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Effect of Sumac, Yeast, and Onion on Broiler Chicken Performance

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Abstract: This study was conducted to determine the effects of sumac, yeast, and onion supplementation to broiler chicken feeds on performance. Four hundred and fifty, one-day-old Ross 308 broiler chicks were obtained from Yagoo Group Hatchery in Sulaymaniyah Province and were randomly distributed into three treatment groups (150 chicks for each group) with six replicates (each 25 chicks). Chicks were raised on floor cages (210 × 200 × 100 cm). T1 (Feed with 0 mg kg^{-1} sumac, yeast, and onion), T2 (Feed with 10, 2 and 20 mg kg^{-1} sumac, yeast, and onion for every day) and T3 (Feed with 10, 2 and 20 mg kg^{-1} sumac, yeast, and onion for 2 days added and 2 days free in the rearing period) experiment groups were constituted. In the study, the effects of the treatments on the performance parameters were found to be statistically significant. In body weight, the highest group in terms of total body weght gain and total feed intake was T3, and it was significantly higher than T2 and control groups ($p<0.001$). Again, T2 was found to be significantly higher in terms of these parameters compared to the control group ($p<0.001$). In total, the feed conversion rate (FCR) was found to be statistically significant. While T3 had a similar FCR (1.50) to the control group, it was significantly lower ($p<0.001$) compared to T2 (1.68). In general, the treatments were found to have a positive effect on performance parameters.

Keywords: Broiler, feed conversion rate, live weight gain, performance

1. Introduction

The aim of broiler feeding is to bring the animals to the highest live weight in the shortest time interval with the least feed intake. To reach the highest live weight in the shortest time, it is important to keep the energy, protein and other nutrients in the ration balanced, as well as to use various feed additives that increase productivity (Karademir and Karademir, 2003). For this purpose, antibiotics have been used in subtropic doses to stimulate growth and maintain health in poultry (Rosen, 1996; Engberg et al., 2000). Antibiotics are known to improve gut health, promoting better feed utilization and growth in poultry. However, it has been revealed that the use of antibiotics in animal nutrition will lead to the development of antibiotic-resistant bacteria that will have harmful effects on humans, and the death of beneficial microorganisms along with pathogenic microorganisms in the digestive system (Nasir and Grashorn, 2006). Therefore, the ban of the use of these growth-promoting antibiotics in animal feed in different parts of the world has been on the carpet. Thus, due to the official ban on antibiotics in the European Union on January 1, 2006, and the increasing pressure on producers in various regions of the world, the use of alternative agents to promote growth and prevent diseases has gained great importance. Recently, aromatic herbs and related essential oils and extracts have been used as potential growth promoters, as they have many advantages such as the absence of side effects and waste parts in the body (Landy et al., 2011).

Since sumac (*Rhus coriaria* L.), onion, and yeast (in bread or fermented beverages) are natural ingredients used daily in human diets, their acceptability by the consumer is high. Sumac (*R. coriaria* L.) is a plant widely grown in Asian countries and used in traditional medicine (Shidfar et al., 2014). Sumac fruits contain organic acids

such as hydrolyzable tannins, flavonols, phenolic acids, antioxidants and malice, citric and tartaric acids (Özcan and Haciseferogullari, 2004). Some researchers have reported that the addition of sumac to broiler diets improves growth performance (Gulmez et al., 2006; Ghasemi et al., 2014) and improves intestinal traits in broiler chicks (Ghasemi et al., 2014). While Valiollahi et al. (2014) reported that the addition of sumac powder to mixed feeds of broilers improved the fattening performance and improved body weight gain, Alishah et al. (2012) reported that the addition of sumac powder to broiler mixed feeds did not affect the fattening performance values. Kheiri et al. (2015) observed in a study they conducted on female broilers that the addition of sumac and milk powder to mixed feeds increased feed intake.

