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Investigation of the impact of blueberries on metabolic factors influencing health

Nilgun Istek [a], Ozan Gurbuz [b,*]

[a] Medical Park Hospital, Nutrition and Dietetic Dept., Osmangazi, Bursa, Turkey
[b] Uludag University, Agricultural Faculty, Dept. of Food Engineering, Gorukle Campus, 16059 Bursa, Turkey

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ABSTRACT

In this study, ingestion of blueberry fruit by overweight and obese individuals, who were participating in medical nutrition therapy, was investigated. The study was designed to determine the impact on body weight and metabolism (glucose, HbA1c, TSH, total cholesterol, LDL cholesterol, HDL cholesterol, triglycerides, ALT, AST, uric acid, insulin, insulin resistance, hemoglobin) of obese patients over a 12 week period of time.

Clients were selected based upon their participation in the clinical study as well as measurements which included: body weight, fat, fluid, muscle ratio, and biochemical parameters. The study was conducted with 54 adults (blueberry n = 27 and control n = 27). Midway through the study, the clients in the blueberry group replaced 50 g of carbohydrates with a 50 g serving of blueberries.

Blueberry fruit is one of the important antioxidant resources due to the content of anthocyanins and phenolic substances. While positive changes were observed in all values in both groups, significant differences in the intervention group were observed in BMI, insulin levels, insulin resistance, LDL, total cholesterol, and uric acid levels. Those differences were observed between baseline and 12th week values. In the 12th week, weight loss (kg) and body fat reduction (%), in the blueberry group was determined to be 11–14% more in males and 3–1.4% more in females, from the control group. Total cholesterol was changed at the beginning 187.29 ± 34.36 mg/dL; 203.19 ± 41.10 mg/dL for control and for blueberry group. At end of the trial, values had changed between 178.59 ± 29.42 mg/dL; 173.20 ± 33.26 mg/dL for control and blueberry groups respectively. LDL and total cholesterol (18.3–14.75%) values were found statistically significant at the end of 12 weeks in the group which added blueberries to replace carbohydrates.

1. Introduction

Recent advances in nutrition science have shown that diet has a potential effect on the maintenance of optimal health and development. Clinical trials and epidemiological studies show that fruit and vegetable consumption has an inverse relationship with regards to the incidence of cardiovascular diseases, cancer, and other chronic diseases. Other studies have also indicated that plant products in some fruits, especially berries, exhibit a wide range of positive biological effects (Kallas et al., 2005). The principal source of antioxidant substances are the foods contained in a daily diet. Phenolic compounds, vitamins (C and E), and carotenoids located in fruits and vegetables have antioxidant activity which includes effective compounds to prevent oxidative stress associated with these diseases. Therefore, determination of the antioxidant capacity of foods has received great interest. Of the fruits and vegetables, berry fruits have been found to be of high antioxidant capacity. In addition to antioxidants, berry fruits are also high in ascorbic acid and phenolic substances.

Studies have found that the edible berry fruits rich in antioxidants, anthocyanins, and other phenolic compounds are reducing the risk of cancer formation (Bomser, Madhavi, Singletary, & Smith, 1996; Katsube, Iwashita, Tsushida, Yamaki, & Kabori, 2003; Neto, 2007; Skupień, Oszmiański, Kostrzewa-Nowak, & Tarasiuk, 2006; Yi, Fischer, Krewer, & Akoh, 2005; Zhao, Giusti, Malik, Moyer, & Magnuson, 2004), cardiovascular diseases (Mckay & Blumberg, 2008; Mckenzie, Li, Kaufman, Seymour, & Kirakosyan, 2009; Neto, 2007), obesity, diabetes (Martineau et al., 2006; Wang & Stoner, 2008), aging (Papandreou et al., 2009; Zafra-Stone et al., 2007), urinary tract infections (Dugoua, Seely,

* Corresponding author at: Department of Food Engineering, Agricultural Faculty, Uludag University, Gorukle Campus, 16059 Nilufer, Bursa, Turkey.
E-mail address: ozang@uludag.edu.tr (O. Gurbuz).

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Perri, Mills, & Koren, 2008; Nowack & Schmitt, 2008; Pérez-López, Haya, & Chedraui, 2009; Ross, 2006), tooth and gum disease (Ho et al., 2010a; Ho et al., 2010b; Nowack & Schmitt, 2008).

Fruits are one of the best sources of fiber. Fiber is more important for digestion and part of a healthy diet. As a result of changes in intestinal viscosity, nutrient absorption, rate of passage, production of short chain fatty acids and production of gut hormones (Lattimer & Haub, 2010 Dec) it can help weight loss, diabetes and heart disease.

Blueberries have a special importance among fresh berry fruits due to their high antioxidant capacity and high concentration of anthocyanins and other phenolic compounds (Prior et al., 1998). They are a good source for phenolic compounds such as chlorogenic acid, quercetin, kaempferol, myricetin, proanthocyanidins, catechin, epicatechin, resveratrol, and vitamin C which contribute to antioxidant activity (Giovanelli & Buratti, 2008). Health benefits of this fruit are proven in many cell culture systems; those which contain colon cancer cells (Parry et al., 2006), endothelial (Bagchi, Sen, Bagchi, & Atalay, 2004), liver (Meyers, Watkins, Pritts, & Atalay, 2003), chest (Singletary, Jung, & Giusti, 2007), and leukemia (Feng et al., 2007). They play an important role in these cell culture systems by increasing the capacity for the absorption of oxygen radicals of anthocyanins, preventing the formation of oxygen free radicals, reducing lipid peroxidation, inhibiting mutation occurring from environmental toxins and carcinogens, reducing cellular growth by organizing signal transduction, and effecting proteins that regulate cell cycle (Wang, Zhang, Zhang, Yao, & Zhang, 2010).

