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BREEDING OF KIWIFRUIT SPECIES (*ACTINIDIA* SP.) - A REVIEW

Larisa Theodora ȚILINCĂ, Florin STĂNICĂ

University of Agronomic Sciences and Veterinary Medicine of Bucharest,
59 Mărăști Blvd, District 1, Bucharest, Romania

Corresponding author email: tilinca_larisa@yahoo.com

Abstract

The origin of most kiwi plant species is located mainly in Yangtze River Valley in the North Eastern part of China. At the beginning of 20th Century, seeds brought from China have been used by Hayward Right, a nursery man from New Zealand, to obtain the first hybrids plants and respectively, first selected cultivars, including Hayward the most cultivated genotype in the world. Later on, together with the extension of kiwifruit crop on several continents, breeding works started in the other countries. New Zealand remained at the forefront of breeding activity and, at the 90's released the first yellow flesh kiwi Hort 16A - Zespri Gold. Other cultivars were obtained in Italy, USA, China, etc. In countries with a colder climate, kiwiberry (A. arguta) has become popular and breeding programs were carried out in New Zealand, Italy, China, Poland, Belgium, and Romania. In addition to public breeding programs, many private ones are active. The review presents the main kiwifruit breeding achievements.

Key words*: cultivars, yellow flesh, crossings, kiwiberry.*

INTRODUCTION

The kiwi plant comes from the North East of China, mainly from the Yangtze-River valley (Sachin, 2015) and the coast of Zhejiang Province.

After the introduction in New Zealand of *Actinidia deliciosa* seeds brought from China, by a young lady named Isabel Fraser, a local nurseryman, Hayward Wright, obtained the first hybrids and started the selections works. Also there, the new fruit plant received the name of kiwi, after the national bird, symbol of New Zealand (Mishra and Shukla, 2014).

In countries with a colder climate, kiwiberry (*Actinidia arguta* Chev. & Zucch.) has become recently popular. First kiwiberry cultivars were created by Ivan Vladimirovici Miciurin in Russia in the first half of the 20th century. His cultivar Annanasnaja, is known also under the name of 'Michurin's Pineapple' (Strik and Hummer, 2006).

Many cultivars were obtained in Italy, China, Poland, Belgium, New Zealand and recently are in vogue creations with red pulp like Hongyang (Red Heart) in China and Rubyred™ in New Zealand. Important achievements were also obtained for *Actinidia deliciosa* in USA, Italy, China and Romania.

Currently, *Actinidia* species are frequently cultivated in New Zealand, China, Japan, Greece, Chile, Italy (Testolin, 2015) and recently, in Romania (Peticilă et al, 2015).

3rd place in the top of the big kiwi producers, Italy recorded a production of 416,060 tons, after China with 2,380,787.59 tons and New Zealand with 628,496.41 tons. (FAOSTAT).

Recognized for their health benefits (Saliyan et al, 2017), rich Vitamin C content and nutrient intake (Richardson et al, 2018), kiwi fruits can be eaten fresh or in different preparations (https://www.kiwifruit.ir/homegapes/kiwifruit2/kiwi-products.html), the most popular being the fruits of *Actinidia deliciosa* (Drzewiecki et al., 2015).

The *Actinidia* genus includes over 76 species (Hamet et al., 2018), among which, we mention *A. deliciosa, A. chinensis, A. arguta, A. eriantha* and *A. kolomikta* species that are the subject of this review.

The aim of most breeding programs is to obtain new cultivars and selections, with increasing resistance to diseases and pests, with high quality fruits.

Table 1 shows some of the countries with kiwifruits breeding programs and their results.

Breeding programs

Together with the extension of the crop on several continents, the first breeding works also began in the cultivating countries. Kiwifruit knowledge was diffused mainly through ISHS International Symposia, until now, 10 dedicated to *Actinidia* being organized.

The first occurred in 1987, in Padua, Italy, and represented the launching pad for kiwi plants worldwide.

