Original Article

The Effect Of Quercetin And Dihydroquercetin On The Activity Of The Sucrase Enzyme In The Small Intestine In Case Of Experimental Hypothyroidism

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Abstract

The development of new drugs for the treatment of hypothyroidism is one of the crucial problem of medicine, physiology and pharmacology. The hypoglycemic properties of biological active compounds were studied in this research to determine the effect of thyroid hormones on the functional parameters of the small intestine in case of experimental hypothyroidism and the correction mechanism with natural substances. In the study, the effect of quercetin and dihydroquercetin polyphenols on the activity of small intestine hydrocarbons in a healthy body was studied and the mechanism of correction with these substances after hypothyroidism was studied.

Keywords. dihydroquercetin, quercetin, sucrase, glucose homeostasis, flavonoids

INTRODUCTION

The metabolic process is accelerated in a young organism. The absorption of various substances through the small intestine can be observed by the rapid growth of young rats. Growing evidence indicates that various dietary polyphenols may influence carbohydrate metabolism at many levels.

Quercetin, the most abundant of the flavonoids (the name comes from the Latin –quercetum, meaning oak forest, Quercus oak) consists of 3 rings and 5 hydroxyl groups (Figure-1) Quercetin acts as a building block for other flavonoids. Fruits and vegetables particularly citrus fruits, apples, onions, parsley, tea, red wine, etc. are the primary dietary sources of Quercetin. Olive oil, grapes, dark cherries, and dark berries such as blueberries and bilberries are also high in flavonoids including quercetin. [1]

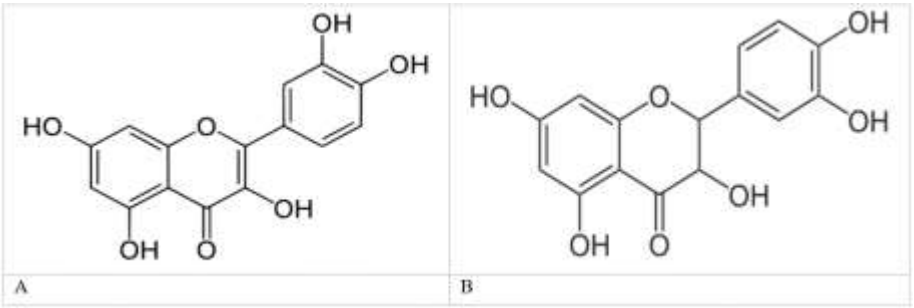

Figure 1. Molecular structure of quercetin (A) and dihydroquercetin (B)

The best described property of Quercetin is its ability to act as antioxidant. Quercetin seems to be the most powerful flavonoids for protecting the body against reactive oxygen species, produced during the normal oxygen metabolism or are induced by exogenous damage.[2,3]Dihydroquercetin was discovered in 1936, by Albert, an American biochemist. Dihydroquercetin mainly found in species of the genus *Larix*, *Douglas Fir*, *Cedrus*and *Pseudotsuga*. By substantial efficiency of hydrogen atom and electron transfer and by keeping metal ions tightly sequestered (metal-chelating agent), Dihydroquercetin brings fundamental means of antioxidant defense against free radical-mediated tissue damage.

MATERIALS AND METHODS

Two-month-old weighing 100–120 g male mice were kept in plastic boxes (5 animals/box). The size of the plastic boxes is 50×30×28 cm. Indoor temperature 22-24° C. Food and drinking water were provided in unlimited and the diet consisted of wheat, sunflower seeds, dairy products, meat products, wheat bread, herbs, vegetables, soups, and mixed feed. The animals were divided into experimental and control groups. The animals of the experimental group were

received with mercazolil at a dose of 10 mg/kg for 14 days, and the animals of the control group were received with 1.0 ml of diluted drinking water. On day 15 of the experiment, blood was taken from the tails of control and experimental animals.[5] A group of animals received from experimental hypothyroidism was given 20 mg/kg of quercetin and dihydroquercetin flavonoids for 14 days after 8-10 hours in the morning. From 8 to 10 am the animals were decapitated and the abdominal cavities were opened immediately, the small intestines were removed and placed in a container with water and ice for further experiments. During the experiments, the small intestine was separated from the mesentery and its cavity was washed with 20-30 ml of Ringer's solution (pH-7.4). Intestinal mass was measured on an electronic scale. The intestinal mucosa was mixed with chilled Ringer's solution 1/10 and homogenized using a tissue homogenizer for 1–1.5 min. The 2% solutions of sucrose was used as substrates for determining the activity of intestinal enzyme. According to the Dahlqvist method (Dahlqvist, 1984), sucrase of the small intestine was determined using a glucose oxidase (Human Germany). The activity of sucrase was calculated based on 1 g of tissue per 1 μm of the decomposition product formed in 1 minute. Statistical processing of the results was carried out according to the Student-Fisher method. The arithmetic average (M), the average error (± m), and the reliability index (R) were determined. $P<0.05$ is considered reliable.

RESULTS AND DISCUSSION

Maintenance of glucose homeostasis is of utmost importance to human physiology, being under strict hormonal control. Failure of this control can result in the metabolic syndrome, a multi-symptom disorder of energy homeostasis encompassing obesity, hyperglycemia, impaired glucose tolerance, hypertension and dyslipidemia. The disturbance of glucose metabolism is often related to the increase of fat mass, especially in the abdominal area and ectopically, to the tissues where fat is not stored in normal energy homeostasis. This in turn results in inflammation and exacerbated oxidative stress at the whole body level, and malfunction in several organs including pancreas, liver, muscle and adipose tissue. Carbohydrate digestion and glucose uptake allow for better glucose control after a high carbohydrate diet. Isolated glucose is transported through intestinal enterocytes by its own carriers. With the introduction of a healthy body of quercetin and dihydroquercetin, the activity of enzymes in the small intestine decreases. Decreased activity of digestive enzymes can impair glucose uptake and glucose transporter absorption in the small intestine, leading to postoperative hyperglycemia.

