Amino acid profile of *Sous vide* cooked poultry breast meat products

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**ABSTRACT**

*Sous vide* cooking method allows preparation of ready-to-eat meat products satisfying consumer demand for convenience and safety. Amino acid composition determines the nutritive value of product and it can be changed during heat treatment and prolonged storage. The aim of this research was to evaluate amino acid profile of four marinated, *sous vide* cooked poultry meat products made from mature hen’s fillet; mature hen’s fillet with vegetable-and-fruit additive; broiler’s fillet; broiler’s fillet with vegetable-and-fruit additive. The skinless fillets and other ingredients were packaged in the polyamide/polyethylene (PA/PE) pouches, vacuum sealed, marinated, *sous vide* cooked, and chilled rapidly. The amino acid profile was evaluated in raw and thermally treated vacuum packaged broiler’s and hen’s fillets. Amino acid profile was determined using HPLC-MS by method LVS ISO 13903:2005.  
Significant differences in amino acid profile between raw broiler’s fillet and mature hen’s fillet were found. The highest content of total amino acids was detected in raw broiler’s fillet 52.16 g 100 g⁻¹. It was reduced to 50.82 g 100 g⁻¹ after heat treatment of *sous vide* cooked broiler’s breast product or to 44.78 g 100 g⁻¹ when heat treated together with vegetable-and-fruit additive. Similar tendency was observed in products made from mature hen’s fillet. The analysis of amino acid content demonstrated quantitative and qualitative differences among the analyzed samples.

**Keywords:** broiler; mature hen; breast meat; amino acid profile

**INTRODUCTION**

The proteins from animal sources are most desirable since they meet the human nutritional requirements. Chicken meat is rich in high quality proteins [1]. Proteins consist of amino acids combined by peptide bonds and other linkages (e.g. disulfide and hydrogen bonds). Amino acid composition greatly determines the nutritive value of meat product, especially content of essential amino acids – phenylalanine (Phe), isoleucine (Ile), leucine (Leu), lysine (Lys), methionine (Met), threonine (Thr), tryptophane (Trp) and valine (Val). Chicken meat is characterized by a high content of lysine, leucine, aspartic acid and glutamic acid [2]. However, when foods are prepared to be eaten, there are significant changes in the flavour as well as in the nutritional composition of food [3]. The optimal heat-treatment of meat should destroy pathogenic organisms, while maintaining a high yield of product and leading to the development of final desirable characteristics. Creed & Reeve described that *Sous vide* cooking reduces heat damage to proteins, diminishes the loss of liquids and aroma compounds at the same time providing longer shelf life comparing to traditional cooking methods [4]. Vacuum packaged storage also reduces weight losses from evaporation and trimming, preserves visual appearance, improves hygienic control, and enhances palatability [5]. It is widely recognized that meat tenderness is the most significant factor in consumers’ satisfaction [6; 7]. The improvement of tenderness in meats is mainly caused by changes in structure of connective tissues solubilised by heat, while at the same time heat-denaturation of myofibrillar proteins generally causes meats toughening [8]. *Sous vide* cooking method allows preparation of ready-to-eat meat products satisfying consumer demand for convenience and safety. In order to enhance nutritional value of the meat product – vegetable-and-fruit additive can be used [9]. Muscle proteins can be divided into three groups, based on their solubility characteristics: sarcoplasmatic (water-soluble), miofibrillar (salt-soluble) and stromal (insoluble) proteins [10]. Miofibrillar proteins have ability to produce three dimensional gels upon heating and subsequent cooling. Chiavaro et al. reported that juice loss from meat tissue after cooking were generally attributed to the denaturation of miofibrillar proteins, (besides collagen), and they were strictly related to water holding capacity [11]. During heating meat proteins denaturate and cause structural changes such as transversal and longitudinal shrinkage of...
muscle fibers and connective tissue shrinkage. The review of Tornberg summarises the structural changes occurring on cooking as follows: When the transverse shrinkage to the fibre axis occurs mainly at 40–60 ºC this widens the gap already present at rigor between the fibres and their surrounding endomysium. At 60–70 ºC the connective tissue network and the muscle fibres co-operatively shrink longitudinally, the extent of shrinkage increasing with temperature. This shrinkage causes the great water loss that is obtained on cooking. It is then presumed that water is expelled by the pressure exerted by the shrinking connective tissue on the aqueous solution in the extracellular void [12]. The results of study conducted by Murphy et al. indicated that the soluble proteins might be used as indicator for the degree of cooking because increasing cooking temperatures significantly reduced the total soluble proteins in the cooked chicken breast patties [13]. As a result amino acid composition in cooked meat is changed compared to raw product.

