The quality of spent hen chicken sausage with the addition of tomato paste \textit{(Solanum lycopersicum)} as natural food colorant

Cintya Dienardila Anisa$^1$, Herly Evanuarini$^1$*, and Imam Thohari$^1$
$^1$Faculty of Animal Science, Universitas Brawijaya Malang, 65145, Indonesia

**Abstract.** Spent hen chicken meat are a meat that from 70 weeks old chicken that usually has a hard texture so further processing are needed to improve the quality. Spent hen chicken meat can be processed as sausage but chicken sausage usually have a pale color. Tomato have a natural coloring agent namely lycopene. Tomato paste can be used as a coloring agent and improve the quality of chicken sausage. The aim of this research was to determine the best percentage of tomato paste addition on chicken sausage based on physicochemical quality. The material used were spent hen chicken meat, tapioca, vegetable oil, tomato paste, seasoning, herbs and spices, skim milk, and ice cube. The research method is a laboratory experimental with a completely randomize design with 4 treatments and 4 replications. Tomato paste was added to sausage formulation 0%, 5%, 10%, and 15% of the total ingredients used. The measured variables were L a*b* color, cooking loss, water holding capacity, and moisture content. The results showed that the treatments gave very significant effect (P<0.01) on L a*b* color, cooking loss, water holding capacity, and moisture content. Tomato paste addition on sausage can increase redness and yellowness but decrease lightness, increase cooking loss and moisture content, but decreased water holding capacity. It can be concluded that the best treatment on this research was chicken sausage with 5% tomato paste.

1 Introduction

Spent hen chicken meat are a meat that from a 70 weeks or more old chicken. Spent hen chicken have a low productivity. Usually laying hen have egg productivity up to 94-95% but spent hen chicken only have 50% of egg productivity so the meat can be used. But, people usually didn’t like the meat from spent hen chicken because it has a hard texture and easier to get rancid [1]. Spent hen chicken meat h’ave a component that almost the same with usual chicken meat but have a higher fat and moisture content. Spent hen chicken meat can processed as food diversification with restructured meat technology to improve the quality and change people’s mindset. Restructured meat are a technology that using a low quality carcass and smaller piece of meat to improve the value and making a new product using a binder, filler, and emulsion [2]. Sausage are the example of restructured meat product.

* Corresponding author: herlyfptub@ub.ac.id
Sausage are an oil in water emulsion made by grinding meat with the additional ingredient and put it on casing. Chicken sausage usually have a pale color so it needed a food colorant to increase the product appearance. Color are the first aspect for consumer to buy something [3]. Nitrite is a food colorant that usually being used for sausage. Nitrite has a bright red color but it can cause a carcinogenic when used excessively [4]. Tomato are ingredients that can be used as a natural food colorant and didn’t have a side effect for consumer. Tomatoes contain a vitamin, glucose, carbohydrate (3.1%), protein (1.1%), ash (0.5%), fat (0.2%) and moisture content (95.1%). Tomato also has an antioxidant ability because of carotenoid [5]. Lycopene are the part of carotenoid who has an antioxidant ability and also a food colorant agent. Lycopene can be found on ripped tomatoes. Lycopene are soluble to fat and can gave a red and yellow color. Tomatoes contain a 0.85mg – 13.6mg of lycopene. Processed tomatoes usually have a higher lycopene content than a fresh tomato. Tomato paste are the example of processed tomatoes [6]. Several previous studies also use a natural food colorant to improve the quality of chicken sausage. Addition of beetroot extract and red dragon fruit can improve the physicho-chemical quality of chicken sausage. It also can improve the redness on sausage that attract panelist and it because the betalains and betacyanin pigment that improve the redness of sausage [7] [8]. The use of tomato paste can be used as natural food colorant on spent hen chicken sausage to improve the quality. This research aims to determined the best percentage addition of tomato paste on spent hen chicken sausage based on L*a*b* color, cooking loss, water holding capacity, and moisture content.

