ISSN 2181-8622

Manufacturing technology problems

Scientific and Technical Journal Namangan Institute of Engineering and Technology

INDEX COPERNICUS INTERNATIONAL

Volume 9
Issue 2
2024

Google Scholar Crossref doi SLIB.UZ Scientific library of Uzbekistan

DETERMINATION OF OPTIMAL CONDITIONS FOR THE EXTRACTION OF GELATIN FROM SECONDARY LOCAL RAW MATERIALS

KHUSENOV ARSLONNAZAR

Professor of Tashkent Institute of Chemical Technology, Tashkent, Uzbekistan
E-mail: sytk@tkti.uz
*Corresponding author.

ASHUROV MIRSHOD

Scientific researcher of Shakhrisabz Branch of Tashkent Institute of Chemical Technology Uzbekistan, Shakhrisabz, Uzbekistan
E-mail.: mirshodbekkimtex@gmail.com

ABDULLAEV OTABEK

Professor of Tashkent Institute of Chemical Technology, Tashkent, Uzbekistan
E-mail.: otabek_abdullayev_81@mail.ru

RAKHMANBERDIEV GAPPAR

Professor of Tashkent Institute of Chemical Technology, Tashkent, Uzbekistan
E-mail.: rgaffar@mail.ru

Abstract: This article presents the experimental results of extracting gelatin from protein-rich secondary local raw cattle skin by alkaline hydrolysis and determining the dependence of gelatin yield on the concentration of the hydrolyzing solution, temperature, and duration of hydrolysis. Also, the effect of hydrolysis conditions on the molecular weight of gelatin has been studied.

Keywords: gelatin, secondary raw materials, hydrolysis, protein content.

Introduction. Gelatin is widely used in medicine due to its biocompatibility, biodegradability, and toxic effects. Gelatin dissolves easily in the digestive system at 35°C and it is used in the pharmaceutical industry to produce hard and soft capsules due to its easy release of bioactive compounds, nutrients and drugs. It also stimulates various functions such as regeneration of injured tissues, healing of wounds and strengthening of bone formation [1-3].

Gelatin is a water-soluble polypeptide obtained by partial hydrolysis of collagen, a natural protein substance. Collagen protein is the main component of the connective tissue of vertebrates. In particular, it is found in large quantities in connective tissues such as bone, skin, cornea, tendon, blood vessels and dentin, and performs an important task of maintaining their integrity. Nowadays, gelatin is mainly extracted from pig skin (46%), cattle skin (29.4%), pig and cattle bones (23.1%) and fish (1.5%) [4-6].

Two different types of gelatin are obtained from the connective tissues of mammals, i.e. pig skin (type A) and cattle skin (type B). While gelatin with a molecular weight of 10 kDa to 400 kDa is obtained from both of these raw materials, the difference lies in different isoelectric points, solubility values, and average molecular weight of gelatin.

Fish gelatin is extracted from the skin and bones of fish. Fish processing waste contains up to 30% collagen [7].

The productivity and quality of gelatin are affected not only by the type of raw material, but also by other factors while it is being extracted. For instance, the concentration of hydrolyzing reagents, pH, temperature and time directly influence on this process [8].

For the extraction of gelatin, collagen-containing raw materials such as purified bone and skin are widely used. 93% of all proteins in bone are collagen. Also, in addition to collagen protein, the protein part of the bone contains elastin, reticulin, albumin, globulin and mucopolysaccharides - mucins and mucoids. Since the skin is the main raw material that stores collagen, it is the most valuable raw material for the production of gelatin. The most valuable raw materials for obtaining high-purity gelatin are pieces of cattle skin. Skin raw materials contain collagen that is resistant to various substances, insoluble in cold water, salts, weak acid and alkaline solutions, organic solvents, and turns into gelatin when heated with water. There are three types of the separation of gelatin from collagen protein: physical, chemical and enzymatic. The isoelectric point of gelatin, that is obtained by the hydrolyzing the skin using a solution of sulfate or hydrochloric acid, is equal to 9.0. The isoelectric point of gelatin hydrolyzed using an alkali (NaOH) solution is 5.0 [9-12].

The purpose of the study. It consists in determining the optimal hydrolysis conditions for the extraction of gelatin from local secondary cattle skin raw materials.

