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BREEDING THE DOMESTIC APPLE TREE (*MALUS DOMESTICA* BORKH.) AS A FAMILY CREATIVE ACTIVITY

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Abstract. *The aim of the work is to make the domestic apple tree breeding process more efficient with the acquisition of new original varieties in the interaction between human and nature also in the form of creative activity of the whole family. In this process, it is possible to use many wild seedlings (WGS) grown from the seeds of domestic apple tree fruits along roadsides, in fields, old gardens and orchards. In the experiment, 39 WGS were selected from different locations in Slovakia, with average fruit weights ranging from 57.45 g to 197.59 g. The fruits were determined to be of different shapes, most often heart-shaped, and varying in colour from light to dark. The colour of the flesh was white, light yellow and slightly red. Many of the seedlings excelled in original aroma and flavour. Process is very simple. In late August, look for suitable seedlings with attractive fruit, take a sample of the fruit and mark the seedling's location. Then take budded cuttings from the seedlings in January for grafting onto prepared rootstocks. In the third year, the first harvests can be evaluated on the WGS. Through this process, each member of the family can get their own original variety in the garden, not only for enjoyment but also for eating the original fruit.*

Keywords: ampelographic evaluation of fruits, domestic apple tree, Malus domestica Borkh., rootstocks wild seedlings, selection of suitable genotypes.

INTRODUCTION

Apples are still one of the most consumed fruits in many countries and cultures, with an annual per capita consumption of around 20-30 kg. By 2050, average daily fruit consumption worldwide is expected to increase from 204 to 242 g per person [1]. When properly grown, stored and used, they are considered a healthy food with significant sources of nutrients and biologically active components [1, 2].

Domestic apple breeding programs primarily focus on improving adaptability to the growing environment, improving tolerance to biotic and abiotic

factors, increasing yield, long-term fruit storage, marketable appearance, fruit size, market pressure, and ever-increasing consumer and producer expectations [3]. Plant breeding is still a powerful and indispensable tool to achieve "harmony" between agriculture and the environment. For this to become a reality, partnerships between plant breeders, ecologists, policy makers and, most importantly, consumers of apple fruit and food products are needed [4].

Although plant breeding has had a very long evolution, at least throughout recorded history, it has rarely lacked new ideas and concepts that have made breeding practices increasingly innovative and efficient. The development of new technologies in recent years has contributed to the strength and versatility of the science and art of plant breeding. Some of these changes have been spectacular, others rather modest. Science and plant breeding are very much intertwined, even if in many cases compromised. This is especially true of so-called basic research. Secretary of Defense Charles Wilson under President Eisenhower defined basic research as follows: "Basic research is when you don't know what you are doing", which basically means that the researcher does not know in advance the answer to the problem being addressed. In doing so, there is a general perception that plant breeders do not conduct any basic research, which is a big misconception [5].

As with other species, hybridisation is the most widely used in apple breeding programmes. This method makes it possible to broaden the genetic base of the selected populations to enhance the heterozygosity of the offspring. In general, intraspecific hybridisation is mainly used, based on the principle of 'crossing the best with the best parent'. It takes 20-25 years to breed a new variety in this process. As the best varieties were also the best known and most widely distributed in the world, relatively few parental components were used in the new breeding programmes. As a result, a small number of parental varieties were repeatedly used during apple breeding [6], and the best-known varieties thus became the parental forms of most of the new varieties. Therefore, many modern varieties found in the world range are related to each other and have common parents or close origins or ancestry, i.e. they share a common genetic basis [7, 8].

At the same time, it is common knowledge that in the early days of plant breeding, seeds from local varieties were used for many plant species and also for apple trees. An example of this was the situation in Finland, where apple trees are grown at the limits of their northern growing possibilities and conditions. Because of these constraints, it was found in practice that growing and thus breeding new varieties by selecting promising individuals from the population of seedlings grown from seed was the most appropriate method for obtaining new varieties that provided a fruit crop for growers in the north. This created a unique culturally and genetically rich indigenous gene pool of local varieties that met the diverse needs of apple growers and consumers from the late 18th century to the mid-19th century [9].

