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The effect on fattening performance and carcass characteristics of adding artichoke vinegar to the drinking water of broiler chickens

[*O efeito no desempenho de engorda e nas características de carcaça da adição de vinagre de alcachofra à água de bebida de frangos de corte*]

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ABSTRACTS

This study was carried out to investigate the effects of adding artichoke vinegar to the drinking water of broilers on their fattening performance and carcass characteristics. In the experiment, 204-day old broiler chickens were used, and the study was continued for 42 days. In the study, 4 different groups were formed, one of which was the control group, and the other 3 were different doses of vinegar (0.5%, 1.0 and 1.5). The experiment was carried out in 3 replications and 17 birds were included in each replication. During the fattening period, the live weight, feed consumption, vinegar water consumption and slaughter weight of the chickens were measured. After slaughter, characteristics such as hot carcass weight, hot carcass yield, internal organ weights and abdominal fat weights were determined. According to the results obtained, in the 0-6 weeks period, the daily average live weight gain, daily average feed intake, total feed intake, feed conversion ratio, average daily water intake and total water intake of the broilers were significantly higher than the values obtained in the treatments with vinegar ($P<0.05$, $P<0.01$). It was determined that the groups showed significant differences in terms of traits such as abdominal fat weight and percentage, liver weight, heart weight and percentage, and kidney weight and percentage. As a result, it can be said that the artichoke vinegar added to the drinking water of broilers has significant effects on some performance characteristics and has the best effect when used at 1.5% level.

Keywords: artichoke vinegar, broiler, carcass characteristics, fattening performance

RESUMO

Este estudo foi realizado para investigar os efeitos da adição de vinagre de alcachofra à água de bebida de frangos de corte no desempenho de engorda e nas características de carcaça. No experimento, foram utilizados frangos de corte com 204 dias de idade, e o estudo foi continuado por 42 dias. No estudo, foram formados quatro grupos diferentes, um dos quais era o grupo controle e os outros três eram diferentes doses de vinagre (0,5%, 1,0% e 1,5%). O experimento foi realizado em três repetições e 17 aves foram incluídas em cada repetição. Durante o período de engorda, foram medidos o peso vivo, o consumo de ração, o consumo de água com vinagre e o peso de abate dos frangos. Após o abate, foram determinadas características como peso de carcaça quente, rendimento de carcaça quente, peso de órgãos internos e peso de gordura abdominal. De acordo com os resultados obtidos, no período de 0-6 semanas, o ganho médio diário de peso vivo, o consumo médio diário de ração, o consumo total de ração, a conversão alimentar, o consumo médio diário de água e o consumo total de água dos frangos de corte foram significativamente maiores do que os valores observados nos tratamentos com a aplicação de vinagre ($P<0,05$, $P<0,01$). Foi determinado que os grupos apresentaram diferenças significativas em termos de características como peso e porcentagem de gordura abdominal, peso do fígado, peso e porcentagem do coração e peso e porcentagem dos rins. Como resultado, pode-se dizer que o vinagre de alcachofra adicionado à água de bebida dos frangos de corte tem efeitos significativos sobre algumas características de desempenho e apresenta melhor efeito quando utilizado no nível de 1,5%.

Palavras-chave: vinagre de alcachofra, frango de corte, características de carcaça, desempenho de engorda

