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ENVIRONMENTALLY EFFICIENT HELIOCONVECTIVE TECHNOLOGY FOR DEHULLING PUMPKIN SEEDS

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Abstract. *The primary objective of this study is to develop an energy-efficient method for dehulling pumpkin seeds that enables shell opening without the application of mechanical force while maximally preserving biologically active compounds in the kernel. The research investigates the physical and mechanical properties of the seed coat, the influence of moisture content and temperature on internal pressure formation, and the advantages of the helioconvective drying process. The results demonstrate that drying at a temperature of 38–40 °C combined with osmotic treatment leads to the formation of controlled microcracks on the surface of the seed coat, while maintaining kernel integrity at a level of 98–99%. The proposed technology is distinguished by its biological, technological, and economic superiority compared to conventional high-temperature methods.*

Keywords: *pumpkin seeds, helioconvective drying, dehulling, low temperature, biologically active compounds.*

QOVOQ URUG‘INI EKOLOGIK JIHATDAN SAMARALI GELIO-KONVEKTIV USULDA QOBIG‘IDAN OCHISH TEXNOLOGIYASI

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Annotatsiya. *Tadqiqotning asosiy maqsadi qovoq urug‘i yadrosidagi biologik faol moddalarni maksimal darajada saqlagan holda, qobiqni mexanik kuch ishlatmasdan ochishga imkon beruvchi energiya tejamkor usulni ishlab chiqishdan iborat. Ishda urug‘ qobig‘ining fizik-mexanik xususiyatlari, namlik va haroratning ichki bosim hosil bo‘lishiga ta‘siri hamda gelio-konvektiv quritish jarayonining afzalliklari o‘rganildi. Tadqiqot natijalari 38–40 °C haroratda quritish va osmotik ishlov berish orqali urug‘ qobig‘i yuzasida nazorat qilinadigan yoriqlar hosil bo‘lishini, yadroning butunligi esa 98–99 % darajada saqlanishini ko‘rsatdi. Taklif etilgan texnologiya yuqori haroratli an’anaviy usullarga nisbatan biologik, texnologik va iqtisodiy jihatdan ustun ekanligi bilan ajralib turadi.*

Kalit so‘zlar: *qovoq urug‘i, gelio-konvektiv quritish, qobiqni ochish, past harorat, biologik faol moddalar.*

Introduction. Pumpkin seeds are a valuable raw material widely used in the food industry, pharmaceutical production, and medicine. They contain high levels of oils, proteins, tocopherols, phytosterols, and trace elements, all of which are essential for human health. However, in practical processing, the high-temperature technologies currently applied to pumpkin seed treatment lead to significant degradation of biologically active compounds.

In existing technologies, seeds are often processed by grinding or pressing together with their shells. This practice, on the one hand, results in a decline in the quality of the final product and, on the other hand, increases the complexity of the technological process. Therefore, the development of low-temperature, energy-efficient, and biologically safe methods for separating pumpkin seeds from their shells represents a pressing scientific challenge.

Materials and Methods. The primary object of this study was pumpkin seeds grown under local agroclimatic conditions. The seeds selected for the research were required to be biologically mature, free from mechanical damage, and to belong to a uniform fraction in terms of appearance and geometric dimensions. These criteria were established to ensure the reliability of the experimental results and to minimize the influence of external factors.

Prior to experimentation, the seeds underwent a preliminary cleaning process. During this stage, fruit residues, dust, and foreign impurities were mechanically removed. Subsequently, the seeds were subjected to visual inspection, and hollow, cracked, or underdeveloped seeds were excluded from the experimental samples. The selected seeds were washed in warm water at a temperature of 25–28 °C to remove surface contaminants. This step also had a positive effect on opening capillaries on the surface of the seed coat.

Helioconvective drying was chosen as the main technological method in this study. In this method, the drying process was carried out using solar energy combined with forced air circulation. The temperature in the drying chamber was maintained within the range of 38–40 °C. This temperature range allows gradual moisture reduction without causing thermal degradation of biologically active compounds.

