Bulgarian Chemical Communications, Volume 49, Special Edition B (pp. 199 – 206) 2017

Oxygen Radical Absorbance Capacity of Bulgarian fruits, vegetables, herbs and mushrooms. A review

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Received February 13, 2017; Revised March 07, 2017

Dedicated to Acad. Bogdan Kurtev on the occasion of his 100^th^ birth anniversary

In search of novel sources of antioxidants in the recent years, traditional plant foods have been extensively studied for their antioxidant activity. Investigation of natural products is a research field with great potential and is especially important in countries possessing great biodiversity, like Bulgaria. About 600 plant species from Bulgarian flora are recognized as medicinal and are traditionally used in ethnopharmacology and phytotherapy. Given the huge interest in antioxidants, the large number of methods developed to give a quantitative assessment of antioxidant action is not surprising. Dozens of methods for determination of antioxidant activity in food and biological samples have been developed. The results reported in following sections are part of a long-term study of the Laboratory of biologically active substances, Institute of Organic Chemistry with Centre of Phytochemistry – Bulgarian Academy of Sciences, on antioxidant activity of Bulgarian fruits, vegetables, herbs and mushrooms. Results are obtained by the Oxygen Radical Absorbance Capacity (ORAC) method in which the inhibition time and inhibition degree can be measured. The ORAC method is relevant for biological samples, since it assesses the radical scavenging activity of the sample against peroxyl radicals, which physiologically are the most important ones. Besides, oxidation process is performed in water media, at physiological pH and temperature. Current review compiles data for antioxidant activity of 90 raw materials, including unpublished results for ORAC value of 11 mushrooms, 4 vegetables and 2 herbs.

Key words: ORAC - Oxygen Radical Absorbance Capacity; Bulgarian plants, fruits, vegetables, herbs, mushrooms

INTRODUCTION

Life on earth is inconceivable without oxygen (O_2) but in higher concentration this vital element is toxic to aerobes. Most of the damaging effects of O_2 are due to oxygen radicals which embrace superoxide ($O_2^{\cdot-}$), hydroperoxyl ($HOO^{\cdot}$), hydroxyl ($HO^{\cdot}$), peroxyl ($ROO^{\cdot}$) and alkoxyl ($RO^{\cdot}$) radicals [1]. These, together with the non-radicals hydrogen peroxide (H_2O_2), ozone (O_3) and singlet oxygen ($^1O_2$) constitute the so called reactive oxygen species (ROS). ROS together with the nitrogen reactive species (RNS): nitric oxide (NO), peroxynitrite ($ONOO^-$), peroxynitrate, *etc.* are constantly produced in our bodies through numerous physiological reactions and processes [2]. Experimental evidence has directly or indirectly suggested that there are six major reactive species causing oxidative damage in human body. These species are superoxide anion, hydrogen peroxide, peroxyl radicals, hydroxyl radical, singlet oxygen and peroxynitrite. Superoxide is formed *in vivo* by NADPH oxidase in phagocytic cells, by other enzymes like xanthine oxidase and xanthine dehydrogenase which reduce O_2 to $O_2^{\cdot-}$ and by the auto-oxidation of many biomolecules like glyceraldehydes, $FMNH_2$, $FADH_2$, adrenalin, noradrenalin and dopamine [3]. The most important source of $O_2^{\cdot-}$ *in vivo* is the mitochondrial electron transport chain and hemoglobin in human erythrocytes also could be a source of superoxide radicals [4]. Hydroxyl radicals are the most potent oxidants among ROS. Physiologically they are being produced mainly trough Fenton-like reactions catalyzed by transition metal ions, UV-induced homolytic cleavage of H_2O_2 [5], γ-rays-assisted homolytic fission of water and hypochlorous acid reacting with $O_2^{\cdot-}$ [6]. Peroxyl and alkoxyl radicals are good oxidizing agents which can easily abstract hydrogen atom from different biomolecules. *In vivo* they are formed trough the reaction of carbon-centered radicals with O_2 or by decomposition of organic peroxides [7]. Hydrogen peroxide is continuously produced in many tissues *in vivo* and mitochondria are the biggest contributors to its generation both by monoamine oxidases and by dismutation of $O_2^{\cdot-}$ [1]. Singlet oxygen is often generated by photosensitization reactions and its detrimental

