Identification of Taste-Active Components in the Chicken Meat Extract by Omission Test – Involvement of Glutamic Acid, IMP and Potassium Ion

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Abstract In order to investigate the taste of chicken meat, taste-active components in the meat extract from 8-week-old female Cobb strain broilers were identified by sensory evaluation. First, the components of the meat extract were analyzed chemically, and total 28 components, i.e., 16 amino acids, 6 adenosine 5'-triphosphate (ATP) metabolites and 6 inorganic ions could be detected. The pH of the extract solution was 5.87. To clarify the contribution of these components to the taste of chicken meat, omission test by triangle difference test was conducted. A mixed chemical solution was prepared based on the composition of the meat extract. When the extract and chemical solution were compared, there was no difference in their taste except for slight sourness. Thus, this mixed solution was used as a reference solution in the subsequent sensory evaluation. From the data of omission test, groups of amino acids, ATP metabolites and inorganic ions affected the taste of chicken meat extract solution. Out of the components of these groups, glutamic acid, 5'-inosinic acid (IMP) and potassium ion (K+) were identified as the taste-active components. To confirm the involvement of these 3 components to the taste of chicken meat, a solution consisting of glutamic acid, IMP and K+ was compared with the reference solution, which exhibited no difference between the taste of these two solutions. These results suggest that these 3 components, glutamic acid, IMP and K+, account for most of the taste of chicken meat.


Key words: chicken meat, taste-active component, amino acid, ATP metabolite, inorganic ion

Chicken meat shares more than 30% of the meat market in Japan, because of its lower price and calorie than beef and pork. In order to supply the meat of better quality to the market, its taste is getting one of the most important considerations. For the purpose of finding the way to improve the taste of chicken meat, we compared taste difference between Hinai-dori, a Japanese native chicken, and broilers to clarify the contribution of 5'-inosinic acid (IMP) and glutamic acid to their difference of 'umami' taste. However, the study was focused only to 'umami' taste, which made it left out to discuss about the overall taste of chicken meat. Therefore, it is necessary to identify the taste-active components of chicken meat not only for 'umami' taste but also for other taste elements from a wide range of possible candidates in the chicken meat extract.
Foods include many taste-active substances, e.g., free amino acids, peptides, proteins, sugars, adenosine 5'-triphosphate (ATP) metabolites, inorganic ions and possibly fats. Compared with animal meat, seafood has been paid much more attention in the efforts to identify taste-active components. In scallops, for example, glycine, alanine, arginine, 5'-adenylic acid (AMP), sodium ion (Na+), potassium ion (K+) and chloride ion (Cl-) were identified as taste-active components. On the other hand, in the chicken meat, there have been very few reports about taste-active components, and the studies reported until now are only about the concentration change of free amino acids and ATP metabolites during storage or among strains. Thus, the present study was undertaken to try to identify taste-active components in the chicken meat extract from a wider range of substances including free amino acids, ATP metabolites and inorganic ions by sensory evaluation. The omission test by triangle difference test was employed because it makes it possible not only to identify taste-active components, individually or as a group, but also to detect interactive effects between the components in the extract.

**Materials and Methods**

*Animals and Diets*: Commercial Cobb strain female broilers were raised with the experimental diets developed in our laboratory and water ad libitum for 8 weeks as described in the previous report. Since the meat of female chicken is more palatable than that of male chicken, the former was chosen in the present study. The composition of diets for 0 to 5 weeks of age is presented in Table 1. All diets were formulated to meet the requirements of vitamins and minerals recommended by the NRC for broilers.

*Chemicals*: The chemicals used were analytical-grade, commercially available unless specifically stated, and the standard solutions of inorganic ions for atomic absorption were purchased from Wako Pure Chemical Co. (Osaka, Japan). The water used was ion-exchanged and filtered with glass filter (Organo, Puric model-S, Tokyo, Japan).

