Effects of dietary yeast culture supplementation on the meat quality and antioxidant capacity of geese[1]

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Primary Audience: Nutritionists, Researchers, Farmers

SUMMARY

This study aimed to evaluate the effects of dietary yeast culture (**YC**) supplementation on the meat quality and antioxidant capacity of geese. Three hundred geese (live weight: 95.57 ± 2.42 g) were fed a basal diet (control), or diets supplemented with 0.5, 1.0, 2.0, or 4.0% YC for 70 d. Compared with the control, dietary YC supplementation increased ($P < 0.05$) the lightness and redness (***a****) readings and catalase and glutathione reductase activities in the goose meat but decreased ($P < 0.05$) the shear force, myofiber diameter, and drip loss. The effects of YC supplementation on the moisture, crude fat, CP, glutathione, and malondialdehyde contents of the meat varied for the different supplementation levels. Meat from the 2.0% YC group had the highest *a** readings and lowest shear force, myofiber diameter, and drip loss values; meat from the 0.5% YC group had the highest crude fat and CP contents and lowest moisture content; and meat from the 1.0% and 2.0% YC groups had the highest glutathione, catalase, and glutathione reductase activities. Supplementing YC had beneficial effects on the meat quality and antioxidant capacity of geese, with different supplementation levels having different effects.

Key words: yeast culture, geese, meat quality, antioxidant

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DESCRIPTION OF PROBLEM

Geese provide nutritious meat and eggs and are therefore a valuable protein source for humans, as well as producing high-quality liver fat and feathers (Yang et al., 2018). With the rapid increase in demand for goose meat products that are nutritious, healthy, and safe, goose breeding has gradually developed into a large-scale industry; however, this increase in intensification has come with a sudden increase in morbidity rates. The excessive use of antibiotics has therefore become common, as producers attempt to reduce the risk of disease. However, geese, especially goslings, are particularly sensitive to drugs, and the imprudent use of antimicrobials can cause casualties owing to drug poisoning, as well as causing environmental pollution and food safety problems.

[1] Mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by Southwest University and Chongqing Three Gorges Vocational College.

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Prebiotics are defined as nondigestive components of feed that improve the health of the host by selectively promoting the metabolism and proliferation of beneficial bacterial species already resident in the digestive tract (Ziemer and Gibson, 1998; Bindels et al., 2015). They have been proven to be effective antibiotic alternatives for improving the health, metabolism, and productive performance of poultry (Gao et al., 2008; Chen et al., 2017; Tavaniello et al., 2018). Yeast culture (**YC**) is a dried prebiotic product containing yeast and various metabolites of yeast fermentation and is rich in vitamins, saccharides, minerals, enzymes, growth-promoting factors, and amino acids (van der Peet-Schwering et al., 2007; Shen et al., 2009). Several studies have reported that dietary YC supplementation has beneficial effects on meat quality, with Geng et al. (2016) reporting that YC supplementation improved beef quality by increasing fat metabolism. Tavaniello et al. (2018) suggested that prebiotics could have positive effects on the meat quality traits of broiler chickens. In addtion, goose feeds fermented liquid feed with probiotics (*Bacillus subtilis* and *Saccharomyces cervisiae*) were found to increase the superoxide dismutase activity and decrease the malondialdehyde (**MDA**) content of the breast muscles (Chen et al., 2013). However, studies on the effects of dietary YC supplementation on goose meat quality and antioxidant capacity are still scarce, where previously that improves the growth performance including BW, feed intake, and feed conversion ratio (unpublished results). This study aimed to evaluate the meat quality and antioxidant capacity of geese fed diets containing varying quantities of YC.

MATERIALS AND METHODS

All procedures involving animal care and management were in accordance with and approved by the Animal Use and Care Committee of Southwest University.

