Effect of glycerides of organic acids on performance and meat quality of broiler chickens under farm conditions

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Abstract

The influence of different levels of glycerides of organic acids on broiler performance and meat quality was studied. 120 Ross type broiler aged 21 days were used in this study. They were normally and equally divided into four treatments, three replicates each. T1 was control (normal water), in T2, T3, and T4 treatments 1 ml/L, 2 ml/L, and 3 ml/L of glycerides of organic acid were administrated in drinking water, respectively. The normal diet was used in all groups. The Initial body weight was measured in day-one of experiment. The BW, BWG, DWG, FI, FCR, and livability were recorded on day 35 for broiler performance. The meat quality parameters including drip loss, meat components percentage, Thiobarbituric Acid Reactive Substances (TBARS), and color were measured. In the results, the addition of glycerides of organic acids (2 ml/L and 3 ml/L) in the broiler drinking water significantly increased the all the production performance and the FCR was significantly improved in these groups. Although the treatments had no effect on meat color, there were significant fluctuations among the treatments and control. The experimental treatments (T3) had significant influence on percentage of meat ingredients (Moisture and Ash), while drip loss, and TBARS were not affected. However, the TBARS was significantly increased on day 7th of storage in T2 and control group. TBARS significantly decreased on the 7th day of storage under the effect of glycerides of organic acids (3 ml/L). This study indicates the importance and beneficial effects of adding glycerides of organic acids in the broiler production cycle.

Keywords: glycerides of Organic acid, Broiler, Meat quality, Performance, Drip loss, FCR.

Introduction

Because of its low-fat level, nutritional value, adaptability to many cuisines, and reasonable cost, people appreciate poultry meat [1]. The delicate nature of chicken flesh, which can change in 4 to 8 days due to the white muscle structure, the animal's general health, and the conditions of slaughter, presents a challenge to the industry despite these many benefits [2, 3]. Additionally, post-slaughter handling during the retail phase increases the rate of spoiling because of improper storage temperatures and cold chain breaks during transportation [4].

Antibiotics (synthetic promoters) have long been shown to increase feed conversion efficiency in animal feeds produced under intensive farming. In the European Union and several other regions of the world, the administration of antibiotics in broiler feed has been restricted. It has been acknowledged that modifying the microbial habitat and gut function of domestic animals with feed additives is a crucial strategy for enhancing feed efficiency and growth performance

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[5]. Synthetic chemicals have been fed to over 80% of domestic animals for either growth promotion or treatment [6]. Antibiotics are no longer permitted as feed additives, which has sped up the search for alternative feed additives for animal feed [7]. Finding unconventional feed additives to use in animal diets has accelerated since the use of antibiotics as feed additives is prohibited [6]. In the comprehensive livestock system, herbal extracts were utilized to enhance the overall performance of the animals [8]. The enhancement of feed intake, digestibility, immune system activation, and anthelmintic properties were the reasons for the beneficial effects of herb extracts [9].

In the chicken business, organic acids (short and medium chain fatty acids) derived from these plants were of particular interest. These organic acids are weak and include a carboxylic group [10]. These organic acids have long been utilized by related businesses to improve growth performance of poultry [11]. There are inconsistent findings on the kind of organic acids (short and medium chain fatty acids) used in the poultry industry, based on previous studies. Short-chain fatty acids (SCFA) have a significant effect on enhancing the intestinal health of broilers, which in turn improves output performance, according to Khan and Iqbal [12]. Furthermore, several studies that used medium-chain fatty acids (MCFA) examined comparable outcomes [13,14]. However, due to bad smell of these organic acids, the glycerides addition is one of the methods to avoid this problem and maintain the feed intake [15].

Besides the investigation of positive effects of these materials on productive performance, this study considers the impact of the glycerides of organic acids on post-mortem characteristics of meat. Therefore, this study aims to show the effect of mixture of glycerides of organic acids on both productive performance and some of the meat properties during the final stage of production.

caprylic acid and Glycerides of capric acid).

Material and Methods

Ethical approval:

The permission of animal ethics was approved by Animal Ethics Committee in Department of Animal Production, College of Agricultural Engineering Sciences, University of Duhok, Iraq.

