

SUMMARY
UNIVERSITY OF CRAIOVA
FACULTY OF HORTICULTURE

PhD THESIS

**RESEARCH ON FOOD VALUE OF SOME PLUM VARIETIES
GROWN IN ROMANIA AND THE POSSIBILITY OF
VALORIFICATION**

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**CRAIOVA
2016**

Keywords: plum, varieties, food value, possibility of revaluation.

PhD thesis „**RESEARCH ON FOOD VALUE OF SOME PLUM VARIETIES GROWN IN ROMANIA AND THE POSSIBILITY OF VALORIFICATION**” was realized in the Doctoral School of the University of Craiova.

Plum culture is a traditional activity for Romanian, being always regarded as an economic activity, profitable, an activity that has provided the necessities of life for many generations of fruit growers. Insufficient historical data does not allow a clear attestation of the period in which plum was taken in culture in our country. Its Latin name, plum - *Prunus*, induce the assumption that plum was known in Dacia even during the Roman rule.

The plum, as fruit tree species has a vast cultural area, due to its ecological plasticity. It can be observed mostly especially in the temperate and northern area, where it can be grown up to the parallel of 56 - 57°.

Culture area of the species is extended across all the continents, but most return areas are in Europe, Asia and North America. From all the structure producing countries, Romania ranks second place after Serbia and stood ahead of countries such as Germany, Hungary, Bulgaria, Poland or the US.

In this thesis, the study was conducted based on the consideration that the environment puts its mark on the characteristics of fruit production, printing its own character on the growing area. For this reason, the work aims to: study of biotope factors that ensure the expression of quantitative and qualitative potential of the varieties grown in that area; study the production potential and economic value of plum varieties grown in Romania, in the localities Bulzești county - Dolj and Mărăcineni – Arges county.

The thesis was conducted during 2010 - 2015 and is structured in accordance with the law, into two main sections: **Bibliographical study** (35 pages) and **Own research** (78 pages).

The first part of the thesis, **Bibliographic study**, is divided into two chapters and presented, in synthesis, information from national and international literature regarding the economic importance of plum culture, ecological requirements and the influence of environmental factors on fruit quality, principles of zoning and main directions of valorification of plums production.

Chapter I, „**PLUM CULTURE, SHORT HISTORY AND ECONOMICAL IMPORTANCE**” includes two subsections in which are presented aspects regarding the economic importance of plum culture, the current situation (surfaces and productions) of plum culture in the world and in Romania, the area of plum culture and requirements for environmental factors as well as plum zoning in Romania.

Chapter II, “**CURRENT STATE OF RESEARCH REGARDING FOOD VALUE OF PLUMS AND THE POSSIBILITY OF THE VALORIFICATION**” is divided into two subsections, which present quality standards and the main indicators for assessing the fruit quality, directions of plums valorification and the influence of pedoclimatic factors on fruit quality.

Chapter III, “**MATERIAL AND METHODS**” presents the aim of the study, biological material and method.

Thesis objectives are:

- Study of biotope factors that ensure the expression of quantitative and qualitative potential of the varieties grown in that area;
- Study of the yielding capacity and economic value of plum varieties grown in Romania, in the Bulzești area– Dolj county, and Mărăcineni area– Arges county.

The research was conducted during 2011-2015 period.

The research was realized in a holding fruit tree located within the locality Bulzești (Dolj). characterized by a consecrated assortment of varieties in fruit growing.

The researches have also been conducted in experimental fields of the Research and Development Institute for Fruit Growing from Pitesti (Mărăcineni) on an improved assortment with prospects of introduction into commercial plantations.

The fruit tree plantation from Dolj was established in 1987 and includes varieties such as Stanley, Anna Spath, Tuleu gras and Centenar, grafted on Otesani 8 rootstock planted at a distance of 5 m between rows and 3 m between trees in a row.

Field trial from RIFG Pitesti Mărăcineni was established in 2007 and comprises Romanian varieties as Agent, Albatros, Alina, Carpatin, Centenar, Pitestean, Record, Tita and foreign varieties as Kirke, Oneida and Valor, grafted on Mirobalan C5 rootstock, planted at a distance of 4 m between rows and 2 m between trees in a row.

Chapter IV, “**RESULTS**” is divided into 4 chapters.

