

Research Article

Ingestion of Goji Berry (*LyciumBarbarum*) Evaluation on Plasma Levels of Total Cholesterol, Lipid Fractions, Glycaemia, Serotonin and Arterial Pressure

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Abstract

Goji Berry is the name of the fruits of the plant *Lyciumbarbarum*. Goji berry contains 19 amino acids, 21 minerals, broad spectrum of carotenoids, β -sitosterol (anti-inflammatory), vitamins A, C and E, among other substances. The objective of this study was to evaluate the levels of lipid fractions, total cholesterol, serotonin levels, blood pressure, body weight and abdominal circumference, before and after the ingestion of goji berry in women. Twenty women, aged between 18 and 50 years, participated in the study. They had the data evaluated: body weight, height, abdominal circumference and blood pressure. Participants received 40 grams of dehydrated goji berry, consumed in two daily servings of 20 grams, one at breakfast and the other after lunch, for 15 days. Laboratory tests were performed to evaluate total cholesterol, lipid fractions, glycaemia and serotonin, on day 0 and 16 of the study. Daily consumption of goji berry provided general well-being, decreased abdominal circumference, body weight LDL, glycaemia, systolic and diastolic blood pressure and increased serotonin, and may be indicated as a complementary treatment for hypertension, diabetes and depression.

Keywords: Blood Pressure; Cholesterol; Glycaemia; Goji Berry; Serotonin

Introduction

Functional foods are defined as any substance or component of a food that provides health benefits, including the prevention and treatment of diseases. Some parameters should be taken into account in relation to functional foods. For Borges [1], they must exert a metabolic or physiological effect that contributes to the physical health and the reduction of the risk of development of chronic diseases. Therefore, functional foods should be part of the daily diet to prevent and control diseases.

Fruit consumption can reduce the risk of cardiovascular diseases, mainly because they contain antioxidants. The best-known antioxidants are the polyphenols and vitamin C found in goji berry.

Goji berry is the name of the fruits of the plant *Lyciumbarbarum*. The plant originates from the mountains of Tibet. Goji berry contains 19 amino acids, 21 minerals, a wide range of carotenoids (β -Carotene, Neoxanthin, Cryptoxanthin, Zeaxanthin), polysaccharides, flavonoids, phytosterols, β -sitosterol (anti-inflammatory), vitamins A, C and E (tocopherol) among other substances [2,3].

Goji berry has several biological activities, including effects on aging [4], neuroprotection [5-7], anti-fatigue/resistance, increased metabolism, welfare promotion, immunomodulation [8], antitumor activity [9-11], glycemic control in diabetics [12] and treatment of osteoporosis with improved bone density and matrix [13]. Tocopherols have been shown to have positive effects on patients with HIV and those with Parkinson syndrome. Phytosterols have been found to reduce the low-density lipoprotein cholesterol level, and increase the high-density lipoprotein cholesterol level in the blood [14].

The s-1 polysaccharides (LBP) extracted from *Lyciumbarbarum* can be used in the treatment of diabetes. *In vitro* and *in vivo* experiments showed that LBP s-1 promoted significant hypoglycemic effects, with increased insulin secretion and pancreatic β -cell proliferation [15].

Goji berry has high antioxidant power and therefore helps in the prevention of diseases related to oxidative stress in humans. Goji effects were investigated in a 30-day, randomized, double-blind, placebo-controlled study of a population of 50 healthy Chinese adults aged 55-72 years. Serum levels of the following antioxidants were evaluated: Superoxide Dismutase (SOD), Glutathione Peroxidase (GSH-Px) and lipid peroxidation (indicated by decreased levels of Malondialdehyde, MDA) before and after consumption of goji or placebo. In the goji group, antioxidants increased significantly from 8.4% for SOD and 9.9% for GSH-Px between pre-treatment and post-treatment, while MDA was significantly lower in 8.7% [16].

The consumption of goji berry has increased worldwide in recent years; however, more clinical studies are needed for its knowledge on human health. The objective of the present study was to evaluate the lipid profile, glycaemia, serotonin, arterial pressure and abdominal circumference before and after the ingestion of goji berry (*Lyciumbarbarum*) in women.

Material and Methods

Twenty female participants, aged 18-50, were selected. All the participants signed informed consent and had the following anthropometric data evaluated: body weight, height, abdominal circumference and blood pressure.

In this study, those who used anticoagulants, goji berry allergy, pregnant women or infants were excluded. Also excluded were women who were taking medication for dyslipidemia and had the following diseases Diabetes mellitus, nephrotic syndrome, acute or chronic renal failure, hypo or hyperthyroidism, hormone replacement therapy or other pathology capable of altering the lipid profile.

The guidelines of the Brazilian Society of Diabetes [17] and the Brazilian Society of Cardiology [18] were used for glycaemia and dyslipidemias, defined as normal glycaemia < 110 mg/dl, hyperglycemia ≥ 126 mg/dl and individuals with decreased glucose tolerance ≥ 110 mg/dl and lower than 126 mg/dl; for high triglycerides, values > 200 mg/dl; altered cholesterol > 200 mg/dl and hypercholesterolemia > 240 mg/dl.