Materials and methods. Cattle skin was chosen as a research object, and reagents of chemical purity and pure brand for analysis were used in the experiments.

Extraction of gelatin from cattle skin. Skin pieces (1x1 cm) were hydrolyzed in alkaline solution for 12-48 hours. The effect of alkali concentration, temperature and duration of hydrolysis on the yield of gelatin during hydrolysis was studied.

Neutralization. After hydrolyzing the skin, it was neutralized with 1% HCl solution.

Determination of humidity. In order to determine the humidity of the skin samples, they were weighed and dried in a drying oven at a temperature of 105°C for 2 hours to a constant weight and weighed.

Determination of gelatin yield by nitrogen. The amount of nitrogen in dry samples of gelatin was determined using the K'eldal method using a semi-automatic device (VELP Scientifica). In this method, nitrogenous organic matter is decomposed under the influence of concentrated sulfuric acid in the presence of catalysts (salts of heavy metals), nitrogen is converted into ammonium sulfate, and ammonia released from ammonium sulfate under the influence of alkali is titrated with an acid solution [13]. The coefficient of conversion of nitrogen to gelatin is 5.62.

Determination of the molecular weight of gelatin. Molecular weights of gelatin samples hydrolyzed under different conditions were determined by the Laemmli method in a 10% polyacrylamide gel [14].

Results and their discussion. There are secondary raw materials suitable for extracting gelatin in the skin processing plants. Chemical processing of these raw

materials is effective not only economically but also ecologically. Keeping this in mind, we used local cattle skin raw material in our research.

In our experiments, initially, gelatin was extracted by hydrolyzing skin with aqueous solution of 0.5; 1; 1.5; 2 and 2.5% NaOH for 12, 24, 36 and 48 hours.

Also, in the experiments, we studied the influence of the concentration of the hydrolyzing reagent and the length of the hydrolysis time on the yield of gelatin extraction. The results of the experiment are presented in Figure 1.

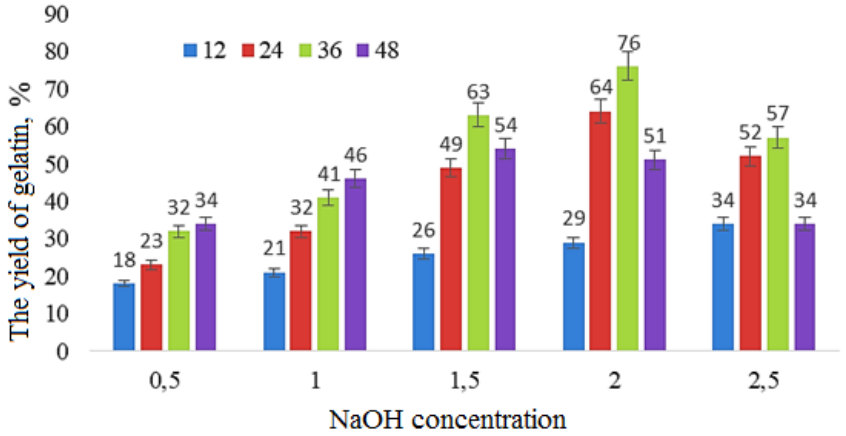

Figure 1. The influence of the alkali concentration and the length of the hydrolysis time on the yield of gelatin.

From the results presented in Figure 1, it can be seen that when hydrolyzing the skin with 0.5 and 1% NaOH solution from 12 to 48 hours, the gelatin yield increased to 34 and 46%, respectively. When hydrolysis with 1.5% NaOH solution was carried out from 12 to 36 hours, it was found that the yield of gelatin first increased to 63% and then decreased to 54% in 48 hours. When hydrolysis with 2% NaOH solution was carried out from 12 to 36 hours, the yield of gelatin initially increased to 76%, and when the duration of hydrolysis was 48 hours, the yield decreased to 54%. In 2.5% NaOH solution, the best yield was 57% in 36 hours when chemically processing skin.