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effect is expressed mainly in skin and eyes damages. Peroxynitrite is generated by the reaction of NO with superoxide radical and the biggest contributors for NO generation are the nitric oxide synthase enzymes. To counteract the assault of all ROS and RNS, living cells had elaborated a complex biological defense system composed of enzymatic and non-enzymatic antioxidants that convert ROS/RNS to harmless species. The term antioxidant is defined as any substance that in low concentrations compared to those of an oxidizable substrate, significantly delays or prevents oxidation of the substrate [1]. By the mechanism of action, antioxidants are divided to preventive and chain-breaking antioxidants. Preventing antioxidants act as the first line defense by suppressing the formation of ROS and RNS. These antioxidants remove active species rapidly before they attack biologically essential molecules. For example, superoxide radical is converted to oxygen and hydrogen peroxide by superoxide dismutase (SOD) and hydrogen peroxide can be converted to water and oxygen by catalase. In contrast, no enzymes are known to counteract $ROO^{\cdot}$, $HO^{\cdot}$, $^1O_2$ and $ONOO^-$ [8]. Therefore, the burden of defense relies on a variety of nonenzymatic antioxidants such as vitamins C and E and many phytochemicals such polyphenols that have the property to scavenge oxidants and free radicals. These scavenging antioxidants act as the second line defense *in vivo*. Usually, there is balance between the antioxidants and the prooxidants *in vivo* but several factors like stress, radiation, nutrition, polluted atmosphere and smoking disrupt the oxidative balance leading to the so called oxidative stress. Oxidative stress is a physiological state which is believed to be a prerequisite for the development of many diseases including cardiovascular disease (CVD), stroke, and neurodegenerative disorders such as Alzheimer disease and Parkinson disease [9–11]. The injury caused by oxidative stress can affect all organ systems. For example, LDL oxidation is the initial step to the arteriosclerosis development, leading to cardiovascular diseases and oxidized DNA basis are mutagenic and are involved in the carcinogenesis. In case of oxidative stress it is necessary to accept exogenous antioxidants with the diet. Most of the antioxidants taken with the diet are of plant origin and the richest sources are herbs, fruit and vegetables. Polyphenol substances, carotenoids, vitamin C and vitamin E are the biggest contributors to the antioxidant properties of these raw materials. A growing amount of evidences indicates that the consumption of plant foods is correlated with a lower risk from development of atherosclerosis and oxidative stress-related diseases [12]. In contrast, diets poor in plant-based foods and rich in animal products and ingredients are related to increased risk for CVD and certain types of cancer [13]. In the last decades, polyphenolic compounds gained a lot of attention and are subject to thorough research because of their antioxidant properties and beneficial effect beyond vitamin action. They are the most abundant antioxidants taken with the diet [14] with over 8000 known compounds which makes them one of the largest groups in plant kingdom. By definition polyphenols are compounds that have more than two phenolic hydroxyl group attached to one or more benzene rings. Natural polyphenols are structurally diverse and vary from single molecules, for example some phenolic acids to highly polymerized structures like tannins [15].

Taking into consideration the diversity of substances with antioxidant activity and that of ROS and RNS, the challenge for the development of a standard universal method for measuring antioxidant activity is high. The situation is complicated additionally by the different physico-chemical characteristics of antioxidants and the fact that antioxidants react differently towards different radicals or oxidants. For example, carotenoids which are poor radical scavengers are very good inhibitors of singlet oxygen. Due to the different mechanisms and reaction characteristics, none of the known methods described in the literature does not accurately reflect all aspects of antioxidant activity against the variety of ROS and RNS, and there is still no consensus for a universal standardized method for determination of antioxidant activity of natural products [16]. The antioxidant activity is defined as the ability of a compound to reduce prooxidant agents. Given the huge interest in antioxidants, the large number of methods developed to give a quantitative assessment of the antioxidant action is not surprising. Dozens of methods for determination of antioxidant activity in food and biological samples have been developed. Typically, the samples analyzed are composed of a large number of individual compounds, which makes difficult the quantitative assessment of their antioxidant action and therefore, most methods measure the common antioxidant activity of the sample. Different methods are based on the generation of different radicals, acting through different mechanisms and still lacks a unified standard method which provides an assessment of the antioxidant properties of a given compound against all radicals. None of the methods invented do fully cover the antioxidant activity, because it expresses the antioxidant properties of a given compound against a given oxidant under defined conditions. Therefore, no method gives "total" evaluation of these properties and it is correct whenever talking about antioxidant activity to note the method by which it is measured [16]. Still the most employed concept for antioxidant action is associated with antioxidants as radical scavengers. Based on the chemical mechanism by which this is done, the methods for the determination of antioxidant activity are divided into two categories: based on hydrogen atom transfer (HAT), and based on a single electron transfer (SET). Those based on SET include redox reaction with the oxidant, which is also the indicator of the reaction. They reflect the ability of the potential antioxidant to transfer single electron, and reduce the oxidant. TBA-based methods measure the ability of an antioxidant to scavenge free radicals by donation of a hydrogen atom. Therefore, HAT-based methods provide a more accurate assessment of the ability of antioxidants to interrupt free radical chain reactions. Because peroxyl radicals are the most physiologically important and are involved in lipid oxidation, it is believed that HAT methods with greater reliability reflect the mechanism by which antioxidants act *in vivo*. However, none of the methods incented do not reflect the total antioxidant activity of a given sample, neither reflect the bioavailability of antioxidants [16].

