EFFECTS OF CURING AGENTS AND CURING TIME ON SAUSAGE TASTE: EVALUATION BY TASTE SENSOR AND ANALYSIS OF BIOCHEMICAL PROPERTIES

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Abstract—**The purpose of this study is to clarify the effects of curing agents and curing time on sausage taste with the application of biochemical analysis and a taste sensor. Canadian pork was used for this study. Samples were treated either independently or in combination with 1.5% salt, 0.02% nitrite and 0.3% phosphate. Sensory evaluation showed a distinct increase in taste as a result of the addition of curing agents. The taste sensor showed that taste was affected by the curing agents in the order of salt, nitrite and phosphate. Each test sample was plotted in a planned position of the principal component analysis (PCA) diagram, depending on the kinds of curing agents added. As curing time increased, those positions shifted toward certain directions. Biochemical analysis revealed that the addition of nitrite inhibited a decline in inosinic acid with curing. It was presumed that this effect was one of the factors involved in improved test sample palatability. The taste sensor method may be applicable as a quantitative method for evaluating taste characteristics generated during curing.**

Index Terms— **cooked meat product, curing agent, curing time, taste sensor**

I. INTRODUCTION

It is known that the taste of raw meat, in terms of both flavor and palatability, generally increases when it is aged at low temperatures for a few days after slaughter. Freshly slaughtered raw meat needs to go through the aging process in order to become ready for consumption. The term aging is also used in meat product processing. This aging is found in cooked meat product manufacturing processes, such as in some types of ham, sausage and bacon manufactured in Japan. Japanese Agricultural Standards (JAS) define aging as the process of storage at a low temperature for a distinct period after the addition of curing agents (salt, nitrite and phosphate) to the raw materials. The addition of salt has been shown to increase binding capacity and water holding capacity, while phosphate is used to reinforce such capacities (Gök, Kayaardi, & Obuz, 2009). Nitrite is used to stabilize the meat color and to suppress the growth of *Clostridium botulinum* (Reddy, Lancaster, & Cornforth, 1983). In addition, it is widely known that a characteristic taste is imparted on the meat during curing. It is difficult to clarify by sensory evaluation that a characteristic taste is generated with curing time. In recent years, there have been several reports on the evaluation of food tastes using a taste sensor (Okayama *et al*., 2006). The advantage of a taste sensor is that it can assess tastes that cannot be evaluated by taste component analyses.

The present study aimed to clarify the effects of curing agents and curing time on the taste of sausage using a taste sensor and biochemical analysis.

II. MATERIALS AND METHODS

A. Sample preparation

Canadian pork shoulder was obtained from Itoham Foods Inc. After removing the connective tissue and fat, the shoulder was chopped and minced. Test samples of the minced meat were combined with 1.5% salt, 0.02% nitrite and 0.3% phosphate as curing agents, either individually or in combination (Table 1). Heat treatment was then performed for all samples after 0 to 168 h of storage at 4°C. A standard heating process was employed, which was the same as for general cooked meat products

B. Sensory evaluation

Twelve grams of the treated samples were mixed with 88 g of distilled water and heated for 60 min. After cooling, the samples were filtered using Advantec No.1 filter paper and offered to the panelist.

Table 1. Test sample composition. (%)

	Control	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6
Meat	85	85	85	85	85	85	85
Ascorbate	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Salt	-	1.5	-	-	1.5	1.5	1.5
Nitrite	-	-	0.02	-	0.02	-	0.02
Phosphate	-	-	-	0.3	-	0.3	0.3
Distilled water	14.88	13.38	14.86	14.58	13.36	13.08	13.06

C. Taste sensor

The Taste Sensory System SA402B (Intelligent Sensor Technology, Japan), which imitates the human tongue, was used. The detection sensor consisted of five electrodes composed of lipid / polymer membranes (Kobayashi, Habara, Ikezaki, Chen, Naito, & Toko, 2010). The principal component analysis (PCA) was carried out using analytical data from this system, and first main component (PC 1) and second main component (PC 2) were chosen.

D. Biochemical analysis

The nucleotides of the test samples were extracted and analyzed by the HPLC method reported by Watanabe, Tsuneishi, & Takimoto (1989). The amino acids of the test samples were analyzed by HPLC, using an amino acid analysis column (Shim-pack Amino-Na 6.0 mm i.d. × 10 cm, Shimadzu, Japan).

