EFFECTS OF THE USE OF SMALLANTHUS SONCHIFOLIUS (YACON) IN THE TREATMENT OF INDIVIDUALS WITH DIABETES MELLITUS

EFEITOS DA UTILIZAÇÃO DE *SMALLANTHUS SONCHIFOLIUS* (YACON) NO TRATAMENTO DE INDIVÍDUOS COM *DIABETES MELLITUS*

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Abstract

The *Smallanthus sonchifolius* (yacon) is a native plant of Andes and cultivated in different countries. As it is similar to sweet potatoes roots, and has a sweet taste and a firm pulp, the option is to consume it raw. The medicinal use of yacon has increased due to the hypoglycemic properties. Their roots and the stems have lot of fructo-oligosacharides of the inulin type, which may be a natural sugar substitute in diet of diabetics. The prevalence of diabetes mellitus type 2 has risen worldwide. In Americas, the number of individuals with DM for 2025 will be 64 million. In developing countries, the young age is the most affected, causing financial losses to health systems. This literature review aimed to evaluate the effects of the use of yacon in the treatment of diabetic carriers. Most studies have been done in rats and there is little done in humans. It could be observed lowering blood glucose with use of yacon, whether in the form of leaves extract, flour pulp or infusion. However, more human studies are needed to better demonstrate their beneficial effects.

Key words: yacon, hipoglicemic, diabetes mellitus, fructo-oligosaccharides, inulin.

Resumo

A *Smallanthus sonchifolius* (yacon) é uma planta perene nativa dos Andes e cultivada em diferentes países. É semelhante, nas suas raízes, às batatas doces e por ter um gosto adocicado e uma polpa firme, opta-se por consumi-la *in natura.* O uso medicinal da yacon tem aumentado devido à sua propriedade hipoglicemiante. Suas raízes tuberosas e os caules apresentam grande quantidade de fruto-oligossacarídeos do tipo inulina, podendo ser um substituto natural do açúcar na alimentação de diabéticos. A prevalência do *diabetes mellitus* do tipo 2 tem se elevado mundialmente. Nas Américas, o número de indivíduos estimado com DM para 2025 será de 64 milhões. Nos países em desenvolvimento, a faixa jovem é a mais acometida, o que acarreta prejuízos financeiros aos sistemas de saúde. Esta revisão bibliográfica teve como objetivo avaliar os efeitos da utilização de yacon no tratamento de portadores de *diabetes mellitus*. A maioria dos estudos foi feita em ratos e existem poucos em humanos. Pode-se observar a redução da glicemia com uso da yacon, seja sob a forma de extrato das folhas, farinha da polpa ou infusão. Mas necessita-se de mais estudos em humanos para melhor comprovar seus efeitos benéficos.

Palavras-chave: Yacon. Hipoglicemiante. Diabetes Mellitus. Fruto-Oligossacarídeos. Inulina.

INTRODUCTION

The use of natural products has been observed in recent times. These are used both as food and for therapeutic purposes, due to socio-economic and cultural issues, or as a search for complementary therapies. In developing countries, more than 80% of the population uses traditional medicine as primary health care (VOLPATO et al., 2007).

According to Duarte, Wolf & Paula (2008), the *Smallanthus sonchifolius* (Poepp.) belongs to the *Asteraceae* Family and is often referred to by the synonym *Polymnia sonchifolia* Poepp. Popularly known as yacon, it is a perennial plan native to the Andes and cultivated in different countries, from Colombia to the northeast of Argentina, in Brazil, Czech Republic, New Zealand and Japan. This tuberous root is part of the diet of the indigenous tribes living in the high Andes Mountains. It is both food and medicinal plant for the local population (SIMONOVSKA et al., 2003).

The species has a complex underground system, consisting of rhizophores and slender and tuberous roots, both adventitious. The rhizophores form a stem axis with characteristics of stem holder of adventitious roots produced by some plants in addition to upright stem axis. A system of rhizophores can help support or stabilize the plant.

Due to this type of underground system, there is no consensus on the name of the parts that form it. Thus, there are references to the tuber, rhizomatous stem, sympodial shizome, tuberous root, edible and tuberous root, woody rhizome, fleshy rhizome and reserve root. An anatomical study conducted in 2004 clearly showed that the organization of the vascular system of this organ is typical of a root, and it justifies only the use of the term tuberous root (MACHADO et al., 2004).

