



Journal homepage: <https://animalscience.com.ua/en>

Animal Science and Food Technology, 12(3), 60-67

Received: x.xx.2021 Revised: x.xx.2021 Accepted: x.xx.2021

UDC 006.83:637.525.3:598.221-047.37

DOI: 10.31548/animal2021.03.005

Application of the papain enzyme in meat products technology

Valentyna Israelian*, Nataliia Holembovska, Nataliia Slobodianiuk

National University of Life and Environmental Sciences

03041, 15 Heroiv Oborony Str., Kyiv, Ukraine

Abstract. The production of enzyme preparations occupies one of the leading places in modern biotechnology and belongs to industries whose production volume is constantly growing, and the scope of application is expanding. Therefore, it is advisable to use enzymes for various industrial processes from an economic and technological standpoint. The main purpose of the study is to examine the chemical composition and activity of the enzyme preparation papain with subsequent use in the technology of meat products production to increase the biological value and improve the functional and technological properties of the finished product. The following research methods were used to solve these problems: moisture content – by drying the sample to a constant mass; fat content – by the Soxhlet method; ash content – by the generally accepted weight method; protein content – by the Kjeldahl method; papain activity was determined by a method based on the spectrophotometric determination of the number of proteolysis products under the action of an enzyme. Based on the results of the analysis of literature sources and own studies, the prospects of the research and use of enzymes and enzyme preparations obtained on their basis in the food industry are demonstrated, since this contributes to improving the quality of finished products and the level of greening of production, more rational use of raw materials and material resources. As a result of a study of the chemical composition, it was determined that the enzyme papain has a high protein content of 87.44%, so it has a broader effect on meat proteins. During the studies, the dependence of papain activity on the pH of the medium, temperature, sodium chloride and enzyme concentrations was investigated. The results of the conducted studies demonstrated that papain shows the greatest activity in the pH range of 5.5-6.0. The enzyme has a maximum collagenase activity of PH 6.0 and at a temperature of 50-60°C. The obtained results allow expanding the range of meat products, increasing the nutritional and biological value of raw materials, and obtaining a finished product with high organoleptic parameters

Keywords: enzyme preparation, papain, enzyme, biotechnology, safety

Suggested Citation:

Israelian, V., Holembovska, N., & Slobodianiuk, N. (2021). Application of the papain enzyme in meat products technology. *Animal Science and Food Technology*, 12(3), 60-67.

*Corresponding author

Relevance

Rational use of meat raw materials and the development of new products of high nutritional value and quality that are safe for the consumer is an urgent task of the meat processing industry in Ukraine and the world [1].

In the modern food industry, the trend of finding and developing innovative technological solutions for the production of products characterised by a high level of quality, environmental friendliness, biological safety, and functional orientation prevails [2].

Resource-saving food technologies are a real source of strengthening the raw material base of processing industries. The growing need for meat products leads to the need to involve raw materials with a high content of connective tissue in technological processes and search for ways to improve its technological properties [3], [4].

Today, scientific discoveries in the field of enzymology have made enzyme preparations an indispensable participant in many food technologies. The creation and implementation of innovative technologies allowed for substantially expanding the scope of the application of enzyme preparations. Today, enzymes help to improve product quality, increase the safety and efficiency of technological processes, reduce production costs and anthropogenic impact on the environment [5].

In food technology, enzyme preparations with amylolytic, proteolytic, lipolytic, pectolytic, and oxidase activity are used.

Of particular importance is the use of proteolytic enzyme preparations, since they are characteristic of high catalytic activity, the possibility of implementation without the use of extreme temperatures and aggressive media,

the specificity of the action of enzymes, and the ease of inactivation at conventional temperatures of heat treatment of meat products [6].

Analysis of recent studies and papers

Technologies of meat products using biotechnology techniques based on enzymatic proteolysis of meat raw materials are widely used in international practice.

