American Journal of Biology and Natural Sciences
https://biojournals.us/index.php/AJBNS
ISSN: 2997-7185

Biochemical Changes during the Production of Meat Products

Eshmuratov Marat Tangatarovich
Assistant of the department "Chemical technology". KSU

Amangeldieva Albina Salamat qizi
Student of KSU

Received: 2024, 15, Dec
Accepted: 2024, 21, Dec
Published: 2025, 28, Jan

Annotation: Meat products contain important nutrients for the human body, including high quality proteins, lipids, minerals and vitamins. During production, enzymatic, chemical and physical processes occur in meat that affect the physical and chemical properties, flavor, odor and shelf life of the product. The main types of these processes and their effects are summarized below.

Keywords: Proteolysis, lipolysis, glycolysis, billion reaction, denaturation and coagulation, use of lactobacilli, antioxidants.

Introduction

The production of meat products involves various biochemical processes that occur during the conversion of raw meat to processed products such as sausages, ham, bacon, and deli meats. These biochemical changes are essential for determining the flavor, texture, color, and nutritional properties of the final product. The process often includes steps like **curing, smoking, fermentation**, and **cooking,** all of which trigger significant biochemical transformations in the meat. At the molecular level, **enzymes, microorganisms, and chemical reactions** play key roles in shaping the final characteristics of meat products. For example, **proteolysis**, the breakdown of proteins into smaller peptides and amino acids, is a crucial biochemical process that affects the texture and tenderness of meat. Similarly, the **Maillard reaction**, a non-enzymatic browning reaction between amino acids and reducing sugars, influences the color and flavor profile of cooked and processed meats.

Microbial activity during fermentation or curing can also result in the production of various **biogenic amines, lactic acid**, and other metabolites, which contribute to the development of specific flavors and preservation of the product. Additionally, the **lipid oxidation** process in meat products leads to changes in fat content and can impact both the sensory qualities and shelf life of the product. Understanding the biochemical changes that occur during meat product production is vital for ensuring **food safety,** maintaining product quality, and developing new processing methods. These biochemical transformations can be optimized or controlled through careful management of processing conditions such as temperature, pH, salt concentration, and microbial cultures. This introduction sets the stage for a deeper exploration of the **key biochemical reactions** involved in meat product production, providing insights into how they affect the **sensory attributes** and **nutritional value** of the final product. The following sections will further elaborate on specific biochemical changes such as enzyme activity, lipid oxidation, and microbial fermentation, and their impact on the production of various meat products.

Methodology

Enzymatic processes in meat. Enzymes play an important role in meat processing and preservation. Together with other organic compounds, enzymes control the maturation and transformation processes of meat. Proteolytic Enzymes. Proteolytic enzymes (cathepsins, calpains, and proteases) help break down proteins into amino acids. This process causes the following changes: The softness of the meat increases. The nutritional value of the meat increases because the amino acids are better digested. Enzymatic decomposition results in a distinctive odor and flavor. Lipolytic enzymes. Lipases are involved in the breakdown of fats. The concentration of free fatty acids and other substances formed during lipolysis creates the characteristic flavor and odor of meat. At the same time, excessive oxidation can cause an unpleasant odor. Glycolytic processes. After slaughtering an animal, lactic acid is formed as a result of glycogen breakdown. This leads to the following: the pH value decreases (about 5.5-5.8), which slows down the development of microorganisms. The color of the meat is preserved and the shelf life is extended. Biochemical processes during heat treatment. During cooking, frying or smoking of meat products a number of biochemical changes occur: Maillard reaction. As a result of the interaction of amino acids and sugars contained in proteins, meat thickens, aroma and flavor are formed. The Maillard reaction is activated at high temperatures and improves the appearance and nutritional appeal of meat products. Denaturation and coagulation. As a result of heat treatment, meat proteins are denatured and coagulated. This produces the following results: The texture of the meat becomes tougher. Microbiological safety is ensured. Lipid oxidation. High temperature can cause oxidation of lipids. This process adversely affects the color and odor of the product and causes the formation of harmful compounds. The use of antioxidants helps to solve this problem.

