REVIEW REGARDING THE CONTENTS IN POLYPHENOLS AND THE NUTRITIONAL VALUE OF PLANTS FROM ROMANIA'S SPONTANEOUS FLORA

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Abstract.
After polyphenols are defined, the benefits they bring to the body are presented and a few examples of polyphenols are given, polyphenol food sources are listed. It is subsequently mentioned that synthetic polyphenols are used in the food industry as additives with antioxidant properties. Because it was found that they negatively affect health efforts are made to replace them with polyphenols extracted from plants. They can be found in every flower making plant, being spread in all vegetative organs but also in flowers and fruits. Furthermore, research outcomes regarding the contents in antioxidants are presented, as well as the nutritive value of certain plants from our country and examples are given of plants from the spontaneous flora the colours of which indicate high contents of anthocyanin in flowers and fruits and flavonoids in flowers.

Keywords: meat industry, myoglobin, natural preservatives, polyphenols, scavenging activity

1. Introduction

Polyphenols are substances characterised by the presence of various classes of phenols, associated to different structures more or less elaborated. Chemically speaking, they are found under the shape of hydrogen, carbon or several groups of hydroxyl atom cyclic structures. Examples could include quercitrine, resveratrol, coumarines, and tannins. (Fig. 1)

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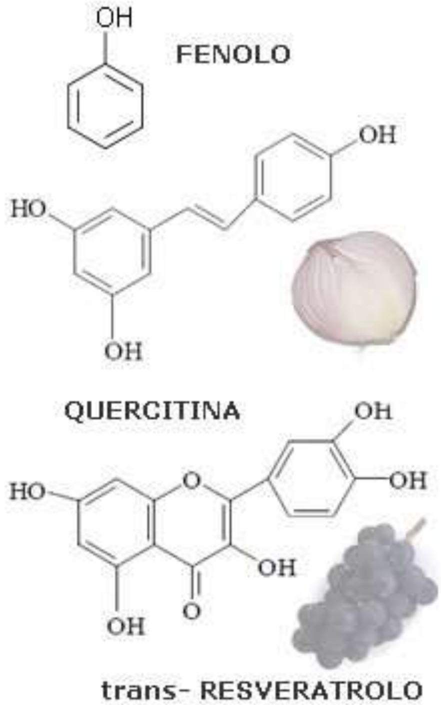

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Fig.1. Examples of polyphenols.

[(37) http://www.my-personaltrainer.it/integratori/polifenoli.html]

Advantages for the body

- Helps in therapies aiming the prevention of tumour formations;
- Succeed in preventing hepatic pathologies;
- Protect the bodies against cardiovascular diseases;
- Successfully prevent inflammatory processes;
- Actively participate to the stimulation of the immunity system;
- Contribute to the acceleration of hair growth.

Polyphenols are known for their antioxidant, anti-inflammatory, anti-bacterial, anti-tumour and anti-atherogenic action (limiting the fat deposition on the blood vessel walls). [36] Simple phenols belong to phenolic acids, for ex.: coumarines and benzoic acids. Their condensation can result in polymers such as lignin.

Tannins include condensed tannins (also known as proanthocyanidins, because by hydrolysis with strong acids they result in anthocyanidine) and hydrolysable tannins. There are heterogeneous polymers which contain phenolic acids (for ex. Gallic acid) and simple sugars.

Flavonoids (in Greek "flavus"= yellow): represent the largest group of natural phenols and they all have as reference structure 2 phenyl-benzo[a]pyrene, a flavonol. Structural variations from the hexane ring allow the subdivision of flavonoids in various families: flavonols, flavones, isoflavones, anthocyanins etc.

Of natural flavones we mention: *Luteolin* 5,7,3'4'-tetrahydroxyflavone, is found in wild Reseda (*Reseda lutea*). *Apigenine* 5,7, 4'-trihydroxyflavonae is found in chamomile (*Matricaria chamomilla*). (15).

Quercetine, 3,5,7,3',4'-penahydroxyflavone, a flavonol-derivative, is found, among others, in hop (*Humulus lupulus*) but also in some species of oak (*Quercus* sp.) [3].

From *Quercus robur* wood *vescalagin* was isolated, an ellagitannin.

From nutshells *juglanin* was isolated, from chestnut wood (*Castanea vesca* Gaertn. sin. *C. vulgaris* Lam. sin. *C. sativa* Gard.) Another ellagitannin was extracted, called *castalagin.* Rich in condensed tannins are also the bark and wood of pine spruce (*Picea excelsa* Lam.), birch (*Betula* type), willow (*Salix fragilis* L.), acacia (*Robinnia pseudoacacia* L.) [(4) p. 1187].-1193). –(n.n. Acacia is cultivated but it also spontaneously multiplied).

