# SUMMARY

of the doctoral thesis entitled:

## RESEARCH ON THE MORPHO-PRODUCTIVE TRAITS OF NEW *LYCIUM* SP. BIOTYPES

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**KEY-WORDS:** *Lycium barbarum* L., *Lycium chinense* Mill., breeding, food cultivars, nutritional quality

The analysis of specialized sources shows the interest in the goji shrub which is becoming more and more popular as a food, acquiring the attribute of "super-fruit". This trend has motivated researchers and growers to develop new varieties, which ensure on the one hand a better adaptation to the specific climatic conditions of the cultivation areas and on the other hand the correlation of the edible characteristics of the fruits (size, shape and resistance) with the commercial requirements of consumption and delivery, but also maintaining a higher level of nutritional intake and content in active biocompounds, which serve the nutritional requirements of a balanced diet and additionally provide therapeutic benefits.

Obtaining some performing varieties of *Lycium* sp., in the culture conditions of our country, is opportune in the context of an unprecedented increase in consumer appetite for goji fruits and processed products. Species of the genus *Lycium* are exploited globally for food or medicinal purposes. Goji berries provide between 349 kcal per 100 g of dried fruit and are recognized for their high content of vitamins, minerals and active compounds.

Goji was first introduced to Europe in the 18th century, but in recent decades, Chinese authorities have invested in research on *Lycium* sp. and promoted their benefits in the West. As a result, the species *Lycium barbarum* and *Lycium chinense* have attracted the attention of growers in South-Eastern Europe, especially Romania and Bulgaria, as well as southern Europe such as Italy and Portugal. Prior to the intensification of this phenomenon on the territory of our country, the species of the genus *Lycium* sp. have been described by specialized literature as a plant exploited for ornamental purposes (hedges) with invasive potential. The geographical origin of goji berries is important for their quality, as the chemical composition is influenced by the growing conditions. For

example, higher altitude, lower temperatures and a longer photoperiod are favorable for the accumulation of active compounds in fruits.

Doctoral thesis with the title "Research on the morpho-productive characteristics of new biotypes of *Lycium* sp." presents the results of the research carried out on a mini collection of goji biotypes with the aim of obtaining some table varieties adapted to the specific conditions of the south-eastern area of Romania, with superior fruits in terms of size, nutritional quality, with superior organoleptic properties and with increased production capacity.

The thesis is structured in two part, consisting of 6 chapters. The first - Chapter I (30 pages), presents the stage of knowledge on the research theme with the aim of documenting the need for research through the prism of the importance and uses of the species of the genus *Lycium* sp., which justifies the increased interest of consumers and growers for the fruits of goji shrubs.

Part II, structured in 5 chapters (149 pages), presents the objectives of the research, describes the biological material used and the working methods - Chapter II. The goji breeding carried out in this research pursued the following directions: (1) Enrichment of the initial material by creating a small collection of goji biotypes and (2) Conducting directed hybridization works to create hybrid populations with *Lycium barbarum* x *Lycium chinense* interspecific hybrids, *L. chinense* x *L. barbarum* as well as intraspecific hybridizations between *L. barbarum* x *L. barbarum* and *L. chinense* x *L. chinense*, to obtain superior fresh fruit varieties through selection. In 2015, Biotypes 1, 2 ('Bucur') *Lycium barbarum* L. and 410 ('Sara') *Lycium chinense* Mill. were planted in the experimental field, constituting the initial source of biological material. In 2015, seeds of another biotype (BUA) belonging to *Lycium barbarum*, as well as seeds from China of 4 other biotypes of *Lycium chinense* (Zhong, S, AS and C9) were sown, the latter being planted in 2018. In 2016 and 2018, improvement works (directed hybridization) were carried out in the mini-collection of goji biotypes to create interspecific hybrid populations using *L. barbarum* x *L. chinense* as well as intraspecific hybridizations between *L. barbarum* x *L. barbarum* and *L. chinense* x *L. chinense*. Using 6 parental genotypes: 410 ('Sara'), B2 ('Bucur'), S, AS, C9 and B1, 272 hybrid progeny were obtained from 12 hybrid combinations (B2 ('Bucur') x 410 ('Sara '), 410 ('Sara') x B2 ('Bucur'), B1 x 410 ('Sara'), 410 ('Sara') x C9, C9 x 410 ('Sara'), AS x B2 ('Bucur'), C9 x AS, AS x C9, S x B1, B1 x B2 ('Bucur'), B2 ('Bucur') x C9, B1 x AS), of which 140 were selected for replanting permanently in the field, 42 hybrids were eliminated, not adapting to the conditions, resulting in 98 hybrid descendants as biological material subject to research. In order to achieve the proposed objectives, phenological observations were made regarding flowering and ripening of fruits, biometric determinations of leaves and fruits and biochemical analysis for each parent and hybrid. The statistical analysis of the data was carried out by unifactorial dispersion analysis (One way ANOVA), the DL test and the genetic analysis of variance.

Chapter III presents the natural framework for carrying out the research, highlighting the pedological and agrochemical characteristics of the soil, as well as the climatic conditions specific to the research period. The research took place within the Doctoral School: Engineering and Management of Plant and Animal Resources from U.S.A.M.V. from Bucharest. The research was located in the north of Bucharest, within the U.S.A.M.V. Bucharest campus, using 3 experimental locations belonging to the Faculty of Horticulture.