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INTRODUCTION

Vinegar is a natural product obtained from the fermentation of fruits and vegetables, and it contains acetic acid, an organic acid of 3-9%, as the main component in its structure (Naziroğlu *et al*., 2014). The main volatile compound in vinegar is acetic acid, which gives vinegar its strong, sour flavor and flavor. Other volatile compounds found in vinegar are mainly alcohols, acids, esters, aldehydes, and ketones (Ho *et al*., 2017). It has been reported that when vinegar is consumed regularly, it has some beneficial effects in terms of digestion, stimulating appetite, antioxidant properties, lowering lipid content and regulating blood pressure (Chou *et al*., 2015). These benefits are due to the various polyphenols, micronutrients and other bioactive compounds found in vinegar that contribute to its pharmacological effects, such as antimicrobial, antidiabetic, antioxidant, anti-obesity and antihypertensive effects. Vinegar is a beverage that, among other benefits, has antidiabetic effects and helps lower blood cholesterol levels by inhibiting the oxidation of low-density lipoproteins (Laranjinha *et al*., 1994, Salbe *et al*., 2009). In addition, it has an effective and significant effect on eliminating harmful bacteria and toxins (Romano *et al*., 2015; Tarraf *et al*., 2015). Vinegar reduces the number of harmful bacteria in the digestive system and causes the breakdown of phosphorus, amino acids, and fats in the intestines. This leads to a decrease in blood lipids (Beheshti *et al*., 2012), strengthening of immunity (Pourmozaffar *et al*., 2017) and an increase in the efficiency of digestion. It has been reported that vinegar can be used to show antibacterial effect in the digestive systems of animals and to stimulate growth due to the organic acids it contains (Song *et al*., 2012). It has been reported that when vinegar is added to the drinking water of poultry, it is effective in the digestion of nutrients, provides significant benefits to the intestinal micro-flora and is effective against pathogenic bacteria. Griggs and Jacob (2005) explained that adding vinegar to the drinking water of broiler chickens raised under organic conditions can be effective in reducing the bacterial load they are exposed to and preventing the spread of bacteria in the flock. Lilly *et al*. (2011) reported that the addition of 0.5% apple cider vinegar to drinking water in organic broiler production did not significantly affect their body weight, feed consumption, body weight gain and feed conversion rates at 49 days. In a study investigating the effects of citric acid, acetic acid and their combinations added to the drinking water of broilers at different rates, it was determined that 0.5% citric acid used in the drinking water gave better results in terms of live weight gain and feed efficiency, while carcass characteristics were not affected (Khandaker *et al*., 2008). Kopecky *et al*. (2012) stated that 0.25% of acetic acid added to the drinking water in broiler production did not have an effect on live weight and carcass characteristics at the end of the 42-day fattening period but had a positive effect on mortality. Kim (2007) reported that the addition of 1% wood vinegar to the diet of broilers resulted in an improvement in body weight gain and a decrease in the crude fat content of meat. Rattanawut *et al*. (2012) reported that the addition of 0.3% vinegar to the diet of broiler chickens caused a tendency to increase in body weight gain and promoted growth. Rattanawut and Yamauchi (2015) reported that adding 0.3% bamboo vinegar to the diets of broilers positively affects body weight gain. Tasharofi *et al*. (2017) reported that adding palm vinegar to the diets of broiler chickens at 1%, 2 and 3 had a positive effect on growth performance. Allahdo *et al*. (2018) reported that adding 1%, 2 and 5 vinegar to broiler water had beneficial effects on performance, immunity and gut health, and that vinegar caused a decrease in the amount of abdominal fat. Hayajneh *et al*. (2018) reported that adding apple cider vinegar to broiler diets improved antioxidant status and immunity, lowered blood MDA concentration, and improved coccidiosis. Mohanad and Saleem (2018) reported that the addition of apple cider vinegar at 1ml/L level to drinking water caused an improvement in body weight gain and feed efficiency in broilers. Sedghi and Akbari Moghaddam Kakhki (2018) reported that with dietary supplementation consisting of 0.2% malt extract + 0.4% malt vinegar mixture for broilers, an increase in average daily live weight gain and carcass yield, and an improvement in feed efficiency were observed. Ruangwittayanusorn *et al*. (2018) reported that the addition of 0.5%, 1 and 1.5 wood vinegar to the diet did not have a negative effect on the growth performance of broiler chickens. Al-Noori (2014) explained that vinegar added to the drinking water of broiler chickens with 5ml/L provides significant improvements in body weight, total weight gain and feed efficiency, and significant reductions in

mortality. Hanchai *et al*. (2021) reported that the addition of 1% wood vinegar to the drinking water of broilers had no effect on growth performance and intestinal microbial.

This study was aimed to investigate the effects of artichoke vinegar added to the drinking water of broilers at different rates on their fattening performance and carcass characteristics.