Rich in tannin is also the alder (common alder) tree bark (*Alnus glutinosa* Gaertn.).

Rutina, 3-ramno-glycoside of quercetin, is found in buckwheat (*Fagopyrum esculentum*) (n.n. we conclude that also in wild buckwheat – *Fagopyrum sagittatum*) *and* rue (*Ruta graveolens*)

Morin, 3,5,7,2',4'-pentahydroxyflavone, isomer with quercetin, isolated from "yellow wood" (*Morus tinctoria*) [15].

- *Arnica* type includes approximately 18 species spread in Europe, Asia, America de Nord. *Arnica montana.*L. (Arnica) which can be found in our country contains Gallic acid, tanning matters. [28 p.504]

Food sources of polyphenols. There are 3 classes of polyphenols: the flavonoids, tannins and phenolic acids. In a regular diet, polyphenols represent most of the antioxidants, especially in fruits and green goods. They are abundantly present in:

- Fruits, especially the ones with red-violet pigmentation, considered as the most popular source of flavonoids and tannins: berries, plums and cherries, but also melons apples, grapes and pears;

- vegetables, beetroot, eggplants, onion, celery, parsley, cabbage, broccoli, peas, beans (important sources of flavonoids);
- whole grains: oats, rye (both of them sources of phenolic acids), soya (rich in flavonoids);
- aromatic plants: oregano, rosemary, salvia, sesame;
- dry fruits: almonds, peanuts, nuts, ground nuts;
- red wine, rich in tannin and flavonoids, especially in resveratrol;
- coffee and chocolate, with a high concentration of phenolic acids;
- green tea and olive oil; [37]

The company Adams Vision from the USA [38] trades a food supplement containing trans-resveratrol, extracted from *Polygonum cuspidatum.*

The European Food Safety Authority (EFSA) reassessed the synthetic antioxidants BHA (E 320) and BHT (E 321) used as additives in food industry and found that, despite the doses used are believed as safe, sometimes they can have negative effects upon people's health: aggravate symptoms of patients suffering from chronic rash, they are cytotoxic and genotoxic, induce apoptosis, have an estrogenic effect, increase the risk for stomach cancer, etc.[33, 34 citated by17]. Plant-extracted polyphenols, especially flavonoids, because of their antioxidant activity, can be efficient replacers of synthetic antioxidants and, in addition, they exert beneficial effects on consumer's health. Despite the fact that they raise the price of food and hinder their characterisation, plant-extracted polyphenols give more value to foods, keep blood vessels healthy and the immunity system as well, and have antibacterial and antifungal properties [35 citated by 17].

Polyphenols represent a group of substances spread in every flower-making plant, being distributed in each vegetative organ, but also in flowers and fruits. They are considered as secondary metabolites involved in the chemical defense systems plats have against pests, as well as in the performance of plant-to-plant interference. From the structural point of view, polyphenols contain at least one aromatic nucleus and one or several hydroxyl groups, engrafted on aromatic nuclei together with other substituents. The studies carried out proved that polyphenols exert important biological properties, having antioxidant, anti-cancerigenous, anti-inflammatory, antibacterial and antiatherogenic effects (limiting the fat deposition on the blood vessel walls).

In the famous magazine European Journal of Clinical Nutrition, Perez Jimenez and col. (2010) published the list of the 100 richest foods in polyphenols. This list includes: clove, mint, star anise, cocoa powder, oregano, beet seeds, sage, rosemary, black olives, capers, green olives, basil, gooseberries, strawberries, ginger, black grapes, red onion, mere, spinach, green tea, broccoli, asparagus, nectarines, anchovies, salad, carrots etc.

Nationally and internationally performed studies proved that medicine plants are also highly rich in polyphenols with a remarkable antioxidant activity. Thus, harvest mite fruits have high contents of phenolic acids, proanthocyanidins and catechins [1 citated by 17], hips contain phenolic acids and flavonoids [18 citated by 17], and sea-buckthorn fruits contain flavonoids [9 citated by 17].

Thanks to the remarkable antioxidant activity and to beneficial effects polyphenols exert on the human body, researchers are interested in the extraction of polyphenols from plants and subproducts of food industry for the purpose of using them as preservatives in the food industry.