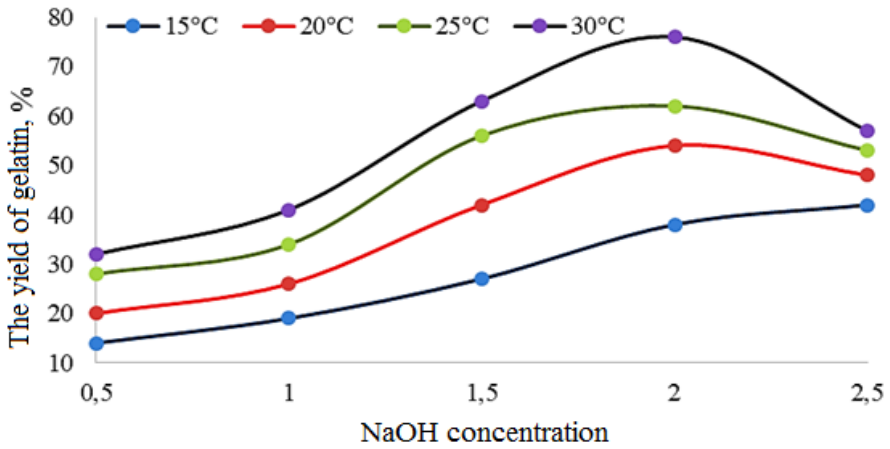

Figure 2. The influence of the alkali concentration and the temperature on the yield of gelatin (the length of the hydrolysis time – 36 hours).

In our next experiments, the influence of alkali concentration and temperature on gelatin yield was studied. The results of the experiment are presented in Figure 2.

The results of the experiment presented in Figure 2 showed that the yield of gelatin extraction increased from 14% to 42% depending on the alkali concentration under hydrolysis conditions at 15°C. At a temperature of 20°C, gelatin yield increased from 20% to 54% in accordance with alkali concentration (0.5-2%). When the concentration of alkali is 2.5%, it was found that the yield of gelatin decreased to 48%. This situation was also observed at temperatures of 25 and 30°C. For example, when the concentration of alkali increased from 0.5% to 2% at a temperature of 25°C, the yield of gelatin increased from 28% to 62%, and when the concentration of alkali was 2.5%, the yield decreased to 53%. At a temperature of 30°C, when the concentration of NaOH increases from 0.5% to 2%, the yield of gelatin increases from 32% to 76%, and when the concentration of NaOH is 2.5%, the yield of gelatin decreases to 57%.

There are several methods for determining the molecular mass of proteins. Among them, the most effective and widely used method is the electrophoresis method. Gelatin samples extracted under different hydrolysis conditions were electrophoresed in a 10% polyacrylamide gel (Figure 3).

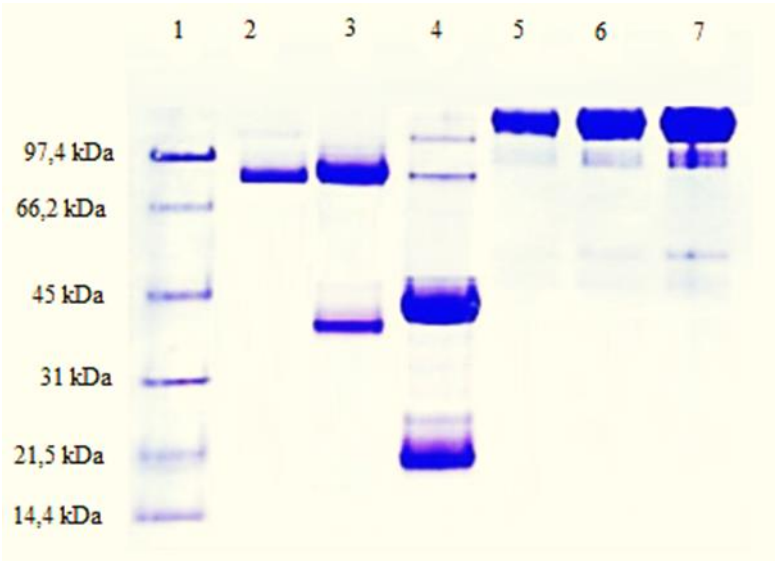

Figure 3. The results of polyacrylamide gel electrophoresis of gelatin samples: standard 1 (97.4; 66.2; 45; 31; 21.5; 14.4 kDa); 2- NaOH 2%, 36 hours; 3- NaOH 2.5%, 36 hours; 4- NaOH 2%, 48 hours; 5- NaOH 0.5%, 36 hours;, 6- NaOH 1%, 36 hours; 7– NaOH 1.5%, 36 hours.

