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Effect of milk thistle with artichoke or gingko leaves extract on growth performance and carcass characteristics in broilers

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Abstract The results showed that the milk thistle with artichoke extract (T1) and the milk thistle with ginkgo leaves extract (T2) significantly decreased the FCR from day 35 to day 42 compared with control group (C) ($P<0.05$). Moreover, the mortality rate tended to decrease in groups T1 and T2 compared with the control group from day 14 to day 21. However, the growth performance that is shown from the body weight gain (BWG), the feed intake (FI) and the average daily gain (ADG) which tended to increase but still not different from the control group (C). Carcass characteristics were studied by sampling 2 birds at 42 days from each replicate, then slaughtered and weighing the organs. Carcass and organs weight of the chickens in the treatment groups (T1 and T2) were not differed from those in the control group (C). Therefore, supplementing this substance in broilers should help to adjust the FCR values and improve growth performance.

Keywords: Milk thistle, Artichoke, Ginkgo, Growth performance, Carcass characteristics

Introduction

In recent years, the poultry industry is currently with rapid growth, by improvement in genetic selection, optimized nutrition formulation and enhanced management practices. To maximize production efficiency, high-density population for highest yield. However, these conditions often induce stress in chickens, decreased immune function, which consequently leads to decreased production (Liu *et al.,* 2024). Historically, antibiotics used as feed additive in poultry and have been utilized to antibiotic promote growth enhance chicken performance, and prevent illnesses (El-Kasrawy *et al.,* 2023) Nevertheless, the prolonged use of antibiotics in animal feed has raised concerns regarding the development of antimicrobial resistance, the European Union (EU) has implemented restrictions on the use of antibiotics as growth promoters in animal husbandry (Castanon, 2007). Consequently, alternative strategies have been

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incorporated to herb supplements. It has antimicrobial activity, antioxidant and immunomodulatory properties.

Milk thistle (*Silybum marianum*) is a medicinal plant with a long history of use in hepatic disorder therapy. *S. marianum* is rich in bioactive compounds. The important bioactive components of silymarin, the active silymarin complex of four main flavonolignan isomers: silybin (50-60%), silychristin (20%), silydianin (10%), and isosilybin (5%). Additionally, it contains flavonoids such as taxifolin and quercetin (Gillessen and Schmidt, 2020). Phytochemical substances have shown medicinal properties, including antimicrobial activity antioxidant and anti-inflammatory (Taleb *et al.,* 2018).

Artichoke (*Cynara scolymus*) is a native plant in the Mediterranean, it has nutritional value and medicinal properties including liver regeneration, liver detoxification and hepatitis relief. The phytochemical substance of artichoke is rich in polyphenolic compounds, including chlorogenic acid, cynarin, and caffeoylquinic derivatives. Additionally, it contains of flavonoids such as apigenin and luteolin (Salem *et al.,* 2015). These bioactive compounds have shown antimicrobial activity and antioxidant. Furthermore, the inulin substance has been found to have polysaccharide which has prebiotic activity (Demir and Ağaoğlu, 2021).

Ginkgo leaves (*Ginkgo biloba*) have a long history of use in traditional herbal medicine. The leaves extract has shown anti-inflammatory, antioxidant and prevent the cardiovascular, neurological disorders (Zhang *et al.,* 2018). The bioactive compounds including 6% terpenoids consist of ginkgolides A, B, C, J, and M (diterpenes, 2.8-3.4%) and bilobalides (sesquiterpenes, 2.6-3.2%). The 24% flavonoids consist of kaempferol, quercetin, and isorhamnetin being the significant active compounds in this herb (Singh *et al.,* 2019).

The current study aimed to investigate the effects of drinking water supplementation of milk thistle combined with artichoke or ginkgo leaves on growth performance, carcass characteristics and visceral organs in broilers.

