EFFECTS OF AGARICUS BISPORUS AND FLAMMULINA VELUTIPES MUSHROOMS ON QUALITY OF CHICKEN BATTERS

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ABSTRACT It was noted the modern tendencies of the cultivated mushrooms using as a fat substitutes in the technology of low-fat meat products. It was states that variety of low-calorie, low-fat foods have come to the fore, and quickly become the mainstream of the future development of food. The mushrooms are worldwide cultivated and rich in protein, vitamins, dietary fiber, amino acids, polysaccharides, minerals, but low in fat and calories. In order to develop low-fat meat products, the compound of Agaricus bisporus and Flammulina velutipes mushrooms were used as fat substitute to replace the pork-back fat in chicken batters. The amino acids content of these mushrooms allows receiving a nice flavor and can be use in the minced meat. It was use a chicken meat as a well-liked raw material for emulsified products. For preparation of meat batters was used chicken breast, salt and sodium tripolyphosphate. The chicken meatballs were prepared with the cultivated mushrooms as fat-substitutes. The mushrooms were compounded to replace fat in chicken batters, and the effect of compounding these mushrooms on the quality of chicken mince was investigated to find the optimal ratio of fat replacement. The cooking loss, water holding capacity, color, texture and rheological properties of chicken batters were studied. The results showed that the compound of Agaricus bisporus and Flammulina velutipes improved the texture, increased the water holding capacity, redness and yellowness, and reduced the cooking loss and brightness of chicken batters. When the ratio of Agaricus bisporus and Flammulina velutipes was 2:1 to replace 30% pork-back fat, chicken batters showed the best quality. In conclusion, the combination of Agaricus bisporus and Flammulina velutipes is a promising fat substitute in the development of low-fat meat products.

Keywords: cultivated mushrooms; Agaricus Bisprous; Flammulina velutipes; chicken meat; fat

ВПЛИВ ГРИБІВ AGARICUS BISPORUS І FLAMMULINA VELUTIPES НА ЯКІСТЬ КУРЯЧОГО ФАРШУ

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АНОТАЦІЯ Розглянуто сучасні тенденції використання культивованих грибів як жирозамінників у технології м'ясних продуктів зі зниженим вмістом жиру. Встановлено, що різноманітність низькокалорійної їжі з низьким вмістом жиру вийшла на перший план і швидко стала основним напрямом майбутнього розвитку харчової продукції. Гриби, які використовувалися під час дослідження, культивуються в усьому світі та багаті білком, вітамінами, харчовими волокнами, амінокислотами, полісахаридами, мінералами, проте мають низький вміст жиру та невисоку калорійність. Для розробки м'ясних продуктів за зниженим вмістом жиру суміш грибів Agaricus bisporus та Flammulina velutipes використовувалася для заміни свинячого жиру в курячому фарші. Вміст амінокислот у грибах дозволяє отримувати присмак і використовувати їх у фарші. Було використано куряче м'ясо, як популярну сировину для емульсійних продуктів. Для приготування м'ясного фаршу використовували курячу грудку, сіль і триполіфосфат натрію. За використанням культивованих грибів, як жирозамінника, були виготовлені курячі фрикадельки. Гриби були використані для заміни жиру в курячому фарші, було досліджено вплив сумішей грибів на якість курячого фаршу, з метою визначення оптимального співвідношення між м'ясом і грибами. Водоутримуюча здатність, колір, консистенція та реологічні властивості курячого фаршу. Результати показали, що суміш Agaricus bisporus і Flammulina velutipes покращила текстуру, збільшила водоутримуючу здатність, колірні характеристики, а також зменшила втрати при тепловій обробці і яскравість курячого фаршу. Встановлено співвідношення Agaricus bisporus і Flammulina velutipes, що становило 2:1 для заміни 30% свинячого жиру, коли курячий фарш вивів найвищі показники якості. Таким чином, подібні Agaricus bisporus і Flammulina velutipes є перспективними для заміни жиру при розробці м'ясних продуктів зі зниженим вмістом жиру.

Ключові слова: культивовані гриби; Agaricus Bisprous; Flammulina velutipes; м'ясо курки; жир

Introduction

Health issues become particularly important with the development of society. As one of the three major nutrients in food, fat provides human body with the nutrients they need, but excessive intake of fat can lead to hypertension, myocardial infarction, stroke and other serious diseases and also easily lead to metabolic...
syndrome, neuropsychiatric disorders and other diseases in obese people. Therefore, a variety of low-calorie, low-fat foods have come to the fore, and quickly become the mainstream of the future development of food [1]. However, fat has important influence on the physical properties of food, such as appearance, flavor, texture and rheology during food processing, the reduction or removal of fat will result in significant decrease in food quality. In view of this, the use of fat substitutes to develop and produce low-fat products that are as consistent as possible with the taste of traditional full-fat products has become a major development trend in the production of low-fat food products, showing great challenges and development potential [2].