According to the results of electrophoresis, it was determined that the molecular weight of gelatin (2), which was hydrolyzed with 2% NaOH solution for 36 hours, was 80 kDa. Under these conditions, gelatin with a molecular mass of 21, 42, and 80 kDa was observed when the hydrolysis time was extended to 48 h (4). In the gelatin sample hydrolyzed for 36 hours using 2.5% NaOH solution, it was found that it consists of two different molecular weights of 80 kDa and 38 kDa. Due to the incomplete hydrolysis at

NaOH concentration of 0.5 (5), 1 (6) and 1.5% (7), hydrolyzate with relatively high molecular weight and low water solubility was obtained.

Conclusion. During the research, gelatin samples were obtained from local secondary skin raw materials by hydrolyzing with different concentrations of NaOH solution. Hydrolysis of cattle skin at 30°C using 2% NaOH solution for 36 hours was chosen as optimal conditions for gelatin extraction. Under these conditions, the yield of gelatin was 76%, and according to the results of electrophoresis, its molecular weight was determined to be 80 kDa.

References

1. Massoumi H., Nourmohammadi J., Marvi M.S., Moztarzadeh F. Comparative study of the properties of sericin-gelatin nanofibrous wound dressing containing halloysite nanotubes loaded with zinc and copper ions // International Journal of Polymeric Materials and Polymeric Biomaterials. 2019. Vol.68, Is.18. P.1142-1153.
2. Dias J.R., Baptista-Silva S., Oliveira C.M.T. de, Sousa A., Oliveira A.L., Bartolo P.J., Granja P.L. In situ crosslinked electrospun gelatin nanofibers for skin regeneration // European Polymer Journal. 2017. Vol.95. P.161-173.
3. Aleman A., Martinez-Alvarez O. Marine collagen as a source of bioactive molecules: A review // The Natural Products Journal. 2013. Vol.3, Is.2. P.105-114.
4. Kasankala L.M., Xue Y., Weilong Y., Hong S.D., He Q. Optimization of gelatine extraction from grass carp (Catenopharyngodon idella) fish skin by response surface methodology // Bioresource Technology. 2007. Vol.98, Is.17. P.3338-3343.
5. Duconseille A., Astruc T., Quintana N., Meersman F., Sante-Lhoutellier V. Gelatin structure and composition linked to hard capsule dissolution: A review // Food Hydrocolloids. 2015. Vol.43. P.360-376.
6. Karim A.A., Bhat R. Fish gelatin: properties, challenges, and prospects as an alternative to mammalian gelatins // Food Hydrocolloids. 2009. Vol.23, Is.3. P.563-576.
7. Lim Y.P., Mohammad A.W. Physicochemical Properties of Mammalian Gelatin in Relation to Membrane Process Requirement // Food and Bioprocess Technology. 2011. Vol.4, Is.2. P.304-311.
8. Montero P., Gómez-Guillén M.C. Extracting conditions for Megrim (Lepidorhombus boscii) skin collagen affect functional properties of the resulting gelatin // Journal of Food Science. 2000. Vol.65, Is.3. P.434-438.
9. Foox M., Zilberman M. Drug delivery from gelatin-based systems // Expert Opinion on Drug Delivery. 2015. Vol.12, Is.9. P.1547-1563.
10. Alshafiee M., Aljammal M.K., Markl D., Ward A., Walton K., Blunt L., Korde S., Pagire S.K., Kelly A.L., Paradkar A., Conway B.R., Asare-Addo K. Hot-melt extrusion process impact on polymer choice of glyburide solid dispersions: The effect of wettability and dissolution // International Journal of Pharmaceutics. 2019. Vol.559. P.245-254.
11. Derkach S.R., Voron'ko N.G., Kuchina Y.A., Kolotova D.S., Gordeeva A.M., Faizullin D.A., Gusev Y.A., Zuev Y.F., Makshakova O.N. Molecular structure and

properties of κ-carrageenan-gelatin gels // Carbohydrate Polymers. 2018. Vol.197. P.66-74.

