The Organoleptic Evaluation of Chicken Meatball Preservation by Liquid Smoke Powder from Durian Rinds (Durio ziberthinus murr.)

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Abstract. Durian rind contains lignocellulosic biomass, such as cellulose, hemicellulose and lignin, which can be converted into liquid smoke powder. Thanks to the phenolic compounds and acetic acid in the smoke powder, it has antimicrobial effects and can be used as an alternative to food preservatives. The purpose of this study was to investigate the potential of liquid smoke powder from durian rind as a chicken meatball preservative through organoleptic analysis (aroma, texture and colour). Spray drying was used to convert durian rind liquid smoke into smoke powder, and two types of bacteria, Escherichia coli and Salmonella typhimurium, were used to test the antibacterial properties of the smoke powder. Organoleptic test data were analysed using the SPSS version 16 and one-way ANOVA, followed by the least significant difference (LSD) test. The results of antibacterial tests on the E. coli and Salmonella bacteria indicated that the smoke powder had an inhibition zone of 10.55 ± 1 and 8.130 ± 12 mm, respectively. The organoleptic evaluation of aroma, texture and colour suggested that the meatballs could be preserved for 64 h. Meanwhile, the pH test results indicated that the meatballs could only be stored for 60 h.

1 Introduction

A popular food item in Indonesia is chicken meatballs, which have sufficient nutritional value, are low in fat, are chicken skin-free and are inexpensive, so people from all walks of life can enjoy them [1]. However, the water content and organic chemicals in chicken meatballs can accelerate microbial growth, making their shelf life relatively short [2].

Currently, some meatballs on the market still contain harmful preservatives, such as formalin and borax [3], the use of which in foodstuffs is strictly prohibited because they can...
cause side effects, such as carcinogenic effects, stomach pain and chronic inflammation in the stomach and intestines, which could lead to death. Therefore, safer natural preservatives, such as liquid smoke, are crucially needed [4]. Liquid smoke is the result of the pyrolysis of biomass at high temperatures, either through direct or indirect heating [5]. Durian rind liquid smoke, for example, can be used as a preservative because of its antibacterial and antioxidant properties [6,7]. The components of liquid smoke from durian skin pyrolyzed at 300-380°C produce acetic acid and phenolic compounds [8], the latter of which can function as antibacterial compounds that kill microorganisms [9-16]. In several previous studies, liquid smoke has been used to preserve foodstuffs, including tofu, meatballs and fish [17]. Furthermore, the use of liquid smoke is not only limited to its liquid form, because in liquid, the components in liquid smoke, especially phenols and other organic acids, will quickly evaporate if stored for a long time [11]. Therefore, innovation is needed to protect the phenol and organic acids by transforming liquid smoke into smoke powder. Smoke powder is the result of the encapsulation process of maltodextrin into liquid smoke as a coating medium, so it has a higher phenol content than liquid smoke and can maintain food products, especially the quality and durability of meatballs [13]. Several studies reported that smoke powder is useful for inhibiting bacterial growth, as well as maintaining the quality of food products [18-20]. Until recently, however, only a few studies on the application of smoke powder as a meatball preservative have been carried out. Therefore, this study aimed to evaluate the ability of smoke powder to extend the shelf life of chicken meatballs through an organoleptic analysis.

2 Methodology

2.1 Preparation of Liquid Smoke

Liquid smoke was obtained by pyrolysing durian rinds at temperatures of 300°C (T1), 340°C (T2) and 380°C (T3) using a slow pyrolysis reactor. The durian rinds were cut in 2–3-cm pieces and dried under sunlight for 2 d until reaching a moisture content of 5%. The slow reactor pyrolysis was used to pyrolyse the durian rinds into liquid smoke, which was then purified by distillation. Fig 1 shows a schematic diagram of liquid smoke preparation from durian rinds, and a detailed experiment was carried out following the procedure used in previous studies [21,22].

2.2 Preparation of Smoke Powder

The preparation of smoke powder was carried out using a BUCHI 190 spray dryer, where a microencapsulated solution was made to coat the core substance with a polymer layer, which caused the solution to become microparticles with a concentration of 30% maltodextrin in the 225 ml liquid smoke solution. The solution was then stirred using a magnetic stirrer at 200 rpm for 30 min. The microencapsulated solution was warmed in a water bath at 45°C for 15 min and then homogenised using a mixer at 400 rpm for 2 min. The resulting microencapsulated solution was dried in an oven at 145°C and then crushed and sifted to a particle size of 125 mesh. The smoke powder was put in a glass container with aluminium foil and stored at room temperature for 2 h.
with aluminium foil and stored at room temperature for 2 h. The resulting microencapsulated solution was dried in an oven at 145°C and then homogenised using a mixer at 400 rpm for 2 min. The microencapsulated solution was warmed in a water bath at 45°C for 15 min and then homogenised using a mixer at 200 rpm for 30 min. The microencapsulated solution was made to coat the core substance with a polymer layer, which caused the solution to become microparticles with a concentration of 30%.