Diet and glycerides organic acids:

The grower commercial diet from a poultry feed industry (Amedy feed factory, Sumel, Duhok) was used during the entire experiment (14 days). Regarding the glycerides of organic acids, a commercially available compound (Active gut, MT Nutri, France) was used which was containing Short Chain Fatty Acids (SCFA) (Glycerides of propionic acid and Glycerides of butyric acid) and Medium Chain Fatty Acids (MCFA) (Glycerides of

Experimental design:

A total of 120 broiler chicks (Ross 308) aged 21 days were used in this study. On the first day of the experiment, their initial body weight was recorded and randomly put into four groups with three replicates each. Floor cages (1 m2) were used for rearing. The first group (T1) served as the control group and received normal diet and water with no glycerides of organic acid addition. The second group (T2) received 1 ml/l of glycerides of organic acids in their drinking water with normal diet. The third group (T3) received 2 ml/l of glycerides of organic acids in the drinking water with normal diet. The fourth group (T4) received 3 ml/l of glycerides of organic acids in the drinking water with normal diet.

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Production parameters:

At the arrival of chicks to the experimental halls, their initial body weight of was recorded. At the end of the experiment (day 35) the chicken's Body Weight (BW), Body Weight Gain (BWG), Daily Weight Gain (DWG), Feed In-take (FI), Feed Conversion Ratio (FCR), and Livability (LIV) were recorded.

Meat quality measurements:

On day 35, two birds from each replicate within each treatment (total 6 birds from each treatment) were randomly taken for meat quality traits measurements. A breast muscle (500 grams) was put in a sealed pack and transferred to the laboratory in a cold box for further tests.

Meat Proximate analysis:

All the samples for the proximate analysis were analyzed in duplicate according to the method of Association of Official Analytical Chemist [AOAC, 2019]. Dry matter content of meat sample was measured according to the procedure 930. 15 [AOAC, 2019]. Meat sample was accurately weighted, and oven dried at 60 °C for 6 days until a constant weight was obtained. Subsequently, dried samples were grinded and frozen at -20 °C for further proximate analysis. Crude protein in meat sample was measured according to method 968. 06 [AOAC, 2019] using Kjeldahl analyzer and a conversion factor 6.25 to convert nitrogen to crude protein. Total fat content of meat sample was measured according to method 948. 22 [AOAC, 2019] using Soxhlet extraction. Ash content of dried meat sample was determined according to method 942. 05 [AOAC, 2019] using muffle furnace after the samples were ashed at 550°C for 4 h.

Drip loss:

The drip loss was measured for the broiler breast according to [16]. A part of the meat breast (80 grams was weighed and placed in the plastic net hung inside an airtight container and stored in a refrigerator (4 ^{o}C for 24 h). Next, the sample of meat was removed from the refrigerator and dried with tissue paper and weighed again. Finally, the following equation was applied to calculate the drip loss value.

Drip loss value (%) = [(Initial weight of raw meat (g) – final weight of meat (g))/ Initial weight of raw meat (g)] ×100

Color:

Breast muscle color was measured was taken three time during retail display (at 4 ^{o}C) on day 1, 4 and 7 using Precise Color Reader (ShenZhen Wave Optoelectronics Technology, China). Color measurements included lightness (L*) and redness (a*) Two readings were taken at each sampling time.

Thiobarbituric Acid Reactive Substances (TBARS):

The TBARS value, a measure of lipid oxidation, was assessed in broiler meat samples using the methodology first described by [17]. About 0.5 grams of ground broiler meat were weighed, their precise weight noted and then put into a 10 ml test tube. To this was added 2.5 ml of TBARS stock solution, which contained 3.75 grams of thiobarbituric acid, 150 grams of trichloroacetic acid, and 0.25 milliliters of HCl. Following a 15-second vortex and a 15-minute immersion in a water bath at 95°C, the test tubes were quickly cooled in cold tap water and centrifuged at 2500 g for 10 minutes at 4°C (K Centrifuge PLC Series, Taiwan). The supernatant was put into a cuvette, and a spectrophotometer (Jenway, 6300 spectrophotometers, UK) was used to quantify the absorbance at 532 nm in comparison to a blank sample that did not include any meat. Using a suitable malondialdehyde standard curve, the TBARS value in broiler meat samples was

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calculated and represented as mg of malondialdehyde equivalents/kg meat.

Statistical analysis:

For statistical analysis among groups, the one-way ANOVA was performed using the SPSS software statistical analysis (version 26). The Duncan's multiple range test was used to indicate any significant variation among treatment means.

