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Original Article

The Effect of Zeolite and Organic Acids Supplement on the Performance, Carcass Traits and Blood Parameters of Broiler Chickens

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ABSTRACT

The present study was carried out at Poultry Research Station, Faculty of Agriculture and Veterinary Medicine, Thamar University, with aim to study the effect of dietary supplementation of zeolite and organic acids on the performance of broiler chickens. One hundred eight one-day old broiler chicks (Ross) were purchased and randomly divided into 4 experimental groups each group containing 3 replicates with 9 birds in each replicate.: T1 received basal diet and acts as control, T2 received 2% Zeolite, T3 received acidified drinking water by 1% blend of organic acids and T4 received 2% zeolite with acidified drinking water by 1% blend of organic acids. In the starter period (0-3weeks), the best FCR was for the zeolite group and combined group compared to acidified group and control group, but in the grower period (3-6 weeks) the best FCR was in group of blends with organic acids and combined group than the other treatments. Concerning whole experimental period (0-7 weeks) feed intake and weight gain were better in groups of zeolite and blend of organic acids followed by group of combined supplementations than the control group, however; at the end of the experiment the three treated groups recorded the best FCR indices compared to control. This can prove that supplementing diet had a significant ($P<0.05$) effect on parameters of growth performance. There were significant differences($P<0.05$) in the mean value of carcass at the end of experiment, combined group had the best carcass value followed by blend of organic acids and zeolite groups than control. Regarding the weight of heart, liver, spleen, gizzard and proventriculus, organic acids group recorded higher weights followed by zeolite and combined groups than control group. Total protein was significantly ($P<0.05$) higher in treated groups. however, the blood cholesterol and triglycerides decreased significantly. The results also revealed that, serum urea and creatinine were lower in treated groups than control. It can be concluded that supplementing broiler diets with zeolite in feed and organic acids in water either alone or in combination have a significant effect on broiler performance, carcass traits and blood parameters, and they have a preferable effect to consumers. So these additives can be used efficiently in broiler diets.

INTRODUCTION

Poultry industry is considered as one of the main suppliers of human's animal protein. This industry is rapidly growing and is facing a future without benefit of some biologically and economically effective feed additives. Feed represents 60-70% of the total cost of poultry production. For this reason, the efficient use of feed is extremely important in broiler production (Llanes and Ramirez 2022). For many years' antimicrobial compounds have been used in poultry industry to improve health status and performance of birds by reduction or correction of the population of the bacteria present in the gastrointestinal tract (Smith *et al.*, 1999, Stahl *et al.*, 2000, Thompson *et al.*, 2000). Questioning use of

antibiotic growth promoters (AGPs) in animal production has resulted in withdrawal of these feed additives in the Europe. Consequently, interest in feed additives that may act as alternatives for AGPs is growing (Papatsiros, *et al.,* 2013), but the lack of incentives for pharmaceutical companies to invest in their development remains a significant barrier (Callaway *et al.,* 2021). Zeolites have the ability to gain and lose water reversibly and to exchange constituent ionic cations without major changes of structure. It contained almost 88% calcium-rich clinoptilolite, which is a naturally occurring zeolite that belongs to a family of crystalline aluminosilicate minerals. They have a 3-dimensional, porous structure that is responsible for specific cation exchange capacity. Finally, clinoptilolite's antioxidant effects and restoration of antioxidant defense mechanisms may also be linked to the positive general systemic impact (Pavelic *et al*., 2018). There has been recent interest in the use of natural zeolites as a feed additive and as a means of reducing odor and ammonia emissions from broiler houses (Simona and Camelia 2019).

Organic acids work in poultry, not only as a growth promoter but also as a meaningful tool of controlling all enteritic bacteria, both pathogenic and non-pathogenic (Wolfenden *et al.,* 2007). Moreover, organic acids feeding is believed to have several beneficial effects such as improving feed conversion ratio, growth performance, enhancing mineral absorption and speeding recovery from fatigue. Contrary to antibiotics, organic acids have other properties like; lowering of the chime pH consequently, enhancing of protein digestion (Brzoska *et al.* 2013, Simona and Camelia 2019, Ali *et al.,* 2020). Little data are available on performance of broiler chickens fed with organic acids and zeolite. Therefore, this study was conducted to investigate the effects of dietary supplementation with natural zeolite (clinoptilolite) in feed and the organic acids acidified drinking water, either alone or in combination on the performance, carcass traits and blood parameters of broilers.

