

## Effects of Compound Enzyme Preparation and Probiotic Supplementation in Sorghum-Based Diets on Apparent Metabolizable Energy, Slaughter Performance, and Meat Quality in Broilers: A Postprint

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### Abstract

This experiment was conducted to investigate the effects of dietary supplementation with enzyme complex and probiotic in sorghum-based diets on slaughter performance, meat quality, apparent metabolizable energy (AME), and apparent digestibility of major nutrients in Liangfenghua broiler chickens. A total of 900 healthy 1-day-old Liangfenghua male broilers with similar body weight were randomly allocated to 5 groups: control (basal diet), sorghum, sorghum+enzyme, sorghum+probiotic, and sorghum+enzyme+probiotic, with 6 replicates per group and 30 birds per replicate. The entire experimental period lasted 68 days and was divided into three phases: starter (1-28 days), grower (29-56 days), and metabolism trial period (57-68 days). In the treatment groups, sorghum replaced 30% of corn during the starter phase with 200 g/t enzyme complex supplementation; sorghum replaced 50% of corn during the grower phase with 300 g/t enzyme complex supplementation; and 100 g/t probiotic was supplemented throughout the entire period. The results showed: 1) Compared with the control group, the sorghum+enzyme and sorghum+enzyme+probiotic groups exhibited significantly improved apparent digestibility of crude fiber (CF) ( $P < 0.05$ ), while no significant differences were observed in AME or apparent digestibility of other nutrients among all treatment groups ( $P > 0.05$ ). 2) Compared with the control group, the sorghum+probiotic and sorghum+enzyme+probiotic groups showed significantly increased semi-viscerated yield ( $P < 0.05$ ), whereas no significant differences were found in other slaughter performance indices among all groups ( $P > 0.05$ ). 3) Compared with the control group, the sorghum+enzyme+probiotic group demonstrated significantly increased lightness (L) *value of breast muscle* ( $P < 0.05$ ), while the

*redness (a)* value of thigh muscle was significantly decreased in all treatment groups ( $P < 0.05$ ). In conclusion, dietary supplementation with enzyme complex and probiotic in sorghum-based diets can improve the apparent digestibility of CF without exerting adverse effects on broiler slaughter performance or meat quality.

## Full Text

### Effects of Compound Enzyme Preparation and Probiotics Supplementation in Sorghum Diets on Apparent Metabolic Energy, Slaughter Performance, and Meat Quality of Broilers

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**Abstract:** This experiment was conducted to investigate the effects of compound enzyme preparation and probiotics supplementation in sorghum diets on the slaughter performance, meat quality, apparent metabolic energy (AME), and major nutrient digestibility of Liangfenghua broilers. A total of 900 healthy 1-day-old Liangfenghua male broilers with similar body weight were randomly allocated to five groups: control group (basal diet), sorghum group, sorghum+compound enzyme group, sorghum+probiotics group, and sorghum+compound enzyme+probiotics group. Each group consisted of six replicates with 30 broilers per replicate. The total experimental period was 68 days, divided into three phases: early phase (1-28 days of age), late phase (29-56 days of age), and metabolic trial period (57-68 days of age). In the experimental groups, sorghum replaced 30% of corn during the early phase with 200 g/t compound enzyme preparation; sorghum replaced 50% of corn during the late phase with 300 g/t compound enzyme preparation; and probiotics were added at 100 g/t throughout the entire period. The results showed that: (1) Compared with the control group, the apparent digestibility of crude fiber (CF) was significantly increased in the sorghum+compound enzyme group and sorghum+compound enzyme+probiotics group ( $P < 0.05$ ), while no significant differences were observed in AME or the apparent digestibility of other nutrients among all experimental groups ( $P > 0.05$ ). (2) Compared with the control group, the half-eviscerated yield percentage was significantly increased in the sorghum+probiotics group and sorghum+compound enzyme+probiotics group ( $P < 0.05$ ), with no significant differences in other slaughter performance indicators among groups ( $P > 0.05$ ). (3) Compared with the control group, the lightness (L) value of breast muscle was significantly increased in the

sorghum+compound enzyme+probiotics group ( $P<0.05$ ), while the redness ( $a$ ) value of thigh muscle was significantly decreased in all experimental groups ( $P<0.05$ ). In conclusion, supplementation with compound enzyme preparation and probiotics in sorghum diets can improve the apparent digestibility of CF and has no adverse effects on the slaughter performance or meat quality of broilers.

