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Cholesterol-lowering effect of diet with added sweet potato (*Ipomea batatas*) vines in rabbits

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SUMMARY: The objective of this study was to evaluate the effect of sweet potato vines as a source of fiber on the plasma parameters in healthy rabbits. For this, 15 rabbits were allocated into five groups, and each group was fed a different diet for a period of 46 days. The diets were as follows: diet without sweet potato vines (0SPV), and experimental diets with 25%, 50%, 75% and 100% of sweet potato vines in replacement of alfalfa hay respectively (25SPV, 50SPV, 75SPV and 100SPV). Triglycerides and VLDL-cholesterol concentrations were approximately 53% lower in rabbits fed the 100SPV than in rabbits fed 0SPV. In addition, aspartate aminotransferase (AST) and total-cholesterol concentrations were lower approximately 40% and 14%, respectively, in rabbits fed the 100SPV than in rabbits fed 0SPV. No significant differences were found among HDL-cholesterol, glucose, proteins, albumin and alanine aminotransferase (ALT) concentrations of the five groups. These results demonstrate that the consumption of sweet potato vines reduces the triglycerides, VLDL-cholesterol and total cholesterol while maintains HDL-cholesterol levels. Therefore, sweet potato vines consumption may be another option to prevent coronary heart diseases in rabbits.

Key words: Cardiovascular diseases, Fiber source, New Zealand rabbits.

RESUMO: Redução de colesterol de coelhos alimentados com dietas contendo baraço de batata-doce (*Ipomea batatas*). O objetivo deste estudo foi avaliar com base no plasma sanguíneo o efeito do baraço de batata-doce como fonte de fibra. Para tal, dividiu-se 15 coelhos em cinco grupos, onde cada grupo foi alimentado com uma dieta diferente por 46 dias. As dietas foram: sem baraço de batata-doce (0SPV), e dietas experimentais com 25%, 50%, 75% e 100% de baraço de batata-doce em substituição ao feno de alfafa, respectivamente (25SPV, 50SPV, 75SPV e 100SPV). As concentrações de triglicérides e VLDL-colesterol foram aproximadamente 53% menores em coelhos alimentados com a dieta 100SPV do que os coelhos alimentados com 0SPV. Além disso, as concentrações de aspartato aminotransferase (AST) e colesterol total foram inferiores em aproximadamente 40% e 14%, respectivamente, nos coelhos alimentados com 100 SPV do que em coelhos alimentados com 0SPV. Não foram encontradas diferenças significativas entre as concentrações colesterol-HDL, glicose, proteínas, albumina e alanina aminotransferase (ALT) dos cinco grupos. Estes resultados demonstram que o consumo de baraço de batata-doce reduz os triglicerídeos, colesterol VLDL e colesterol total, enquanto mantém os níveis de colesterol HDL. Portanto, o baraço de batata-doce pode ser uma opção viável para prevenir doenças coronarianas.

Palavras chave: Doenças cardiovasculares, fontes de fibra, coelhos Nova Zelândia.

INTRODUCTION

Interest in residues, such as sweet potato (Ipomoea batatas) vines (SPV), has been the interest of current research due to its high nutritional value. SPV provide a dietary source of vitamins, minerals, antioxidants, dietary fiber, and essential fatty acids (1). In addition, SPV are known to contain high potassium-sodium ratio and can, therefore, be used in low salt diets (2).

Sweet potato is one of the most important food crops in the world (3). In developing countries, where desertification has contributed to a reduction in cultivated land area and thus to an increase in food shortage (4), SPV are widely used for human consumption (5). In this sense, SPV have great potential for improving food and nutritional security, especially in developing and underdeveloped countries, where most of farms are small (6).

Some studies conducted with SPV affirm that the bioactive compounds contained in this vegetable play a role in health promotion by improving immune function, reducing oxidative stress and free radical damage, reducing cardiovascular disease risk, and suppressing cancer cell growth (1). Other studies suggested that the simultaneous intake of SPV and the high-fat diet inhibited the excessive accumulation of adipose tissue in rats (7).

Many studies have showed that cholesterol levels could be reduced in animals, through the inclusion of alternative ingredients in their diets. However, studies that focus on disease prevention in healthy animals are scarce. In this sense, the objective of this study was to evaluate the effect of SPV on lipid plasma level, in healthy rabbits.

MATERIALS AND METHODS

This study was approved by the Biosecurity and ethics committee, project filled under the number 098/2011.