In this study, following the preliminary evaluation of the consultants who were referred by the Dietetic Clinic, attempts were made to follow the body weight, fat, fluid, muscle ratios and biochemical parameters (Glucose, HbA1C, TSH, Total cholesterol, LDL, HDL, Triglyceride, ALT, AST, Uric Acid, Insulin, Insulin resistance, Hemoglobin) and establish blueberry control groups on those who were eligible for the study and agreed to participate in the study.

2. Materials and methods

2.1. Materials

Blueberry fruits were grown at an organic farm in Kutluca, İznik, Bursa, Turkey. The highbush organic blueberry cv. Bluecrop (*Vaccinium corymbosum* L.) was obtained from Kutluca Village (Elevation: 885 m and DMS Lat: 40 °34′20.12″N, DMS Long: 29 °50′49.84″E), Iznik, Bursa. It was harvested at the optimum maturity. Investigation of the physico-chemical composition and antioxidant capacities, revealed the presence of 8 different phenolics of blueberry which has been reported in our previous research (Yildiz, 2012). Total acidity 1.54 g/100 g, pH 2.83, dry matter 11.73 g/100 g, ash 1.84 g/100 g, total phenolics 395.6 mg GAE/kg and total anthocyanins 12.83 mg(CDE)/L. Average concentrations expressed as mg/kg of individual flavonoids and phenolic acids (HPLC-DAD) have been determined as (+)-catechin (14.76), myricetin (97.40), caffeic acid (2.05), resveratrol (7.94), morin (6.23), tannic acid (4.41), quercetin (0.62) and kaempferol (0.59). Antioxidant capacities were determined by DPPH (2.14 μmolTE/g FW) and CUPRAC (5.98 μmolTE/g FW) methods. The bioaccessibility (%) of phenolics and antioxidant compounds changed 61.86%, DPPH 69.63% and CUPRAC 77.43% (Anson et al., 2009; Bouayed, Deußer, Hoffmann, & Bohn, 2012).

The antioxidant capacity of various extracts were determined using two different methods, DPPH (2,2diphenyl-1-picrylhydrazyl) and CUPRAC (cupric reducing antioxidant capacity) assays. The analytical procedures were performed with the use of modified methods proposed by Apak, Güçlü, Özyürek, and Çelik (2008) and Boskou et al. (2006). The results are expressed as l μmol Trolox equivalent (TE) per g sample. All experiments were performed in triplicate.

After the blueberry fruits were gathered, they were preserved in cold storage and kept in the freezer until delivered to the client in the hospital. The fruit was brought to the hospital in a cooler. Upon arrival at the hospital, the berries were weighed out in 50 g portions, put into plastic caps, and placed into a freezer until given to the clients.

2.2. Methods

This research was carried out at the Medical Park Hospital Nutrition and Diet Clinic, an outpatient clinic for weight management and metabolic control. This particular hospital includes appropriate facilities for research. Clinical trial procedures were approved by the Medical Park Hospital Ethics Committee. The protocol number of the Ethical Permission is ref: 2012/BSHK-555 (18.07.2012).

All of the clients, who agreed to be in this study, participated in consultations once every three-weeks. Counselors worked with the clients for a total of 12 weeks by repeating nutrition therapy and nutrition training. After the first interview, the diet was followed up for 3 weeks. After the first 6 weeks of treatment, a carbohydrate source (1 serving of fruit) was deleted and the blueberries added to the diet of the clients in the blueberry group. Because our study is directed towards participants who are obese and involved in medical nutrition therapy, appropriate characteristics for the client were necessary as well as voluntary compliance evaluations. A set of procedures was set up in order to determine which clients could be included in the study (see Individual's flow chart).

2.3. The preliminary procedure (Ethics)

The study's Medical Park Bursa Hospital Nutrition and Diet Clinic schedule was utilized with the client and reference to the hospital's Medical Directorate was made in order to allow the work to be undertaken in this study. An application form and petition was submitted (Specialty Thesis and/or non-Clinical Drug Studies Application Form).

The petition was discussed with the Ethical Board and evaluated by the Director.

After the Ethics Board approval, the following form was used: Clinical Research Ethics Committee Informed Volunteers Form. The next step was to gather an appropriate sample of individuals, which volunteered by completing this form and were confirmed.

Following the preliminary evaluation of the consultants who were referred by the Dietetic Clinic, attempts were made to follow the body weight, fat, fluid, muscle ratios and biochemical parameters (Glucose, HbA1C, TSH, Total cholesterol, LDL, HDL, Triglyceride, ALT, AST, Uric Acid, Insulin, Insulin resistance, Hemoglobin) and establish blueberry control groups on those who were eligible for the study and agreed to participate in the study. In the first consultation to all participants the INFORMED VOLUNTARY FORM of CLINICAL RESEARCH ETHICS COMMITTEE was read and given. They filled out the form and put their name and signature (see informed voluntary form of clinical research ethics committee).

2.4. Dietary guidelines

The following guidelines were the clinic's dietary outline for the participants of this study:

1. Energy: The daily energy intake from food should be reduced to ensure the 0.5–1.0 kg per week weight loss. The individual basal metabolic rate (BMR) or resting metabolic rate