**Keywords:** sorghum; compound enzyme preparation; Bacillus; slaughter performance; meat quality; metabolic energy; nutrient digestibility

Sorghum is an annual gramineous plant with nutritional value similar to corn, which can be used as an alternative energy feed ingredient to replace corn [1]. However, its application in production is limited due to the presence of anti-nutritional factors such as tannins, prolamin, and phytic acid, which affect nutrient digestion and absorption [2]. Wu et al. [3] investigated the effects of compound enzyme preparation supplementation in sorghum diets on apparent metabolic energy (AME) and crude protein (CP) digestibility in broilers, finding that enzyme supplementation improved AME and CP apparent digestibility. Zhang et al. [4] reported that dietary supplementation with *Bacillus subtilis* improved the apparent digestibility of crude fiber (CF), neutral detergent fiber (NDF), and acid detergent fiber (ADF) in Wulong geese aged 5–16 weeks. Lin et al. [5] studied the effects of dietary compound enzyme preparation and probiotics on nutrient utilization and slaughter performance in yellow-feathered broilers, demonstrating that combined use improved nutrient utilization and slaughter performance. However, few reports have examined the combined effects of compound enzyme preparation and probiotics in sorghum diets for broilers. Therefore, this experiment was conducted to explore the effects of compound enzyme preparation and probiotics supplementation in sorghum diets on nutrient digestion, slaughter performance, and meat quality in Liangfenghua broilers, providing a basis for better application of sorghum in animal production.

## 1.1 Experimental Materials

**Experimental animals:** Nine hundred Liangfenghua male broilers were provided by Hunan Xiangjia Animal Husbandry Co., Ltd.

**Enzyme preparation:** Sorghum-specific compound enzyme was provided by a Beijing company, containing tannase (activity 2,000 U/g), xylanase (activity 20,000 U/g),  $\beta$ -mannanase (activity 1,500 U/g), protease (activity 3,000 U/g), and amylase (activity 500 U/g).

**Probiotics:** Containing *Bacillus subtilis*, provided by a Shandong company, with viable bacteria count  $2.97 \times 10^{10}$  CFU/g.

**Sorghum:** American sorghum purchased from Yueyang Port.

## 1.2 Experimental Animals and Grouping

Nine hundred 1-day-old Liangfenghua male broilers were randomly divided into five groups with six replicates per group and 30 broilers per replicate. Initial body weight showed no significant differences among groups ( $P>0.05$ ). The 68-day experimental period was divided into three phases: early phase (1-28 days of age), late phase (29-56 days of age), and metabolic trial period (57-68 days of age). A single-factor randomized design was employed with five dietary treatments: basal diet group (control), sorghum group, sorghum+compound enzyme group, sorghum+probiotics group, and sorghum+compound enzyme+probiotics group. In the experimental groups, sorghum replaced 30% of corn with 200 g/t compound enzyme preparation during the early phase; sorghum replaced 50% of corn with 300 g/t compound enzyme preparation during the late phase; and probiotics were added at 100 g/t throughout the entire period. Broilers were fed mash diets.

## 1.3 Experimental Diets and Nutrient Levels

The basal diets were formulated according to the nutrient requirements for broilers in NRC (1994) and NY/T 33–2004 *Feeding Standard of Chickens*, using corn, soybean meal, rice protein meal, rapeseed meal, and other ingredients. The composition and nutrient levels of experimental diets are shown in Table 1.

**Table 1** Composition and nutrient levels of experimental diets (air-dry basis), %

Items	1-28 days of age		29-56 days of age	
	Control group	Experimental group	Control group	Experimental group
<b>Ingredients</b>				
Corn	58.00	40.60	63.00	31.50
Sorghum	0.00	17.40	0.00	31.50
Soybean meal	25.00	25.00	20.00	20.00
Rice protein meal	5.00	5.00	5.00	5.00
Rapeseed meal	5.00	5.00	5.00	5.00
Oil	3.00	3.00	3.50	3.50
Limestone	1.20	1.20	1.20	1.20
CaHPO <sub>4</sub>	1.80	1.80	1.30	1.30
Premix <sup>1)</sup>	1.00	1.00	1.00	1.00
<b>Total</b>	100.00	100.00	100.00	100.00
<b>Nutrient levels<sup>2)</sup></b>				