Sweet potato-vines

All SPV used in the experimental diets was of the cultivar BRS Cuia (RNC-27.315) obtained from a farm which focuses on biodiesel production. The SPV was dried in a forced air circulation oven at 52ºC for 36 hours and milled in a knife mill. No synthetic product, like amino acids, dyes, flavoring, additives, and preservative were added to the diets. The proximate composition for dry matter, protein, ash, lipids and fiber (Table 1) was quantified in the Laboratory of animal nutrition of Federal University of Santa Maria (UFSM).

TABLE 1. Composition of dry sweet potato vines*

Vines components	g / 100 g
Moisture	16
Crude Protein	14
Crude Fiber	20
Lipids	3
Crude Ash	11
Carbohydrate (per difference)	36

*Sweet potato vines were of the variety BRS-Cuia.

Animals

The rabbits were born in Laboratory of rabbit breeding, of the Department of Animal Science, of Federal University of Santa Maria. Fifteen mixed-sex New Zealand rabbits, weighing approximately 600g and 35 days of age, were randomly assigned to one of the five experimental groups (3 rabbits/diet). Thereafter, each group was fed a different diet for 46 days in individual cages measuring 50x50 (Figure 1). Due to the fact that the animals were born in the same facility where the biological assay was conducted, no adaptation period was needed.

FIGURE 1. Rabbit in individual cage.

Diets

Rabbits were offered ad libitum fresh water and one of the five experimental diets: The control diet (0SPV) – diet without dry sweet-potato vines; 25SPV, 50SPV, 75SPV and 100SPV – experimental diets with 25%, 50%, 75% and 100% sweet-potato vines as alfalfa hay substitute, respectively. Diets were formulated to contain a similar crude protein and fiber (Table 2). No antibiotics were added to either the diets or water. Blood samples were collected at the end of the biological assay. The animals were deprived of food for 12 hours before this.

Assays

Total cholesterol, triglycerides, total protein, albumin, AST, ALT and glucose were assayed using kits REF.76, 87, 99, 19, 108,109, 133 respectively, from Labtest (Lagoa Santa, Brazil). VLDL-cholesterol and LDL-cholesterol were calculated by the respective formulas (8):

VLDL-cholesterol = triglycerides/5;

LDL-cholesterol = (total cholesterol) – (HDL-cholesterol) – (triglycerides/5).

Statistical analyses

Data were analyzed in a completely randomized design with the Statistical Analysis System using the general linear model (GLM procedure). The variance analysis was performed with the diet as the sole source of variation. Each animal was considered an experimental unit. The means were compared by variance analysis followed by Tukey test ($p < 0.05$).

TABLE 2. Composition of experimental diets.

	Experimental diets				
Ingredients (g)	0SPV	25SPV	50SPV	75SPV	100SPV
Corn	17.25	17.25	17.00	17.00	16.75
Wheat meal	25.00	25.00	24.75	24.75	24.50
Soy-bean meal 45	17.50	17.50	18.00	18.00	18.50
Soy-bean oil	2.50	2.50	2.50	2.50	2.50
Rice hulls	6.00	6.00	6.00	6.00	6.00
Alfalfa hay	30.00	22.50	15.00	7.50	-
Sweet potato vines	-	7.50	15.00	22.50	30.00
Dicalcium phosphate	0.80	0.80	0.80	0.80	0.80
Calcitic Limestone	0.25	0.25	0.25	0.25	0.25
Salt	0.50	0.50	0.50	0.50	0.50
Vitamin/mineral premix*	0.20	0.20	0.20	0.20	0.20

0SPV: Treatment without sweet potato vines, 25SPV, 50SPV, 75SPV, 100SPV: Treatment with Sweet potato vines replacing 25%, 50%, 75%, 100% of alfalfa hay, respectively. *Premix supplied per kg of diet.

TABLE 3. Plasma parameters in rabbits fed diets with sweet potato vines in substitution of alfalfa hay.

