

IMPACT OF OSMODEHYDRATED ANDEAN BERRY (*Vaccinium meridionale Swartz*) ON OVERWEIGHT ADULTS

IMPACTO DEL CONSUMO DE AGRAZ (*Vaccinium meridionale Swartz*) OSMODESHIDRATADO EN ADULTOS CON SOBREPESO

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ABSTRACT

Background: Andean berry (*Vaccinium meridionale Swartz*) is a native Colombian berry with potential health benefit comparable to cranberry (*Vaccinium macrocarpon*), both rich in phenolic compounds with a wide range of biological activities. **Objectives:** to evaluate the effect of Andean berry consumption on blood biochemical parameters (lipid profile and glucose), anthropometric parameters (body weight, waist circumference, body mass index or BMI) and blood pressure of overweight adults. **Methods:** glycemia, total cholesterol, LDL-cholesterol, HDL-cholesterol and total triglycerides in blood serum, body weight, size and waist perimeter, and blood pressure were analyzed in 25 overweight adults at day 1 and 21 after consumption of 35 g/day of osmodehydrated Andean berry. **Results:** a significant reduction in diastolic blood pressure (10%, $p = 0.0388$), systolic blood pressure (6%, $p = 0.0400$), BMI (1.7%, $p = 0.0306$), weight (2%, $p = 0.0388$) and waist circumference (4.1%, $p = 0.0052$) were observed in the participants who completed the study. However, the lipid profile did not have a significant effect, the glycemia increased significantly (6.9%, $p = 0.0004$). **Conclusions:** the results of the present study suggest that the regular consumption of Andean berry treated by osmotic dehydration is a food that may help control weight and blood pressure; however, it requires another type of osmotic agent to prevent the increase of glycemia.

Keywords: *Vaccinium meridionale*, overweight, osmotic dehydration, berry, blood pressure.

RESUMEN

Antecedentes: Agraz (*Vaccinium meridionale Swartz*) es una baya nativa colombiana con potencial beneficio en la salud comparable al arándano (*Vaccinium macrocarpon*), ambas ricas en compuestos fenólicos con amplio rango de actividades biológicas. **Objetivo:** evaluar el efecto del consumo de agraz osmodeshidratado en parámetros bioquímicos sanguíneos (perfil lipídico y glucemia), antropométricos, (perímetro de cintura, índice de masa corporal o IMC) y presión arterial en adultos con sobrepeso. **Métodos:** se analizaron los parámetros glucosa, colesterol total, colesterol-LD, colesterol-HDL, triglicéridos totales en suero, peso, talla y perímetro de cintura, y presión arterial de adultos con sobrepeso al inicio y 21 días después de consumir 35g de agraz osmodeshidratado/día. **Resultados:** se observó en los participantes que completaron el estudio una reducción significativa en la presión arterial diastólica (10%, $p = 0,0388$) y sistólica (6%, $p = 0,0400$), así como en el índice de masa corporal (1,7%, $p = 0,0306$), peso (2%, $p = 0,0388$) y perímetro de cintura (4,1%, $p = 0,0052$). Sin embargo, en el perfil lipídico no

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tuvo efecto significativo, aunque si aumentó significativamente el valor de la glicemia (6,9%, $p = 0,0004$).

Conclusión: los resultados del presente estudio sugieren que el consumo regular de agraz tratado por deshidratación osmótica es un alimento que ayuda al control del peso y presión arterial, sin embargo requiere otro tipo de agente osmótico para evitar el aumento de la glicemia.

Palabras clave: *Vaccinium meridionale*, sobrepeso, osmodeshidratación, baya, presión arterial.

INTRODUCTION

Dietary factors such as the intake of foods with high lipid content and energy intake are positively associated with the increase in body weight because the former is stored in adipose tissue favoring the gain of weight; thus the lipogenesis and the imbalance with energy expenditure leads to excessive deposition of body fat (1, 2). The strategies to promote weight loss should not only include an increase in physical activity, but also a reduction in the intake of foods with high-energy intake (fatty acids and carbohydrates). Therefore, foods that should be part of dietary strategies able to reduce or control body weight should influence the sensation of hunger and satiety (3).