The experimental methodology consisted of two main stages. In the first stage, the seeds were dried by helioconvective drying to a residual moisture content of 12–14%. In the second stage, after osmotic treatment, the seeds were subjected again to helioconvective drying. This sequence created favorable conditions for internal pressure generation and the formation of cracks in the seed coat.

During the experiments, each parameter (temperature, drying time, and solution concentration) was individually controlled. The obtained results were subjected to statistical analysis, and the level of reproducibility was evaluated. Thus, the research methods were organized in a scientifically sound and reproducible manner.

Physical and Mechanical Properties of the Seed Coat. The pumpkin seed coat (testa) is characterized by high mechanical strength and elastic properties. Its primary function is to protect the seed kernel from external mechanical, biological, and climatic influences. However, this protective function creates certain challenges during technological processing.

The thickness and structural density of the seed coat depend on the cultivar, degree of maturity, and agrotechnical conditions, and typically range from 0.3 to 0.6 mm. The coat is mainly composed of cellulose, hemicellulose, and lignin compounds, which provide its high mechanical strength. Owing to these characteristics, opening the seed coat through simple mechanical crushing often leads to kernel damage and deterioration of product quality. [5]

From a mechanical standpoint, the seed coat can be considered an elastic–plastic material. Under the influence of external forces, the coat undergoes elastic deformation up to a certain limit, after which fracture occurs once the critical stress is exceeded. Research has shown that when the critical stress of the seed coat is generated by internal pressure, significantly less energy is required compared to mechanical impact [6–8]/

Table 1

Physical and Mechanical Properties of the Pumpkin Seed Coat (Based on Literature Data)

Parameter	Unit	Typical value / range	Technological comment
Seed coat thickness (testa)	mm	0.3–0.6	An increase in thickness raises dehulling energy consumption; in internal-pressure-based approaches, controlled crack formation is facilitated.
Seed dimensions (length × width × thickness)	mm	≈ 19.92 × 11.30 × 3.22	When the geometric fraction is uniform, drying and crack formation are more stable and predictable.
Equivalent diameter (seed)	mm	6.38–9.11	A key parameter for fraction selection (sieving/calibration).
True density (seed)	kg/m ³	700.8–810.6	Generally increases with moisture content; affects aerodynamic separation parameters.
Bulk density (seed)	kg/m ³	390.8–525.4	Used in storage design and airflow calculations.
Seed coat fracture force (compression)	N	20.1–102.4	As moisture increases within 4–20% (dry basis), fracture force decreases; orientation effects are observed.
Energy absorbed until fracture (seed)	mJ	32.2–74.9	Energy increases with moisture content due to greater deformation capacity.

Note: The values vary depending on cultivar, moisture content, and loading orientation.