Experimental Design and Goose Husbandry

Three hundred 1-day-old healthy mixed-sex Sichuan white geese, with average BW of 95.57 ± 2.42 g, were used in a completely randomized study and divided into 5 groups fed either 0% (control), 0.5, 1.0, 2.0, or 4.0% commercial YC product (Beijing Enhalor Biotechnology Co., Ltd., Beijing, China). The YC was a fermented product composed of inactivated *S. cerevisiae* grown on a medium. The ingredient analysis shows that YC contains ∼15.0% CP, ∼3.5% crude fat, ∼8.7% crude fiber, ∼14.2% amino acid, ∼3.3% mannan, ∼14.0% β-glucan, and other microcomponents. The corn–soybean meal basal diets were formulated (Table 1) to meet the recommendations of the NRC (1994) during the starter (Day 1–28) and grower (Day 29–70) periods. Geese were housed in pens (3.5 m × 3.0 m) and net-reared in a windowed poultry house from April to June 2019. Each group consisted of 3 replicate pens with 20 geese per pen. Geese were injected with *Astragalus* polysaccharides

Table 1. Composition and nutrient content of starter (Day 1–28) and grower (Day 29–70) basal diets (dry basis).

Items	Starter	Grower
Ingredients (%)		
Corn	63.80	53.60
Wheat bran	2.99	14.50
Soybean meal	20.00	11.50
Rapeseed meal	4.00	/
Rice bran	/	13.40
Silkworm chrysalis	4.30	1.79
$CaHPO_4$	1.59	0.90
Limestone	0.87	0.75
L-Lysine (98.5%)	0.15	0.18
DL-Methionine	0.05	0.07
Salt (NaCl)	0.20	0.20
Choline chloride	0.05	0.12
Premix[1]	2.00	2.00
Sand	/	1.00
Total	100	100
Nutrient content		
ME ($MJ\cdot kg^{-1}$)[2]	11.97	11.21
CP (%)	20.43	14.81
Crude fiber (%)	4.12	8.04
Calcium (%)	0.87	0.80
Available P (%)[2]	0.43	0.40
Lysine (%)	1.14	0.85
Methionine (%)	0.36	0.30

[1]The premix provide the following per kilogram of diet: VA, 2,000 IU; VD_3, 1,000 IU; VE, 3,000 mg; VK_3, 200 mg; VB_1, 100 mg; VB_2, 1,200 mg; VB_6, 200 mg; VB_{12}, 2.5 mg; nicotinic acid, 600 mg; pantothenic acid, 1,800 mg; folic acid, 200 mg; biotin, 20 mg; Fe, 6 g; Cu, 0.2 g; Mn, 15 g; Zn, 8 g; I, 10 mg; Se, 30 mg.

[2]Calculated values.

(Yongjian Biological, Chongqing, China) and administered multidimensional electrolytes in their water on day 1 and 7. Geese were allowed access to feed (in pellet form) and water ad libitum throughout the experimental period. Feed was provided 4 times daily at 7:30, 12:30, 17:00, and 21:00 h. The average house temperature during the experimental period was 21.32°C ± 2.39°C and the RH was 84.03 ± 5.15%.

Sampling and Measurements

Nine fasted geese randomly selected from each group (3 geese per pen) and sacrificed by cervical dislocation at day 70. Breast muscle samples were collected and divided into 2 parts, one part for measured meat quality and the other part was cryogenically frozen in liquid nitrogen and stored in a –80°C freezer for measuring antioxidant enzyme activities. The basic physical characteristics (shear force, pH, drip loss, and color) and chemical composition (moisture, crude fat, CP, and ash) of meat were measured as per the methods of Zhang et al. (2018). The myofiber diameter was measured as described previously (Zhang et al., 2013). The glutathione, catalase (**CAT**), glutathione reductase, and MDA content were measured using commercial analytical kits as per the manufacturer's instructions (Solarbio, Beijing, China).

Statistical Analysis

Data were analyzed using 1-way ANOVA of SPSS 22.0 software package for Windows (IBM Corporation, 2014) with least significant difference multiple comparison tests. The effect of supplemental levels of YC was determined using orthogonal polynomials for linear and quadratic effects. Variability in the data is expressed as the SEM, and a probability level of $P \leq 0.05$ was considered to be statistically significant.

