.05$) on feed intake. The improvement may be due to the activity of materials like cinnamaldehyde and ugenol found in sumac, causing greater efficiency in the utilization of feed, resulting in enhanced growth (Mohammad *et al.,* 2014) The effect of interactions between all main factors in this study on increasing feed intake may be explained the major effect of chick body weight from old breeders (breeder ages) followed by other factors like egg storage and addition of sumac powder to the diet that causing greater efficiency in the utilization of feed, resulting in enhanced growth (Mohammad *et al.,* 2014).

Feed conversion ratio

Effect of broiler breeder ages, egg storage periods, egg storage types and sumac powder on feed conversion ratio (FCR)

Table (5) revealed significant ($p \leq 0.05$) effects of broiler breeder ages on feed conversion ratio at 3rd and 4th weeks of rearing periods but had no significant effect at other rearing periods and at the end of the experiment (42 days old). There was significant ($p \leq 0.05$) effect of storage periods at 1st and 6th weeks of rearing periods but no significant effect was found at other rearing periods and at the end of this experiment (42 days old). There was significant ($p \leq 0.05$) effect of storage types at 1st, 2nd, 3rd , 5th and 6th weeks of rearing periods but no significant effect at 4th and at the end of this experiment. There was significant ($p \leq 0.05$) effect of sumac powder at 2nd and 3rd weeks of rearing periods but no significant effect was found at other rearing periods and at the end of the experiment (42 days old). Generally, at the end of this experiment (42 days old) there was no significant effect of the main factors on feed conversion ratio, however, numerically there was a difference in FCR values between the main factors.

The interactions for all rearing periods and at the end of the experiment between broiler breeder ages, storage periods, storage types and sumac powder had significant ($p \leq 0.05$) effect on feed conversion ratio (continued table 5), the highest value (2.16) of (FCR) was recorded by broiler breeder 50 weeks of age with 2 day of storage period with hot room condition of storage type and added sumac powder and the lowest value (1.64) was recorded by broiler breeder 50 weeks of age with 2 day of storage period with oil covered condition of storage type and without added sumac powder.

According to the results in the present study feed conversion ratio was not influenced by broiler breeder ages, egg storage periods, egg storage types and sumac powder at the end of the study. This was may be due to the positive relation between feed intake and body weight gain. These results were in agreement with (Michael *et al.,* 2015) whom founded that feed conversion ratio was not affected by storage period. Ashraf *et al*., (2012) also, found that feed conversion ratio was not affected by adding sumac powder and similarly (Mohamed *et al.,* 2013; Ulmer-Franco *et al.,* 2010; Mustafa and Al-Sardary, 2009) whom founded that feed conversion ratio was not affected by broiler breeder age.

Mortality percentage and production index

Effect of broiler breeder ages, egg storage periods, egg storage types and sumac powder on mortality percentage (mortality %) and production index (PI)

Table (6) showed significant ($p \leq 0.05$) effects of broiler breeder ages, storage periods, storage types and sumac powder on mortality percentage and production index at the end of the experiment. The highest value (3.37 %) of mortality percentage was recorded by broiler breeder 35 weeks and the lowest value (2.36 %) was recorded by broiler breeder 50 weeks of age, the highest value (2.95 %) was recorded by 2 day of storage period and the lowest value (2.79 %) was recorded by 6 day of storage period, the highest value (3.69 %) was recorded by hot room condition of storage type and the lowest value (1.98 %) was recorded by cooling condition of storage type and the highest value (3.23 %) was recorded by without added sumac powder and the lowest value (2.51 %) was recorded by without added sumac powder. Moreover, the highest value (295.42) of (PI) was recorded by broiler breeder 50 weeks of age and the lowest value (288.61) was recorded by broiler breeder 35 weeks of age, the highest value (294.14) was recorded by 2 day of storage period and the lowest value (289.89) was recorded by 6 day of storage period, the highest value (303.41) was recorded by oil covered condition of storage type and the lowest value (276.03) was recorded by hot room condition

of storage type and the highest value (295.02) was recorded by added sumac powder and the lowest value (289) was recorded by without added sumac powder.

The interactions between broiler breeder ages, storage periods, storage types and sumac powder at the end of the experiment had significant ($p \leq 0.05$) effects on mortality percentage and production index (continued table 6). The highest value (5.56 %) of mortality percentage was recorded by broiler breeder 35 weeks of age with 2 day of storage period with oil covered condition of storage type and without added sumac powder and the lowest value (0 %) was recorded by broiler breeder 35 weeks of age with 2 day of storage period with cooling condition of storage type and added sumac powder. However, (there were no significant differences between broiler breeder 35 weeks of age, 2 day of storage period, hot room condition of storage type and added sumac powder with broiler breeder 50 weeks of age, 6 day of storage period, cooling condition of storage type and added sumac powder, also, broiler breeder 50 weeks of age, 6 day of storage period, oil covered condition of storage type with added and without added sumac powder). The highest value (344.89) of production index was also recorded by broiler breeder 50 weeks of age with 6 day of storage period with oil covered condition of storage type and with added sumac powder and the lowest value (240.85) was recorded by broiler breeder 50 weeks of age with 2 day of storage period with hot room condition of storage type and without added sumac powder.

However there were significant effects of broiler breeder ages, egg storage periods, egg storage types and sumac powder and their interactions on mortality percentage during the experiment, but there was no clearly causes to effect of these factors on the mortality (%), and the difference in values may be explained by the some of environmental factors during the experiment such as change in temperature, individual immunity and disease. There were also significant effects of broiler breeder ages, egg storage periods, egg storage types and sumac powder and their interactions on production index during the experiment, these effects were might be due to the effect of live body weight and mortality percentage on production index equation, because positive relationship was present between live body weight and mortality percentage with production index. The results of storage period were agreed with finding of (Mustafa and Al-Sardary, 2009) whom reported that storing eggs for (1, 2 and 3 days) had significant effect on production index in broiler chicks.