12. Kolodziejska I., Kaczorowski K., Piotrowska B., Sadowska M. Modification of the properties of gelatin from skins of Baltic cod (Gadus morhua) with transglutaminase // Food Chemistry. 2004. Vol.86, Is.2. P.203-209.

13. Control methods. Chemical factors. Guide to methods of quality control and safety of biologically active food additives.2004. P 4.1.1672-03. (In Russian)

14. Laemmli U. K. Cleavage of structural proteins during the assembly of the head of bacteriophage T4 // Nature. 1970. Vol. 227. P. 680-685.

CONTENTS

PRIMARY PROCESSING OF COTTON, TEXTILE AND LIGHT INDUSTRY

Usmanova N., Abdukarimova M., Kamolova M., Ismoilova S. Research on the process of building dress shapes in 3d space	**3**
Rayimjonov M., Rahimov F., Sarimsakov A., Muradov R. Increasing the efficiency of retaining device for fine and large heavy mixtures in cotton raw materials	**13**
Kosimov A., Ahmadjanov S. Design of the mechanical properties of the fabric used by wind yarn spinning from cotton and polyester fibers	**19**
Salokhiddinova M., Muradov M. Ways to improve the efficiency of moving device used in air transportation of cotton	**27**
Nazarova M. Research of methods of antibacterial treatment of textile materials	**33**
Sheraliyeva R., O'ralov L. Study of technological indicators of two-layer knitted fabrics obtained on long Xing LXA 252 knitting machine	**37**
Turdiyeva O'., Khojiyev A. Mathematical modeling of the development technology of selected leather for the transformation assortment	**42**

GROWING, STORAGE, PROCESSING AND AGRICULTURAL PRODUCTS AND FOOD TECHNOLOGIES

Uzaydullaev A. Research on the food safety of pomegranate juice and concentrate production technology	**49**
Kuzibekov S. Safety studies in soybean oil production process	**56**
Ismoilov K., Khamdamov A. Acceleration of heat and matter exchange processes in the final distiller with a convex-concave plate	**62**
Abdullaeva B., Soliev M. Method of making syrup for cold drinks	**67**
Meliboyev M., Qurbanov U. Compounds that determine their nutritional value based on the types of food products	**73**

Nishanov O'., Atakhanov Sh., Mamajanova M. Effect of energy drinks on the human body	**79**
Ikromova Y., Nuriddinov Sh., Hamdamov A. Optimization of heat load in three-stage distillation of vegetable oil micelles	**84**
Turg'unov Sh., Mallabayev O. Use in a new receptor in functional bread making	**90**
CHEMICAL TECHNOLOGIES	
Ergashev O., Bakhronov Kh., Esonkulova N., Asfandiyorov M., Akhmadov M., Absalyamova I. Determination of the inhibitory efficiency of the inhibitor synthesized based on maleic anhydride by the electrochemical method	**95**
Ergashev O., Rakhmatkarieva F., Davlatova O. Mechanism of H_2O vapor adsorption in a type zeolites. The adsorption isotherms.	**102**
Yoqubjonova M., Boymirzaev A. Biomedical properties and applications of chitosan derivatives	**107**
Rajabaliyev N., Rahmonov J., Nigmatillayeva M., Rajabov Y., Akbarov Kh. Thermodynamic study of the anti-corrosion properties of diciandiamide in an acid environment	**116**
Ochilov A., Urinboeva M., Abdikamalova A., Kuldasheva Sh., Eshmetov I. Study of rheological flow curves of ED20 emulsions	**123**
Nozimov E., Sultanov B., Kholmatov D., Sherkuziev D., Nodirov A. Phosphorus fertilizer technology activated from phosphorus powder and mineralized mass	**129**
Kadirova M., Sabirov V. Results of mechanochemical synthesis of methylene blue complex with d-metals	**135**
Jalilov A., Sottikulov E., Karimova M., Boymirzaev A Synthesis of polycarboxylate plasticizer based on acrylic acid and apeg and its gel chromatographic analysis	**142**
Khusenov A., Ashurov M., Abdullaev O., Rakhmanberdiev G. Determination of optimal conditions for the extraction of gelatin from secondary local raw materials	**149**
Lutpillaeva M., Hoshimov F., Ergashev O. Synthesis of silver nanoparticles using various reducing agents and stabilizers	**155**

