

## Antioxidant Effect of *Monascus koji* in Sausage Mixture

– Research Note –

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### Abstract

The antioxidative capacity of *Monascus koji* was studied in raw bologna-type sausage by measuring thiobarbituric acid reactive substances (TBARS) and peroxide values (POV) during storage at 25°C for 7 days. The addition of 2% *Monascus koji* effectively inhibited lipid oxidation in the mixture without vitamin C and NaNO<sub>2</sub>, evidenced by its prevention of an increase in TBARS and a significantly reduction in increases in POV. *Monascus koji* in raw minced processed meat significantly improved the shelf life of the food.

**Key words:** antioxidant effect, *Monascus koji*, POV, TBARS

### INTRODUCTION

For centuries the fungal genus *Monascus* has traditionally been used as a source of bright red pigments in some Asian countries. *Monascus koji*, the product of the *Monascus* fungus grown on rice grains, has been added to many foods to give color, improve flavor, and to preserve the foods (1). *Monascus koji* is also a traditional Chinese medicine. The biological actions of fungi used as traditional medicines have been the subject of numerous scientific investigations (2-6); narrowing the knowledge gap between traditional use and scientific use of the fungi. In this study, *Monascus koji* was tested for its ability to replace traditional food additives in processed meat products (7-9). Others have also reported that it has hypocholesterolemic effects when used as a dietary supplement and hypotensive food (10,11). The present study was conducted to examine the addition of *Monascus koji* to processed meat, with the aim of increasing the shelf life of raw bologna-type sausage.

### MATERIALS AND METHODS

#### Preparation of *Monascus koji*

*Monascus koji* was prepared according as previously reported (6) with *M. ruber* IFO 32318 which was selected by preliminary experiments from thirty seven *Monascus* strains for application to meat products. The *koji* powder was screened through a 30 mesh screen before being added to the sausage mixture.

#### Preparation of raw meat patties

The bologna-type sausage mixtures were prepared as follows (per kg mixture): 200 g beef, 400 g pork, 200 g pork fat, 200 g ice, 16 g salt, 3 g phosphate, 5 g sugar,

0.5 g MSG, 6 g seasoning mixture (ginger, garlic, onion, pepper etc.), 0.2 g vitamin C, and 0.09 g NaNO<sub>2</sub> for control I; the same mixture without vitamin C and NaNO<sub>2</sub> was the control II. The control I and II samples had no *Monascus koji*. To make the *Monascus* experimental mixture, 20 g/kg of *Monascus koji* was added to the control II mixture. All samples were divided into 50 g portions and sealed in polyethylene films. Samples were randomly assayed over the storage period: fresh (0 day), and stored at 25°C for 2, 4 and 7 days.

#### Analytical methods

The extent of lipid oxidation was assayed by the thiobarbituric acid reactive substances (TBARS) test and expressed as malondialdehyde (MDA) mg per kg meat (12), and peroxide value according to AOCS (13) with a slight modification and expressed as milliequivalent peroxide per kg meat.

#### Statistical analysis

For statistical evaluations, Student-Newman-Keuls test and one-way analysis of variance (ANOVA) were used. Data are expressed as the mean  $\pm$  standard deviation (SD) of three replicates.

### RESULTS AND DISCUSSION

#### Effect of *Monascus koji* on lipid oxidation

Table 1 shows the concentrations of TBARS produced in raw sausage mixtures during storage at 25°C. There were no significant changes in TBARS in control I during storage; however, there was a continuous increase in samples without vitamin C and NaNO<sub>2</sub> (control II). At the beginning of the experiment, TBARS concentrations in control

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**Table 1.** Effect of *Monascus koji* on TBARS content of raw bologna-type sausage mixture during storage

Sample	TBARS (MDA mg per kg meat)			
	Storage days			
	0	2	4	7
Control I	0.247 ± 0.005 <sup>1)a2)</sup>	0.251 ± 0.002 <sup>a</sup>	0.253 ± 0.011 <sup>a</sup>	0.253 ± 0.011 <sup>a</sup>
Control II	0.352 ± 0.009 <sup>b</sup>	0.375 ± 0.054 <sup>b</sup>	0.486 ± 0.165 <sup>b</sup>	0.514 ± 0.075 <sup>b</sup>
<i>Monascus</i>	0.351 ± 0.003 <sup>b</sup>	0.336 ± 0.015 <sup>b</sup>	0.315 ± 0.011 <sup>a</sup>	0.316 ± 0.017 <sup>a</sup>

<sup>1)</sup>Values expressed as mean ± SD of three samples.

<sup>2)</sup>Values of different superscripts within the same column are significantly different at  $p < 0.05$  level among groups by Student-Newman-Keul test.

**Table 2.** Effect of *Monascus koji* on peroxide value in raw bologna-type sausage mixture during storage

Sample	POV (meq peroxide per kg meat)			
	Storage days			
	0	2	4	7
Control I	0.04 ± 0.01 <sup>1)a2)</sup>	1.72 ± 0.07 <sup>a</sup>	2.29 ± 0.07 <sup>a</sup>	3.83 ± 0.31 <sup>a</sup>
Control II	0.04 ± 0.02 <sup>a</sup>	7.98 ± 0.07 <sup>b</sup>	9.01 ± 0.44 <sup>b</sup>	8.88 ± 0.00 <sup>b</sup>
<i>Monascus</i>	0.04 ± 0.01 <sup>a</sup>	1.68 ± 0.13 <sup>a</sup>	2.46 ± 0.07 <sup>a</sup>	3.79 ± 0.19 <sup>a</sup>

<sup>1)</sup>Values expressed as mean ± SD of three samples.

<sup>2)</sup>Values of different superscripts within the same column are significantly different at  $p < 0.05$  level among groups by Student-Newman-Keul test.

II and *Monascus* samples were more than 40% higher than control I. After 4 days of storage there were no significant differences in TBARS concentrations between control I and *Monascus* samples. These results demonstrate that *Monascus koji* can prevent oxidative rancidity in raw sausage mixture for up to 7 days.

#### Effect of *Monascus koji* on the peroxide value

Table 2 shows the changes in peroxide values (POV) during storage. The POV increased steadily in all sausage samples during storage at 25°C, but in control II samples, those without vitamin C and NaNO<sub>2</sub> (control II) or *Monascus koji*, the POV increased much more rapidly. Although POV increased in both control I and *Monascus* samples, there were no significant differences between them at any time point, and both were significantly lower than control II samples at all but the initial time points. These results suggest that *Monascus koji* is an effective antioxidant preservative for raw sausage mixture during storage at 25°C for up to 7 days, and may be as effective as the combination of ascorbic acid and NaNO<sub>2</sub>.

Several studies on the effect of *Monascus* extracts as color enhancers have indicated that *Monascus* pigments functioned as viable substitutes for nitrite salts and nitrate, which are traditionally added to enhance meat color (7-9). Our results demonstrated that *Monascus koji* also reduced lipid oxidation, as demonstrated by lowering the concentrations of malondialdehyde and peroxide values. Further investigation is needed to determine optimal concentrations of *Monascus koji* in various processed meats to max-

imize nutritional quality and sensory appeal. It is concluded that *Monascus koji* may serve dual functions as both a functional food and as an effective food preservative.

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