Carcass weight (g) and dressing percentage

Effect of broiler breeder ages, egg storage periods, egg storage types and sumac powder on carcass weight (g) and dressing percentage

There were a significant ($p \leq 0.05$) effects of broiler breeder ages, storage periods, storage types and sumac powder on carcass weight (g) (42 days old), but no significant ($p \leq 0.05$) effects of these factors were found on dressing percentage. However, numerically there were small differences between the values obtained from each factors (Table 7). The highest value (1723.515 g) of carcass weight was recorded by broiler breeder 50 weeks of age and the lowest value (1667.136 g) was recorded by broiler breeder 35 weeks of age, the highest value (1718.171g) was recorded by 2 day of storage period and the lowest value (1672.480 g) was recorded by 6 day of storage period, the highest value (1741.106 g) was recorded by cooling condition of storage type and the lowest value (1637.235 g) was recorded by hot room condition of storage type and the highest value (1701.568 g) was recorded by treated that added sumac powder and the lowest value (1689.084 g) was recorded by without added sumac powder.

The interactions between broiler breeder ages, storage periods, storage types and sumac powder had significant ($p \leq 0.05$) effects on carcass weight (g), but no significant ($p \leq 0.05$) effects on dressing percentage (continued table 7). The highest value of carcass weight was recorded by broiler breeder 50 weeks of age with 2 days of storage period with cooling condition of storage type and added sumac powder (1845.367 g) and the lowest value was recorded by broiler breeder 35 weeks of age with 6 days of storage period with hot room condition of storage type and without added sumac powder (1507.890 g). The effect of broiler breeder ages, storage periods, storage types and sumac powder and their interactions on carcass weight may be explained by effect of these factors and their interactions on live body weight of the bird. The results in the present study were in agreement with finding by (Alsobayel *et al.,* 2016; Alsobayel and AL-Miman, 2010) who reported the effect of storage period on carcass weight, and results by Reza *et al.* (2014) reported the effect of adding sumac extract on carcass weight. Alsobayel *et al.* (2016) showed that there was a significant effect of storage period on broilers carcass weight, who reported that the highest carcass weight of broilers was obtained from eggs that was not stored compared to those of stored eggs. Alsobayel and AL-Miman, (2010) indicated that live weight of slaughtered birds from eggs stored for one day was significantly ($p<0.05$) higher and had higher carcass, liver and abdominal fat weights than those hatched from eggs stored for 7 and 14 days, from the results it can be concluded that broilers produced from one day stored hatching eggs had in general better growth performance which was reflected in higher body and carcass weights. Reza *et al.* (2014) observed that using sumac extract enhance the performance of broilers especially body weight and carcass weight.

Table 2 : Effect of broiler breeder ages, egg storage periods, egg storage types and sumac powder on live body weight (g) (Mean ± SEM).

Main factors	LBW (g)						
	At hatch	1st week	2nd week	3rd week	4th week	5th week	6th week
Breeder age (week)							
35	36.71 b ±0.2	123.50 a ±0.54	312.49 b ±12.9	723.87 b ±10.7	1337.17 a ±22.7	1906.75 b ±24.2	2335.46 b ±75.1
50	38.07 a ±0.11	122.16 b ±0.32	317.64 a ±12.2	785.97 a ±16.9	1335.77 b ±48.5	1931.64 a ±34.8	2400.33 a ±38.6
Storage period(day)							
2	38.13 a ±0.71	123.70 a ±0.58	313.55 b ±12.6	758.39 a ±10.1	1363.63 a ±31.3	1932.00 a ±58.5	2392.59 a ±80.7
6	36.65 b ±0.01	121.96 b ±0.55	316.57 a ±11.9	751.46 b ±10.1	1309.31 b ±13.9	1906.39 b ±55.8	2343.20 b ±17.8
Storage type							
C	39.13 a ±0.06	124.06 a ±0.51	323.71 a ±17.8	760.93 a ±13.7	1375.9 a ±25.3	1945.66 a ±55	2413.95 a ±86.1
H	34.69 b ±0.02	123.12 a ±0.54	308.51 c ±10.5	747.13 c ±10.4	1315.16 c ±33.6	1867.01 b ±47.6	2302.98 b ±68.8
O	38.35 a ±0.1	121.31 b ±0.54	312.96 b ±31.3	756.71 b ±15.7	1318.34 b ±19.9	1944.91 a ±57.3	2386.75 a ±53.1
Sumac powder (%)							
0	---	123.57 a ±0.25	310.94 b ±12.4	765.21 a ±9.2	1329.35 b ±24.6	1924.51 a ±25.2	2364.22 b ±56.1
1	---	122.09 b ±0.37	319.19 a ±16.3	744.64 b ±12.1	1343.59 a ±24.2	1913.88 b ±16.3	2371.56 a ±36.4

Means values in the same column having different superscripts are significantly different at P≤0.05.
Means values in the same column having the same superscripts are not significantly different at P≤0.05.

Table 2 (Continued) : Effect of interactions between broiler breeder ages, egg storage periods (Sp), egg storage types (St) and sumac powder (Su) on live body weight (LBW) g (Mean ± SEM).

