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REVIEW

BIOFLAVONOID QUERCETIN-FOOD SOURCES, BIOAVAILABILITY, ABSORBTION AND EFFECT ON ANIMAL CELLS

Zuzana Baková, Adriana Kolesárová*

Address: Ing. Zuzana Baková, Slovak University of Agriculture in Nitra, Department of Animal Physiology, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia

*Corresponding author: Zuzana.Bakova@yahoo.com

ABSTRACT

Bioflavonoid quercetin is found in the edible portion of the majority of dietary plants. The absorption and metabolism of quercetin is still poorly understood. It is known that aglycone form of quercetin, which is absorbed better than quercetin administered in nonglucosidic forms Absorbed quercetin is probably extensively modified before being excreted by kidneys. It has a broad range of activities within animal cells and occurs to be able to prevent or reduce the development of different type of diseases.

Keywords: bioflavonoid, quercetin, sources, bioavailability, absorbtion, animal cells

INTRODUCTION

Bioflavonoid quercetin belongs to a group of natural substances with variable phenolic structures and is found in fruit, vegetables, grains, bark, roots, stems, flowers, tea, and wine **(Middleton, 1998)**.

The absorption and metabolism of quercetin is still poorly understood. For many years, it was believed that quercetin was not absorbed at all, since no unchanged compound could be measured in the plasma after oral administration. In the last few years, it has become clear that theis bioflavonoid is indeed absorbed but heavily metabolized prior to reaching the

plasma. Most of the metabolism is in the form of glucuronidation or the formation of glucuronide conjugates **(Drewa et al., 2001)**.

Quercetin has a broad range of activities within cells **(Bjeldanes and Chang, 1977)**. Scientific studies suggest its antioxidative (**Song et al., 2001)**, antiproliferative **(Yoshida et al., 1992)**, antiinflammatory **(Comalada et al., 2005; Dias et al., 2005)**, anticarcinogenic **(Soleas et al., 2006)**, antihypertensive **(Duarte et al., 2001)**, antidiabetic **(Vessal et al., 2003)** effect and is able to protect different types of cells against various diseases such as osteoporosis, certain forms of cancer, pulmonary and cardiovascular diseases but also against aging **(Boots and Guido, 2008).**

Quercetin

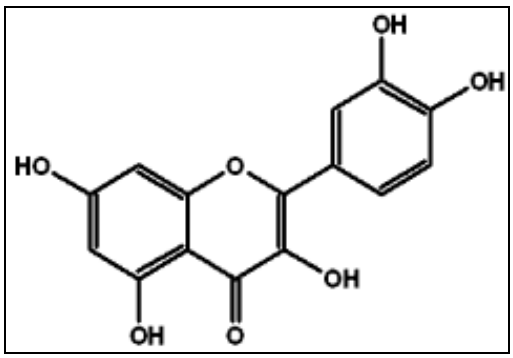

Figure 1 Molecular structure of quercetin **(Moskuag, 2004)**

Food sources

Bioflavonoid quercetin found in the edible portion of the majority of dietary plants (e.g., citrus, berries, leafy vegetables, roots, tubers and bulbs, herbs and spices, legumes, cereal grains, tea, and cocoa) **(Singleton, 1981)**. Quercetin is ingested as a major constituent in the diet **(Bjeldanes and Chang, 1977; Holman and Katan, 1997)**. Content of aglycone form of quercetin, which is absorbed better than quercetin administered in nonglucosidic forms, varies among different food sources (see Table 1).

Table 1 Content of aglycone form of quercetin in different food sources **(**pursuant to **Erlund, 2004)**

Forms of quercetin	**Source**	**Content of aglycone (mg/kg) and reference**
Quercetin-3,4′-glucoside	Onion	284-486 **(Hertog et al., 1992)**
Quercetin-3-glucoside		
Quercetin-3-rhamnoglucoside (rutin)	Black tea	10-25 (**Hertog et al., 1993)**
Quercetin-3-galactoside	Apple	21-72 **(Hertog et al., 1992)**
Quercetin-3-rhamnoside		
Quercetin-3-arabinoside		
Quercetin-3-glucoside		
Quercetin-3-rhamnoglucoside	Black currant	44 **(Häkkinen et al., 1999)**
Quercetin-3-rhamnoside		
Quercetin-3-galactoside		
Myrisetin-3-glucoside		

Bioavailabity and absorbtion

Like many other compounds absorbed quercetin is probably extensively modified before being excreted by kidneys **(Ueno et al., 1982)**.