OXYGEN RADICAL ABSORBANCE CAPACITY OF BULGARIAN FRUITS, VEGETABLES, HERBS AND MUSHROOMS

In search of novel sources of antioxidants in the last years, traditional plant foods have been extensively studied for their antioxidant activity. The ingestion of fresh fruit, vegetables and teas rich in natural antioxidants has been associated with prevention of cancer and cardiovascular diseases [17]. The higher intake of plant foods correlates with lower risk of mortality from these diseases [18]. Approximately 60% of the commercially available anti-tumoral and anti-infective agents are of natural origin [19]. Investigation of natural products is a research field with great potential and is especially important in countries possessing great biodiversity, like Bulgaria. About 600 plant species from the Bulgarian flora are recognized as medicinal and are traditionally used in ethnopharmacology and phytotherapy [20, 21]. The results reported in the following sections are part of a long-term investigation performed in the Laboratory of biologically active substances, Institute of Organic Chemistry with Centre of Phytochemistry – Bulgarian Academy of Sciences on antioxidant activity of fruits, vegetables and herbs grown in Bulgaria. Results are obtained by the Oxygen Radical Absorbance Capacity (ORAC) in which the inhibition time and inhibition degree are measured as the oxidation reaction goes to completion [22]. The ORAC method is relevant for biological samples, since it assesses the radical scavenging activity of the sample against peroxyl radicals, which physiologically are the most important ones. Besides, oxidation process is performed in water media at physiological pH and temperature [8, 16, 23]. It was found that ORAC method is more sensitive than other methods, thus indicating antioxidant properties in samples with very low quantities of polyphenols [24]. The accumulation of biologically active substances in plants depends on several genetic and environmental factors including cultivar, climate, fertilization, irrigation, sun exposure, *etc.* Ou *et al.* [25] reported variable results even for samples from one species depending on the variety, place of origin, and harvest time. Therefore, it is of a particular interest to evaluate the antioxidant activity of local natural products, since they are the most consumed by the Bulgarian population. The presented results are part of a long-term investigation, aiming the development of a database with antioxidant capacities of Bulgarian raw materials. The development of such database will identify the major contributors to the antioxidant potential of our daily diet. In the literature, similar ORAC databases are already reported for common foods in the USA [26] and fruits produced in south Andes region of South America [27].

Bulgarian Fruits

Fresh fruits are a good source of antioxidants and their use in human nutrition is of fundamental importance. To encourage fruit consumption among the population it is important to recognize which fruits have the highest antioxidant activity and to promote their regular consumption. In a recent study, we evaluated the ORAC antioxidant activity of 26 fruits of Bulgarian origin and results are shown in Table 1 [28]. Since polyphenols contribute significantly to the antioxidant activity of plant materials, their content in the investigated fruits is given in the table, as well.

Table 1. ORAC antioxidant activity and polyphenol content of Bulgarian fruits according to Denev *et al.*, 2013 [28]. Results are expressed as means ± standard deviations on a fresh weight basis.