Materials and methods

Experimental design, animal, diet and management

In experiment using total, 630 one-day-old commercial male Cobb 500 broilers chick with an average initial weight (45.96 g). The experimental design using the completely randomized design (CRD) were randomly into 3 groups consisting of 6 replicates of 35 birds. The experimental treatment included the first group was a group that without substances. It is a control group (C), the second group added milk thistle 1.5% and artichoke extract 1.5% in drinking

water 1 ml/L (T1) and the last group added milk thistle 0.9% and ginkgo leaves extract 0.9% in drinking water 250 mg/L (T2) for during the entire experiment. Broilers were fed a commercial diet as starter diet (21% of protein) was fed from 1 to 14 days, followed by a grower diet (20% of protein) from 15 to 28 days and finisher (19% of protein) from 29 to 42 days. Feed and water were *ad libitum*. The 35 broilers were raised in each pen (size 1.5 × 2 m^2) bedded by rice husk under an evarpolative cooling system. The temperature was set at 34 °C for the first week. After first week it was reduced to 28 °C. The birds provided constant 24 h light for first week, then were reduced to 18 h light and 6 h dark cycle for the rest of the feeding.

Data collection

Growth performance

Body weights were measured individually at 1, 7, 14, 21, 28, 35 and 42 days of age. Body weight gain (BWG) was calculated as the difference weight of birds at start and finisher. Average daily gain (ADG). Feed intake (FI) was calculated as the difference weight between of feed at the beginning and feed residual of each week. Feed conversion ratio (FCR) is calculated at each week as the amount of feed consumed per bodyweight gain. Mortality rate (%) calculated by subtracting the number of live broilers at the end of week from total number of broilers at the beginning and multiplied by 100.

Carcass characteristics and visceral organs weight

At the end of the experiment (d 42) 2 broilers were randomly selected from each replicate pen and abstained feed for 8 hrs. before slaughtering birds. Each bird was weighed and stunning with CO_2 then slaughtered via neck cut and bled for 2 min. hard scalded at 60 °C for 4 min. then defeathered for 4 min. Following defeathering, carcasses continued through evisceration, immersion, chilling and weighing of visceral organs and chicken parts for all treatments and expressed in percentage demonstrated by USDA (2000).

Statistical analysis

All data were analyzed by one-way analysis of variance (ANOVA) using SPSS statistic software (version 29.0; IBM Corp. Armonk, NY, USA), followed by the Duncan's Multiple Range Test (DMRT). The statistically significant level for the difference was present at p value<0.05.

Results

Growth performance

The broiler chickens supplemented with milk thistle with artichoke or ginkgo leaves extracts were studied. The final body weights (BW) in the control, T1 and T2 were not significantly differed. Additionally, body weight gain (BWG) during each period of the experiment was not significantly differed between the control, T1 and T2 group. However, the average daily weight gain (ADG) in broiler chickens also was not significantly differed between the experimental groups. On the other hand, in term of feed conversion ratio (FCR) in the control group was highest at 35 to 42 days as compared to T1 and T2 group significantly ($P<0.05$), although there were not significantly differed between the groups throughout the entire experiment (Table1). Also, the supplementation of milk thistle, artichoke and ginkgo leaves in broilers drinking water hadtended to decrease the mortality rate at days 14 to 21 ($P = 0.07$).

Table 1. The effect of herb supplementation on growth performance of broilers

Items	Control	T1	T2	Pooled SE	P-value
BW (g)					
d 1	45.37	46.23	46.30		
d 7	178.57	176.26	179.26	1.59	0.75
d 14	491.31	499.15	495.94	4.34	0.78
d 21	989.89	997.42	977.00	8.27	0.62
d 28	1685.38	1670.34	1656.50	19.11	0.84
d 35	2445.08	2358.89	2445.08	31.45	0.55
d 42	3053.41	3037.57	3062.60	41.95	0.97
BWG (g)					
d 1 to 7	133.19	130.03	132.96	1.75	0.74
d 7 to 14	312.74	316.67	322.87	3.15	0.44
d 14 to 21	498.57	498.27	481.05	5.84	0.40
d 21 to 28	695.48	672.91	679.50	12.60	0.78
d 28 to 35	729.70	720.33	728.90	17.55	0.27
d 35 to 42	608.33	678.68	677.20	21.75	0.34
d 1 to 42	3008.00	2991.33	3016.00	41.66	0.97
FI (g/bird)					
d 1 to 7	160.00	159.04	158.00	1.87	0.92
d 7 to 14	384.75	389.96	392.64	3.68	0.70
d 14 to 21	685.88	687.48	690.46	7.48	0.97
d 21 to 28	1054.50	1026.98	1040.15	9.42	0.52
d 28 to 35	1216.44	1120.45	1219.35	28.56	0.29
d 35 to 42	1298.56	1221.84	1240.31	28.43	0.55
d 1 to 42	4800.16	4605.77	4740.92	51.26	0.30

Table 1. (cont.)