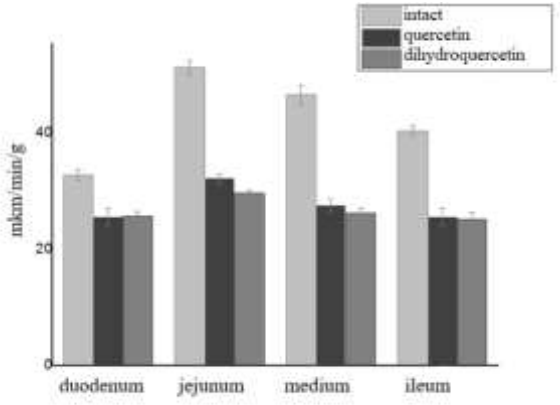

Figure 2. Effect of the quercetin and dihydroquercetin flavonoids on the activity of the sucrase enzyme in the small intestine in a healthy body. Note: $P<0.05$ in all cases; $n = 5$.

If the jejeum section of the small intestine, which has the highest enzymatic activity, was 51.3 μmol/min/g of tissue, and in duodenum part it has a maximum of 32.9 μmol / min/g. In the medium section, the specific activity of the main enzyme was 90.8% (46.6 μmol /min/g of tissue), and in the ileum section, the activity of the sucrase enzyme was 78.7% (40.4 μmol/min/g of tissue) (Figure-2).

Under the influence of quercetin flavonoids, the specific activity of sucrase decreased by 62.7% in the jejunum section of the small intestine and sucrase activity declined by 78.3% in the duodenal section. Sucrase activity in the medium and at a ileum part decreased by 1.7 and 1.6%, respectively. Under the influence of a dihydroquercetin, the decrease observed in sucrase activity in the duodenum intestine by 78.3% and the activity of main enzyme declined by 57.8% in the proximal intestine. In the medium and ileum sections of the small intestine, under the influence of this flavonoid, the activity of enzymes decreased by 56.2% and 62.3%, respectively. In these cases, the activity of enzymes decreased due to flavonoids and the inhibitory effect on the absorption of glucose in the body. As a result, the amount of carbohydrates consumed in the body is excreted from the body. This prevents the accumulation of excess weight in the body.

The results of specific activity of the sucrase enzyme was observed in the total activity. The total activity of the enzyme is related to the mass of the mucous membrane of the small intestine. The total activity of the sucrase enzyme in the duodenum was 2/5 of the specific activity and was equal to26.5 μmol/min/total mass of the mucous layer. In the jejunum small intestine, sucrase activity was higher than the duodenum by 36.3%. The specific activity of the sucrase

enzyme in the medium and ileum small intestine was 46.6 and 40.4 μmol/min/total mass of the mucous layer, respectively.

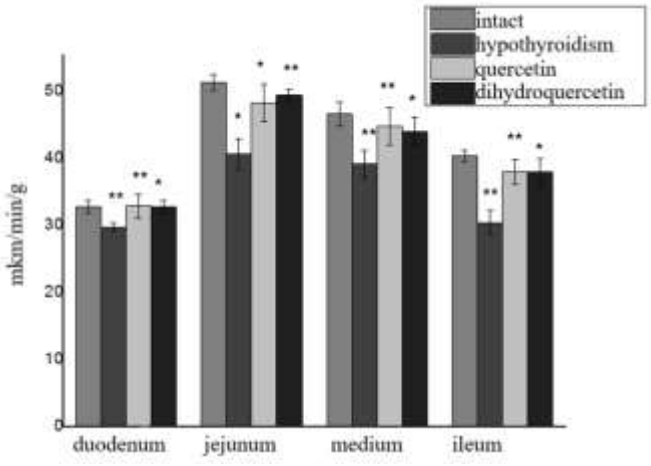

Figure 3. Effect of quercetin and dihydroquercetinflavonoids on the activity of the sucrase enzyme in the small intestine in experimental hypothyroidism

Note: in all cases * P<0.05; ** P<0.01; n = 5

With the exclusion of experimental hypothyroidism, the activity of sucrase in the jejunumpart of the small intestine decreased by 20.7%. This indicates that in case of hypothyroidism there are some crucial changes wereobserved that based on the processes of energy metabolism in the body. In the duodenum, the activity of the sucrase enzyme decreased by 9.45%, and in the medium section - by 16%. In the ileum section, the activity of the sucrase enzyme decreased by 24.7%. When corrected with quercetin, sucrase activity increased in the jejeum section by 94.7%, in the medium and ileum sections by 94.0% and 96.0% (48.3 μmol/min/g, 40.4 μmol/min/g). Under the influence of dihydroquercetin in the jejunum intestine up to 96.8%, in the medium part 94.5% approached the level of a healthy body (Fig. 3). Flavonoid-based diets are highly effective in improving nutrient metabolism in the small intestine. The dihydroquercetinpolyphenol has a relatively high effect on the activity of the sucrase enzyme.

CONCLUSION

The quercetin and dihydroquercetin flavonoids have an inhibitory effect on the activity of enzymes in a healthy body. In experimental hypothyroidism, as a result of the regulatory influence of thyroid hormones on the development of the digestive organs, the activity of sucrase decreases. As a result of the correction of the quercetin and dihydroquercetin compounds, the activity of the sucrase enzyme improved and the amount of thyroid hormones in the blood was restored.

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