*Preparation of the Meat Extract Solution*: The chickens at 8 weeks of age were killed by exsanguination via the carotid artery. The breast muscle, M. pectoralis superficialis, was taken from 8 chickens to prepare the meat extract solution at 4°C as soon as possible. The meat was weighed, added with distilled water and homogenized with Polytron (Kinematica, Switzerland) to make the homogenate about 10 g/50 ml. A portion of homogenate was boiled with stirring for 15 min, and centrifuged at 5,000 rpm for 15 min (High Speed Refrigerate Centrifuge Model-6800, Kubota Ltd., Tokyo, Japan). The supernatants were withdrawn by pipetting, instead of filtration.
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because of its better efficiency. Then, they were deproteinized with ethanol (final concentration 80%). After eliminating the ethanol with rotary evaporator (Eyela, Tokyo Rikakikai Co. Ltd., Tokyo, Japan), the residue was filled up to 50 ml with distilled water, and stored in a freezer at −20°C for later analyses. The whole process was carefully conducted in order to get rid of bacterial contamination.

Amino Acid Determination: Amino acids in the chicken meat extract solution were analyzed by the method of Ishida et al.6) with HPLC (Shimadzu, LC-10A System, Kyoto, Japan) using Shim-pak Amino-Li column (lithium type, 150×6.0 mm, Shimadzu, Kyoto, Japan) at 39°C with a linear gradient from 150 mM lithium citrate and 7% ethylene glycol monomethyl ether, pH 2.6, to 300 mM lithium citrate and 20 mM boric acid, pH 10.0, as described by Fujimura et al.1,2).

ATP Metabolite Determination: ATP, adenosine 5’-diphosphate (ADP), AMP, IMP, inosine (Ino) and hypoxanthine (Hyp) were analyzed with HPLC LC-6A System using CLC-ODS column (150×6.0 mm, Shimadzu, Kyoto, Japan) at 45°C with 20 mM citric acid and 30 mM diethylaminoethanol.

Inorganic Ion Determination: K+, magnesium ion (Mg2+), Na+ and calcium ion (Ca2+) were detected with atomic absorption spectrophotometer (Hitachi Polarized Zeeman Atomic Absorption Spectrophotometer Z-1600, Hitachi Ltd., Tokyo, Japan). Phosphate ion (PO43−) was determined with spectrophotometer (Hitachi Spectrophotometer U-2000, Hitachi Ltd., Tokyo, Japan) as phosphomolybdate25). CI− was analyzed with ion chromatograph using Hitachi 2710-SA–IC column (50×4.0 mm, Tokyo, Japan) at 40°C with 0.75 mM potassium hydrogen phthalate, 5% isopropyl alcohol and 2% ethylene glycol. The Cl− in eluates was determined with ion electrode detector (L-3720, Hitachi Ltd., Tokyo, Japan).

pH Determination: The pH was determined with pH meter using a micro electrode, TPX-90–i (Toko Chemical Laboratories Co., Tokyo, Japan). All measurements were conducted at 20.0±0.5°C.

Mixed Reference Solution: The mixed reference solution was formulated using 27 reagents simulating the contents of the chicken meat extract solution and their actual concentrations were 5 times diluted levels of those in Table 2 in order to offer the solution for sensory evaluation. Amino acids and ATP metabolites were used as a crystal form. Inorganic ions were prepared as following chemicals; K+, tripotassium phosphate n-hydrate and potassium chloride; Na+, trisodium phosphate 12-hydrate, sodium chloride and sodium hydroxide; PO43−, tripotassium phosphate n-hydrate and trisodium phosphate 12-hydrate; Cl−, L-lysine monohydrochloride, potassium chloride and sodium chloride. For omission test, group or individual components were omitted from the complete reference solution. The pH of each mixed solution was adjusted with 4N nitric acid to be the same as the chicken meat extract solution.

Sensory Evaluation of the Chicken Meat Extract and the Reference Solution: The taste of both solutions was compared by an open panel method at room temperature (20–25°C). Whether the taste is the same between the solutions or not was judged by panelists.

Sensory Evaluation by Omission Test: Trained 12 to 18 panelists were joined to the test. All the sensory tests with omitted solutions were run by a triangle difference test in which a set of test solutions (one odd and two duplicate same samples) was presented at 20±2°C to each panelist to select the one odd sample.

