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Review Article

How Phytochemicals May be Valuable Against Oxidative Stress in Brain Tissue?

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ABSTRACT

This short commentary is intended to briefly discuss the benefits of plant secondary metabolites against brain tissue injury promoted by oxidative stress. Henceforth, the physicochemical features and biological activities of phytochemicals were assessed based on literature reports, which showcased their thermodynamic feasibility to reduce reactive oxygen species. It was strongly hinted that secondary metabolites possessing antioxidant potential may be of use in the therapeutics against neurodegenerative disorders owing to free radical scavenging, what hinders further damage to brain tissue.

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Antioxidant Plant Secondary Metabolites and Their Biosynthesis

The richness of phytochemicals provided by plant secondary metabolism is widely known in health sciences. These compounds may be obtained in purer forms using several extraction methods, providing thence distinct preparations with standard concentrations of selected phytochemical markers [1, 2]. Considering that most of these preparations are the first contact to healthcare in regions of low income or where plant-based medicine plays a bigger role in therapeutics, the investigation of the components of these preparations as well as their biological potential is of utmost importance [3, 4].

Regarding the therapeutic potential of phytochemicals, there are several biosynthetic pathway products which could be exploited in healthcare. Amongst these pathways are: *i*. Phenylpropanoid; *ii*. Polyketide; and *iii*. Mevalonate pathways [5, 6]. Although diverse in the sense of biological activities, many products from these biosynthetic routes showcase phenolic moieties, which are known to confer thermodynamic feasibility of reactive oxygen species (ROS) scavenging [7-9]. Figure 1 showcases a simplified sketch of these biosynthetic pathways.

The Physicochemical Aspects of Phytochemical Antioxidants

The antioxidant capacity of phytochemicals is a well-known feature, and its mechanisms are nonetheless explored in many cosmetic and nutraceutical products [9, 10]. Given the relationship between the chemical structure and physicochemical features such as antioxidant capacity, many compounds bearing similar structural characteristics also showcase similar thermodynamic feasibility to undergo oxidation [11-13]. Amongst these compounds are polyphenols, whose oxidation mechanism often contemplates reversibility, as showcased with *o*-catechol as instance in (Figure 2).

As showcased in (Figure 2), polyphenols are thermodynamically feasible to undergo oxidation, therefore donating two electrons and two protons to an endogenous antioxidant (peroxidases, superoxide dismutase and others) or even directly to ROS [13, 14]. This process results in the restitution of the endogenous antioxidant or the stabilization of the free radical and considering that the end-product of *o*-catechol oxidation (i.e. *o*-quinone) may undergo reduction due to the reversibility of this reaction, the antioxidant capacity of polyphenols may be even higher than expected [14, 15].

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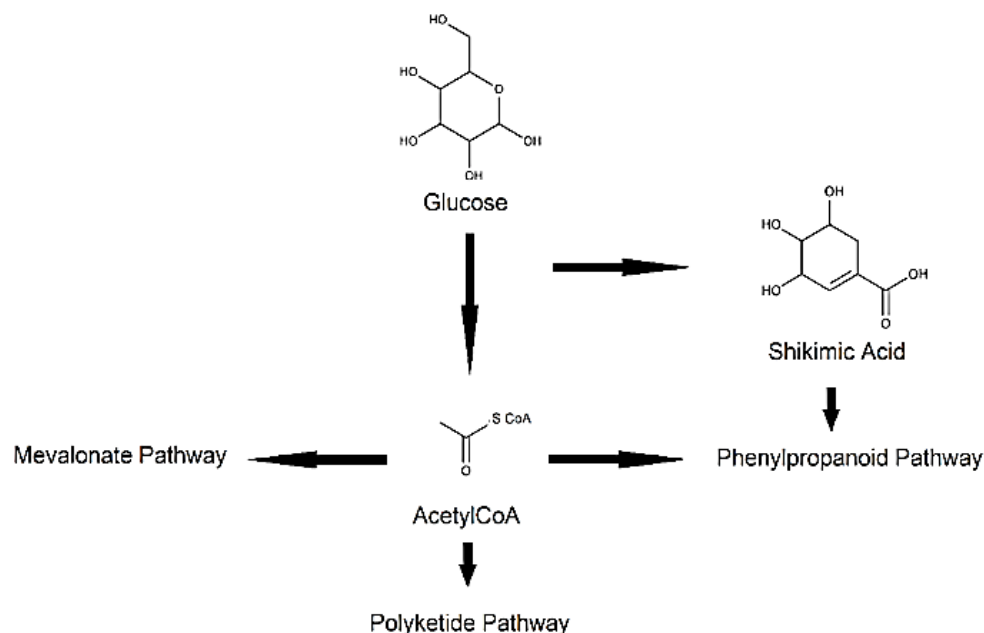