E. Statistical analysis

Each result is expressed as the mean ± SEM. The statistical significance of differences was evaluated using Student's t-test (Snedecor & Cochran, 1967).

III. RESULTS AND DISCUSSION

Among the test samples used in the present study, the product of test 6 at 0-h curing time refers to a simple model for standard commercially available sausage, and the product of test 6 at 168-h curing time refers to that of aged sausage.

In order to clarify the effect of curing agents, sensory evaluation between control (without curing agents) and test 6 (with all curing agents) at 0-h curing time was carried out. Test 6 was evaluated as being superior for all parameters, such as strength, umami, complexity, duration, richness, and overall acceptability, which indicates that the taste of the extracts was dramatically changed by the addition of curing agents.

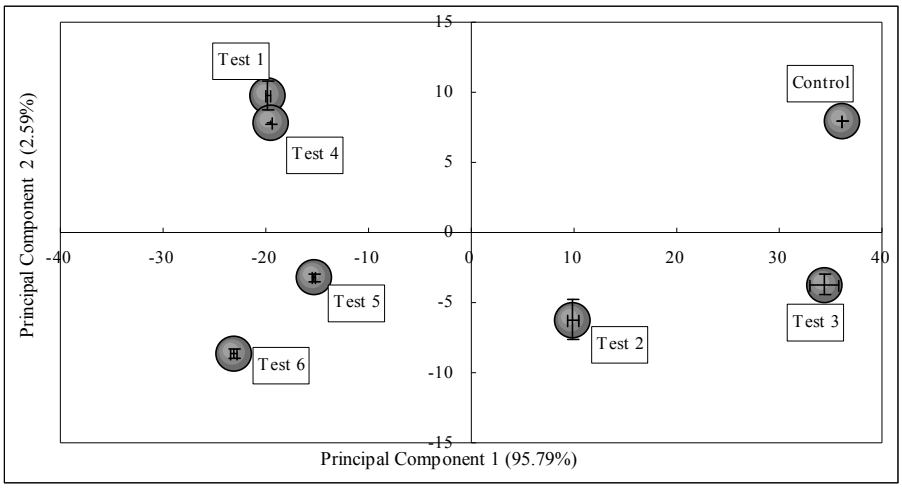

Figure 1. Principal component analysis diagram of all test samples at 0-h curing time using the taste sensor. Values are plotted as mean ± SEM.

Figure 1 shows the results of the principal component analysis of detected values after measuring the test samples using the taste sensor. Contribution levels to the taste were 95.79% and 2.59% on the X-axis (PC 1) and Y-axis (PC 2), respectively. Comparing the control to test 6, the plotted position of test 6 was furthest from that of the control, which was similar in the sensory evaluation. Salt had the greatest influence on taste, followed by nitrite. Although the addition of nitrite as well as salt could promote changes in taste, its strength was equivalent to the phosphate. In combination

with other curing agents, the effect of nitrite might be slightly reduced as compared to nitrite alone. Differences in the position on the PCA plot suggest that the taste sensor may be more effective than the conventional method in assessing taste-related compounds.