Results

Chemical Analysis of chicken meat extract: The contents of free amino acids, ATP metabolites and inorganic ions in the chicken meat extract solution are summarized in Table 2. The total amount of amino acids, ATP metabo-
lites and inorganic ions was 9.49 mg/g fresh muscle. Nine major components, i.e., lysine, glutamic acid, AMP, IMP, Ino, K\(^+\), Na\(^+\), Cl\(^-\) and PO\(_4^{3-}\) occupied 95.6\% of total weight. Sixteen amino acids were detected. In the meat extract, the total amount of amino acids was 428 \(\mu g/g\). The content of lysine was 57.7 \(\mu g/g\). The contents of glutamic acid, glycine, threonine, alanine, proline and serine were all more than 30 \(\mu g/g\), and the sum of above 7 amino acids shared 69.1\% of total amino acids detected. Small amounts of isoleucine, histidine and valine were also detected in the chicken meat extract solution. Within all amino acids detected, only glutamic acid (53.2 \(\mu g/g\)) exceeded its threshold value\(^9\).

In 6 ATP metabolites, the main compound was IMP which concentration was 33 times that of AMP. The content of IMP amounted to 3.32 mg/g fresh muscle, which was far beyond the threshold value\(^27\). The contents of ATP, ADP and Hyp were less than 50 \(\mu g/g\).

In 6 inorganic ions, the sum of K\(^+\) and PO\(_4^{3-}\) occupied 89\% of all inorganic ions measured. The levels of K\(^+\) and Na\(^+\) were 2.81 and 0.27 mg/g, respectively. The contents of Mg\(^{2+}\) and Ca\(^{2+}\) were 45.5 and 0.3 \(\mu g/g\), respectively. As for anions, the contents of PO\(_4^{3-}\) and Cl\(^-\) were 2.02 and 0.28 mg/g, respectively. The pH of the chicken meat extract solution was 5.87 \(\pm\) 0.07.

Comparison between the Chicken Meat Extract and Mixed Chemical Solution by Sensory Evaluation: The taste of the complete mixed chemical solution was judged to be less sourer than that of the chicken meat extract (data not shown). However, there were no differences in other tastes, i.e., umami, sweetness, bitterness and saltiness, between them. Therefore, this mixed chemical solution was used as a reference solution in subsequent taste panel assessments.

Omission of Group Components: The results of omission test of group components are shown in Table 3. When all amino acids were omitted from the reference solution, 10 out of 12 panelists recognized taste difference correctly. There were also significant differences when all ATP metabolites and inorganic ions were omitted.

Omission of Amino Aids: When lysine or all amino acids except glutamic acid and lysine were omitted, the taste of the omitted solutions was not different from that of the reference solution. On the other hand, glutamic acid–omitted solution had different taste from the reference solution. Glutamic acid was the only component that was near the threshold value\(^3\) in all amino acids, and judged to be indispensable for producing the taste of the chicken meat extract.

Omission of ATP Metabolites: The omission test of ATP metabolites was carried out in the same manner as amino acids. Nine out of 12 panelists correctly identified the difference of taste between the reference and IMP-omitted solution. No difference was found with other ATP metabolites–omitted solution.

