Antiossidanti naturali: la pratica sportiva e la salute umana

Natural antioxidants: sport practice & human health

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Abstract

In this paper a focus on the properties and human usage of antioxidants rich foods will be treated in relation of their application in sportive practice and human health. Antioxidants are naturally present chemical compounds useful to faith the dangerous action of reactive oxygen and nitrogen species (ROS and RNS, respectively) produced during cellular metabolism. Therefore, as the production of ROS and/or RNS raised during the aerobic sport exercise, antioxidants are receiving great attention in terms of their supplementation both using antioxidant-rich foods and specific diet integration.

Keywords

Natural Antioxidants; Aerobic Exercises; ROS; RNS.
Antiossidanti Naturali; Esercizi Aerobici: ROS; RNS

Introduction

Sport practice is becoming increasingly important in modern society as the scientific approach in this field has allowed us to establish a deeper connection between the non-competitive practiced sport in and its positive effect on human health. More recently, the coupling of a right amount of sports practice and the right power supply has allowed to further refine the above mentioned link. In particular, the use of specific foods allowed on one hand to provide practitioners suitable nutritional supplements in terms of metabolic fuels and on the other hand the integration of micro-elements necessary to recovery any biomolecular components consumed or damaged during sport performance. Under this regard, the usage of foods rich in antioxidants are receiving more attention as they are considered protective of the human health and therefore to be used in the diet of athletes practicing sport even of non-competitive type.

Among the various food integrators, antioxidants are molecules widely present in nature which are involved in numerous biological functions. The most relevant beneficial

effect exerted by polyphenols is due to their radical scavenging properties against reactive oxygen (ROS) and/or nitrogen (RNS) species. Acute physical exercise can induce oxidative stress through the generation of free radicals produced by lactic acid, increases in catecholamines and inflammatory response following skeletal muscle damage.

ROS and RNS are normally produced during the oxidative metabolism when the transfer of electrons to molecular oxygen in the last stage of this process, does not take place properly. It has been estimated that about 4–5% of the oxygen consumed during oxidative phosphorylation is not completely reduced to water, instead forming free radicals. However, at the same time physical training may also enhance the antioxidant defense system that can counteract the exercise induced ROS production.

ROS and RNS thanks to their high oxidizing power, although they perform different physiological functions being involved in many intracellular pathways, are highly reactive species able to chemically react with a large amount of biomolecules leading to their inactive forms no longer useful or even toxic for health. Higher organisms, however, both of the animal and primarily plant kingdoms, have developed defence systems against these chemical species that include simple or complex antioxidant compounds that ensure homeostasis of a proper amount of ROS/RNS only where and when they are required.

1. Naturally occurrig antioxidants

The main antioxidants of natural origin belong to one of the following classes: carotenoids, flavonoids and anthocyanins, isothiocyanates, tannins, polyphenols and resveratrol.

1.1. Carotenoids

Carotenoids are organic compounds consisting of a 35-40 carbon atoms chain that in some cases terminated with a ring. The main carotenoids include lycopene, β-carotene and lutein, substances contained in the yellow/orange vegetables such as carrots, sweet potatoes and tomatoes

1.2. Flavonoids and anthocyanins

Most common natural flavonoids include quercetin, rutin, anthocyanins, and apigenin. The main natural sources of flavonoids are cocoa, apples, pears, apricots, strawberries, raspberries, beans, blueberries, citrus fruits, olives, oregano, purple cauliflower and grapes. Anthocyanins are found primarily in purple and blue colour fruits and vegetables such as blueberries, blackberries, black and purple carrots, berries. The basic structure of these compounds is that of the flavylium cation (Fig. 1) in which the different hydroxyl and/or methoxy substituents characterize the different flavonoids.

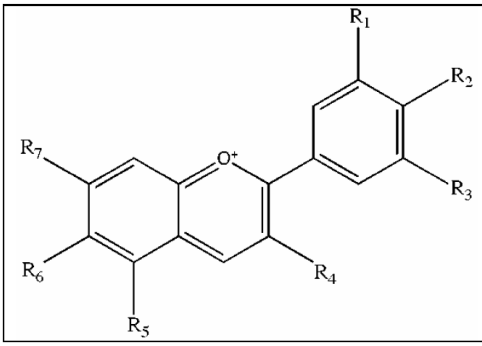

Fig. 1. Flavylium cation, basic constituent of different flavonoids. R_1 –> hydroxyl (–OH) and/or methoxyl ($–OCH_3$) substituents.

1.3. **Isothiocyanates**

Isothiocyanates (Fig. 2) are sulfur-containing compounds. The main sources of isothiocyanates are broccoli, cauliflower, Brussels sprouts, and cabbages. They are obtained by hydrolysis of more complex molecules called glucosinolates.

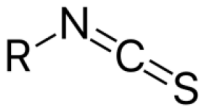

Fig. 2. Generic isothiocyanates structure.

