

Study of some morphological and biochemical characters of *Rumex acetosa* L.

Tincuța GOCAN¹, Șandor ROZSA^{1*}, Ileana ANDREICA¹, Alexandru APAHIDEAN¹, Viorel TĂMAȘ¹, Gheorghe POȘTA^{2*}

¹Faculty of Horticulture and Business in Rural Development, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Mănăștur St. 3-5, Cluj, Cluj-Napoca, Romania

²Faculty of Engineering and Applied Technologies, University of Life Sciences "King Mihai I" from Timisoara, Aradului St. 119, Timisoara, Timis, Romania

*Corresponding author e-mail: rozsa.sandor@usamvcluj.ro, gheorghe_posta@usvt.ro

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Abstract

Sorrel (*Rumex acetosa* L.) is a perennial, dioecious plant found as a plant in the wild flora, then cultivated for its medicinal properties containing many biochemical compounds. Sorrel is also a tasty herb and its leaves are a good source of macro and micronutrients. Consumer demand for fresh or minimally prepared vegetables encourages the introduction of this species on the market as a fresh product. In our study we followed three cultivars: ('Pallagi Nagylevelű', 'Bloody Dock', 'de Lyon') obtained from ecological cultures in the Cluj area. The chemical determinations were carried out at the Faculty of Horticulture and Business in Rural Development, Horticultural Products Technology discipline. The average of the leaf surface recorded values between 104.09-148.01 cm². The lowest amount in acidity (oxalic acid) was obtained in the cultivar Bloody Dock, (0.236%). Results on C vitamin were obtained values in the range of 19.88-23.11 mg/100g f.s. The results were statistically interpreted with ANOVA.

Key words: *Rumex acetosa*, vegetables, fresh products, C vitamin, acidity

Introduction

Rumex is a genus with about 200 species, which belong to the *Polygonaceae* family and are distributed in Europe, Asia, Africa and North America, primarily in the Northern Hemisphere [18]. The common names of *Rumex* species are varied and even confusingly overlap between species. The etymological origin of the genus name *Rumex* probably comes from the Greek word for spear or arrow, due to the spear-shaped leaves of the plant [10]. The species name *acetosa* is derived from *acetum*, the Latin word for vinegar, referring to the sour taste [12]. This plant has a string of names by which it is popularly called all over the world, in Hungary "Sóska" [4], in Belgium "Zurikel" [17], in Lithuania "Rūgštinė" (Hussain), and in our country it is called of sorrel. The fact that sorrel multiplies easily under our conditions, both sexually and vegetatively, is a benefit, as is the fact that no serious disease and pest problems are reported. Fresh-cut products are obtained from minimally processed leafy vegetables or fruits, which are packed in foil or plastic boxes, stored, transported and marketed at temperatures between 0 and 8°C. It is a tasty plant and its leaves are a good source of macronutrients and micronutrients. In traditional cuisines the leaves are used in mixed salads, boiled vegetables and pies [8]. *Rumex acetosa* leaves are used to treat bruises, jaundice, sore throats, scurvy, wounds and warts in Great Britain and Ireland [2]. Another important use of *R. acetosa* leaves is to induce water excretion and treat fever. The stems of *R. acetosa* are eaten as appetizers [11; 1].

Rumex L. species have gained acceptance since the use of plants by humans as a remedy against some diseases and ailments due to its healing benefits and various therapeutic advantages [3]. Sorrel has a rich nutritional composition, being a valuable source of vitamins and minerals. First, sorrel is rich in vitamin C, which plays an important role in maintaining a strong immune system and protecting cells against oxidative stress. Sorrel also contains vitamin A, essential for eye and skin health, as well as vitamins from the B complex, necessary for the optimal functioning of the metabolism. Among minerals, iron is essential for the production of red blood cells and the transport of oxygen in the body, and magnesium and calcium are involved in maintaining the health of bones and the nervous system [18].

Sorrel leaves are sour in taste and contain high levels of oxalic acid. The presence of high levels of oxalic acid reduces the bioavailability of some minerals, especially calcium, when uncooked plant parts are used. Consuming large amounts of oxalic acid has many disadvantages including: its ability to bind to

micronutrients such as iron and calcium, decreasing its absorption; oxalates irritate the digestive system when consumed in large quantities and also oxalic acid when combined with calcium forms crystallized calcium oxalate, this in the human system can lead to the formation of kidney stones, and can also accumulate in the heart, circulatory vessels and lungs. It has been shown that the concentration of tannins in the leaves of *R. acetosa* is between 8 and 16%, so care should be taken to consume its fresh leaves in large quantities, especially for children, pregnant women and the elderly, as the tannins can cause stomach disorders and/or kidney and liver damage [5]. Fortunately, light cooking greatly reduces the concentration of oxalic acid to negligible amounts [6; 18]. Further investigations on different sorrel compounds are still needed to show their effect in a healthy and balanced diet.

