# ANTIOXIDANT CAPACITY, ASCORBIC ACID AND PHENOLICS CONTENT IN WILD EDIBLE FRUITS

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A B S T R A C T

The studied material were the fruits of 7 wild species: dog rose (*Rosa canina* L.), blackberry (*Rubus caesius* L.), elderberry (*Sambucus nigra* L.), blueberry (*Vaccinium myrtillus* L.), blackthorn (*Prunus spinosa* L.), rowan (*Sorbus aucuparia* L.) and wild strawberry (*Fragaria vesca* L.). The fruits were subjected to an antioxidant activity assay (AA). Two methods were used: FRAP and ABTS. The fruit samples were also subjected to analyses for phenolics (recalculated onto gallic acid) by means of the Folin-Ciocalteau method. The fruit samples were subjected to vitamin C analyses as well, applying the Tilmans' method. Dog rose fruits were characterized by the largest antioxidant capacity – 127.78±1.85 mM Fe·100 $g^{-1}$ of fresh mass (FRAP method) and 38.75±0.33 µM TE·$g^{-1}$ of fresh mass (ABTS method). At the same time, they contained the largest amounts of vitamin C – 1252.37±6.58 mg·100 $g^{-1}$ of fresh mass and phenolics – 3217.28±11.94 mg·100 $g^{-1}$ of fresh mass. Blackthorn, rowan and wild strawberry had the lowest antioxidant capacity of all the fruits studied. The examination confirmed a high correlation between antioxidant capacity, and vitamin C and phenolics content in fruits.

**Key words**: antioxidant activity, FRAP, ABTS, ascorbic acid, phenolics, wild fruits

## INTRODUCTION

According to much of the research done, fruits are a valuable source of anticancer and antimutagenic substances, or substances which help protect against cardiac disorders. Those diseases often result

from oxidation changes due to free radicals that damage lipids, proteins, and nucleic acids. Vitamins A, C and E, as well as polyphenols contained in fruit have antioxidant features and can play an important role in the prevention of many diseases. A number of methods were worked out to evaluate the antioxidant activity in foodstuffs. Some of the methods are based on the ability to sweep off free radicals by substances which are characterized as having antioxidant properties. Another group of methods consists in the reduction of metal ions by the examined antioxidant agent. Due to the fact that the reducing abilities cannot always be considered as antioxidant activity, most of authors present results from two or more methods.

The antioxidant properties of cultivated plants are usually well recognized. There is, however, little data about the features of wild edible fruits. In Poland, wild edible fruits are very popular and often consumed raw or processed.

## MATERIAL AND METHODS

Fruits of 7 wild species were the material for this study: dog rose (*Rosa canina* L.), blackberry (*Rubus caesius* L.), elderberry (*Sambucus nigra* L.), blueberry (*Vaccinium myrtillus* L.), blackthorn (*Prunus spinosa* L.), rowan (*Sorbus aucuparia* L.) and wild strawberry (*Fragaria vesca* L.). Fruits were harvested from their natural habitats in the Łęczna district (Lublin region) from July till October. Collected samples were frozen and stored at –20°C until needed for the analyses.

Fruits were subjected to an antioxidant activity assay (AA). Two methods were used: Ferric Reducing/Antioxidant Power (FRAP) and 2,2'-azino-bis(3-ethylbenzothiazoline--6-sulfonic acid – based one (ABTS). The FRAP method consists in the reduction of Fe+3 ions to Fe+2, which in turn form a blue-coloured complex with 2,4,6-tripirydylo-s--triazine (TPTZ). The intensity of the colour is dependent on the antioxidant concentration. Results were expressed as equivalents of Fe(II) (Benzie and Strain, 1996). The ABTS method is based on the evaluation of the sweeping level of free ABTS + radicals previously produced from the ammonium salt of 2,2'-azine-bis(3-ethylbenzothiazoline--6-sulfonic acid). The ability to sweep the ABTS + radicals by substances with antioxidant features is compared to the activity of Trolox (TE) – vitamin E analogue – and expressed as Trolox Equivalent Antioxidant Capacity (TEAC) (Re et al., 1999).