Yacon is similar, in its roots, to sweet potato, and for having a sweet taste and firmer flesh, it is most consumed in natura (SANTANA; CARDOSO, 2008). Much of it is composed of water (85%) and the rest of a type of soluble fiber, the fructo-oligosaccharides (FOS) (KANASHIRO; FERRARO**;** POLTRONIERI**,** 2008). These are considered prebiotics, since they promote the growth of some probiotics such as *Acidophillus* and *Bifidus* (PASSOS; PARK, 2003).

In addition to these benefits, yacon has few calories: 100g of it contain 23.96 Kcal, which becomes attractive for those who need food control (DA SILVA, 2006). The roots of

Smallanthus sonchifolius, as well as the stems, have plenty of inulin, and can be a natural substitute for sugar in the diet of diabetics (MACHADO et al., 2004).

The prevalence of type 2 diabetes has been rising worldwide; it is estimated that in 2025, in the Americas, there will be 64 million diabetic individuals. In developing countries, the young age group is the most affected, which results in financial losses to health systems (SARTORELLI; FRANCO; CARDOSO, 2006), since this disease, when uncontrolled, ceases with acute complications (severe hypoglycemia, seizures and diabetic ketoacidosis) and chronic (psychological) (GROSS et al., 2000; POLONSKY, 2001).

Relevant to the increased prevalence of type 2 diabetes is the increasing rate of overweight and obesity. Results of several population surveys show that the incidence of diabetes increases with the average weight of the population (HARRIS et al., 1987). Interestingly, the incidence of obesity in children under 12 years of age doubled in the last decade in the United States (CDCP, 1997). The implications of this increased rate of obesity in children are still uncertain, but surely resonate in the incidence of diabetes few years later. It has been reported that type 2 diabetes is manifesting earlier, even in adolescence (ADA, 2005).

Changes in the structure of the diet, associated with economic, social and economic changes and its impact on population health, have been observed in several developing countries (POPKIN, 2001). Some evidence suggests that physical inactivity, aided by modern life, is a risk factor as important as inadequate diet in the etiology of obesity, and has a direct and positive relation with the increasing incidence of type 2 diabetes in adults, regardless of the body mass index or family history of diabetes (SARTORELLI; FRANCO, 2003).

Research on food that can help prevent and treat diseases are becoming more frequent, especially chronic non-communicable diseases such as diabetes. Trying to increase awareness of the yacon, this study aims to review literature on the effect of consumption of *Smallanthus sonchifolius* (yacon) in the treatment of *diabetes mellitus*.

METHOD

All of the papers analyzed were found through systematic literature review, whose main sources were the databases Medline, Lilacs, Scielo and Pubmed, in the years 2000-2009, based on the expressions *"Smallanthus onchifolius"*, "yacon" and "*diabetes mellitus*". Websites were also surveyed on the subject.

DISCUSSION

Until mid-1980's, the *Smallanthus sonchifolius* was a virtually unknown plant in Brazil. Its introduction in the country occurred in 1991, as cash crop in the city of Capão Bonito, state of São Paulo, and now it is also cultivated in the region of Itajaí, state of Rio Grande do Sul (SILVEIRA, 2009).

The yacon has tuberous roots that contain 60-70% of fructans in the form of fructo-oligosaccharides of the inulin type, which can be used both in industry of dietetic foods and food for children, and for the production of fructose syrup, sugar of high interest to the food industry (VILHENA; CAMARA; KAKIHARA, 2000).

The medicinal use of yacon has increased due to the hypoglycemic property reported for this species (CORRÊA et al., 2009), related to the FOS. In addition to this property, other benefic effects of yacon have been related to the human health, which would be its non-carcinogenicity, reduced energetic value, reduced blood lipids, increased absorption of minerals such as calcium, magnesium and iron, and inhibition of early stages of colon cancer (QUINTEROS, 2000; VANINI et al., 2009; SILVA et al*.,* 2004).

FOS reduce the absorption of glucose by the same mechanisms of highly fermentable fibers which may affect the application and insulin sensitivity by its ability to increase the production of peptide-1 similar to glucagon (GLP-1), a hormone that increases as glucose is absorbed and decreases the production of glucagon (CABELO, 2005). GLP-1 stimulates the production of insulin. In addition, fructan, polymers of fructose, as they are not digested, reduce the efficiency of enzyme hydrolysis and slow the rate at which glucose enters the bloodstream, so it has the ability to extend the period of fullness. Another influence on metabolism in general is related to short-chain fatty acids, which are produced during fermentation, and increase glucose tolerance in the next meal (GENTA et al., 2005).

However, literature data confirm that several aspects can affect the amount of FOS, such as growing conditions, storage of the plant and variations in the harvest may influence its functional mechanism of glucose reduction (PEREIRA et al., 2009).