Results and Discussion

The effects of these glycerides of organic acids on broiler performance are shown in Table 1. The daily weight gain, body weight gain, and final body weight have significantly increased ($P < 0.001$) in treated groups which received 2ml/L and 3 ml/L glycerides of organic acids compared to the control group. The feed intake in the treated groups was significantly increased in T2 and T3 ($P<0.022$) compared to T4 and control group. However, the most important indicator of feed efficiency, which is Feed Conversion Ratio (FCR), was significantly improved ($P<0.0001$) in treated groups with glycerides of organic acids (T3 and T4), except in group two (T2) which received 1 ml/L glycerides of organic acids. [15] found an increase in body weight and an improvement in FCR with highest level of glycerides of butyric acids administrated to broiler chickens which totally agree with current results. These positive data may be due to the effect of the glycerides of organic acid mixture in improving the gut conditions by reducing the pH in the intestine and therefore digestive enzymes and nutrient digestibility are promoted [18,19]. Additionally, these results agree with those found previously that stated an improvement in broiler performance supplemented with glycerides of organic acids [20,21]. The potential methods for reducing the birds' FCR through supplementing the glycerides of organic acids, are by enhancing the retention of protein, dry matter, mineral absorption, utilization, and increases the digestibility of nutrients [22,23].

Table 2 shows the moisture %, fat %, protein %, ash % and drip loss parameters of broiler meat under the influence of different levels of glycerides of organic acids. These parameters were not affected by administration of glycerides of organic acids. However, treatments had numerically decreased the drip loss and fat content of meat compared to the control group. Drip loss, according to [24], refers to the loss of fluid from raw meat during refrigerated storage and is mostly caused by the ability of myofibrillar protein to bind and hold water [25]. As a result, a free radical mechanism oxidizes animal proteins in the same trend as fat [26]. The highest percentage of drip loss is seen as having an unfavorable effect on the quality of the meat [27]. [28] found that the solubility of myofibrillar and sarcoplasmic proteins in meat declined with increasing time. [29] obtained similar results of drip loss in breast muscle of broilers administrated with glycerides of organic acids. However, [30] found a significant decrease in drip loss of broilers fed the mixture of organic acids. Therefore, postmortem breakdown of muscle protein and fat content affects muscular water retention [31,32]; according to [33], the more the meat's fat content, the less drip loss may occur. This finding is consistent with the results of the present study in that the fat and drip loss indicators were shown in the same trend.

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Table 1. Effect of glycerides organic acids on performance of broiler chickens.

Treatment *	IBW (21 days)	BW (35 days)	BWG	DWG	FI	FCR	LIV
T1	1034.33	1993.33 [b]	959.0 [b]	68.50 [b]	1667.71 [b]	1.739 [b]	100
T2	1059	2068 [b]	1009 [b]	72.07 [b]	1855 [a]	1.838 [a]	100
T3	1062.67	2293.33 [a]	1230.67 [a]	87.90 [a]	1891.66 [a]	1.536 [c]	100
T4	1069	2244 [a]	1175 [a]	83.92 [a]	1796.33 [ab]	1.528 [c]	100
SEM	6.617	38.50	35.17	2.51	31.08	0.041	NA
P value	0.288	0.0001	0.0001	0.0001	0.022	0.0001	NA

*Means followed by different letters within the same column are significantly different at $P \leq 0.05$.

Table 2. Effect of glycerides organic acids on the broiler chickens breast muscle quality parameters.

Treatment	Moisture %	Fat %	Protein %	Ash %	Drip loss
T1	74.45	1.69	22.19	1.35	3.09
T2	75.16	1.52	21.81	1.15	2.20
T3	74.58	1.03	22.67	1.47	2.45
T4	75.00	1.52	21.86	1.24	2.57
SEM	0.122	0.070	0.139	0.038	0.155
P value	0.12	0.001	0.09	0.01	0.218

Table 3 shows the effect of different levels of glycerides of organic acids, stage of administration, and interaction between them in TBARS and color parameters of broiler chicken meat. It has been noted that TBARS is a secondary byproduct of lipid oxidation and is an excellent indication of the oxidation status. Off-flavor and aromas are linked to elevated TBARS values, which negatively impact meat's sensory qualities, nutritional value, and shelf life [34]. Overall, the treatments (the levels of used compound) had no significant effects on TBARS. However, the glycerides of organic acids had significantly affected ($P<0.0001$) the L score of meat color in which the T3 had significantly lower score compared to all studied levels and control groups. Although the TBARS did not differ significantly under the various levels of glycerides of organic acids administration, the lowest TBARS was obtained in T3. This may be reason for lower lightness of meat in the same treatments in which less lipid oxidation occurs under this level of glycerides of organic acids.