RESULTS AND DISCUSSION

Meat Quality

Yeast culture supplementation had no effects on the meat pH and yellowness (***b****) readings and ash contents (Table 2). In general, compared with the control, the YC supplementation increased ($P < 0.05$) the lightness (***L****) and redness (***a****) readings of the meat, while decreasing ($P < 0.05$) the shear force, myofiber diameter, and drip loss. The highest *a** readings and lowest shear force, myofiber diameter, and drip loss values were found for the geese supplemented with 2.0% YC. A lower shear force value indicates tenderer meat, with these results concurring with those of Geng et al. (2016), who reported that YC supplementation improved beef tenderness. However, Pelicano et al. (2005), Gomes et al. (2009), and Geng et al. (2016) reported that meat pH, drip loss, and color (*L**, *a**, and *b**) values were not affected by the supplementation of prebiotics. In contrast, studies on broilers (Maiorano et al., 2012; Tavaniello et al., 2018) and lambs (Rufino et al., 2013) indicated that dietary prebiotic supplementation reduced the meat pH and *L**, *a**, and *b** readings. Here, we speculate that it may be related to changes in muscle-fiber types (Zhao et al., 2012), but the specific mechanism is not yet clear.

Yeast culture supplementation at 1.0 and 4.0% significantly increased the moisture content, at 0.5 and 2.0% significantly increased the crude fat content, and at 0.5% significantly increased the CP content ($P < 0.05$), while 1.0 and 4.0% YC significantly decreased the crude fat content relative to the control ($P < 0.05$). Yeast preparations have been found to improve animal energy intake and ME, which in turn, affects the growth of protein and fat deposition (Hhansen et al., 2017; Purchas et al., 2002). Rufino et al. (2013) showed that inactive dry yeast supplementation increased the meat CP and ash content and decreased the intramuscular fat content in lambs. However, Geng et al. (2016) reported that YC supplementation had no effect on the meat ash, protein, or intramuscular fat content in finishing bulls. Similar results were also reported by Gomes et al. (2009), who observed no effects of YC supplementation on the fat content of the meat from feedlot finished steers. These conflicting results may be linked to differences in the formulations and organisms present in the products supplemented, the duration of the supplementation and dosages applied, the nutritional densities of the basal diets, and the animal species tested.

Table 2. Effects of the dietary supplementation of yeast culture to geese on meat quality.

	Yeast culture supplementation (% of diet)						*P*-value	
Items	0	0.5	1.0	2.0	4.0	SEM	L	Q
Physical characteristics								
Shear force (N)	33.52^{a}	30.57^{b,c}	31.14^{b}	29.93^{c}	32.29^{a}	0.30	0.90	0.21
Myofiber diameter (μm)	16.11^{a}	15.92^{a,b}	15.79^{b}	15.14^{c}	15.77^{b}	0.08	0.55	0.12
pH	6.03	5.96	5.93	6.00	6.02	0.04	0.18	0.14
Drip loss (%)	6.43^{a}	5.56^{b}	4.78^{c}	4.58^{d}	5.34^{e}	0.05	0.53	0.15
L^*	49.23^{a,b}	48.70^{a}	50.70^{c}	50.17^{b,c}	50.37^{c}	0.33	0.30	0.50
a^*	7.90^{a}	9.07^{b}	8.77^{b}	9.80^{c}	8.23^{a}	0.12	0.95	0.16
b^*	11.93	12.10	11.57	11.87	11.33	0.31	0.12	0.37
Chemical composition								
Moisture (%)	75.54^{a}	74.70^{a}	76.67^{b}	75.27^{a}	76.91^{b}	0.25	0.29	0.61
Crude fat (%)	2.06^{a}	2.49^{b}	1.69^{c}	2.65^{b}	1.65^{c}	0.06	0.58	0.68
CP (%)	20.20^{a}	21.13^{b}	19.64^{a}	20.39^{a,b}	19.52^{a}	0.29	0.34	0.68
Ash (%)	1.36	1.36	1.50	1.34	1.25	0.08	0.27	0.43

[a-c]Means in the same row with different superscript letters differ significantly ($P < 0.05$).