Items	Control	T1	T2	Pooled SE	P-value
ADG (g/bird/days)					
d 1 to 7	19.02	18.58	18.99	0.25	0.74
d 7 to 14	44.67	45.23	46.12	0.45	0.44
d 14 to 21	71.22	71.18	68.72	0.83	0.40
d 21 to 28	99.35	96.13	97.07	1.80	0.78
d 28 to 35	108.53	98.36	104.13	2.50	0.27
d 35 to 42	86.90	96.74	96.95	3.10	0.34
d 1 to 42	71.62	71.22	71.81	0.99	0.97
FCR					
d 1 to 7	1.20	1.22	1.19	0.01	0.57
d 7 to 14	1.23	1.20	1.23	0.01	0.19
d 14 to 21	1.37	1.38	1.40	0.01	0.13
d 21 to 28	1.51	1.53	1.54	0.02	0.92
d 28 to 35	1.61	1.63	1.68	0.04	0.82
d 35 to 42	2.2[b]	1.81[a]	1.83[a]	0.07	0.03
d 1 to 42	1.60	1.54	1.57	0.01	0.25
Mortality rate (%)					
d 7 to 14	0.47	0.47	0.47	0.25	1.00
d 14 to 21	2.85	0.00	0.96	0.57	0.07
d 21 to 28	1.51	0.00	1.01	0.59	0.59
d 28 to 35	2.12	1.04	1.20	0.65	0.81
d 35 to 42	1.42	2.08	1.65	0.73	0.90
d 1 to 42	7.61	3.33	4.70	1.27	0.39

[a,b] Means within a row different letters indicate a significant difference ($P<0.05$) T1 = milk thistle and artichoke extract, T2 = milk thistle and ginkgo leaves extract, BW = body weight, BWG = body weight gain, ADG = average daily gain, FI = feed intake, ADG = average daily gain, FCR = Feed conversion ratio

Carcass characteristics and visceral organs weight

The characteristics of chicken carcasses at the end of the experiment (day 42) were analyzed. The live weights of the control, T1 and T2 group were not significantly differed ($P > 0.05$). Similarly, carcass weights were also not significantly differed ($P > 0.05$) between the experimental groups. When, investigate individual chicken parts, including breast, fillet, thigh, drumstick, wing, head and neck, leg, and bottom were not significantly differed ($P > 0.05$) between the experimental groups (Table 2).

The results of visceral organs were not significantly differed ($P>0.05$) between the experimental groups in the weight percentages of esophagus, heart, liver, spleen, gizzard, proventriculus, full intestine, gall bladder and abdominal fat (Table 3).

Table 2. The effect of herb supplementation on carcass trails of broilers

Item	Control	T1	T2	Pooled SE	P-value
Live weight (g)	330.41	3284.16	3365.41	36.65	0.66
carcass weight (g)	2878.16	2836.50	2955.66	34.75	0.39
carcass (%)	87.12	86.41	87.82	0.33	0.23
Breast (%)	26.18	26.27	27.30	0.43	0.53
Fillet (%)	4.61	4.43	4.37	0.07	0.39
Thigh (%)	14.47	15.12	15.21	0.51	0.84
Drumstick (%)	11.39	11.39	11.39	0.07	1.00
Wing (%)	10.41	11.02	10.37	0.19	0.34
Head and Neck (%)	6.08	6.75	5.80	0.20	0.16
Leg (%)	4.06	4.16	4.08	0.04	0.65
Bottom (%)	0.69	0.72	0.76	0.01	0.33

[a,b] Means within a row different letters indicate a significant difference ($P<0.05$)

Table 3. The effect of herb supplementation on visceral organs of broilers

Item	Control	T1	T2	Pooled SE	P-value
Esophagus (%)	0.45	0.50	0.47	0.02	0.72
Heart (%)	0.38	0.38	0.37	0.01	0.98
Liver (%)	1.69	1.79	1.80	0.03	0.45
Spleen (%)	0.07	0.07	0.08	0.00	0.70
Gizzard (%)	0.99	0.93	1.03	0.03	0.47
Proventriculus (%)	0.29	0.27	0.28	0.22	0.76
Full intestine (%)	2.37	2.70	2.55	0.09	0.41
Gall bladder (%)	0.09	0.10	0.09	0.00	0.29
Abdominal Fat (%)	1.30	1.62	1.40	0.06	0.13