MATERIAL AND METHOD

In this study, 204 Ross 308 broiler chickens at daily age were used as animal material. All birds used in the experiment were cared for according to the European Union directive on animal welfare for scientific purposes (Directive…, 2010). The experiment was carried out in a windowed house belonging to Bursa Uludağ University Agricultural Research and Application Center and continued for 6 weeks. Birds were housed in the floor compartments (12 birds per m^2) during the experiment and the animals were randomly distributed in the compartments. Birds were raised in a litter system and wood shavings were used as litter material. In the experiment, which was designed as four groups and with 3 replications, 51 birds were included in each group and 17 birds were included in the replications. During the experiment, vinegar was not added to the water of the control group, and 0.5%, 1.0 and 1.5% artichoke vinegar was added to the drinking water of the treatment groups. The artichoke vinegar used in the experiment was obtained from a commercial company. Vinegar water was prepared weekly in 40 lt drums. The vinegar water intake of the birds was determined on a weekly basis. At the end of the week, the remaining vinegar water supplied was weighed and renewed. The addition of vinegar to the waters of the animals started in the 1st week and continued until the end of the experiment. The feed and water need of the birds were provided *ad libitum*. Concentrated feeds (starter, grower, developer, finisher feeds) used in the experiment were obtained from a commercial company. Raw nutrient analyzes of the feeds were carried out in the animal nutrition laboratory of Bursa Uludağ University Faculty of Agriculture, Department of Animal Science, using the methods reported by AOAC (Official…, 1997). The results regarding the nutrient content of the analyzed feeds are given in Table 1.

Table 1. Nutrient content of concentrated feeds used in the experiment

	Diets			
Nutrients	Starter 0-11 days	Grower 12-21 days	Developer 22-35 days	Finisher 36-42 days
Moisture, %	12.18	11.80	12.40	12.12
Crude cellulose, %	2.54	3.30	3.80	3.46
Crude oil, %	5.01	7.67	7.97	8.25
Crude ash, %	4.90	4.90	4.32	4.48
Ca, %	1.05	0.90	0.77	0.66
P, %	0.73	0.70	0.65	0.63
Na, %	0.19	0.17	0.15	0.16
Lysine, %	1.53	1.27	1.10	1.26
Methionine, %	0.66	0.75	0.67	0.53
Crude protein ,%	23.47	20.79	19.93	20.25
ME, kcal/kg	2975	3125	3270	3150

ME: Metabolic Energy

During the growing period, the chicks were warmed to 30-33 °C in the first week, 27-30°C in the second week and 24-27°C in the third week. Heating was not applied from the 4th week of the experiment due to the suitable temperature in the coop. The coop is ventilated with fans. The experiment was carried out in the period of May-June, during this period the average indoor average temperature was calculated to be 28°C, and the relative humidity was 52%.

The live weights of the birds were determined by weighing each week individually. Feed intake, on the other hand, was determined at the group level and on a weekly basis. At the end of the experiment, 6 male and female (2 from each replicate) chickens from each group and a total of 48 chickens were slaughtered to determine the carcass characteristics. Slaughter weight, hot carcass weight, carcass percentage, internal organ (liver, heart, gizzard, and kidney) weights

and abdominal fat weight of chickens were determined. The obtained data were analyzed with One-Way analysis of variance using SPSS 21.0 program and Duncan test was used to compare the means ($Yij = \mu + \alpha i + \varepsilon ij$).

RESULTS

The effects of adding different levels of artichoke vinegar to the drinking water of broilers on their performance characteristics are shown in Table 2. The effect of vinegar doses on the body weight of broilers was not significant in the 0-3 week period. Addition of vinegar to drinking water had a statistically significant (P<0.01) effect on live weights at 4th and 5th weeks. At week 4, the treatment groups had higher body weights than the control group. The highest body weight value was observed in the group that added 1.5% vinegar, followed by 1.0% and 0.5% added groups, respectively. In the 5th week, 1.5% and 1.0% vinegar added groups had higher body weights, while the control group had the lowest value. It was observed that the addition of vinegar to the drinking water had an effect (P<0.01) on the live weights of the chickens at the 5th week. The differences between the control and treatment groups in terms of body weight at 6 weeks were insignificant. It can be said that the addition of vinegar to the drinking water has no effect on the 6-week-old fattening live weight of broiler chickens.

