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Correlation between the levels of potassium and polyamines in the leaves of grapevine

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ABSTRACT Potassium and the most abundant polyamines (putrescine, spermidine and spermine) concentrations were determined in the leaf blades of *Vitis vinifera* L. cv. White Riesling, Ezerjó, Kövidinka, Chardonnay, Cabernet Sauvignon, Merlot, Kadarka varieties at ripening to characterize the correlation between these two types of osmolytes under drought stress and low nutrient supply. K^+ concentration in the leaf blades changed in the range of 0.27-0.81%, indicating serious K^+ deficiency. Kadarka and Ezerjó varieties accumulated the lowest and Kövidinka the greatest quantity of potassium. Below 0.5% K^+ content the increase of free and soluble-conjugated putrescine concentration could be observed. The highest levels were formed in the leaves of Ezerjó: 1785 nmol/g fw. free and 589 nmol/g fw. soluble-conjugated putrescine and these values decreased to 11 nmol/g fw. and 14 nmol/g fw. at Kövidinka variety. Free spermidine concentration changed in the range of 25-100 nmol/g fw and the content of conjugated form was lower. The free and soluble-conjugated spermine levels remained below 20 nmol/g fw. Accumulation of spermidine and spermine didnot correlate with the K^+ concentration in the leaf blades. **Acta Biol Szeged 46(3-4):203-204 (2002)**

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Potassium is a multifunctional constituent of plant cells, its high concentration in the symplast makes it the main inorganic osmolyte in the cells. K^+ deficiency can result an imbalance between inorganic anions and cations, consequently a decrease in the cellular pH (Hare and Cress 1997; Aziz et al. 1999).

Accumulation of polyamines has been shown under different abiotic and biotic stress conditions such as K^+ deficiency, low temperature, low pH or osmotic stress, herbicides, pathogenes, etc. (Evans and Malmberg 1989; Hare and Cress 1997; Roubelakis-Angelakis 2001). Putrescine, spermine and spermidine are ubiquitous in plant cells. They occur in free form as cations, but are often conjugated to small molecules like phenolic acids or various macromolecules. K^+ have been shown to modulate the level of polyamines in plants. The K^+ deficiency induced increase in putrescine level was interpreted as an adaptive response of plants (Sarjala and Kaunisto 1993; Aziz et al. 1999).

Elevated putrescine levels were found in grapevine leaves displaying symptoms of K^+ deficiency (Adams 1990). Geny et al. (1997) reported that polyamines, especially conjugated and wall-bound polyamines of different plant organs were influenced by K^+ supply before deficiency symptoms had appeared, also free spermidine and conjugated putrescine seemed to be good markers of K^+ deficiency during anthesis.

In Hungary the K^+ supply of vineyards is controlled on the basis of K^+ concentration in leaf blades at flowering and ripening, the 1.2-1.4 K% (flowering) and 1.0 -1.4 K% (ripening) concentrations are considered as optimum ranges. The optimum depends on the variety because of varietal differences in K^+ uptake efficiencies and transport properties (Erdei et al. 1985) Under extreme environmental and growing conditions such as insufficient K^+ fertilization, hot and dry summer, high yield, the K^+ concentration in the leaf blades can decrease significantly below the optimal level until ripening (Miklós et al. 2000).

The aim of our preliminary work was to study the formation of polyamines and the relationship between potassium and polyamines accumulation in the leaves of grapevine varieties grown under the same condition , at the end of a drought growing season.

Materials and Methods

Plant material

Leaf blades of *Vitis vinifera* L cv. White Riesling, Ezerjó, Kövidinka, Chardonnay, Cabernet Sauvignon, Merlot, Kadarka varieties were gathered in a vineyard of collection of variety (ten plants of each variety) at ripening time in the middle of September. The plantation is situated on a light sandy soil, which can be characterized by unfavorable water-household properties and low nutrient supply. Leaf blades samples were frozen in liquid nitrogen immediately after cutting off. Then they were transferred to a refrigerator and stored at -80ºC for analysis.

Potassium measurement

Samples were dry-ashed at 550ºC. The ashes were digested in 6 M HCl. After filtration and dilution with distilled water, potassium was measured by AAS method using Perkin-Elmer AAnalyst 300 spectrophotometer.

Polyamines extraction and analysis

Free and soluble-conjugated polyamines were extracted in 5% $HClO_4$ and the dansylated derivates of putrescine (Put), spermidine (Spd) and spermine (Spm) were analyzed by HPLC as described by Sarjala and Kaunisto (1993).

Table 1. Potassium, free polyamines and soluble-conjugated polyamines concentration in the leaf blades of grapevine varieties.

Variety	K % in dw.	Free polyamines Put. (nmol/g fw.)	Spd.	Spm.	Soluble-conjugated polyamines Put. (nmol/g fw.)	Spd.	Spm.
Kadarka	0,27	152	66	6	78	35	9
Ezerjó	0,29	1785	78	4	539	40	4
W. Riesling	0,35	188	98	8	40	20	4
Chardonnay	0,43	237	68	7	0	2	1
Merlot	0,53	32	28	10	36	87	13
Cab.Sauv.	0,68	34	78	18	6	0	0
Kövidinka	0,81	11	49	6	14	37	9

Results and Discussion

The examined varieties were grown under the same conditions in a vineyard of collection of varieties. The light sandy soil, the low potassium supply, the drought and hot weather in August and the K^+ demand of berry development resulted extremely low K^+ concentration in the leaf blades at ripening. In the leaves of Ezerjó and Kadarka varieties less than 0.3% K^+ was found. According to our previous results Ezerjó can be characterized by low K^+ uptake efficiency, accumulating K^+ in the leaf blades only at high K^+ supply (Erdei et al. 1985). This variety is known as an inefficient K-utilizer in cultivation practice. The highest K^+ level was measured in the leaf blades of Kövidinka (0.87%), but it was under the 1,0-1,4% range considered as the optimum K^+ level at ripening (Table 1). Kövidinka is a late ripening, ancient variety of this region. This variety has an extensive root system for water and nutrient uptake. The environmental conditions decreased the difference in the ripening time (about one month) of the varieties, but the same sampling time could result a positive shift in K^+ concentration at late ripening varieties.

The content of polyamines in leaf blades was of the same order of magnitude (nmol/g fw.) as reported in the leaves of fruiting cutting of Cabernet Sauvignon (Geny et al. 1997) and in vitro propagated plantlets (Roubelakis-Angelakis 2001). Under severe K^+ deficiency both free and soluble-conjugated form of diamine putrescine was accumulated in the leaves in high extent (Table 1)which is in a good agreement with the previous observations from grapevine and other plant species. Below 0.5% K^+ content the free putrescine concentration significantly increased. High putrescine levels in the case of Ezerjó might indicate an effective adaptation ability of this variety. Spermidine and spermine levels was not affected by the degree of K^+ deficiency. The correlation between the concentration of potassium and putrescine seemed to be loose, probably because of the varietal differences in K^+ uptake ef ficiency, drought tolerance and yield.

These first results give some tendency concerning nutrient supply and polyamines formation but further well established experiments have to be carried out to get more information on this field.

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