ABSTRACT

Research undertaken in this paper make the connection between informations presented in consulted specialized literature and own measurements in the specific area of Iasi.

The study aimed to determine the physical, chemical and technological aspects of fruits from 12 sweet cherry cultivars and to establish the correlation of these features for use in fresh consumption or industrial processing.

These correlations were followed in experimental plot from Fruit Growing Research Station Iasi for a period of three years, respectively in 2007-2009 period.

The main objectives were:

- Study of physico-chemical variability and technological parameters of cherry fruit under the influence area of Fruit Growing Research Station Iasi.
- Identify the newly created main cultivars and promoted them in sweet cherry culture to diversify the assortment of area.
- Establishing directions for use of the analyzed cultivars on the basis of their physico-chemical and technological properties.
- Testing consumer preferences for both fresh and processed sweet cherry consumption.
- Development of recommendations on the use of studied cultivars for further research and for production.

Doctoral thesis titled "Studies about Technological Features of Sweet Cherry Cultivars for Fresh Consumption and Processing" is divided into eight chapters summarized below.

In Part I "The actual stage of knowledge on fruits technological characteristics of some sweet cherry cultivars " are contained in Chapters I, II and III. In Part II, named "Own contributions on the analysis of physico-chemical and fruits technological characteristics of some sweet cherry cultivars" are presented the original data and results of observations and experiments contained in Chapters IV, V, VI, VII, VIII and references. Chapter I titled "The importance of sweet cherry culture and range area", includes three chapters describing the food value of sweet cherries, a brief history and current situation of sweet cherry culture.

Chapter II titled "Assortment and new sweet cherry cultivars created in the world and from Romania ", includes three sub-chapters in which we show sweet cherry cultivars created

in recent years in Europe and elsewhere and new cultivars created in Romania. Also in this section we present the main sweet cherry cultivars grown in Romania with foreign or native origin.

In Chapter III "Research of the current stage about physico-chemical and technological features of fruits at sweet cherry tree" we made a synthesis of specialized literature concerning the physical features, chemical properties and technological characteristics of fruits of sweet cherry tree.

The special part begins with Chapter IV "The purpose, objectives, material and method of research" are presented in four sub-chapters the purpose and objectives for research, the biological material used, method of research and how it was achieved statistical processing of experimental data.

In chapter V, titled "Natural and institutional conditions where the research took place" are presented geographical location, relief characteristics, hydrological characteristics, soil characteristics, agro-climatic characteristics and institutional conditions of fruit growing research station iasi.

Chapter VI, "Experimental research" contains the obtained data and their statistical interpretation in three sub-chapters which are structured according to the type of followed parameters at studied sweet cherry cultivars.

Thus, section 6.1. contains the results of the physical characteristics of the fruit, such as equatorial diameter, fruit mass, stone size and the stone : fruit ratio.

Equatorial diameter of the studied fruits of sweet cherry cultivars was influenced by local climatic conditions and biological characteristics of each cultivar. Therefore, this parameter has been studied both during all experimental period and the dynamic on maturation period.

In statistical terms, throughout the period studied, most valuable cultivars of fruit size were *Golia, Bucium* and *Boambe de Cotnari*, which showed average values between 22 and 22.17 mm in equatorial diameter, the differences between them and all other cultivars being significant. Of early cultivars, the most valuable has been *Catalina* and *Bigarreau Burlat*, and of bitter cherry cultivars, *Galata* recorded the highest fruit size throughout the studied period.

Fruit mass is a parameter that is also influenced by local climatic conditions and biological characteristics of each cultivar. As average values for the period 2007-2009, the heaviest fruits had *Boambe de Cotnari* with 7.01 g, followed by *Bucium* (6.6 g), *Van* (6.5 g) and *Golia* (6.59 g), the last with significant difference to *Boambe de Cotnari* but non-significant differences between them. The cultivars studied were followed during the ripening

period every 6 days and a continuous growth of fruits was seen from an interval to another. Thus, it was observed that the differences from one phase to another are significant at *Ştefan* (3.3 g, 4.73 g, 5.69 g and 7.25 g respectively) and *Galata* (1.57 g, 2.74 g, 3.46 g and 4.23 g respectively), while *Bucium, Tereza* and *Golia* had an non-significant increase in fruit mass between phase III and IV. Therefore, these cultivars could be harvested in phase III of maturation.

During years 2007 – 2009, at studied cultivars, the stone size had values ranging from 0.1 g (*Cetățuia,* in 2009) and 0.52 g (at *Bucium,* in 2007) and the values of fruit / stone ratio was between 11.15 (at *Bucium,* in 2007) and 36.24 (at *Maria,* in 2009).