	Experimental diets					
	0SPV	25SPV	50SPV	75SPV	100SPV	P value
Total Proteins (g/dL)	5.22± 3	5.43± 5	5.02± 8	5.16± 7	5.26± 6	0.29
Albumin (g/dL)	3.82	3.97	3.70	3.91	3.95	0.22
Cholesterol (mg/dL)	97.0±10	94.7±21	92.2±16	93.0±13	84.2±11	0.74
VLDL (mg/dL)	17.85a ±0.19	18.23a ±0.24	8.93 b ±0.27	6.83c ±0.41	8.43bc ±0.41	0.0000002
HDL (mg/dL)	27±8	36±17	29±37	30±41	30±39	0.51
LDL (mg/dL)	52±0.12	40±0.27	54±0.31	56±0.12	46±0.26	0.11
ALT (U/L)	106.5±41	98.3±6	79.3±18	101.2±36	99.0±31	0.58
AST (U/L)	52.2a ±5	37.3bc ±33	29.5b ±24	34.5bc ±25	38.5bc ±4	0.0004
Glucose (mg/dL)	122a±4	128a±4	125a ±7	126a ±8	138b±4	0.006
Triglycerides (mg/dL)	89 a ± 20	91a ± 24	45b ± 12	34c ± 21	42bc ± 41	0.0000002

Means are followed by coefficient of variation. Different letters in the same line indicate difference by Tukey test (0.05).

RESULTS

After a 46-day feeding period, the total triglycerides and VLDL-cholesterol levels were linearly lower according inclusion of SPV. In this sense, the control group showed 89 mg/dL of triglycerides and 17.85 mg/dL of VLDL-cholesterol while 100SPV, only 42 mg/dL and 8.43 mg/dL respectively. The same was observed for the aspartate aminotransferase (AST) that lowered from 52.2 U/L in control group to 38.5 U/L in 100 SPV. Moreover, no differences were observed in the groups in HDL-cholesterol levels, proteins, albumin, glucose and alanine aminotransferase (ALT). Results and the statistical analysis are present in Table 3.

DISCUSSION

The influence of SPV on lipid metabolism in rats fed a high-fat diet was investigated. After 35 days of biological assay, the weight gain and adipose tissue weight were lower in the rats fed a high-fat diet supplemented with SPV than in those not fed SPV(7). Plasma triglyceride and total cholesterol, and liver total cholesterol level were significantly lower in rats fed with SPV compared to rats fed the high-fat diet alone.

SPV presents a high content of dietary fiber. The leaves were characterized to contain the highest amount of soluble dietary fiber among all part of sweet potato (9). Since it is known that most of the mucilaginous dietary fibers have reducing effects on postprandial blood glucose and liver cholesterol, the current interest is focusing heavily on sweet potato leaves.

In this sense, perhaps the use of the SPV as fiber source will be able to lower the oxidative stress. Oxidative stress is linked to obesity, hypertension, and other disease (10). In addition, according to the oxidative hypothesis, oxidative modification of LDL is a primary initiating event in atherosclerosis (11).

In order to prevent LDL from oxidation, there are many kinds of antioxidants in human plasma and in lipoprotein particles (11). In a previous study, researchers cited the presence of many antioxidants in lipid portion of SPV, including linalool and p-hydroxybenzoic acid (12). Moreover, SPV contains a vast array of dietary antioxidants, including anthocyanins, polyphenols, flavonoids, and caffeic acid derivatives (1). These bioactive components may have significant health promoting and medicinal effects in human health (4). These characteristics of SPV favored the decrease of AST due to indicating less cell deterioration.

In its lipid portion, SPV contain palmitic, linoleic, and linolenic acids with high values (13); these fatty acids are required for the digestion, absorption and transport of vitamins A, D, E, and K (4). In addition, linolenic acid is required to lower non-high density lipoprotein cholesterol (14). The non-high density lipoprotein was associated with the formation of atheromatous plaque (15).

In this study, SPV decreased VLDL-C, Total-C and aspartate aminotransferase levels and kept the HDL-C level and other parameters stable in healthy rabbits. Additionally, SPV had no toxic effects in the serum as reported in literature (1, 2, 4, 5, 6, 7, 8). In this sense, these data suggest a promising application of SPV in preventing cardiovascular diseases. However, it is very important to highlight that in this study we evaluate healthy animals fed with SPV as a source of fiber.

Due to the fact that food or a combination of foods lowers plasma cholesterol, both in animals and humans, is complex and not uniform (16). The use of SPV as fiber source with the aim of lowering lower cholesterol levels should be done in association with a balanced diet. Likewise, data in humans about consumption of SPV is lacking and requires further studies.

CONCLUSIONS

Replacing the traditional fiber source by sweet potato vines in rabbits diets decreased VLDL-cholesterol and AST while it maintaining HDL-cholesterol levels at normal range. The animals fed sweet potato vines reduced oxidative stress. These data suggest a possible application of SPV in the prevention of cardiovascular diseases. However, for the time being, these results only describe animal response.

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