The interest in dehydrated fruits has increased because may contribute to satiety thanks to the fiber content. Satiety is a physiological process that regulates appetite or hunger by secreting several peptides that activate biochemical signals from various parts of the body (4). Therefore, foods rich in dietary fiber can produce a state of satiety that favors the reduction in food intake and directly influence total energy consumption (5). Dietary fiber creates a viscous intestinal environment like a gel that slows gastric emptying and reduces the activity of digestive enzymes of carbohydrates (amylase), triglycerides (lipases) and proteins (proteases) (6). This slow digestion of macronutrients favors contact with receptors that stimulate the intestinal secretion of satiety hormones that can reduce the sensation of hunger and finally decrease the consumption of food (7, 8). In addition, the gel produced by soluble fiber increases the volume of undigested food, which favors the reduction of the total energy acquired in the diet (9-11).

The dehydration of foods is a process that allows increasing the useful life of some types of food (meats, fish, fruits and vegetables) (12), in particular, there is a greater interest in osmotic dehydration

because there is a minimum of processing in the food (13, 14). Osmotic dehydration is a pretreatment process based on the diffusion of food moisture by immersion in a hypertonic solution; among the most used osmotic agents are sucrose, fructose, glucose, sorbitol, and maltodextrin (12, 15). Osmotic dehydration usually followed by drying methods such as air-drying, deep fat frying, and drying freezing, among others, to obtain a final product of better quality. This process is energy efficient, avoids the use of treatments with chemical agents like inhibitors of enzymatic activity and contributes to a greater stability of the product during the storage. Also improves the retention of the color and flavor, provides softer textures to the products with fruits and vegetables, if the osmotic agent is properly selected and there is a balanced ratio of impregnation and elimination of water (12, 16-18).

Vaccinium meridionale Swartz, commonly known as Andean berry, is a plant native to Colombia of the Ericaceae family that produces a fruit, an intense purple globose berry when it is ripe, coming from cold climate regions of the Departments of Antioquia, Boyacá, and Cundinamarca (Colombia) (19). It has been reported that in 2007 the internal consumption of Andean berry was greater than 20 tons per year, with a value higher than USD135000. In addition, this fruit admitted since 2006 in the list of species can enter into the US market, where blueberries have an important commercial value. Thus, it will have a positive impact on the production and generation of employment in Colombia; however, it is a fruit that presents two moments of harvest a year, May and December (20) with the consequent nutritional variation of the fruit (21).

Because the process of osmotic dehydration is an option to maintain over time the nutritional characteristics and microbiological quality of fruits such as Andean berry, which has two harvest moments in Colombia, the fruit can be constantly

available in the market and used as an appetizer or a healthy snack. In addition to supplying the need for satiety, contributes to health benefits, which is more valuable. Taking account the above, the present study aimed to determine the effect of the consumption of osmodehydrated Andean berry in biochemical parameters (glycemia and lipid profile), anthropometrics (waist circumference, weight, body mass index) and blood pressure in overweight adults.

MATERIALS AND METHODS

Plant material and preparation of the osmodehydrated fruit

Fresh and ripe berries of Andean berry (black-violaceous color) were obtained from the municipality of Retiro (Antioquia, Colombia), at 2175 meters above sea level and 16°C; these berries were washed, selected, disinfected with 50 ppm sodium hypochlorite, and again washed with water. The osmotic dehydration was performed with 70% sucrose solution (1 fruit: 3 sucrose solution). The berries kept in sucrose solution for 24 h at 80 rpm and submitted to heat dehydration (Cabela's TS160D) for 14 h at 60°C. The dehydrated fruit was stored in portions of 35g in air-tight plastic bags at 4°C until consumption.

Study design

A quasi-experimental, prospective study with an intervention period of 21 days (3 weeks). Twenty-five adults men and women with excess weight were recruited and received 21 packages each one containing 35 g of Andean berry to consume daily. Participants during the intervention instructed not to alter their dietary habits or lifestyle, they should only restrict the consumption of berries and other foods with high anthocyanin content, for which each volunteer received a complete list of foods rich in anthocyanins to avoid. At the beginning and at the end of the study fasting venous blood samples were collected from each participant in heparin tubes and without heparin, both tubes were centrifuged to obtain serum stored at -80°C until the analysis of biochemical parameters.

Study participants

Twenty-five overweight adults (25-50 years) from the cities of Medellín and Envigado

(Colombia) were recruited into the study. The Bioethics Committee of the Faculty of Dentistry of the University of Antioquia on September 30, 2016, act 08, approved the protocol of the research and informed consent was obtained from each participant. None of the volunteers had prescription medications, cigarette consumption or vitamin/mineral, antioxidant or plant supplements.

