MIRZO ULUG‘BEK NOMIDAGI
O‘ZBEKISTON MILLIY UNIVERSITETI
JIZZAX FILIALI



"BIOTEXNOLOGIYANING RIVOJLANISH ISTIQBOLLARI VA MUAMMOLARI"

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МИНИСТЕРСТВО ВЫСШЕГО ОБРАЗОВАНИЯ, НАУКИ И ИННОВАЦИЙ РЕСПУБЛИКИ УЗБЕКИСТАН

ДЖИЗАКСКИЙ ФИЛИАЛ НАЦИОНАЛЬНОГО УНИВЕРСИТЕТА УЗБЕКИСТАНА ИМЕНИ МИРЗО УЛУГБЕКА

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POSSIBILITIES OF INCREASING SALT TOLERANCE IN BARLEY USING CRISPR-CAS9 TECHNOLOGY

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Abstract: This analytical thesis examines the potential of using CRISPR/Cas9 technology to enhance salt tolerance in barley (Hordeum vulgare L.). Ensuring global food security and increasing crop productivity are among the most pressing challenges worldwide. Soil salinization is a major limiting factor in agriculture, significantly reducing crop yields, especially for essential cereal crops such as barley. This thesis analyzes the genes responsible for salt stress response, their molecular mechanisms, and the possibilities of improving their function through gene editing using CRISPR/Cas9 technology. Research indicates that the CRISPR/Cas9 system can enhance stress tolerance in barley by modifying genes related to salt tolerance, such as ABi5, NHX1, HKT1;5, and SOS1 [8, 9]. Additionally, the advantages, limitations, and prospects of this technology in agriculture are discussed. This study contributes to understanding how CRISPR/Cas9 technology can be effectively applied in future research and breeding programs.

Keywords: Barley (Hordeum vulgare L.), salt stress, CRISPR/Cas9, gene editing, ABi5, NHX1, HKT1;5, SOS1, molecular breeding, genetic engineering, agricultural biotechnology.

Introduction: The agricultural sector faces significant challenges in ensuring global food security. According to the Food and Agriculture Organization (FAO) of the United Nations, global food production must increase by at least 70% by 2050 to meet the growing needs of humanity [6]. Factors such as population growth, climate change, and decreasing natural resources have made increasing

agricultural productivity an urgent issue. Among these challenges, soil salinization is one of the primary global constraints, as it directly affects crop growth and development. Salt stress disrupts plant nutrient and water uptake, impairs photosynthesis, and reduces crop yields [7]. The increasing prevalence of salinized agricultural land worldwide further complicates the situation, with approximately 20% of irrigated land affected by salinity [10]. Recent advancements in genome editing technologies have accelerated breeding programs and enhanced crop resilience to environmental stressors. Traditional breeding methods require substantial time and resources, whereas advanced biotechnologies such as CRISPR/Cas9 enable precise and efficient modifications in plant genomes [2, 5]. This technology opens new prospects for editing genes involved in salt stress response, potentially leading to the development of salt-tolerant barley varieties.

Scientific Basis of CRISPR/Cas9 Technology and Its Role in Enhancing Barley's Salt Tolerance

Significant progress has been made in genome engineering and plant breeding in recent years. While traditional mutagenesis techniques, including physical (gamma radiation), chemical (ethyl methanesulfonate – EMS), and biological (transposon insertion) approaches, can alter plant genomes, they are often time-consuming and result in random mutations [1, 2]. Modern biotechnological approaches, particularly CRISPR/Cas9 technology, have revolutionized genome editing by allowing targeted genetic modifications that are unattainable with conventional breeding methods [3].

CRISPR/Cas9 (Clustered Regularly Interspaced Short Palindromic Repeats – CRISPR-associated protein 9) was initially discovered as a natural immune defence system in bacteria, protecting them from viral infections [4].

This technology, based on the type II CRISPR/Cas9 system from Streptococcus enables precise DNA editing by introducing targeted cuts at specific genomic locations [11].

Application of CRISPR/Cas9 Technology in Enhancing Barley's Salt Tolerance

Barley (Hordeum vulgare L.) exhibits greater salt tolerance than other cereals, yet its growth and productivity significantly decline under high salt concentrations (>200 mM NaCl) [6]. Salt stress leads to excessive accumulation of sodium (Na^+) and chloride (Cl^-) ions within cells, disrupting ionic balance, increasing osmotic pressure, and impairing metabolic processes [7].

CRISPR/Cas9 technology offers several strategies to enhance barley's salt tolerance:

1. Editing Salt-Responsive Genes – Enhancing or suppressing the expression of genes involved in salt stress response can create salt-tolerant phenotypes. For

example, modifying genes such as NHX1, HKT1;5, SOS1, and ABI5 can significantly improve barley's salt stress resilience [8].

2. Improving Root System and Ion Transport Mechanisms CRISPR can enhance root cell capacity for sodium ion (Na^+) extrusion or sequestration. For instance, the HKT1;5 gene restricts the movement of sodium ions from roots to leaves, reducing salt toxicity [9].

3. Enhancing Osmoprotectant Synthesis – Proline and trehalose help plants cope with salt stress. CRISPR can be utilized to upregulate metabolic pathways that increase the synthesis of these osmoprotectants, improving salt tolerance [5].

Conclusion

CRISPR/Cas9 technology is a powerful tool for improving salt tolerance in barley, accelerating breeding programs, and enhancing crop adaptation to climate change. Modifying key salt stress-responsive genes, can significantly increase barley's agricultural value and contribute to global food security. Therefore, expanding research on CRISPR-Cas9-based strategies for improving stress tolerance in barley remains a crucial scientific priority.

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POSSIBILITIES OF INCREASING OIL CONTENT IN SUNFLOWER BASED ON CRISPR/CAS9 TECHNOLOGY

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Abstract: This thesis analyzes the potential of increasing oil content in sunflower (*Helianthus annuus* L.) using CRISPR/Cas9 technology. Sunflower is a key crop in the food industry due to its high oil content and beneficial fatty acid composition. CRISPR/Cas9 technology is an advanced biotechnology that enables precise and efficient modification of plant genomes. The thesis examines the scientific basis and practical achievements of modifying genes that negatively influence oil content, specifically the modification of FAD2, FAD3, DGAT1, and WRI1 genes. These methods can be applied to improve the quality and efficiency of sunflower cultivation.

Keywords: CRISPR/Cas9, sunflower, oil content, genetic modification, FAD2, FAD3, DGAT1, WRI1, biotechnology, plant breeding.

Ensuring global food security and increasing agricultural production are crucial challenges today. Sunflower (*Helianthus annuus* L.) is recognized as one of the most important crops for oil production. One of the primary goals in sunflower cultivation is to increase its oil content. Today, modern biotechnologies, especially CRISPR/Cas9, provide the opportunity to precisely and effectively modify the genetic makeup of plants. This thesis explores the potential of using CRISPR/Cas9 technology to increase oil content in sunflower by knocking out genes that negatively affect oil synthesis.

Importance of Food Security and Sunflower Cultivation: Sunflower is an oilseed crop that plays a significant role in the food industry. It is widely cultivated for its high oil content and beneficial fatty acid composition. Despite its advantages, the oil content in sunflower is limited by existing selection and agronomic methods. Genetic modifications using technologies like CRISPR/Cas9 are necessary to improve oil production processes and enhance plant efficiency [3-5]