The preparation of smoke powder was carried out using a BUCHI 190 spray dryer, where a maltodextrin in the 225 ml liquid smoke solution. The solution was then stirred using a magnetic stirrer at 200 rpm for 30 min. The microencapsulated solution was warmed in a slow reactor pyrolysis was used to pyrolyse the durian rinds into liquid smoke, which was then purified by distillation. Fig. 1 shows a schematic diagram of liquid smoke and smoke powder preparation from durian rinds.

### 2.3 Antibacterial activity Test

The antimicrobial test was conducted using agar well-diffusion method as described by Desvita et al (2020). The antimicrobial tested to measure the inhibitory zone against Escherichia coli ATCC 25992 and Salmonella ATCC 335345 0.5 McFarland. Tetracycline antibiotics used as a positive control, and aquadest used for negative control. One-way ANOVA and the Least Significant Difference (LSD) test using SPSS ver.22 software was accomplished for statistical analysis.

### 2.4 Organoleptic Test

An organoleptic test was carried out using human sensory devices to analyse the physical appearance of a product. Chicken meatballs was coated by the sprinkling with smoke powder thoroughly, then put in the container box. The organoleptic test includes assessing the aroma, texture and colour of the meatballs. The test involved ten panellists and was carried out in the Chemical Engineering Laboratory. The panellists tested the smoke powdered chicken meatballs in terms of their aroma, texture and colour.

### 3. Results and discussion

#### 3.1 Antibacterial Activity Test Results

An antibacterial activity test was carried out to determine the inhibition zone formed. Table 1 presents the effects of smoke powder on bacterial activity. Table 1 shows that in the control using distilled water, no inhibition zone (0 mm) was formed for both bacteria. An illustration of the antimicrobial activity test is shown in Fig. 2. The results demonstrate that the largest inhibition zone was found in the control of ciprofloxacin for *E. Coli* and of gentamicin for *Salmonella*, with inhibition zone values of 35.2 and 26.64 mm, respectively.
The strongest antibacterial activity of smoke powder was obtained by the smoke powder from the pyrolysis temperature of 380°C (T3), whose inhibition zone for the *E. Coli* bacteria was 10.55 mm and for the *Salmonella* bacteria was 8.13 mm. In the smoke powder from the 300°C and 340°C pyrolysis temperatures, each bacterium had an inhibition zone diameter that varied from 8.79 to 9.97 mm for *E. Coli* bacteria and 7.07 to 7.97 mm for *Salmonella* bacteria. The results of the LSD test showed that the pyrolysis temperatures in the preparation of smoke powder for T2 and T3 was not significantly different in their inhibition zone formations. Smoke powder from the durian rinds pyrolysed at 300°C has a low inhibition zone, indicating an increase in the ability of bacteria. Furthermore, the temperature during pyrolysis had an impact on the smoke powder's component and content, which in turn had an impact on its antimicrobial properties.

<table>
<thead>
<tr>
<th>Treatment</th>
<th><em>E. coli</em> (mm)</th>
<th><em>Salmonella</em> (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>8.79±0.22B</td>
<td>7.07±0.05B</td>
</tr>
<tr>
<td>T2</td>
<td>9.97±0.93C</td>
<td>7.97±0.12C</td>
</tr>
<tr>
<td>T3</td>
<td>10.55±1C</td>
<td>8.13±0.12C</td>
</tr>
<tr>
<td>KP</td>
<td>35.2±0.43D</td>
<td>26.64±0.19D</td>
</tr>
<tr>
<td>KN</td>
<td>0.00±0.00A</td>
<td>0.00±0.00A</td>
</tr>
</tbody>
</table>

Note: T1: smoke powder from 300°C pyrolysis; T2: smoke powder from 340°C pyrolysis; T3: smoke powder from 380°C pyrolysis; KP: control; KN: distilled water