Orthogonal contrasts: L = linear and Q = quadratic effect of yeast culture supplementation.

Abbreviations: a^*, measure of redness; b^*, measure of yellowness; L^*, measure of lightness.

Nonetheless, the increase in fat deposition caused by the supplementation of yeast preparations has a positive effect on meat tenderness (Swyers et al., 2014; Geng et al., 2016), and the results for these 2 parameters are consistent in this study.

Antioxidant Enzymes

As shown in Table 3, CAT and glutathione reductase activities were higher in meat samples from the YC-supplemented geese than the controls ($P < 0.05$), whereas the MDA content was lower in the samples from the 2.0 and 4.0% YC groups ($P < 0.05$). The glutathione activity was significantly higher in the 1.0 and 2.0% YC groups ($P < 0.05$) but lower in the 4.0% YC group ($P < 0.05$) than in the control. In addition, the 1.0% YC group had higher ($P < 0.05$) CAT and glutathione reductase activities than the 0.5, 2.0, and 4.0% YC groups did. A similar study on broilers reported that probiotic supplementation increased the SOD activity and decreased the MDA contents of the breast muscles of geese (Chen et al., 2013). Tagang et al. (2013) also showed that yeast probiotic supplementation increased the serum glutathione peroxidase and CAT activities in broiler meat. This may be linked to the antioxidant effects of the mannan and β-glucan contained in YC (Kogan et al., 2008; Krizková et al., 2001). However, our results contrasted with the findings of Maiorano et al. (2017), who reported that the MDA content was higher in meat from broilers provided with a prebiotic treatment. These differences may be linked to the higher susceptibility of broiler chickens to oxidative stress, as a result of their intensive genetic selection for improved productive performance (Sihvo et al., 2014). Furthermore,

Table 3. Effects of the dietary supplementation of yeast culture to geese on the antioxidant enzyme activities and MDA content of the meat.

	Yeast culture supplementation (% of diet)						*P*-value	
Items	0	0.5	1.0	2.0	4.0	SEM	L	Q
GSH (μmol/g)	0.89^{a}	0.85^{a}	1.23^{b}	1.92^{c}	0.55^{d}	0.07	0.90	0.29
CAT (U/mg)	1.59^{a}	2.05^{b}	2.59^{c}	2.26^{b}	2.25^{b}	0.07	0.46	0.36
GR (U/g)	24.37^{a}	25.52^{a}	48.92^{b}	43.49^{b}	33.82^{c}	1.51	0.64	0.32
MDA (nmol/mg)	4.27^{a,b}	4.39^{a}	3.92^{b,c}	3.69^{c}	3.65^{c}	0.14	0.07	0.15

[a-c]Means in the same row with different superscript letters differ significantly ($P < 0.05$).

Orthogonal contrasts: L = linear and Q = quadratic effect of yeast culture supplementation.

Abbreviations: CAT, catalase; GR, glutathione reductase; GSH, glutathione; MDA, malondialdehyde.

4.0% YC was not more effective in present study, which may be owing to the high level of YC disrupted the nutritional and energy metabolism balance.

CONCLUSIONS AND APPLICATIONS

1. At appropriate levels, dietary YC supplementation had a positive effect on the meat quality and antioxidant capacity of geese.
2. The supplementation of 2% YC produced the best physical meat properties, and 0.5% YC produced the best chemical meat composition.
3. The 1 and 2% YC supplementation resulted in the most improvement of the geese's antioxidant capacity.
4. Further research is needed to determine the most appropriate dietary YC level to optimize both the meat quality and antioxidant capacity of geese.

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DISCLOSURES

The authors declare no conflicts of interest.

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