The fruit samples were also subjected to analyses of phenolics (recalculated onto gallic acid) by means of the Folin-Ciocalteau method (Arnous et al., 2001). The fruit samples were analyzed for vitamin C content using the Tilmans' method (PN-A-04019:1998). All determinations were performed in 3 replications and the results were recalculated onto the fresh weight of the raw material. Results were subjected to statistical processing using Tukey's test.

## RESULTS AND DISCUSSION

The analytical results are presented in Tables 1 and 2. The statistical analysis revealed the significant differentiation of the studied traits. A high correlation (0.925-0.993) between polyphenols and ascorbic acid contents as components with antioxidant activity vs. antioxidant capacity was recorded (Tab. 3). The correlation is slightly higher in reference to phenolics than vitamin C, which confirms the results achieved by Kalt et al. (1999) and Proteggente et al. (2002).

Dog rose fruits were characterized by the highest antioxidant activity (127.78 mM Fe·100 $g^{-1}$, on average, FRAP method) and 38.75 µM TE·$g^{-1}$ (ABTS method). These values are much higher than those found by Halvorsen et al. (2002): 39.46 mM Fe·100 $g^{-1}$ (FRAP). Dog rose fruits also contained the highest amount of ascorbic acid – 1252.37 mg·100 $g^{-1}$ and phenolics contents – 3217.28 mg·100 $g^{-1}$ on average. Dog rose fruits are a valuable and well-known source of vitamin C. Nojavan et al. (2008) reported that they contain six times more ascorbic acid than oranges. Babis and Kucharska (2004) recorded 2425 and 668 mg·100 $g^{-1}$ of vitamin C as well as 1610 and 1205 mg·100 $g^{-1}$ of polyphenols in *Rosa hybrida* and *Rosa spinosissima* fruits, respectively.

Elderberries as well as blueberries were characterized by high antioxidant activity: 29.56 mM Fe·100 $g^{-1}$ (FRAP) and 15.88 µM TE·$g^{-1}$ (ABTS), as well as 30.48 mM Fe·100 $g^{-1}$ and 16.87 µM TE·$g^{-1}$, respectively. These results are similar to those achieved by Giovanelli and Buratti (2009), who additionally reported that wild blueberries had a higher antioxidant capacity than cultivated blueberries. Halvorsen et al. (2002) found much lower antioxidant activities – for blueberry 8.23, and for elderberry 4.31 mM Fe·100 $g^{-1}$ (FRAP).

Among the studied berries, the lowest antioxidant activity was recorded for rowan berry and wild strawberry. These fruits were relatively abundant in ascorbic acid (68.18 and 80.84 mg·100 $g^{-1}$, respectively), although they had lower contents of phenolics (226.58 and 165.46 mg·100 $g^{-1}$, respectively).

## CONCLUSIONS

1. Dog rose fruits were characterized by the largest antioxidant capacity – 127.78±1.85 mM Fe·100 $g^{-1}$ of fresh mass (FRAP method) and 38.75±0.33 µM TE·$g^{-1}$ fresh mass (ABTS method). At the same time, they contained the largest amounts of vitamin C – 1252.37±6.58 mg·100 $g^{-1}$ of fresh mass and phenolics – 3217.28±11.94 mg·100 $g^{-1}$ of fresh mass.
2. Rowan and wild strawberry had the lowest antioxidant capacity among all the studied fruits.
3. The study confirmed a high correlation between antioxidant capacity and vitamin C and phenolics content in fruits.
4. The achieved results indicate a high biological value of the analysed wild fruit species.