Onion (*Allium cepa* L.), which is used as a food and medicine plant, is a plant that is widely grown almost all over the world, especially in China, India, and the USA (Ebesunun et al., 2007). Onion contains cycloalicin, flavonoids, phenolic acids, cholesterol, saponins, sugars, and essential oil compounds consisting mainly of sulfur compounds, with proven antioxidant, antibacterial and hypolipidemic activity (Melvin et al., 2009). It has been reported that onion extract has a positive effect on the growth performance of broilers (Aji et al., 2011; Goodarzi et al., 2013). Onion supplementation up to 100 mg kg^{-1} in broiler diets has been reported to improve performance (Aji et al., 2011). Studies on the benefit and appropriate level of supplementation of the onion diet are limited (Aditya et al., 2017).

For a long time, yeast products have been successfully included in feeds as natural growth promoters for animals and poultry. *Saccharomyces cerevisiae* (SC) is one of the most widely known commercialized products and is one of the effective adsorbents rich in bioavailable crude protein, B complex vitamins, and important trace minerals (Reed and Nagodawithana, 1999). Yeast culture can be used to reduce mortality and improve and maximize chickens' genetic potential for feed efficiency and weight gain (Abdelrahman, 2013). It is known that the addition of live yeast to animal feed improves the nutritional quality of feeds and animal performance (Glade and Sist, 1988; Martin et al., 1989). Stanley et al. (1993) showed that the addition of 0.1% Saccharomyces cerevisiae to broiler diets increased live weight and decreased aflatoxin intensity.

The present study was carried out to determine the effect of adding sumac, onion, and yeast in different doses to broiler diets on performance criteria.

2. Materials and Methods

2.1. Birds, experimental design, and treatments

This study was carried out at Garmian University, College of Agriculture, Poultry Farm between February 10 and March 16, 2020, to examine the effect of the addition of sumac (*Rhus coriaria* L.), yeast (*Saccharomyces cerevisiae*), and onion (*Allium cepa* L.) to broiler chicken diets on body weight (BW), body weight gain (BWG), feed intake (FI) and feed conversion rate (FCR) of broilers**.**

Four hundred and fifty, one-day-old Ross 308 broiler chicks were obtained from Yagoo Group Hatchery in Sulaymaniyah Province and were randomly distributed into three treatment groups (150 chicks for each group) with six replicates (25 chicks for each replicate). Chicks were raised on floor cages (210 × 200 × 100 cm).

In the study, the treatment groups consisted of T1: basal diet, T2: basal diet + 10 mg kg^{-1} sumac + 2 mg kg^{-1} yeast (*S. cerevisiae*) + 20 mg kg^{-1} onion and T3: basal diet + 10 mg kg^{-1} sumac + 2 mg kg^{-1} yeast (*S. cerevisiae*) (for 2 days added and 2 days free in the rearing period).

Basal diets were prepared to contain the nutrient recommended for broiler chickens according to Anonymous (1994). The nutrient content and chemical composition of the diet are presented in Table 1. Feed and water were provided ad-libitum.

2.2. Growth performance

One-day-old broiler chicks were weighed and those whose body weights were close to each other were selected and used in the experiment. Bodyweight values were recorded by weighing as a group in each week of the 35 days. Live weight gains were again weighed as a group every week and subtracted from the previous week's body weight.

Feed intake was also included in the weekly leftover feeds and weighed and recorded. The FCR was calculated with the following Equation 1.

$$FCR = \frac{\mathrm{FI}}{BWG} \quad (1)$$

2.3. Statistical method

All data obtained were subjected to statistical analysis using standard methods. Anonymous (2011) package program was used to calculate the

Table 1. Ingredients and calculated nutrient composition of the basal standard diet used in the experiment

Ingredients	Diet		
Phase	Starter	Grower	Finisher
Days	(0-10)	(11-24)	(25-35)
Wheat	14.5	8.0	10.0
Corn	40.4	48.0	49.5
Bakery meal	6.8	7.2	8.7
Oil	1.0	1.5	1.8
Animal protein contents	4.9	4.4	4.5
Soybean meal	29.3	27.8	22.8
Limestone	0.9	0.7	0.4
Iodized salt	0.2	0.2	0.1
Primex*	2.0	2.2	2.2
Total	100	100	100
Chemical compositions			
Crude protein (%)	23	21	19
Metabolic energy (kcal kg^{-1})	3000	3050	3100
Calcium (%)	0.95	0.92	0.89
Available phosphorus (%)	0.45	0.41	0.38
Sodium (%)	0.22	0.21	0.20
Methionine (%)	0.57	0.57	0.47
Meth + Cystine (%)	0.95	0.88	0.75
Lysine (%)	1.30	1.15	1.00