The research and breeding collective at the Julius Kuehn Institute in Dresden-Pillnitz has a long-standing focus on breeding resistant apple varieties. Between 1972 and 1998 they used 52 000 seeds from apple trees to obtain new varieties. From this number of seedlings, at the end of the experiment, they selected and registered in 2006 3 resistant varieties under the name (Re-cultivars, Recolor, Rekarda). The production of the three cultivars from approximately 52 000 seeds means that 17 000 seeds were needed to obtain one cultivar. Only one of the approximately 9 000 seedlings was resistant to scab and was of sufficient quality to become a variety. This proportion documents the enormous effort required to develop a new cultivar [10].

At present, research and breeding teams are focusing mainly on improving the nutritional and therapeutic value of apples, with a priority on increasing the content of flavonoids and other nutrients. An important example is the Department of Primary Industries and Regional Development (DPIRD) and the University of Western Australia (UWA) who are conducting research into breeding flavonoid-rich apples – healthier apples for consumers. The national project focuses on aspects of the breeding process and the market knowledge needed to deliver a healthier apple to the consumer. Apples are bred to maximise certain characteristics such as initial eating quality, appearance, shelf life and resistance to pests and diseases. Maximising the nutrient content of the fruit is increasingly in demand and project staff are investigating how to breed future high flavonoid varieties with additional positive attributes [11].

MATERIALS AND METHODS

The aim of the present work is to document how the complex and long-term breeding process of the domestic apple tree can be made more efficient with the acquisition of "new varieties" in the interaction between man and nature in the form of creative activity of the whole family. The essence of this process is the search for suitable wild seedlings grown in nature at the time of fruit ripening. The seedlings with the best fruit are propagated on prepared rootstocks and planted in gardens and orchards for use.

Specific objectives

(a) Exploration and search for wild seedlings in selected areas of Slovakia as genetic resources for breeding new varieties,

(b) Determination of the economic value of the fruits of wild seedlings in morphological traits.

Biological material

Wild seedlings in number 39 obtained by selection of fruiting wild seedlings grown from seeds of domestic apple tree fruits next to roads, in fields, old gardens

and orchards, pastures and other places. In our experiments we referred to them with the abbreviation "WGS - wild seedlings".

Implemented working procedures

(a) The search and selection of genotypes from wild seedlings was carried out in selected regions during the period of fruit ripening,

(b) Criteria for selection of wild seedlings - good health without disease symptoms, fruit size and shape and bush habit,

(c) Location of the selected genotype was recorded under registration number with simultaneous determination of its geographical location by GPS device,

(d)The image records of the genotype were made with Fuji FinePix S 7000, Panasonic DMC FZ50 and Zeiss Discovery V12 stereomacroscope with 3 Mpx digital camera ICc3.

Morphometric analysis

The following agrophysical parameters were evaluated for the fruits - fruit height (mm), fruit width (mm), fruit weight (g), pedicel pit depth (mm), calyx pit depth (mm), carpel width (mm), carpel length (mm). In this study we present the weight of the fruits, their shape and the colour of fruits the pulp.

RESULTS AND DISCUSSIONS

It is well known that plant breeding, including domestic apple breeding, is an intellectually, time-consuming, technically, technologically and financially very expensive process [12]. According to the Law of the Slovak Republic, "plant variety breeding is the process by which new varieties of plants are discovered, created and developed, and by which their traits and characteristics are maintained during reproduction" [13]. It also follows from the Act that a variety can be created and developed using classical intra- or interspecific hybridisation or also using modern genetic technologies. This process requires knowledge of new scientific knowledge in the fields of genetics, breeding, physiology, biochemistry, plant nutrition, trends in human nutrition, plant protection against diseases and animal pests, current requirements for cultivation technologies, storage and marketing technologies, consumer and processor requirements for fruit quality and other scientific areas that are complexly related to the breeding of a new variety for large-scale cultivation. Indeed, even today, this process requires 20-25 years to breed a single variety from a domesticated apple tree [12]. But there is also the possibility of obtaining a new variety from domestic apple trees in the form of its discovery from bud mutations [14] or with the selection of suitable wild seedlings grown from seed in nature [10]. This process was also implemented in our experiment. In the conditions of Slovakia, we searched for and selected 39 wild seedlings for evaluation based on a survey. The search is very easy because WGS grow in the form of a shrub. They do not have a separate stem from the crown (Figure 1). Seedlings can form a variety

of even exotic shrub shapes.



