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The Evaluation of Sweet Cherry Genotypes Resistance to Coccomyces Blight According to the Leaf Biochemical Characteristics

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Abstract

Objective: In the article experimental data of sweet cherry genotypes leaf apparatus studying according to biochemical characteristics (chlorogenic and ascorbic acids quantitative content) are given and the breed characteristics of the parameters under study are identified.

Methods: Thirteen sweet cherry genotypes from the collector plantations of Federal State Budgetary Scientific Institution "All-Russian Horticultural Institute for Breeding, Agro technology and Nursery", Russia, Moscow with different resistance to Coccomyces blight were studied. For the research fully shaped leaves from the middle part of one-year whips were taken. The quantity of chlorogenic and ascorbic acids was determined via highly efficiency liquid chromatography method.

Results: The experimental data of sweet cherry genotypes leaf apparatus studying according to biochemical characteristics (chlorogenic and ascorbic acids quantitative content) are given and the breed characteristics of the parameters under study are identified. There is an interconnection (R=0.99) between ascorbic and chlorogenic acids in the sweet cherry leaves resistant to Coccomyces blight.

Conclusion: The carried-out analysis is determined that can be used for the development of diagnostic method to identify sweet cherry resistance to environmental biotic factors and for the formation of new approaches to selection process speed-up.

Keywords: Sweet cherry; Coccomyces blight; Ascorbic acid; Chlorogenic acid

Introduction

Sweet cherry is the plant of a moderate climate. It is grown practically on all the continents. Sweet cherry fruit are of all colour palettes: berries differ from one another with pigmental substances content and sugars and organic acids percentage ratio [1]. Nutritive substances contained in sweet cherry are especially useful for children; they are provitamin A, vitamins C and P, group B, nicotinic acid, and a lot of P, Ca and Fe. Sweet cherry fruit are not only tasty, but they are also dietary and can render real assistance at kidneys and hepar diseases, hypertension, arthritis, gastritis and anemia [2,3]. However, nowadays sweet cherry plantations in Russian midland are in disastrous state because of the fungus disease – Coccomyces blight. To speed up the selection process and to create highly adaptive breeds resistant to environmental biotic factors early diagnostics, the possibility to forecast genetic variability and the inheritance of physiological and biochemical characteristics at the selection process early stages become more actual. It was determined by the researches of a great number of scientists that while studying the plants resistance nature to environmental biotic and abiotic factors a special attention has to be paid to secondary origin substances – ascorbic acid, phenols connected with the breathing process, photosynthesis and plants immunity. The researches of Zaptometov et al. [4], Samorodova-Bianki et al. [5], Eremin et al. [6] showed the role of ascorbic and chlorogenic acids in plants biochemical processes, in work and cherry resistance to Coccomyces blight. The purpose of the research is to develop the early diagnostics methods of sweet cherry resistance to Coccomyces blight according to the leaf biochemical characteristics.

Materials and Methods

Thirteen sweet cherry genotypes from the collector plantations of Federal State Budgetary Scientific Institution "All-Russian Horticultural Institute for Breeding, Agro technology and Nursery", Russia, Moscow with different resistance to Coccomyces blight were studied. For the research fully shaped leaves from the middle part of one-year whips were taken. Ascorbic acid was extracted via 6% metaphosphoric acid with the following centrifugation at as 9000 rpm for 5 min. Ascorbic acid (AsA) determination was held using HELC method [7,8], the chromatograph KNAUER (Germany) was used. Chromatographic conditions: HELC column SilasorbC18 (5 mkm), 150×4.0 mm (Biohimmac, Russia), the column temperature is 25℃, flow speed 1.0 mlmin^{-1}, the detector UV, the wave length l=251 nm, the mobile phase MeOH: water - 5:95 (r./r), aliquote for injections 20 mkl.

Phenol compounds were extracted via 70% ethanol when heated on the boiling water-bath. Chlorogenic acids (CA) were determined by [9], using a KNAUER. HPLC analyses were performed on a Purosphere reverse phase C18 column (4 mm x 250 mm x 5 mm) (Merck, KGaA, Darmstadt, Germany). The detection wavelengths were conducted at 327 nm.

To delete non-polar compounds (chlorophyll and tanning agents and others) the chloroform extraction was used.

Results and Discussion

The Asc.A content in sweet cherry leaves ranges within 93.6 – 243.7 (mg/100 g). The minimal content of Asc.A is indicated in Wild sweet cherry and Bakhor breed (97.2 and 93.7 mg/100g) respectively. The maximum content of Asc.A is detected in the leaves of the following breeds: Poeziya, Malysh and Orlovskaya yantarnaya (202.6; 231.8 and 242.1) mg/100 g respectively. The minimal content of chlorogenic acid contains in the leaves of Podarok Orlu (0.029 mg/100 g) and Poeziya (0.076 mg/100 g). The maximum content of chlorogenic acid is indicated in the leaves of the following breeds: Bakhor, Iput', Kompaktnaya, Mak (0.350, 0.365, 0.375 and 0.412) mg/100 g

respectively (Table 1). The breeds having the common origin (Orlovskaya yantarnaya and Malysh) are characterized by relatively equal concentrations of the components under study.