New Zealand was the forefront of breeding programs for many years, which at the beginning of the 90's released the first variety of *Actinidia chinensis* - Hort 16A - Zespri Gold (Ferguson & Stanley, 2003) (Table 1).

Zespri Gold was the first important step for the promotion of kiwifruits with yellow flesh (Martin and Luxton, 2005). New Zealand also release several *Actinidia arguta* cultivars as: 'Hortgem Tahi', 'Hortgem Toru', 'Hortgem Wha', 'Hortgem Rua' (Advances in food and research, volume 52).

Within the breeding programs, **Italy** obtained cultivars such as 'Autari' (*A. deliciosa*), 'Soreli' and 'Belen' (*A. chinensis*).

In 2006, CRA-FRU Centro di Ricerca per la Frutticoltura developed an important breeding program in which the cultivars were studied Hort 16 A, 'Jintao' (*Actinidia chinensis*) and 'Hayward', 'Green Light', 'Summer kiwi' (*Actinidia deliciosa*), as well as selections of male and female plants of these two species (Conte *et al*, 2011). Before the introduction of the 'Jintao' cultivar in Europe, other fewer known selections were brought as well as the 'Lushan' and 'Kuimi' cultivars which unfortunately did not meet the conditions required by the specialists (Cipriani and Testolin, 2006).

Another breeding program took place at in **China** at Wuhan Botanical Garden, Chinese Academy of Sciences starting with 2002. This was aimed at obtaining new cultivars and selections of *Actinidia chinensis*, by crossing male and female plants of the same species. At the end of the program, the 'Jinmei' was obtained, and in 2014 it was approved by National Forestry Cultivar Approval Committee (Zhong, C. et al, 2018). In 2011, the cultivar 'Guichang' (*A. deliciosa*) was registered.

In 2014, **Korea** obtained Goldone which represent an important cultivar belonging to the *A. chinensis* species (Kwack et al., 2017). Another important cultivar is Chiak which belongs the *A. arguta* species (Advances in food and research, volume 52).

Two other lesser-known species of *Actinidia* spp. are *Actinidia eriantha* and *Actinidia kolomikta.*

Actinidia eriantha was introduced from China to Korea through Sungkunwan University (Kiwifruit, 2016). In 1997, a breeding program was also initiated with the obtaining of seedlings through the interspecific crossing of seeds, and a year later they were planted at the Wando Station. In 2003, following the selections, 'Bidan' cultivar was obtained, and was registered by Korea National Seed Management Office. Although the specie is less known, 'Bidan' cultivar is appreciated for its nutraceutical properties (Jo et al, 2007)

A. kolomikta was studied at the University of Agriculture, Kaunas, **Lithuania** since 1988. This is also where the 'Laiba', 'Lanke', 'Lande', 'Paukstes Sakarua' cultivars were obtained (Pranckietis et al, 2009).

In **Turkey**, kiwifruit was brought for the first time in 1988 at Ataturk Horticultural Central Research Institute, for scientific purposes. The first breeding program started in 2008 and had as main objective the study of several cultivars as 'Hort16A',' Hayward', 'Jintao', 'Topstar', as well as other numerous genotypes (Atak et al, 2018).

At the same time, the development of research programs for kiwi continued (Atak, 2015) and in 2018, the cultivar 'Ilkaltin' (*A. chinensis*) was obtained. (https://arastirma.tarimorman.gov.tr/yalovabahce/News/80/The-First-Kiwifruit-Cultivar-Of-Our-Country-Was-Registered-Under-The-Name-Ilkaltin).

The first kiwi crop in **Romania** was established in 1993, in Ostrov, Constanța county, and the first species cultivated was *Actinidia deliciosa* Chev (Stănică, 2009). Since then, a Romanian-Italian breeding program was started and several *A. arguta* cultivars as 'Jumbo', 'Rosana', 'Francesca' were used for crossings (Stănică et al., 2004) (Table 1).