1.4. **Polyphenols**

Polyphenols are a rather heterogeneous class of compounds that share a basic structure in which numerous phenolic hydroxyl group are present. The main sources of polyphenols are derivatives of catechin (Fig. 3) and/or gallic acid (Fig. 4). Polyphenols are very represented in the plants world and their derived food; they can be found in grapes, white and red wine, green tea, lentils, pomegranates, persimmons, walnuts and hazelnuts.

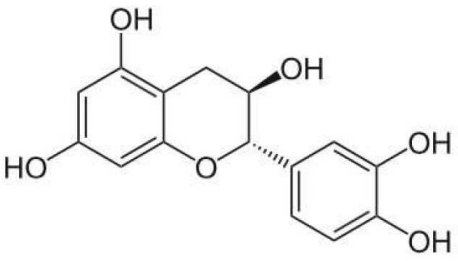

Fig. 3. Catechin structure.

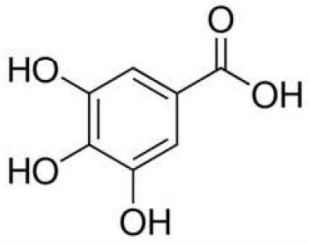

Fig. 3. Gallic acid structure.

1.5. **Resveratrol**

Resveratrol is a non-flavonoid phenol present mainly in the skin of grapes; plants use it to protect themselves from bacterial and fungal infections.

The main sources of resveratrol are: red and black grapes, grape juice, red wine, peanuts, blacks blueberries, cranberries.

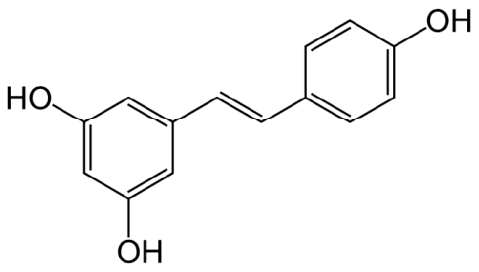

Fig. 3. Resveratrol structure.

2. Antioxidants and sport practice.

The sports practice, mainly aerobic, produces a high amount of ROS/RNS. The specific detrimental effect of these substances lead to muscle fatigue, and therefore, to a decrease in the intensity and performance of physical exercise. These considerations have led to the formulation of the hypothesis that practitioners who do not consume a diet containing foods rich in antioxidants, can run into these problems. On the other hand, there is other evidence that, although the physical exercise induces oxidative stress, the body is able to autonomously produce antioxidant substances to fight the harmful action of ROS/RNS, especially if the sport is conducted regularly and/or with intense training sessions.

From a molecular point of view, the action of some antioxidants on sports practice can be associated to the transcriptional activation of certain genes involved in mitochondrial biogenesis. Therefore it is plausible that an alteration in mitochondrial activity, including also a fine regulation of mitochondria number, may account for the beneficial effects of antioxidants. Furthermore, some antioxidants with a vasodilatory effect, may be involved in the maintenance of a constant muscular activity during time, thanks to continuous nutrient and oxygen supply in this tissue. Finally, preliminary results indicate that some polyphenols may be involved in the regulation of fat oxidation during the recovery phase.

3. Antioxidant: diet supplementation.

It is generally well recognized that a balanced diet, can be the first approach to a proper supply of all the nutrients needed for the development and maintenance of human health. In the sports practice, this approach can be modulated with the use of dietary supplements that, by supplying proper amounts of particular macro- and micro-nutrients, can improve both the sporting gesture and the phase of energy/structural recovery. In this context the integration with antioxidants is increasingly occurring, on the basis of beneficial effects exerted by these substances. However, it has to be considered that from the chemical point of view the antioxidant properties of these substances are carried out by means of oxidation-reduction reactions in which the antioxidants themselves are oxidized, causing the reduction of ROS/RNS to species less reactive and toxic. Therefore dietary supplementation with antioxidants leads to the

introduction in the organism of quantities rather important of these substances which are denoted of high intrinsic reactivity that could be detrimental especially for the gastrointestinal tract, with which these substances are first in contact to account for of their bioavailability.

4. Conclusions

In conclusion, from what stated above it may be inferred that the antioxidant substances can be regarded as of molecules that help the human body to combat the deleterious action exerted by highly reactive species. Free radicals are normally produced in the human cells during normal evolution of metabolism, the complex system of biochemical reactions necessary to maintain physiological homeostasis. Physical activity increases skeletal muscle metabolism that enhances the production of these reactive species whose harmful action must be efficiently controlled. Although a body trained to practice sport autonomously develops an increased production of endogenous antioxidants, the use of a diet supply naturally rich in antioxidants can help the body to ensure a very efficient management of both the athletic action itself, and the post-exercise recovery phase. However, an external supplementation of these substances must be well controlled since antioxidants are compounds denoted of high intrinsic reactivity. Further research studies will be necessary to better clarify the efficacy and safety of polyphenol supplementation.

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