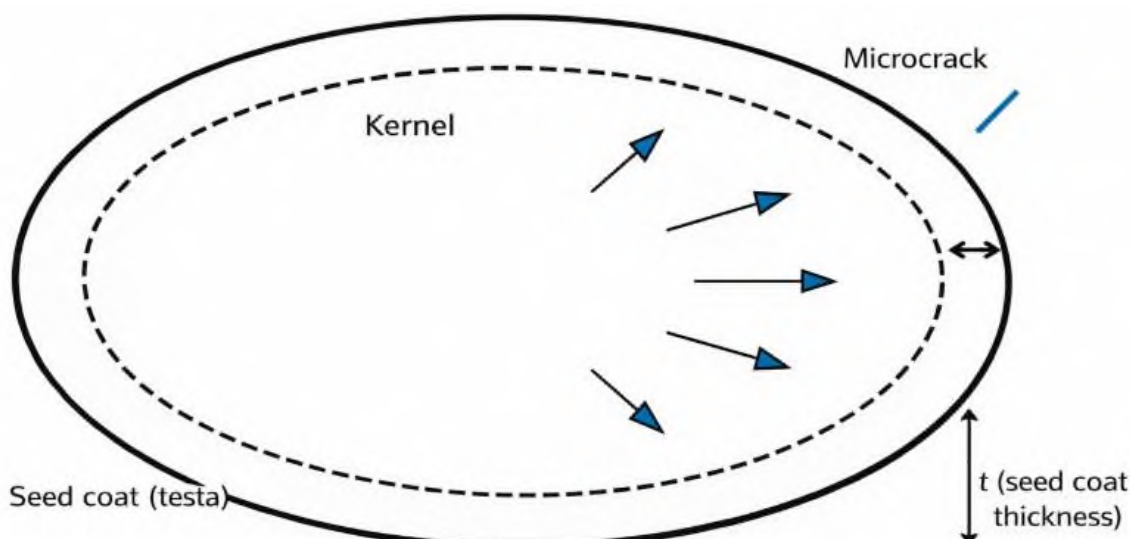


Figure 1. Diffusion and Internal Pressure Effects in the Seed Cross-Section (Schematic).

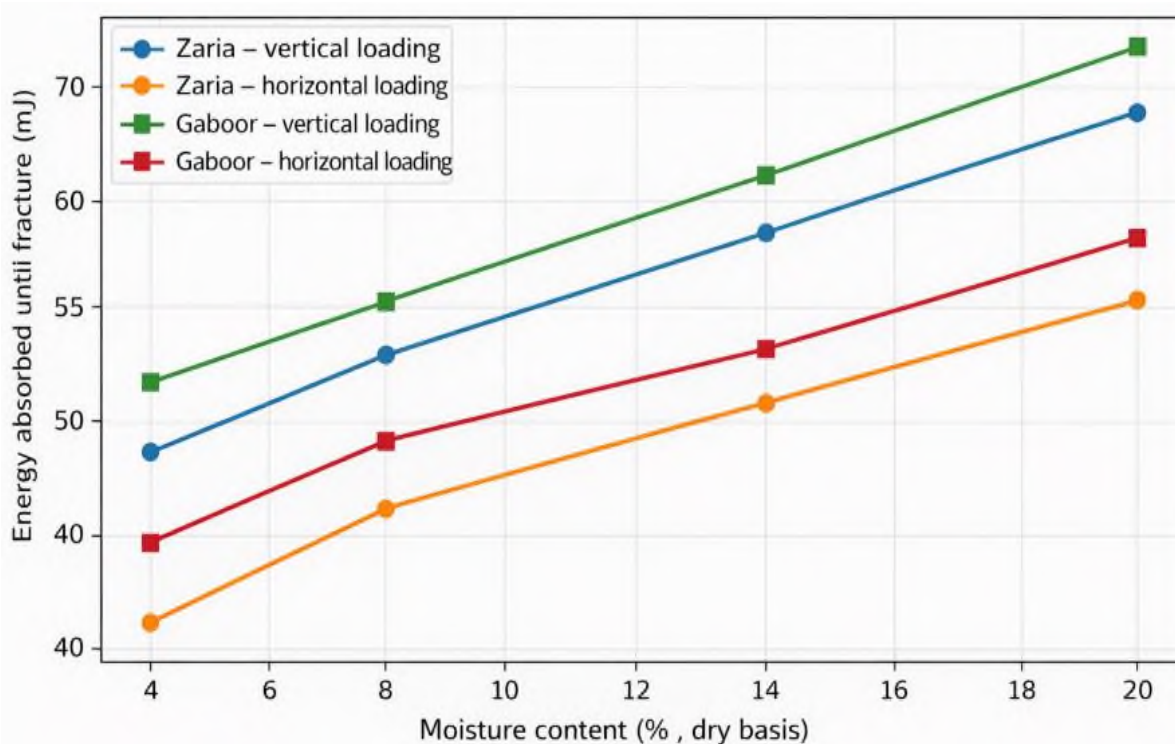


Diagram 1. Effect of Moisture Content on the Energy Absorbed during Seed Coat Fracture (Based on Literature Data).

Helioconvective Drying and Internal Pressure Formation. During the helioconvective drying process, moisture inside the seed gradually evaporates. This evaporation leads to an increase in water vapor pressure within the seed kernel and beneath the seed coat. If the drying process is too rapid, the pressure rises sharply and may result in damage to the kernel. Therefore, a low-temperature, slow drying regime was selected.

