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Chemical Composition of the Fruits of Several Apple Cultivars Growth as Biological Crop

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Abstract

To obtain a better quality of fruits and to adapt to the requirements of consumers needs, the researchers regard the content of fruits attentively, especially the content of sugar, vitamins and mineral substances. The aims of the research were to test ten apple cultivars from the point of view of sugars, water content, proteins, acidity, vitamin C and also mineral elements: N, P, K, Ca, Mg, Fe. Results obtain for sugars show a higher content of sugar between 9.53 and 12.34%. The higher sugar content was registered for H3/73 hybrid (12.34%). Total acidity (%) falls between 0.127 and 0.345%, a small content registered at all cultivars determining a good quality of fruits and a good taste. The highest value was obtained for 'Jonathan' apple variety. Vitamin C varied between 25.75 and 77 mg/100g. 'Mutzu' and 'Jonathan' cultivars registered the highest value for vitamin C. Mineral elements, respectively macro elements N, P and K varied within the apple varieties. Total nitrogen form varied between 0.67 and 0.111 %, phosphorous between 0.15 and 0.235 % and potassium between 0.40 and 0.75 %. The values for Ca varied between 2.5 and 7.8 mg/100g and Fe between 0.2 and 0.28 mg/100g. The atmosphere and soil in the studied zone of apple culture were unpolluted, so there was no risk of food contamination. The chemical values of fruits showed a higher content of mineral elements and also a good quality for the products obtained from the apple industry, so the apple production could be used in obtaining juice and pulp without any risk of illness.

Keywords: fruit crops, nutritive value, risk of food contamination

Introduction

The surface of the apple crop is on all continents and also in temperate areas, both in the Northern and Southern hemisphere.

Among fruits crops, apple represents the 4th place worldwide with 56 millions tones annually (FAO, 1998). The nutritive value is well known and represents the variable content of sugar, proteins, ascorbic acid, and mineral substances. The consumption of fresh fruits or juice, food pastes, jellies, jams assure the vitamins for a better life. Apples are a part in all food diets and its therapeutic value is well known for different illnesses (determines the absorption of gastric secretions, the elimination of toxins, has diuretic effect).

Firmness and sugar content are important quality attributes that directly influence consumers on purchasing fresh apple fruit. Nondestructive sensing of fruit for internal quality, especially firmness and sugar content, would allow the fruit industry to provide better, more consistent fruit to the consumer and, thus, improve industry competitiveness and profitability (Yankun and Renfu, 2006; Harsan *et al.*, 2006).

Flavor is most complex to analyze, and over 350 volatile compounds have been detected in apple (Maarse, 1991). Organic acids are an important component of fruit flavor and, together with soluble sugars and aromas, contribute to the overall organoleptic quality of fresh apple fruits. Eleven organic acids were identified in apple pulp with an additional five in the whole fruit (Hulme, 1971). Malic acid is the predominant organic acid in apple fruits, and it has been proposed by several authors that malic acid content in fruit is controlled by a major gene (Nybom, 1959; Visser *et al.*, 1968; Visser and Verhaegh, 1978) with homozygous individuals being either too sweet (flat) or too sour, although not always in unison (Visser *et al.*, 1968). Also, the identification of low-acid varieties have revealed the effect of a major gene governing acidity in other species including peach (Yoshida, 1970). The low-acid character was found to be recessive in apple (Visser and Verhaegh, 1978) but dominant in peach (Yoshida, 1970).

According to Schuphan (1956), Mapson (1970), and Fisher (1999), apple contains 2-30 mg ascorbic acid per 100 g, depending on the cv. This concentration decreases progressively from the peel to the core of the fruit (Ulrich and Delaporte, 1970; Machlin, 1991) and there is twice as

much ascorbic acid in the red part of apple peel than in the green part (Tavernier and Jacquin, 1946). Vitamin C is present in two forms in apples-ascorbic acid, and its oxidised form, dehydroascorbic acid (Davies *et al.*, 1991). The total level of the two forms is constant per unit weight during growth, although the ascorbic acid/dehydroascorbic acid ratio increases to at least 95/5 at fruit maturity (Mapson, 1970). The variability of ascorbic acid levels between fruits of a same cv and between years can be very high (Trzcinski and Bouckoms, 1973; Trzcinski and Vandermeir, 1974; Delmotte, 1984).