Subsection 1 includes the presentation of edafic factor, the interaction of climatic factors in two locations: holding fruit tree of Dolj and Research and Development Institute for Fruit Growing Pitesti Mărăcineni. From the description of pedoclimatic factors results the both locations are favorable for plum culture.

Subsection 2 refers to results on the plum food value of varieties studied, given the ripening time, physical properties of fruit, average fruit weight, chemical composition and flesh firmness of fruit.

Thus, regarding the ripening time of fruits we can say that regarding the observations made in holding fruit tree of Dolj and in the Research and Development Institute for Fruit Growing Pitesti Mărăcineni found that the assortment studied provides a staggering of harvest and supply the market with fresh plums, and for canning factories, for a long time, from the third decade of July (Centenar, Carpatin, Albatros, Pitestean, Tita), to the first decade of September (Anna Spath).

In this subchapter were also evaluated the physical properties of the fruit: fruit shape, skin color and flesh, the adherence of stone to flesh.

Regarding the fruit shape, plum varieties studied had different shapes (spherical, ellipsoid and ovoid). In this aspect, the breeder has a possibility to choice the initial material for the cross combinations and to recommend for extension in commercial orchards of varieties resulting from Romanian breeding program.

To appreciate the fruit color of plum varieties studied have used several methods: visual assessment, the color code for cherries from CTIFL France and Konica Minolta colorimeter. Thus, the color varied from red fruit (Anna Spath, Agent, Tuleu gras) to dark blue (Centenar, Stanley, Pitestean). According to color code CTIFL, plum varieties studied were classified in group 4 (Anna Spath, Agent, Tuleu gras), 5 (Albatros, Alina, Carpatin Pitestean, Record, Tita, Kirke, Oneida, Valor) and 6 (Stanley, Centenary).

Analyzing the color of the fruit with Konica Minolta colorimeter, it can be observed that there are not significant differences between varieties. The mean value for L^* is 24.85, the values ranging from 21.00 (Kirke) and 29.26 (Alina), values which places the varieties on L^* axis closer to black colour. Regarding axis a^* , the values obtained show that there are significant differences between varieties. Thus, the average was +5.05, which means red colour, the highest values are recorded the variety Alina, +8.21 (fruit light blue), and the smallest variety Stanley, +1.33 (fruit dark blue). Regarding axis b^* , is found also that there are significant differences between varieties, most values being negative, indicating blue colour. The average value was -1.04, the highest values (positive) being to the varieties Kirke (+1.33) and Agent (+1.21) - varieties with fruits red and blue colour, while the lowest values (negative) recorded varieties Tita (-2.94), Stanley (-3.00), Centenar (-3.00) and Pitestean (-4.99), which are varieties with fruit blue and dark blue colour.

It is known that, with the approaching at ripening time, the varieties become more brightness (L^*), more red (a^*) and blue (b^*).

Regarding the degree of stone adherence to the flesh, on the market, is preferred varieties with freestone adherence to the flesh, but we must not forget that adherence to the

flesh is correlated with a high percentage of dry matter. The most varieties studied have free stone adherence to the flesh with the exception of four varieties (Agent, Albatros, Record, Valor) who have semi adherence stone.

The average fruit weight of varieties studied ranged from 35.12 g (Agent) and 70.06 g (Record). The varieties studied were classified in five classes:

- Class 5 - medium fruit (26-40 g) - two varieties: Agent, Tuleu gras;
- Class 7 - large fruit (41-55 g) - 10 varieties: Centenar, Stanley, Anna Spath, Kirke, Albatros, Oneida, Alina, Carpatin, Tita, Valor;
- Class 8 - large fruit (56-70 g) - 1 variety: Pitestean.
- Class 9 - fruit is extremely high (over 70 g) - 1 variety: Record.

For breeding works and for extension in commercial orchards, interested genotypes with large fruit. It is estimated that an amount of 40-50 grams is appropriate for a modern plum variety.

The variability coefficient of the character "fruit weight" was medium (16.49%), showing a middle variability of this trait, and therefore the possibility to choice an initial material for the next breeding works and also the possibility of recommendation for extension in commercial orchards of new plum varieties.

On holding fruit trees, it is noted that in Dolj, the largest fruit were recorded at old varieties Anna Spath and Stanley.