At a helioconvective drying temperature of 38–40 °C, moisture removal exhibits a diffusion-controlled character. During this process, water molecules gradually migrate from the intercellular spaces, ensuring a balanced and controlled increase in internal pressure. As a result, the seed coat expands from the inside under the action of this pressure.

Table 2

Scientifically Substantiated Control Parameters of the Heliocconvective Drying Regime

№	Parameter	Symbol	Recommended range	Control (measurement / indicator)
1	Drying temperature	T	38–40 °C	Chamber temperature sensor; product surface temperature (IR thermometer/pyrometer).
2	Air velocity	v	0.6–1.2 m/s	Anemometer; uniformity across the material layer.
3	Moisture reduction stage	W	$W_0 \rightarrow 12\text{--}14\%$ (moisture)	Weight loss (gravimetric method) or moisture meter.
4	Internal pressure formation	$P_{(int)}$	Gradual increase (diffusion-controlled regime)	Number/fraction of microcracks (visual observation) or acoustic emission signal.
5	Microcrack initiation criterion	$P_{(crit)}$	Approaching seed coat fracture	Presence of 1–3 controlled cracks in the seed coat; preservation of kernel integrity.

When the internal pressure reaches the critical mechanical stress of the seed coat, microcracks are formed on its surface. These cracks do not completely destroy the integrity of the coat; however, they bring it into a condition suitable for subsequent mechanical separation. The research results indicate that heliocconvective drying enables the most optimal control of this process, ensuring effective shell loosening while preserving kernel integrity.