MATERIALS AND METHODS

Table 1. Summarizes the suggested experimental design

T &G	Cntrl	Ze	AOs	Ze & OA
Comm. diet	+	+	+	+
Ze in feed	-	+	-	+
OA in water	-	-	+	+

T&G=Treatment, Ctrl=Control, Ze=zeolite, O.Acid

This An experiment was conducted at Division of Veterinary Medicine, Faculty of Agriculture and Veterinary Medicine, Thamar University to study the effect of supplementing broiler diets with zeolite in feed or organic acids in drinking water individually or in combination on the performance, carcass traits and blood serum parameters of broilers during rearing period of broilers (1- 49 days). The Zeolite used in this experiment is a product of Yemen zeolite company and contains clinoptilolite as the active substance, and the blend of organic acids was a commercial acidifier (ACPure®) imported by Yemen Ayadi, and consists of formic, propionic, citric, and lactic acids.

Experimental Chicks and housing

A total number of 108 one-day old of mixed Ross chicks obtained from a local commercial source. Experimental birds were individually weighed (averaged 45 g/ bird). The birds were randomly allotted into four groups, each of 27 chicks with three replicates with 9 chicks in each replicate. All groups were reared under standard managemental condition. The prophylactic measures were taken to control diseases and to increase the viability of the birds. The experimental room of the broilers house properly prepared, disinfected with 4% formalin and divided into four separated compartments of equal size (1.5 x 2m) each of 3 $m^{2.}$. The floor area was bedded by a layer of chaffed sawdust. Experimental compartments were equipped with cylindrical hanging feeders, water fount, gas brooders, all the bird groups were subjected to 24 hours lighting which extended to the age of 7 weeks. Room temperature maintained by gas brooders at 34˚C during the first three days and gradually decreased by 0.5˚C daily till it reaches 25˚C at the end of the third week, then it maintained at 24˚C thereafter till the end of the experiment.

Chicks were investigated to evaluate the effect of supplementing broiler diets with zeolite in feed and/or with acidified drinking water by organic acids for the period of 1-49 days of age on growth performance, carcass traits and blood biochemistry. 1st group, birds were fed with broiler starter and grower commercial diet, 2nd , 3rd and 4thgroups were receiving zeolite in feed, zeolite with organic acids in feeds and water respectively as presented in Table 1. All experimental diets were formulated to meet the nutrient requirements according to NRC (1994) recommendation for broilers.

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Growth performance and feed conversion

Chicks were weighed weekly, live body weight (LBW) and feed consumption was recorded to calculate the body weight gain (BWG) and feed conversion ratio (FCR). The amount of feed consumed was weekly recorded in each bird of the different experimental groups. The average amount of feed intake (FI) by each bird was calculated by dividing the weekly consumed feed by its respective number of living birds in each group at this week.

Regarding the development of the body weight and weight gain, the birds were individually weighed every week and the live weight changes were taken as the criteria of the effect of the different treatments, and as a measure for growth, the amount of feed consumed was divided by the body weight gain of the bird in order to calculate the rate of feed conversion.

Carcass traits and blood samples

Five birds were randomly selected from each group and slaughtered at the end of the experimental period for carcass traits and for blood samples collection. Birds were prohibited from feeding, but not for drinking 12 hours prior slaughtering. The weights of Carcass and internal organs of birds including gizzard, liver and heart were recorded individually at the end of the experiment.

A blood samples were collected from each slaughtered birds of all groups at the end of the experiment. The blood samples were allotted to clot at ambient temperature, centrifuged for 10 minutes at 3000 *rpm*, and serum from each sample was extracted. The serum samples (1ml/vial) were kept at -20°C until biochemical parameters were measured.

Blood biochemistry

Biochemical parameters, including total serum protein and its fractions (albumin and globulin), cholesterol, triglycerides, urea and creatinine were determined using standard test kits supplied by SGM (Roma / Italia).