Today, the use of biotechnological techniques is a common practice in the United States, Canada, England, France, Germany, etc. Enzymes of proteolytic and collagenase action, in meat and meat systems enable [7], [8]:

- the intensification of autolytic processes and acceleration of maturation;
- provision of a high level of juiciness and tenderness of meat;
- an increase in the production of high-quality natural meat products;
- obtainment of new sources of meat resources in the form of meat pastes, emulsions, hydrolysates for enriching various food products with protein, developing therapeutic nutrition;
- use of meat products as part of prescription and component solutions instead of the main raw materials;
- rational and maximum use of meat resources to increase the yield of useful products per unit of raw materials.

Enzyme preparations must meet the requirements imposed by specific technologies not only for the type of catalysed reaction but also for the conditions of their action: pH, temperature, stability, the presence of activators and inhibitors, that is, those factors that

determine the effectiveness of the preparation in this environment and allow correctly determining the technological modes of its application [9].

Depending on the purpose of the application, certain requirements are imposed on enzyme preparations not only for the composition of enzymes and optimal conditions of their action, but also for the degree of purification, fillers used, cost, and a number of other parameters [10], [11].

The purpose of the study. Study the chemical composition and activity of the enzyme preparation papain with subsequent use in the production technology of meat products to increase the biological value and improve the functional and technological properties of the finished product.

Methods

The research was conducted in the laboratory of the Department of Meat, Fish and Seafood Technology of the National University of Life and Environmental Sciences of Ukraine.

For the research, the enzyme papain was selected, which is the most commonly used proteolytic enzyme in production, it is produced from the latex of the melon tree fruit (*Carica papaya*).

The experimental studies were conducted according to the established relevant standard methods: moisture content – by drying according to DSTU ISO 1442:2005 Meat and meat products. Method for determining the moisture content [12]; the amount of protein was determined according to GOST 25011-2017 Meat and meat products. Methods for determining protein [13]; the amount of fat was determined by DSTU 8380: 2015 Meat and meat products. Method for measuring the mass fraction of

fat [14]; the mass fraction of ash was determined by weight according to DSTU ISO 936:2008 Meat and meat products. Method for determining the mass fraction of total ash [15]; papain activity was determined by a method based on the spectrophotometric determination of the number of proteolysis products of tyrosine-containing substances under the action of an enzyme.

Results and Discussion

The practice of using enzyme preparations shows that not all drugs have the same effect on the muscle and connective tissue proteins of meat, including raw materials with abnormal autolysis. The same enzyme preparation, depending on the reaction of the meat medium, hydrolyses protein macromolecules in different ways. Technologists are largely interested in questions concerning the effect of enzyme preparations on the connective tissue proteins of meat. Therewith, an important point is to investigate the effect of enzyme preparations on the structural and mechanical properties of meat raw materials, which ultimately affect the quality of the resulting finished products.

Of particular interest are enzymes that contribute to the formation of the structure of meat products. In this case, the choice of the papain enzyme for softening meat is primarily due to the specificity of its effect on connective tissue proteins and the fact that it is now presented on the internal market and is offered for use in the meat industry.

Any technological processes are influenced by various factors. Therefore, to identify the field of practical use of biocatalysts, an important aspect is to investigate the behaviour and stability of biologically active systems and find optimal parameters for their operating mode.

Based on this, restructuring meat is the purpose of proteolytic enzymes. Softening of meat is effective under the action of endogenous

proteases, especially neutral ones. The total chemical composition of the enzyme papain is presented in Table 1.

Table 1. Chemical composition of the enzyme papain, (n=3, p<0,95)

Indicator	Content, %			
	Moisture	Protein	Fat	Ash
Enzyme Papain	10, 86 ± 0,85	87, 44 ± 2,76	0,61 ± 0,05	0,87 ± 0,02

According to Table 1, the enzyme papain has a high protein content of 87.44%, so it has a broader effect on meat proteins. The enzyme papain is a tested preparation that has proven itself to accelerate the maturation and tenderisation of meat with a high content of connective tissue.