Chromatic characteristics of fruits of studied sweet cherry cultivars shows luminosity values ranging from 90.6, at *Boambe de Cotnari,* to 73.8, at *Golia*. Among the color parameters the parameter a* (red-green axis) presented absolute positive values ranging from 21.58 (*Boambe de Cotnari*) and 49.24 (*Golia*), which indicates an important content in red pigments. Parameter b (yellow-blue axis) presented absolute positive values ranging from 4.87 (*Boambe de Cotnari*) and 15.93 (*Golia*), which suggests the presence of small amounts of yellow pigments.

In section 6.2., we presented data obtained on the chemical properties of fruits of studied sweet cherry cultivars. Throughout the period of experimentation, most valuable cultivars in terms of soluble solids content were *Galata*, *Maxut* and *Boambe de Cotnari,* which showed mean values between 17.9ºBrix and 18.63ºBrix.

Reducing sugar content recorded different values for the studied cultivars, being registered an average of years experience between 8.4 g% (*Galata*) and 13.25 g% (*Maxut*). As average values of titratable acidity during the all period of experiment, *Bigarreau Burlat* recorded the lowest values (0.56 g malic acid / 100 g fresh fruit), while *Maxut* recorded the highest values (0.99 g malic acid / 100 g fresh fruit). The reducing sugars content and titratable acidity ratio showed values between 8.93 at *Van* (in 2008) and 26.0 at *Bigarreau Burlat* (in 2009), this being an important parameter that determines the fruit's taste and which is strongly influenced by climatic conditions of each year of harvest.

At cultivars taken under study we also performed analysis of total phenolics content, that plays an important role in determining the taste and aroma of sweet cherries and has an antioxidant properties with anticancer effect. The highest values of total phenolics were recorded at *Golia* and *Cetățuia* (13.41 and 13.16, respectively) and lowest values were recorded at *Cătălina* and *Tereza* (7.58 and 7, respectively).

Antioxidant capacity was falso determined at sweet cherry cultivars. It was observed that this parameter is determined by biochemical characteristics of each cultivar. Thus, redox potential expressed by rH recorded values which indicate that *Ştefan, Maria*, *Cetăţuia, Bucium, Golia* and *Boambe de Cotnari* have a reducing character.

Antioxidant capacity of fruits can be determined by using a synthetic free radical (like DPPH - 1,1 diphenyl - 2 - picrilhidrazil) that can be neutralized by hydroalcoholic solutions and the highest value of antiradical capacity was registered at *Cetăţuia* with 1/158 ED_{50} while *Tereza* with 1/49 ED_{50} had the lowest value.

The antioxidant activity was also determined using the method ACW (antioxidant capacity in water solutions) with the Photochem system at all samples in the hydrophilic extract samples. In this way the antioxidant activity were recorded between 4.2 mg ascorbic acid equivalent / 100 mL extract (at *Bucium)* and 18.6 mg ascorbic acid equivalent / 100 mL extract (at *Ştefan*). Average values of studied sweet chrries cultivars was 10.2 mg ascorbic acid equivalent / 100 mL extract.

For more completed characterization of sweet cherry cultivars under study we determined individual anthocyanins and phenolics compounds by high performance liquid chromatography with diode array detector method (HPLC - DAD). These compounds have beneficial effects on the human body so are carefully studied in recent years in the professional literature.

At the bitter cherry cultivars (e.g. *Maxut* and *Galata*) the syringic acid was recorded in much higher content compared with some sweet cherry cultivars (e.g. *Boambe de Cotnari, Golia* and *Ştefan*). At *Tereza*, *Bucium, Van* and *Cetăţuia* that are also sweet cherry cultivars, this compound was not detected at all. Syringic acid has received special attention in recent research due to its blood sugar regulating properties.

Hydroxycinnamic acids represent a major category of polyphenols which are present in sweet cherries, the most valuable cultivars of this view being *Bucium, Ştefan* and *Boambe de Cotnari*. By analyzing anthocyanins compounds in different sweet cherry cultivars in different years, it was observed that some compounds are not consistently identified or are below limit of detection for the method used. Thus, peonidin-3-glucoside was detected in 2008, even if in a smaller amount compared with other compounds at *Boambe de Cotnari*, *Bucium, Ştefan, Tereza, Cătălina, Golia* and *Maria*. However, samples taken in 2009, peonidin-3-glucoside was identified only at *Tereza* and *Maxut* and only in a very small proportion.

In section 6.3., are presented data from the technological features of the studied fruits sweet cherry cultivars. As ripening period, the cultivars under study required 32 - 66 days between full bloom and maturity. Ripening period was extended from May 20 and June 28 at the 12 studied sweet cherry cultivars thus achieving a varietal conveer from period of 40 days.