### Table 2. Contents of free amino acids, ATP metabolites and inorganic ions in the chicken meat extract

<table>
<thead>
<tr>
<th>Amino acids ((\mu g/g))(^1)</th>
<th>ATP metabolites (mg/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lys</strong> 57.7 (\pm) 3.5</td>
<td><strong>IMP</strong> 3.32 (\pm) 0.16</td>
</tr>
<tr>
<td><strong>Glu</strong> 52.0 (\pm) 11.9</td>
<td><strong>Ino</strong> 0.15 (\pm) 0.02</td>
</tr>
<tr>
<td><strong>Gly</strong> 42.0 (\pm) 3.6</td>
<td><strong>AMP</strong> 0.10 (\pm) 0.01</td>
</tr>
<tr>
<td><strong>Thr</strong> 40.1 (\pm) 1.7</td>
<td><strong>ADP</strong> 0.033 (\pm) 0.007</td>
</tr>
<tr>
<td><strong>Ala</strong> 36.3 (\pm) 2.7</td>
<td><strong>Hyp</strong> 0.014 (\pm) 0.002</td>
</tr>
<tr>
<td><strong>Pro</strong> 33.7 (\pm) 1.7</td>
<td><strong>ATP</strong> 0.012 (\pm) 0.001</td>
</tr>
<tr>
<td><strong>Ser</strong> 32.8 (\pm) 1.9</td>
<td></td>
</tr>
<tr>
<td><strong>Met</strong> 29.3 (\pm) 1.7</td>
<td></td>
</tr>
<tr>
<td><strong>Arg</strong> 24.1 (\pm) 1.0</td>
<td></td>
</tr>
<tr>
<td><strong>Tyr</strong> 20.3 (\pm) 0.5</td>
<td><strong>K(^+)</strong> 2.81 (\pm) 0.14</td>
</tr>
<tr>
<td><strong>Asp</strong> 13.6 (\pm) 1.5</td>
<td><strong>PO(_4^{3-})</strong> 2.02 (\pm) 0.09</td>
</tr>
<tr>
<td><strong>Leu</strong> 12.6 (\pm) 0.5</td>
<td><strong>Cl(^-)</strong> 0.28 (\pm) 0.01</td>
</tr>
<tr>
<td><strong>Phe</strong> 10.0 (\pm) 0.2</td>
<td><strong>Na(^+)</strong> 0.27 (\pm) 0.01</td>
</tr>
<tr>
<td><strong>Val</strong> 6.7 (\pm) 0.6</td>
<td><strong>Mg(^{2+})</strong> 0.045 (\pm) 0.007</td>
</tr>
<tr>
<td><strong>His</strong> 4.9 (\pm) 0.4</td>
<td><strong>Ca(^{2+})</strong> 0.0003 (\pm) 0.0001</td>
</tr>
<tr>
<td><strong>Ile</strong> 4.5 (\pm) 0.5</td>
<td></td>
</tr>
</tbody>
</table>

Values are means \(\pm\) SE for 8 chickens.

\(^1\) Gln and Asn were not determined.
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Table 3. Triangle difference test by omission of group components, individual amino acids, ATP metabolites and inorganic ions

<table>
<thead>
<tr>
<th>Omitted components</th>
<th>Number of Panelists</th>
<th>Correct identifications</th>
<th>Level of significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group components</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amino acids</td>
<td>12</td>
<td>10</td>
<td>***</td>
</tr>
<tr>
<td>ATP metabolites</td>
<td>12</td>
<td>10</td>
<td>***</td>
</tr>
<tr>
<td>Inorganic ions</td>
<td>18</td>
<td>10</td>
<td>*</td>
</tr>
<tr>
<td>Amino acids</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lysine</td>
<td>12</td>
<td>5</td>
<td>NS</td>
</tr>
<tr>
<td>Glutamic acid</td>
<td>12</td>
<td>8</td>
<td>*</td>
</tr>
<tr>
<td>Amino acids except lysine and glutamic acid</td>
<td>12</td>
<td>4</td>
<td>NS</td>
</tr>
<tr>
<td>ATP metabolites</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IMP</td>
<td>12</td>
<td>9</td>
<td>**</td>
</tr>
<tr>
<td>ATP metabolites except IMP</td>
<td>12</td>
<td>4</td>
<td>NS</td>
</tr>
<tr>
<td>Inorganic ions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K⁺</td>
<td>12</td>
<td>8</td>
<td>*</td>
</tr>
<tr>
<td>Na⁺</td>
<td>12</td>
<td>3</td>
<td>NS</td>
</tr>
<tr>
<td>PO₄³⁻</td>
<td>12</td>
<td>1</td>
<td>NS</td>
</tr>
<tr>
<td>Cl⁻</td>
<td>12</td>
<td>4</td>
<td>NS</td>
</tr>
</tbody>
</table>

***, p < 0.001 ; **, p < 0.01 ; *, p < 0.05 and NS, not significant.

Table 4. Triangle difference test between the reference and simplified mixed solution

<table>
<thead>
<tr>
<th></th>
<th>Number of Panelists</th>
<th>Correct identifications</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simplified mixed solution (Glu, IMP and K⁺)</td>
<td>12</td>
<td>7</td>
<td>NS</td>
</tr>
</tbody>
</table>

NS, not significant.

Omission of Inorganic Ions: In individual inorganic ion-omitted solutions, only K⁺-omitted solution showed a significant difference from the reference solution. The other components, Na⁺, PO₄³⁻ and Cl⁻ did not exhibit any taste-active effects.