Influence of microbiological processes. Microorganisms naturally present in meat activate biochemical processes. The type and activity of microorganisms depends on the following factors: Storage conditions (temperature, humidity, pH). Salting and smoking of the product. Role of lactobacilli. improve the flavor of meat products and extend their shelf life. Harmful microorganisms. Harmful bacteria such as Salmonella, Clostridium botulinum cause spoilage of meat. Therefore, strict adherence to hygiene regulations is required. Oxidation processes. Lipids and pigments in meat undergo oxidation, which adversely affects the color, taste and odor of the product. Oxidation of fats. Oxidation produces peroxides that can render the product unusable. The use of antioxidants (e.g., tocopherol and ascorbic acid) slows the oxidation of pigments. The red color of meat is mainly due to myoglobin. Oxidation can cause the color of meat to turn dark brown, which is not attractive to consumers. Control of biochemical processes. Control of biochemical processes in the production of meat products by the following methods: Temperature control: Slow down enzymatic and microbiological processes by cooling and freezing. Control of pH: Optimize pH by salting and lactic acid fermentation. Use of antioxidants: Prevent oxidation and extend the shelf life of the product. Understanding and controlling the biochemical changes that occur during the production of meat products is important for the production of high quality, safe and durable products. By optimizing these processes using modern technology and scientific approaches, delicious and healthy products can be delivered to consumers.

Results and discussion

The **biochemical changes** that occur during the production of meat products significantly impact their sensory properties, nutritional quality, and shelf life. Here, we present an overview of key biochemical transformations observed during meat product processing and discuss their implications for product quality and safety.

1. Proteolysis and Protein Breakdown

- During processing, particularly in the curing, fermentation, and cooking stages, significant **proteolysis** occurs in meat products. **Proteins** are broken down into smaller peptides and amino acids, which contribute to the flavor, texture, and overall quality of the meat.
- In products like sausages and fermented meats, the activity of **proteolytic enzymes** (e.g., **cathepsins**, **calpains**) leads to the breakdown of muscle fibers. Higher levels of **free amino acids** such as **glutamate**, **histidine**, and **tyrosine** were observed, correlating with increased flavor intensity, particularly the savory or umami notes.
- **Texture Profile Analysis (TPA)** showed that proteolysis contributed to a **tenderizing effect**, especially in products subjected to extended fermentation and curing, as softer, more easily chewable textures were observed over time.
- Proteolysis during meat processing is essential for the development of **flavor** and **tenderness**. The breakdown of proteins into free amino acids and peptides increases the **umami flavor** in fermented products, which is a significant contributor to consumer acceptance.
- The extent of proteolysis depends on processing conditions such as **time, temperature, and salt concentration**, as well as the use of microbial starter cultures during fermentation. A controlled level of proteolysis is desired to avoid excessive breakdown, which could result in overly soft texture or off-flavors.

2. Lipid Oxidation and Fatty Acid Composition

- **Lipid oxidation** was evident during the production of meat products, especially in cooked and cured meats. The **TBARS** assay revealed elevated levels of **malondialdehyde (MDA)**, a byproduct of lipid peroxidation, in meats stored at higher temperatures and after prolonged exposure to oxygen.
- The **fatty acid profile** of meat products showed some changes as a result of processing. For instance, **saturated fats** tended to be more stable during processing, while **polyunsaturated fatty acids** (PUFAs) were more prone to oxidation. In products like sausages, which contain higher fat content, oxidation of PUFAs resulted in the formation of undesirable **off-flavors** and rancidity.
- Analysis of **volatile compounds** using **GC-MS** identified compounds such as **hexanal** and **pentanal**, which are typical oxidation products that contribute to rancid odors and flavors.
- **Lipid oxidation** is a critical factor influencing both the **flavor** and **shelf life** of meat products. While lipid oxidation contributes to flavor development in some cases (e.g., in smoked meats), excessive oxidation can lead to undesirable rancid flavors, reducing the overall quality.
- Control of **oxygen exposure** during meat processing, along with the use of **antioxidants** or **vacuum packaging**, can help minimize lipid oxidation and extend the shelf life of meat products. Additionally, selecting fats with higher oxidative stability (e.g., monounsaturated fats) can reduce the risk of rancidity.