The most important indicators that characterise the effectiveness of various enzyme preparations on meat raw materials are

structural and mechanical properties, which, in the end, characterise the tenderness of the finished product.

The dependence of papain on the pH of the medium was investigated to clarify the activity of the enzyme used in the study. The results of the conducted studies showed (Fig. 1) that the greatest proteolytic activity of papain is manifested at pH 5.5-6.0, and at pH 6, the enzyme has the maximum collagenase activity.

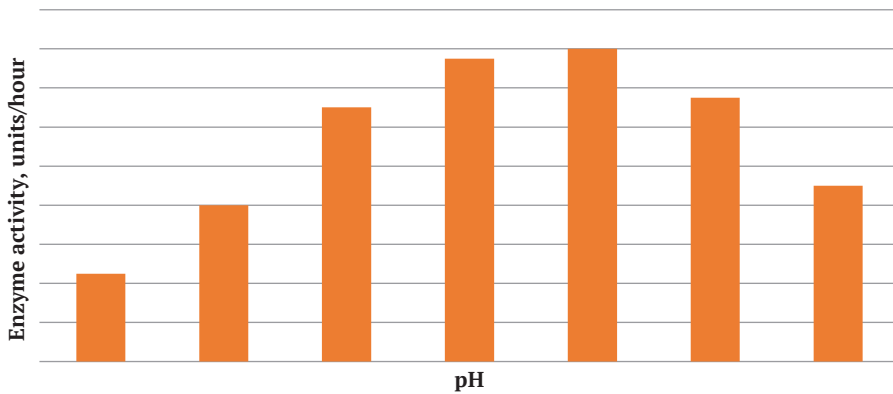


Figure 1. Effect of medium pH on papain enzyme activity

It is known that for the meat industry, the activity of the enzyme at temperatures of 2±2°C, recommended during salting, maturation of

meat, and for storing finished products, is of practical interest. The effect of temperature on papain activity is displayed in Figure 2.

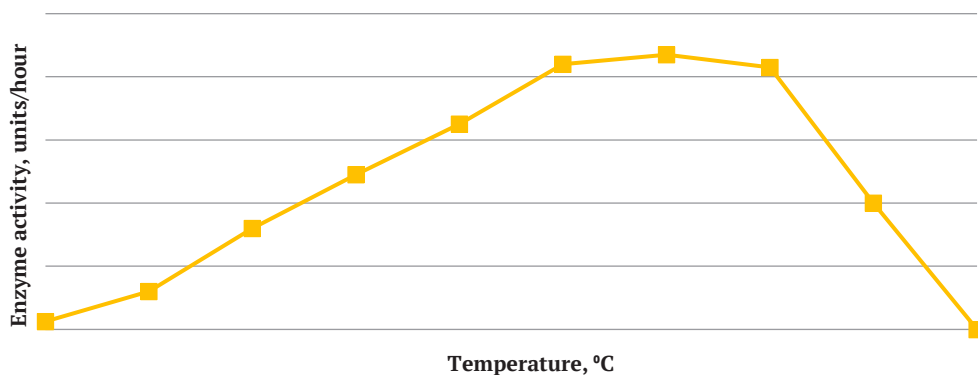


Figure 2. Effect of temperature on papain activity

Notably, the collagenase activity of papain in this experiment was recorded after 60 minutes of hydrolysis and therefore it is necessary to regard the “short-term activity”, that is, the highest specific activity of papain at each specific temperature. The obtained data showed that papain shows maximum activity at temperatures of 50-60°C. At $t=4^{\circ}\text{C}$, the activity of papain is 6.0% of the maximum value. According to the results of studies, complete

inactivation of papain occurs at $t=90^{\circ}\text{C}$. It is known from the literature sources that during the production of meat products, the maturation of raw materials occurs in the presence of sodium chloride, which increases or decreases the activity of proteolytic enzymes. In this regard, the effect of sodium chloride on papain activity was investigated. The dependence of the activity of the papain enzyme on the NaCl concentration is shown in Figure 3.