I meat there are three major oxidative processes affecting the taste, smell and colour of the means and food products obtained from meat, namely the oxidation of membrane lipids, oxidation of proteins and oxidation of the conjugated protein - myoglobin. The oxidation of lipids from meat, also known as lipid peroxidation, is an undesired chemical process because the resulted peroxides decompose and form toxic carbonic compounds with an unpleasant smell (they give to the meat the characteristic smell of rankness). Moreover, lipid oxidation can also initiate other unwanted chemical processes such as myoglobin and protein oxidation of, affecting the quality of the meat and meat products. Myoglobin oxidation (red-coloured pigment) with met myoglobin (brown-coloured pigment) is responsible for the change of the colour of the meat and the protein oxidation is responsible for various biochemical changes, protein fragmentation or aggregation and the decease of their solvability [14].

Lipid oxidation. Lipids' stability to oxidation depends on the balance existing between anti- and pro-oxidants, including on the concentration of polyunsaturated fatty acids. In the cell membranes meat has high contents of polyunsaturated fatty acids likely to oxidation chain reactions, hard to control, initiated by free radicals. The initiation of oxidation takes place by pulling out a hydrogen atom from a methylene grouping of the lipid molecule (LH), under the action of a free radical (R•):

$$LH + R\bullet \rightarrow RH + L\bullet$$

The number of lipid radicals (L•) increases with the number of bis-allylic carbon atoms, namely with the degree of fatty unsaturation. The polyunsaturated radical L• undertakes an intermolecular electronic rearrangement forming a conjugates diene, capable of reacting with molecular oxygen and forming the peroxyl radical (LOO•):

$$L\bullet + O_2 \rightarrow LOO\bullet$$

In the propagation phase, LOO• pulls out a hydrogen atom from another lipid molecule and forms a peroxide (LOOH) and another lipid radical L•:

$$LOO\bullet + LH \rightarrow LOOH + L\bullet$$

Resulted lipid peroxides are considered primary products of lipid peroxidation because at high temperatures or in the presence of transitional metal ions they decompose in secondary volatile or non-volatile products such as carbonyl compounds, alcohols, alkanes, furans which determine the change in smell and taste of foods products.

The reaction chain is concluded with the union of two radicals existing in the reaction environment:

$$L\bullet + L\bullet \rightarrow LL$$
$$LOO\bullet + LOO\bullet \rightarrow LOOL + O_2$$
$$L\bullet + LOO\bullet \rightarrow LOOL$$

Protein oxidation occurs, just as lipid oxidation, by a chain radical mechanism, but much more complex if taken into consideration the large number of oxidation products formed. Pulling out a hydrogen atom by a reactive oxygen species (ROS) from a protein (PH) generates a carbon-centred protein radical (P•) consecutively converted into peroxyl radical (POO•), in the presence of oxygen and in alkyl peroxide (POOH), by pulling out a hydrogen atom from another molecule. Further reactions with the hydroperoxyl radical ($HO_2\bullet$) generate an alkoxy radical (PO•) and its hydroxyl derivatives (POH) [7]:

$$PH + ROS\ (ex.,\ HO\bullet) \rightarrow P\bullet + H_2O$$
$$P\bullet + O_2 \rightarrow POO\bullet$$
$$POO\bullet + P \rightarrow POOH + P\bullet$$
$$P\bullet + HO_2\bullet \rightarrow PO\bullet + POH$$

Myofibril proteins are likely to oxidate, the most sensitive of all being the myozine, followed by troponin T. Of amino acids, cysteine, tyrosine, phenylalanine, tryptophan, histidine, proline, arginine, methionine and lysine were characterised as being sensitive to free radical attack.

The nature of the resulted reaction products depends on the primary structure of polypeptide catenary. Radicals coming from arginine, lysine and proline are oxidated at carbonilic radicals and the ones coming from cysteine and methionine take part to the formation of crossed covalent connections or to the formation of sulphur derivatives.

In conclusion, the most significant chemical changes occurring with muscular proteins because of oxidation are: *The formation of protein carbonyl, loss of thiol functional groupings and crossed tying of proteins.*

Myoglobin oxidation. Oxidation of feros-oxymyoglobin (Fe^{2+}) to feric-metmyoglobin (Fe^{3+}) is responsible for the discoloration of meat while stored. The oxidation of the ion Fe^{2+} from the oxymyoglobin occurs as a consequence of two reactions:

1) $Fe^{2+} + O_2 \rightarrow Fe^{3+} + O_2\bullet^-$; $O_2\bullet^- + 2H^+ \rightarrow H_2O_2 + O_2$
2) $Fe^{2+} + H_2O_2 \rightarrow Fe^{3+} + HO^- + HO\bullet$