Figure 1. Habitus of a wild seedling of a domestic apple tree in flowering season
(Photo Š. Hajdu, 2010)

We searched for WGS during the ripening period according to the above methodology. In this publication, due to the limited number of pages, we only present results from fruit weight and some external fruit quality traits. Comparisons of fruit weights from the first WGS group are presented in Figure 2. The comparison shows that the fruit weight was determined in the range from 57.45 g (WGS021) to 197.59 g (WGS003). This means that even with WGS it is possible to find seedlings with lower or even higher fruit weight. This is a criterion of the purposefulness of the use of the fruits. However, the optimum fruit weight of apples for different purposes varies. For marketing purposes, a minimum weight of 90 grams is generally accepted for apples, but smaller sizes may be acceptable if they meet certain quality standards. For storage, the average weight of apples for the Golden Delicious variety is 160 ± 60 grams. In general, an average weight of around 140 grams is required for a medium-sized apple [15].

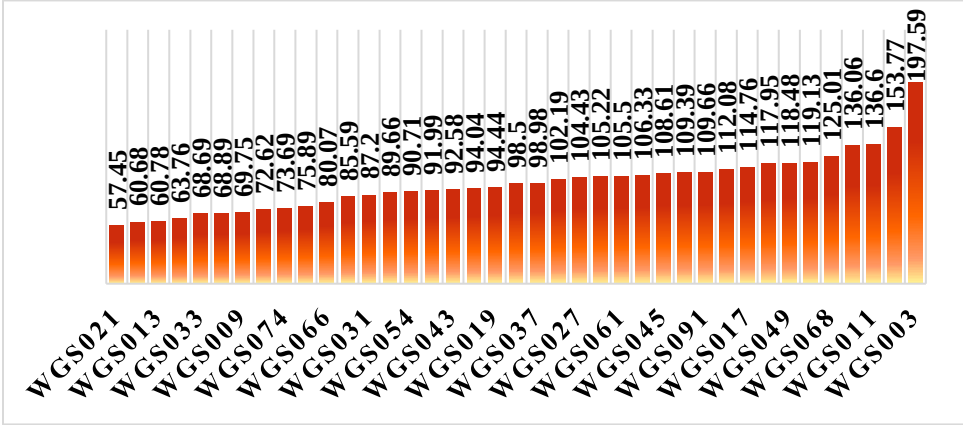


Figure 2 Comparison of evaluated wild apple seedlings in fruit weight (g)

In addition to fruit weight, many consumers prefer the colour of apple fruit, which is the most influential factor affecting market acceptance and price. Consumers judge fruit by sight; specifically, consumers "eat with their eyes" [16]. Red-skinned varieties are generally more desirable [17]. In nature, WGS can be found with a variety of fruit shape and colour. This is documented by the presentation of the shape and colour of some of the WGS evaluated in Figure 3.



Figure 3 Comparison of the selected WGS group in fruit shape, size and colour *(Photo A. Oravec, 2011)*

The presented results, even in short form, clearly document that WGS are very interesting genotypes of domestic apple from which it is possible to search and, after their comprehensive evaluation, to select a potentially new variety.

CONCLUSIONS

Although many breeders and researchers do not recognise the breeding of native apple trees from seed and consider the process to be 'unscientific', this system has its merits. This is evidenced by the dozens of varieties of native apple trees, typified by Golden Delicius and others, which have been obtained from WGS. For breeders, this is a great creative activity, a chance and an opportunity to select WGS from the wild from domestic apple trees with interesting fruit shape and colour and to propagate them on prepared rootstocks in the garden. Each member of the family can have their own original variety "even with their own registration". This system is also suitable for so-called "open science". Many so called "naturalists" can provide breeders with very interesting information about unique WGS from their regions, which stand out for some morphological traits on fruits but also on other parts of the plants and can be potentially and practically useful as new genetic

resources. This system allows for a more active expansion, maintenance and use of biodiversity in fruit production, thus eliminating the priority cultivation of only a few dozen modern apple varieties in home gardens and orchards.

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