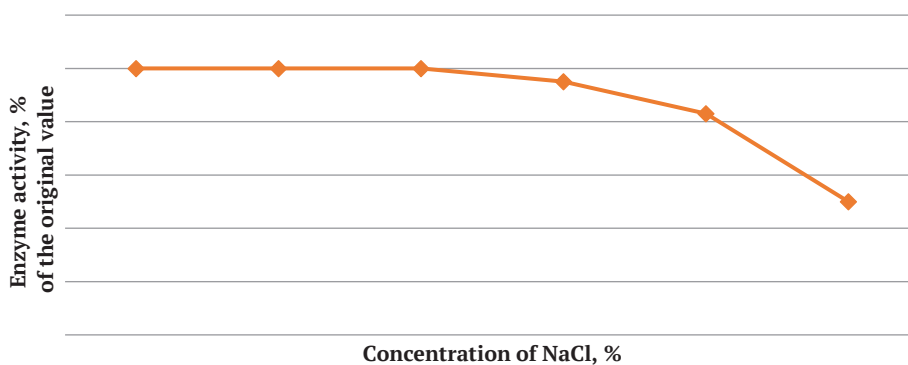


Figure 3. Dependence of papain enzyme activity on NaCl concentration

The results of research suggest that the plant enzyme papain can be used to tenderise meat. The greatest proteolytic activity of papain is manifested at pH 5.5-6.0, temperatures 60-80°C, and NaCl concentrations of approximately 2%, which are used for boiled meat products. The use of the enzyme papain for the fermentation of ostrich meat will increase the production of high-quality whole meat products.

Conclusions and Prospects

The obtained research results allow concluding that the use of the enzyme papain for the

production of meat products is promising for the rational use of raw materials and the development of new types of meat products with high quality indicators.

During the studies, the dependence of papain activity on the pH of the medium, temperature, sodium chloride concentration, and enzyme concentration was investigated. The results of the conducted studies demonstrated that papain shows the greatest activity in the pH range of 5.5-6.0. The enzyme has a maximum collagenase activity at PH 6.0 and at a temperature of 50-60°C. Enzyme activity at 2±2°C.

References

- [1] Kolpakova, V., Gulakova, V., & Sardzhveladze, A. Composition on the basis of plant based proteins with the use of transglutaminase. *International Multidisciplinary Scientific GeoConference: SGEM*. 2018. 18(6.2). 119-127.
- [2] Kamble, S.S., Gunasekaran, A., & Gawankar, S.A. Achieving sustainable performance in a data-driven agriculture supply chain: A review for research and applications. *International Journal of Production Economics*. 2020. 219. 179-194.
- [3] Israelian, V., & Holembovska, N. The use of non-traditional raw materials in baby food. *Prodovolcha industriia APK*. 2018. 6. 37-40.
- [4] Palamarchuk, I., Palamarchuk, V., Gudzenko, M., Sarana, V., & Mukoid, R. (2021). Hydrolysis of vegetable raw pectin-containing materials under vibration and centrifugal mixing of liquid environment. *Advances in Design, Simulation and Manufacturing IV. DSMIE 2021. Lecture Notes in Mechanical Engineering*. Springer, Cham. 277-286. doi: 10.1007/978-3-030-77823-1_28
- [5] Shtonda O.A., & Israelian V.M. Changes in the functional and technological parameters of African ostrich meat under the action of plant enzymes in the composition of salting brines. *Naukovi dopovidi NUBiP Ukrainy*. 2021. No. 1 (89).
- [6] Holembovska, N., Tyshchenko, L., Slobodyanyuk, N., Israelian, V., Kryzhova, Y., Ivaniuta, A., Pylypchuk O., Menchynska, A., Shtonda, O., & Nosevych, D. Use of aromatic root vegetables in the technology of freshwater fish preserves. *Potravinarstvo Slovak Journal of Food Sciences*. 2021. 15. 296-305.
- [7] Zheplinska, M., Mushtruk, M., Vasylyv, V., Kuts, A., Slobodyanyuk, N., Bal-Prylypko, L., Nikolaenko, M., Kokhan, O., Reznichenko, Y., & Salavor, O. The micronutrient profile of medicinal plant extracts. *Potravinarstvo Slovak Journal of Food Sciences*. 2021.15. 528-535.