[a,b] Means within a row different letters indicate a significant difference ($P<0.05$)

Discussion

This study evaluated the potential of milk thistle and artichoke, or ginkgo leaves extract, which are content for rich of bioactive compound (Shanmugam *et al.,* 2022; Tajodini *et al.,* 2015; Cao *et al.,* 2012). Our study, it was found that the feed conversion ratio (FCR) in T1 and T2, especially finisher period (35 to 42 days) has significant effect ($P<0.05$). The herb supplement could improve growth performance can be seen from the feed intake and the body values. Nevertheless, the study report of milk thistle combination with artichoke or ginkgo leaves remains limited. However, the use of herbal supplementation in drinking water for broilers should be separate considerations such as a dosage of medical herb, a combination of plants, results were also reported by Jahanian *et al.* (2017) reported that silymarin 500 and 1000 mg/kg. in diet increase FCR. Result are similar Shanmugam *et al.* (2022) showed that addition with 200, 400 and 600 mg/kg. of silymarin supplementation in feed has increase BWG. In contrast, Schiavone *et al.* (2007) found 40 and 80 mg/kg. of silymarin supplementation has no effect on growth performance. Similary, recent study of a combination

with milk thistle and artichoke extracts was no found effect on growth performance in difference levels of dosage (Zaker-Esteghamati *et al.,* 2021). Karimi *et al.* (2020) was evaluated potentially of 500 mg/kg artichoke extract supplementation on the growth performance of broilers, the results were found BWG and FCR values at 21–35 days significant of improvement. Unlike a study from Tajodini *et al.* (2015) reported 15 and 30 g/kg. of artichoke powder supplement in fed has lower BWG and increase FCR. Further, Cao *et al.* (2012) showed 4, 7 and 10 g/kg. of ginkgo leaves in fed has decrease FCR. Moreover, the bioactive properties of milk thistle (*Silybum marianum*), artichoke (*Cynara scolymus*), and ginkgo leaves (*Ginkgo biloba*) has explained anti-inflammatory, antibacterial activity, antioxidant, immune-modulatory and improve gut health which are important of growth-promoting. Silymarin a major component of milk thistle, expression antimicrobial activity by inhibit the growth of pathogens in the gastrointestinal tract to alter the digestibility by changing intestinal microflora, while supporting the proliferation of beneficial intestinal bacteria, such as *Lactobacillus* spp. In young broilers, when gastrointestinal development is incomplete, pathogens such as *Escherichia coli* and *Salmonella* spp. They could be damage to gut health. According to Shanmugam *et al.* (2022) was studied the dietary supplementation with silymarin significantly increases *lactobacillus* spp. and tendency to reduces *E. coli* in coliform bacteria group, providing evidence for its role in enhancing gut health. This finding is consistent with Jahanian *et al.* (2017), who reported that silymarin supplementation mitigates mucosal damage, increases villi height, and expands the surface area for nutrient absorption, relate to antibacterial properties. Moreover, Karimi *et al.* (2020) demonstrated that cynarin, which a polyphenolic compound derived from artichoke, possesses potent antioxidant activity, reduce oxidative stress, increase epithelial cell proliferation in the intestines, and improving nutrient digestibility and absorption. The small intestine especially, jejunum is a critical site for nutrient absorption, it is highly sensitive to changing structural in response to oxidative damage, toxins, or harmful bacteria. Under oxidative stress, new enterocytes (absorptive cells) are generated by crypts cells to replace damaged cells, leads to reduced villus height, impairing nutrient absorption. Zhang *et al.* (2012) was found that ginkgolides, bioactive compounds in *Ginkgo biloba*, can be inhibit the growth of harmful bacteria by damaged to cell wall, causing leakage from cell membrane. While flavonoids such as quercetin, another bioactive constituent, acts as a potent antioxidant, reduce to damage epithelial cell by free radical and decreasing cell turnover in the villi and enhancing nutrient absorption capacity. These effects collectively contribute to improved growth performance in broilers. However, appropriate management practices and optimal gut health are also critical determinants of growth and productivity.