Material and Method







The biological material analyzed was harvested from a privately owned greenhouse culture, and from the didactic greenhouse of the vegetable growing discipline at the University of Agricultural Sciences and Veterinary Medicine in Cluj-Napoca. The culture technology applied in the two sampling locations subjected to the analyzes was conventional, using ecologically certified inputs. The time of harvesting the plants was the beginning of March, using the current technique of sampling and conditioning the plant matter subject to laboratory determinations. In this comparative study, certain morphological characters and biochemical content were determined in the leaves of sorrel plants, in the case of the three cultivars: 'Pallagi Nagylevelű', 'Bloody Dock' and 'de Lyon', Table 1.

The physical-chemical determinations were carried out at the Faculty of Horticulture and Business in Rural Development from Cluj-Napoca, in the laboratory of the Horticultural Products Technology discipline, using measuring instruments (balance, meter, caliper, etc.).

Biochemical determinations were also carried out on the biological material:

- ✓ Soluble dry substance (SDS) by the refractometric method;
- ✓ Acidity by the titrimetric method;
- ✓ C vitamin by the iodometric method; using the standardized methodologies presented in the specialized literature [14].

Table 1. The biological material used in the experiment and the experimental variants

Experimental variants (cultivar)	Aspects of leaves during plant maturation	Cultivated plants in the form of a bush
'Pallagi Nagylevelű'		
'Bloody Dock'		
'de Lyon'		

Results and Discussions

The level of realization of the morphological characters is different from one variety to another, and within the same variety, from one plant (rosette) to another. The number of leaves that form in the rosette is determined by the biological nature of the variety. They are usually large, but their size can fluctuate depending on age and growing conditions. These morphological characteristics can vary slightly between sorrel species or between different individual plants, and sometimes they can also be influenced by the environmental conditions in which the plant grows. The leaf area of macris leaves can fluctuate depending on the species, age and growing conditions, but in general, macris leaves have a fairly large leaf area. This is one of the key features that allows plants to carry out photosynthesis efficiently, absorbing sunlight, oxygen and carbon dioxide from the air. Comparing the average values of the characters between the three varieties, regardless of the rosette, it was found that the 'de Lyon' variety registers high values in terms of the analyzed leaf characters (except the length of the petiole), followed by the cultivar 'Pallagi Nagylevelű' (Table 2).

Table 2. The main physical properties of *Rumex acetosa* L.

Variety	Average values of the morphological characters				
	Leaf length [cm]	Leaf width [cm]	Petiole length [cm]	Number of leaves in the rosette	Leaf surface [cm ²]
'Pallagi Nagylevelű'	17.27	10.28	9.14	38.45	111.43
'Bloody Dock'	14.25	8.69	7.91	26.42	104.09
'de Lyon'	19.35	12.95	8.52	49.21	148.00

The content of soluble dry matter in sorrel leaves (*Rumex acetosa* L.) can fluctuate according to several factors (genetic, biological, ecological, technological). However, in general, sorrel leaves contain a significant amount of soluble dry matter, as they are the main photosynthetic organs of the plant and contain a variety of organic substances necessary for plant metabolism and growth. Regarding the influence of the content of soluble dry matter, it is found that, regardless of the variety, it falls within the existing values in the specialized literature. Analyzing the significance of the differences of the three resulting variants, the 'Bloody Dock' variety stands out with a content of 6.20%, with a significant difference from the experience average of 1.04. The lowest results were recorded for the cultivar 'de Lyon' (4.27%) with a difference of -0.89 compared to the same control (Table 3).

Table 3. Soluble dry matter (SDM) content of sorrel leaves

Variety	SDM [%]	Relative values [%]	Differences ±	Signification
'Pallagi Nagylevelű'	5.00	97.0	-0.16	-
'Bloody Dock'	6.20	120.3	1.04	*
'de Lyon'	4.27	82.8	-0.89	0
Average	5.16	100.0	0.00	Control

LSD (p 5%)

0.63

LSD (p 1%)

1.05

LSD (p 0.1%)

1.96

It is important to note that the acidity of sorrel leaves can also be different, depending on the ecopedological conditions (altitude, climate, soil and other environmental factors). It is also possible that some hybrids or varieties of sorrel have different levels of acidity, and this can also be influenced by the age of the leaves and their stage of development. The significance of the differences of the three variants in terms of the amount of oxalic acid (Table 4), shows that the variety 'Pallagi Nagylevelű' registers a difference of 0.46 being very significant, in close proximity is the variety 'de Lyon' with a difference of 0.26 being distinctly significant compared to the average of the experience considered as a control. A very significant deficit was registered at 'Bloody Dock' where the value of oxalic acid was 4.25% [16]. There are other organic acids than oxalates that can also cause a sour taste in plants [13].