Table 1. Antioxidant capacity (FRAP, ABTS) of fruits

| Fruits | FRAP [mM Fe·100g$^{-1}$ f.w.] | ABTS [μM TE·g$^{-1}$ f.w.] |
|---|---|---|
| Dog rose | 127.78±1.85 c* | 38.75±0.33 f |
| Blackberry | 15.17±0.21 a | 9.55±0.22 c |
| Elderberry | 29.56±1.92 b | 15.88±0.11 d |
| Blueberry | 30.48±1.42 b | 16.87±0.22 e |
| Blackthorn | 14.17±3.06 a | 5.33±0.22 a |
| Rowan | 10.75±0.07 a | 5.94±0.06 b |
| Wild strawberry | 10.99±0.29 a | 5.61±0.06 ab |
| Mean | 34.13 | 13.99 |

*Values designated with the same letters within columns do not significantly differ at p = 0.05

Table 2. The contents of phenolics and vitamin C in fruits

| Fruits | Phenolics [mg gallic acid·100 g$^{-1}$f.w.] | Vitamin C [mg·100 g$^{-1}$f.w.] |
|---|---|---|
| Dog rose | 3217.28±11.94 e* | 1252.37±6.58 g |
| Blackberry | 247.25±11.14 b | 33.85±1.92 b |
| Elderberry | 535.98±8.04 d | 116.70±4.22 f |
| Blueberry | 424.72±14.05 c | 60.11±2.62 c |
| Blackthorn | 402.67±12.44 c | 21.94±1.42 a |
| Rowan | 226.58±13.47 b | 68.18±2.05 c |
| Wild strawberry | 165.46±13.07 a | 80.84±1.75 d |
| Mean | 745.70 | 233.43 |

*Explanations, see Table 1

Table 3. Correlations between FRAP and ABTS values and the contents of phenolics and vitamin C in fruits

| | $R^2$ vs phenolics | $R^2$ vs vitamin C |
|---|---|---|
| FRAP | 0.993 | 0.984 |
| ABTS | 0.943 | 0.925 |

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# WŁAŚCIWOŚCI PRZECIWUTLENIAJĄCE ORAZ ZAWARTOŚĆ ZWIĄZKÓW FENOLOWYCH I WITAMINY C W JADALNYCH OWOCACH ROŚLIN DZIKO ROSNĄCYCH

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S T R E S Z C Z E N I E

Badano owoce 7 gatunków dziko rosnących roślin: dzika róża (*Rosa canina* L.), jeżyna (*Rubus caesius* L.), czarny bez (*Sambucus nigra* L.), czarna jagoda (*Vaccinium myrtillus* L.), tarnina (*Prunus spinosa* L.), jarzębina (*Sorbus aucuparia* L.) oraz poziomka (*Fragaria vesca* L.). Owoce poddano badaniu aktywności antyoksydacyjnej (AA) dwoma metodami: FRAP oraz ABTS. W owocach oznaczono dodatkowo zawartość związków fenolowych, w przeliczeniu na kwas galusowy, metodą Folina-Ciocalteau oraz witaminy C metodą Tilmansa, jako substancji o działaniu przeciwutleniającym. Najwyższą aktywnością antyoksydacyjną charakteryzowały się owoce dzikiej róży, średnio 127,78 mM Fe·100g$^{-1}$ (±1,85 mM Fe·100g$^{-1}$) świeżej masy (metoda FRAP) oraz 38,75 µM TE·g$^{-1}$ (± 0,33 µM TE·g$^{-1}$) świeżej masy (metoda ABTS). Jednocześnie zawierały one największe ilości witaminy C – średnio 1252.37 mg·100 g$^{-1}$ (±6.58 mg·100 g$^{-1}$) świeżej masy oraz związków fenolowych – średnio 3217,28 mg·100 g$^{-1}$ (±11,94 mg·100 g$^{-1}$) świeżej masy. Najniższą aktywność antyoksydacyjną spośród badanych owoców stwierdzono w przypadku tarniny, jarzębiny i poziomki. Przeprowadzone badania potwierdzają wysoką korelację pomiędzy mierzoną aktywnością antyoksydacyjną a zawartością witaminy C i związków fenolowych w owocach.

**Słowa kluczowe**: aktywność antyoksydacyjna, FRAP, ABTS, witamina C, związki fenolowe, dzikie owoce