Not only myoglobin oxidation affects the colour of the meat but also the stability of lipids and proteins from meat, metmyoglobin being pro-oxidant in these two processes. When antioxidant enzymes (reducers) from muscles are exhausted as a result of sacrifice, metmyoglobin accumulated in the meat will react with the hydrogen peroxide and will form the species of myoglobin hypervalente perpherilmyoglobin (•MbFe(IV)=O) and ferrimyoglobin (MbFe(IV)=O). In order for the radical •MbFe(IV)=O, which is extremely reactive, to stabilize it will pull out a hydrogen atom from another lipid or protein molecule and it will determine the formation of new radicals capable of initiating other chain reactions:

$$\bullet MbFe(IV){=}O + LH \rightarrow MbFe(IV){=}O + L\bullet + H^+$$

$$\bullet MbFe(IV){=}O + PH \rightarrow MbFe(IV){=}O + P\bullet + H^+$$

Recent studies proved that ferrimyoglobin can also initiate the protein oxidation reaction, for ex., myosin oxidation ([Baron and Andersen, 2002).

The protective effect of polyphenols over lipids and proteins is mediated by the following mechanisms: 1) polyphenols remove the species of oxygen and nitrogen free radicals; 2) polyphenols inhibit the formation of oxygen and nitrogen free radicals with the inhibition of certain enzymes and the chelating of ions corresponding to traditional metals involved in the production of free radicals; 3) polyphenols regulate or protect antioxidant defense [5].

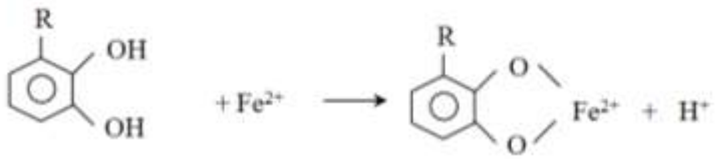
4) Polyphenols (PFOH) work as hydrogen donors, being capable of annihilating free radicals (R•) and interrupt the reaction chain. The resulted phenoxyl radicals (PFO•) have low reactivity and cannot initiate another reaction chain. In some cases, phenoxyl radicals can combine with other radicals they interfere with, working as terminators of the reaction chain:

$$PFOH + R\bullet \rightarrow PFO\bullet + RH$$

$$PFO\bullet + R\bullet \rightarrow PFOR$$

The capacity of polyphenols to annihilate free radicals depends on the number of hydroxyl grouping (phenolic acids) and the structure if the polycyclic system (flavonoids).

5) Polyphenols which have in their structure two neighbouring hydroxyl groupings (for ex., gallates and catecholates) can form with ions Fe^{2+}, Cu^{2+} or Cu^+ inactive complexes:



Chelating ions Fe^{2+}, Cu^{2+} and Cu^{+} is highly important as these ions generate free radicals in the Fenton reaction:

$$H_2O_2 + Cu^+ \text{ or } Fe^{2+} \rightarrow Cu^{2+} \text{ or } Fe^{3+} + HO\bullet + HO^-$$

Davies and Slater (1987) believe that the ion Fe^{2+} has the ability to decompose lipid peroxides (LOOH) according to a mechanism similar to the decomposition of oxygenated water in the Fenton reaction:

$$LOOH + Fe^{2+} \rightarrow LO\bullet + HO^- + Fe^{3+}$$

Radical LO• has the ability to extract hydrogen from another fatty acid or LOOH molecule, generating other chain reactions. The LO• radical's ability to extract hydrogen atoms from the mentioned molecules was proved based on the reduction potential of LO• (+1,6 V) and based on the Gibbs (ΔG°) free energy exchanges in hydrogen's reaction with the bis-allyl carbon of propene (-23kcal/mole) and LOOH (-14 kcal/mole).

To the meat industry, polyphenols' property of chelating the Fe^{2+} ions is very important because meat can be easily contaminated with these ions from knives and metal pots. This contamination accelerates oxidative processes both regarding lipids and proteins. In conclusion, adding plant-extract polyphenols in the products obtained from meat inhibit lipid and protein oxidation because of their ability to annihilate free radicals and chelating transitional metal ions. The antioxidant activity of polyphenols is explained by their capacity to inhibit certain enzymes directly involved in the oxidative processes (lipooxygenases, cyclooxygenases, myeloperoxidases, NADPH oxidases, xantinoxidases), generating reacti oxygen species, and even organic peroxides (8), as well as the activity of certain enzymes indirectly involved in the oxidative processes (for ex., phospholipases A_2) [11].

6) Poliphenols stimulate the activity of antioxidant enzymes superoxid dismutase (SOD) and catalases (CAT) [32].