At the RIFG Pitesti Mărăcineni, the largest fruit (even higher than those of Dolj) were registered at varieties Oneida, Alina, Carpatin, Tita, Valor, Pitestean and Record (over 45 g), these varieties being extended in commercial orchards. They are highly appreciated by consumers.

Fruits soluble solids content is very important to plums, as well as to other fruits. From this trait depends the taste of the fruits.

After the determinations made at plum varieties studied, the average soluble solids content was 17.56%, amplitude was 14%, the highest soluble solids content being at the variety Agent (26.00%) in 2015, and the smallest at variety Albatros (12.00%) in 2011. It should be noted that the most varieties had more than 16% soluble solids, excepting four varieties (Albatros, Stanley, Pitestean and Valor). However all varieties were designated to fresh consumption, except the variety Agent who has mixed destination for fresh consumption, but especially for dehydration due to high content in soluble solids. The standard deviation values were medium 3.03%, the variability coefficient was 17.27% (medium variability).

Fruits content in useful substances influences the nutritional value of plums and clearly determines their taste. Both, table varieties and varieties of industrialization must have fruits rich in sugar and acidity, with a minimum of 1.5% acidity and over 8.5 to 9.0% sugar.

In our experience, total sugar, the main component of dry matter, ranged from 9.06% (Tita) and 12.89% (Agent) and has the advantage that over 90% of its content is the glucose and fructose, which are easily assimilated by the human body. The following varieties Anna Spath, Albatros, Agent, Carpatin, Centenar, Tuleu gras, Oneida, Valor, Record and Kirke had a total sugar content of more than 10%.

Plums are rich in organic acids, total acidity values ranging between 0.46% (Record) and 1.17% (Albatros and Kirke). For most varieties total acidity values were located around 1% value.

Tanoide and pectin substances have organoleptic role, contributing to the harmonization of taste closely with sugars and organic acids. The limits of variation in the composition of substances tanoide in the varieties studied were between 0.070% (Centenary) and 0.273% (Agent). The content of pectin substances ranged between 0.558 (Alina) and 0.956 (Tita).

The varieties studied had also variable ash content, ranging from 0.41 at Stanley variety to 0.58 for Agent variety.

In general, plums are recognized as a fruit rich in minerals, especially phosphorus and potassium.

Thus, the phosphorus content ranged from 15.77 mg% at Carpatin variety and 22.56 % for the variety Record, pointing out the rich in phosphorus the following varieties: Record, Oneida, Pitestean, Albatros, Anna Spath, Stanley and Tuleu gras.

Regarding the potassium content, it is ranged from 152.5 mg% at Carpatin variety to 245.7 mg% to variety Record. They are noteced by high content of potassium, very important element in the human diet, the following varieties: Record, Pitestean, Albatros, Centenar, Anna Spath, Tuleu gras, Kirke, Valor and Agent.

Regarding the calcium content, it was between 3.2 mg% at Record variety and 6.4 mg% for the variety Centenar.

Given the antioxidant role of anthocyanins and vitamin C in metabolism consumers, the varieties studied were analyzed from this point of view in the Chemistry Laboratory of the RIFG Pitesti Mărăcineni.

Thus, anthocyanin content ranged from 0.2 mg / 100 g at varieties Agent and Alina and 3.0 mg / 100 g at variety Stanley, the richest in anthocyanins are the following varieties Stanley, Centenar and Kirke.

Vitamin C content was very high in all varieties studied, ranging from 8.0 mg / 100 g at the varieties Anna Spath, Tuleu gras, Centenar, Agent and 9.3 mg / 100 g at variety Stanley.

To appreciate the flesh firmness, plum varieties were harvested at full maturity. Flesh firmness average has value 67.33 HPE units, the maximum amplitude variation being 13.40 HPE units, the lowest average value recorded variety Agent (59,50 units HPE) and the highest average value registered variety Stanley (72.9 units HPE). Given the classification made by Vangdal and Flatland (2010) in maturation groups according to the fruit firmness, Romanian plum varieties were divided into two groups: group 2 –beginning of ripening (fruits should not be harvest, if still harvest, they should be allowed a short period of time and then sold) and group 3 - optimum time of harvest (fruit is optimal stage of harvesting and marketing), which means that the following varieties Valor, Kirke, Tita, Pitestean and Stanley would have left a few days and then harvested.