From the above results, 3 components, glutamic acid, IMP and K⁺, were found to contribute to the taste of the mixed reference solution. As a final step in a series of omission tests, therefore, it was attempted to evaluate the taste of the simplified mixed chemical solution containing glutamic acid, IMP and K⁺. No significant differences were recognized between the reference and simplified mixed solution as shown in Table 4.

Discussion

The purpose of the present study is to identify the taste-active components in the chicken meat extract in order to clarify the difference of taste among chicken strains. In the previous report, free amino acids and IMP were analyzed to compare the taste difference of the
meat extracts between Hinai-dori, a Japanese native chicken and broilers. However, since the test solutions for sensory evaluation included only IMP and glutamic acid, which are both ‘umami’ indicator substances, we could not discuss the overall taste of chicken meat other than umami taste. In this report, therefore, all the other amino acids and ATP metabolites in addition to IMP and glutamic acid were included in the solution for sensory evaluation. The contribution of inorganic ions was also tested. In addition, although extraction with cold 3% sulfosalicylic acid was used in the previous study, extraction with boiling water was employed here according to Konosu et al., in order to mimic the extraction method to more ordinary way of cooking of meat.

From chemical analysis, 28 components were detected in the extract of broiler’s meat. The contents of free amino acids and ATP metabolites in the chicken meat extract vary widely in the literature mainly due to the difference of preparation method and the chickens used, e.g., meat location, strain, sex and age of chicken. The contents of amino acids obtained in the present study were in similar ranges to the data by Nishimura et al. and Saegusa et al. who employed the same extraction method as ours. When compared with seafood, in which taste-active components have been much more characterized, the contents of amino acids in the chicken meat were similar to those in scallops except glutamic acid, proline, glycine and alanine. In scallops and crabs, glutamic acid, glycine, alanine and arginine are recognized as taste-active amino acids. The levels of these amino acids in the meat of livestock were much lower than those in seafood. Scallops contain more than 100 times these amino acids as many as chicken meat. The difference of amino acid balance between species is of quite interest. The contents of all the above amino acids except for glutamic acid were less than respective threshold values as reported previously. Therefore, the contribution of these amino acids to the taste of chicken meat must be, if any, small. Only glutamic acid exceeded its threshold value, and was actually taste-active amino acid.

The contents of ATP metabolites obtained here were in similar ranges to previous reports. IMP is the main component of ATP metabolites in the chicken meat extract, while AMP is the largest and taste-active component in crabs. As reported by Nishimura et al., the content of AMP in the chicken meat was less than that in beef and pork, and below its threshold value. ATP metabolites might not be accumulated as AMP in the chicken meat, because AMP deaminase activity in the chicken meat is higher than that in the meat of other livestock. As for inorganic ions, the contents of K+ and PO43- were in the same ranges as those in scallops. Although reported as the most taste-active in scallops, Na+ and Cl- were lower level in the chicken meat than in scallops and crabs.

From chemical analysis, it was suggested that major components in the chicken meat extract, e.g., glutamic cid, lysine, IMP, K+, Na+, PO43- and Cl- may be taste-active components. Therefore, these 7 components were submitted to the omission test. At first, the mixed chemical solution was prepared based on the composition of the chicken extract and was tested whether it shows the same taste as the extract solution. By sensory evaluation, the mixed chemical solution exhibited no difference in basic tastes from the chicken meat extract solution except for slight sourness. Suyama and Shimizu pointed out that carnosine, a dipeptide, shows sourness at pH 5.7. The chicken extract contains a large amount of carnosine, which is about 23 times that of glutamic acid. Because the pH of the chicken meat extract was 5.9 in the present study, less sour taste of the mixed chemical solution might have been due to the lack of carnosine.
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Indeed, in our preliminary experiment, this level of carnosine showed a slight increase of sourness and a decrease of 'umami' taste (unpublished data). However, the peptide was omitted from a series of omission test in the present study, because the mixed chemical solution was judged to reproduce almost all of the characteristic taste of the chicken meat without addition of carnosine. The possibility that other tasty peptides may contribute to the taste of chicken meat cannot be ignored, of course. However, their contribution doesn't seem significant because of the fact that peptide pool in skeletal muscle is only about one tenth of free amino acid pool except for carnosine and anserine.