Interactions				LBW (g)						
Age	Sp	St	Su	At hatch	1st week	2nd week	3rd week	4th week	5th week	6th week
35	2	C	0	39.21 abcd ±0.3	122.20 fg ±0.3	305.20 f ±10.8	761.00 h ±11.3	1395.22 d ±33.4	2065.00 e ±48.2	2541.67 a ±57.9
			1	38.85 abcde ±0.2	125.40 bcdef ±0.3	337.14 b ±15.4	752.00 i ±10.7	1353.33 k ±64.8	1853.75 r ±25.9	2381.30 h ±91.3
		H	0	35.10 efg ±0.4	127.60 abc ±0.3	292.80 j ±13.4	752.00 i ±10.9	1401.29 c ±45.8	1892.08 m ±87.5	2312.50 m ±84.2
			1	34.80 fg ±0.3	123.11 defg ±0.3	291.11 j ±19.9	792.00 f ±12	1410.00 a ±14	2025.67 f ±45.7	2333.33 k ±25.2
		O	0	39.09 abcd ±0.2	124.18 cdefg ±0.0	301.60 gh ±12.7	647.00 p ±10.9	1335.63 m ±28.4	1786.67 t ±66.5	2266.67 n ±66.5
			1	38.93 abcde ±0.0	114.40 hi ±0.5	330.00 c ±17.8	690.0 m ±13.7	1315.00 n ±25.3	2000.00 h ±55	2395.83 g ±86.1
	6	C	0	38.25 abcdef ±0.1	111.70 ij ±0.3	337.11 b ±16.3	739.47 j ±12.1	1382.22 f ±24.2	2111.11 b ±16.3	2395.83 g ±36.4
			1	37.80 abcdef ±0.1	129.20 a ±0.3	308.80 e ±12.2	750.00 i ±16.9	1396.67 d ±48.5	1870.00 o ±34.8	2437.50 d ±38.6
		H	0	32.85 g ±0.7	125.20 bcdef ±0.5	300.81 gh ±12.6	660.00 n ±10.1	1178.33 u ±31.3	1672.50 w ±58.5	2151.67 q ±55.7
			1	32.56 g ±0.2	126.70 abcd ±0.2	311.56 e ±23.3	652.00 o ±9.9	1275.00 r ±22.5	1720.83 v ±55.2	2246.67 o ±62
		O	0	36.96 abcdef ±0.2	128.33 ab ±0.0	330.20 c ±12.6	838.00 c ±9.7	1316.67 n ±33	2156.67 a ±39.1	2395.83 g ±39.1
			1	36.14 bcdefg ±0.1	123.99 cdefg ±0.3	303.50 fg ±20.3	653.00 o ±11.1	1286.67 p ±66.3	1726.67 u ±36.5	2166.67 p ±27.6
50	2	C	0	40.73 a ±0.2	128.11 ab ±0.5	338.00 b ±10.5	762.00 h ±10.4	1360.00 j ±33.6	1857.08 q ±47.6	2354.17 i ±68.8
			1	40.31 a ±0.3	121.30 g ±0.2	326.20 d ±12.4	749.00 i ±9.2	1355.31 k ±24.6	2092.78 c ±25.2	2543.58 a ±56.1
		H	0	35.78 cdefg ±0.1	125.50 abcdef ±0.5	283.56 k ±11.9	932.00 a ±10.1	1363.33 i ±13.9	1837.92 s ±55.8	2312.50 m ±17.8
			1	35.34 defg ±0.1	124.02 cdefg ±0.3	328.24 cd ±15.5	772.00 g ±11.9	1406.67 b ±17.5	1880.42 n ±89.3	2317.17 l ±30.8
		O	0	39.96 ab ±0.3	122.80 efg ±0.1	289.60 j ±15.5	752.00 i ±10.9	1290.00 o ±20.2	1943.33 j ±50.5	2431.51 e ±85.2
			1	39.54 abc ±0.0	125.80 abcdef ±0.3	339.20 b ±15.2	739.67 j ±11	1377.78 g ±46.3	1949.31 i ±38	2520.83 b ±53.2
	6	C	0	39.21 abcd ±0.2	128.20 ab ±0.4	297.35 i ±14.6	812.00 e ±11	1391.11 e ±42.2	1851.81 r ±79.2	2312.50 m ±45.8
			1	38.72 abcde ±0.5	126.40 abcde ±0.3	339.91 b ±16.1	762.00 h ±12.3	1373.33 h ±28.7	1863.75 p ±27.5	2345.06 j ±43
		H	0	35.65 defg ±0.2	124.00 cdefg ±0.2	355.00 a ±15.7	705.00 l ±11.1	1256.67 s ±23.4	2006.67 g ±44	2395.83 g ±61.3
			1	35.47 defg ±0.6	108.80 j ±0.1	305.00 f ±17.4	712.00 k ±13	1230.00 t ±16.4	1900.00 l ±54.7	2354.17 i ±25.5
		O	0	38.30 abcdef ±0.2	115.00 hi ±0.5	300.00 hi ±12.9	822.00 d ±10.7	1281.67 q ±22.7	1913.33 k ±24.2	2500.00 c ±75.1
			1	37.87 abcdef ±0.1	116.00 h ±0.5	309.60 e ±31.3	912.00 b ±15.7	1343.33 l ±19.9	2083.33 d ±57.3	2416.67 f ±53.1

Means values in the same column having different superscripts are significantly different at P≤0.05.
Means values in the same column having the same superscripts are not significantly different at P≤0.05.

Table 3 : Effect of broiler breeder ages, egg storage periods, egg storage types and sumac powder on weekly weight gain (g) (Mean ± SEM).