Anthropometric data and blood pressure

Day 1 and day 22, at the end of the intervention, we assessed weight, height, body mass index (BMI), systolic blood pressure (SBP) and diastolic blood pressure (DBP), Tanita BC-1500 Ironman Radio Wireless equipment were used, tape measure Seca 201 and digital tensiometer Welch Allyn respectively.

Biochemical tests

A certified Clinic Laboratory (Laboratorio Clínico VID, Medellín, Colombia) according to the ISO 9001: 2008 standard Quality Management System, performed the analysis of glucose, total cholesterol, HDL-cholesterol, LDL-cholesterol and total triglycerides in blood serum.

Statistical analysis

The data are presented as mean \pm standard deviation (SD). For the statistical differences. The difference in the distributions of the levels of parameters analyzed before and after the intervention was evaluated by the non-parametric Wilcoxon rank-sum test. In order to determine the correlation between the BMI at the end of the study and the results of the glycemia, blood pressure and waist circumference, the Spearman coefficients (R) were calculated. The level of significance was $p < 0.05$. All analyzes were performed using the statistical program GraphPad Prism version 6.00.

RESULTS

Table 1 shows the effect on the parameters analyzed in the overweight adults after consumption of 35 g of osmodehydrated Andean berry for 21 days. Table 1 shows a positive effect on body weight and blood pressure. The most important anthropometric change was observed at the level of the waist circumference, a reduction of 4.1% (Table 1). In relation to blood pressure, although the group of participants had an optimal blood pressure, the

consumption of osmodehydrated Andean berry contributed to its control and significant reduction (Table 1). On the other hand, despite the positive impact on some variables, there were no changes in the lipid profile but the glycemia value increased significantly.

Table 1. Effect of osmodehydrated Andean berry consumption for 21 days.

Parameter	Initial time (Day 1)	Final time (day 22)	p
Glycemia (mg/dL)	84.0 ± 10.7	89.5 ± 8.4	0.0004***
Triglycerides (mg/dL)	131.0 ± 87.6	109.0 ± 53.5	0.0531
Total cholesterol (mg/dL)	202.0 ± 24.3	193.5 ± 32.0	0.545
HDL cholesterol (mg/dL)	49.3 ± 11.2	48.9 ± 13.2	0.369
LDL cholesterol (mg/dL)	115.9 ± 23.9	119.5 ± 29.1	0.713
BMI (kg/m ²)	28.9 ± 2.77	28.4 ± 2.62	0.0306*
Weight (kg)	73.6 ± 11.2	72.1 ± 10.6	0.0388*
Waist circumference (cm)	92.5 ± 7.19	88.7 ± 8.27	0.0052*
SBP (mmHg)	118.0 ± 10.0	112.0 ± 8.48	0.0400*
DBP (mmHg)	80.0 ± 11.2	72.1 ± 10.6	0.0388*

* $p < 0.05$; *** $p < 0.0001$.

In addition, it was found a significant reduction in BMI positively correlated with the change in the waist circumference (Table 2); however, this correlation was not statistically significant, whereas the reduction in DBP and SBP was correlated positively and significantly with the change observed in the BMI (Table 2).

Table 2. Spearman correlation coefficient with BMI in the final time.

Parameter	R	p
Waist circumference (cm)	0,0654	0,840
SBP (mmHg)	0,447	0,0484*
DBP (mmHg)	0.0654	0,0246*
Glycemia (mg/dL)	0.0169	0,478

* $p < 0,05$.

DISCUSSION

Fruits are an important source of nutrients and bioactive compounds that have positive effects in the human body for the prevention of chronic noncommunicable diseases (cardiovascular, cancer, diabetes, obesity), or to improve the physiological state and reach an optimal nutritional condition, and reduce the risk of these. Among the components

present in fruits with health benefits are vitamins, minerals, fiber, phenolic compounds (phenolic acids and polyphenols), carotenoids, among others (22). Particularly, the fruits of the genus *Vaccinium*, which include blueberries that are considered functional foods because of their important content in anthocyanins and antioxidants (23,24), and the increase of their demand in recent years as well as their production are indicators of increasing use as food. However, Andean berry is a fruit with two harvest seasons per year, one between April and May, and the most abundant harvest between September and December (25), which leads to considering strategies for preserving the fruit, reaching the final consumer not only in times of greater production but permanently. Hence, techniques such as osmodehydration used for food preservation and without significant effect on the quality of taste and color, is a process of low energy cost and that confers a benefit to the final product while retaining its nutritional properties, with health benefits and availability for any time of the year.