Statistical analysis

Analysis System (SPSS Inc., Chicago, IL, USA), for analyzing the data were used. The differences ($P<0.05$) among treatment means groups were tested using Duncan's multiple range test.

RESULTS AND DISCUSSION

The effect of zeolite feed or/and organic acids supplement on performance of broilers are presented in Table 2. In the starter period (0-3weeks), there were significant effects($P<0.05$) on LBW, BWG, FI and FCR. It was obvious in this period that birds in the groups of zeolite and the blend of organic acids showed significantly better feed intake and weight gains but the best FCR was for the zeolite group and the combined group than the acidified water group and the control.

Also, there was a significant effect ($P < 0.05$) observed in the grower period (3-6 weeks) and entire period (0-7weeks) for the groups of zeolite and the blend of organic acids which recorded better feed intakes and weight gains but the best FCR in the grower period was for the groups of blend of organic acids and the combined group (Table 2).

Concerning the whole experimental period (0-7 weeks) feed intake was better in the groups of zeolite and the blend of organic acids followed by the group of combined supplementation than the control, (Figure 1). Weight gain also was better in the groups of zeolite and the blend of organic acids followed by the group of combined supplementation than the control (Figure 2). At the end of the experiment, the three treated groups (the zeolite, the blend of organic acids and the group of combined supplementations) showed($P<0.05$) the best FCR indices than the control as presented in Table (2). This study agreed with the other studies which proved earlier that the addition of zeolite or an organic acid-plus-zeolite to the diet, had positive effects on the performance of broilers (Garcia *et al.* 2007, Levic *et al.* 2008, Suresh *et al.,* 2018, Abaş *et al.*, 2011).

The positive effect of zeolite on broiler performance might be attributed to its chemical characteristics by reduction toxic effects of aflatoxins, ammonia and hydrogen sulfide and reduced bacterial contamination of intestine due to its high absorption capacity. Furthermore. Zeolite contained minerals (macro- and microelements) which in an ionic state exist and can be beneficial for birds' growth (Amad, & Al-ansi, 2018). VasiljevI, *et al*. (2021) suggested that zeolite is useful in the elimination of a variety of contaminants from the body or in amelioration of the intestinal status (VasiljevI, *et al*., 2021).

In the present study, There were significant differences in the Mean value($P<0.05$) of carcass at the end of this experiment, the group of combined supplementation had the best carcass mean value followed by the blend of organic acids and the zeolite groups compared to control group. These results are in accordance with findings reported by Abbasi *et al.*, (2018). Regarding the weight of heart liver spleen gizzard and proventriculus, mean values were increased significantly ($P<0.05$) in the treated groups compared to control. The organic acids group recorded higher weights followed by the zeolite and

the combined groups compared to control group, as presented in Table 3. Total protein mean value was significantly (P<0.05) higher in the treated groups. However, the blood cholesterol and triglycerides decreased significantly. Serum urea and creatinine were lower in the treated groups compared to control (Table 4). These results in agreement with findings of Abaş et al. (2011).

Table 2. Effect of zeolite and organic acids on feed intake, body weight, feed conversion rate in broiler chickens

Stage	Experimental treatments			
	Control	Zeolite	Organic Acids	Z. & O.A.
		Feed intake (g/bird)		
(0-3 weeks)	797.89	823.03	820.63	788.67
(3-6 weeks)	2339.31	2569.33	2538.97	2486.08
(6-7 weeks)	1145.89	1059.56	1074.27	1075.63
(0-7 weeks)	4283.09	4451.92	4433.87	4350.38
		Body weight gain (g/bird)		
(0-3 weeks)	379.13 ±6.38^{b}	400.44 ±7.45^{a}	384.72 ±6.74^{ab}	381.85±6.25^{ab}
(3-6 weeks)	1117.16±17.70^{b}	1264.27±21.62^{a}	1279.48±19.11^{a}	1246.16±20.43^{ab}
(6-7 weeks)	543.08 ±13.99^{b}	540.59 ±12.05^{b}	556.62 ±14.80^{a}	551.61 ± 12.97^{a}
(0-7 weeks)	2039.37±31.14^{c}	2205.30±33.23^{a}	2220.82±37.59^{a}	2179.62±32.73^{a}
		FCR (g/g):		
(0-3 weeks)	2.1	2.05	2.13	2.06
(3-6 weeks)	2.09	2.03	1.98	1.99
(6-7 weeks)	2.11	1.96	1.93	1.95
(0-7 weeks)	2.10	2.02	1.99	1.99