Main factors	WG (g)						
	1st week	2nd week	3rd week	4th week	5th week	6th week	At all 42 days
Breeder age (week)							
35	86.79 a ±19.3	188.99 b ±8.1	411.39 b ±8.9	613.30 a ±21.6	569.58 b ±16.8	428.71 b ±28.4	2298.74 b ±69.5
50	84.09 b ±8.9	195.48 a ±9.4	468.33 a ±9.5	549.79 b ±6.9	595.88 a ±16.9	468.53 a ±23.4	2362.10 a ±46.5
Storage period(day)							
2	85.57 a ±16	189.85 b ±6.2	444.83 a ±16.5	605.24 a ±5	568.37 b ±9.3	460.43 a ±33	2354.29 a ±48.5
6	85.31 a ±13.3	194.61 a ±25.4	434.89 b ±45.8	557.85 b ±8.4	597.08 a ±8.5	436.81 b ±11.7	2306.55 b ±52
Storage type							
C	84.93 b ±14.1	199.65 a ±31.4	437.22 c ±41.6	614.97 a ±6.2	569.76 b ±8.9	468.05 a ±8.8	2374.58 a ±12.8
H	88.42 a ±9.4	185.39 c ±9.7	438.62 b ±4.2	568.04 b ±5.7	551.85 c ±3.4	435.97 c ±46.3	2268.28 c ±23.6
O	82.96 c ±8.6	191.65 b ±6.8	443.75 a ±30.3	561.63 c ±12.7	626.57 a ±8.5	441.84 b ±11.4	2348.40 b ±35.4
Sumac powder (%)							
0	85.98 a ±9	187.37 b ±26.7	454.27 a ±66.2	564.14 b ±11.5	595.17 a ±9.7	439.71 b ±14.6	2326.63 b ±81.2
1	84.90 b ±22.2	197.10 a ±26.5	425.45 b ±59.8	598.95 a ±8.4	570.28 b ±14.9	457.53 a ±4.6	2334.21 a ±75.5

Means values in the same column having different superscripts are significantly different at P≤0.05.
Means values in the same column having the same superscripts are not significantly different at P≤0.05.

Table 3 (Continued) : Effect of interactions between broiler breeder ages, egg storage periods (Sp), egg storage types (St) and sumac powder (Su) on weekly weight gain (g) (Mean ± SEM).

Interactions				WG (g)						
Age	Sp	St	Su	1st week	2nd week	3rd week	4th week	5th week	6th week	At all 42 days
35	2	C	0	82.99 fg ±11.5	183 h ±9.7	455.8 h ±14.6	634.22 e ±13.4	669.78 f ±11.3	476.67 hi ±24.6	2502.46 a ±14.3
			1	86.55 de ±8.4	211.74 de ±14.9	414.86 k ±4.6	601.33 j ±27.3	500.42 k ±31.3	527.55 d ±24.2	2342.45 h ±76.6
		H	0	92.5 ab ±6.2	165.2 l ±8.9	459.2 g ±8.8	649.29 b ±9.5	490.79 m ±27.5	420.42 o ±25.3	2277.4 n ±78.9
			1	88.31 cde ±13.1	168 kl ±2.2	500.89 f ±10.6	618 g ±20	615.67 i ±56.4	307.67 s ±22.5	2298.54 l ±29.5
		O	0	85.09 ef ±25	177.42 ij ±18.4	345.4 p ±22.9	688.63 a ±19.3	451.04 p ±8.1	480 gh ±8.9	2227.58 p ±68.5
			1	75.47 ij ±14.1	215.6 c ±31.4	360 n ±41.6	625 f ±6.2	685 e ±8.9	395.83 p ±8.8	2356.91 g ±12.8
	6	C	0	73.45 j ±22.2	225.41 b ±26.5	402.36 m ±59.8	642.76 c ±8.4	728.89 d ±14.9	284.72 t ±4.6	2357.58 g ±75.5
			1	91.4 abc ±8.9	179.6 i ±9.4	441.2 i ±9.5	646.67 b ±6.9	473.33 n ±16.9	567.5 c ±23.4	2399.7 d ±46.5
		H	0	92.35 ab ±16	175.61 j ±6.2	359.19 n ±16.5	518.33 o ±5	494.17 l ±9.3	479.17 gh ±33	2118.81 s ±48.5
			1	94.14 a ±21.3	184.86 h ±6.6	340.44 q ±45.6	623 f ±13.1	445.83 q ±12.2	525.83 d ±10.6	2214.1 q ±67.7
		O	0	91.37 abc ±19.3	201.87 f ±8.5	507.8 e ±27	478.67 p ±16	840 a ±6.2	239.17 u ±16.5	2358.87 g ±8.7
			1	87.85 cde ±21.6	179.51 i ±14.1	349.5 o ±12.5	633.67 e ±33.8	440 r ±9.3	440 m ±17.5	2130.52 r ±82.2
50	2	C	0	87.38 de ±9.4	209.89 e ±9.7	424 j ±4.2	598 k ±5.7	497.08 l ±3.4	497.08 e ±46.3	2313.44 j ±23.6
			1	80.99 gh ±9	204.9 f ±26.7	422.8 j ±66.2	606.31 i ±11.5	737.47 c ±9.7	448.89 l ±14.6	2501.35 a ±81.2
		H	0	89.72 bcd ±13.3	158.06 m ±25.4	648.44 a ±45.8	431.33 r ±8.4	474.58 n ±8.5	474.58 i ±11.7	2276.72 n ±52
			1	88.68 cde ±28.3	204.22 f ±20.5	443.76 i ±94.9	634.67 e ±21.6	473.75 n ±14.1	436.75 n ±12.5	2281.83 m ±11.8
		O	0	82.84 fg ±12.7	166.8 kl ±8.5	462.4 g ±11.4	538 n ±17.3	653.33 g ±28.2	488.18 f ±19.9	2391.55 e ±77.3
			1	86.26 def ±40.9	213.4 cd ±42.9	400.47 m ±16.5	638.11 d ±9.4	571.53 j ±9.7	571.53 b ±4.2	2481.3 b ±24
	6	C	0	88.99 bcd ±8.4	169.15 k ±8.5	514.65 d ±11.7	579.11 l ±11.6	460.69 o ±12.5	460.69 j ±13.9	2273.29 o ±13.8
			1	87.68 cde ±11.6	213.51 cd ±20.2	422.09 j ±21.2	611.33 h ±15.9	490.42 m ±32.9	481.31 g ±16.4	2306.34 k ±49.6
		H	0	88.35 cde ±7.6	231 a ±35.6	350 o ±14.1	551.67 m ±8.9	750 b ±9.4	389.17 q ±9.5	2360.18 g ±65.6
			1	73.33 j ±15	196.2 g ±16.2	407 l ±35.4	518 o ±11.6	670 f ±20.2	454.17 k ±21.2	2318.69 i ±47.7
		O	0	76.7 ij ±19.3	185 h ±8.1	522 c ±8.9	459.67 q ±21.6	631.67 h ±16.8	586.67 a ±28.4	2461.7 c ±69.5
			1	78.13 hi ±8.6	193.6 g ±6.8	602.4 b ±30.3	431.33 r ±12.7	740 c ±8.5	333.33 r ±11.4	2378.8 f ±35.4