2. Material and method

In works [12] and [13] the method and materials used are broadly described and, as such, they will only be mentioned again very briefly when needed, so as not to affect the cursive understanding of the text. Work [10] was not published.

In order to identify plants from our country's spontaneous flora which contain polyphenols, in what quantities and conditions, Israel-Roming Florentina et al. [10, 2014] carried out certain determinations in the laboratory, on ramsin (*Allium ursinnum* L.), celandine (*Ficaria verna* Huds. sin.*Ranunculus Ficaria* L.) and dandelion plants (*Taraxacum officinale* Weber.), which were picked before blooming, mid-March, from two different places: Băneasa forest and Tulcea forest. As a reference plant greenhouse-cultivated salad was used (*Lactuca sativa)*, purchased from a market in Bucharest.

Table 1 lists information on the analysed samples.

Table 1

Information on the analysed samples
(ISRAEL -ROMING Florentina ş.a., 2014)

Sample	**Sample code**	**Origin**	**Cropping period**	**Development stage when cropped**	**Used part**
Ramsin	LT	Tulcea forest	14.03.2014	before blooming	young leaves
Ramsin	LB	Băneasa forest	13.03.2014	before blooming	young leaves
Celandine	UT	Tulcea forest	13.03.2014	before blooming	young leaves
Celandine	UB	Băneasa forest	14.03.2014	before blooming	young leaves
Dandelion	PT	Tulcea forest	20.03.2014	before blooming	young leaves
Dandelion	PT	Băneasa forest	20.03.2014	before blooming	young leaves
Salad	S	Bucharest Market (greenhouse)	20.03.2014	maturity	leaves

Table 2 shows the outcomes of the analyses carried out on the plants mentioned in the previous table regarding the polyphenol contents and Table 3 - the contents in ascorbic acid.

Table 2
Overall polyphenol contents
(ISRAEL -ROMING Florentina and collaborators, [10])

Sample	**mg GAE/g su.***	**mg GAE/g su.**
LT	2,41	22,12
LB	2,12	19,57
UT	2,34	19,61
UB	2,80	21,78
PT	1,14	8,58
PT	0,94	7,00
S	0,41	6,55

- su = stove dried substance at 105º C
- GAE = Gallic acid equivalent.

Table 3 Ascorbic acid contents
(ISRAEL -ROMING Florentina and collaborators, [10])

Sample	**mg/g sp**	**mg/gsu**
LT	0,66	6,06
LB	0,80	7,41
UT	0,76	6,36
UB	0,90	7,06
PT	0,23	1,76
PT	0,13	0,98
S	0,04	0,69

I can be noticed the high nutritive value of plants in the spontaneous flora by their antioxidant content.

A comparative study on the antioxidant content in some bacca fruit from six species - raspberries (*Rubus idaeus* L.), blackberries (*Rubus fructicosus* L.), strawberries (*Fragaria ananassa*), field ash (*Aronia melanocarpa*), blackcurrants (*Ribes nigrum L.*), sea-buckthorn (*Hippophaë Rhamnoides* L.) was carried out by Luţă Gabriela and collaborators [12]. The overall polyphenol content is showed in table 4.

Table 4. Overall polyphenol content of some bacca fruit (Gabriela LUŢĂ and collaborators [12])

Species	Overall polyphenol content – GAE mg/100g	Standard deviation	Relative standard deviation %
Field ash	7791,6	695,5	8,93
Raspberries	1728,6	75,3	4,36
Blackberries	3340,2	134,2	4,02
Strawberries	4501,1	207,6	4,61
Blackcurrants	6339,1	312,8	4,93
Sea buckthorn	2890,6	119,6	4,14

Regarding the anthocyanin level, the highest content was found in blackcurrants and the lowest - in strawberries (table 5). After the Cernobâl accident, Bulgaria exported in Ukraine blackcurrant juice.

Table 5 Anthocyanin content of some bacca fruit Gabriela LUŢĂ and collaborators [12]

Species	Anthocyanin cianidine-3 Glucosidal equivalent	Standard deviation	Relative standard deviation %
Field ash	386,,2	7,4	1,92
Raspberries	109,0	12,0	11,01
Blackberries	266,9	21,3	7,98
Strawberries	91,3	3,4	3,72
Blackcurrants	520,0	14,1	2,71

These analyses do not include sea-buckthorn because the colour of sea-buckthorn leaves is yellow. The standard deviation has values which may vary up to three times, probably because frozen fruit were analysed.