Previous studies showed that a 5% concentration of cocoa husk liquid smoke had an inhibition zone of 7.22 mm for *E. Coli* bacteria [23], while 5% rice husk liquid smoke provided an inhibition zone for the *E. Coli* and *Salmonella* bacteria of 7.07 and 7.26 mm, respectively [9]. In the analysis of antibacterial activity, the inhibition zone formed on disc diffusion with a diameter of less than 5 mm can be categorised as weak, while that of 5–10 mm is categorised as moderate and that of 10–19 mm as strong. Meanwhile, an inhibition zone greater than 20 mm is categorised as very strong. Therefore, the ability of smoke powder from durian rinds pyrolysed at 300, 340, and 380°C in inhibiting bacteria can be categorised as moderate, with an inhibition zone of 5–10 mm, which is effective enough to be a preservative in chicken meatballs containing *E. Coli* and *Salmonella* bacteria [24].
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**Table 1. Results of the LSD test on the antibacterial activity of the durian rinds smoke powder**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>E.coli Inhibition Zone (mm)</th>
<th>Salmonella Inhibition Zone (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>8.79±0.22</td>
<td>7.07±0.05</td>
</tr>
<tr>
<td>T2</td>
<td>9.97±0.93</td>
<td>7.97±0.12</td>
</tr>
<tr>
<td>T3</td>
<td>10.55±1</td>
<td>8.13±0.12</td>
</tr>
<tr>
<td>KP</td>
<td>35.2±0.43</td>
<td>26.64±0.19</td>
</tr>
<tr>
<td>KN</td>
<td>0.00±0.00</td>
<td>0.00±0.00</td>
</tr>
</tbody>
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3.2 Organoleptic Test Result

3.2.1 Aroma

Coating the meatballs with smoke powder from different pyrolysis temperatures will change the aroma of the meatballs during storage. The results of the assessment of the meatballs aromas are presented in Table 2.

In Table 2, the use of smoke powder from different pyrolysis temperatures had different aroma effects on storage time. Smoke powder from the higher pyrolysis temperature could slow down the aroma deterioration, where the aroma of meatballs without smoke powder coating was still acceptable for 36 h of storage. The meatballs in samples T1 and T2 had an acceptable aroma over a storage time of 56 h, while in sample T3, a storage time of 64 h was still acceptable. After 68 h, the meatballs began to emit an unpleasant aroma. Based on the LSD test results, the difference in pyrolysis temperature during the preparation of liquid smoke affects the aroma of meatballs during storage, as found in previous studies [18]. The aroma of chicken meatballs is influenced by several factors, including the cooking process, during which time various reactions between the filler and the meat took place, so the aroma of the meat was reduced during processing. The produced aroma is influenced by the oxidation of fatty acids, which produces peroxide and hydroperoxide compounds [26]. A one-way ANOVA test shows that smoke powder from pyrolysis temperatures of 300, 340, and 380°C showed significant differences for each treatment on the meatball samples, while the LSD test also showed significantly different results.

3.3 pH Test Results

The pH measurement aims to determine the quality of a food product, such as, in this case, chicken meatballs. More specifically, it was carried out to determine a decrease or increase in the meatballs’ pH during storage. The pH value of a food, as regulated by the Indonesian National Standards (SNI), should be in the range of 6.0–7.0. The effect of the storage time
and pyrolysis temperature of smoke powder on the pH value of chicken meatballs is presented in Fig. 3.

Table 2. The aroma of the smoke powder-coated chicken meatballs

<table>
<thead>
<tr>
<th>Storage time (hours)</th>
<th>T0</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>5.00±0.00^A</td>
<td>5.00±0.00^A</td>
<td>5.00±0.00^A</td>
<td>5.00±0.00^A</td>
</tr>
<tr>
<td>4</td>
<td>5.00±0.00^A</td>
<td>5.00±0.00^A</td>
<td>5.00±0.00^A</td>
<td>5.00±0.00^A</td>
</tr>
<tr>
<td>8</td>
<td>5.00±0.00^A</td>
<td>5.00±0.00^A</td>
<td>5.00±0.00^A</td>
<td>5.00±0.00^A</td>
</tr>
<tr>
<td>12</td>
<td>5.00±0.00^A</td>
<td>5.00±0.00^A</td>
<td>5.00±0.00^A</td>
<td>5.00±0.00^A</td>
</tr>
<tr>
<td>16</td>
<td>5.00±0.00^A</td>
<td>5.00±0.00^A</td>
<td>5.00±0.00^A</td>
<td>5.00±0.00^A</td>
</tr>
<tr>
<td>20</td>
<td>4.9±0.32^A</td>
<td>5.00±0.00^A</td>
<td>5.00±0.00^A</td>
<td>5.00±0.00^A</td>
</tr>
<tr>
<td>24</td>
<td>4.6±0.52^A</td>
<td>5.00±0.00^B</td>
<td>5.00±0.00^B</td>
<td>5.00±0.00^B</td>
</tr>
<tr>
<td>28</td>
<td>3.9±0.32^A</td>
<td>5.00±0.00^B</td>
<td>5.00±0.00^B</td>
<td>5.00±0.00^B</td>
</tr>
<tr>
<td>32</td>
<td>3.9±0.32^A</td>
<td>5.00±0.00^B</td>
<td>5.00±0.00^B</td>
<td>5.00±0.00^B</td>
</tr>
<tr>
<td>36</td>
<td>3.9±0.32^A</td>
<td>5.00±0.00^B</td>
<td>5.00±0.00^B</td>
<td>5.00±0.00^B</td>
</tr>
<tr>
<td>40</td>
<td>3.2±0.42^A</td>
<td>4.4±0.52^B</td>
<td>4.9±0.32^C</td>
<td>5.00±0.01^C</td>
</tr>
<tr>
<td>44</td>
<td>2.9±0.32^A</td>
<td>4.2±0.42^B</td>
<td>4.6±0.52^BC</td>
<td>4.9±0.32^C</td>
</tr>
<tr>
<td>48</td>
<td>2.4±0.52^A</td>
<td>3.9±0.32^B</td>
<td>4.3±0.48^BC</td>
<td>4.6±0.52^C</td>
</tr>
<tr>
<td>52</td>
<td>1.9±0.57^A</td>
<td>3.9±0.32^B</td>
<td>4.0±0.0^B</td>
<td>4.4±0.52^C</td>
</tr>
<tr>
<td>56</td>
<td>1.7±0.48^A</td>
<td>3.5±0.53^B</td>
<td>3.7±0.48^BC</td>
<td>4.1±0.32^C</td>
</tr>
<tr>
<td>60</td>
<td>1.4±0.52^A</td>
<td>3.2±0.42^B</td>
<td>3.1±0.32^B</td>
<td>4.1±0.32^C</td>
</tr>
<tr>
<td>64</td>
<td>1.3±0.48^A</td>
<td>2.6±0.52^B</td>
<td>3.0±0.0^C</td>
<td>3.7±0.48^D</td>
</tr>
<tr>
<td>68</td>
<td>1.1±0.32^A</td>
<td>2.4±0.52^B</td>
<td>2.9±0.32^BC</td>
<td>3.3±0.48^C</td>
</tr>
<tr>
<td>72</td>
<td>1.00±0.0^A</td>
<td>1.9±0.32^B</td>
<td>2.8±0.42^C</td>
<td>2.8±0.42^C</td>
</tr>
</tbody>
</table>