Means values in the same column having different superscripts are significantly different at P≤0.05.
Means values in the same column having the same superscripts are not significantly different at P≤0.05.

Table 4 : Effect of broiler breeder ages, egg storage periods, egg storage types and sumac powder on weekly feed intake (g) (Mean ± SEM).

Main factors	FI (g).						
	1st week	2nd week	3rd week	4th week	5th week	6th week	At all 42 days
Breeder age (week)							
35	214.20 a ±21.5	446.47 b ±21.8	806.37 b ±22	909.83 a ±23.8	1089.43 b ±31.5	825.27 b ±21.6	4291.57 b ±123.8
50	206.34 b ±19.2	451.69 a ±19.4	859.43 a ±19.5	902.12 b ±21.5	1149.74 a ±29.2	916.94 a ±11.6	4486.26 a ±111.5
Storage period(day)							
2	219.13 a ±20.3	447.10 b ±20.5	850.21 a ±20.6	931.67 a ±22.6	1125.69 a ±30.3	874.38 a ±13.1	4448.18 a ±106.6
6	201.42 b ±23.4	451.06 a ±23.6	815.59 b ±24	880.29 b ±24.7	1113.47 b ±33.4	867.83 b ±8.9	4329.66 b ±117.7
Storage type							
C	204.38 b ±25.4	435.08 c ±25.5	889.05 a ±25.7	938.47 a ±25.8	1170.65 a ±35.4	880.17 b ±19.3	4517.81 a ±125.8
H	222.92 a ±19.2	445.78 b ±20.8	811.65 b ±21.1	886.91 c ±21.6	1107.84 b ±29.2	882.38 a ±8.4	4357.48 b ±151.6
O	203.51 b ±26.4	466.37 a ±26.8	798 c ±27.4	892.55 b ±28.1	1080.27 c ±36.4	850.77 c ±16	4291.46 c ±188.1
Sumac powder (%)							
0	211.57 a ±22.4	415.08 b ±22.7	811.85 b ±22.9	890.20 b ±24.3	1125.26 a ±32.4	864.04 b ±9.4	4318.01 b ±114.3
1	208.97 b ±26.2	483.07 a ±26.4	853.94 a ±26.6	921.75 a ±26.7	1113.90 b ±36.2	878.18 a ±11.6	4459.82 a ±116.7

Means values in the same column having different superscripts are significantly different at P≤0.05.
Means values in the same column having the same superscripts are not significantly different at P≤0.05.

Table 4 (Continued) : Effect of interactions between broiler breeder ages, egg storage periods (Sp), egg storage types (St) and sumac powder (Su) on weekly feed intake (g) (Mean ± SEM).