This study found that most studies on yacon have been performed through experimental research, which will be described below.

Rats and leaf extracts of yacon

In recent years, several studies have found that that yacon leaf extract protects against free radicals, and therefore is a candidate for the prevention and treatment of chronic

diseases involving oxidative stress, particularly diabetes (VALENTOVÁ; SERSEN; ULRICHOVA, 2005).

Study by Valentová et al. (2003) in rats using extract of dried leaves of *Smallanthus sonchifolius* showed that the phenolic compounds have antioxidant potential and protect against oxidative damage that could possibly occur in the liver of diabetic rats. Results showed that the use of leaves of yacon in the human diet have strong effects in preventing chronic diseases caused by free radicals.

In 2004, another study was conducted by the same author, aiming to assess the effects of two organic fractions and two extracts from the leaves of yacon on the viability of rats hepatocytes in oxidative damage induced by tert-butyl hydroperoxide (t-BH), chemical species that helps assessing lipid oxidation, and allyl alcohol (AA) in glucose metabolism and insulin-like effect on the expression of P450 cytochrome (CYP) mRNA. Results showed that all tested extracts had strong protective effect against oxidative damage in liver, reducing hepatic glucose via gluconeogenesis and glycogenolysis. Moreover, the effects of the organic fraction (200 and 250 g/ml) and, to a lesser extent, tea infusion (500 g/ml), were observed with similar effects to insulin. The cytoprotective and anti-hyperglycemic effect of *Smallanthus sonchifolius* leaves prevents and helps treating chronic diseases that involve oxidative stress, especially diabetes (VALENTOVÁ et al., 2004).

Rats and pulp of yacon flower extract

Study conducted by Ribeiro (2008) using the pulp of yacon flower (PYF) in rats showed reduction of postprandial glucose, and may be a tool in prevention and treatment of diabetes and obesity. The work also showed that increased PYF in diets brought proportional lipids to the feces of animals.

Pereira et al. (2009) used PYF and yacon extract in groups of diabetic and non-diabetic rats. Groups of non-diabetic rats showed normal blood glucose values for the species, within the range of 50 mg/dl to 120 mg/dl throughout the experiment, regardless of the consumed diet. However, diabetic rats that consumed yacon in the form of flour or extract had the tendency to stabilize glucose levels, detected by the slight elevation of blood glucose.

Yacon leaves – infusion

According to a study by Aybar et al. (2001), there was no correlation between yacon and the reduction of blood glucose in rats. The authors note that, although popular accounts

claim that eating *Smallanthus sonchifolius* in the form of infusion of leaves reduces hyperglycemia in diabetic subjects, in their study there was no evidence of such an effect.

Yacon aqueous solution

Using an aqueous solution of yacon, Oliveira et al. (2009) observed, in their study, no change of the hypoglycemic effect in the control group, which was seen only in groups of diabetic rats.

Dry root flour

Study on the dry flour of the yacon root in tablets, in rats, could demonstrate, in the glucose tolerance test, increased plasma glucose one hour after taking the yacon tablet, while the consumption of glucose tablet resulted in increased plasma glucose 20 minutes after ingestion. This could prove that FOS have the ability to slow the absorption of sugars (GENTA et al., 2005).

Humans

In this study, only two research works on humans were found. The other ones were conducted in rats.

Of the works conducted with humans, one addressed the addition of fresh yacon to industrialized orange juice. The survey was conducted with students of both sexes and aged between 20 and 40 years, without diabetes, normal weight, non-pregnant and lactating women. Individuals who consumed the juice plus yacon had gradual increase in blood glucose and then a slow decrease also. Thus one may infer that orange juice added with yacon helped blood glucose remain more homogenous, a feature that makes increase and decline occur gradually.

Besides having a higher content of dietary fiber, the presence of FOS of the inulin type, which are soluble fibers with prebiotic action, with several health benefits, becomes an important aid to the prevention and treatment of non-communicable chronic diseases, such as diabetes and obesity, which are considered public health problems in Brazil (TEIXEIRA et al., 2009).

The other research work was done with a group made up of nine women aged 17 to 43 years. At the time of joining the study women with cardiovascular disease, diabetes, hypercholesterolemia and pregnancy were excluded. The reference food (control) was 50 grams of white bread offered to each participant. As test food, 250 grams of fresh yacon were offered.

The average glycemic response after ingestion of 50 grams of white bread and, as it might be expected, there was prolonged increase in blood glucose after intake. The ingestion of 250 grams of fresh yacon produced peak glucose with intermediate elevation at 30 minutes after consumption, and then presented constant fall in blood glucose levels.