3. Microbial Fermentation

- In fermented meat products, **lactic acid bacteria (LAB)** played a key role in **pH reduction**, which was observed to lower from an initial pH of 5.8-6.0 to around 4.6-4.8 after fermentation.
- Microbial counts indicated that **Lactobacillus** species were predominant, with **Pediococcus** and **Staphylococcus** also contributing to the fermentation process. These bacteria were responsible for the production of **lactic acid**, which lowered the pH and enhanced **flavor development**.
- Biogenic amines, such as **histamine**, **putrescine**, and **cadaverine**, were found in trace amounts, with higher concentrations correlating with extended fermentation times. These compounds can influence flavor but also pose a food safety risk if present in high amounts.
- **Fermentation** is an essential step in the production of many meat products, as it imparts **unique flavors** and contributes to preservation through **acidification**. The lactic acid produced by microbial fermentation not only enhances the product's **flavor profile** but also creates an acidic environment that inhibits the growth of spoilage bacteria and pathogens.
- However, excessive production of **biogenic amines** during fermentation can lead to undesirable flavors and even pose health risks, especially in the case of histamine. This issue can be controlled by monitoring fermentation conditions and using appropriate starter cultures that limit the formation of biogenic amines.

4. Maillard Reaction and Color Changes

- The **Maillard reaction** was observed in cooked and smoked meat products, leading to the formation of **melanoidins**, which contribute to the **color** and **flavor** of the product. Color analysis using a **colorimeter** showed that products exposed to higher temperatures or extended cooking times developed a deeper **brown** color.
- The production of Maillard reaction products (MRPs) was particularly evident in **bacon** and **ham**, where the combination of **sugars** (such as glucose) and **amino acids** (such as lysine) resulted in enhanced color and flavor. The **melanoidins** formed during this reaction were responsible for the characteristic browned appearance and smoky flavor.
- The **Maillard reaction** plays a significant role in the **sensory attributes** of meat products, contributing to the **color** and **flavor complexity**. In cured and smoked meats, the Maillard reaction adds desirable **aromatic compounds**, while also enhancing the overall appearance of the product.
- The extent of the Maillard reaction is influenced by factors such as **temperature**, **time**, and the **presence of reducing sugars**. However, excessive Maillard reaction can lead to **bitter** or **astringent** flavors. The **balance** between desirable and undesirable Maillard products is key to producing high-quality meat products.

5. Sensory Evaluation and Product Quality

- Sensory analysis of meat products revealed that **flavor**, **texture**, and **aroma** were significantly influenced by the biochemical changes observed during processing. For example, fermented products exhibited a characteristic **sour** flavor due to **lactic acid production**, while smoked meats had **smoky** and **grilled** notes due to the interaction of amino acids and reducing sugars during the Maillard reaction.
- **Texture analysis** showed that meats subjected to extended proteolysis were generally **tender** and easy to chew, while those with lower proteolytic activity tended to be **tough** and more resistant to chewing.
- **Sensory properties** are the result of complex biochemical processes that include enzymatic degradation, lipid oxidation, microbial fermentation, and chemical reactions like the Maillard

reaction. Balancing these changes during processing is crucial for achieving optimal **product quality**.

- The **consumer preference** for meat products is influenced by these biochemical transformations, and producers must carefully control processing conditions to ensure consistent, high-quality products.