Figure 1: Simplified sketch of the Phenylpropanoid; Polyketide; and Mevalonate pathways.

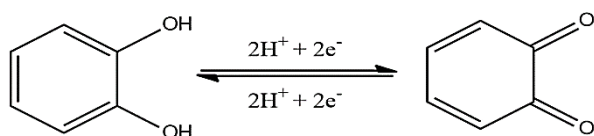


Figure 2: Oxidation mechanism of *o*-catechol contemplating reversibility following the equivalence of protons and electrons.

How Can Secondary Metabolites Hinder Brain Tissue Damage Upon Oxidative Stress?

Brain tissue is highly susceptible to oxidative damage hence the high aerobic metabolism of these cells. Literature states that higher cellular activity leads to enhanced production of ROS as byproducts of regular metabolic processes, and the buildup of these reactive components may lead to tissue damage. In this sense, it can be implied that the endogenous antioxidant arsenal plays a large role in controlling ROS-related damage as well as preserving neurons [16, 17]. Considering that exogenous antioxidants such as plant secondary metabolites may reconstitute and preserve the activity of the endogenous antioxidant arsenal, as well as scavenge ROS, it can be suggested that these phytochemicals may play a part in aiding brain tissue to keep its integrity. Notwithstanding, several reports showcased the effectiveness of plant-based antioxidants such as polyphenols in mopping up free radicals and hindering lipid peroxidation, as well as preserving nervous functions such as memory, mobility, balance and other cognitive features [11, 12].

The benefits of polyphenolic phytochemicals consumption may be related to both their favorable thermodynamic to undergo redox reactions, as well as their proneness to bind to several bodily receptors, thence limiting physicochemical changes in the environment which could enhance ROS build up. For instance, it is widely known that inflammation increases the genesis of free radicals, being anti-

inflammatory agents also valuable in keeping tissue integrity. Moreover, polyphenols are acknowledged to bind to many inflammation-related targets and nucleic acids, as well as enzymes whose role is to regulate neuron communication, such as acetylcholinesterase [11, 12, 18].

However, although many reports support this assumption, polyphenols are highly polar compounds, what suggests that they might not easily cross blood-brain barrier. In this sense, some researchers obtained remarkable enhancement of antioxidant-related neuroprotection by encapsulating polyphenols and other polar antioxidant compounds into lipidic and other less hydrophilic carriers [17-19]. Notwithstanding, this kinetic aspect of plant-based antioxidants is of utmost importance when their biological activity is concerned.

Conclusion

This short commentary was intended to briefly discuss the benefits of plant secondary metabolites against brain tissue injury promoted by oxidative stress. It was strongly hinted that secondary metabolites possessing antioxidant potential may be of use in the therapeutics against neurodegenerative disorders owing to free radical scavenging, what hinders further damage to brain tissue. However, more studies are needed to evaluate the kinetics of these compounds regarding the crossing of the blood-brain barrier and how the use of lipidic carriers may improve their access to the brain.

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Conflicts of Interest

None.

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