**Letters in the same row having the same superscripts are not significantly different (P< 0.05)*

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Table 3. Mean weights of dressed carcass and some internal organs of broilers supplemented with zeolite in feed or/and organic acids in water

Item	Experimental treatments			
	Control	Zeolite	Organic acids	Z. & O.A.
Dressed carcass	71.46± 0.93^{c}	72.1± 1.11^{b}	72.67± 0.91^{ab}	72.94± 1.02^{a}
Heart	0.490± 0.02^{bc}	0.478± 0.04^{c}	0.517± 0.04^{a}	0.510± 0.04^{ab}
Liver	2.25± 0.04^{c}	2.27± 0.05^{bc}	2.32± 0.05^{a}	2.29± 0.03^{b}
Spleen	0.153± 0.01^{b}	0.158± 0.01^{ab}	0.168± 0.03^{a}	0.166± 0.03^{a}
Gizzard	1.490± 0.08^{b}	1.480± 0.05^{b}	1.630± 0.05^{a}	1.620± 0.04^{a}
Proventriculus	0.406± 0.01^{b}	0.420± 0.01^{ab}	0.430± 0.01^{a}	0.421± 0.02^{ab}

**Letters in the same row having the same superscripts are not significantly different (P< 0.05).*

Table 4. Mean blood parameters of broilers supplemented with zeolite in feed or/and Organic acids in water

Item	Treatments and control groups			
	Control	Zeolite	Organic acids	Z. & O.A.
Cholesterol (mg /dl)	114.13±0.6^{b}	107.34±0.6^{ab}	104.06±0.92 ^{b}	102.12±0.6^{b}
Triglycerides (mg /dl)	68.44±0.65^{a}	65.44±0.41^{a}	59.98±0.96 ^{c}	62.65±0.18^{ab}
T-protein (g / dl)	4.32±0.18^{b}	4.54±0.04^{ab}	4.74± 0.19^{a}	4.64± 0.20^{a}
Albumin (g / dl)	2.18± 0.07^{b}	2.30± 0.08^{ab}	2.48± 0.04^{a}	2.37± 0.19^{a}
Globulin (g / dl)	2.14± 0.21^{b}	2.21± 0.03^{ab}	2.26± 0.15^{a}	2.27± 0.20^{a}
Urea (mg/dl)	2.14± 0.04^{a}	1.92± 0.05^{b}	1.98± 0.07^{ab}	1.97± 0.03^{ab}
Creatinine (mg/dl)	0.19± 0.02^{a}	0.17± 0.04^{a}	0.15± 0.01^{ab}	0.14± 0.02^{b}