Laboratory tests were performed to evaluate glycaemia, total cholesterol, triglycerides, HDL and LDL, on day 0 and 16 of the study. Participants received 40 grams of dehydrated goji berry, consumed in two daily servings of 20 grams, one at breakfast and the other after lunch, for 15 days. All participants answered, at the end of the study, a questionnaire containing questions about pos-

sible beneficial and side effects of goji berry consumption.

Statistical analysis of the following measurements arterial pressure, lipid fractions, glycaemia, serotonin, abdominal circumference and body weight before and after goji consumption were performed. The t test was used and values of p less than 0.05 were considered statistically significant.

Results

There was a significant increase in serotonin levels and significant reduction in abdominal circumference, total cholesterol, LDL, blood glucose, and diastolic and systolic arterial pressure. Differences in triglyceride levels, HDL and body weight were detected before and after the goji consumption, however, these were not significant (Table 1).

Parameter	Day 0	Day 16	p
Weight body (Kg)	79.0 \pm 3.5	78.4 \pm 3.4	0.007
Abdominal circumference (cm)	95.1 \pm 2.6	91.8 \pm 2.9	<0.0001
Systolic arterial pressure (mmHg)	120.0 \pm 2.5	111.5 \pm 2.7	0.0017
Diastolic arterial pressure (mmHg)	83.5 \pm 2.7	75.0 \pm 3.0	0.0037
Cholesterol (mg/dl)	183.6 \pm 8.5	174.8 \pm 9.1	0.06
HDL (mg/dl)	47.1 \pm 2.7	49.3 \pm 2.1	0.06
LDL (mg/dl)	156.7 \pm 24.2	109.2 \pm 17.0	0.02
Triglyceride (mg/dl)	169.6 \pm 27.6	172.9 \pm 23.1	0.44
Glucose (mg/dl)	89.9 \pm 3.4	85.0 \pm 2.8	0.0007
Serotonin levels (ng/ml)	54.5 \pm 3.4	93.1 \pm 8.2	0.04

Table 1: Anthropometric Data, Diastolic and Systolic Blood Pressure and Serotonin Levels from the 20 Participants, Before (Day 0) and After (Day 16) the Consumption of Goji Berry. Data Expressed as Mean \pm Standard Error.

Participants reported subjective feeling of the satiety, increased energy level, sleep quality, ease to wake up, improvement in concentration, calmness, well-being, contentment, happiness, reduced fatigue and stress and improved the regularity of gastrointestinal function.

Discussion

Amagase and Nance [8] showed that *Lyciumbarbarum* increased metabolic rate and reduced body weight in adults, as well as contributed to general well-being. These authors detected a significant mean reduction of 5.5 ± 0.8 cm in the abdominal circumference of the subjects who consumed goji berry juice for 14 days (valor de p). Another study that evaluated the consumption of 120ml/day of goji berry juice in overweight adults for 14 days also showed a significant reduction in abdominal circumference, with a mean loss of 5.54 ± 0.65 cm. It is noteworthy that the group that consumed goji

berry was also subjected to a daily intake of 1,200 calories. The placebo group also underwent caloric restriction and had a loss of 0.88 ± 0.83 cm of abdominal circumference throughout the experiment [19]. It was demonstrated in the present study a significant difference in abdominal circumference before and after consumption of *L. barbarum* for 15 days, with a reduction of 3.3 cm.

Obesity is a worldwide public health problem and is associated with increased morbidity and mortality. Excess abdominal fat is strongly associated with increased cardiometabolic risk, cardiovascular problems and morbidity. One of the criteria for the diagnosis of the metabolic syndrome includes the measurement of abdominal circumference because the increased visceral adipose tissue is one of the triggers of the syndrome [20]. Therefore, daily consumption of goji berry may be indicated for reduction of abdominal circumference and decreased risk for metabolic and cardiac diseases.

Luo, et al. [21] reported that crude or purified polysaccharides (LBP) from *L. barbarum* can reduce blood glucose levels and serum concentrations of Total Cholesterol (TC) and Triglycerides (TG), while increasing High-Density Lipoprotein Density (HDL) in diabetic rabbits induced by alloxan. The results of another study also indicated that treatment with LBP for 28 days resulted in a significant decrease in the concentration of glucose, CT and TG levels in diabetic alloxan-induced rats [22]. These effects are due to LBP, the main bioactive constituents of *L. barbarum*.

Our study detected a significant reduction of glucose from 89.9 ± 3.4 to 85.0 ± 2.8 mg/dl and LDL from 156.7 ± 24.2 to 109.2 ± 17.0 mg/dl in women that consumed 40 g/day of *L. barbarum* for 15 days. There was a reduction of cholesterol from 183.6 ± 8.5 to 174.8 ± 9.1 mg/dl in the participants, however, this difference was not statistically significant. An in vitro study revealed that the polysaccharide LBP-1 protects pancreatic cells producing insulin and also acts on insulin-resistant cells, facilitating the entry and consumption of glucose by the cells, contributing to the hypoglycemic effect of *L. barbarum* [23].