Items	1-28 days of age	29-56 days of age	
ME (MJ/kg)	12.54	12.542.96	12.96
CP	21.00	21.009.00	19.00
EE	4.50	4.505.00	5.00
Ca	1.00	1.000.90	0.90
Non- phytate phospho- rus	0.45	0.450.38	0.38
NaCl	0.30	0.300.30	0.30
Lys	1.15	1.151.00	1.00
Met	0.50	0.500.38	0.38
Thr	0.78	0.780.68	0.68
Met+Cys	0.82	0.820.70	0.70

1) The premix provided the following per kg of diets: Cu 25 mg, Fe 96 mg, Mn 105.4 mg, Zn 98 mg, Na 0.9 mg, VA 1,200 IU, VD<sub>3</sub> 2,500 IU, VE 20 mg, VK<sub>3</sub> 3.0 mg, VB<sub>1</sub> 3.0 mg, VB<sub>2</sub> 8.0 mg, VB<sub>6</sub> 7.0 mg, VB<sub>12</sub> 0.03 mg, pantothenic acid 20.0 mg, niacin 50.0 mg, biotin 0.1 mg, folic acid 1.5 mg.

2) Nutrient levels were calculated values.

#### 1.4 Management

Broilers were raised in multi-tier cage systems with continuous artificial lighting. Normal temperature was maintained using boiler heating: 30-33°C at 1-7 days, 27-29°C at 8-14 days, 24-26°C at 15-21 days, and 20-21°C at 27-56 days. The chicken house had natural ventilation, and regular cleaning maintained relative humidity at 55-65%. Broilers had free access to water and feed and received routine vaccinations. At 57 days of age, one healthy Liangfenghua rooster approaching average body weight with normal behavior and feeding was selected from each replicate of each group for individual metabolic trials. After a 5-day preliminary period to observe feed intake, broilers were fasted for 1-2 days until no solid fecal matter was observed. The formal trial lasted 5 days with small, frequent feedings, and metabolic trials were conducted using the total collection method.

##### 1.5.1 AME and Nutrient Apparent Digestibility

Diet samples (1 kg) were collected according to GB/T 14699.1-2005 *Feed Sampling* and reduced to 250 g using the quartering method, then stored in labeled bags at -20°C for analysis.

During the formal period, excreta were collected from trays 4 hours after feeding, with feathers and spilled feed removed. For every 100 g of fresh feces, 20 mL of

10% sulfuric acid was added, and samples were stored at  $-10^{\circ}\text{C}$ . After collection, excreta were dried at  $65^{\circ}\text{C}$  to constant weight, equilibrated at room temperature for 24 hours, and the dry excreta weight per replicate was recorded. Samples were then ground, passed through a 40-mesh sieve, mixed uniformly, and sealed in bags for analysis.

Dry matter (DM) content in diets and feces was determined according to GB/T 6435–2006. Gross energy (GE) was measured using a WZR-1T-B automatic calorimeter. CP content was determined according to GB/T 6432–1994 using a FOSS-2300 automatic Kjeldahl nitrogen analyzer. Ether extract (EE) content was measured by Soxhlet extraction according to GB/T 6433–2006. CF content was determined using an ANKOM A200i semi-automatic fiber analyzer according to GB/T 6434–2006. Ash content was measured according to GB/T 6438–92.

Calculations: - Nitrogen-free extract (NFE) = DM - (ash + CP + CF + EE)  
- Nutrient apparent digestibility in diets (%) =  $100 \times (\text{nutrient intake} - \text{corresponding nutrient in feces}) / \text{nutrient intake}$

AME was calculated by the total collection method: - AME = GE - FUE -  
Where: AME = metabolizable energy intake per broiler per day (MJ); GE = gross energy intake per broiler per day (MJ); FUE = fecal and urinary energy excreted per broiler per day (MJ).

### 1.5.2 Slaughter Performance

At 56 days of age, one broiler approaching the group average weight was selected from each replicate of each group for slaughter and determination of slaughter performance. Referring to NY/T 823–2004 *Poultry Production Performance Terminology and Measurement Statistics*, dressing percentage, half-eviscerated yield, eviscerated yield, breast muscle percentage, thigh muscle percentage, and abdominal fat percentage were calculated:

- Dressing percentage (%) =  $100 \times \text{carcass weight} / \text{pre-slaughter live weight}$
- Half-eviscerated yield (%) =  $100 \times \text{half-eviscerated weight} / \text{pre-slaughter live weight}$
- Eviscerated yield (%) =  $100 \times \text{eviscerated weight} / \text{pre-slaughter live weight}$
- Breast muscle percentage (%) =  $100 \times \text{breast muscle weight} / \text{eviscerated weight}$
- Thigh muscle percentage (%) =  $100 \times \text{thigh muscle weight} / \text{eviscerated weight}$
- Abdominal fat percentage (%) =  $100 \times \text{abdominal fat weight} / \text{eviscerated weight}$

### 1.5.3 Meat Quality Determination

At 56 days of age, one broiler approaching the group average weight was selected from each replicate of each group. After slaughter, conventional meat quality indicators including shear force, cooking loss, drip loss, meat color, and pH were measured within specified time periods using the following methods:

**Shear force:** Measured using a digital muscle tenderness meter (C-LM4, Northeast Agricultural University Engineering College). Immediately after slaughter, one breast muscle and one thigh muscle sample (2.54 cm thick) were taken from each broiler, heated in a water bath or roasted to an internal temperature of 72–75°C, then cooled naturally or at low temperature. Six or more cylinders (1.27 cm diameter) were cut along the muscle fiber direction, and shear force values were recorded by cutting the cylinders along the fiber direction using the tenderness meter.

**Cooking loss:** Breast and thigh muscle samples (2.54 cm thick) were weighed and placed in 0.08 cm-thick polyethylene bags, vacuum-packaged, and heated in a 75°C water bath for 20 minutes. After heating, samples were cooled in 15°C running water for 40 minutes, then removed from bags, surface moisture was blotted with filter paper, and samples were reweighed. Cooking loss was calculated as:  $\text{Cooking loss (\%)} = 100 \times [W_1 - W_2] / W_1$ , where  $W_1$  = fresh muscle weight (g) and  $W_2$  = weight after cooking (g).

**Drip loss:** Within 1 hour post-slaughter, muscle was trimmed into 2 cm × 2 cm × 1 cm blocks and weighed. The block was hooked with thin wire at one end so muscle fibers hung vertically downward, with the other end fixed to the bottom of a plastic cup. The cup was placed in a sealed 保鲜袋 (preservation bag) and stored at 4°C for 24 hours. After removal, surface moisture was blotted with clean filter paper and the block was reweighed. Drip loss at 24 hours was calculated as:  $\text{Drip loss (\%)} = 100 \times [W_3 - W_4] / W_3$ , where  $W_3$  = fresh muscle weight (g) and  $W_4$  = weight after 24 hours (g).

**Meat color:** Breast and thigh muscle samples (30–45 minutes post-slaughter) were placed on a tray with the inner muscle surface kept as flat and smooth as possible. A calibrated colorimeter (CR-400, Konica Minolta Sensing, Inc.) was inserted into the sample to measure lightness (L), *redness* (*a*), and yellowness (*b*<sup>\*</sup>) values on the bone-side muscle surface (free of discoloration, hemorrhage, or bruising). Three repeated measurements were taken and averaged.

**pH:** Measured directly using a portable pH meter (Testo 205, Testo AG, Germany). Breast and thigh muscle samples (45 minutes post-slaughter) were measured by inserting the calibrated probe into the sample to ensure full contact with muscle tissue fluid. The reading was recorded when stable, with three repetitions per sample averaged as the final value.

## 1.6 Data Analysis

Experimental data were preliminarily processed using Excel 2007, then analyzed using one-way ANOVA in SPSS 17.0. If significant differences were detected among groups, Duncan's multiple comparison test was applied, with  $P < 0.05$  as the significance threshold. Results are expressed as "mean  $\pm$  standard deviation."

## 2.1 AME and Nutrient Apparent Digestibility

As shown in Table 3, compared with the control group, the apparent digestibility of CF was significantly increased in the sorghum+compound enzyme group and sorghum+compound enzyme+probiotics group ( $P < 0.05$ ), while the sorghum group and sorghum+probiotics group showed an upward trend without significant difference ( $P > 0.05$ ). Gross energy was equivalent among all groups, and no significant differences were observed in AME or apparent digestibility of ash, DM, EE, NFE, and CP among groups ( $P > 0.05$ ).