The comparison of sweet cherry breeds according to their resistance to Coccomyces blight is shown in Table 2. The ascorbic acid concentration in the each group breeds which are different in Coccomyces blight resistance is unequal and it is impossible to reveal any regularities. According to chlorogenic acid concentration resistant breeds are characterized by higher values, 0.328 mg/100 g on the average, than non-resistant ones. The average ascorbic acid concentration in sweet cherry leaves grows up from 117.9 mg % (affection grade 0 and 1) till 220.1 mg% (affection grade 3) as the resistance goes down. The chlorogenic acid concentration vice versa has a tendency to growing down as the resistance goes down. That's why comparing only ascorbic and chlorogenic acids values in the leaves of resistant and non-resistant sweet cherry breeds it is very difficult to define the resistance. There have been recorded the data about the usage of the substances correlations (coefficients) which are

stable, not depending on the external conditions and used as genotypical characteristics [10]. The ratio of ascorbic acid to chlorogenic one (resistance coefficient) and correlations between the characteristics were calculated. Table 2 shows that the coefficients usage lets to characterize the breeds because of their resistance to Coccomyces blight more accurately:

The resistance coefficient for the breeds with affection grade 0 and 1 is rather stable and fluctuates within 0.469 and 0.549.

The resistance coefficient for the breeds with affection grade 2 is higher and is within 0.929 and 4.531.

The resistance coefficient for the breeds with affection grade 3 is non-stable and fluctuates within 0.271 and 0.855.

The correlation coefficient between ascorbic and chrologenic acids in the breeds resistant to Coccomyces blight is high (R=0.99), in the breeds with affection grade 2 is medium (R=0.66), and in the breeds with affection grade 3 is low, negative (R=-0.23).

Breed	Ascorbic acid, mg%	Chlorogenic acid, mg%
Wild sweet cherry	96.109	0.175
Fatezh (open pollination seedling of Leningradskaya zheltaya breed)	171.462	0.148
Orlovskaya yantarnaya (open pollination seedling of unknown origin)	243.658	0.285
Malysh (radiation mutant of sweet cherry Orlovskaya yantarnaya breed)	235.847	0.254
Podarok Orlu (open pollination seedling of sweet cherry Biggaro breed from Donetzk)	131.401	0.029
Poeziya (open pollination seedling of Donetzk breeds mixture)	205.112	0.076
Zolotaya Loshitzkaya (open pollination seedling of Denissen zheltaya breed)	135.462	0.131
Venera (Zolitaya Loshitskaya x Rannya Marki)	180.052	0.228
Donetskiy Velikan (cherry Lyubskaya x Valeriy Chralov)	122.380	0.219
Iput' (seedling 3-36 x seedling 8-14)	171.448	0.365
Mak (Melitopol'skaya black x Frantsuzskaya chernaya)	195.687	0.412
Bakhor (Frants – Iosif x Safry surkhony)	93.566	0.350
Kompaktnaya (open pollination seedling of Leningradskaya chernaya)	183.511	0.375

Table 1: The content of ascorbic and chlorogenic acids in sweet cherry leaves, mg%.

Breed	Ascorbic acid, mg %	Chlorogenic acid, mg %	Resistance coefficient Asc./Chl. ·10-3
Breeds Coccomyces blight affection, grade 0 and 1			
Iput'	170.2	0.365	0.469
Wild sweet cherry	97.2	0.175	0.549
Mak	193.3	0.412	0.475
Kompaktnaya	184.8	0.375	0.524
Average	117.9	0.328	0.5
HCP01	11.76	0.03	**R = 0.99**

Breeds Coccomyces blight affection, grade 2			
Fatezh	170.5	0.148	1.159
Malysh	231.8	0.254	0.929
Podarok Orlu	132.8	0.029	4.531
Poeziya	202.6	0.076	2,698
Zolotaya Loshitskaya	133.9	0.131	1.034
Average	174.3	0.217	2.1
HCP01	3.86	0.04	**R = 0.66**
Breeds Coccomyces blight affection, grade 3			
Orlovskaya yantarnaya	242.1	0.285	0.855
Venera	179.8	0.228	0.789
Donetskiy Velikan	122.1	0.219	0.559
Bakhor	93.7	0.345	0.271
Average	220.1	0.269	0.6
HCP01	2.40	0.03	**R = - 0.23**

Table 2: The comparative concentration of ascorbic and chlorogenic acids in sweet cherry leaves depending on Coccomyces blight resistance grade.

Conclusion

Species and breeds characteristics of ascorbic and chlorogenic acids accretion in sweet cheery leaves are defined; the interconnections between ascorbic and chlorogenic acids concentration point to their combined participation in exchange conjoint reactions in sweet cherry leaves.

The resistant to Coccomyces blight sweet cherry genotypes have more stable approximate resistance coefficient values ($R_{Caver.}$=0.5) and higher correlation coefficient (R=0.99) than unstable breeds, which resistance coefficient value is higher and fluctuates within 0.6 and 2.1, but correlation coefficient goes down till R=0.66 and R=-0.23.

The usage of correlation and resistance coefficients (ratio Asc.A value/Chl.A value) between ascorbic and chlorogenic acids concentration in the leaves can be used as additional marker characteristics while evaluating sweet cherry resistance to Coccomyces blight.

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