Carcass Characteristics serve as indicators for nutrient utilization in muscle development. Muscle mass and abdominal fat are key indicators in the metabolic process, and enhancing yield is a primary objective for producers. This study examined the effects of milk thistle extract combined with artichoke or ginkgo leaves. The findings indicated no significant impact on carcass weight, chicken parts weight including breast, fillet, thighs, wings, head and neck, legs, bottom and visceral organs. These results align with the study by Zaker-Esteghamati *et al.* (2021), which assessed the supplementation of milk thistle extract with artichoke and was found no significant differences in live weight, carcass weight, breast, thighs, wings, abdominal fat, heart, liver, gizzard, and proventriculus. Similarly, Feshanghchi *et al.* (2022) who reported that supplementation with milk thistle powder at 10 g/kg had no significant effect on carcass weight, breast, thigh, liver and abdominal fat. Conversely, Schiavone *et al.* (2007) observed that supplementation with milk thistle extract at 40 and 80 mg/kg resulted in a significant reduction in carcass, breast, and thigh weights, while also significantly decreasing lipid content in the breast and thighs compared to the control group. On the other hand, Niu *et al.* (2017) demonstrated that supplementation with ginkgo leaves dosages at 4, 7 and 10 g/kg significantly increased breast and thigh weights. This is corroborated by Ren *et al.* (2018), who reported that supplementation with ginkgo leaves extract at 400 and 800 mg/kg improved digestion, nutrient absorption and utilization. Can be seen from attributed to the antioxidant properties of flavonoids, which are factors that disrupt the metabolic processes of proteins and lipids. The reduction of free radicals consequently enhances metabolic efficiency and facilitates the utilization of dietary nutrients for muscle synthesis (Zhang *et al.,* 2009).

In conclusion, the effects of drinking water supplementation of milk thistle combined with artichoke or ginkgo leaves on growth performance improve the feed conversion ratio (FCR) and incline to decreased mortality rate. It does not affect to carcass characteristics and visceral organs weight in broilers.

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References

Cao, F. L., Zhang, X. H., Yu, W. W., Zhao, L. G. and Wang, T. (2012). Effect of feeding fermented Ginkgo biloba leaves on growth performance, meat quality, and lipid metabolism in broilers. Poultry Science, 91:1210-1221.

Castanon, J. I. (2007). History of the use of antibiotic as growth promoters in European poultry feed. Poultry Science, 86:2466-2471.

Demir, T. and Ağaoğlu, S. (2021). Antioxidant, antimicrobial and metmyoglobin reducing activity of artichoke (*Cynara scolymus*) powder extract-added minced meat during frozen storage. Molecules, 26:5494.

Gillessen, A., and Schmidt, H. H. J. (2020). Silymarin as supportive treatment in liver diseases: A narrative review. Advances in therapy, 37:1279-1301.

El-Kasrawy, N. I., Majrashi, K. A., El-Naggar, K., Abd Elreheim, A. M., Essa, B. H., Mahmoud, S. F., Ibrahim, S.A., Raafat, M., Abd El-Hack, M. E. and Aboghanima, M. M. (2023). Impacts of supplemental Ginkgo biloba oil on broilers growth, blood indices, intestinal and hepatic morphology and expression of growth-related genes. Poultry Science, 102:102520.

Feshanghchi, M., Baghban-Kanani, P., Kashefi-Motlagh, B., Adib, F., Azimi-Youvalari, S., Hosseintabar-Ghasemabad, B., Slozhenkina, M., Gorlov, I., Zangeronimo, M. G., Swelum, A. A. and Seidavi, A. (2022). Milk Thistle (*Silybum marianum*), Marine Algae (*Spirulina platensis*) and toxin binder powders in the diets of broiler chickens exposed to aflatoxin-B1: Growth performance, humoral immune response and cecal microbiota. Agriculture, 12:805.

Jahanian, E., Mahdavi, A. H., Asgary, S. and Jahanian, R. (2017). Effects of dietary inclusion of silymarin on performance, intestinal morphology and ileal bacterial count in aflatoxin-challenged broiler chicks. Journal of animal physiology and animal nutrition, 101:43-54.

Karimi, M., Samadi, F., Ahmadifar, M., Nateghi, R. and Mashhadizadeh, N. (2020). The effects of artichoke aqueous extract on the growth performance, intestinal morphology, and blood metabolites in broiler chickens. Modern Medical Laboratory Journal, 3:60-68.