Data presented in this study suggest that probably the presence of FOS in yacon interfered significantly in the glycemic response, gradually reducing postprandial glucose after consumption of fresh yacon tuberous root. From these results, Da Silva (2006) believes that the yacon tuberous root contains compounds that have hypoglycemic activity after its consumption in natura.

CONCLUSION

According to this study, there are few studies on the effects of *Smallanthus sonchifolius* in the treatment of *diabetes mellitus* in humans. The papers were positive about the use of yacon in lowering blood glucose. The content of FOC provided the ability to slow the absorption of sugars.

The potential first introduced by the use of yacon in reducing blood glucose in rats indicated the need for further studies in humans, in order to confirm these effects.

REFERENCES

AMERICAN DIABETES ASSOCIATION. Type 2 diabetes in children and adolescents. *Clinical Diabetes Care*, v. 23, n. 4, p. 181-185, 2005.

AYBAR, M.J. et al. Hypoglycemic effect of the water extract of *Smallanthus sonchifolius* (yakon) leaves in normal and diabetic rats. *Journal of Ethnopharmacology*, v. 74, p. 125-32, 2001.

CABELLO, C. Extração e pré- tratamento químico de frutanos de yacon. *Ciênc. Tecnol. Alim.*, Campinas, v. 25, n. 2, p. 202-207, 2005.

CENTERS FOR DISEASE CONTROL AND PREVENTION. Update. *Prevalence of overweight among children, adolescents, and adults*. United States, 1988-1994. *JAMA*, n. 227, p. 1111, 1997.

CORRÊA, C.M. et al. Plant regeneration through somatic embryogenesis of yacon [*Smallanthus sonchifolius* (poepp. and endl.) H. Robinson]. *Braz. arch. biol. technol.*, Curitiba, v. 52, n. 3, p. 12, 2009.

DA SILVA, A.S.S. et al. Avaliação da resposta glicêmica em mulheres saudáveis após a ingestão de yacon (*Smallantus sonchifollius*) *in natura*, cultivadas no estado de Santa Catarina - Brasil. *Alim. Nutr.,* Araraquara, v. 17, n. 2, p. 137-142, abr.-jun. 2006.

DUARTE, M.R.; WOLF, S.; PAULA, B.G. *Smallanthus sonchifolius* (Poepp.) H. Rob. (yacon): identificação microscópica de folha e caule para o controle de qualidade farmacognóstico. *Revista Brasileira Ciências Farmacológicas*, São Paulo, v. 44, n. 1, jan./mar. 2008.

GENTA, S.B. et al. Subchronic 4-month oral toxicity study of dried *Smallanthus sonchifolius* (yacon) roots as a diet supplement in rats. *Food Chem. Toxicol.*, v. 43, p. 1657-1665, 2005.

GROSS, J.L. et al. Diagnóstico e classificação do diabetes melito e tratamento do diabetes melito tipo 2. *Arq Bras Endocrinol Metab.*,v. 44, n. 4, p. 5-10, 2000.

HARRIS, M.I. et al. Prevalence of diabetes and impaired glucose tolerance and plasma glucose levels in US population aged 20-74 Yr. *Diabetes*, v. 36, p. 523-534, 1987.

KANASHIRO**,** R.S.; FERRARO, R.G.; POLTRONIERI**,** F. Yacon (*Smallanthus sonchifolius*): importância funcional. *Nutrição em Pauta*, São Paulo: Núcleo Consultoria Com. e Rep, v. 16, n. 92, p. 9-12, il. set./out. 2008.

MACHADO, S.R. et al. Morfoanatomia do sistema subterrâneo de *Smallanthus sonchifolius* (Poepp. & Endl.) H. Robinson (Asteraceae). *Revista Brasileira de Botânica*, v. 27, p. 115-123, 2004.

OLIVEIRA, L.A. et al. Respostas glicêmicas de ratos diabéticos recebendo solução aquosa de yacon. *Alim. Nutr.*, Araraquara, v. 20, n. 1, p. 61-67, jan.-mar. 2009.

PASSOS, L.M.L.; PARK, Y.K. Fruto-oligossacarídeos: implicações na saúde humana e utilização em alimentos. *Ciência Rural*, Santa Maria, v. 33, n. 2, abr. 2003.

PEREIRA, S.C.L. et al. Avaliação do efeito hipoglicemiante da farinha e do extrato de Yacon (*Polymnia sonchifolia*) em ratos normais e diabéticos. *Rev. Med. Res.*, v. 11, n. 4, p. 147-154, 2009.