*Premix: Vitamin A, Vitamin D3, Vitamin E, Vitamin K3, Vitamin B1, Vitamin B2, niacin, pantothenic acid, Vitamin B6, Vitamin B12, biotin, folic acid, betain, iron, copper, zinc, manganese, iodine, selenium, cobalt, lysine, methionine, Methionine + Cystine, threonine, tryptophane, calcium, phosphorus, sodium, chlor, phytase

effects of the treatments. Duncan's multiple comparison test was used to determine the difference between means (Duncan, 1955).

3. Results

Growth performance values of broilers are given in Tables 2 and 3. All weeks broilers BW, BWG, FI, and FCR were significantly affected by treatments.

Comparing T3 with T1, T2 with T1, and T3 with T2, it is seen that 39.22%, 38.55, and 0.48% more live weight gain was obtained in the first week of the experiment, respectively ($p<0.001$). Again, at the 2nd week, 49.49%, 30.87, 14.23% ($p<0.001$); at the 3rd week 35.84, 25.17, 8.52% ($p<0.001$); at the 4th week 34.60, 23.76, 8.76 ($p<0.001$); at the 5th week, 11.65%, 3.38, 8.00 ($p<0.05$), and in total, 29.66, 19.23 and 8.75 ($p<0.001$) higher body weight gain were obtained, respectively (Table 2).

When the feed intake values were examined, T3 with T1, T2 with T1, and T3 with T2 were compared, and there was an increase of 42.00%, 36.92, and 3.71 in the first week, respectively ($p<0.05$). In the second week of the experiment, again 46.52, 44.51, 1.39 ($p<0.001$); at the 3rd week 39.67, 35.09, 3.39 ($p<0.05$); at the 4th week, 41.27%, 36.99, 3.12 ($p<0.05$); at the 5th week, when T3 with T1 and T2 with T1 were compared, respectively, 8.64%, 26.95 more feed was consumed, while T3 and T2 consumed 14.42% less

Table 2. Body weight (g) and weight gain (g) difference between treatments[1]

Parameters	Body weight			P
	T1	T2	T3	
First-day	42.23±3.17	42.03±2.37	41.52±2.98	ns
1st week	153.15^{b}±10.35	195.72^{a}±9.78	195.93^{a}±7.57	***
2th week	421.00^{c}±10.00	546.25^{b}±10.25	596.33^{a}±14.67	***
3th week	860.00^{c}±29.00	1095.75^{b}±37.75	1192.67^{a}±22.67	***
4th week	1492.92^{c}±45.58	1879.08^{b}±48.58	2044.58^{a}±37.92	***
5th week	2171.17^{c}±49.17	2580.25^{b}±44.75	2801.83^{a}±38.17	***
	Body weight gain			
1st week	110.917^{b}±7.18	153.683^{a}±7.42	154.417^{a}±5.52	***
2nd week	267.850^{c}±3.65	350.533^{b}±7.03	400.400^{a}±20.20	***
3rd week	439.000^{c}±19.50	549.500^{b}±27.50	596.333^{a}±17.67	***
4th week	632.917^{c}±18.58	783.333^{b}±10.83	851.917^{a}±26.58	***
5th week	678.250^{c}±14.75	701.167^{b}±34.83	757.250^{a}±22.75	*
Total	2128.93^{c}±47.43	2538.22^{b}±44.28	2760.32^{a}±35.18	***

[1]: The difference between the means indicated by the same letter in the same row / in the same group is not statistically significant, $\bar{x}$ ± Standard deviation, P: Probability, *: $p<0.05$, ***: $p<0.001$, ns: Non significant

Table 3. Feed intake (g) and FCR difference between treatments[1]