Interactions				FI (g)						
Age	Sp	St	Su	1st week	2nd week	3rd week	4th week	5th week	6th week	At all 42 days
35	2	C	0	169.22 m ±10.4	391.05 o ±11	983 b ±11.3	990.14 b ±11.5	1170 d ±20.4	915.63 g ±5.7	4619.04 c ±101.5
			1	190.34 j ±14.2	539.69 d ±14.2	889.17 f ±14.4	922.75 h ±14.9	1179.75 c ±24.2	858 i ±11.5	4579.7 e ±104.9
		H	0	251.67 d ±13.5	421.89 l ±13.7	797 n ±14	913.17 i ±14.4	1072.5 f ±23.5	750.75 l ±21.6	4206.98 p ±104.4
			1	239.42 e ±16.3	360.36 s ±16.8	733.79 t ±17	924 h ±17.1	1053 h ±26.3	819 j ±12.7	4129.57 r ±107.1
		O	0	255 d ±33.2	482.4 h ±33.3	713.33 u ±33.4	956.18 d ±33.5	1053 h ±43.2	1053 a ±9	4512.91 h ±123.5
			1	193.89 i ±25.4	536.69 d ±25.5	851.86 j ±25.7	950.27 e ±25.8	1053 h ±35.4	633.77 m ±19.3	4219.49 n ±115.8
	6	C	0	169.88 m ±26.2	321.09 u ±26.4	848.19 k ±26.6	931.83 g ±26.7	1135.59 e ±36.2	760.97 k ±11.6	4167.54 q ±116.7
			1	273.44 a ±19.2	514.36 f ±19.4	854.63 ij ±19.5	924 h ±21.5	1072.5 f ±29.2	858 i ±11.6	4496.93 i ±111.5
		H	0	234.56 f ±20.3	397.9 n ±20.5	748.33 r ±20.6	794.25 q ±22.6	1179.75 c ±30.3	858 i ±13.1	4212.8 o ±112.6
			1	199.42 h ±28.5	478.87 i ±28.8	753.33 q ±29.2	869.42 l ±29.5	965.25 i ±38.5	858 i ±21.6	4124.29 s ±119.5
		O	0	198.55 h ±32.3	496.16 g ±32.4	765.42 p ±32.5	871.08 l ±33.4	1072.5 f ±42.3	618.83 n ±19.3	4022.54 t ±123.4
			1	195 i ±17.9	417.13 m ±18.3	738.33 s ±18.3	870.91 l ±18.5	1066.37 g ±27.9	919.29 f ±6.2	4207.04 p ±108.5
50	2	C	0	192.33 ij ±19.2	327.09 t ±20.8	896.67 e ±21.1	908.45 j ±21.6	1287 a ±29.2	936 e ±8.4	4547.54 f ±111.6
			1	178.43 l ±22.4	368.78 q ±22.7	915.26 d ±22.9	959.97 c ±24.3	1135.59 e ±32.4	984.18 c ±9.4	4542.21 g ±114.3
		H	0	251.67 d ±23.4	454.93 k ±23.6	787 o ±24	905.67 j ±24.7	1179.75 c ±33.4	965.25 d ±8.9	4544.27 g ±114.7
			1	262.08 c ±29.9	566.34 a ±30.1	991.82 a ±30.2	1010.27 a ±30.7	1287 a ±39.9	819 j ±9.4	4936.51 a ±120.7
		O	0	212.48 g ±12.2	377.04 p ±12.4	787.29 o ±12.9	845.67 n ±13.3	965.25 i ±22.2	750.75 l ±5	3938.47 u ±103.3
			1	232.99 f ±31.4	538.89 d ±31.8	856.33 i ±32	893.44 k ±32.8	1072.5 f ±41.4	1007.28 b ±8.9	4601.43 d ±122.8
	6	C	0	266.47 b ±11.2	466.14 j ±11.7	801.53 m ±12	924.18 h ±12.2	1135.59 e ±21.2	858 i ±6.9	4451.91 j ±102.2
			1	194.93 i ±15.5	552.45 c ±15.6	924 c ±15.8	946.44 f ±16.6	1249.15 b ±25.5	870.62 h ±8.4	4737.59 b ±106.6
		H	0	183.53 k ±31.5	521.29 e ±31.6	817.25 l ±31.8	813 p ±32.1	1072.5 f ±41.5	936 e ±16	4343.57 l ±122.1
			1	161.03 n ±27.3	364.65 r ±27.5	864.64 h ±27.6	865.55 m ±27.9	1053 h ±37.3	1053 a ±13.1	4361.85 k ±117.9
		O	0	153.51 o ±21.5	323.96 tu ±21.8	797.25 n ±22	828.83 o ±23.8	1179.75 c ±31.5	965.25 d ±21.6	4248.55 m ±113.8
			1	186.66 k ±26.4	558.69 b ±26.8	874.17 g ±27.4	924 h ±28.1	1179.75 c ±36.4	858 i ±16	4581.27 e ±118.1

Means values in the same column having different superscripts are significantly different at P≤0.05.
Means values in the same column having the same superscripts are not significantly different at P≤0.05.

Table 5 : Effect of broiler breeder ages, egg storage periods, egg storage types and sumac powder on weekly feed conversion ratio (Mean ± SEM).

Main factors	FCR						
	1st week	2nd week	3rd week	4th week	5th week	6th week	At all 42 days
Breeder age (week)							
35	2.46 a ±0.01	2.37 a ±1.54	1.99 a ±0.02	1.49 b ±0.03	1.99 a ±0.04	2.00 a ±0.55	1.86 a ±1.02
50	2.44 a ±0.03	2.32 a ±2.37	1.89 b ±0.03	1.66 a ±0.04	2.01 a ±0.03	1.99 a ±0.19	1.90 a ±0.91
Storage period(day)							
2	2.55 a ±0.01	2.36 a ±1.47	1.95 a ±0.03	1.55 a ±0.04	2.04 a ±0.03	1.92 b ±0.35	1.89 a ±1.21
6	2.35 b ±0.02	2.33 a ±0.41	1.92 a ±0.01	1.60 a ±0.01	1.96 a ±0.18	2.07 a ±0.34	1.88 a ±1.16
Storage type							
C	2.39 b ±0.01	2.20 b ±1.73	2.04 a ±0.01	1.52 a ±0.04	2.13 a ±0.11	1.93 b ±0.46	1.90 a ±0.59
H	2.51 a ±0.01	2.41 a ±2.17	1.92 b ±0.04	1.58 a ±0.06	2.08 a ±0.02	2.06 a ±0.31	1.92 a ±1.02
O	2.45 ab ±0.03	2.42 a ±0.16	1.85 b ±0.06	1.62 a ±0.01	1.79 b ±0.18	1.99 ab ±0.53	1.83 a ±0.51
Sumac powder (%)							
0	2.45 a ±0.01	2.25 b ±1.24	1.84 b ±0.04	1.60 a ±0.08	1.98 a ±0.07	2.02 a ±0.33	1.85 a ±2.27
1	2.45 a ±0.02	2.44 a ±1.89	2.04 a ±0.01	1.55 a ±0.02	2.02 a ±0.14	1.97 a ±0.18	1.91 a ±0.86

Means values in the same column having different superscripts are significantly different at P≤0.05.
Means values in the same column having the same superscripts are not significantly different at P≤0.05.

Table 5 (Continued) : Effect of interactions between broiler breeder ages, egg storage periods (Sp), egg storage types (St) and sumac powder (Su) on weekly feed conversion ratio (Mean ± SEM).