Table 2. Effects values on some performance characteristics and vinegar water intake of artichoke vinegar added to drinking water in broiler chickens

Characteristics	Vinegar levels (%)				P
	0	0.5	1.0	1.5	
Body weights, g					
3 wk	758.5±10.4	776.4±12.0	789.0±9.5	785.2±6.7	NS
4 wk	1025.6±10.5^{c}	1093.5±42.8^{bc}	1190.9±16.3^{b}	1331.3±16.6^{a}	**
5 wk	1817.6±27.4^{b}	1907.8±31.7^{ab}	1997.4±13.9^{a}	1988.2±11.3^{a}	**
6 wk	2402.5±81.0	2476.6±28.8	2588.1±52.0	2603.4±36.7	NS
Live weight gains, g					
0-3 wk	236.0±3.5	242.0±2.3	246.1±3.2	244.9±2.3	NS
4-6 wk	561.8±3.7^{b}	575.5±4.4^{b}	599.7±3.4^{a}	603.9±4.1^{a}	**
0-6 wk	2352.2±81.0	2426.2±28.7	2537.3±52.4	2552.9±36.9	NS
Daily gain, g					
0-3 wk	33.71±0.50	34.57±0.32	35.15±0.45	34.99±0.33	NS
4-6 wk	80.26±0.53^{b}	82.21±0.63^{ab}	85.12±0.78^{a}	85.82±0.95^{a}	**
0-6 wk	336.0±7.6^{b}	346.6±4.1^{ab}	362.46±7.5^{a}	364.7±5.3^{a}	*
Daily feed intake, g					
0-3 wk	47.16±0.08	48.58±1.10	46.60±0.66	48.31±0.73	NS
4-6 wk	128.89±0.91^{b}	136.63±0.93^{a}	129.52±0.89^{b}	139.27±0.16^{a}	**
0-6 wk	88.25±0.71^{b}	92.60±0.89^{a}	88.06±0.87^{b}	93.78±0.45^{a}	**
Feed intake, g					
0-3 wk	990.3±1.6	1019.8±11.5	981.9±10.4	1014.43±15.4	NS
4-6 wk	2706.8±19.1^{b}	2869.4±19.5^{a}	2720.0±8.8^{b}	2924.5±3.7^{a}	**
0-6 wk	3706.6±29.7^{b}	3889.2±37.3^{a}	3698.57±36.4^{b}	3938.9±18.9^{a}	**
Feed conversion, g:g					
0-3 wk	1.46±0.01^{a}	1.46±0.02^{a}	1.36±0.01^{b}	1.46±0.02^{a}	**
4-6 wk	1.80±0.01^{b}	1.86±0.00^{a}	1.61±0.01^{c}	1.62±0.00^{c}	**
0-6 wk	1.58±0.02^{a}	1.60±0.00^{a}	1.46±0.02^{b}	1.54±0.02^{a}	**
Daily water intake, lt					
0-3 wk	0.48±0.01^{b}	0.49±0.01^{b}	0.49±0.00^{b}	0.52±0.01^{a}	*
4-6 wk	0.76±0.01^{b}	0.81±0.02^{b}	0.80±0.00^{b}	0.87±0.01^{a}	**
0-6 wk	1.24±0.02^{b}	1.30±0.01^{b}	1.29±0.00^{b}	1.40±0.03^{a}	**
Water intake, lt					
0-3 wk	3.33±0.05^{b}	3.46±0.06^{b}	3.40±0.02^{b}	3.65±0.07^{a}	*
4-6 wk	5.33±0.09^{b}	5.66±0.12^{b}	5.63±0.02^{b}	6.13±0.08^{a}	**
0-6 wk	8.65±0.09^{c}	9.38±0.25^{ab}	9.04±0.03^{bc}	9.77±0.10^{a}	**

^{a,b,c}: Differences between means with different letters in the same row are significant. *: P≤0.05, **: P≤0.01, NS: Non-significant.