The change observed in the anthropometric variables associated with excess weight was analyzed taking into account the body weight, the BMI that combines weight and height under the assumption

of a cylindrical shape of the body with uniform density, and the waist circumference, which it is a risk factor associated with diabetes (9). When the waist circumference exceeds 88 cm for women and 94 cm for men (26), it becomes a risk factor for diseases associated with obesity such as diabetes, therefore the results obtained here after ingestion with the fruit at the end of the intervention period, account for its benefit in controlling and decreasing body weight, particularly in this population. Among the factors to which the benefit of fruit is attributed is the contribution of fiber, berries are considered a good source of dietary fiber, although it has also been observed in some studies with extracts rich in anthocyanins (27, 28) or blueberry juice (29, 30) that its effect in decreasing weight and appetite is not associated with fiber content. On the other hand, the effect on weight control associated with fiber is related to physiological effects such as a laxative, increased satiety, decreased caloric intake and increased loss of fecal energy (10, 31, 32).

Hypertension, defined as a systolic pressure (SBP) ≥ 140 mmHg or a diastolic pressure ≥ 90 mmHg, is the main risk factor for cardiovascular diseases and is one of the risk factors considered in the definition of metabolic syndrome (33). The ability of the berries of the genus *Vaccinium* to reduce blood pressure explained through at least one mechanism of action involving the nitric oxide (NO)-dependent pathway, a compound capable of inducing vasorelaxation, reducing circulating molecules of cell adhesion consequently improving vascular function (34). These results observed in studies with an animal model of hypertensive rats prone to cerebral attacks, who received a diet supplemented with 3% of lyophilized blueberries for 8 weeks producing a 30% reduction in SBP (35). Similarly, in obese men and women with metabolic syndrome after the intake of lyophilized blueberries (50g/d) for 8 weeks, a decrease in blood pressure was observed (36), similar effects have been observed in hypertensive Sprague-Dawley adult rats supplemented with 8% blueberries, improving vascular tone and positively modulating NO production at the level of the aortic endothelium (37,38). Therefore, the results of our study consistent with similar findings with other *Vaccinium* berries show that the osmodehydrated Andean berry is a fruit with anti-hypertensive potential and can help reduce the risk for cardiovascular diseases.

Paradoxically, the benefits found after the regular consumption of the osmodehydrated fruit in this group of participants, contrast with the increase in blood glucose levels at the end of the intervention, even so, the glucose levels reported here are within physiological limits according to the American Diabetes Association 2014 (70 - 100 mg / dL). The excess of sucrose could explain this effect as described in the materials and methods section, the berries kept in the osmotic solution of 70% sucrose for 24 h and then transferred to the dehydrator. Therefore, after osmotic dehydration must be necessary wash the fruit to remove the sugar solution prior to hot dehydration or explore other possibilities of dehydration.

The correlation analysis of the BMI with the parameters that showed significant and positive changes such as the waist circumference was not statistically significant. This indicates that it does not imply that there is not a correlation at all, but rather that the presented evidence is not enough to conclude that decrease in waist circumference is attributed to the reduction in BMI. Therefore, a new study with a greater number of participants is required as well as an increase in the time of the intervention, and changes in the preparation of the dehydrated fruit.

On the other hand, the positive and significant correlation between BMI and blood pressure suggests that the loss of body weight is associated with the decrease of risk factors for cardiovascular diseases, such as high blood pressure. This has been also reported in other studies where lost at least 5% of body weight in obese people is due to the acquisition of healthy habits and changes in eating behavior maintained over time. Although they do not lead to ideal weight, it generates benefits related to hypertension, hyperlipidemia, diabetes, and respiratory diseases; while rapid losses of body weight have risks of diseases such as cholelithiasis, cholecystitis, and in the long term, rebound in weight gain (39).

CONCLUSIONS

These results showed that after 21 days of regular consumption of this fruit treated with an osmotic solution of 70% sucrose, a positive and significant impact was obtained in the anthropometric parameters evaluated as well as in the blood pressure of the participants.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

AUTHORS CONTRIBUTION

MEMC and DT performed the study design, collected the literature, analyze the results and wrote the sections related to Introduction, results and discussion. CR participate in development of nutritional intervention and contribute to the statistical analysis. EG prepared the plant material and the osmodehydrate fruit. AGG and GP assessed and analysed the anthropometric, blood pressure and biochemical data.

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