EVALUATING STABILITY OF RESTRUCTURED PORK ADDED WITH GINGER EXTRACTS BY MEANS OF CHEMICAL AND SENSORY ANALYSIS

N.M. Dang
Faculty of Chemical Engineering, College of Technology, Da Nang University
Email: dm_nhat@yahoo.com

Abstract

The aim of the study was to examine the possibility to use ginger extract for stabilizing restructured pork. Ginger extracts were prepared by extraction with ethanol. The extracts were added to minced pork at concentration of 0.1%, 0.2%, 0.3% and 0.4% with regard to dry matter. The samples were then subjected to bake at 180°C and store at 4°C. During the storage, samples were taken for measurement of the malonaldehyde content and sensory evaluation of appearance, flavour and taste using 1-10 intensity scale. The results have shown ginger extracts retard the autooxidation of lipid and have a positive effect on the sensory quality of baked pork during the storage. In general, these effects increase with the concentration of the extract.

Keywords: ginger, spice, antioxidant, sensory analysis, pork, lipid oxidation.

INTRODUCTION

Lipids play an important role in technological, nutritional and sensory function of food. However they are liable to undergo autooxidation that leads to the formation of a number of undesirable compounds. In an effort to retard this process, various antioxidants are employed. The application of synthetic antioxidants has recently been restricted because there is suspicion that they are carcinogenic. For this reason a growing interest has been paid to the research of natural antioxidants, among which spices occupy an important position (Pokorny et al., 2001).

Ginger is a popular spice, grown everywhere in Vietnam. Thank to its pleasant taste and flavour, it has become an important ingredient not only in Vietnamese cooking but also worldwide. Many papers have reported ginger antioxidant activity against the oxidation of lipid in various model systems such as lard, vegetable oils, oil /water emulsion etc (Takacsova, Nguyen, Kristianova, 2001; Yamazaki et al.,2007; Madsen & Bertelsen, 1995). This antioxidant effect was shown to be linked to the presence of gingerol related compounds and diaryl heptanoid (Kikuzaki & Nakatani, 1993).

Our work has been focusing on the antioxidative capacity of ginger grown in Vietnam. Results of our previous work had shown its antioxidant effect in lard (Dang, Takacsova, Nguyen, & Kristianova 2000). Thus, the aim of our current study was to examine the possibility to use ginger extract for stabilizing baked restructured pork.
MATERIALS AND METHODS

Chemicals
Tetramethoxypropane for synthesis, 30% acetic acid reag. Ph.Aur, 37% HCl for synthesis and Acetonitril HPLC grade from MERCK (Germany).

Preparation of ginger extract
Ginger was collected from Da Nang, Viet Nam. It was sliced and sun dried. The spice was then ground to fine powder by a vibration mill before using for experiments.

A slurry of 10% (w/w) ginger powder in ethanol (96%) was prepared. The slurry was then stored in dark for three days for occasional stirring. A supernatant after centrifugation of the slurry was used as ginger extract for application to pork samples.

Preparation of restructured pork for experiment
Fresh pork was trimmed to remove connective tissues, skin and visible fat. Pork meat contained 32.15% dry mass and 10.78% fat as determined by the Soxhlet extraction method. It was then minced and mixed thoroughly with NaCl (1.2%), water (20% regard to pork weight). The emulsion was divided into five lots: one without addition of ginger and the other four with ginger extract at concentration 0.1%, 0.2%, 0.3% and 0.4% (with regard to dry mass). Homogenized pork was packed in aluminum sheet and evenly spread to a thickness of 1.5 cm. Samples were baked at 180 °C for 40 min in an electric cooker. After cooking, restructured pork was ground to small lumps, homogenized and wrapped in PE bags to store in the refrigerator at 5 °C.

During storage, samples were taken for analysis of the malonaldehyde content and sensory analysis.