Liu, M., Chen, R., Wang, T., Ding, Y., Zhang, Y., Huang, G., Huang, J., Qu, Q., Lv, W. and Guo, S. (2024). Dietary Chinese herbal mixture supplementation improves production performance by regulating reproductive hormones, antioxidant capacity, immunity, and intestinal health of broiler breeders. Poultry Science, 103:103201.

Niu, Y., Wan, X. L., Zhang, X. H., Zhao, L. G., He, J. T., Zhang, J. F., Zhang, L. L. and Wang, T. (2017). Effect of supplemental fermented Ginkgo biloba leaves at different levels on growth performance, meat quality, and antioxidant status of breast and thigh muscles in broiler chickens. Poultry Science, 96:869-877.

Ren, X. J., Yang, Z. B., Ding, X. and Yang, C. W. (2018). Effects of Ginkgo biloba leaves (*Ginkgo biloba*) and Ginkgo biloba extract on nutrient and energy utilization of broilers. Poultry science, 97:1342-1351.

Salem, M. B., Affes, H., Ksouda, K., Dhouibi, R., Sahnoun, Z., Hammami, S. and Zeghal, K. M. (2015). Pharmacological studies of artichoke leaf extract and their health benefits. Plant foods for human nutrition, 70:441-453.

Schiavone, A., Righi, F., Quarantelli, A., Bruni, R., Serventi, P. and Fusari, A. (2007). Use of Silybum marianum fruit extract in broiler chicken nutrition: influence on performance and meat. Journal of Animal Physiology and Animal Nutrition, 91:256-262.

Shanmugam, S., Park, J. H., Cho, S. and Kim, I. H. (2022). Silymarin seed extract supplementation enhances the growth performance, meat quality, and nutrients digestibility, and reduces gas emission in broilers. Animal Bioscience, 35:215-1222.

Singh, S. K., Srivastav, S., Castellani, R. J., Plascencia-Villa, G. and Perry, G. (2019). Neuroprotective and antioxidant effect of Ginkgo biloba extract against AD and other neurological disorders. Neurotherapeutics, 16:666-674.

Tajodini, M., Samadi, F., Hasani, S., Hashemi, S. R. and Samadi, S. (2015). Influence of artichoke (*Cynara scolymus*) leaf powder on growth performance, carcass traits and

blood parameters in broiler chicken. Iranian Journal of Applied Animal Science, 5:141-146.
Taleb, A., Ahmad, K. A., Ihsan, A. U., Qu, J., Lin, N. A., Hezam, K., Koju, N., Hui, L. and Qilong, D. (2018). Antioxidant effects and mechanism of silymarin in oxidative stress induced cardiovascular diseases. Biomedicine & Pharmacotherapy, 102:689-698.
USDA (2000). U.S. Trade Descriptions for poultry. Retrieved from https://www.ams.usda.gov/sites/default/files/media/Chicken_Trade_Descriptions.pdf.
Zaker-Esteghamati, H., Seidavi, A. and Bouyeh, M. (2021). The effects of Cynara scolymus and Silybum marianum on growth, carcass and organ characteristics, immunity, blood constitutes, liver enzymes, jejunum morphology, and fatty acid profile of breast meat in broilers. Food Science & Nutrition, 9:6692-6706.
Zhang, G. F., Yang, Z. B., Wang, Y., Yang, W. R., Jiang, S. Z. and Gai, G. S. (2009). Effects of ginger root (*Zingiber officinale*) processed to different particle sizes on growth performance, antioxidant status, and serum metabolites of broiler chickens. Poultry science, 88:2159-2166.
Zhang, N., Lan, W., Wang, Q., Sun, X. and Xie, J. (2018). Antibacterial mechanism of Ginkgo biloba leaf extract when applied to Shewanella putrefaciens and Saprophytic staphylococcus. Aquaculture and Fisheries, 3:163-169.
Zhang, X., Cao, F., Sun, Z., Yu, W., Zhao, L., Wang, G. and Wang, T. (2012). Effect of feeding Aspergillus niger-fermented Ginkgo biloba-leaves on growth, small intestinal structure and function of broiler chicks. Livestock Science, 147:170-180.

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