Table 3. Effect of glycerides of organic acids, stage of administration, and interaction between them on TBARS and color parameters of broiler chickens' meat.

Treatment*	TBARS	Color	
		L	a
T1	0.440	50.418 [a]	3.515
T2	0.399	51.372 [a]	3.226
T3	0.268	46.978 [b]	2.621
T4	0.361	51.235 [a]	2.350
SEM	0.031	0.387	0.195
P value	0.248	0.0001	0.130
Time			
Day 1	0.130 [c]	50.660	3.301 [a]
Day 4	0.303 [b]	49.301	3.173 [ab]
Day 7	0.669 [a]	50.042	2.309 [b]
SEM	0.031	0.387	0.195
P value	0.0001	0.363	0.078
Interaction (days x treatments)			
1x1	0.124 [f]	52.248 [ab]	3.981 [a]
1x2	0.144 [f]	53.245 [a]	2.948 [ab]
1x3	0.121 [f]	45.343 [d]	3.640 [a]
1x4	0.131 [f]	51.803 [ab]	2.635 [ab]
4x1	0.373 [cd]	49.291 [bc]	3.473 [a]
4x2	0.301 [de]	51.118 [ab]	3.493 [a]
4x3	0.225 [ef]	46.346 [cd]	2.381 [ab]
4x4	0.312 [de]	50.448 [ab]	3.345 [a]
7x1	0.823 [a]	49.716 [b]	3.090 [ab]
7x2	0.752 [ab]	49.755 [b]	3.236 [a]
7x3	0.459 [c]	49.245 [bc]	1.841 [ab]
7x4	0.641 [b]	51.455 [ab]	1.070 [b]
SEM	0.031	0.387	0.195
P value	0.0001	0.0001	0.112

*Means followed by different letters within the same column are significantly different at $P \leq 0.05$.

On the other hand, the duration (time) of meat storage had a significant effect on TBARS. The highest TBARS measurement was recorded on the seventh day followed by the fourth and first days of storage. According to reports, an increase in TBARS in meat is a sign of advanced lipid oxidation, which causes off smells and odors that can negatively affect the meat's nutritional value and sensory qualities, ultimately reducing the meat's shelf life [35,36]. These results were in line with those of [37], who found that after 10 days of storage, chopped chicken meat infused with anise extract had a lower TBARS value when compared to the control. Regarding the meat color and time of storage, the A score was significantly affected on the seventh day of storage and recorded the lowest score (Duncan test). These results are in agreement with those achieved by [29] that they found a linear increase in redness score as well as a decrease in lightness score under the effect

of glycerides of organic acid mixture over the period of 24 hours of storage with no statistical significance.

Considering the experimental interaction between treatments and time of storage and their effects on meat quality parameters, the TBARS was significantly lower in the first day in all studied groups. Nevertheless, this parameter was significantly higher on day four in control group and treatment 2. Additionally, on the seventh day, treatment 3 followed by treatment 4 was recorded with the significantly lowest TBARS measurement. Although there were significant variations in color scores (L and A) among treatments and storage time, these parameters fluctuated during the entire storage period under the influence of various levels of glycerides of organic acids. Lowest TBARS, which is an indicator of lipid oxidation was recorded in T3 on day 7th. This may declare the beneficial effect of this level of glycerides of organic acids on meat quality in broiler. However, this trait was increased in control and T2 at the same time of meat storage.

Conclusion

In conclusion, the administration of glycerides of organic acids to broiler during the final stage of production has a great influence on improving the production and meat quality measurements. An increased level of glycerides of organic acids enhanced the FCR and therefore increased the body weight. Although the meat components percentage (fat, moisture, ash, protein) and drip loss were not changed, the meat color and TBARS were improved under the effect of this product. Further studies are needed to investigate the effect of these glycerides of organic acids on broiler performance from day one of production.

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