Materials and methods

Research was conducted in the University of Agronomic Sciences and Veterinary Medicine, Bucharest on some apple-tree cultivars that were cultivated in Romania at the Voinesti Tree Society. Experimental variants are presented in Tab. 1. Cultivars of apple H-3/23, H -4/50, H-4/101 and H-5/79 are elites of apple-trees from a micro culture from 2001 at the Voinesti Tree Society. These genotypes were obtained from irradiation of post maturated seeds and from seeds resulted from open pollenization of Prima flowers.

Tab. 1. Experimental variants

No	Specification	No	Specification
1	'Delicious'	6	H -3/123
2	'Jonathan'	7	H -4/50
3	'Mutzu'	8	H -4/56
4	H-3/23	9	H -4/101
5	H -3/73	10	H-5/79

Variant H-4/56 is a hybrid obtained from Prima noniradiated seeds and variant H-3/73 is a hybrid obtained from flower pollination of Goldenspur cultivars with irradiated pollen from Prima cultivars.

Research regarding the apple quality consists of biochemical determinations and determinations of mineral elements and toxic compounds. For biochemical characteristics, standard methods of analysis were used. Mineral elements and total forms were obtained through the break up of the apples, drying and wet mineralization, according to the Kjeldahl method.

The methods for the determination of mineral elements were: for total nitrogen-the volumetric method, for phosphorus-the colorimetric method and for calcium and potassium the flame photometric method. Microelements: Cu and Zn and heavy metals: Pb, Cd were determined with the help of the spectrophotometer method. Apple nitrates in soluble forms were determined through the colorimetric method.

Results and discussions

Results regarding the biochemical content of apples (Tab. 2) present a high content of sugar, which varies between 9.53 and 12.34%. High values of sugars are registered in 'Mutzu' and H4/50 cultivars and the higher value was for the H3/73 hybrid of 12.34%.

The sugar content of apples differs depending on the weather conditions, cultivars, culture technology, position and exposition of the fruits in the crown (Davidescu and Davidescu, 1999; Mitre *et al.*, 2009; Sestras *et al.*, 2009). High contents of sugar are obtained, due to weather conditions with high temperature and high nutritive element contents of soils, which permitted the assimilation of sugars.

Total acidity registered values between 0.127 and 0.345%, low values, values under the maximum permitted limits of 0.31%. Low acidity determines a good quality for human consumption.

Vitamin C (mg/100g fresh fruit) varies between 7.19 and 7.89 mg/100g fresh fruit. The highest values are obtained from 'Delicious', 'Mutzu' and 'Jonathan' cultivars.

Mineral elements, macro elements, respectively N, P, K content, registered values that varied within apple cultivars.

Tab. 2. Biochemical characteristics of apples

Specification	Dry matter total content %	Dry matter soluble content %	Sugar %	Water content %	Total acidity %	Vitamin C mg/100g fresh content	Ash content %
'Mutzu'	13.89	15.00	12.03	86.11	0.244	7.51	2.77
'Jonathan'	14.29	11.50	9.84	85.71	0.345	7.66	2.38
'Delicious'	18.18	11.00	9.53	81.82	0.173	7.89	1.81
H-3/73	19.61	15.50	12.34	80.39	0.199	7.79	1.96
H -4/101	15.59	11.75	10.00	84.31	0.195	7.56	1.96
H-3/123	21.31	11.00	9.53	76.69	0.157	7.40	1.63
H -5/79	16.22	13.25	10.94	83.78	0.232	7.67	2.70
H -4/56	15.69	11.00	9.53	84.31	0.127	7.19	1.96
H -3/23	13.95	12.50	10.46	86.05	0.127	7.21	2.32
H-4/50	11.63	15.00	12.03	88.37	0.210	7.19	2.33

Tab. 3. Mineral composition of apples

Specification	N total %	Proteine %	P_2O_5 %	K_2O %	CaO %	FeO %
Mutsu	0.654	4.08	0.389	0.48	0.140	2.304
'Jonathan'	0.837	5.22	0.465	0.60	0.266	2.56
'Delicious'	0.758	4.73	0.526	0.78	0.280	2.24
H-3/73	0.523	3.263	0.407	0.60	0.245	2.752
H -4/101	0.476	2.97	0.385	0.60	0.266	2.112
H-3/123	0.758	4.73	0.430	0.78	0.140	1.996
H -5/79	0.504	3.14	0.481	0.90	0.210	2.688
H -4/56	0.354	2.21	0.598	0.78	0.266	2.726
H-3/23	0.701	4.37	0.351	0.48	0.245	2.752
H- 4/50	0.466	2.91	0.385	0.84	0.252	2.304