Interactions				FCR						
Age	Sp	St	Su	1st week	2nd week	3rd week	4th week	5th week	6th week	At all 42 days
35	2	C	0	2.03 fg ±0.03	2.13 de ±0.14	2.15 ab ±0.44	1.56 cd ±0.12	1.74 ef ±1.73	1.92 efg ±0.25	1.84 abc ±0.98
			1	2.19 efg ±0.02	2.54 abc ±1.03	2.14 ab ±0.01	1.53 cd ±0.07	2.35 bc ±0.12	1.62 ghi ±0.464	1.95 abc ±0.65
		H	0	2.72 abc ±0.10	2.55 abc ±0.99	1.73 cd ±0.45	1.40 d ±0.01	2.18 cd ±0.22	1.78 fghi ±0.109	1.84 abc ±1.12
			1	2.71 abc ±0.02	2.14 de ±0.98	1.46 de ±0.06	1.49 cd ±0.06	1.71 ef ±0.13	2.66 a ±0.471	1.79 abc ±0.14
		O	0	2.99 a ±0.02	2.71 ab ±0.21	2.06 ab ±0.17	1.38 d ±0.16	2.33 bc ±0.69	2.19 cde ±0.103	2.02 ab ±0.76
			1	2.56 bcd ±0.01	2.48 bcd ±1.73	2.36 a ±0.01	1.52 cd ±0.23	1.53 efg ±0.11	1.60 ghi ±0.456	1.79 abc ±0.59
	6	C	0	2.31 defg ±0.03	1.42 g ±1.89	2.10 ab ±0.01	1.45 cd ±0.03	1.55 efg ±0.14	2.67 a ±0.179	1.76 bc ±0.86
			1	2.99 a ±0.02	2.86 a ±2.37	1.93 bc ±0.03	1.42 d ±0.04	2.26 bc ±0.03	1.51 i ±0.187	1.87 abc ±0.91
		H	0	2.54 bcde ±0.01	2.26 cd ±1.47	2.08 ab ±0.03	1.53 cd ±0.04	2.38 abc ±0.03	1.79 fghi ±0.352	1.98 abc ±1.21
			1	2.11 fg ±0.01	2.59 abc ±1.37	2.21 ab ±0.12	1.39 d ±0.01	2.16 cd ±0.28	1.63 ghi ±0.067	1.86 abc ±1.15
		O	0	2.17 fg ±0.01	2.45 bcd ±0.19	1.5 de ±0.14	1.82 bc ±0.41	1.27 g ±0.18	2.58 ab ±0.131	1.7 bc ±0.45
			1	2.22 efg ±0.01	2.32 cd ±0.21	2.11 ab ±0.03	1.37 d ±0.08	2.42 abc ±0.09	2.08 cdef ±0.651	1.97 abc ±0.49
50	2	C	0	2.20 efg ±0.02	1.55 fg ±2.17	2.11 ab ±0.04	1.51 cd ±0.06	2.58 ab ±0.02	1.88 efgh ±0.306	1.96 abc ±1.02
			1	2.20 efg ±0.04	1.80 f ±1.24	2.16 ab ±0.21	1.58 cd ±0.08	1.54 efg ±0.07	2.19 cde ±0.33	1.81 abc ±2.27
		H	0	2.80 ab ±0.03	2.87 a ±0.41	1.21 e ±0.01	2.10 ab ±0.01	2.48 abc ±0.18	2.03 def ±0.344	1.99 abc ±1.16
			1	2.95 a ±0.01	2.77 ab ±1.15	2.23 ab ±0.02	1.59 cd ±1.47	2.71 a ±0.04	1.87 efghi ±0.373	2.16 a ±1.38
		O	0	2.56 bcd ±0.01	2.26 cd ±1.06	1.70 cd ±0.38	1.57 cd ±0.1	1.47 fg ±0.03	1.53 hi ±0.308	1.64 c ±2.12
			1	2.70 abc ±0.01	2.52 abc ±1.01	2.13 ab ±0.02	1.40 d ±1.54	1.87 de ±0.07	1.76 fghi ±0.289	1.85 abc ±0.69
	6	C	0	2.99 a ±0.03	2.75 ab ±0.97	1.55 de ±0.46	1.59 cd ±0.13	2.46 abc ±1.89	1.86 efghi ±0.187	1.95 abc ±1.83
			1	2.22 efg ±0.01	2.58 abc ±0.96	2.18 ab ±0.26	1.54 cd ±0.01	2.54 ab ±0.12	1.80 fghi ±0.536	2.05 ab ±0.66
		H	0	2.07 fg ±0.02	2.25 cd ±0.06	2.33 a ±0.03	1.47 cd ±1.24	1.43 fg ±0.18	2.40 abc ±0.196	1.84 abc ±0.55
			1	2.19 efg ±0.02	1.85 ef ±1.31	2.12 ab ±0.01	1.67 cd ±0.03	1.57 efg ±0.13	2.31 bcd ±0.982	1.88 abc ±0.72
		O	0	2.00 g ±0.01	1.75 f ±1.54	1.52 de ±0.02	1.80 bc ±0.03	1.86 de ±0.04	1.64 ghi ±0.546	1.72 bc ±1.02
			1	2.38 cdef ±0.03	2.88 a ±0.16	1.45 de ±0.06	2.14 a ±0.01	1.59 efg ±0.18	2.57 ab ±0.53	1.92 abc ±0.51

Means values in the same column having different superscripts are significantly different at P≤0.05.
Means values in the same column having the same superscripts are not significantly different at P≤0.05.

Table 6 : Effect of broiler breeder ages, egg storage periods, egg storage types and sumac powder on mortality percentage and production index at the end of the study (Mean ± SEM).