Analysis of malonaldehyde
Malonaldehyde is formed from the decomposition of lipid peroxide in pork. Its content indicates the extension of lipid oxidation in pork. Malonaldehyde was retrieved from meat samples by hydrodistillation. Twenty µl of distillate was injected to HPLC system. For evaluating the malonaldehyde content, the HPLC method according to Kakuda et al. (1981) was employed. The HPLC system was composed of HPP 5001 pump, UV detector (Laboratory Equipments Praha) and the column Nucleosil C-18, 250×4.6 mm (Phenomenex). The mobile phase was composed of acetonitril: 1% acetic acid (85:15). Conditions of HPLC analysis were as follows: flow rate: 2 ml/min; the wave length used in UV detection: 254 nm; injection volume: 20 µl. Analysis was carried out at room temperature and retention time was 1.4 min.

Determination of standard curve
Ten µl of tetramethoxypropane was diluted with 10 ml 0.1 M HCl in bruised tube. The solution was heated in a boiling water bath for 5 min. After that it was cooled quickly in
tap water. The basic solution was prepared with 1 ml hydrolyzed acetal diluted in water to fill 100 ml volumetric flask. This basic solution had the concentration of $6.07 \times 10^{-5}$ M or 0.437 µg/ml malonaldehyde. From this solution, a series of standard solutions was made by dilution with water in ratio 1/10, 2/10, 3/10, 4/10, 5/10, 6/10.

The equation for standard curve for malonaldehyde gave the result of $n = 0.234 + 0.00122 \cdot H$ (with a squared correlation coefficient $R^2 = 0.993$), where $n (10^{-11}$ mol) is the content of malonaldehyde and $H$ is the peak height. The content of malonaldehyde in samples was calculated as $m (\text{mg malonaldehyde/kg}) = 1.8 \cdot k \cdot n$, where $k$ is the distillation yield ($k=0.732$).

**Sensory analysis**

Sensory analysis were carried out using five panellists from the faculty staff. The pork samples were heated for three min in microwave oven and immediately presented to the panellists. The analyses were conducted in isolated booths. In order to reach an accurate result, panellists were provided with distilled water to clean their palates after every tasting. The taste, flavour and appearance were determined using a 10-point scale (1 = like a lot, 10 = dislike a lot).

**Statistical analysis**

Statistical assessment was carried out with the software system Statgraphics Plus for Windows 4.0. The results of malonaldehyde content and sensory analysis were analyzed using two samples comparison t-test with significant level $\alpha=0.05$.

**RESULTS AND DISCUSSION**

**The effect of ginger extracts on formation of malonaldehyde**

Due to oxidation of lipid in pork during the storage, peroxides were formed in the first stage of the auto-oxidation process. In the second stage, peroxides were decomposed and led to formation of various undesirable volatile compounds, among which malonaldehyde is an important indicator for extension of lipid oxidation.

The content of malonaldehyde was determined by mean of HPLC as mentioned above. Every two days from the beginning to the 8th day of storage, samples of baked restructured pork were taken to measure. Analysis was done in triplicate and mean values were calculated. The result is shown in table 1 as mean ± standard deviation.

Results from table 1 show that ginger extracts inhibited the oxidation immediately after cooking (initial day). Due to the effect of temperature and oxygen during cooking, oxidation of lipid took place, leading to formation of peroxides and their decomposed products. It is known that meat contains hemoglobin that could catalyze lipid oxidation. Thus, in this case the pork samples could oxidize quickly and extensively. HPLC analysis showed the presence of malonaldehyd right after cooking. However, the value of malonaldehyde content in all samples added with ginger extracts at the beginning day were
significantly lower than those of control sample (p<0.05). Malonaldehyde is one of the volatile compounds formed during lipid oxidation, which are responsible for off-flavor of fat rich food. Therefore, it is possible to suppose ginger extracts have significant effect on inhibition of off-flavor formation in pork samples.