Nitrogen total form normal content must have values between 0.40 and 0.80%. Nitrogen is an element which determines the accumulation of sugars and high yields. After analysis, total apple nitrogen varies between 0.466 and 0.837%. This content was influenced by the correct fertilization technique of apple trees, which determines an accumulation of this element within normal limits and also a good quality of fruit for consumption and the possibility to preserve the yield because nitrogen excess determines apple spots.

Phosphorus is accumulated in quantities between 0.351 and 0.526% P_2O_5, a good normal content that determines the equilibrium between nutritive elements, especially with nitrogen. The equilibrium between nitrogen and phosphorus determines an accumulation of sugars and a good quality of fruits.

Potassium total content in apples must be close to the 1.20% K_2O value.

The analysis of total forms shows a low content of potassium with values between 0.48 and 0.90% K_2O. A low content of this element could determine some problems in terms of the quality of apples, especially during the storage of apples for a long time.

Calcium and iron are macro elements with a secondary part in plant development but which influence the consumption quality of fruits in a fresh state. They are accumulated in values which vary between 0.140 and 0.280% CaO and 1.996 and 2.752% FeO.

To find the influence of the correct fertilization system, the compound which determines the limitation and excludes consumption is the nitrate ion. The negative influence of high nitrate content in apple fruits, either in raw apples or different products, is well known. In children, the high nitrate content could determine illnesses, because nitrate assimilation and transformation into nitrosamines, which determines the transformation of hemoglobin into met-hemoglobin. This compound determines the blockage of blood oxygenation. In the case of large and permanent consumption, nitrates could determine baby blue illness in children and for other people, stomach ulcer and cancer (Addiscott *et al.*, 1990).

Potassium total content in apples must be near the 1.20% K_2O value.

The analysis of total forms shows a low content of potassium with values between 0.48 and 0.90% K_2O. A low content of this element could determine some problems on the quality of apples especially at the lodging of apples for a long time.

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To limit the consumption and marketing of products with a high nitrate content in our country, there are laws about the contents of nitrates, heavy metals and pesticides in vegetables and fruit. The law about the quality conditions for fresh vegetables and fruit for human consumption is Governmental Order no. 1 from 3 January 2002, where nitrate content for fresh apples is 60 ppm.

The analysis of nitrates shows a low content, between 35 and 60 ppm. These values show that the nitrogen fertilization system was conducted correctly and the apple quality is good. Influence of other pollutants is also important, such as heavy metals, which could appear due to the location of the Voinesti Tree Society near highways with high auto traffic or near industrial areas, which release Cu, Zn, Pb, Cd compounds in the environment and which could affect the quality of fruit and vegetables. So, Cu, Zn, Pb and Cd contents are determined. Copper, which is a microelement and also a heavy metal varies between 2.1 and 4.3 ppm, a content which does not affect the quality of apples.

From the Zn, Pb and Cd apple analysis, it is observed that the values of these elements are low and do not influence negatively the quality of apples. The maximum admitted limits from the Governmental Order no. 1 from 3 January 2002 for these elements are 5 ppm for Cu, 5 ppm for Zn, 0.5 ppm for Pb, and 0.05 ppm for cadmium. Tab. 3 shows that the values of these elements are within normal limits, so apples are not affected by pollution and the area is well protected in this respect.

Conclusions

Results regarding the biochemical content of apples revealed a high content of sugar, which varied between 9.53 and 12.34%.

Phosphorus was accumulated in quantities between 0.351 and 0.526% P_2O_5, a good normal content that determines the equilibrium between nutritive elements, especially with nitrogen.

The nitrate analysis, on a pollutant compound which could determine the consumption quality of apples revealed values between 35 and 60 ppm.

The heavy metal analysis of Cu, Zn, Pb, Cd respectively shown low values for fresh apples and from this point of view, a good quality for consumption.

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