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# Compare antioxidant capacity of various foods

## ～Superoxide scavenging capacity and DPPH radical scavenging capacity

Introduction.

Recently, oxidative stress caused by free radicals and reactive oxygen species (e.g., superoxide) has been reported to cause cancer and other life-threatening diseases.
Antioxidant capacity (i.e., the ability to scavenge free radicals and reactive oxygen species) of foods has been attracting attention because of its significant role in lifestyle-related diseases and the growing health consciousness, which can be called a "boom".

The antioxidant capacity of various foods and food components has been reported in many cases. However, even if we speak of the ability to scavenge free radicals and reactive oxygen species, the results obtained may differ greatly due to differences in the target radical species (or reactive oxygen species) and measurement methods, and it is not easy to compare antioxidant capacity among various foods.

In this article, we will discuss the relationship between superoxide ($O_2^{-}$) and 1,1-diphenyl-2-picrylhydrazyl (DPPH, Fig. 1).

The following are data collected on the radical scavenging capacity of various foods[1]) for two radical species, namely

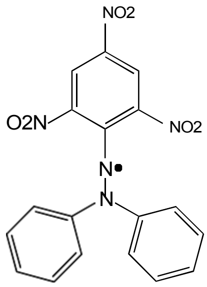


Figure 1 1,1-diphenyl-2-picrylhydrazyl(DPPH)

Comparative data on antioxidant capacity of various foods

Data on superoxide scavenging capacity and DPPH radical scavenging capacity of various foods are shown in Table 1. Data for some antioxidants are also shown for reference. All food data are for edible portions. The data for tea leaves, etc., were obtained without any heating, cooking, or other processing. Table 1
A high correlation (correlation coefficient r = 0.9867) is observed between the scavenging capacities of the two types of each food shown in 1.

In Table 1, the relatively low value of α-tocopherol, a typical antioxidant, is thought to be due to the fact that the measurement system used is not suitable for evaluating the antioxidant capacity of water insoluble substances. Therefore, the values of α-tocopherol and α-tocopherol in Table 1 are relatively low.
1 data may not correctly assess the antioxidant capacity of foods that contain relatively high amounts of insoluble antioxidant components.

Figure 2 shows the relationship between the superoxide scavenging capacity and DPPH radical scavenging capacity of each food, with a bar graph showing the value obtained by dividing the superoxide scavenging capacity by the DPPH radical scavenging capacity. In otherwords, foods near the left end in Figure 2 have relatively higher DPPH radical scavenging capacity, while foods near the right end have relatively higher superoxide scavenging capacity. Figure 2 shows that DPPH radical scavenging capacity tends to be relatively higher for vitamin C-rich vegetables and fruits (Group A), while superoxide scavenging capacity tends to be relatively higher for protein-rich foods (Group C). Foods containing yellowish-red pigments (Group B) seem to fall in between these two groups.

