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Annals of Infectious Diseases & Preventive Medicine

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# Flavonoids as a New Pharmacological Tool

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Received: Aug 19, 2022

Accepted: Sep 16, 2022

Published Online: Sep 19, 2022

Journal: Annals of Infectious Diseases & Preventive Medicine

Publisher: MedDocs Publishers LLC

Online edition: http://meddocsonline.org/



## Mini review

Flavonoids are a large family of plant substances that were described by Szent-Gyorgi A. (Nobel Prize in Biochemistry); who in 1930 isolated citrine from the lemonpeel, an active principle that regulates the permeability of capillaries, was also called vitamin P (for permeability) and also vitamin C2 (because some flavonoids had properties similar to vitamin C). Flavonoids comprise several classes of natural substances, which give them a variety of colors: Yellow, orange, red, violet, and blue [1]. Their molecular structures meet any of the three important characteristics for their function, having the presence of: A) In ring B of the catechol or O-dihydroxy structure; B) A double bond in position 2,3; C) Hydroxyl groups in position 3 and 5. Foritspart, quercetin presents the three characteristics; however, catechinonly presents the second, while diosmetin presents the first [2]. Its molecular structure comprises a variable number of phenolichydroxyl groups in addition to two benzene (or aromatic) rings, linked through a chain of three carbonatoms, in addition to phenolich ydroxyl groups and excellent chelation properties for iron and other transition metals, which gives them great antioxidant capacity, in addition to other properties that include the stimulation of communications through gap junctions, the impact of cell growth regulation, the induction of detoxification enzymes such as monooxygenases dependent oncytochrome P450 and its anti parasitic effect. They are classified into several groups: chalcones, flavones, flavonols, flavanones, flavanonols, anthocyanidias, cateruins, epicatechins, aurones, isoflavonoids, pterocarpans, rotenoids, etc. They are extremely abundant in the families: Lamiales and Asterales, Gentianales, Geraniales, Fabales and Astereaceaeof this last family, so far 1200 different is oforms have been described in terms of function and activity. They are organized as linear acycliccompounds, play a protective role against predators, and form part of foliar coatings that limit wáter loss [2]. They are widely distributed in fruits, vegetables, seeds, and flowers, as well as in beer, wine, green tea, black tea, soybeans, blueberries, gingkobiloba, and milkthistle. They are mostly consumed in the human dieton a regular basis and can also be used as nutritional supplements, along with certain vitamins and minerals [3].

**Cite this article:** Velázquez-Domínguez J. Flavonoids as a New Pharmacological Tool. Ann Infect Dis Prev Med. 2022; 1(1): 1004.

These compounds play an important role in plantbiology; they respond to light and control the levels of auxins that regulate plant growth and differentiation. Other functions include an antifungal and bactericidal role, they confercoloration, which can contribute to pollination phenomena [2]. In addition to their physiological role in plants, they have various properties, they can bind to biologicalpolymers, such as enzymes, transport proteins [4]and DNA, chelatetransient metal ions, such as Fe2+, Ca2+ and Zn2+, catalyze electron transport and scavenge free radicals. Due to this fact, protective effects against oxidative damage phenomena have been described; Similarly, a protective role has been observed in pathologies such as diabetes [5], cáncer [6,7], heart disease [8]. Other activities that deserve to be highlighted such as antithrombotic [9,10] anti-inflammatory [11,12] antiviral [13]anti asthmatic [6] and inhibitors of the enzymes reverse transcriptase, proteinkinase C, tyrosinekinase C, calmodulin, ornithine decarboxylase, hexokinase, aldolase reductase, phospholipase C, and topoisomerase II [14].

Interestingly, it is worth mentioning the importance of flavonoids and their antiprotozoalaction. In 2004 Mendoca-Fino et al., [15] reported the anti leishmanial effects of the extract rich in flavonoids from Cocos nucifera, finding that 10 µg/ml completely inhibits the growth of the parasite, in addition to its lysis. Pérez-Victoria et al., 1999 [16], showed that flavonoids inhibit daumycinef flux and reverse daumycin resistance by binding to the cytosolicdomain of the P-gptransporter in L. tropica. The anti parasitic effects of some other flavonoids that have been isolated from Helianthemumglomeratum and Geranium mexicanum have recently been described, exhibiting in vitro antiparasitic activities: Giardialamblia [17]. Epicatechin [18,19], Kaempferol (Kp) the latter was isolated from the Cupheapinetorum family, which showed anti amoebic activity with an IC50 of 7.93 µg/mL [20]. Recent studies have shown that (epicatechin and Kp) directly affect the structure of the cytoskeleton in protozoan parasites (Entamoebahistolytica, Giardialamblia), depolymerizing actin and inhibiting the union of some accessory proteins (myosin II short chain) which induces anultrastructural alteration that contributes to the death of the parasite [21,22]. Furthermore, *in vivo* analysis has shown that Kp inhibits the development of amoebic liver abscess without showing evidence of liver and kidney tissue changes [22]. Although dosage and pharmacovigilance studies in humans are needed, they could be suitable candidates to propose them as possible new treatments in patients with parasitosis.

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