Live weight gains of broilers did not show significant differences in the 0-3 week period. It was determined that the live weight gains of the experimental groups in the first three weeks were not affected by the application of vinegar.

In the 4-6 weeks period, the live weight gains of the birds showed significant ($P<0.01$) differences. Addition of 1.0% and 1.5% vinegar to drinking water significantly increased the live weight gains in this period. The group with the lowest weight gain was determined as the control group. When the whole experiment is evaluated (0-6 weeks), it is observed that the broilers of the control and treatment groups have a similar level of live weight gain. When the daily live weight gain averages of the experimental groups are examined, there are insignificant differences in the 0-3 weeks period and significant ($P<0.05$, $P<0.01$) differences in the 4-6 and 0-6 week period. During these periods, chickens in the control group showed lower average daily gain increase compared to the treatment groups. When the whole treatment is evaluated (0-6 weeks), it can be said that adding vinegar to drinking water is effective on daily live weight gain.

While the results regarding the daily feed intake of the groups were similar for the 0-3 week period, they showed significant differences in the 4-6 and 0-6 week periods. In the 4-6 and 0-6 week periods, the groups that added 1.5% and 0.5% vinegar to the drinking water had higher daily feed intake than the control group and the other group ($P<0.01$). It can be said that vinegar application significantly affects the daily feed intake of broilers. In terms of total feed consumption, vinegar application, which was not effective in the first three weeks, was effective in the last two periods (4-6 and 0-6 weeks) ($P<0.01$). The highest values in terms of the amount of feed consumed in the 4-6 and 0-6 week periods were obtained from the groups using 1.5% and 0.5% vinegar. It can be said that the feed intake of broiler chickens is significantly affected by artichoke vinegar.

The differences between the averages of the feed conversion ratios of the groups were significant ($P<0.01$). In the 0-3 week period, the group that added 1.0% vinegar showed better feed conversion than the other groups. In the 4-6 week period, the group applied 0.5% vinegar had the worst feed conversion. When the entire 0-6 week fattening period is evaluated, it can be said that feed efficiency is better in the group given 1.0% vinegar.

The vinegar water consumption of the birds was measured, and the daily average water intake was found to be higher in the 1.5% group in the 0-3, 4-6 and 0-6 week periods ($P<0.05$, $P<0.01$). The differences between the control group and the other groups were not significant. During the fattening period, it was determined that the consumption of vinegar water increased due to the increase in the dose of vinegar applied. In terms of total vinegar water consumed, significant ($P<0.05$, $P<0.01$) differences were detected for all three periods studied. It was determined that the highest level of vinegar addition caused the highest water intake. The results regarding the carcass characteristics, internal organ weights and their percentages of the control and treatment groups are given in Table 3.

No significant differences were observed between the groups in terms of slaughter weight from the carcass characteristics examined. It can be said that vinegar applications are not effective on slaughter weight. Although the cutting weights of the treatment groups were found to be higher numerically, it was not statistically significant. In terms of hot carcass weight and carcass percentage, the results were similar and the differences between the averages were not significant.

The addition of vinegar to the drinking water significantly ($P<0.01$) affected the abdominal fat weight of the experimental groups, and higher values were obtained in the groups that received 1.0% and 1.5% vinegar water. The group with the lowest abdominal fat weight was the control group. When the abdominal fat percentage was examined, similar results were observed and the differences between the group averages were found to be significant ($P<0.01$). In terms of this feature, the highest value was obtained from the group that added 1% vinegar to their water.