Fruits	ORAC, μmol TE/g	Total polyphenols, GAE/100g
Apple	13.8 ± 2.6	126.0 ± 5.6
Apricot	7.2 ± 1.0	44.4 ± 0.4
Black currant	96.0 ± 3.2	835.1 ± 19.1
Blackberry	74.2 ± 3.5	688.2 ± 19.0
Blackthorn	79.1 ± 3.9	858.3 ± 19.4
Blueberry	98.8 ± 7.1	819.5 ± 9.7
Cherry	25.8 ± 1.2	118.4 ± 6.7
Chokeberry	160.8 ± 4.8	1 817.8 ± 34.8
Cornel cherry	49.0 ± 3.5	624.6 ± 1.3
Cranberry	70.0 ± 1.9	705.5 ± 17.9
Elderberry	205.4 ± 15.2	1 148.0 ± 11.9
Fig	13.6 ± 1.6	98.7 ± 2.8
Hawthorn	153.6 ± 9.1	1 184.4 ± 15.7
Honeydew melon	2.3 ± 0.1	40.4 ± 1.1
Peach	6.2 ± 1.5	41.1 ± 1.4
Plum	10.8 ± 1.1	64.5 ± 1.7
Pomegranate	19.7 ± 3.1	195.1 ± 8.0
Pumpkin	4.9 ± 0.5	14.6 ± 0.9
Raspberry	38.9 ± 2.0	369.1 ± 1.7
Red grapes	26.8 ± 3.4	195.5 ± 8.9
Rosehip	201.1 ± 14.6	1 934.3 ± 4.3
Rowanberry	80.9 ± 6.2	733.6 ± 7.4
Sour cherry	58.6 ± 5.8	529.9 ± 10.0
Strawberry	47.2 ± 3.1	386.5 ± 15.2
Watermelon	3.8 ± 0.5	39.8 ± 0.8
White grapes	6.3 ± 1.3	112.1 ± 0.3

The total antioxidant activity varied considerably among the investigated fruits. For example, on the basis of fresh weight, elderberry and rosehip showed the highest antioxidant capacity - (205.38 ± 15.24 μmol TE/g) and (201.14 ± 14.59 μmol TE/g), respectively. Pumpkin, watermelon and honeydew melon revealed the lowest ORAC antioxidant activity (4.92 ± 0.47, 3.80 ± 0.47 and 2.33 ± 0.12 μmol TE/g, respectively). The beneficial properties of elderberry, rosehip and hawthorn are well known to the Bulgarian population as they have been widely used in ethnopharmacology and traditional medicine since ancient times. Another fruit with high antioxidant activity, chokeberry is of North American origin and was introduced to Bulgaria about 60 years ago. Nowadays it is cultivated successfully as an industrial crop and deserves attention, because it is recognized as an especially beneficial medicinal plant. There are many papers attempting to rank the antioxidant properties of different plant materials *via* different methods [29, 30] including ORAC [25, 26, 31]. When comparing the results with other published data it is seen that Bulgarian fruits reveal different antioxidant properties. Our results 47.2 μmol TE/g and 98.8 μmol TE/g for strawberries and blueberries are 18.5% and 37% higher than the results reported by Wu *et al.* [26] for the same plant species. On the other hand, results reported from the same authors for raspberry are 26% higher than the results in our study. The accumulation of biologically active substances in plants depends on several genetic and environmental factors including cultivar, climate, fertilization, irrigation, sun exposure, *etc.* Therefore, it is of a particular interest to evaluate the antioxidant activity of local natural products. In one of the first attempts to quantify dietary antioxidant needs of the body Prior *et al.* [32] demonstrated that consumption of certain berries and fruits such as blueberries, mixed grape and kiwifruit was associated with increased ORAC plasma antioxidant capacity in the postprandial state and consumption of an energy source of macronutrients containing no antioxidants was associated with a decline in plasma antioxidant capacity. The authors estimated that according to the energy intake of the diet, 5000 – 15000 μmol TE are necessary to cover human daily antioxidant needs. Therefore, comparative studies such as the current are interesting not only from research point of view, but also for the consumers and nutritionists. The obtained results are a good tool for the medical professionals to promote the consumption of fruits with high antioxidant activity as a part of a healthy diet. For example, the consumption of only 25–75 g elderberries or briers, or 30–90 g chokeberries will cover the necessary antioxidant units per day. In contrast, approximately 2170–6500 g of honeydew melons will provide the same amount of ORAC units.