- [8] Golembovskaya, N. Usage of chia seeds in the composition of dietary semi-finished minced products. *Scientific Messenger of LNU of Veterinary Medicine and Biotechnologies. Series: Food Technologies*. 2019. 21(92), 19-22. doi: 10.32718/nvlvet-f9204
- [9] Cherednichenko, O., Bal-Prylypko, L., Paska, M., & Nikolaenko, M. Expediency of creation of technology of production of meat products of long term of storage of the combined structure. *IOP Conference Series: Earth and Environmental Science*. 2021. 723 (3). 032086.
- [10] Bal-Prilipko, L.V., Leonova, B.I., Brona, A., & Kovtun, V.A. Biotechnological methods for curing meat raw materials. scientific result. *Business and service technologies*. 2018. 4 (3). 46-55.
- [11] Raveendran, S., Parameswaran, B., Beevi Ummalya, S., et al. Applications of microbial enzymes in food industry. *Food technology and biotechnology*. 2018. 56(1). 16-30.
- [12] DSTU ISO 1442:2005. Meat and meat products. Method for determining the moisture content.
- [13] GOST 25011-2017. Meat and meat products. Protein determination methods.
- [14] DSTU 8380:2015. Meat and meat products. The method of massaging fat mass.
- [15] DSTU ISO 936:2008. Meat and meat products. Method for determining the mass fraction of total ash.

Застосування ферменту папаїну в технології м'ясних виробів

**Валентина Миколаївна Ізраєлян, Наталія Володимирівна Голембовська,
Наталія Михайлівна Слободянюк**

Національний університет біоресурсів і природокористування України
03041, вул. Героїв Оборони, 15, м. Київ, Україна

Анотація. Виробництво ферментних препаратів займає одне з провідних місць у сучасній біотехнології й належить до галузей, обсяг продукції яких постійно зростає, а сфера застосування розширюється. Тому ферменти доцільно використовувати для проведення різних промислових процесів, як з економічної, так і з технологічної точок зору. Основна мета роботи спрямована на дослідженні хімічного складу та активності ферментного препарату папаїн із подальшим використанням у технології виробництва м'ясних виробів для підвищення біологічної цінності та покращення функціонально-технологічних властивостей готового продукту. Для вирішення поставлених завдань використовували такі методи досліджень: вміст вологи – методом висушування зразка до постійної маси; вміст жиру – методом Сокслета; зольність – загальноприйнятим ваговим методом; визначення вмісту білка – методом К'ельдаля; активність папаїну визначали за методом, заснованим на спектрофотометричному визначенні кількості продуктів протеолізу під дією ферменту. За результатами аналізу літературних джерел та власних досліджень показано перспективність дослідження та використання ферментів і одержаних на їхній основі ферментних препаратів у галузі харчової промисловості, оскільки це сприяє підвищенню якості готової продукції та рівня екологізації виробництва, більш раціональному використанню сировинних та матеріальних ресурсів. У результаті дослідження хімічного складу встановлено, що фермент папаїн має високий вміст білку 87,44 %, завдяки чому володіє більш широким впливом на білки м'яса. Під час досліджень була вивчена залежність активності папаїну від рН середовища, температури, концентрації хлориду натрію і концентрації ферменту. Результати виконаних досліджень показали, що найбільшу активність папаїн проявляє в діапазоні за рН 5,5-6,0. Фермент має максимальну колагеназну активність рН 6,0 та за температури 50-60 °С. Отримані результати досліджень дають змогу розширити асортимент м'ясних виробів, підвищити харчову і біологічну цінність сировини, отримати готовий продукт з високими органолептичними показниками

Ключові слова: ферментний препарат, папаїн, фермент, біотехнологія, безпечність