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DIRECTIONS FOR CREATING GM POTATOES. FOOD PRODUCTS CREATED WITH ITS USE
(НАПРЯМИ СТВОРЕННЯ ГМ КАРТОПЛІ. ХАРЧОВІ ПРОДУКТИ, ЩО СТВОРЕНІ З ЇЇ ЗАСТОСУВАННЯМ)

У статті йдеться про напрями створення ГМ картоплі та про харчові продукти, що створені з її застосуванням.

Ключові слова: *картопля, харчові продукти, трансформація, ß-казеїн.*

This article discusses directions for the creation of GM potatoes and food products created with its use.

Keywords: *potatoes, food products, transformation, beta-casein.*

Why is the use of biotechnology so important in potato production?

Potato (Solanum tuberosum L.) is a globally important agricultural plant that produces tubers of high nutritional quality. It is the fourth most important staple crop (after wheat, maize and rice) in terms of production and demand, with around 378 million tons produced annually [1].

The tuber, which serves the plant as a storage organ and as a vegetative propagation system, is an excellent source of complex carbohydrates, proteins, and vitamins. Therefore, it is considered one of the promising crops to overcome the challenges of poverty and hunger worldwide. In addition, potato is largely used in industry to make processed food products, alcohol, animal feed, and for bioenergy production substrates like biofuel. Because of its physical and chemical properties, refined starch is also used as a thickener and stabilizer for food products, as well as a raw material for paper, textiles, cosmetics, adhesives and plastics. Altogether, the importance of potato cultivation lies not only in its use as a basic food crop but also as a source of compounds of interest. While wide climate adaptability has facilitated potato to be extensively distributed in the world, several factors like climate change, industrialization, and urbanization have overburdened the existing agriculture lands and food resources

Potato production faces important challenges such as biotic (viruses, bacteria, fungal, and insect pests) and abiotic stresses (drought, flooding, salinity, heat, and cold), and postharvest problems (accumulation of reducing sugars during cold storage, injury-induced enzymatic browning). Due to its large negative impacts on yield and tuber quality, improving resistance to disease and pests and/or abiotic factors, as well as quality traits is of significant economic importance.

Genetic engineering makes it possible to introduce the genes of interest without changing the allele combinations that characterize varieties successfully grown for commercial purposes. Recently, so-called new breeding technologies (NBTs), including genome editing, allow inducing modifications of target sequences in the genome to reduce off-target effects.

Successful plant transformation requires a suitable DNA transduction system, efficient plant regeneration protocols and optimal selecti on methods to recognize the transformed cells. There is a large variety of DNA transfection systems for potato transformation. Most of them embed the gene of interest in the nuclear genome [2].

A. tumefaciens methods are more efficient than others, with a higher proportion of plants having a single copy of the transgene inserted, minimizing potential side effects.

Nevertheless, A. tumefaciens-mediated transgene stacking has been successfully achieved using various approaches:

- crossing of individual transgenic plants,
- re-transformation with independent genetic constructs,
- use of gene combining constructs,

- co-transformation with double constructs,
- the use of polyprotein systems [2].

Generation of transgenic potato using other bacteria species, such as Sinorhizobium meliloti, Rhizobium sp. NGR234, Mesorhizobium loti, Sinorhizobium adhaerens, and Agrobacterium rhizogenes, has also been reported.

A. rhizogenes is often applied for obtaining transgenic roots faster than using A. tumefaciens, since plant regeneration is not needed, representing an alternative tool for potato functional studies and characterization of root genes.

Another biotechnological approach that has proven successful in stacking resistance genes against potato viruses is the RNAi method. It should be noted that many RNAi approaches have been used for pest control.

DNA transfection is performed by direct DNA incorporation, including microinjection, particle bombardment, polyethylene glycol (PEG) protoplast transfection and protoplast electrofection. These methodologies facilitate the integration and coordinated expression of multiple genes and manipulation of metabolic pathways in potato, but disadvantages such as complex integration patterns, high copy number, transgene rearrangement and gene silencing have also been reported. New genetic engineering methodologies, such as passive gene recognition using nanoparticles, have been successfully applied to potato [2].

Genetically modified potato plants in nutrition and prevention of diseases in humans and animals.