The Faculty of Horticulture in Bucharest, in collaboration with Vitroplant Italia from Cesena, continued in the following years, the selection of kiwiberry hybrids, and in 2017, two elites were patented: R8P23, with green

flesh, became the 'Vip Green' cultivar, and R9P20, with red flesh became the 'Vip Red' cultivar.

The two cultivars proved to be resistant to diseases and pests as well as frost and were registered at CPVO, Angers (Stănică et al, 2007).

From the same breeding program, following the crossings of *Actinidia deliciosa* and *Actinidia chinensis*, valuable inter- and intra-specific hybrids were obtained. Four of the selected elites were introduced into culture (Stănică et al, 2022), and on 30 March 2023, they were registered under the name of 'Kisweet' (R0P13), 'Kiball' (R1P9), 'Kigiant' (R1P12) and the male 'Kiflor' (R2P8).

At the same time, two kiwiberry cultivars were also registered: 'Ariana' (R8P1) and 'Andros' (R9P16) (Table 2).

In addition to public breeding programs, have recently been expanded private breeding programs in many countries.

Table 1. Countries with breeding programs and results obtained

Country	Year of registration	Species	Cultivar
New Zealand	1924	*A. deliciosa*	Hayward
New Zealand	1997	*A. deliciosa*	Zespri Green
New Zealand	1997	*A. chinensis*	Zespri Gold
New Zealand	1997	*A. chinensis*	RubyRed
New Zealand	1990	*A. arguta*	Nergi
China	2011	*A. deliciosa*	Guichang
China	2014	*A. chinensis*	Jinmei
China	2007	*A. chinensis*	Jintao
Korea	2003	*A. eriantha*	Bidan
Korea	2014	*A. chinensis*	Goldone
Korea	2014	*A. arguta*	Chiak
Italy	2001	*A. deliciosa*	Autari
Italy	2006	*A. deliciosa*	Green Light
Italy	1999	*A. deliciosa*	Summer Kiwi
Italy	2008	*A. chinensis*	Soreli
Italy	2015	*A. chinensis*	Belen
Italy	2012	*A. chinensis*	Dori
Lithuania	2009	*A. kolomikta*	Laiba
Lithuania	2009	*A. kolomikta*	Lanke
Lithuania	2009	*A. kolomikta*	Lande
Lithuania	2009	*A. kolomikta*	Paukstes
Lithuania	2009	*A. kolomikta*	Sakarua
Romania	2001	*A. chinensis*	Jumbo
Romania	2001	*A. chinensis*	Rosana
Romania	2001	*A. chinensis*	Francesca
Romania	2017	*A. arguta*	Vip Green
Romania	2017	*A. arguta*	Vip Red
Romania	2023	*A. deliciosa*	Kiflor
Romania	2023	*A. deliciosa*	Kisweet
Romania	2023	*A. deliciosa*	Kigiant
Romania	2023	*A. deliciosa*	Kiball
Romania	2023	*A. arguta*	Ariana
Romania	2023	*A. arguta*	Andros
Turkey	2018	*A. chinensis*	Ilkaltin
Poland	2010	*A. arguta*	Bingo

Table 2. Kiwifruit cultivars obtained in Romania

Country	Year of registration	Species	Cultivar
Romania	2001	*A. chinensis*	Jumbo
Romania	2001	*A. chinensis*	Rosana
Romania	2001	*A. chinensis*	Francesca
Romania	2017	*A. arguta*	Vip Green
Romania	2017	*A. arguta*	Vip Red
Romania	2023	*A. deliciosa*	Kiflor
Romania	2023	*A. deliciosa*	Kisweet
Romania	2023	*A. deliciosa*	Kigiant
Romania	2023	*A. deliciosa*	Kiball
Romania	2023	*A. arguta*	Ariana
Romania	2023	*A. arguta*	Andros

CONCLUSIONS

In addition to recognizing the merits of researchers, breeding programs also support farmers by creating new valuable cultivars to be introduced into production.

Thanks to breeding programs, the evolution of *Actinidia* sp. from their origins to the present has become easy to follow.

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