Another important parameter that determines the quality of fruits at sweet cherry tree is resistance to deformation, which shows the degree of elasticity of tissues. A great resistance to deformation has sweet cherry cultivars membership in the group of type *Bigarreau.* In this regard we propose a mechanical device for measuring the resistance to deformation of the fruits, which can be used with different types of mass applied to various fruit tree species or grapes. Among cultivars, *Maria* and *Bucium* was the most resistant to deformation at all stages of maturation and recorded significant differences from other cultivars.

Uniformity of fruit size is an essential element of the classification standards by quality categories for sweet cherries marketing for fresh consumption, so in paragraph 6.3.3. can be found data on this parameter. Throughout the experimental period were noted uniformity with over 80% of fruit's size in the same category at *Galata* (93.3% fruits from 16-18mm), *Maria* (85.7% between 20-22 mm fruits), *Tereza* (83.3% fruits between 18-20 mm) and *Golia* (80% fruits between 20-22 mm).

Paragraph 6.3.4. describes the data obtained in tests organized in specialty commissions but also directly to consumers, the latter being made in public spaces. So, in June 2008, we organized in Central Market Iasi a 'consumer test' on sweet cherries samples which was attended by 61 persons of both sexes with ages between 14 and 70 years. In this test, in the general appreciation of the tasters, *Bucium* was the most preferred cultivar with an average score of 4.3 from a maximum of 5.

Subsequently, in 2009, at 5 of the 12 studied cultivars, we performed as canned fruits processing, in industrial flow technology to the SC Contec Foods SRL Tecuci. Samples of these canned fruits were usedin a 'consumer test' at university restaurant. Taking into account all the parameters of the test track, compote made of *Maria* cultivar was most appreciated by consumers, achieving average score of 4.19 to fruit's parameters and 4.29 of syrup parameters.

Chapter VII shows the relationships between determined physico-chemical parameters of fruits. There was a significant positive relationship between physical characteristics which determine fruit's size, as average mass and equatorial diameter, respectively. By correlating these parameters from all studied sweet cherry cultivars (mean values 2007-2009), a

coefficient of determination of 0.9796 was obtained, which means that a increasing equatorial diameter determines a corresponding increase of fruit mass. It was also noted that there is a positive relationship (r^2 = 0.2485) but statistically non-significant between fruit mass and stone mass (average of all cultivars throughout the entire experimental period). By correlation between the parameter a* of colour (red + to green -) and phenols content (expressed by polyphenolic index D_{280}), analyzed as the average of all cultivars, we observed a direct and distinct significant relationship, which means that the sweet cherry cultivars with darkish colour of fruits have a higher content of phenols. In addition, correlating values of phenols content with anthocyanins content values,obtained from studied sweet cherry cultivars, it was observed a positive distinct significant relationship (r2 = 0.8657) these results being in accordance to similar studies from the literature. The relationships between phenols content, anthocyanins content and antioxidant capacity were also tested and an interdependence between these three features was shown. Thus, testing the correlation between phenols content expressed as ED_{50}, with antioxidant capacity we found that these values are in positive distinct significant relationship (r^2 = 0.6212), so sweet cherry cultivars with a higher content in phenols have a higher antioxidant capacity. Also, by testing the relationship between anthocyanins content and antioxidant capacity we observed that there is a directly significant interdependence of these parameters (r^2 = 0.435).

From all these tested relationships, it can be concluded that the darker sweet cherry cultivars, and therefore with an higher values of the parameter a* of colour, are rich in compounds which determines an antioxidant capacity, and they can be recommended in specific therapeutic diets.

After studies on technological and physico-chemical characteristics of fruit at the analyzed sweet cherry cultivars we consider the following recommendation:

A) For research:

1. Among the studied cultivars are important **for breeding research** as follows:

- Early ripening and very good fruit's qualities – *Cătălina* and *Bigarreau Burlat*;
- Very good fruit's qualities - *Boambe de Cotnari, Van, Bucium, Maria, Golia*;
- Special qualities for processing - *Galata, Maxut* and *Maria*.

2. Establishment of the most valuable cultivars **in terms of therapeutic effect**, must be based on detailed analysis of the fruits, in order to quantify precisely of the compounds with antioxidant role.

B) For production:

1. Promoting as regards the extension of cultivated areas with new sweet cherry cultivars with different ripening period but with special properties of fruit's qualities:

- For fresh consumption: *Cătălina, Bucium, Maria, Golia*;
- For processing as jams with yellow bitter cherries: *Galata*;
- For processing as jams with black bitter cherries: *Maxut*;
- For processing as bitter cherry liqueurs: *Maxut*;
- For processing as canned fruits: *Maria*.

2. Maintenance in sweet cherry culture the established cultivars of foreign origin, valuable: *Bigarreau Burlat, Van*.

3. Maintenance in sweet cherry culture of *Boambe de Cotnari* along with other valuable cultivars of autochthonous or foreign origin.