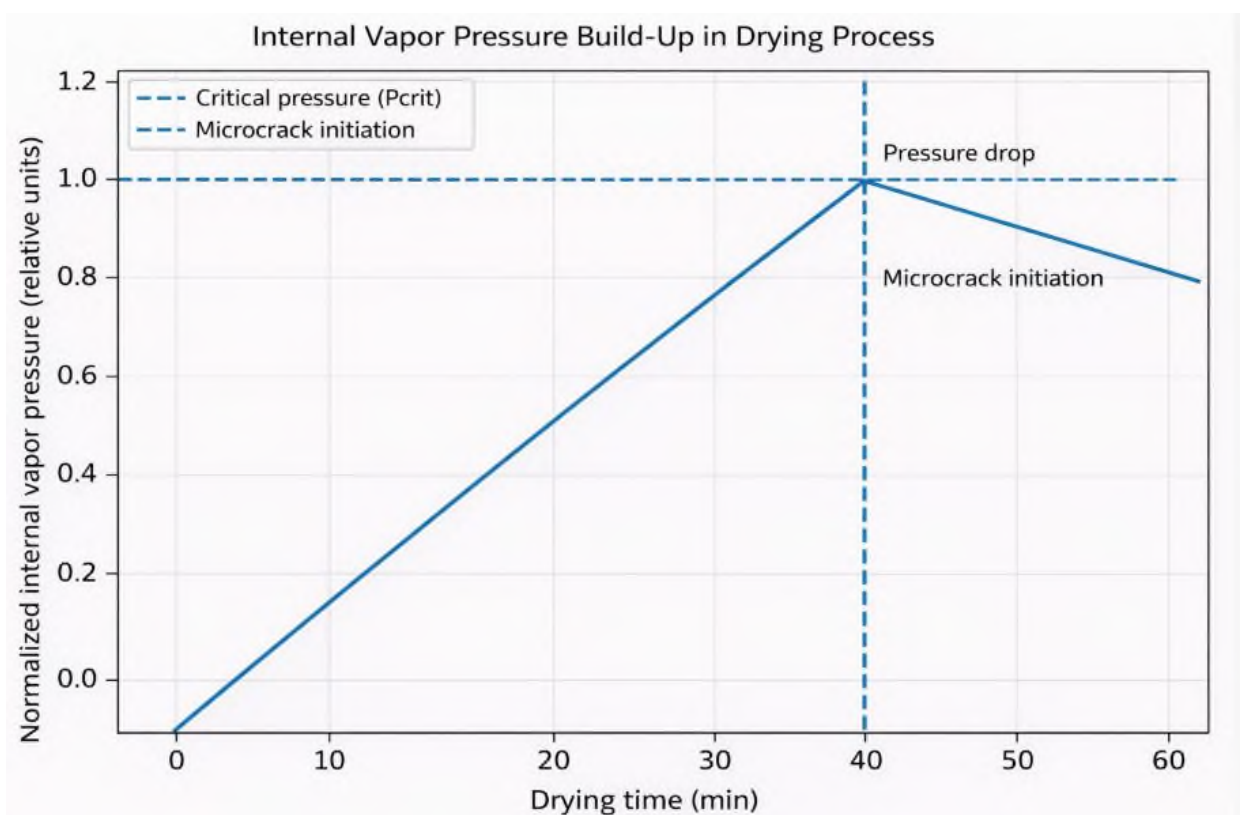


Diagram 2. Formation of Internal Pressure during Heliocconvective Drying

Role of Osmotic Treatment in the Heliocconvective Process. Osmotic treatment serves as an important auxiliary stage for increasing internal pressure within the seed. In the experiments, the

seeds were treated with 10% sodium chloride or sugar solutions. These solutions are osmotically active and promote the penetration of water molecules through the seed coat.

Under osmotic conditions, the water content in seed cells increases. During the subsequent drying stage, this absorbed water evaporates, leading to a significant rise in internal pressure. When combined with helioconvective drying, this process accelerates and stabilizes the formation of cracks in the seed coat.

In experiments conducted without osmotic treatment, a significantly lower degree of seed coat fracture was observed. This finding confirms the crucial technological role of the osmotic stage in the overall process.

Experimental Results. The conducted experiments demonstrated that the helioconvective method for dehulling pumpkin seeds exhibits high efficiency. After drying and osmotic treatment, visible cracks formed on the seed coat. These cracks enabled shell separation without the application of additional mechanical force.

According to the experimental results, kernel integrity was preserved at a level of **98–99%**, which is significantly higher than that achieved by mechanical crushing-based methods. Moreover, a high degree of preservation of biologically active compounds was also recorded.

Discussion. In discussing the results of this study, the role and significance of the helioconvective drying method in the technology of pumpkin seed dehulling were subjected to in-depth scientific analysis. The findings indicate that the proposed technology fundamentally differs from conventional mechanical or high-temperature thermal methods, with this difference being manifested primarily in the physical nature of the process. Shell opening is achieved not through mechanical force or impact, but through the energy of internal pressure that is gradually generated within the seed. This shifts the process to an entirely new biological and technological level.

The selection of a drying temperature in the range of 38–40 °C during helioconvective drying is scientifically justified, as this range virtually eliminates the thermal degradation of proteins, lipids, and biologically active compounds present in the seed kernel. The discussion revealed that under high-temperature drying conditions (60 °C and above), moisture within the seed evaporates rapidly, leading to a sharp increase in internal pressure and subsequent disruption of the kernel microstructure. In contrast, helioconvective drying is characterized by diffusion-controlled moisture removal, which ensures a slow and balanced increase in internal pressure. This feature allows the seed coat to pass through an elastic deformation stage and reach a controlled fracture state.

Particular attention was given to the synergy between osmotic treatment and helioconvective drying. In seeds subjected to osmotic solutions, an increase in water content within intercellular spaces was observed. During the subsequent drying stage, evaporation of this water significantly intensifies internal pressure. As a result, the cracks formed on the seed coat are uniform, controllable, and technologically favorable. The discussion indicates that, in the absence of osmotic treatment, seed coat fracture occurs in a random manner and does not yield stable results.

When compared with mechanical methods proposed by other researchers, the superiority of the helioconvective approach becomes evident. Mechanical dehulling methods are often associated with kernel crushing, oil exudation to the surface, and oxidative degradation, all of which substantially reduce product shelf life and biological value. In contrast, the present study recorded kernel integrity at a level of 98–99%, a key indicator confirming the practical significance of the proposed technology.