**Letters in the same row having the same superscripts are not significantly different (P< 0.05).*

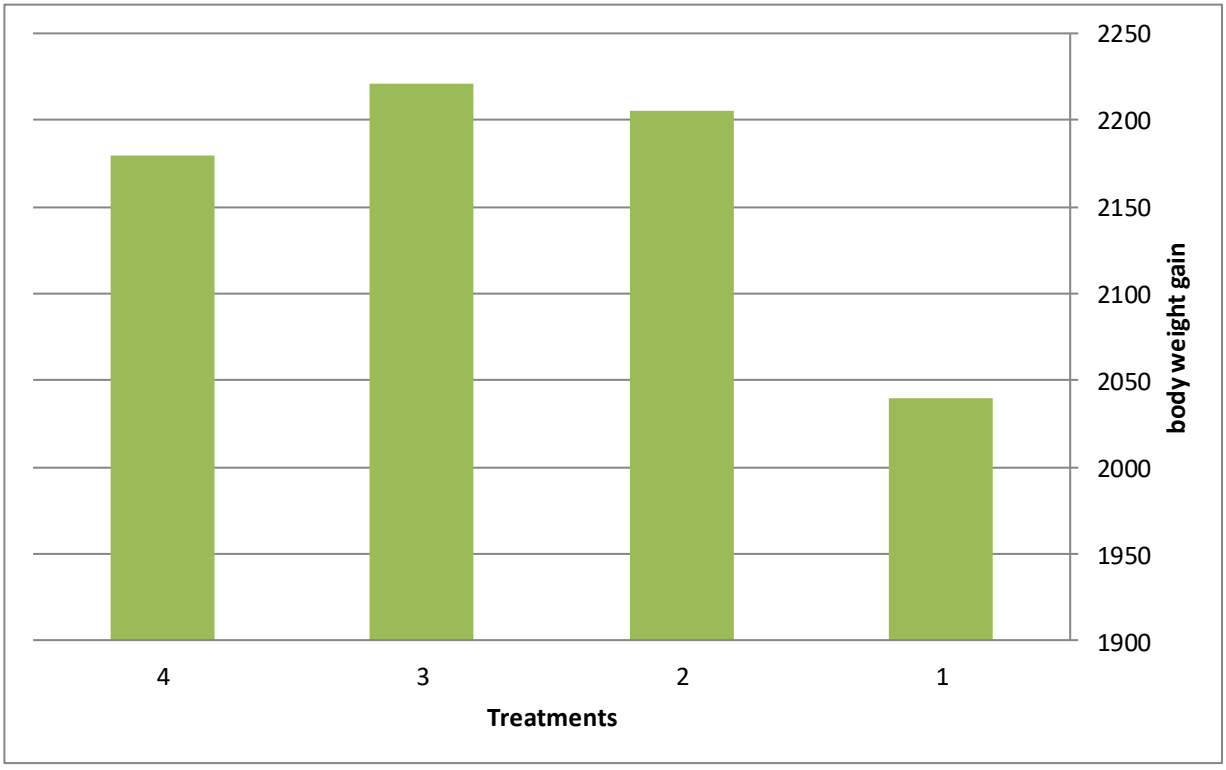

Fig. 1. Body weight gain (gm) of broilers supplemented with zeolite in feed and organic acids in water

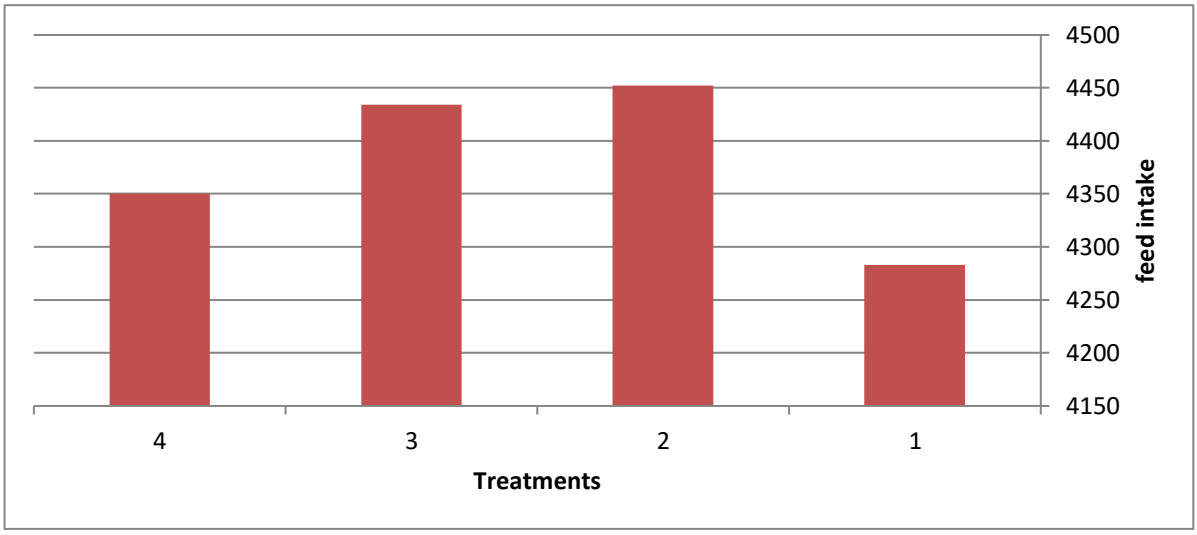

Fig. 2. Feed intake (gm) of broilers of broilers supplemented with zeolite in feed and organic acids in water

CONCLUSION

The present results showed that there are a positive and significant effect of supplementing the broiler diets with zeolite in feed and organic acids in water either alone or in combination on broiler chickens in terms of growth performance, carcass and blood parameters, and they have a preferable effect on to consumers. Thus, these additives can be used efficiently in broiler diets.