Table 4. The acidity content of sorrel leaves

Cultivar	Aciditate [acid oxalic %]	Relative values [%]	Differences ±	Signification
'Pallagi Nagylevelű'	5.44	109.3	0.46	***
'Bloody Dock'	4.25	85.5	-0.72	000

'de Lyon'	5.23	105.2	0.26	**
Average	4.97	100.0	0.00	Control

LSD (p 5%)

0.14

LSD (p 1%)

0.23

LSD (p 0.1%)

0.44

C vitamin, also known as ascorbic acid, is an antioxidant essential to human health, being involved in numerous metabolic processes and having multiple health benefits, including boosting the immune system and protecting against free radicals. Although macris is not known to be a rich source of C vitamin, compared to other horticultural species such as citrus fruits or berries, its leaves can still contain a significant amount of this vitamin. C vitamin is a powerful antioxidant that can help protect plant cells against oxidative stress. The C vitamin content of sorrel leaves shown in Table 5, records high values for each variety approximately the same as those obtained by Samancioglu et al., 2016 [15], with the highest value, 13.11 mg/100 g in the 'Bloody Dock' variety, the difference obtained compared to the average of the experience considered as a control being significant (1.56).

Table 5. C vitamin content in sorrel leaves

Variety	C vitamin [mg / 100 g]	Relative values [%]	Difference ±	Signification
'Pallagi Nagylevelű'	11.85	101.4	0.30	-
'Bloody Dock'	13.11	107.2	1.56	*
'de Lyon'	9.69	91.4	-1.86	0
Average	11.55	100.0	0.00	Control

LSD (p 5%)

1.27

LSD (p 1%)

2.11

LSD (p 0.1%)

3.95

Studies on the relationship between leaf area and acidity content in sorrel leaves are quite limited, but some general conclusions can be drawn. Leaf acidity can be influenced by several factors, including environmental conditions, plant genetics, and nutrient availability. However, the results related to the content of hydroxycinnamic acids were unexpected. Either there was no significant correlation between the level of antioxidant activity (Figure 1).

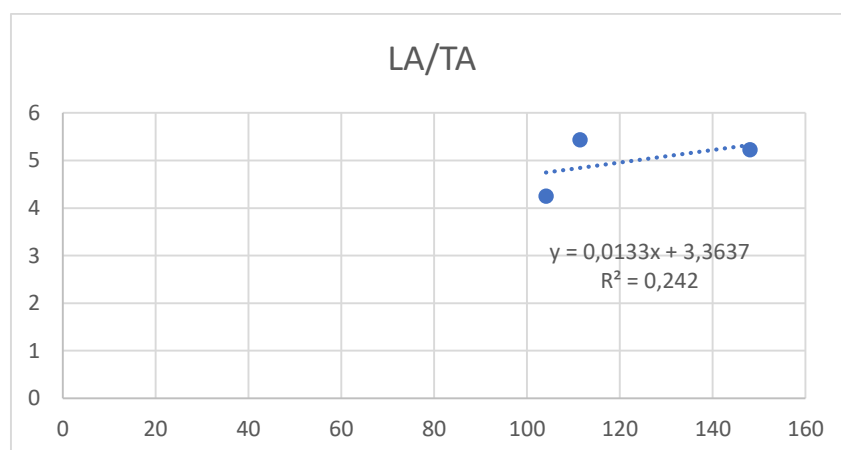


Figure 1. Correlation between leaf area (LA) and total acidity (TA) (oxalic acid)

Large leaf area may indicate a high photosynthetic capacity. Photosynthesis is the process by which plants make carbohydrates and other organic substances, including C vitamin, using sunlight. Thus, it is possible that plants with a larger leaf area have a higher production of vitamin C. The correlation analysis performed between the two parameters was found to be positive and highly significant (Figure 2).