Parameters	Feed intake			P
	T1	T2	T3	
1st week	134.20^{c}±4.73	183.74^{b}±8.00	190.56^{a}±7.45	*
2nd week	355.11^{b}±3.10	513.17^{a}±4.22	520.32^{a}±24.79	***
3rd week	619.96^{c}±11.88	837.52^{b}±20.42	865.89^{a}±38.12	*
4th week	929.05^{c}±18.64	1272.72^{b}±33.91	1312.48^{a}±32.03	*
5th week	1155.96^{c}±10.74	1467.54^{a}±25.58	1255.87^{b}±42.49	***
Total	3194.28^{c}±38.70	4274.69^{a}±57.37	4145.12^{b}±119.30	***
	Feed conversion rate			
1st week	1.21^{b}±0.04	1.20^{b}±0.02	1.23^{a}±0.01	*
2nd week	1.33^{b}±0.01	1.46^{a}±0.02	1.30^{c}±0.02	***
3rd week	1.41^{c}±0.04	1.53^{a}±0.04	1.45^{b}±0.05	*
4th week	1.47^{c}±0.02	1.62^{a}±0.03	1.54^{b}±0.03	***
5th week	1.70^{b}±0.02	2.09^{a}±0.07	1.66^{c}±0.01	**
Total	1.50^{b}±0.02	1.68^{a}±0.01	1.50^{b}±0.02	***

[1]: The difference between the means indicated by the same letter in the same row / in the same group is not statistically significant, $\bar{x}$ ± Standard deviation, P: Probability, *: p<0.05, **: p<0.01, ***: p<0.001, ns: Non significant

feed (p<0.001). In total, when T3 with T1, T2 with T1 were compared, it had 29.77% and 33.82% more feed intake, respectively, and T3 consumed 3.03% less (p<0.001) than T2 (Table 3).

In terms of feed conversion rate, there was an increase of 1.65% and 2.50 when T3 with T1, T3 with T2 were compared in the first week of the experiment, respectively, and a decrease of 0.83% when compared to T2 with T1 (p<0.05). In the second week of the experiment, while T3 with T1 were compared to T3 with T2, there was a decrease by 2.26% and 10.96, respectively, when comparison of T2 to T1 increased by 22.94% (p<0.001). Again, while T3 and T1, T2 and T1 were compared at the 3rd and 4th week of the experiment, it is increased by 2.84% to 8.51 and 4.76% to 10.20, respectively, comparing T3 with T2, there was a 5.23% decrease at week 3 and 4.94 at week 4, respectively (p<0.05; p<0.001). In the 5th week of the experiment, while T3 and T1, T3 and T2 were compared, it is decreased by 2.35 and 20.57, respectively, when T2 and T1 were compared, the feed conversion rate increased by 22.94% (p<0.01). While there was no difference between T3 and T1 in terms of feed conversion ratio in total, there was an increase of 12% when T2 and T1 were compared and a decrease of 10.71% when T3 and T2 were compared (p<0.001) (Table 3).

4. Discussion and Conclusion

The findings of the present study showed that the treatments significantly improved the growth performance of broilers. One of the reasons for this improvement in growth performance may be due to the positive effect of the active materials in the structure of onions on the digestibility of amino acids by increasing the absorption surface by improving the intestinal health of poultry (Omar et al., 2020). Again, this positive effect of sumac on growth performance may be due to the role played by active materials (especially cinnamaldehyde and eugenol) in the use of nutrients (Ghasemi et al., 2014). These natural growth promoters also have advantages over antibiotics such as not leaving residue and not causing microbial mutations (Gibson and Roberfroid, 2008).

Researchers report that yeast and its derivatives used as a growth factor by adding to feeds make it difficult for pathogenic microorganisms to adhere to the intestinal microorganism flora, increasing the live weight of broilers and can be used as a growth factor instead of antibiotics (Hooge et al., 2003; Zhang et al., 2005; Soltan, 2008). In addition, mannan oligosaccharides and beta-glucans (Spring et al., 2000), which are the main 2 active compounds in the yeast cell wall, and the indigestible prebiotic and fructooligosaccharide components (Omar et al., 2020) in the structure of onions, and especially mannan oligosaccharide are considered to be a carbohydrate known to have many benefits in farm animals and it is known to cause improvement in growth performance, feed conversion, and viability in broilers and turkeys. In addition, onion extract contains active compounds that stimulate digestion and support growth, such as phenols, polyphenols, terpenoids, polypeptides, lectin, alkalis, and essential oil (Lee et al., 2003; Cross et al., 2007). In addition, these additives, which contain live microorganisms that contribute positively to the health of the host in the diet of poultry and are probiotic effective, strengthen the natural defense system of the host (Shareef and Al-Dabbagh, 2009; Hassanein and Soliman, 2010).