Table 3. Average values of carcass characteristics and internal weights of broiler chickens with different levels of artichoke vinegar added to drinking water

Carcass traits	Vinegar levels (%)				P
	0	0.5	1.0	1.5	
Slaughter weight, g	2580.4±59.1	2687.9±94.7	2658.8±84.8	2657.9±45.5	NS
Hot carcass weight, g	1794.7±41.7	1878.9±61.7	1864.8±59.9	1850.4±32.0	NS
Hot carcass percentage, %	69.56±0.20	69.97±0.24	70.13±0.22	69.62±0.15	NS
Abdominal fat weight, g	14.31±0.37^{b}	15.52±0.90^{b}	17.30±1.01^{ab}	19.83±1.52^{a}	**
Abdominal fat percentage, %	0.80±0.02^{b}	0.84±0.05^{b}	0.93±0.05^{ab}	1.07±0.08^{a}	**
Liver weight, g	42.29±1.53^{b}	52.98±2.53^{a}	48.56±2.00^{ab}	46.94±2.24^{ab}	**
Liver percentage, %	2.37±0.11	2.83±0.12	2.63±0.13	2.55±0.13	NS
Gizzard weight, g	31.39±1.11	33.81±1.87	31.62±1.46	34.82±1.52	NS
Gizzard percentage, g	1.76±0.07	1.80±0.07	1.71±0.10	1.89±0.09	NS
Heart weight, g	11.58±0.18^{b}	15.65±0.47^{a}	12.52±0.23^{b}	14.41±0.69^{a}	**
Heart percentage, g	0.65±0.02^{c}	0.84±0.03^{a}	0.68±0.03^{bc}	0.78±0.03^{ab}	**
Kidney weight, g	2.02±0.13^{b}	2.76±0.08^{a}	2.25±0.13^{b}	2.42±0.15^{ab}	**
Kidney percentage, %	0.11±0.01^{b}	0.15±0.01^{a}	0.12±0.01^{ab}	0.13±0.01^{ab}	**

^{a,b}: Differences between means with different letters in the same row are significant. **: P≤0.01, NS: Non-significant.

The results regarding the liver weights of the experimental groups showed significant (P<0.01) differences. The control group had a lower value in terms of liver weight compared to the other groups. However, the liver percentage did not show significant differences between the groups. The addition of artichoke vinegar to the drinking water of the chickens had no effect on the gizzard weight and gizzard percentage. It can be said that gizzard weight and gizzard percentages are not affected by vinegar application. The heart weight and heart percentage values of the experimental groups showed significant differences, and the differences between the obtained averages were significant (P<0.01). In terms of these characteristics, the treatment groups had higher values than the control group. Kidney weight and kidney percentage were significantly affected (P<0.01) in chickens that consumed different levels of vinegar with drinking water. In terms of these characteristics, the control group showed lower values compared to the other groups.

DİSCUSSİON

In this study, which was carried out to investigate the effect of adding 0.5%, 1.0 and 1.5 artichoke vinegar to the drinking water of broiler chickens, on the fattening performance and some carcass characteristics, some important results were obtained. Research findings support the approaches of some researchers that vinegar reduces the number of pathogenic bacteria in the digestive systems of animals, making digestion more efficient and stimulating growth (Beheshti *et al*., 2012; Pourmozaffar *et al*., 2017; Song *et al*., 2012). Griggs and Jacob (2005) explained that adding vinegar to the drinking water of broiler chickens raised under organic conditions can be effective in reducing the bacterial load they are exposed to and preventing the spread of bacteria in the flock. Hayajneh *et al*., (2018) reported that adding apple cider vinegar to broiler diets improved antioxidant status and immunity.

In this study, it was observed that the vinegar application significantly increased the live weights of the chickens in the 4th and 5th weeks during the 6-week fattening period. Although the differences between the body weight values of the groups disappeared in the 6th week, it can be said that the vinegar application had a positive effect on the body weights. Different findings have been obtained in studies on adding vinegar to drinking water in broilers. Tasharofi *et al*. (2017) reported that adding palm vinegar to the diets of broiler chickens had a positive effect on growth performance. Al-Noori (2014) explained that vinegar added to the drinking water of broilers causes a significant increase in live weights. On the other hand, Ruangwittayanusorn *et al*. (2018) reported that the addition of 0.5%, 1 and 1.5% wood vinegar to the diet did not have a negative effect on the growth performance of broiler chickens. Kopecky *et al*. (2012) reported that acetic acid added to drinking water in broiler production had no effect on live weight. Hanchai *et al*. (2021) reported that the addition of wood vinegar to the drinking water of broilers had no effect on growth performance. Lilly *et al*. (2011)

reported that the addition of apple cider vinegar to the drinking water of broiler chickens grown under organic conditions did not significantly affect body weights.