Agaricus Bisporus (Ab) and Flammulina velutipes (Fv) mushrooms are cultivated worldwide and rich in protein, vitamins, dietary fiber, amino acids, polysaccharides, minerals, but low in fat and calories [3,4].

One of the most well-liked emulsified meat items around the world is chicken products. Typically, a chicken sausage comprises 20–35% fat, which is crucial for the water holding capacity, cooking loss, flavor, color and textual qualities of emulsified products [1]. In this study, for the first time, Ab and Fv mushrooms were compounded to replace fat in chicken batters, and the effect of compounding Ab and Fv mushrooms on the quality of chicken mince was investigated to find the optimal ratio of fat replacement. Many studies have demonstrated that proteins and dietary fibers contribute to the formation of the gel system of minced meat[5,6]. The abundance of amino acids in Ab and Fv mushroom also adds flavor to minced meat. Therefore, Ab and Fv mushroom should be ideal fat substitutes. The results of this study can be used as a reference for the development of low-fat meat products.

The purpose of the work

The goal of the work is investigation of Agaricus bisporus and Flammulina velutipes as a valuable raw materials for fat substitutes in meat products.

Materials and Methods

Materials. Fresh chicken breast meat, pork-back fat, Agaricus bisporus (Ab) mushroom, Flammulina velutipes (Fv) mushroom, sugar, white pepper powder, sodium tripolyphosphate were obtained from Silpo Supermarket, Sumy, Ukraine. Methyl silicone oil was analytically pure grade.

Raw material treatment. Ab and Fv mushrooms were washed, dried (45°C for 12 h) and ground. Ab powder sieved through a 200 mesh sieve and Fv powder sieved through a 40 mesh sieve. The excess fat and connective tissue of the fresh chicken breasts and the excess connective tissue of pork-back fat were removed, and then chicken breasts meat and pork-back fat were placed into vacuum bags respectively after being ground separately using a grinder with a 6 mm perforated plate, (MM-12, Guangdong, China). Then they were stored at -40°C.

Chicken batters preparation. The chicken meat and pork-back fat were thawed. The preparation of meat batters was carried out in an ice water bath as follows: chicken breast, salt and sodium tripolyphosphate were mixed in a cutter bowl (Joyoung S2-A808, Jinan, China) for 30 seconds. After a 3-minute break, the one-third of the ice water was added, and the mixture was then chopped for 30 seconds. Pork-back fat, Ab and Fv mushroom powder, white pepper powder, sugar, one-third of the ice water were added, and the mixture was then chopped for 2 minutes after a 3-minutes pause. Finally, the remaining one-third of the ice water was added, and the mixture was then chopped for 1 minute after a 3-minutes pause. The meat batters was placed into a 50 ml centrifuge tube and centrifuged at 500 x g for 5 minutes to remove the residual air. The rheology was determined for the raw meat batters after the above treatments. The rest of the meat batters was boiled at 80 °C in a constant-temperature water bath for 30 minutes, and then cooled in the ice-water bath for 20 minutes. The cooked chicken batters were taken out for the determination of cooking loss, water holding capacity, color and texture.

Determination of cooking loss (CL). According to Choe et al. [7] with a slight modification, m1 gram of raw chicken batters was placed into a 50ml centrifuge tube and cooked at 80°C. Next, the cooked chicken batters were weighed to obtain m2 after absorbing the surface moisture with absorbent paper. Finally, the CL was calculated according to the following formula. For each formulation, the measurement was performed three times.

\[
\text{CL} (\%) = \frac{m_1 - m_2}{m_1} \times 100
\]  

Determination of water holding capacity (WIC). According to the method of Wang et al.[8] with a slight modification, about 10 g (m1) of cooked chicken batters was wrapped in absorbent paper and placed into a 50 mL centrifuge tube and then centrifuged at 8000 r/min for 10 minutes. Next, cooked chicken batters was weighted after removing the absorbent paper to obtain m2. For each formulation, the measurement was performed three times.

Determination of color. According to the method of Zahari et al.[9] with a slight modification, the cooked chicken batters was cut into 2 cm cylinders. The colour of its center part was measured with CR-400 color meter, and the L* value, a* value and b* value were recorded. Where L* represented the brightness, a* represented the redness, and b* represented the yellowness. The colour of the Standard white colorimetric plate was L*=96.15,
Table 3 shows the effects of different proportions of Ab and Fv mushrooms on the TPA of chicken batters. From Table 4, it can be seen that the addition of Ab and Fv mushrooms decreased the brightness (L*) and increased the yellowness (b*) of chicken batters. As the amount of Ab and Fv mushrooms increased, the brightness decreased significantly (P < 0.05), and the yellowness and redness did not change significantly (P > 0.05). The main reason for this was the browning of Ab and Fv mushrooms during drying, which deepened their color and accordingly gave them a low brightness and high redness and yellowness [13].