Key: 1=Very smelly, 2=Smelly 3=Fairly smelly, 4=Quite smelly, and 5= Not smelly.
The different superscript letters in the columns represent the actual differences with α = 0.05.

Key: 1=Squishy, 2=Soft, 3=A bit firm, 4=Quite firm, and 5= Firm
The different superscript letters in the columns represent the actual differences with α = 0.05

Key: 1=white, 2=greyish white, 3=pale grey, 4=grey, and 5= dark grey
The different superscript letters in the columns represent the actual differences by α = 0.05

From Fig. 3, it is seen that the pH values at 0 h of storage were 6.38 to 6.39, indicating that the values are in the neutral pH range of 6.0–7.0, as per the SNI. The pH value did not decrease significantly until 16 h for samples T1, T2 and T3, while that of sample T0 decreased after 12 h of storage. Then, at 48 h, the pH values in samples T0, T1, T2 and T3 were 5.93, 6.02, 6.07 and 6.08, respectively. The pH value in sample T0 did not meet the SNI standards, and it was unsuitable for consumption, while samples T1, T2 and T3 did meet the SNI standards, indicating they were still suitable for consumption. However, at 56 h of storage time, the pH values for samples T1, T2 and T3 had dropped to 5.96, 5.97 and 6.00, respectively, which means that they do not meet SNI standards [29] and are unsuitable for consumption. This condition was the result of the microorganisms’ maximum activity, so the rate of decomposition of carbohydrates into acids is very high and the amount of acid produced is higher [30]. Previous studies have shown that liquid smoke from young coconut husks with a concentration of 2.5% was only able to maintain food quality for up to 1 d of storage [31], while the 0.5% durian rinds liquid smoke was able to maintain the quality of the meatballs for up to 48 h [32].
The decrease in the pH values of the chicken meatball samples was due to the failure of the oxygen supply, and thus, the respiration process stopped. Some bacteria can grow in low pH (acidophilic) and anaerobic conditions. Bacteria that grow on organic substrates can produce (H+ ions) so the pH value in the sample decreases [33].

![Fig 3. Effect of storage time on T1-T3 pH values](image)

### 4 Conclusion

An antibacterial activity test of smoke powder on *E. coli* and *Salmonella* bacteria was carried out. It was found that smoke powder obtained from liquid smoke (produced from the pyrolysis of durian rinds at 380°C) had moderate inhibitory power, around 10.55 and 8.13 mm, respectively. With this inhibitory characteristic, the smoke powder could extend the shelf life of meatballs up to 50–60 h. The results of the organoleptic tests, including aroma, texture and colour assessments, found that chicken meatballs could only last for 60 h of storage. Meanwhile, the pH value of chicken meatballs that had been coated with smoke powder from various pyrolysis temperatures reached the threshold at 56 h. Thus, it can be concluded that durian rind smoke powder could increase the shelf life of meatballs by about 25 h.

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### References