In the experiment, the effects of vinegar application on body weight gain of broilers were significant (P<0.01) in the 4-6 week period, while it was insignificant in the other periods. In terms of daily average live weight gain, significant improvements were observed in the 4-6 and 0-6 week periods. It was determined that the treatment groups generally performed better than the control group in terms of body weight gain. It has been determined that the use of vinegar has significant and positive effects, especially on the daily average body weight gain of broilers. The findings reported by different researchers in studies on this subject are generally consistent with these results.

Khandaker *et al*. (2008) reported that citric acid added to the drinking water of broiler chickens gave better results in terms of live weight gain. Similarly, Kim (2007) reported that the addition of wood vinegar to the diet of broilers resulted in improvement in body weight gain. Rattanawut *et al*. (2012) and Rattanawut and Yamauchi (2015), on the other hand, reported that the addition of bamboo vinegar to the diets of broilers resulted in an improvement in body weight gain. Mohanad and Saleem (2018) reported that the addition of apple cider vinegar to drinking water caused an improvement in body weight gain in broilers. Sedghi and Akbari Moghaddam Kakhki (2018) reported that broilers showed an improvement in average daily body weight gain with a dietary supplement containing malt vinegar. Al-Noori (2014) explained that the addition of vinegar to the drinking water of broilers provides significant improvements in total weight gain. Contrary to these results, Lilly *et al*. (2011) reported that the addition of apple cider vinegar to drinking water did not significantly affect body weight gain in broilers.

In the study, different results were obtained from different experimental groups in terms of total feed intake and daily average feed intake. The addition of artichoke vinegar to drinking water caused significant increases in feed intake of broilers (0-6 weeks). The treatment groups generally consumed more feed than the control group (P<0.01). Lilly *et al*. (2011) reported that the addition of vinegar to drinking water in organic broilers did not significantly affect feed intake. In terms of feed conversion ratio, the performance of the chickens belonging to the experimental groups showed significant differences (P<0.01) and generally the treatment groups benefited from better feed. It can be said that artichoke vinegar is effective on feed efficiency in broilers and has a healing effect on feed efficiency. Similar results have been reported in studies on this subject. It has been determined that citric acid added to the drinking water of broiler chickens gives better results in terms of feed utilization (Khandaker *et al*., 2008). Al-Noori (2014), Mohanad and Saleem (2018), and Sedghi and Akbari Moghaddam Kakhki (2018) reported that vinegar added to drinking water caused an improvement in feed efficiency in broilers. Contrary to these results, Lilly *et al*. (2011) reported that the addition of vinegar to drinking water in organic broiler production did not significantly affect feed conversion ratios.

It was observed that the chickens of the control and treatment groups did not show significant differences in terms of carcass weight and carcass percentage. It can be said that these properties are not significantly affected by vinegar application. The results obtained are generally similar to the findings of studies on this subject. Khandaker *et al*. (2008) reported that citric acid added to the drinking water of broiler chickens did not affect the carcass characteristics. Kopecky *et al*. (2012) reported that acetic acid added to drinking water in broiler production had no effect on carcass characteristics. In contrast, Sedghi and Akbari Moghaddam Kakhki (2018) reported that vinegar given to broilers as a dietary supplement increased carcass yield. In the study, the differences between the groups in the amount of abdominal fat were significant (P<0.01) and there were significant increases in the weight and percentage of abdominal fat in parallel with the increase in vinegar level. The results obtained were different from the findings of some studies on this subject. Allahdo *et al*. (2018) reported that adding vinegar to the drinking water of broiler chickens caused a decrease in the amount of abdominal fat. Kim (2007) reported that the addition of vinegar to the diet of broiler chickens caused a decrease in the crude fat content of the meat. As a result, many beneficial effects were

observed when adding artichoke vinegar up to 1.5% to the drinking water of broiler chickens. It can be said that artichoke vinegar, which is a completely harmless and natural product in terms of health, can be given to broilers with drinking water without any problems.

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