Goodarzi and Nanekareni (2014) reported that the addition of 1% and 2% onion extracts to the drinking water of broilers increased the average feed intake, while the addition of 1% onion extract increased the growth and body weight gain during

the total experiment. Again, Farahani et al. (2015) reported that adding 1% onion extract to drinking water had a positive effect on growth performance in a study they conducted on two types of broiler chickens (ross and cobb). In another study, broilers feed 7.5 g kg^{-1} kg onion extract had higher body weight gain in general and added 5, 7.5, and 10 g kg^{-1} onion extract to the diet increased feed intake (Aditya et al., 2017). The increase in feed intake may be due to the pleasant taste and flavor of onions (Gonzalez et al., 2010).

A recent study reported that although broiler chickens in all experimental groups consumed similar amounts of feed, the addition of 1.5-2.0 g kg^{-1} whole yeast and yeast cell wall to the diet, in particular, may provide prebiotic and growth-promoting effects by providing an improvement in BWG, FCR and meat yield (Ahiwe et al., 2020). In a study by Paryad and Mahmoudi (2008), they reported an improvement in body weight gain with the addition of 1.5% yeast to broiler diets, while Reisinger et al. (2012) reported that the addition of 0.1% yeast derivate provided 10.6% more live weight gain on day 35 compared to the control group. Again, Shareef and Al-Dabbagh (2009) reported that adding 1, 1.5, and 2% baker's yeast to their 1-21-day broiler diets and Gao et al. (2008) adding 2.5 g kg^{-1} of yeast culture to broiler diets for 0-42 days significantly improved live weight compared to the control group. In addition, similar to our current study, Hosseini (2011) reported that the addition of yeast significantly increased body weight, body weight gain, and feed intake throughout the experiment.

Similar to the findings of our study, Mansoub (2012) showed that using different levels of sumac has significant effects on feed intake, body weight gain, and FCR in broilers. Mohammadi et al. (2011), in their study by adding different levels of sumac powder and probiotic (protexin) separately and together to broiler mixed feeds, reported that the group in which the two additives were given combined showed higher body weight gain. Valiollahi et al. (2014) found a significant increase in total live weight and body weight gain of the group feed with 0.02% sumac powder compared to 0.02% ajwain powder, 0.02% virginiamycin, and control group in a study they conducted with broilers. Ghasemi et al. (2014) reported that 0.1% sumac addition increased both body weight gain and carcass ratio, and Shariatmadari et al. (2015) reported that adding 0.2% sumac to the diet significantly increased the live weight of broiler chickens. Again, Shata et al. (2017) reported that the addition of sumac seed powder at different levels (0, 1.5, 2, 2.5, %) to their diets significantly increased body weight and body weight gain in Japanese quails compared to the control group. In their study, Toghyani and Faghan (2017) compared the effect of adding different levels of sumac powder to the diet (3 and 7 g kg^{-1} feed) as a growth stimulant in broiler chickens with the group given the antibiotic group. At the end of the trial, they found that feed intake decreased significantly, feed efficiency improved, but body weight gain did not change in groups that added 3 and 7 g kg^{-1} of sumac powder to the diet.

In conclusion, research findings have shown that 10, 2, and 20 mg kg^{-1} sumac, onion, and yeast, respectively, can be used safely in broilers and increase their growth performance. Again, the findings showed that the use of onion, sumac, and yeast in combination can create synergistic effects and positively affect broiler performance.

Declaration of Author Contributions

The authors declare that they have contributed equally to the article. All authors declare that they have seen/read and approved the final version of the article ready for publication.

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Declaration of Conflicts of Interest

All authors declare that there is no conflict of interest related to this article.

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