Results from Table 1 also show that the effect of storage time on malonaldehyd formation differed among samples without and with different ginger addition. While the malonaldehyd amount in control sample increased continuously (p<0.05), from the 2\textsuperscript{nd} day of storage, samples added with ginger extracts did not show significant increase or decrease in malonaldehyd concentration. The level of malonaldehyd content in these samples always remained lower than in control samples. At the last day of analysis, the content of malonaldehyde in control samples was higher, approximately 2, 3, 5, 8 times than samples with 0.1%, 0.2%, 0.3%, 0.4% ginger extract.

Table 1. Changes of malonaldehyd content (mg/kg) in samples of pork during storage (day)

<table>
<thead>
<tr>
<th>Samples</th>
<th>0 day</th>
<th>2 days</th>
<th>4 days</th>
<th>6 days</th>
<th>8 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>2.47±0.10</td>
<td>3.90±0.10</td>
<td>5.64±0.25</td>
<td>6.77±0.31</td>
<td>7.81±0.28</td>
</tr>
<tr>
<td>0.1% ginger</td>
<td>0.85±0.01</td>
<td>2.89±0.05</td>
<td>4.06±0.34</td>
<td>4.44±0.02</td>
<td>4.15±0.15</td>
</tr>
<tr>
<td>0.2% ginger</td>
<td>1.01±0.03</td>
<td>2.69±0.07</td>
<td>3.06±0.00</td>
<td>2.63±0.03</td>
<td>2.76±0.03</td>
</tr>
<tr>
<td>0.3% ginger</td>
<td>0.95±0.02</td>
<td>1.75±0.03</td>
<td>1.53±0.27</td>
<td>1.49±0.03</td>
<td>1.58±0.03</td>
</tr>
<tr>
<td>0.4% ginger</td>
<td>0.45±0.00</td>
<td>0.97±0.07</td>
<td>1.39±0.07</td>
<td>1.43±0.17</td>
<td>0.99±0.02</td>
</tr>
</tbody>
</table>

Therefore, it is possible to conclude that in general, the higher concentration of applied ginger extract, the less malonaldehyde was formed. The oxidative stability effect of ginger presumably was related to their gingerol related compounds. The higher concentration of these compounds could better inhibit lipid oxidation.

**Sensory analysis**

Sensory value is very important to any food, because it is the ultimate measurement consumers take to accept or reject a product. A spice extract could exhibit an excellent antioxidative capacity, but if it fails sensory test, it will not be accepted.

In order to check how the addition of ginger extract impacts the sensory value of baked minced pork, the appearance, flavor and taste of minced pork samples were evaluated using a 10-point intensity scale. Table 2 summarizes the result of evaluation as mean ± standard deviation of the five panelists' scores.

At the first day of storage, there was no significant difference in appearance and taste among all samples. However, it would be surprising that the control sample had the highest score of flavour. Paired t–test showed significant difference in flavor between control sample and sample with 0.1%, 0.2% ginger extracts, but there was no statistical difference among other samples. It is supposed that after cooking the off-flavor still didn't occure and control sample had an excellent odor, which was familiar to every panelist. Meanwhile, samples with addition of extract contained amount of ethanol which did not vanish completely after baking, so it could have been perceived as an unfamiliar odor to assessors.
Table 2. Effect of ginger extract concentration on results of sensory evaluation of baked pork samples.