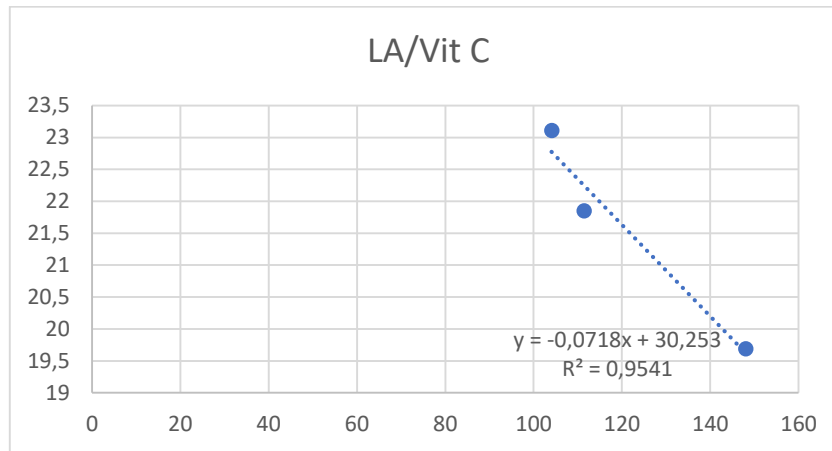


Figure 2. Correlation between leaf area (LA) and C vitamin

The relationship between soluble dry matter and acidity (Figure 3), could also reflect the overall metabolic activity of the plant. An increase in soluble dry matter could indicate increased photosynthetic activity or better nutrient utilization efficiency, which could affect acidity levels. It is important to note that these correlations are hypothetical and that specific scientific research is needed to validate any relationship between soluble dry matter and acidity of macris leaves. In our case, the significance of the correlation being distinctly significant.

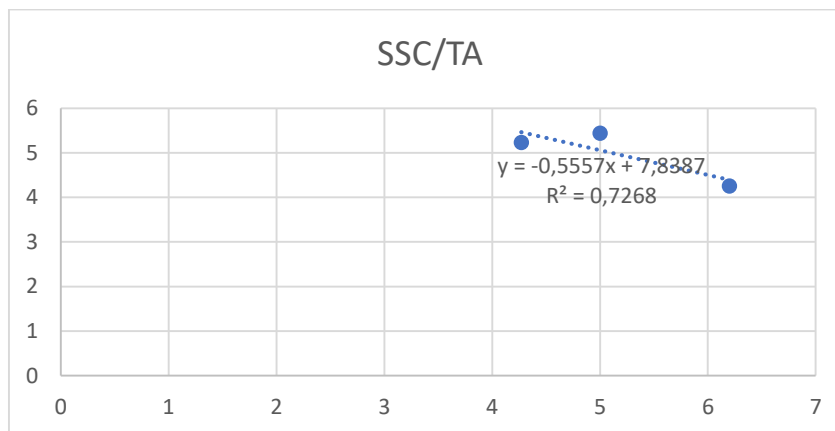


Figure 3. Correlation between soluble dry matter (SSC) and acidity (oxalic acid) (TA)

C vitamin C content in leaves can be influenced by environmental factors such as sunlight, temperature and nutrient availability. An increased content of soluble dry matter can be associated with better photosynthesis and better absorption of nutrients, which can also stimulate the production of vitamin C. The link between the two factors is closely related in our experience being very significant (Figure 4).

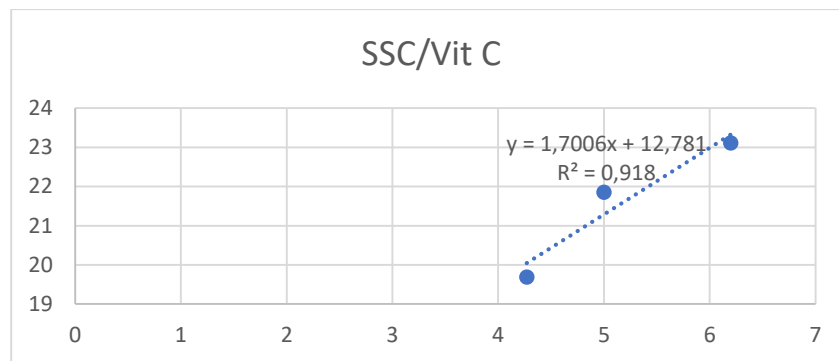


Figure 4. Correlation between soluble dry matter (SSC) and vitamin C

Conclusions

A benefit is that sorrel is easily propagated and is a vegetable species tolerant to adverse environmental factors (climate, disease and pests). Sorrel is largely consumed by cultivation in family gardens, and yet there is still potential for much greater use in culinary arts. The cultivation of this species in forced (greenhouses) or protected (solar) spaces makes it possible to consume it fresh all year round and contributes to the diversification of the assortment of green vegetables for a healthy diet. The introduction of this species on a large scale through its use in the production of food supplements beneficial to the body due to the properties and chemical compounds found in all the component parts of the plant is still an objective in the expansion of cultivated areas in Romania. It should be noted that following the determinations made in this study, the influence of the interdependence of experimental factors (genetic, biological, ecological, technological) is essential on the analyzed quality parameters.

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