POLONSKY, W.H. Aspectos emocionais e da qualidade de vida do tratamento do diabetes. *Curr Diab Rep Lat Am.*, v. 1, p. 388-96, 2001.

POPKIN, B.M. The nutrition transition and obesity in the developing world. *Journal of Nutrition*, v. 131, p. 871-873, 2001.

QUINTEROS, E.T.T. Produção com tratamento enzimático e avaliação do suco de yacon. Campinas, 2000.164f. Tese (Doutorado em Tecnologia de Alimentos) - Faculdade de Engenharia de Alimentos, Universidade Estadual de Campinas, Campinas, 2000.

RIBEIRO, J.A.R. Estudo químico e bioquímico do yacon (*Smallanthus sonchifolius*) *in natura* e processado e influência do consumo de yacon sobre níveis glicêmicos e lipídeos fecais de ratos. 2008. 83f. Dissertação (Mestrado em Ciências dos Alimentos) - Universidade Federal de Lavras, Minas Gerais, 2008.

SANTANA, I.; CARDOSO, M.H. Raiz tuberosa de yacon (*Smallanthus sonchifolius*): potencialidade de cultivo, aspectos tecnológicos e nutricionais. *Ciência Rural*, Santa Maria, v. 38, n. 3, maio-jun. 2008.

SARTORELLI, D. S.; FRANCO, L. J. Tendências do diabetes mellitus no Brasil: o papel da transição nutricional. Cad. Saúde Pública, Rio de Janeiro, v. 19, supl. 1, 2003.

SARTORELLI, D.S.; FRANCO, L.J.; CARDOSO, M.A. Intervenção nutricional e prevenção primária do diabetes mellitus tipo 2: uma revisão sistemática. *Caderno Saúde Pública*, Rio de Janeiro, v. 22, n. 1, jan. 2006.

SILVA, E.B. et al. Composição química da raiz e das folhas desidratadas do yacon (*Polymnina sonchifolia Poepp.). Rev. Bras. Pl. Med.*, Botucatu, v .6, n. 3, p. 48-52, 2004.

SILVEIRA, N.D.P. O emprego da metodologia de superfície de resposta no desenvolvimento de um novo produto simbiótico, fermentado com *Enterococcus faecium* CRL 183 e *Lactobacillus helveticus* ssp*. Jugurti* CRL 416 à base de extratos aquosos de soja e de yacon (*Smallantus sonchifolia*). 2009. 133f. Dissertação (Mestrado em Alimentos e Nutrição) – Faculdade de Ciências Farmacêuticas, Universidade Estadual Paulista, São Paulo, 2009.

SIMONOVSKA, B. et al. Investigation of phenolic acids in yacon (*Smallanthus sonchifolius*) leaves and tubers*. Journal of Chromatography*, Czech Republic, v. 1016, n. 1, p.89-98, 2003.

TEIXEIRA, A.P. et al. O efeito da adição de yacon no suco de laranja industrializado sobre a curva glicêmica de estudantes universitários. *Alim. Nutr., Araraquara*, v. 20, n. 2, p. 313-319, abr.-jun. 2009.

VALENTOVA, K. et al. Antioxidant activity of extracts from the leaves of *Smallanthus sonchifolius*. *Eur. J. Nutr*., v. 42, p. 61-66, 2003.

VALENTOVA, K.; MONCION, A.; WAZIERS, I.; ULRICHOVA, J. The effect of Smallanthus sonchifolius leaf extracts on rat hepatic metabolism. *Cell. Biol. Toxicol.,* v. 20, p. 109- 120, 2004.

VALENTOVÁ, K.; SERSEN, F.; ULRICHOVÁ, J. Radical scavenging and anti-lipoperoxidative activities of *Smallanthus sonchifolius* leaf extracts. *Journal of Agricultural and Food Chemistry*, v. 53, p. 5.577-82, 2005.

VANINI, M. et al. A relação do tubérculo andino yacon com a saúde humana. *Cienc Cuid Saude*, v. 8, p. 92-96, 2009.

VILHENA, S.M.C.; CÂMARA, F.L.A.; KAKIHARA, S.T. O cultivo de yacon no Brasil. *Horticultura Bras.*, v. 18, n. 1, p. 5-8, 2000.

VOLPATO, G.T. et al. Efeito do extrato aquoso de folhas de *Polymnia sonchifolia* (yacon) em ratas diabéticas. *Revista Brasileira Plantas Medicinais*, Botucatu, v. 9, n. 2, p. 88-93, 2007.

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