<table>
<thead>
<tr>
<th>Storage</th>
<th>Descriptors</th>
<th>Control</th>
<th>0.1%</th>
<th>0.2%</th>
<th>0.3%</th>
<th>0.4%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 day</td>
<td>Appearance</td>
<td>7.6±1.7</td>
<td>6.6±1.7</td>
<td>7.6±1.7</td>
<td>8.4±1.7</td>
<td>7.6±1.7</td>
</tr>
<tr>
<td></td>
<td>Flavour</td>
<td>9.0±1.0</td>
<td>6.6±1.7</td>
<td>7.6±0.9</td>
<td>8.0±1.4</td>
<td>8.6±1.7</td>
</tr>
<tr>
<td></td>
<td>Taste</td>
<td>9.4±0.9</td>
<td>9.0±1.0</td>
<td>9.0±1.0</td>
<td>9.4±0.9</td>
<td>9.8±0.4</td>
</tr>
<tr>
<td></td>
<td>Appearance</td>
<td>7.6±1.0</td>
<td>7.8±1.5</td>
<td>7.0±1.7</td>
<td>7.6±0.9</td>
<td>8.0±1.4</td>
</tr>
<tr>
<td>5 days</td>
<td>Flavour</td>
<td>10.0±0.0</td>
<td>9.4±0.9</td>
<td>9.4±0.9</td>
<td>8.6±0.9</td>
<td>9.8±0.4</td>
</tr>
<tr>
<td></td>
<td>Taste</td>
<td>9.0±1.0</td>
<td>9.0±1.0</td>
<td>9.0±1.0</td>
<td>8.0±0.0</td>
<td>9.0±1.0</td>
</tr>
<tr>
<td></td>
<td>Appearance</td>
<td>5.0±1.0</td>
<td>7.0±1.7</td>
<td>6.0±1.4</td>
<td>7.0±1.7</td>
<td>7.0±1.7</td>
</tr>
<tr>
<td>9 days</td>
<td>Flavour</td>
<td>5.8±0.4</td>
<td>6.0±2.0</td>
<td>6.0±1.4</td>
<td>6.6±0.9</td>
<td>7.0±1.7</td>
</tr>
<tr>
<td></td>
<td>Taste</td>
<td>4.6±0.9</td>
<td>6.6±0.9</td>
<td>7.6±0.9</td>
<td>7.0±1.0</td>
<td>8.6±0.9</td>
</tr>
</tbody>
</table>

who gave lower scores. If the concentration of ginger was high enough, ginger odor could hide the ethanol one. That could make the flavor of sample more pleasant.

After five days of storage, scores for all attributes were high, indicating that the sensory quality of all products was still very good. It is interesting to observe significant increase in flavor (p<0.05) of samples with 0.1% and 0.2% of ginger extract (about 42% and 24% respectively). This could be explained by the evaporation of ethanol during the storage.

The sensory quality of products, especially of the control sample, reduced remarkably after storing nine days. The control sample became unacceptable to panelists. All scores of appearance, taste and flavor were lower than 6. Comparing scores of 6th day to the 9th day, significant reductions of these values in control sample were observed (p<0.05).

Comparison t-tests failed to show significant difference in appearance between the control sample and samples with ginger extract (α=0.05). However, all samples with ginger extract had significant higher values of taste and flavor in comparison with control samples. This suggests that ginger extracted at concentration 0.1%, 0.2%, 0.3% and 0.4% had a stabilizing effect on sensory value of baked minced pork, stored at 5°C. In general, this effect increases with the concentration of spice.

Our results agree with those reported by El-Alim et al. (1999) and Takacsova et al (2000). In their research, El Alim et al. also studied the influence of ginger extract and other spices on the oxidation stability of fresh minced poultry stored in freezing conditions. Measurement of peroxide and TBARS values confirmed the antioxidative effect of ginger extract. A similar result was reported by Takacsova et al. in their study on the antioxidant activity of ginger extract in ground pork patties.

CONCLUSIONS

According to the present results, it is possible to confirm that ginger extracts at concentration from 0.1% to 0.4% has positive effect on oxidative and sensory quality of baked restructured pork. The spice extracts significantly reduce formation of malonaldehyde that is secondary product of lipid oxidation, causing off-flavors to meat products. Besides, the presence of these extracts also helps to stabilize taste and flavor of
products, makes them still acceptable after nine days of storage at 5°C in refrigerator. However, further work should be carried out on the use of other forms of extracts, for example in powder form to eliminate the effect of solvent on sensory value. Our study demonstrates the possibility to use ginger extracts to extend shelf-life of meat without using synthetic antioxidants, which should be a safety concern.

REFERENCES