Table-1 Radical Scavenging Potential of Various Foods and Reagents

| sample | superoxide scavenging capacity (SOD units/g) | DPPH radical scavenging capacity (DPPH units/g) |
|---|---|---|
| Alpha-tocopherol | 90 | 460 |
| gallic acid | 1,800,000 | 16,000 |
| ascorbic acid | 330,000 | 5,400 |
| roasted green tea | 70,000 | 1,300 |
| rooibos tea | 3,900 | 330 |
| cocoa (beverage, cocoa solids) | 1,800 | 170 |
| black tea | 75,000 | 1,700 |
| instant coffee | 26,000 | 650 |
| Grape juice (purple) | 800 | 11 |
| Grape juice (white) | 90 | 3 |
| Orange juice (100% juice) | 110 | 3 |
| Orange juice (20% juice) | 70 | 2 |
| asparagus | 160 | 4 |
| great burdock (Arctium lappa) | 900 | 5 |
| shiitake mushroom (Lentinula edodes) | 170 | 2 |
| tomato | 240 | 2 |
| garlic chive (Allium tuberosum) | 160 | 3 |
| green bell pepper | 130 | 4 |
| lemon | 210 | 5 |
| Green onion (white) | 30 | 1 |
| spinach | 150 | 4 |
| ginger (Zingiber officinale) | 230 | 11 |
| broccoli | 230 | 4 |
| person with a shaved head | 510 | 16 |
| carrot (Daucus carota) | 120 | 1 |
| Green onion | 30 | 1 |
| onion (edible plant, Allium cepa) | 50 | 1 |
| bean sprouts | 160 | 1 |
| Paprika (red) | 760 | 10 |
| Paprika (yellow) | 580 | 9 |
| Paprika (orange) | 750 | 10 |
| strawberry (esp. the garden strawberry, Fragaria x ananassa) | 110 | 6 |
| grapefruit | 100 | 2 |
| kiwi | 180 | 4 |
| adzuki beans | 1,800 | 12 |
| soya bean (soybean) | 1,600 | 3 |
| black sesame (seeds) | 60 | 5 |
| toasted seaweed | 420 | 47 |
| hijiki (dark edible seaweed usu. sold in dried black strips; Hizikia fusiformis) | 760 | 10 |
| (small crunchy) dried sardines | 60 | 1 |
| natto (fermented soybeans) | 300 | 2 |
| unrefined soba (buckwheat noodles) | 210 | 2 |
| prune | 1,100 | 24 |
| capsicum (Capsicum annuum, esp. the cultivated chili peppers) | 1,200 | 25 |
| beef | 290 | 1 |
| pork | 270 | 1 |
| chicken meat | 200 | 1 |