Akhmadjanov I., Djalilov A., Karimov M.	
Studying isotherms of adsorption and desorption of nitrogen on a sorbent synthesis for selective extraction of lithium	**164**
Kalbaev A., Salixanov A., Seitnazarova O., Abdikamalova A.	
Change of cation exchange capacity during the thermal treatment of bentonite and their textural characteristics	**171**
MECHANICS AND ENGINEERING	
Obidov A., Shamshitdinov M., Mashrabboyev I.	
Reduce energy consumption by adjusting the electrodvigate speed of the linter device	**178**
Haydarova R.	
Development of boundary conditions for mathematical models of unsteady water movement in water management facilities	**184**
Bekmirzayev D., Qosimov E., Ismoilov A.	
Consequences of earthquakes and preventive measures based on foreign experiences	**189**
Aliev R., Eraliyev A., Nosirov M., Mirzaalimov A., Mirzaalimov N.	
Investigation of an improved solar water heater in comsol multiphysics software	**196**
Obidov A., Akhmadalieva D., Otaqo‘ziyev D.	
Development of an experimental construction of a device for cleaning from small piece of contaminants	**202**
Obidov A., Mirzaumidov A., Abdurasulov A., Otaqo‘ziyev D.	
Deformation of the shaft in torsion and the effect of torsion along with bending	**208**
Matkarimov P., Juraev D., Usmonkhujayev S.	
Study of stress-strain state of an earth dam using a three-dimensional model of the structure	**217**
Mamajonov Sh.	
Methods of determining the efficiency of the cotton regenator in the cleaning process	**228**
Xuramova X.	
Establishment of the device for separation of fibers suitable for spinning from the waste of the cotton cleaning process	**236**
Kholboyeva Sh., Kosimov A.	
Principles of classification of costs to ensure product quality in production	**243**
Kholboyeva Sh., Kosimov A.	
Methodological processing of quality control of technological processes of manufacturing enterprises	**249**

Shoxobidinova Sh., Kosimov A., Mamadaliyeva D.
General guidelines for quality management and technologies in the metallurgical industry supply chain **255**

Sheraliyeva R., O'ralov L.
Study of technological indicators of two-layer knitted fabrics obtained on long Xing LXA 252 knitting machine **262**

Tuychiev T., Turdiev H., Rozmetov R., Shorakhmedova M.
Effect of screw cleaner on cotton spinning **267**

ADVANCED PEDAGOGICAL TECHNOLOGIES IN EDUCATION

Kayumov M.
Enlightenment movement of Jadids in Khiva khanate **272**

Alikhanov M.
Constitutional reforms in Uzbekistan during the years of independence **278**

Alikhanov M.
The struggle for constitutional monarchy in the khanate of Khiva at the beginning of the XX century **283**

Azibaev A.
Forecasting GDP growth and GDP per capita in Uzbekistan by the ordinary least squares (OLS) regression analysis **289**

Tuychibayeva G., Kukibayeva M.
Overwiev of teaching English to teenagers in Uzbekistan secondary schools **296**

Ismailova Z.
Methodology for improving lexical competence of future english language teachers **301**

Xuramov L.
Algorithms for modeling function and medical signals in wavelet methods **307**

ECONOMICAL SCIENCES

Bekmirzayev B.
Agriculture development in ensuring economic security in Uzbekistan: theory, analysis and prospects **316**

Mirzatov B.
Social evaluation of the youth behavior and value sphere in Namangan region **323**

Khojimatov R.
The development competitiveness of silk industry in Namangan region **329**

Maksudov A.
The development and formation of competition of the market for the products of the sewing and knitting industry **335**

Maksudov A. Government support of the garment and knitting industry within the scope of business activity	**341**
Yuldasheva D. Personnel competencies in the field of tourism personnel management	**346**
Abdieva N. Development of small business and private entrepreneurship with the help of investments	**350**
Abdieva N. The labor market and its effect on the economy	**357**
Yuldasheva D., Hashimov P. Tax systems and their assessment criteria	**365**