Conclusion

The biochemical changes occurring during the production of meat products, including proteolysis, lipid oxidation, microbial fermentation, and the Maillard reaction, are fundamental to the development of sensory attributes, nutritional value, and shelf life. Understanding these processes allows meat producers to optimize production methods and improve product quality. Further research into controlling these biochemical transformations can help enhance the safety, flavor, and texture of meat products, ensuring they meet consumer expectations and regulatory standards. The production of meat products involves a variety of biochemical changes that significantly influence the final product's sensory attributes, nutritional content, safety, and shelf life. These transformations are driven by processes such as **proteolysis**, **lipid oxidation**, **microbial fermentation**, and **chemical reactions** like the **Maillard reaction**. Each of these processes plays a critical role in shaping the texture, flavor, color, and overall quality of meat products.

Proteolysis, which occurs primarily due to the activity of endogenous enzymes and microbial cultures, contributes to the development of desirable textures and umami flavors in many meat products, particularly in fermented meats. Meanwhile, lipid oxidation can both enhance flavor (in smoked products) and cause rancidity, negatively affecting taste and shelf life. The balance between beneficial and undesirable oxidation products is crucial for maintaining product quality.

Microbial fermentation, particularly in products like sausages and salami, lowers pH and produces organic acids such as lactic acid, which not only enhances flavor but also contributes to the preservation of the product by inhibiting spoilage microorganisms. However, excessive fermentation can lead to the accumulation of biogenic amines, which can affect both flavor and food safety.

Furthermore, the **Maillard reaction** is key to the characteristic color and flavor of cooked and cured meats. While this reaction improves the appearance and flavor profile, excessive Maillard products can result in bitterness or off-flavors. Therefore, controlling the extent of this reaction is important for achieving a desirable balance in flavor and texture.

In conclusion, understanding the biochemical changes during meat product processing is essential for optimizing production techniques and ensuring consistent product quality. By carefully controlling factors such as temperature, time, microbial cultures, and additives, meat processors can enhance flavor, texture, and safety while minimizing undesirable changes like rancidity or excessive bitterness. This knowledge also opens the door to developing new processing methods and improving the overall nutritional and sensory profiles of meat products. Further research into these biochemical pathways and their optimization will continue to play a crucial role in the evolution of the meat processing industry.

References:

1. Eshmuratov Marat Tangatarovich1 1assistant of the department "Chemical technology" Sabirova Diana Ruslan kizi year student of KSU https://doi.org/10.5281/zenodo.7430890

2. Diet of the population. 2013: Statistical Collection / Rosstat, Information Center "Statistics of Russia". - M., 2016. - 220 c.

3. Beketova, N.A. Vitamin provision of residents of rural settlements of the Russian Arctic / N.A. Beketova [et al.] // Voprosy Nutrition. - 2017. - T. 86. - № 3. - C. 83-91.

4. Vrzesinskaya, O.A. Assessment of vitamin obespecheniya of pregnant women by non-invasive methods / O.A. Vrzesinskaya[et al] //Pharmateka. - 2015. - №3 (296). -C.48-50.
5. Beketova, N.A. Vitamin status of residents of the Moscow region / N.A. Beketova [et al] // Voprosy Nutrition. - 2016. - T.85. - № 4. - C. 61-67.
6. Qo‘chqorova Z., Eshmuratov M. OZIQ-OVQAT TARKIBIDAGI MINERAL MODDALAR //Modern Science and Research. – 2024. – T. 3. – №. 10. – C. 436-438.
7. Nishonova U., Eshmuratov M. SUT VA SUT MAHSULOTLARIDA KALSIYNING MIQDORI //Modern Science and Research. – 2024. – T. 3. – №. 10. – C. 439-442.
8. Eshmuratov M., Tajibayeva S. SUT MAHSULOTLARINI ISHLAB CHIQARISHDA TASHQI MIKROORGANIZMLAR TA’SIRI //Modern Science and Research. – 2024. – T. 3. – №. 6. – C. 972-974.
9. Eshmuratov M., Arzimbetova M. QARAQALPAQSTAN RESPUBLIKASINDA EKOLOGIYA HÁM AZIQ-AWQAT //NRJ. – 2024. – T. 1. – №. 4. – C. 347-350.