2 Materials and methods

2.1 Materials

Materials used on this research are spent hen chicken sausage with the optional ingredients including spent hen chicken meat breast (60%), crushed garlic (3%), salt (2%), tapioca (6%), pepper (0.5%), nutmeg powder (0.25%), ginger powder (0.25%), sugar (2%), mushroom powder (1%), vegetable oil (10%), ice (10%), powdered skim milk (5%), and tomato paste for the treatments (0%, 5%, 10%, 15%). Materials for analysis are distilled water. The tools used on making sausage are meat grinder, spoon, knife, plastic glove, stove, bowl, pot, cutting board, thermometer, scale, and sausage casing made from celulose diameter 21 mm. The tools used on analysis are oven 105°C, petri dish, waterbath, excicator, colorider, 35 kg weight, and glasses.

2.2 Methods

The method of this research is a laboratory experimental with a completely randomize design with 4 treatments and 4 replications. The experimental design are presented in Table 1.

Table 1. Experimental design and research treatment

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Sausage with no addition of tomato paste</td>
</tr>
<tr>
<td>S1</td>
<td>Sausage with the addition of 5% tomato paste</td>
</tr>
<tr>
<td>S2</td>
<td>Sausage with the addition of 10% tomato paste</td>
</tr>
<tr>
<td>S3</td>
<td>Sausage with the addition of 15% tomato paste</td>
</tr>
</tbody>
</table>
2.3 Tomato Paste Preparation

The tomatoes used for this research was purchased from the traditional market in Malang. First, wash the tomatoes using water then cut the tomatoes. Blanch the tomatoes at 40 °C for 5 minutes and then put it on the cold water so it easier to peel. Peel of the tomatoes skin, put them on the blender and grind the tomatoes. After grinding, filter the pulp so the seed are separated from the juice. Evaporated the tomato juice until it thicken. Tomato paste was ready to used.

2.4 Sausage Preparation

Clean the spent hen chicken meat before processing, remove the skin, bones, and fat. Chop the meat and put it on the meat grinder. Add the salt and ice then minced for a while. Put the other ingredients, tapioca, garlic, pepper, nutmeg, ginger, sugar, mushroom powder, vegetable oil, and skim milk, then minced it again. For the treatment, put the tomato paste (5%, 10%, 15) and minced them until it homogenous. Put the sausage batter in cellulose casing using sausage stuffer, give the space about 7 cm and tied it with thread so the sausage can be divided. Boiled the sausage with 80°C for 20 minutes and then put it on the cold water for 10 minutes so the sausage can be hardened. Spent hen chicken meat can be used for further analysis.

2.5 Data Analysis

Data were calculated using Microsoft Excel 2010 then were analysis with analysis of variance (ANOVA). If there were a significant effect, it will continued by Duncan’s Multiple Range Test (DMRT).

2.6 Characterization of Sausage

2.6.1 L a*b* color

Color analysis was using a colorider. Calibrated the colorider with black and white plate before using it for analysis. Cut the center part of sausage and place it on a smooth surface. Put the colorider near the samples and click the button. The values of lightness, redness, and yellowness will be shown on the colorider screen.

2.6.2 Cooking Loss

Cooking loss was determined using a 80°C waterbath. Put the 10 g sausage batter on the vacuum plastic bag (A). Boiled the sample using a waterbath at 80°C for 30 minutes. Cooled the sample and dry it with tissue. Weighed the cooked sample (B). Calculated the cooking loss using the formulation =

\[
\text{cooking loss (\%)} = \frac{A-B}{A} \times 100\%
\]  

(1)

2.6.3 Water Holding Capacity

Water holding capacity was determined using a 35 kg weight. Put the 0,3 g sample on the filter paper Whatmann 42 and then place it on two glass plates. Place the 35 kg weight on the top glass plates and wait for 5 minutes. Draw the water loss on milimeter block for counting diameter of wet area and calculated WHC using formulation =
(\textit{MgH}_2\textit{O}) = \frac{\text{diameter of wet area (cm}^2\text{)} - \text{B}}{0.0948} \quad (2)

wet sample area = \frac{\text{mgH}_2\textit{O}}{\text{sample weight}} \times 100\% \quad (3)