The aim of this research was to evaluate amino acid profile of four marinated, sous vide cooked poultry meat products made from mature hen’s fillet; mature hen’s fillet with vegetable-and-fruit additive; broiler’s fillet; broiler’s fillet with vegetable-and-fruit additive.

MATERIALS & METHODS

The average age of slaughtered broilers of the cross Ross 308 was 44 days; age of parents’ stock hens was 60 weeks. The slaughter and primary treatment was performed at a meat processing plant (line Stork PMT). Broilers and mature hens were stunned, then killed with a knife, bleded for 2 and 3 minutes, and scalded in a steam bath at 56±0.2 ºC and 60±0.2 ºC, respectively, defeathered, eviscered and chilled for 100 minutes at +1±0.5 ºC. The obtained carcasses were refrigerated for 24 hours at temperature +1±0.5 ºC to reach rigor mortis. Carcasses were randomly selected for separating a fillet (musculus pectoralis). The obtained skinless fillets together with other ingredients were packaged in polyamide/polyethylene (PA/PE) pouches (film thickness 90 µm, pouch size 230×145 mm), vacuum sealed, marinated and sous vide cooked according to the technology described in the patent of Republic of Latvia no. 14095 [9]. Each package contained 130±5 g fillet mixed with salt and spices (dried dill, dried parsley, fresh chopped garlic) and 12 ml semi-dry white wine. Half of the packages additionally contained a mix (65±3 g) of shredded carrots with sea buckthorn sauce. Vacuum packaged marinated products were thermally treated in a water bath (Clifton Food Range) for 40 min at 80 ºC. Four types of products were analysed: broiler’s fillet with spices; broiler’s fillet with spices and vegetable-and fruit additive (further broiler’s fillet with additive); hen’s fillet with spices; broiler’s fillet with spices and vegetable-and fruit additive (further hen’s fillet with additive).

Chemical composition of poultry meat was analysed in triplicate using the following methods: protein content by the Kjeldahl method LVS ISO 937:1978; fat content by the Soxhlet method LVS ISO 1443:1973; ash content by the method ISO 936:1996 using a muffle furnace. The amino acid profile was evaluated in raw and thermally treated vacuum packaged broiler’s and hen’s fillets. Amino acid profile was determined using HPLC-MS by method LVS ISO 13903:2005. Amino acids were extracted by hydrochloric acid in closed process of hydrolysis and determined by HPLC Waters 2695 and mass selective detector Waters 3100. Totally 17 amino acids were detected, including 7 essential amino acids. Amino acid content is reported as average of three replications in g 100 g-1 dry weight (DW). Relative changes of amino acid content were calculated as percentage of difference against the content in a raw product.

RESULTS & DISCUSSION

Raw and thermally treated broiler’s fillet and hen’s fillet chemical composition and pH are presented in Table 1. Chemical composition showed significant differences (p<0.05) between broiler and hen meat, regarding water and protein content. Mature hen’s fillet has lower water content and higher protein content. Research on various species has indicated that an increase in age is accompanied by an increase in intramuscular fat, increased saturation of intramuscular lipids, increased myoglobin concentration and an increase in toughness due to changes in the nature of the connective tissue present in the muscle [13]. Moreover amino acid content (Fig. 1) and especially content of individual essential amino acids (Table 2) varies with bird age, being lower in mature hen’s fillet compared to broiler’s fillet.

In the thermal treatment process a cooking loss was observed due to loss of water, fat, and soluble proteins. However relatively higher loss of water was observed thus the total proportion of proteins per 100 g of product was increased after heat treatment. Previous researchers have shown that water content was changed from 72.5 g 100 g-1 in raw lean chicken to 67.9 g 100 g-1 in oven roasted chicken, while protein content was changed from 20.2 g 100 g-1 to 24.5 g 100 g-1, respectively [3].
Table 1. Physical-and-chemical characteristics of broiler’s and hen’s fillets