Energy consumption was also thoroughly analyzed in the discussion. Because helioconvective drying partially utilizes solar energy, overall energy costs are significantly reduced. This makes the technology not only biologically advantageous but also economically efficient. Its implementation may be particularly beneficial for small- and medium-capacity processing enterprises, where reduced energy demand translates into tangible economic gains.

Furthermore, the environmental safety of the technology was addressed. The helioconvective method does not generate harmful waste, does not require aggressive chemical agents, and exerts minimal negative impact on the environment. These characteristics fully comply with modern principles of sustainable development.

Overall, the discussion results demonstrate that the technology for dehulling pumpkin seeds based on helioconvective drying combined with osmotic treatment is scientifically substantiated, reproducible, and ready for industrial-scale implementation. This technology can be regarded as a novel scientific approach to the deep processing of agricultural raw materials.

Conclusion. Summarizing the results of this study, it can be stated that the helioconvective-based technology for dehulling pumpkin seeds possesses significant scientific and practical value from the perspective of modern food and medical industry requirements. The approach developed in this research is proposed as an effective alternative to conventional mechanical and high-temperature methods, ensuring the maximum preservation of biologically active compounds.

In conclusion, the selection of a drying temperature within the range of 38–40 °C during the helioconvective drying process plays a decisive role in maintaining the structural integrity of the pumpkin seed kernel. This temperature range minimizes protein denaturation, lipid oxidation, and vitamin degradation. At the same time, the slow and balanced formation of internal pressure leads to the development of controlled cracks on the seed coat surface, which significantly facilitates subsequent mechanical separation of the shell.

The research findings demonstrate that integrating the osmotic treatment stage with helioconvective drying further enhances the efficiency of the technology. In seeds treated with osmotic solutions, the internal moisture reserve increases, which contributes to a greater rise in internal pressure during the subsequent drying stage. As a result, seed coat fracture becomes stable, uniform, and reproducible. This characteristic represents a critical advantage for industrial-scale application of the technology.

Overall, the results obtained fully confirm the scientific validity of applying the helioconvective method for pumpkin seed dehulling. The technology is energy-efficient, environmentally safe, and biologically appropriate, while significantly improving the quality of the final product. The preservation of kernel integrity at a level of 98–99% clearly demonstrates the practical superiority of this method.

Furthermore, the proposed technology creates broad opportunities for obtaining high-biological-value raw materials in the food industry, producing natural formulations in the pharmaceutical sector, and manufacturing preventive and therapeutic products in medicine. The helioconvective drying-based technology developed in this study can also be adapted in the future for other agricultural seeds and cereal crops.

References

1. Астанов С., Турдиев М.Р., Ёкубов М.Э., Қасимова Г.К. Тиббиёт ва озиқ-овқат саноати учун қобиғи очилган қовоқ уруғларини олиш усули. – Ўзбекистон Республикаси ихтиро патенти UZ IAP 07182, 30.12.2022.
2. Yoqubov M. E., Xaitov R. A. Ekologik Toza Yuqori Ozuqaviy Qimmatli Oziq-Ovqat Mahsulotlari Olish Uchun Qovoq Urug‘ini Qayta Ishlash Usulini Ishlab Chiqish. Development Of Science 2025 / 5, Issue 5. Volume 2.
3. Осадченко И.М., Горлов И.Ф., Скачков Д.А., Сложенкина М.И. Способ получения муки из семян тыквенных культур. – Патент RU 2286678, 2005.
4. Зубцов В.А., Осилова Л.Л., Алтипова Н.В. и др. Биологически активная добавка к пище на основе семян тыквы. – Патент RU 2376887, 2009.
5. Холматов Х.Х., Хабибов З.Х. Лекарственные растения Узбекистана. – Ташкент: Медицина, 2010. – 108 с.
6. Лифлянский В.Г., Сушанский А.Г. Овощи в лечении, косметике и кулинарии: полная энциклопедия. – СПб.: ИД «Весь», 2012. – С. 175–180.