Bulgarian Vegetables

Vegetables are among the major antioxidant sources in our daily diet, and therefore the estimation of daily antioxidant capacity intake from these foods is beneficial [9]. Vegetables are known to possess a variety of antioxidant effects and properties. Flavonols (such as quercetin, myricetin, kaempherol) and flavones (e.g. apigenin, luteolin) in plant materials are closely associated with their antioxidant function mainly due to their redox properties exerted by various possible mechanisms: free-radical scavenging activity, transition-metal-chelating activity, and/or singlet-oxygen-quenching capacity [33, 34].

Our study in 2010 was the first reporting antioxidant activity of Bulgarian vegetables [24]. These vegetables are commonly consumed by the Bulgarian population as an important constituent of their traditional food [24]. The total polyphenol content of these selected vegetables was measured as well, so as to evaluate its contribution to their total antioxidant function. The objective of the study was to supply both new methodological background for the food quality control in food industry and new information on the antioxidant function of selected vegetables for nutritionists and public. Results are shown in Table 2.

Table 2. ORAC antioxidant activity and polyphenol content of Bulgarian vegetables according to Ciz *et al.*, 2010 [24]. Results are expressed as means ± standard deviations on fresh weight basis.

Vegetables	ORAC, μmol TE/g	Total polyphenols, GAE/100g
Beans *	20 ± 1.8	98.2 ± 4.3
Broccoli	16.1 ± 1.2	102.1 ± 5.9
Capsicum	19.9 ± 1.4	286.7 ± 5.1
Carrot	4.8 ± 1.1	35.2 ± 2.0
Celery leaves	113.5 ± 6.1	605.6 ± 9.4
Celery root	15.3 ± 1.2	43.8 ± 2.3
Chick peas *	28 ± 2.1	107.6 ± 5.6
Chilli pepper	36.1 ± 6.5	298.6 ± 1.8
Cucumber	1.2 ± 0.2	24.2 ± 2.4
Dill	10.5 ± 1.1	150.4 ± 0.9
Eggplant	16.2 ± 2.0	102.9 ± 4.7
Goathorn pepper	30.6 ± 1.4	260.5 ± 5.0
Green beans	14.5 ± 1.2	101.5 ± 3.3
Green onion	14.7 ± 1.5	92.7 ± 0.9
Green pepper	5.6 ± 0.3	80.7 ± 3.6
Gumbo	14.6 ± 0.8	89.8 ± 4.0
Lentils *	49 ± 3.7	254.3 ± 8.4
Lovage	57.3 ± 5.0	267.0 ± 2.1
Parsley	108.6 ± 13.1	599.7 ± 0.4
Potato	10.3 ± 1.3	65.5 ± 1.1
Radish	23.6 ± 1.7	89.9 ± 1.7
Red beet	12.6 ± 1.6	81.5 ± 1.6
Red pepper	9.3 ± 0.9	115.7 ± 1.5
Soybean *	99 ± 5.2	589. 6 ± 32.1
Tomato	5.4 ± 0.3	41.3 ± 2.2
Vegetable marrow	2.9 ± 0.3	20.0 ± 1.7

* Unpublished results

The total phenolic content in the vegetable analyzed was in the range of 605.6 to 20.0 mg GAE/100g fresh weight and there was a direct relationship between the total phenolic content and ORAC antioxidant activity with correlation coefficient r = 0.95. As we have shown, aromatic vegetable such as parsley, dill and lovage with high polyphenol content and high ORAC values could be excellent sources of antioxidant and should be a part of everyday diet.

Bulgarian Herbs

In search of novel sources of antioxidants in the last years, medicinal plants have been extensively studied for their antioxidant activity. From ancient times, herbs have been used in many areas, including nutrition, medicine, flavoring, beverages, cosmetics, *etc.* It is of particular interest to investigate the antioxidant properties of medicinal plants, especially those traditionally used in folk medicine. Prior to our study, there was just scarce information on antioxidant activity of Bulgarian herbs with methods like DPPH and ABTS [35, 36]. In our study, we investigated medicinal plants, which were chosen based on their use in traditional medicine [37]. Table 3 shows the ORAC antioxidant activity of the investigated medicinal plants. The greatest ORAC value of 2917 μmol TE/g was found for peppermint. This study was the first one reporting ORAC antioxidant activity for several medicinal plants, such as: wild basil (*Clinopodium vulgare*) leaves, birch (*Betula pendula*) leaves, caltrop (*Tribulus terrestris*) aerial parts, mountain tea (*Sideritis scardica*) aerial parts, hop (*Humulus lupulus*) flowers, marigold (*Calendula officinalis*) flowers and greater burdock (*Arctium lappa*) roots.