Chapters IV and V present the results of research, differentiating between the main phenological phases (flowering and ripening of fruits), productivity elements, biometric characteristics (leaves and fruits) and biochemical analysis of *Lycium* sp. (Chapter IV) and performing the same determinations on the hybrid progeny obtained from the 12 hybrid combinations (Chapter V). Based on the results obtained, conclusions and recommendations regarding the selection of elite hybrids with superior fruits in terms of size and nutritional quality are formulated in Chapter VI.

From the analysis of the main phenological phases of the genitors, it was noted that in 2022 the flowering period of the parental genotypes varied between 61 and 89 calendar days, and in 2023 it varied between 42 and 74 days, with the onset occurring towards the end of the second decade of May, respectively the beginning of the third decade. In terms of fruit weight and height, the parent 410 ('Sara') stood out in both years, with the best results (with values of 0.54 g - 0.61 g in terms of average fruit weight and values of 16.82 mm – 19.32 mm in terms of fruit height), superior to the other parental lines, and by the number of seeds and the weight of seeds per fruit, the AS and S parents stood out, with the lowest values. Genotype 410 ('Sara') was also the most valuable for its content in chemical biocompounds: vitamin C (36.81 mg/100 g), polyphenols (1,710.01 mg GAE/100 g), flavonoids (175, 93 mg/ 100 g) and carotene (22.44 mg/ 100 g). In contrast, parent B1 had the highest content of fat (11.55 g%), total nitrogen (5.14 g%) and crude protein (32.13 g%), and parent B2 ('Bucur') was noted for its higher carbohydrate content (55.7 g%). Biotypes S, C9 and AS are recommended for low number of seeds per fruit.

For goji hybrids in 2022 as well in 2023, the beginning of flowering took place at the end of the second decade of May, ending in 2022 mainly on August 20, continuing in some hybrid combinations until September 1. In 2023, in most hybrid combinations, flowering ended on August 1. When comparing the two years, it is particularly clear that the hybrids' productivity was impacted by the longer fruiting period, albeit the shrubs' maturity also played a role. Thus, the year 2023 (when the hybrids were in the second year of cultivation) stood out with a more pronounced fruiting. From the 98 hybrid progenies obtained in different hybrid combinations, there were hybrids superior to the parental lines in terms of fruit weight, biometric and biochemical characteristics. Of major interest were the hybrid progeny with productivity, biometric and biochemical characteristics superior to the parental lines, with the best results, respectively 410 ('Sara'), B1, B2 ('Bucur') as well as the AS and C9 parents.

Thus, hybrids 16.40, 16.51, 18.18 from the hybrid combination B2 ('Bucur') x 410 ('Sara') were noted with superior values of fruit production, fruit weight, diameter and fruit height in relation to the maternal parent 410 ('Sara') '). The highest fruit production obtained in 2023 was recorded by hybrid 18.18 (243.10 g). Compared to the parental lines, higher yields were also recorded in hybrids 16.39 (176.72 g), followed by 16.40 (156.88 g). Genotypes 18.18 and 16.39 brought highly significant increases over the parents. Hybrid 16.40 adds value to the chemical composition of the fruit, ensuring superior antioxidant properties through the high content of polyphenols and flavones.

The progeny 18.57 and 18.59 from the cross B1 x 410 ('Sara') are also considered valuable. Hybrid 18.59 with a fruit weight of 0.61 g showed increases compared to the parental lines, followed by hybrids 18.57 and 18.60 which also obtained higher weights than the parents. Hybrid 18.59 is valuable for its content of polyphenols (1,391.21 mg GAE/100 g), total soluble carbohydrates (32.09 g%) and crude fat (12.47 g%), higher than the maternal line.

From the crossing of the B1 x AS parents, the hybrids 18.139 and 18.132 stand out, which bring increases in the values of the biometric characteristics of the fruits (fruit height, total diameter) and especially in the chemical composition, especially for the 18.139 hybrid, which is valuable due to its content in vitamin C, carotene and total soluble carbohydrates. Hybrids 18.132 (8.05 $cm^2$) and 18.139 (6.85 $cm^2$) are also distinguished by a larger leaf surface compared to the paternal variety AS (3.04 $cm^2$), but also to the maternal variety B1 (4.27 $cm^2$).

From the hybrid combination C9 x AS, hybrids 18.81 and 18.78 are valuable for the lowest number of seeds/fruit, but also among the lowest seed weight. The hybrids 18.82 and 18.92 are particularly noteworthy for a small fruit shape index, corresponding to an almost round fruit (1.44 hybrid 18.82 and 1.66 hybrid 18.92 in 2023), and hybrid 18.83 for a small shape index (1.67) and for the shape of the truncated fruit, with a small bevel near the tip, slightly resembling a hot pepper.

Analyzing the leaf surface of the hybrids obtained from the C9 x AS cross, the superiority of the hybrid offspring 18.82 with 7.74 $cm^2$, 18.83 with 7.59 $cm^2$ and 18.92 with 7.52 $cm^2$ can be observed, in relation to the parental genotypes C9 with 3.31 $cm^2$ and AS with 3.04 $cm^2$, appreciating that this indicator contributes to a large extent in the photosynthesis process.

The hybrid 18.98 belonging to the AS x C9 hybrid combination stands out for the lowest shape index (1.27) compared to the parents AS (1.74) and C9 (1.84) but also for the almost spherical shape of the fruit.

The hybrid progeny 16.40, 16.51, 18.18, 18.57, 18.59, 18.132, 18.139, 18.82, 18.83, 18.92, and 18.98 will be used as a new source for the continuation of the improvement process and for the transition to the following selection links (hybrid plots research), a step prior to the registration of at least two new varieties at ISTIS, according to the results of the analysis and selection of goji hybrids.