Taste-active effects were found in all groups of amino acids, ATP metabolites and inorganic ions. As individual taste-active components, glutamic acid in amino acid group and IMP in ATP metabolite group were judged significantly to contribute to the taste of chicken meat extract solution. They are known to show the 'umami' taste by their synergistic effect. The contents of both components obtained in this report ranked within the range of strong synergistic effect. Therefore, the taste difference of IMP- or glutamic acid-omitted solution from the reference solution must have been intensified by the loss of their synergistic effect.

The present results demonstrated that inorganic ions also contribute to the taste of chicken meat like scallops and crabs. Out of the ions tested, however, only K+ turned out to be a taste-active component. K+ is the most abundant inorganic ion in the meat. This is the first report to demonstrate the contribution of K+ to the taste of chicken meat. Its significance to the taste has already been reported in seafood. The lack of K+ in scallops, for example, led to the decrease of 'umami' taste, and the increase of bitterness, and significantly diminished continuity, fullness, complexity and mildness of taste. HAYASHI et al. studied the role of taste-active components in snowcrabs, concluding that K+ represents sourness.

In our mixed chemical solution simulated to the chicken extract, the lack of K+ clearly lowered the complexity of taste, and resulted in the decrease of sweetness and saltiness (FUJIMURA, DOHURA and ISHIBASHI, manuscript in preparation). Thus, the taste to which K+ contributes varies depending on foods. It might be because K+ is not taste-active by itself, but affects the taste of food by interacting with other components. On the other hand, it should be noted that K+ has common characteristics to have a potency of overall preference and strengthening the continuity of taste, which may be called a 'flavor-improving' effect.

Phosphate ion was secondly abundant in chicken meat, but did not show any taste effect. The chicken extract in the present study included the same level of PO₄³⁻ as scallops and crabs, in which PO₄³⁻ was taste-active. It is interesting that Na⁺ and Cl⁻ were not significantly taste-active components in chicken meat, whereas they are taste-active in seafood. The reason for these apparent discrepancies of their taste-active potency is not known at present. In the case of these inorganic ions, different from glutamic acid and IMP, the way to contribute to the taste may not be direct. Instead, the interaction with other co-existing components may be essential for their taste-active effect.

In the present study, a mixture of glutamic acid, IMP and K+, only 3 components in the chicken extract, reproduced almost the same taste as the reference solution. Further efforts to search for many other taste-active components in the chicken meat are necessary, of course. However, we can conclude that the taste of chicken meat is mainly explained by these 3 components, a synergistic effect of 'umami' taste by glutamic acid and IMP, and a flavor-improving effect by K+. 
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オミッションテストによる鶏肉抽出液の呈味有効成分の特定

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肉の呈味成分であるアミノ酸，核酸関連物質，さらに無機イオンの中から，オミッションテストを用いて鶏肉抽出液の呈味有効成分を検討した。前報では，鶏肉の呈味成分を明らかにするために，鶏種間の成分比較を行なない，イノシン酸の影響が大きいことを特定した。しかし，鶏種間の成分の濃度差が小さいことなどから，この手法で鶏肉の呈味を完全に説明することは困難であった。肉の呈味を論ずるに当り，呈味有効成分を把握しておくことは重要であり，本研究を行なった。鶏肉の筋肉抽出液は，NRCの栄養素要求量を満たす配合飼料を給与して飼育した8週齢のCobb系ブロイラー雌の浅腹筋を熱水抽出して調製した。抽出液のpHを測定後，遊離アミノ酸16成分，核酸関連物質6成分および無機イオン6成分を定量した。その分析値に基づき化学混合液を作成し，天然抽出液との官感比較を行ない，若干の酸味を除くと，両者が同様の呈味を有することを確認した。次にこの化学混合液を用いて，3点識別法によるオミッションテストを行ない，アミノ酸群，核酸関連物質群および無機イオン群のいずれも呈味に影響する成分群であることを確認した。次いで，個々の成分のオミッションテストを行ない，グルタミン酸，イノシン酸およびカリウムイオンの3成分について単独での呈味効果を認めた。鶏肉抽出液の味は，グルタミン酸およびイノシン酸の呈味相乗効果ならびにカリウムイオンの風味に及ぼす影響が主たる要因となり，形成されていると推察された。

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