\textit{WHC} (\%) = \text{Moisture content (\%)} - \text{wet sample area(\%)} \quad (4)

2.6.4 Moisture Content

Moisture content was determined with thermogravimetric method. Put the petri dish on the 105°C oven for 24 hours. After that, put the petri dish on the eksikator for 30 minutes then weighed it using analytical scale (A). Put the 2 gram sample on the petri dish and weighed it (B). Dry the sample on the 105°C oven for 24 hours, then put it on the eksikator for 30 minutes. Weighed the petri dish + sample after dried (C). Calculated the final weight using the formulation:

\textit{Moisture content (\%)} = \frac{(\text{B} - \text{C})}{(\text{B} - \text{A})} \times 100\% \quad (5)

3 Results and Discussion

3.1 L a*b* color

Addition of different percentage of tomato paste (0%, 5%, 10%, and 15%) gave highly significant effect (P<0.01) on sausage color. The average L a*b* color of chicken sausage with the addition of tomato paste shown on Table 2. The difference color of spent hen chicken sausage with the addition of tomato paste shown on Figure 1.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Lightness (L)</th>
<th>Redness (a*)</th>
<th>Yellowness (b*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC</td>
<td>67.57 ± 0.22^b</td>
<td>1.06 ± 0.06^a</td>
<td>14.14 ± 0.15^a</td>
</tr>
<tr>
<td>S1</td>
<td>67.12 ± 0.03^b</td>
<td>2.13 ± 0.08^b</td>
<td>22.27 ± 0.42^b</td>
</tr>
<tr>
<td>S2</td>
<td>66.94 ± 0.77^b</td>
<td>3.81 ± 0.07^c</td>
<td>23.20 ± 0.06^c</td>
</tr>
<tr>
<td>S3</td>
<td>65.80 ± 0.06^a</td>
<td>4.89 ± 0.03^d</td>
<td>24.74 ± 0.23^d</td>
</tr>
</tbody>
</table>

Notes: superscripts on the column (a,b,c,d) shown a highly significant effect (P<0.01)

Fig. 1. Difference color of chicken sausage with the addition of tomato paste
3.1.1 Lightness

Lightness of chicken sausage keep decreasing with the addition of tomato paste. Addition of a component on a meat can decrease the color of food product. Maillard reaction also the cause of decreased lightness. Maillard reaction can be happening when cooking a sausage addition of tomato paste with a high temperature so ascorbate acid in tomatoes denaturated [9]. Maillard reaction are a glucose – amino reaction. When it getting a high temperature, the bond of glucose – amino can create a melanoidin which gave a browning color on food [10].

3.1.2 Redness

Redness of chicken sausage increased with the addition of tomato paste. This is because of natural food colorant pigment in tomato namely lycopene. Lycopene are a red pigment which part of carotenoid. The lycopene stability are higher when the tomatoes getting processed into a tomato paste, tomato pomace, or tomato flour. Lycopene content on tomato paste are nearly 184.29 g [11]. Processed tomato into paste can change the isomer trans to cis that makes a more soluble lycopene when put it on meat batter. The change of trans into cis are happening when lycopene get a high temperature when cooking the tomato paste [9].

3.1.3 Yellowness

Yellowness of chicken sausage also increased with the addition of tomato paste. This is because of tomato pigment, beta-caroten and xantofil, which give a orange-yellowness color [12]. Beta-caroten and xantofil also have a cis isomer which can turn into trans when tomato are processed into paste. Processed tomato into paste can make beta-caroten and xantofil more soluble and homogenous in the chicken sausage so it has a yellowish color [13].

3.2 Cooking loss

Addition of different percentage of tomato paste (0%, 5%, 10%, and 15%) gave highly significant effect (P<0.01) on cooking loss. The average cooking loss of spent hen chicken sausage with the addition of tomato paste shown on Table 3.