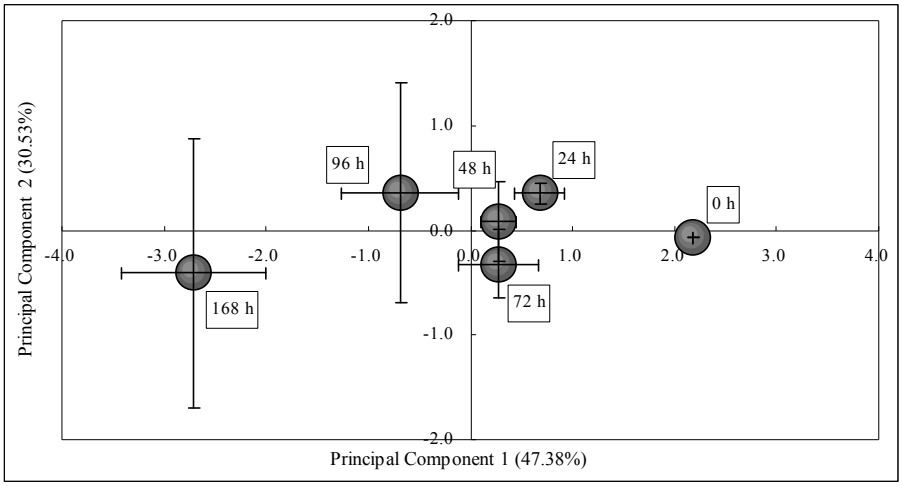

Figure 2. Principal component analysis plot of taste sensor data for test 6 products at 0- to 168-h curing times. Values are plotted as mean ± SEM.

Figure 2 shows the results of the PCA analysis of taste sensor data measured in test 6 samples at 0 to 168 h of curing. Contribution levels to taste are 47.38% and 30.53% on the X-axis and Y-axis, respectively. The sample's position on the PCA plot was dependent on the duration of curing. PC 1 changed significantly with curing time, whereas PC 2 changed slightly, indicating that changes in taste during curing may be affected by several factors.

Biochemical analyses indicated that generation of new ingredients was not identified during curing. Figure 3 shows changes in free amino acid and inosinic acid content in the control and test 6 samples. Inosinic acid content was always significantly higher in test 6 than in the control. Inosinic acid levels were similar in test 2 and test 4, the nitrite added samples (data not shown). In all tests, the total amount of free amino acids increased with curing time; however, the content of glutamic acid, a taste-contributing amino acid, did not change throughout the test period. Yamaguchi (1967) has proposed a synergy effect of glutamic acid with inosinic acid on the strength of umami or palatability resulting from the levels of inosinic acid residue. The addition of the curing agents inhibited a decline of inosinic acid during curing. Thus, the taste of the test samples (with curing agents) was improved by the synergistic interaction between glutamic acid and inosinic acid compared to that of control. Simultaneously, the increase of free amino acid also improved overall accessibility of the taste.

In the present study, it was shown that a taste sensor was able to evaluate complex tastes. Further investigations are needed to ascertain the relationship between the output of taste sensors and sensory evaluations using panelists..

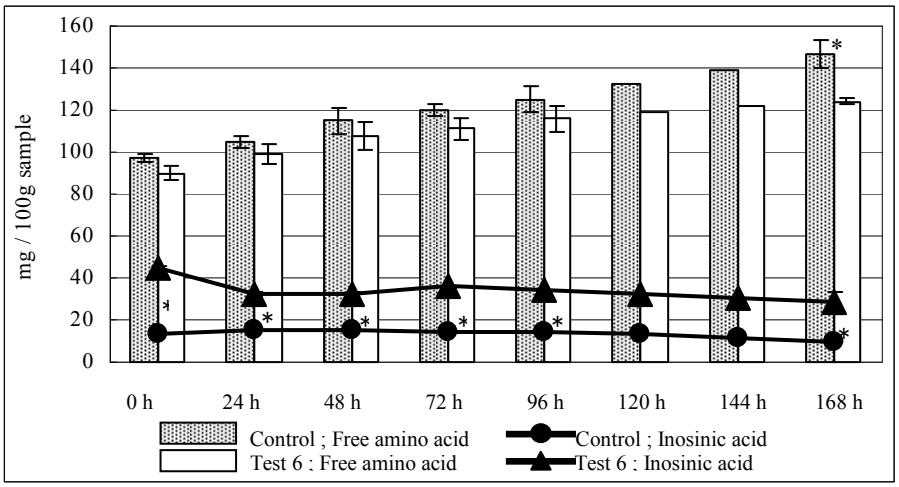

Figure 3. Changes in the content of free amino acids and inosinic acid in the control and test 6 samples. Values are plotted as mean ± SEM. *Treatments with different letters are significantly different ($p < 0.05$).

IV. CONCLUSION

In the sensory evaluation between control and test 6 at 0-h curing time, test 6 was superior in all tested parameters, indicating that the taste of the extracts was dramatically changed by the addition of curing agents. The principal component analysis plot of taste sensor data showed that the plot position of each test sample depended on the types of curing agents. Biochemical analysis revealed that the addition of curing agents suppressed a decline in inosinic acid levels.

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