Bulgarian Mushrooms

Mushrooms are another common food for the Bulgarian population. Therefore, we investigated antioxidant activity of the following 11 mushrooms of Bulgarian origin: black chanterelle (*Craterellus cornucopioides*), Caesar's mushroom (*Amanita caesarea*), champignon (*Agaricus bisporus*), chanterelle (*Cantharellus cibarius*), edible boletus (*Boletus edulis*), fairy ring mushroom (*Marasmius oreades*), honey mushroom (*Armillaria mellea*), Judas's ear fungus (*Auricularia auricular*), Oyster mushroom (*Pleurothus ostreatus*), shiitake (*Lentinus edodes*), yellow foot (*Cantharellus aurora*). These results are unpublished and are depicted on Fig. 1. From the results it is evident that edible boletus distinct among other mushrooms with ORAC value of 113.9 μmol TE/g dry weight followed by fairy ring mushroom and Judas's ear fungus. These results indicate that mushrooms are not very rich source of antioxidants but could contribute the total antioxidant value of our daily diet.

Table 3. ORAC antioxidant activity and polyphenol content of Bulgarian herbs according to Kratchanova et al., 2010 [37]. Results are presented as means ± SD based on dry weight.

Herb	ORAC, µmol TE/g	Total polyphenols, mg/100g
Basil *(Ocimum basilicum)* leaves	402 ± 40	2391 ± 38
Birch *(Betula pendula)* leaves	1185 ± 73	5542 ± 201
Caltrop *(Tribulus terrestris)* aerial parts	819 ± 56	5681 ± 200
Camomile *(Matricaria chamomilla)* flowers	814 ± 72	4665 ± 137
Chicory *(Cichohrium intybus)* aerial parts	398 ± 22	1821 ± 63
Common balm *(Melissa officinalis)* leaves	1121 ± 60	11885 ±109
Dandelion *(Taraxacum officinale)* aerial parts	381 ± 16	2206 ± 58
Dandelion *(Taraxacum officinale)* roots *	193 ± 12	1210 ± 72
Fenugreek *(Trigonella foenum-graecum)* seeds	327 ± 28	1692 ± 105
Greater burdock *(Arctium lappa)* roots	365 ± 31	2742 ± 112
Hawthorn *(Crataegus monogyna)* leaves and flowers	2163 ± 89	7104 ± 111
Hop *(Humulus lupulus)* flowers	749 ± 62	5728 ± 262
Laurel leaves *(Laurus nobilis)* leaves	837 ± 81	7081 ± 299
Lime *(Tilia cordata)* flowers	1020 ± 88	9296 ± 427
Liquorice *(Glycyrrhiza glabra)* roots	670 ± 48	3452 ± 98
Marigold *(Calendula officinalis)* flowers	407 ± 57	2141 ± 115
Mountain tea *(Sideritis scardica)* aerial parts	778 ± 77	3984 ± 201
Nettle *(Urtica dioica) leaves*	162 ± 11	958 ± 43
Nettle *(Urtica dioica)* roots *	23 ± 1.8	345 ± 18
Peppermint *(Mentha piperita)* leaves	2917 ± 52	20216 ± 359
Raspberry *(Rubus idaeus)* leaves	1156 ± 80	7759 ± 216
Sage *(Salvia officinalis)* leaves	966 ± 69	5295 ± 148
Spearmint *(Mentha spicata)* leaves	748 ± 57	4522 ± 102
St. John's worth *(Hypericum perforatum)* aerial parts	1141 ± 93	11283 ± 74
Thyme *(Thymus vulgaris)* aerial parts	1637 ± 59	11409 ± 171
Wild basil *(Clinopodium vulgare)* aerial parts	1437 ± 60	9468 ± 128
Yarrow *(Achillea millefolium)* flowers	842 ± 80	5728 ± 232