The overall flavonoid content was high in each sample taken (table 6)

Table 6. The overall flavonoid content of some bacca fruit
(Gabriela LUȚĂ and collaborators [12])

Species	The overall flavonoid content quercetin equivalent–mg/100g	Standard deviation	Relative standard deviation %
Field ash	1793,3	23,2	1,29
Raspberries	536,6	25,7	4,79
Blackberries	591,2	11,0	1,86
Strawberries	662,8	31,7	4,78
Blackcurrants	1288,4	58,3	4,52
Sea buckthorn	1379,9	45,1	3,27

The highest flavonoid content was found with the field ash. A comparative analysis reveal field ash and sea-buckthorn as the richest sources of phenolic antioxidants for the bacca fruit studied.

The authors conclude that, by the high content of phenolic compounds found, the analysed bacca fruit are an excellent source of natural antioxidants with a beneficial medical potential.

According to some authors, the overall phenol content in sea-buckthorn depends on the cropping and varies between 828,7-1099,6 mg/100g [16, 31].

Gabriela Luţă and collaborators [13] also made estimations regarding the overall antioxidant content (phenols and ascorbic acid) and their scavenging activity (antioxidant activity), from raspberry (*Rubus idaeus* L.), strawberry (*Fragaria ananassa*) and sea-buckthorn (*Hippophaë Rhamnoides* L.) samples coming from the market. The determinations were made by using fresh fruit. The results are showed in image 2. It highlights the fact that sea-buckthorn fruit are the richest in polyphenols and ascorbic acid and have the most intense scavenging activity, and raspberry fruit have the lowest scavenging capacity, requiring the highest concentration in antioxidants of the sample (512,76 µg/ml, respectively 727,63µg/ml) in order to remove 50% of the free radical DPPH.

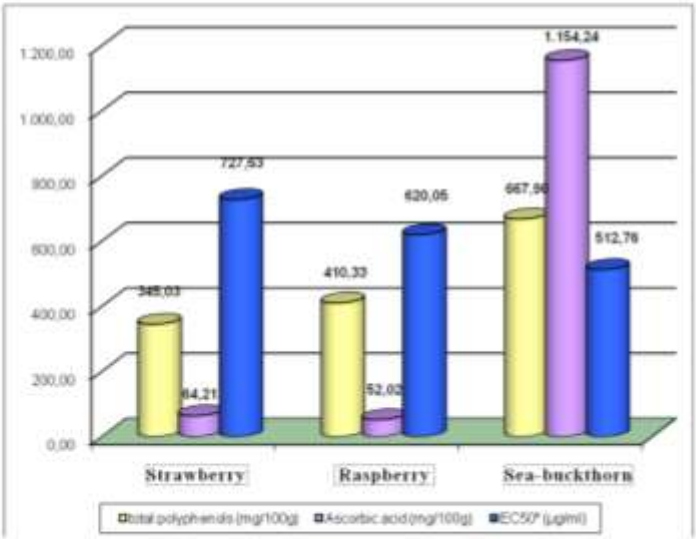


Fig. 2. The antioxidant content and scavenging activity from the analysed fruit (LUŢĂ Gabriela and collaborators [13]).

* Free radical scavenging activity (overall antioxidant capacity) was determined (expressed) by using the stable free radical diphenylpicrilhydrazyl (DPPH). EC_{50} is the sample's concentration in antioxidants, necessary so as to remove 50% of the free radical DPPH.

Furthermore, examples are given of plants from our country's spontaneous flora the colours of which indicate high content of anthocyanin in flowers and fruit and flavonoids in flowers (some were previously mentioned).

Anthocyanin containing plants (with pink, red, purple, blue coloured flowers)

- Genus *Corydalis* Vent. (stagger weed) [22 p. 84-95]: *C. solida* L.- violet-red flowers.
- Genus *Arctium* L. [28 p. 622-631] includes 5 species spread in Europe and Asia. They have red flowers, thus they contain anthocyanin. Ex. *A. tomentosum*. (burdock).
- Genus *Agrostemma* L. [21 p. 123-127] *A. Githago* L. (corn cockle)
- Genus *Ajuga* L. (bugleweed) [27 p. 86-97] : *A. genevesis* L..
- Genus *Melandrium* Röhl. [21 p. 186- 198]:): *M. Rubrum* (Weig.) red campion.
- Genus *Dianthus* L. (carnation, dianthus). In [21 *p.* 217-290] 42 species and various hybrids are described: *D. Armeria* L. – red corolla; *D. trifasciculatus* Kit. – red petals;
- Genus *Carduus* L. [28 p. 631-672] includes over 120 species, of which in *Flora* 17 species are described.