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CONFLICTS OF INTEREST

The authors of this article declare that no conflict of interest regarding to this article.

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تأثير اضافة الزيوليت والأحماض العضوية على الأداء وصفات الذبيحة وقياسات الدم في دجاج اللحم

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الملخص

أجريت الدراسة الحالية في المحطات البحثية التابعة لكلية الزراعة والطب البيطري جامعة ذمار، بهدف دراسة تأثير الزيوليت والاحماض العضوية على الأداء وصفات الذبيحة وقياسات الدم في دجاج اللحم، حيث تم توزيع او تقسيم عدد ١٠٨ من كتاكيت اللحم نوع روس بعمر يوم واحد بشكل عشوائي على ٤ مجموعات لتحتوي كل مجموعة على ٢٧ كتكوت مقسمة الى ٣ مكررات في كل منها ٩ كتاكيت.: تم إعطاء المجموعة(1) عليقة اعتيادية (مجموعة السيطرة)،و المجموعة (2) عليقة اعتيادية مضاف لها 2٪ زيوليت (مجموعة الزيوليت)، و المجموعة(3) عليقة اعتيادية مع اضافة مزيج الاحماض العضوية في مياه الشرب بنسبة 1٪ (مجموعة الاحماض العضوية) و المجموعة(4) عليقة اعتيادية مضاف لها 2٪ زيوليت مع اضافة نسبة 1%من مزيج الأحماض العضوية في ماء الشرب (المجموعة المشتركة). كشفت النتائج انه في فترة البادئ (٠-٣ اسابيع)، كان أفضل معامل تحويل غذائي لمجموعة الزيوليت والمجموعة المشتركة(P<0.05)، بينما في فترة النامي (٣-٦أسابيع) كان أفضل معامل تحويل غذائي لمجموعة الأحماض العضوية والمجموعة المشتركة أيضاً مقارنة ببقية المجموعات. وبالنسبة لنتائج الفترة التجريبية كاملة (٠-٧ أسابيع)، كان تناول العلف والوزن المكتسب أفضل في مجموعتي الزيوليت والأحماض العضوية تلتهما المجموعة المشتركة ثم مجموعة السيطرة، وفي نهاية التجربة سجلت المعاملات (الزيوليت والاحماض العضوية والمجموعة المشتركة) أفضل تحويل غذائي (P<0.05) مقارنة بمجموعة السيطرة. لوحظت فروق معنوية (P<0.05)، في نسب التصافي للذبائح عند نهاية هذه التجربة، حيث حققت المجموعة المشتركة أفضل نسبة تصافي للذبيحة تلتها مجموعة الزيوليت ثم مجموعة الأحماض العضوية ثم مجموعة السيطرة. وفيما يتعلق بوزن القلب والكبد والطحال والقانصة والمعدة الغدية فقد سجلت مجموعة الأحماض العضوية أعلى الاوزان تلتها مجموعتي الزيوليت والمجموعة المشتركة ثم مجموعة السيطرة. كما كشفت النتائج ايضا ان البروتين الكلي في مجموعتي (الزيوليت والاحماض العضوية والمجموعة المشتركة) كانت أعلى بكثير عن مجموعة السيطرة، بينما انخفضت نسبة الكوليسترول والدهون الثلاثية، اليوريا والكرياتينين في الدم في المجموعات المعالجة بشكل ملحوظ عن مجموعة السيطرة. نستنتج من هذه الدراسة أن اضافة الزيوليت بالاكل والأحماض العضوية في الماء إما بمفردها أو مجتمعة كان له تأثير كبير على أداء دجاج اللحم وصفات الذبيحة وقياسات الدم، وعليه يمكن استخدام هذه الإضافات بكفاءة في العلائق الغذائية للدواجن.

الكلمات المفتاحية: دجاج اللحم، الذبيحة، قياسات الدم، الاحماض العضوية، الزيوليت

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