* Unpublished results

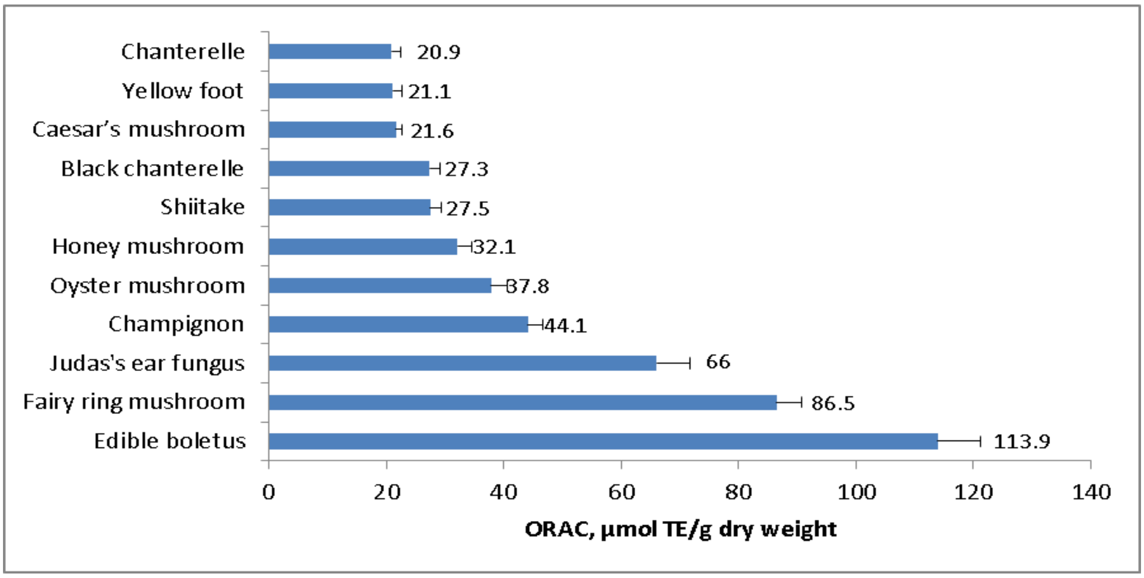

Fig. 1. ORAC antioxidant activity of Bulgarian mushrooms.

FINAL REMARKS

The results for the antioxidant activity of selected Bulgarian fruits, vegetables, herbs and mushrooms are a good tool for the medical professionals to promote the consumption of foods with high antioxidant activity as a part of a healthy diet. Such kind of information is useful to not only doctors and nutritionists, but also to food scientist and technologists for the development of functional foods, rich in natural antioxidants. These results enrich the national database for antioxidant activity in foods helping the identification of the major contributors to the antioxidant potential of Bulgarian daily diet.

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ORAC АНТИОКСИДАНТНА АКТИВНОСТ НА БЪЛГАРСКИ ПЛОДОВЕ, ЗЕЛЕНЧУЦИ, БИЛКИ И ГЪБИ. ОБЗОР

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Постъпила на 13 февруари 2017 г.; Коригирана на 07 март 2017 г.

(Резюме)

В търсене на нови източници на антиоксиданти през последните години, растителните храни са обект на задълбочени изследвания по отношение на тяхната антиоксидантна активност. Изучаването на природни продукти е научно направление с голям потенциал и е особено важно за страни, които притежават богато биологично разнообразие, като България. Около 600 вида растения от българската флора са признати като лечебни и се използват традиционно в етнофармакологията и фитотерапията. Като се има предвид огромния интерес към антиоксидантите, не е изненадващ и големия брой методи, разработени, за да се направи количествена оценка на тяхното антиоксидантно действие. В резултат са разработени десетки методи за определяне на антиоксидантна активност в хранителни и биологични проби. Резултатите, представени в настоящия обзор са част от дългогодишно изследване в Лаборатория по биологично активни вещества, Институт по органична химия с Център по фитохимия - Българска Академия на Науките върху антиоксидантната активност на български плодове, зеленчуци, билки и гъби. Резултатите са получени чрез Oxygen Radical Absorbance Capacity метода, при който окислителната реакция протича практически до край отчитайки и времето, и степента на инхибиране. Установено е, че ORAC методът е подходящ за биологични проби, тъй като измерва радикало-улавящата способност на антиоксидантите срещу пероскилни радикали, които са физиологически най-значими. Освен това, окислителната реакция протича във водна среда при физиологични стойности на pH и температура. Настоящият обзор обобщава данните за антиоксидантната активност на 90 български суровини, включвайки и непубликувани до момента резултати за ORAC стойността на 11 гъби, 4 зеленчука и 2 билки.