Subsection 3 presents the results on the possibilities of valorification on fruit.

One of the methods for assessing the fruit quality and their possibilities of valorification is the sensory evaluation according to tastepanelspecific taste fruitspecies, where each character is appreciated by scores of 1-9.

Thus, samples of fruits plum varieties studied were submitted to tasting by a team of tasters made up of 10 people with different ages, professions and gender.

Sensory evaluation is an important tool to evaluate the market potential of plum varieties. Based on the marks scored in questionnaire, the best appearance (size, shape, skin colour and bloom) was obtained at Anna Spath, Centenar, Albatros, Alina, Carpatin, Pitestean, Record, Tita, Oneida varieties. A less appreciated appearance was noted for Stanley, Tuleu gras, Kirke and Valor varieties. The highest score for the intern characteristics of fruits were obtained the following cultivars: Anna Spath, Tuleu gras, Tita, Carpatin, Centenar, Pitestean, Oneida and Valor.

The highest value (general score) based on the tasters evaluation were noted for ‘Tita (64.4), and the smallest value at varieties Agent (50.5) and Albatros (51.5).

In general all varieties evaluated had a very good score, being recommended for fresh consumption. Exception is Agent variety, which because it contains high soluble dry matter can be sold both as fresh fruit as well as fruit dehydrated.

Subsection 4 presents the results of the yielding capacity and economic value of plum varieties studied in two locations.

In our experience the average fruit production ranged from 13.04 kg / tree in 2011 at 17.67 kg / tree in 2015. The standard deviation ranged between 2.07 in 2011 and 2013 and 3.46

in 2015. The variability coefficient ranged from 13.95 in 2013 and 19.57 in 2015 this values showing a middle variation.

Analyzing the average production of fruit per each varieties for the experimentation period and for two locations, it is found that the lower fruit production in kg / tree registered Agent (10.34 kg / tree) and Albatros (10, 64 kg / tree) varieties, and the highest production was registered Pitestean and Stanley varieties (18.52 kg / tree). Also, it was also marked by high yields (above 15 kg / tree) Centenar, Alina, Oneida, Valor, Tuleu gras, Record and Tita varieties.

On the holding fruit trees are found that in Dolj fruit production ranged from 14.20 kg / tree in 2011 at 18.07 kg / tree in 2015, when in the RIFG Pitesti Mărăcineni, production was a little more small, ranging from 12.62 kg / tree in 2011 at 17.67 kg / tree in 2015. This small difference between the two holdings can be explained by the fact that plantation from Dolj is a little more old (year of establishing 1987) and the plantation from Mărăcineni is beginning bearing, established in 2007. It also recorded the highest production variety Stanley (18.52 kg / tree) in plantation from Dolj, self fertile variety, knowing from literature that the self fertile varieties are more productive. The same amount of fruit per tree was registered at Pitestean (18.52 kg / tree) variety in plantations from RIFG Pitesti Maracineni, male sterile variety, but higher production is cross-pollination effect.

In general, most plum varieties are destined for fresh consumption, but are also suitable for the intensive culture. This means that these fruits can be sold at a much higher price. The economic value of these varieties, suitable of modern culture, exemplified by a comparative study at RIFG Pitesti Mărăcineni in a classic orchard and intensive one.

Thus, in a modern plantation plum, 1 hectare, although the value of the investment is very high compared to conventional plantation, return on investment is after only 9 years comparative 16 years for a plantation classics. Operating costs in a plantation with modern technology, although much higher than in a classic plantation technology followed by a production value of the commodity higher. In conclusion, the profit resulted in the two plum orchards, 1 hectare each, it is very high in case of application of modern technology culture to applying conventional technology.

Technical and economic study conducted that the production in modernized version is almost 3 times higher. Even if total costs are higher, valorification of production at the same price leads to the realization of very high taxable income, which enables a very high annual profit.

Also, it appears that the production cost is reduced by 48% in plum technological modernized version.

Chapter V "**CONCLUSIONS**", contains the general conclusions formulated in the course of experiments, conclusions that emerged from the presentation of results from each chapter and subchapter.

You can say that, a modern assortment for fresh consumption, resistant to disease, to which apply a modernized technology aims at increasing economic efficiency in plum plantations in Romania.