Main factors	Mortality %	PI
Breeder age (week)		
35	3.37 a ±0.07	288.61 b ±8.1
50	2.36 b ±0.2	295.42 a ±9.4
Storage period (day)		
2	2.95 a ±0.45	294.14 a ±6.2
6	2.79 b ±0.34	289.89 b ±11.7
Storage type		
C	1.98 c ±0.1	297.60 a ±8.8
H	3.69 a ±0.28	276.03 b ±9.7
O	2.94 b ±0.12	303.41 a ±11.4
Sumac powder (%)		
0	3.23 a ±0.38	289.00 b ±4.6
1	2.51 b ±0.33	295.02 a ±14.6

Means values in the same column having different superscripts are significantly different at P≤0.05.
Means values in the same column having the same superscripts are not significantly different at P≤0.05.

Table 6 (Continued) : Effect of interactions between broiler breeder ages, egg storage periods (Sp), egg storage types (St) and sumac powder (Su) on mortality percentage and production index at the end of the study (Mean ± SEM).

Interactions				Mortality %		PI	
Age	Sp	St	Su				
35	2	C	0	2.80 fgh	±0.18	290.00 h	±14.9
			1	0.00 j	±0	318.69 c	±9.7
		H	0	4.27 c	±0.32	309.22 e	±2.2
			1	0.00 j	±0	285.32 i	±8.9
		O	0	5.56 a	±0.06	305.53 f	±8.8
			1	4.11 c	±0.1	251.59 m	±8.9
	6	C	0	2.50 h	±0.33	301.09 g	±9.4
			1	2.78 fgh	±0.2	314.63 d	±4.6
		H	0	4.84 b	±0.45	271.22 kl	±10.6
			1	5.56 a	±0.26	245.18 n	±6.2
		O	0	5.28 a	±0.28	253.99 m	±14.1
			1	2.78 fgh	±0.33	316.85 cd	±16.5
50	2	C	0	1.78 i	±0.28	324.57 b	±14.6
			1	2.68 gh	±0.38	280.06 j	±9.7
		H	0	2.78 fgh	±0.34	240.85 o	±12.5
			1	5.56 a	±0.27	268.19 l	±11.7
		O	0	2.78 fgh	±0.06	313.85 d	±4.2
			1	3.03 ef	±0.14	341.78 a	±8.5
	6	C	0	3.28 e	±0.71	271.81 k	±20.2
			1	0.00 j	±0	271.93 k	±8.5
		H	0	2.84 fg	±0.39	287.13 hi	±21.2
			1	3.64 d	±0.29	301.15 g	±9.5
		O	0	0.00 j	±0	298.77 g	±11.4
			1	0.00 j	±0	344.89 a	±8.1

Means values in the same column having different superscripts are significantly different at P≤0.05.
Means values in the same column having the same superscripts are not significantly different at P≤0.05.

Table 7 : Effect of broiler breeder ages, egg storage periods, egg storage types and sumac powder on carcass weight (g) and dressing percentage (Mean ± SEM).

Main factors	Carcass weight (g)	Dressing percentage
Breeder age (week)		
35	1667.136 b ±33.33	71.371 a ±0.92
50	1723.515 a ±47.14	71.802 a ±0.50
Storage period (day)		
2	1718.171 a ±57.74	71.804 a ±0.06
6	1672.480 b ±44.44	71.368 a ±0.72
Storage type		
C	1741.106 a ±24.31	72.135 a ±0.79
H	1637.235 c ±26.52	71.086 a ±0.85
O	1707.636 b ±49.30	71.538 a ±0.89
Sumac powder (%)		
0	1689.084 b ±51.49	71.440 a ±0.72
1	1701.568 a ±48.61	71.733 a ±1.00

Means values in the same column having different superscripts are significantly different at P≤0.05.
Means values in the same column having the same superscripts are not significantly different at P≤0.05.

Table 7 (Continued) : Effect of interactions between broiler breeder ages, egg storage periods (Sp), egg storage types (St) and sumac powder (Su) on carcass weight (g) and dressing percentage (Mean ± SEM).

Interactions				Carcass weight (g)	Dressing percentage
Age	Sp	St	Su		
35	2	C	0	1810.432 c ±22.22	71.230 a ±0.07
			1	1701.201 j ±24.24	71.440 a ±0.85
		H	0	1665.231 n ±47.14	72.010 a ±0.93
			1	1663.898 n ±49.24	71.310 a ±0.92
		O	0	1613.189 p ±47.64	71.170 a ±0.97
			1	1726.435 g ±20.26	72.060 a ±0.79
	6	C	0	1714.456 i ±65.96	71.560 a ±1.00
			1	1760.363 e ±34.35	72.220 a ±0.06
		H	0	1507.890 s ±51.10	70.080 a ±0.64
			1	1594.911 q ±35.46	70.990 a ±0.70
		O	0	1701.279 j ±52.79	71.010 a ±0.80
			1	1546.352 r ±33.51	71.370 a ±0.83
50	2	C	0	1715.719 i ±36.83	72.880 a ±0.69
			1	1845.367 a ±57.50	72.550 a ±1.00
		H	0	1652.281 o ±63.18	71.450 a ±0.04
			1	1652.837 o ±39.15	71.330 a ±0.22
		O	0	1744.365 f ±56.50	71.740 a ±0.45
			1	1827.098 b ±35.11	72.480 a ±0.39
	6	C	0	1684.194 l ±56.37	72.830 a ±0.42
			1	1697.120 k ±61.49	72.370 a ±0.62
		H	0	1679.716 m ±23.74	70.110 a ±0.65
			1	1681.113 lm ±24.80	71.410 a ±0.56
		O	0	1780.250 d ±20.63	71.210 a ±0.50
			1	1722.119 h ±22.50	71.260 a ±0.25

Means values in the same column having different superscripts are significantly different at P≤0.05.
Means values in the same column having the same superscripts are not significantly different at P≤0.05.

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