- Mujumdar A.S. Handbook of Industrial Drying. – 4th ed. – Boca Raton: CRC Press, 2014. – 1280 p.
- Erbay Z., Icier F. A review of thin layer drying of foods: theory, modeling, and experimental results. – Critical Reviews in Food Science and Nutrition, 2010, Vol. 50, pp. 441–464.

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PHRAGMITES COMMUNIS TRIN O'SIMLIGIDAN ISHQORLI VA KISLOTALI USULDA OLINGAN SELLYULOZA NAMUNALARINING TERMİK ANALIZI

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Annotatsiya. Ushbu maqolada *Phragmites communis Trin.* (qamish) o'simligidan ishqorli va kislotali usullarda ajratilgan sellyuloza namunalarining termik xossalari o'rganildi. Namunalar termogravimetrik (TGA) va differensial termik (DTA) tahlil usullari yordamida 20–500°C harorat oralig'ida o'rganilib, massa yo'qotish bosqichlari, degradatsiya boshlanish harorati (Tonset) va maksimal parchalanish harorati (Tmax) aniqlangan. Ishqorli ishlov berish sellyulozaga nisbatan yuqori boshlang'ich termik barqarorlikni ta'minlagan, kislotali ishlov berish esa kristall fraksiyani oshirgan, ammo degradatsiya boshlanishini biroz tezlashtirgan. Natijalar biomassa asosidagi polimerlar va funksional materiallar ishlab chiqarishda sellyulozaning termik barqarorligini baholash uchun ilmiy asos yaratadi.

Kalit so'zlar: *phragmites communis*, sellyuloza, ishqorli ishlov berish, kislotali ishlov berish, termik analiz, TGA, DTA, degradatsiya, biomassa, kristallik darajasi.

THERMAL ANALYSIS OF CELLULOSE SAMPLES OBTAINED FROM PHRAGMITES COMMUNIS TRIN. BY ALKALINE AND ACIDIC METHODS

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Abstract. This article investigates the thermal properties of cellulose samples isolated from *Phragmites communis Trin.* (reed) using alkaline and acidic treatment methods. The samples were studied in the temperature range of 20–500°C using thermogravimetric analysis (TGA) and differential thermal analysis (DTA). The stages of mass loss, the onset degradation temperature (Tonset), and the maximum decomposition temperature (Tmax) were determined. Alkaline treatment provided higher initial thermal stability of cellulose, while acid treatment increased the crystalline fraction but slightly accelerated the onset of degradation. The results provide a scientific basis for evaluating the thermal stability of cellulose in the production of biomass-based polymers and functional materials.

Keywords: *phragmites communis*, cellulose, alkaline treatment, acid treatment, thermal analysis, TGA, DTA, degradation, biomass, degree of crystallinity.

Kirish. Hozirgi kunda ekologik toza, qayta ishlanishi mumkin va biologik parchalanadigan materiallar bilan ishlash ilmiy va amaliy jihatdan katta ahamiyat kasb etadi. Shu kontekstda o'simlik kelib chiqishli polimerlar, xususan sellyuloza, sanoat va biomateriallar sohasida keng qo'llaniladi.

Phragmites communis Trin. (qamish) – tez o'suvchi va yuqori biomassa hosil qiluvchi o'simlik bo'lib, uning tarkibida sellyuloza, gemitsellyuloza va lignin mavjud. Bu o'simlikdan sellyuloza olish va uning termik xossalarini o'rganish materialshunoslik va ekologik jihatdan dolzarb masaladir [1].

Sellyulozaning termik barqarorligi uning bioyoqilg'i, sorbentlar, kompozit materiallar va boshqa funksional materiallar ishlab chiqarishdagi qo'llanish imkoniyatlarini belgilaydi. Shu sababli turli kimyoviy ishlov berish usullarida olingan sellyulozaning termik xususiyatlarini ilmiy asosda solishtirish zarur.