<table>
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<th>Broiler’s fillet</th>
<th>Mature hen’s fillet</th>
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<tbody>
<tr>
<td></td>
<td>Chilled</td>
<td>Thermally treated</td>
</tr>
<tr>
<td>pH</td>
<td>5.91±0.10</td>
<td>6.10±0.05</td>
</tr>
<tr>
<td>Water</td>
<td>74.30±0.30</td>
<td>69.51±0.30</td>
</tr>
<tr>
<td>Protein</td>
<td>22.85±0.29</td>
<td>25.98±0.10</td>
</tr>
<tr>
<td>Fat</td>
<td>1.70±0.10</td>
<td>1.79±0.10</td>
</tr>
<tr>
<td>Ash</td>
<td>1.15±0.01</td>
<td>2.32±0.02</td>
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</tbody>
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The highest content of total amino acids among studied samples was detected in raw broiler fillet 52.16 g 100 g⁻¹. It was reduced to 50.82 g 100 g⁻¹ after heat treatment or to 44.78 g 100 g⁻¹ when it was heat treated together with vegetable-and-fruit additive. Similar loss of amino acids was observed in hen’s fillet after cooking, but it was not significantly different in both thermally treated products (without/with vegetable-and-fruit additive (p>0.05).

Figure 1. Content of amino acids in broiler’s and hen’s fillets and their products.

The total content of amino acids decreased by 3.3% in thermally treated broiler’s fillet. While in broiler’s fillet with vegetable-and-fruit additive the decrease in total amino acid content was significantly higher (14.8%). It can be due to slightly lower pH in product with vegetable-and-fruit additive, as well as some interactions between amino acids and biologically active substances present in this additive. The decrease in total amino acid content in thermally treated hen’s fillet without or with additive was similar in both cases, 10.7% on average comparing to amino acid content in raw hen’s fillet.

Table 2. Content of essential amino acids in broiler’s fillet, hen’s fillet, and their products, g 100 g⁻¹ DW

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<th>Broiler’s fillet</th>
<th>Mature hen’s fillet</th>
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<tbody>
<tr>
<td></td>
<td>Chilled</td>
<td>Thermally treated</td>
</tr>
<tr>
<td>Phenylalanine</td>
<td>3.01±0.29</td>
<td>2.93±0.09</td>
</tr>
<tr>
<td>Isoleucine</td>
<td>2.17±0.18</td>
<td>2.03±0.07</td>
</tr>
<tr>
<td>Leucine</td>
<td>4.33±0.36</td>
<td>4.05±0.15</td>
</tr>
<tr>
<td>Lysine</td>
<td>2.76±0.01</td>
<td>2.72±0.05</td>
</tr>
<tr>
<td>Methionine</td>
<td>2.53±0.13</td>
<td>2.32±0.05</td>
</tr>
<tr>
<td>Threonine</td>
<td>2.92±0.28</td>
<td>2.73±0.02</td>
</tr>
<tr>
<td>Valine</td>
<td>4.04±0.42</td>
<td>4.00±0.10</td>
</tr>
</tbody>
</table>
In hen’s fillet significantly lower content of some essential amino acids was observed comparing to broiler’s fillet: methionine by 40.3%, lysine by 34.7% and valine by 25.0%. Results give evidence on higher biological value of broiler’s fillet comparing to hen’s fillet.

In order to compare change in content of essential and non-essential (including semi-essential arginine and histidine) amino acids during sous vide cooking, the relative change comparing to raw fillet was calculated (Fig. 2 and 3).

![Figure 2](image)

**Figure 2.** Relative change in content of essential and nonessential amino acids in vacuum packaged broiler’s and hen’s fillets during heat treatment depending on product recipe.

Results show higher non-essential amino acid content decrease in all studied vacuum packaged broiler’s fillet and hen’s fillet products during their heat treatment compared to essential amino acid content decrease. Relative decrease in amino acid content of broiler’s fillet product cooked together with vegetable-and-fruit additive is more than two times higher comparing to relative decrease in the same product cooked without additive. It can be due to higher moisture content in broiler meat. As a result better migration of soluble components from broiler meat to vegetable-and fruit additive probably occurs.

![Figure 3](image)

**Figure 3.** Relative change in content of individual essential amino acids in vacuum packaged broiler’s and hen’s fillets during heat treatment depending on product recipe.

Among essential amino acids the highest relative decrease is observed for methionine in thermally treated broiler’s fillet either without or with additive, as well as in hen’s fillet with additive. It can be related to the
high activity of sulfide group of this amino acid, for example, it is readily oxidized into the sulfoxide and further in the sulfone.

**CONCLUSIONS**

1. In cross Ross 308 broiler’s fillet significantly higher content of essential amino acids – methionine, lysine, and valine was observed comparing to parent’s stock hen’s fillet of the same breed.
2. Relative decrease in essential and non-essential amino acid content of broiler’s fillet product *sous vide* cooked together with vegetable-and-fruit additive is more than two times higher comparing to relative decrease in the same product cooked without additive.
3. In thermal treatment process the highest relative decrease among studied amino acids was observed for methionine.

**REFERENCES**