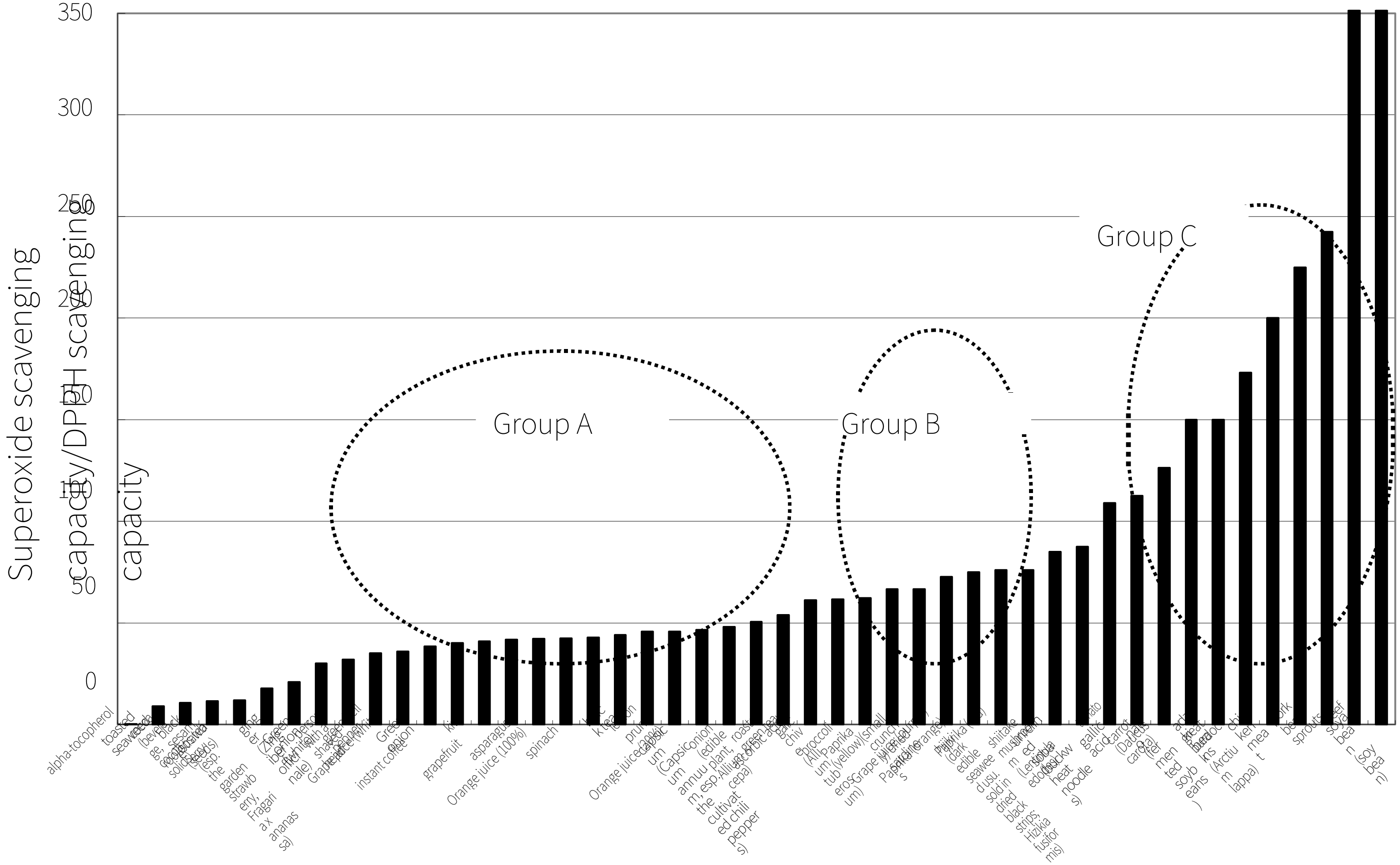


Figure 2. Ratio of superoxide scavenging capacity/DPPH radical scavenging capacity in various foods

## An overview of the evaluation methods used

The evaluation methods used to obtain the data in Table 1 are as follows

1) Evaluation method for superoxide scavenging capacity[2)]

Superoxide in the hypoxanthine/xanthine oxidase system ($O_2^-$) was generated, and the extracts prepared from each food (extracts with 0.1 M phosphate buffer solution at pH 7.8) were added to it.

The results were evaluated using the electron spin resonance (ESR) method to determine the degree to which superoxide can be scavenged when superoxide dismutase (SOD, superoxide dismutase) is added. The results are expressed as "1 SOD unit," which corresponds to 1 unit of SOD, using superoxide dismutase (SOD, superoxide dismutase), a representative enzyme with superoxide scavenging ability, as a control.

2) Evaluation method for DPPH radical scavenging capacity[3)]

When extracts prepared from each food (extracts with 50% ethanol) were added to 0.1 M DPPH solution (50% ethanol solution), the degree to which DPPH radicals could be scavenged was evaluated by spectrophotometry (measurement wavelength: 520 nm).

The results showed that the DPPH radical scavenging capacity corresponding to 1 μmol of Trolox (Fig. 3), a typical substance with superoxide scavenging capacity, was significantly higher than that of the control substance, Trolox, which was made water soluble by removing the side chain of α-tocopherol, a typical substance with superoxide scavenging capacity.

The unit is expressed as "1 DPPH unit."

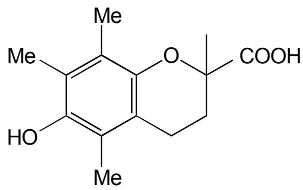

Figure 3 Trolox

## reference data


1) Hirofumi Goto et al.: Proceedings of the 49th Annual Meeting of the Japanese Society for Food Science and Technology, 106 (2002)

2) Takashi Ujiie: Food and Development, 31(2), 43-46 (1996)

3) Kazuki Shinohara et al.: Food Function Research Methods (Korin) pp. 218-220 (2000)


legume (esp. edible legumes or their seeds, such as beans knowledge knowledge

Active oxygen [active oxygen]

It refers to chemical species containing oxygen atoms that are extremely reactive, such as superoxide, hydrogen peroxide, hydroxyl radicals, and singlet oxygen. For example, superoxide is produced in phagocytes (macrophages) and plays an important role in breaking down foreign substances preyed upon by phagocytes (i.e., it plays a role as part of the defense mechanism), but when superoxide is produced in excess, it is secreted out of phagocytes, causing damage to other tissues and contributing to many diseases It is also a cause of many diseases.

ROS generating systems include NADPH oxidase, xanthine oxidase, and arachidonic acid cascade, while ROS scavenging systems include superoxide dismutase (SOD), catalase, peroxidase, and glutathione peroxidase.