Quercetin aglycone and its glucosides are absorbed better than quercetin administered in nonglucosidic forms. The bioavailability of 2 quercetin glucosides, 3-glucoside and 4'-glucoside, do not differ When quercetin and its derivatives are provided for consumption along with their natural sources in which these compounds are dispersed in the matrix, quercetin aglycone is more bioavailable than its glucosides. This finding suggests that in some cases, bioavailability of isolated food components consumed as food supplements could be less than when they are consumed with the food matrix **(Olthof et al., 2000)**. Autors Graefe et al. **(2001)** in theirs scientific study observed that the bioavailability of quercetin from onion, in which a variety of quercetin glucosides is present, is comparable to the bioavailability of isolated quercetin 4-glucoside. The lipophilic character of quercetin suggests that it can cross enterocyte membranes via simple diffusion **(Wiczkowski et al.,**

2008). Urinary excretion of quercetin seemed to be a small but constant function of quercetin intake **(Young et al., 1999)**. Nowadays is known that humans absorb appreciable amounts of quercetin and that absorption is enhanced by conjugation with glucose **(Hollman et al., 1995)**.

Effect on animal cells

Quercetin has a broad range of activities within cells **(Bjeldanes and Chang, 1977)**. As an antioxidant, it prevents oxidation of low-density lipoproteins and the expression of metalloproteinase 1, thus inhibiting the disruption of atherosclerotic plaques and contributing to plaque stabilization **(Song et al., 2001)** and also brings about the regeneration of the pancreatic islets and probably increases insulin release in streptozocin-induced diabetic rats; thus exerting its beneficial antidiabetic effects **(Vessal et al., 2003)**.

It has been suggested as a potent anticarcinogenic flavonol. In 9,10-dimethyl-1,2-benzanthracene-initiated and TPA-promoted two-stage mouse skin cancer models, quercetin exerted the anticarcinogenic effects **(Soleas et al., 2006)**. In tumor cells, it exerts antiproliferative effects, arrests human leukemic T cells in late G1 phase of the cell cycle **(Yoshida et al., 1992)** and markedly inhibited the growth of human gastric cancer cells **(Yoshida et al., 1990).** Quercetin decreased expression of metalloproteinase-2 and metalloproteinase -9 in a dose-dependent manner in prostate cancer cells PC-3 *in vitro* **(Vijayababu et al., 2006)**.

Quercetin has also antiinflammatory effects, regulating nitric oxide, interleukin-6, and tumor necrosis factor-α release **(Comalada et al., 2005; Dias et al., 2005; Liu et al., 2005a; Manjeet and Glosh, 1999; Kim et al., 2007; Kumayawa et al., 2006),** thereby alleviating oxidative damage in the tissue **(Dias et al., 2005)** and inhibiting the lipopolysaccharide-induced delay in spontaneous apoptosis and activation of neutrophils **(Liu et al., 2005b)**. It is likely that quercetin may be inhibiting the synthesis of the hormone or interfering with hormone-receptor binding. It could also be blocking some primary events stimulated by the hormone-receptor interaction. Quercetin does appear to inhibit tyrosine protein kinase activity **(Levy et al., 1984; Sharoni et al., 1986)** what have been implicated as necessary for normal mammary growth and development **(Levy et al., 1984; Sharoni et al., 1986)**.

It is examined that a single oral daily dose of the bioflavonoid quercetin reduced blood pressure and heart rate, the cardiac and renal hypertrophy, the endothelial dysfunction and the oxidant status in a rat model of spontaneous hypertension , but had no effect on normotensive

rats. This report showed the chronic antihypertensive effect of a quercetin **(Duarte et al., 2001)**.

Protective effect of quercetin against various diseases such as osteoporosis, certain forms of cancer, pulmonary and cardiovascular diseases but also against aging was also observed **(Boots et al., 2008).** Short-term, high intake of black currant and apple juices had a prooxidant effect on plasma proteins and increased glutathione peroxidase activity, whereas lipid oxidation in plasma seemed to decrease **(Young et al., 1999)**. Quercetin (12,5-50 mg/kg) reduced the area of gastric ulcer but not the number. It is suggested that α2-adrenergic receptors mediate the effect of quercetin on intestinal motility and secretion **(Carlo et al., 1994)**.

SUMMARY, CONCLUSIONS, AND FUTURE PERSPECTIVES

Data from several studies suggest that quercetin has a broad range of activities within animal cells and occurs to be able to prevent or reduce the development of different type of diseases. The absorption and metabolism of quercetin is still poorly understood, but future studies can detect more facts connected with these processes.

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