**Table 2** Gross energy, apparent metabolic energy, and apparent digestibility of major nutrients

Items	Sorghum+compound		Sorghum+compound enzyme+probiotics		P-value	
	Control group	Sorghum enzyme group	Sorghum+probiotics group	Sorghum+compound enzyme+probiotics group		
GE (MJ/kg)	13.38 $\pm$ 0.18	13.27 $\pm$ 0.34	13.64 $\pm$ 0.33	13.26 $\pm$ 0.24	13.31 $\pm$ 0.23	AME(MJ/kg) 13.38 $\pm$ 0.18 13.27 $\pm$ 0.34 13.64 $\pm$ 0.33 13.26 $\pm$ 0.24 13.31 $\pm$ 0.23

In the same row, values with no letter or the same letter superscripts mean no significant difference ( $P > 0.05$ ), while different lowercase letter superscripts mean significant difference ( $P < 0.05$ ), and different capital letter superscripts mean significant difference ( $P < 0.01$ ). The same as below.

## 2.2 Slaughter Performance

As shown in Table 3, dressing percentage was consistent across groups with no significant differences ( $P > 0.05$ ). For half-eviscerated yield, both the sorghum+probiotics group and sorghum+compound enzyme+probiotics group showed significant increases compared with the control group ( $P < 0.05$ ). Compared with the sorghum group, the sorghum+compound enzyme group, sorghum+probiotics group, and sorghum+compound enzyme+probiotics group showed extremely significant increases in half-eviscerated yield ( $P < 0.01$ ). No significant differences were observed in eviscerated yield, breast muscle percentage, thigh muscle percentage, or abdominal fat percentage among experimental groups compared with the control group ( $P > 0.05$ ).

**Table 3** Effects of compound enzyme preparation and probiotics supplementation in sorghum diets on broiler slaughter performance

Items	Control group	Sorghum group	Sorghum+compound enzyme group	Sorghum+probiotics group	Sorghum+compound enzyme+probiotics group	P-value
Dressing yield	76.5±0.87	91.09±0.30	91.35±0.27	91.44±0.82	91.47±0.72	
Half- <i>Eviscerated yield</i>	82.41±0.84 <sup>Bc</sup>	80.98±1.35 <sup>c</sup>	83.40±1.41 <sup>Ab</sup>	84.52±1.46 <sup>Aa</sup>	84.10±1.54 <sup>Aa</sup>	<
cent- <i>Eviscerated yield</i>	69.67±3.34	67.02±0.81	68.14±0.97	68.37±1.99	68.49±1.33	
<i>Breast muscle percentage</i>						

### 2.3 Meat Quality

As shown in Table 4, no significant differences were observed in pH, shear force, or drip loss of breast and thigh muscles among experimental groups compared with the control group (P>0.05). The L\* value of breast muscle in the sorghum+compound enzyme+probiotics group showed extremely significant differences compared with the sorghum group and sorghum+probiotics group (P<0.01) and significant difference compared with the control group (P<0.05). For thigh muscle a\* values, all experimental groups showed significant differences compared with the control group (P<0.05), while no significant differences were observed among experimental groups (P>0.05). Cooking loss of thigh muscle in the sorghum group and sorghum+compound enzyme+probiotics group showed significant differences compared with the control group (P<0.05), but no significant differences were observed among experimental groups (P>0.05).

**Table 4** Effects of compound enzyme preparation and probiotics supplementation in sorghum diets on broiler meat quality

Items	Control group	Sorghum group	Sorghum+compound enzyme group	Sorghum+probiotics group	Sorghum+compound enzyme+probiotics group	P-value
<b>Breast muscle</b>						



preparation alone showing the best effect. The combined treatment also had significant effects, though slightly weaker than enzyme alone, possibly because probiotics affected intestinal pH, which in turn influenced enzyme-substrate binding and CF digestibility. In this experiment, GE was equivalent across groups, and no significant differences were observed in AME or apparent digestibility of DM, EE, CP, ash, and NFE. After sorghum addition, CP apparent digestibility in all experimental groups was lower than in the control group, possibly due to structural differences between sorghum and corn proteins, or because sorghum tannins bound to digestive proteases, reducing protein digestibility.