Table 3. Average of cooking loss of chicken sausage with the addition of tomato paste

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Cooking loss (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC</td>
<td>1.59± 0.20a</td>
</tr>
<tr>
<td>S1</td>
<td>2.01 ± 0.06b</td>
</tr>
<tr>
<td>S2</td>
<td>2.36 ± 0.09c</td>
</tr>
<tr>
<td>S3</td>
<td>2.75 ± 0.10d</td>
</tr>
</tbody>
</table>

Notes : superscripts on the column (a,b,c,d) shown a highly significant effect (P<0.01)

Cooking loss are an analysis to find how much protein can hold water after meat batter getting cooked. Cooking loss can affect texture from meat product [14]. Cooking loss of chicken sausage with the addition of tomato paste are increasing as the percentage of tomato paste increase. The reason of this are the moisture content. When moisture content increase, it’s possible that pH decrease when cooking loss increase [15]. Protein can also affect cooking loss. The higher cooking loss on the chicken sausage means that tomato paste can’t stop...
syneresis. It because tomato paste component have a low ability to be a binder. Binder usually has a higher protein so it can make a good texture and emulsion [16] but tomato paste contain higher carbohydrates (4.50%) than protein (1.44%).

3.3 Water Holding Capacity

Addition of different percentage of tomato paste (0%, 5%, 10%, and 15%) gave highly significant effect (P<0.01) on water holding capacity. The average water holding capacity of spent hen chicken sausage with the addition of tomato paste shown on Table 4.

Table 4. Average of water holding capacity of chicken sausage with the addition of tomato paste

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Water Holding Capacity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC</td>
<td>36.85 ± 0.76d</td>
</tr>
<tr>
<td>S1</td>
<td>35.36 ± 0.22c</td>
</tr>
<tr>
<td>S2</td>
<td>33.43 ± 0.43b</td>
</tr>
<tr>
<td>S3</td>
<td>31.54 ± 0.54a</td>
</tr>
</tbody>
</table>

Notes : superscripts on the column (a,b,c,d) shown a highly significant effect (P<0.01)

Water Holding Capacity (WHC) are an analysis to find how much sample can bind the water on food products. WHC can affect the texture, especially juiciness, on sausage. The higher WHC means that the sample can bind water very well [17]. WHC on chicken sausage decrease as the percentage of tomato paste increase. It’s because tomato paste contain high water. Tomato paste are an acid product because of ascorbat acid and it can affect WHC. When an acid component meet the protein it can lead to protein denaturation. Protein denaturation can make the water on sample didn’t bind as much as usual so the water keep leaking on sample that means the sample didn’t have a great binding capability [18].

3.4 Moisture Content

Addition of different percentage of tomato paste (0%, 5%, 10%, and 15%) gave highly significant effect (P<0.01) on moisture content. The average moisture content of spent hen chicken sausage with the addition of tomato paste shown on Table 5.

Table 5. Average of moisture content of chicken sausage with the addition of tomato paste

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Moisture Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC</td>
<td>44.42 ± 0.81a</td>
</tr>
<tr>
<td>S1</td>
<td>48.64 ± 0.51b</td>
</tr>
<tr>
<td>S2</td>
<td>51.11 ± 0.37c</td>
</tr>
<tr>
<td>S3</td>
<td>53.26 ± 0.23d</td>
</tr>
</tbody>
</table>

Notes : superscripts on the column (a,b,c,d) shown a highly significant effect (P<0.01)

Moisture content on chicken sausage are increase as the percentage of tomato paste increase. It’s because tomato paste have a higher moisture content that are almost 94% [19]. Moisture
content can indicate the stability and shelf life of product. The higher moisture content can improve the growth of microorganism [20]. The increased of moisture content also because the low fiber on tomato paste. Tomato paste have 0.35% fiber that can’t bind the water that much. Pectin, tomato fiber, usually have the ability to bind the water in meat products but when it get an unstable – high temperature, it can lead to pectin degradation which mean pectin didn’t have strong ability to bind water anymore [21].

4 Conclusion

The addition of 5% tomato paste on spent hen chicken meat are the best treatment on this research from the L a*b* color, cooking loss, water holding capacity, and moisture content.

References

18. B. P. Ismail, L. Senaratne-Lenagaia, A. Stube, A. Brackenridge, Feature Article, 10, 54-63 (2020)