Effect of Ab and Fv mushrooms on the colour of chicken batters. Table 3 shows the effects of different proportions of Ab and Fv mushrooms on the colour of chicken batters. From Table 4, it can be seen that the addition of Ab and Fv mushrooms complex decreased the brightness (L*) and increased the yellowness (b*) and redness (a*) of chicken batters. As the amount of Ab and Fv mushrooms increased, the brightness decreased significantly (P < 0.05), and the yellowness and redness did not change significantly (P > 0.05). The main reason for this was the browning of Ab and Fv mushrooms during drying, which deepened their color and accordingly gave them a low brightness and high redness and yellowness [13].

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Effect of Ab and Fv mushrooms on the G’ of chicken batters

Myofibrillar proteins and protein-protein interactions, particularly those involving the myosin protein, are constantly changing processes that are reflected in dynamic rheological properties. These processes are strongly related to the intramolecular and intermolecular binding in protein molecules. The matrix strength and elastic characteristics of the meat gel network are indicated by variations in the storage modulus (G’) [15]. As can be seen from Fig. 1, the changes of G’ of chicken batters with different amount of Ab and Fv mushrooms had a similar trend, which was roughly divided into five stages. G’ increased slightly (21–25 °C); G’ slowly decreased (26–53 °C); G’ continued to increase (54–59 °C), the myosin head polymerization in chicken batters made the reaction between proteins to form a weak gel in this stage[16]. G’ appeared to fall sharply to reach the bottom (60–63 °C) due to the denaturation of the myosin tail in chicken batters, resulting in the formation of the structure of the protein gel damage [5,17]. G’ increased sharply (64–80 °C), the proteins

Table 1 – Cooking loss of chicken batters

<table>
<thead>
<tr>
<th>Treatments</th>
<th>CK</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooking loss /%</td>
<td>2.98±0.25a</td>
<td>2.45±0.22b</td>
<td>2.23±0.11b</td>
<td>2.09±0.21b</td>
<td>1.61±0.20c</td>
</tr>
</tbody>
</table>

a–c Means within a line with different letters are significantly different (p < 0.05)

Table 2 – WHC of chicken batters

<table>
<thead>
<tr>
<th>Treatments</th>
<th>CK</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHC/%</td>
<td>93.10±0.25bc</td>
<td>90.63±0.09d</td>
<td>92.77±0.20c</td>
<td>93.63±0.45b</td>
<td>94.55±0.37a</td>
</tr>
</tbody>
</table>

a–d Means within a line with different letters are significantly different (p < 0.05).

Table 3 – Colour of chicken batters

<table>
<thead>
<tr>
<th>Treatments</th>
<th>L’</th>
<th>a’</th>
<th>b’</th>
</tr>
</thead>
<tbody>
<tr>
<td>CK</td>
<td>87.89±0.30a</td>
<td>0.13±0.10b</td>
<td>12.63±0.47b</td>
</tr>
<tr>
<td>T1</td>
<td>69.01±0.58b</td>
<td>2.77±0.19a</td>
<td>16.46±0.41a</td>
</tr>
<tr>
<td>T2</td>
<td>68.34±0.59b</td>
<td>2.58±0.14a</td>
<td>16.21±0.26a</td>
</tr>
<tr>
<td>T3</td>
<td>64.63±1.14c</td>
<td>2.39±0.26a</td>
<td>16.69±0.25a</td>
</tr>
<tr>
<td>T4</td>
<td>61.76±0.38d</td>
<td>2.75±0.10a</td>
<td>16.25±0.21a</td>
</tr>
</tbody>
</table>

Fig. 1 – G’ of chicken batters
aggregated and formed a gel, and the semi-soluble gel formed an elastic gel after being heated, and then the chicken batters was transformed from a viscous-elastic sol-gel state to an elastic gel network structure in this stage[6,18]. Throughout the temperature rise, the G’ of chicken batters with Ab and Fv mushrooms compound were greater than that of CK and increased with increasing mushroom amount. Higher G’ values indicated a more compact pattern of the change of its G’ value is related to the gel denaturation temperature [10,20].

**Conclusion**

Partial replacement of pork-back fat in chicken batters with Ab and Fv mushrooms compound reduced cooking loss, increased redness and yellowness, decreased brightness and improved rheological properties of chicken batters. Water holding capacity, chewiness, hardness and springiness of chicken batters were increased, and the cohesiveness decreased significantly when fat substitution exceeded 30%. In conclusion: all the qualities of chicken batters were improved when Ab and Fv mushrooms were compounded at 2:1 to replace 30% of pork-back fat in chicken batters. Ab and Fv mushrooms compound is a promising fat substitute for producing low-fat meat products.

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