### 3.2 Effects of Compound Enzyme Preparation and Probiotics on Slaughter Performance in Sorghum Diets

Slaughter performance is an important indicator of carcass quality in meat-producing animals and is specified in chicken meat standards in many developed countries as an important parameter alongside nutritional value [10]. This experiment showed dressing percentages above 90% and eviscerated yields above 67% across groups, indicating good meat production performance. For half-eviscerated yield, the sorghum+probiotics group and sorghum+compound enzyme+probiotics group showed significant increases of 2.56% and 2.05% compared with the control group, respectively. Among the four experimental groups, the sorghum group had extremely significantly lower half-eviscerated yield than the other three groups. These results are similar to findings by Huang et al. [11] and Liao et al. [12]. However, Li et al. [13] reported that dietary microecological preparation had no significant effects on broiler slaughter performance. He et al. [14] studied the effects of cellulase complex on broiler slaughter performance and found that supplementation significantly increased dressing percentage, half-eviscerated yield, eviscerated yield, and breast muscle percentage, which is similar to our results. In this experiment, except for half-eviscerated yield, no other indicators showed significant differences. Garcia et al. [15] fed broilers with low-tannin and high-tannin sorghum and found no significant effects on carcass yield, which is consistent with our results. Qi et al. [16] also showed that dietary *Bacillus subtilis* had no significant effects on broiler slaughter performance. Overall, the results indicate that replacing corn with sorghum and adding compound enzyme preparation and *Bacillus* preparation in sorghum diets has no adverse effects on broiler slaughter performance, though further research is needed on sorghum dosage, preparation combinations, and supplementation levels for optimal production results.

### 3.3 Effects of Compound Enzyme Preparation and Probiotics on Meat Quality in Sorghum Diets

Meat quality is primarily evaluated through indicators including pH, color, tenderness, and water-holding capacity. pH affects meat flavor because sodium glutamate, an important flavor substance [17], is mainly influenced by pH, with maximum umami taste at pH around 6.0 and disappearance of umami when

pH exceeds 7.0 [18]. High-quality chicken should have pH between 6.0–6.5 at approximately 45 minutes post-slaughter [19]. pH varies slightly among different breeds or within different parts of the same breed [18]. In this experiment, no significant differences in pH of breast or thigh muscles were observed among groups, with all values except breast muscle pH in the sorghum group falling within the 6.0–6.5 range.

Meat color is an important appearance indicator that influences consumer purchase desire, though it is not directly related to nutritional value. Significant differences in meat color exist among different local chicken breeds in China and among different parts of the same breed, mainly due to varying contents of red and white muscle fibers [20]. Poultry meat color is closely related to other meat quality indicators. This experiment used a colorimeter to measure CIELAB (International Commission on Illumination) system L, *a*, and *b*\* values, which provides more objective and accurate quantitative measurement than visual assessment [21]. The *a*\* value indicates myoglobin content and status in muscle. Myoglobin itself is purplish-red; when combined with oxygen, it forms bright red oxymyoglobin, indicating fresh meat. Over time, myoglobin and oxymyoglobin oxidize to brown metmyoglobin, darkening meat color [22]. The *L*\* value indicates muscle brightness, related to color saturation, drip loss, pH, and ambient light [23]. This experiment showed that the *L*\* value of breast muscle in the sorghum+compound enzyme+probiotics group was extremely significantly different from the sorghum group and sorghum+probiotics group and significantly different from the control group. For thigh muscle *a*\* values, all experimental groups were significantly different from the control group, while no significant differences existed among experimental groups.

Water-holding capacity reflects muscle's ability to retain moisture, commonly evaluated by water loss rate, drip loss, and cooking loss in poultry. It is an important meat quality indicator affecting processed meat structure, yield, and color, directly determining economic benefits for meat processors [24]. Lower drip loss and cooking loss indicate higher water-holding capacity [25]. This experiment evaluated water-holding capacity by measuring drip loss and cooking loss. Results showed no significant differences in breast muscle cooking loss compared with the control group, though all values were higher than the control. Significant differences existed in thigh muscle cooking loss among groups, with the sorghum group and sorghum+compound enzyme+probiotics group showing significant increases compared with the control group, though no significant differences were observed among experimental groups.

Muscle tenderness reflects meat texture, depending primarily on muscle tissue components and biochemical changes affecting component characteristics, mainly determined by connective tissue, myofibrils, and sarcoplasmic protein content and chemical structure [26]. This experiment used the C-LM4 mechanical muscle tenderness meter developed by Northeast Agricultural University to measure poultry meat tenderness. No significant differences in shear force of breast or thigh muscles were observed among groups, indicating that probiotics

and compound enzyme preparation supplementation in sorghum diets does not affect meat tenderness.

In conclusion, replacing corn with sorghum and adding compound enzyme preparation and probiotics in sorghum diets has no adverse effects on broiler slaughter performance, meat quality, apparent metabolic energy, or nutrient digestibility, but can improve CF apparent digestibility.

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