One study conducted in 67 patients with type 2 diabetes, 30 in the control group and 37 in the experimental group, who received 300 mg/day of LPB for three months, showed a reduction in glycaemia, total cholesterol, triglycerides, LDL and increase in HDL, in the experimental group [24]. In this study, it was found that HDL increase in the participants after consumption of *L. barbarum* for 15 days, however, was not significant. HDL plays an important role in the transport of cholesterol from the peripheral blood to the liver via a reverse cholesterol transport pathway. Therefore, increased HDL is associated with a decreased risk of heart disease [25].

Adipokines are cytokines or hormones produced by adipocytes. It is reported that some adipokines such as TNF α , leptin, IL-6 and ADPN are related to insulin resistance and subsequent

development of type 2 diabetes [26]. Individuals with type 2 diabetes who used LPB had lower amounts of TNF α , increased glucose uptake into cells and decreased insulin resistance [24].

One study evaluated the effects of *L. barbarum* LBP on fatigue after physical exercise. The model chosen was swimming in mice with weight overload and consumed LBP at the oral dose of 20mg/day and 60mg/day for a period of 14 days. It has been found that LBP can significantly prolong swimming time with weight overload, increase hepatic glycogen content, retard and prevent the increase of lactic acid in the blood as well as assist in the faster recovery of fatigue in these animals [27]. The best results were obtained with daily consumption of 60mg/day LBP, when compared to the 20mg/day LBP and control group of animals that did not receive LBP [27].

It is known that the body's resilience has declined sharply if the power is depleted. Because glycogen is the most important energy source during exercise, increasing the glycogen stored in the liver is an advantage for resistance to exercise. Increased glycogen consumption and accumulation of urea and other metabolites cause body fatigue [28]. One study demonstrated that LBP ingestion of *L. barbarum* improved the physical performance and energy metabolism of rats with weight overload during swimming [27].

In our study, the participants reported as subjective feeling the reduction of fatigue. However, more clinical studies are needed to better understand the anti-fatigue mechanism of *L. barbarum* LBP. Goji berry also has vascular effects. A study carried out with rat aorta rings that consumed LBP detected increased expression of Endothelial Nitric Oxide Synthase (eNOS) and increased nitric oxide, a vasodilator agent produced by the endothelium of blood vessels. Therefore, LBP helps reduce blood pressure by increasing the production of nitric oxide and vasodilation [29]. The consumption of goji berry for 15 days by participants in this study significantly reduced systolic and diastolic blood pressure.

It is known that administration of goji berry (150 mg/kg/day and 300 mg/kg/day) improves testosterone levels and sexual activity in rats of advanced age. The hypothesis is that goji berry prevents the decrease of serum testosterone due to its antioxidant effect. In addition, it increases the expression of eNOS, Neural Nitric Oxide Synthase (nNOS) and Cyclic Guanosine Monophosphate (cGMP), subsequently inhibiting apoptosis in muscle cells and deposition of collagen in the penis, improving penile erection and sexual function in aged rats [30].

In addition, the effects of well-being, tranquility, and happiness attributed to goji are possibly due to tryptophan, the precursor of serotonin, in the Central Nervous System and maintenance of catecholamine levels [31]. *L. barbarum* is indicated as an auxiliary treatment for depression, a condition that affects 10% of the world population [32]. Daily diet with goji berry can also have positive effect in preventing this disease. In addition, this fruit also contains

safranal, an aromatic compound, with anti-depressive properties and which acts as a GABA_A receptor agonist [31].

The effects of *Lycium barbarum* were measured on the well-being of healthy adults (18-60 years of age), who consumed a standardized juice of goji berry. Subjects consumed 120 ml/day of goji berry or placebo for 30 days. The researchers applied questions with a scale of 0-5 for general well-being, stress, depression and plasma levels of catecholamines (epinephrine and norepinephrine) before and after the intervention [33]. [Higher study characteristics].

Amagase and Nance [33] showed a significant improvement in sleep quality and ease of wakefulness, as well as a significant reduction in concentration difficulty, excessive worry, memory loss, and fatigue after exercise in the goji berry group (n = 20). The placebo group (n = 19) did not show significant changes, but there was a tendency to increase stress and depression. Plasma levels of epinephrine and norepinephrine in the placebo group, compared to pre-intervention, increased significantly by 20% and 31%, respectively, whereas the goji berry group did not show significant changes. These results suggest that daily consumption of goji berry increases subjective feelings of general well-being and decreases stress and depression, which may be related to stabilization of catecholamine levels [33].

A meta-analysis study including 161 participants, allocated to two groups: experimental (n = 81) and placebo (n = 80), in which the experimental group consumed 120 ml of goji berry juice per day, demonstrated welfare and neurological and psychological performance in the group that consumed goji berry when compared to placebo [34].

Conclusions

Our results indicate the following clinical results of goji berry, LDL reduction, decreased arterial pressure, blood glucose, abdominal circumference, and increased feelings of well-being. The benefits of goji berry are numerous for health and because of its nutritional components it is the best functional food known to date and can be used in the prevention and treatment of type 2 diabetes, hypertension, overweight and obesity, hypercholesterolemia and depression.

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