Potatoes with increased amino acid production

Transgenic potato plants were produced by introducing a gene for the non-allergenic protein AmA1 from A. hypochondriacus. These modified potato tubers are characterized by increased production of all amino acids, in contrast to control plants. The production of the following amino acids is particularly important.

Lysine, methionine, cysteine and tyrosine, the production of which is very limited in commonly grown potatoes. This increase can be very useful in improving the nutritional status of man and can be used to combat malnutrition among the poorest children in India [3].

Production of beta-casein from human lactobacillus

Transgenic potatoes that produce human beta-lactobacillus casein may have significant nutritional value. Although the amount of casein produced from potatoes is relatively small, this experiment shows that casein can be expressed in food crops. Human beta-casein produced from plants may be used in the future to produce breast milk proteins, such as lactoferrin and lysozyme, and to make nutritious baby foods. Preventive action against gastric and intestinal dysfunction in children [3].

Flour with better functionality

Potato starch pasta has low elasticity characteristics, which limits its use in the food industry. Therefore, transgenic potatoes with a low molecular weight glutenin gene (LMW-GS-MB1) were successfully bred to improve the functional properties of the flour. The source of the gene is wheat seed (Triticum aestivum variety Chinese spring), which contains this protein as one of the important reserve proteins. The LMW-GS-MB1 units that accumulate in the transgenic tubers act as polymers and bind with other components present in the tuber to form a matrix, increasing the viscosity of potato starch up to three times [3].

Potatoes with low sugar content

Genetically modified potatoes are also produced in the Czech Republic. These are potatoes in which the phosphofructokinase gene from the bacterium Lactobacillus bulgaricus has been introduced. This gene causes the breakdown of monosaccharides through the glycolytic system. Phosphofructokinase is also present in the body of the potato plant, with one important difference. The potato plant enzyme is sensitive to low temperatures (unlike the bacterial enzyme) and therefore stops working at low temperatures. This leads to an accumulation of monosaccharides and a sweet taste when potatoes are stored at low temperatures.

In addition, potatoes with high levels of monosaccharides turn black when fried, making them less attractive to consumers. Not only do GMO potatoes have a lower sugar content, but chips made from them are also lighter in colour than chips made from non-GMO potatoes [3].

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TRANSITION TO A NEW GENERATION OF SEP: AN IMPORTANT PREREQUISITE FOR THE QUALITATIVE DEVELOPMENT OF UKRAINE'S PAYMENT INFRASTRUCTURE

У статті розглянуто перехід на нове покоління СЕП на базі стандарту ISO 20022. Виявлено основні особливості та переваги нового стандарту. Досліджено діяльність НБУ у зв'язку з переходом на нове покоління СЕП. Доведено важливість переходу на нове покоління СЕП для подальшого якісного розвитку платіжної інфраструктури України.

Ключові слова: *Система електронних платежів, стандарт ISO 20022, НБУ, платіжні операції.*

The article discusses the transition to a new generation of SEP based on the ISO 20022 standard. The main features and advantages of the new standard are revealed. The activity of the NBU in connection with the transition to a new generation of SEP was studied. The importance of the transition to a new generation of SEP for the further qualitative development of the payment infrastructure of Ukraine has been proven.

Keywords: *Electronic payment system, ISO 20022 standard, NBU, payment operations.*

The Law of Ukraine dated June 30, 2021 No. 1591-IX "On Payment Services" (hereinafter - the Law) created the conditions for the transition of the Ukrainian payment infrastructure to the international standard for the exchange of payment messages ISO 20022, which is the basis of the functioning of European payment systems. In compliance with the requirements of the above-mentioned Law, the Board of the National Bank of Ukraine adopted Resolution No. 93 dated 16.09.2021 "On the introduction of the international standard ISO 20022 in the payment infrastructure of Ukraine", according to which, as part of the implementation of the project of the National Bank of Ukraine "Development of the Payment Infrastructure of Ukraine" from April 1, 2023 the international standard ISO 20022 was introduced in the payment infrastructure of Ukraine [1].

ISO 20022 is an ISO standard for electronic data interchange between financial institutions. It describes a metadata repository containing descriptions of messages and business processes, and a maintenance process for the repository content. The standard covers financial information transferred between financial institutions that includes payment transactions, securities trading and settlement information, credit and debit card transactions and other financial information [2].