Species from genus *Carduus* contain anthocyanin (mauve, pink, red, purple coloured leaves).

C. nutans L. (sin. *C. ortocephalus* Schur.) (thistle). Red flowers.

- Genus *Cirsium* Adans. [28 p. .672-743] includes approximately 120 species (after another 200 species) and various hybrids.

Most of the species in genus *Cirsium* contain anthocyanin (pink, purple coloured leaves).

In [28] 31 species are described. We will list the first 9.

.- *C. arvense* L. (bull thistle). Light red and violet flowers

.- *C. lanceolatum* L. (Saint Mary's thistle, burr). Red flowers

- *C. furiens* Gris et Sch.. (sin. *C transsilvanicum* Schur Enum., sin. *C. ferox* Baumg., *C. ciliatum* Auct., etc.) Saint Mary's thistle – light red or white-pink flowers.

.- *C. albidum* Velen. (sin. *C. Albidum* ssp. *poycroum* Petrak) red flowers.

.- *C. bulgaricum* DC. (sin *C. odontolepis* Boiss.) – red flowers.

.- *C. sintenisii* Freyn. (sin. *C. Boissieri* Freyn et Bornm. Sin. *C. Sintenisii* ssp.*galaticum* Freyn l.c.) – pink flowers.

- *C. ciliatum* (Murr) - red flowers.

.- *C. serulatum* M.B. (sin. *Cnicus serrulatus* M.B.) – red flowers.

.- *C. eriophorum* (L.) (sin. *Cnicus eriophorus* Baumg) – red purple flowers.

-Genus *Onopordon* L. [28 p.748-751] includes 30 species.. red flowers.

- *Onopordon acanthium* L.(sin. *Cousinia bulgarica* Koch.) (thistle, big butcher's broom).

- Genus *Papaver* L. [22 p. 64-83]:): *P. Rhoeas* L. (corn poppy), *P. dubium* L. (wild poppy).

- Genus *Centaurea* L. (buggleweed, knotweed, cornflower) includes over 400 species). In Flora RPR [28 p. 785-951] 69 species and various hybrids are described. Most of the species have flowers with anthocyanin (blue, black-purple, red, pink or sometimes white). Howerver there are species with yellow flowers.

- *C. cyanus* L. (sin. *Cyanus segetum* Baumg.) (bluebottle, buggleweed). Disk flowers mauve, the marginal radiant ones are blue, rarely white or pink.

- Genus *Vicia* L. [24 p. 349-402] (vetch) includes approximately 150 species. *V. villosa* Roth., *V. cracca* L., *V. sativa* L.

- *C. orientalis* L. (sin. *Cyanus orientalis* Baumg.). Yellowish flowers.

- Genus *Medicago* L. (lucerne) [24 p. 118-136]. Blue-violet flower species are *M. sativa* L. (lucerne) and *M. varia* Martyn.

- Genus *Rhododendron* L. (rhododendron) [26 p. 121-122] *R. kotschyi Simk.*

- Genus *Trifolium* L. (clover). [24 p, 145-220)].. *T. pratense L.* (red clover).

- Genus *Viola* L. [22 p. 553- 625] includes approximately 500 species spread all over the globe. Ex. *V. ambigua* W. Et K. (sin. *V. campestre* M.B.) dark violet petals.

- *V. tricolor* L. (pansy) – usually has dark violet flowers, rarely light violet, yellow or violet-blue.

Genera and species the fruit of which contain anthocyanin

- Genus *Berberis* L. [22 p. 28-32)]**:***)***:** *B. vugaris* L. (barberry) vermillion fruit.
- Genus *Fragaria* L. (strawberries, wild strawberries) [23 p. 580-595].. Ex. *F. vesca* L. (forest wild strawberries). Red-carmine receptacle flowers.
- Genus *Phytolacca* L. [20 p. 607-612] includes an overall number of 26 species of which in our country only 2 can be found: *P. esculenta* Van Houtte. and *P. americana* L. Fruit are bacca, of dark-red colour and are used to colour the wine.
- Genus *Crataegus* L. (hawthorn) [23 p. 256-271] *: C. monogyna* Jacq. (hawthorn, dahlia).
- Genus *Punus* L. (plum, myrobalan plum) [23 p. 835-847]: *P. spinosa* L. (porumbar). Rimy blackish blue flowers.
- Genus *Cerasus* Adans. (sweet cherry, sour cherry) [23 p. 847-861] : C. av*ium* (L.) Mnch. (sin. *Prunus avium* L., sin. Prunus Cerasus var. *Avium* L) (sweet cherry).
- Genus *Ribes* L. [23 p. 136] *: R. rubrum* L. (red currant); *R. nigrum* L. (blackcurrant).
- Genus *Rosa* L. *(*brier, eglantine, rose) [23 p. 708-835].). Ex. : *R. canina* L. (brier).
- Genus *Rubus* L. (blackberries, brambles, raspberries, [23 p. 276-580]. 101 species and various hybrids are described. Ex. : *R. caesius* L. (stubble bramble), *R. idaeus* L. (raspberry).
- Genus *Ruscus* L. [39 p. 379-683]: *Ruscus aculeatus* L. (bur).

Flavonoid containing plants (the have yellow coloured flowers)

- Genus *Abutilon* Adans.(abutilon, corchorus) [25 p. 29-30]: *A. theophrastii* Medik.; corchorus, abutilon.
- Genus *Adonis* L. [21 p. 653-661]: *A. vernalis* L. (adonis).
- Genus *Chelidonium* L. [22 p. 62-63]*: C. majus* L. (common celandine).
- Genus *Crocus* L. includes two species with yellow flowers: *C. chrysanthus* Herb. and *C. moesiacus* Ker-Gawl. [30 p. 450-454)].
- Genus *Lotus* L. (bird's-foot trefoil). [24 p. 230-236]. *Lotus corniculatus* L.(small bird's-foot trefoil).
- Genus *Melilotus* (L.) Adans. [24 p. 136-145]. Includes two species with yellow flowers: *M. officinallis* (L.) Medik (melilot) and *M. arenarius*. Greek.
- Genus *Medicago* L. (lucerne) [24 p. 118-136] mentioned at the blue-violet flower species. The yellow flower species include *M. lupulina* L. (small clover), *M. falcata* L. (yellow lucerne, trefoil) etc.

- Genus *Onobriychis* Adans. (esparcet) [24 p. 338-346]. *O. viciifolia* (esparcet).
- Genus *Papaver* L. [22 p. 64-83]: *P. pyrenaicum* L., *P. Agemone* L.
- Genus *Ranunculus* L. (crawfoot) [21 p. 561-627]. Ex.: *R. Lingua*. L., *R. sardous* Cr., *R. Bulbom* L.
- Genus *Nuphar* Sm. (water lily) [22 p. 38-39]. *N. luteum* (L.) yellor (water lily).
- Genus *Reseda* L. [22 p. 501-509]: *R. Luteola* L. (reseda); *R. lutea* L. (weld).
- Genus *Rorippa* Scop. [22 p. 215-250]: *R. pyrenaica* (L.) Rchb. (marigold); *R. islandica* (Oed.) Borb. (urnip); *R. austriaca* Cr. (marigold).
- Genus *Sinapis* L. [22 p. 467-473]: *S. arvensis* L. (sin. *S. campestris* Schurr.) (charlock, canola).
- Genus *Rapistrum* Crantz. (barilla) [22 p. 481- 486]: *R. perenne* (L.) All.; (sin. *Bunias Erucago* Landoz. (white barilla).
- Genus *Taraxacum* Wigg. [29 p. 109-126]: *T. officinale* Weber. (dandelion).

Conclusions

Based on the data showed the following important conclusions can be reached:

(1) – Upon determinations made in spring, by their antioxidant cintent, some plants from the spontaneous flora - ramson (*Allium ursinnum*) and celandine (*Ficaria verna* sin. *Ranunculus ficaria*) – have a much higher nutritional value compared to greenhouse salad.

(2) – With regard to the level of anthocyanin, the largest content was found in blackcurrants and the lowest – in strawberries.

(3) – Among the plants from our country's spontaneous flora there are species with a very high polyphenol content; in this respect field ash (*Aronia melanocarpa*) and sea-buckthorn (*Hippophaë rhamnoides*) fruit are noticed. (Overall polyphenol content – 7791,6 GAE mg/100g, respectively 2890,6 GAE mg/100g)

(4) – Comparative research in strawberry, raspberry and sea-buckthorn fruit highlighted that sea-buckthorn fruit are the richest in polyphenols and ascorbic acid and have the most intense scavenging activity (require an antioxidant concentration of the sample of only 512,76 μg/ml in order to remove 50% of the free radical DPPH), and raspberry fruit have the lowest scavenging activity and require the highest antioxidant concentration of the sample (727,63μg/ml) in order to remove 50% of the free radical DPPH.

(5) – Research is necessary on the polyphenol content of more and more species from the spontaneous flora in order to highlight other species useful in the food industry, as well.

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