ARTICLE IN PRESS

Bioactive Carbohydrates and Dietary Fibre xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Bioactive Carbohydrates and Dietary Fibre

journal homepage: www.elsevier.com/locate/bcdf

Influence of low molecular weight compounds associated to cashew (*Anacardium occidentale* L.) fiber on lipid metabolism, glycemia and insulinemia of normal mice

Diana Valesca Carvalho[a], Flávia Almeida Santos[b], Renan Pereira de Lima[c], Ana Flávia Seraine Custódio Viana[b], Said Gonçalves Cruz Fonseca[d], Paulo Iury Gomes Nunes[b], Tiago Sousa de Melo[e], Maria Izabel Gallão[f], Edy Sousa de Brito[g,*]

[a] *Instituto de Cultura e Arte, Universidade Federal do Ceará, Fortaleza, CE, Brazil*
[b] *Departamento de Fisiologia e Farmacologia, Faculdade de Medicina, Fortaleza, CE, Brazil*
[c] *Faculdade de Farmácia, Universidade de Fortaleza, Fortaleza, CE, Brazil*
[d] *Departamento de Farmácia, Faculdade de Farmácia, Odontologia e Enfermagem, Universidade Federal do Ceará, Fortaleza, CE, Brazil*
[e] *Faculdade de Farmácia, Instituto Superior de Teologia Aplicada, Sobral, CE, Brazil*
[f] *Departamento de Biologia, Universidade Federal do Ceará, Fortaleza, CE, Brazil*
[g] *Embrapa Agroindústria Tropical, R Dra Sara Mesquita, 2270, Pici, 60511-110 Fortaleza, CE, Brazil*

ARTICLE INFO

Keywords:
Abdominal fat
Dietary fiber
Fruit
Insulin
Obesity

ABSTRACT

The objective of this study was to evaluate the effect of cashew fiber wheter or not associated with low molecular weight compounds on lipid profile, abdominal adiposity, glycemia and insulinemia and serum concentration of ghrelin and leptin hormones from normal mice. We evaluated the cashew fiber in its integral form (IcF) and the cashew fiber after being submitted to the process of extraction of low molecular weight metabolites (cFSM). The two fibers were incorporated into the feed of male Swiss mice for 15 weeks. At the end of the treatment, blood glucose, total cholesterol and fractions, triglycerides, urea, AST, ALT, hormone levels of insulin, leptin and ghrelin were analyzed, as well as GSH and hepatic MDA. The consumption of cFSM diet promoted reduction of glycemia, insulin and ghrelin. Animals fed the IcF diet showed hyperlipidemia, hyperleptinemia and increased abdominal fat. In addition, no changes were observed in the lipid profile of the animals, in the abdominal adiposity and in the leptin hormone in the group that received cFSM diet. We conclude that the removal of small molecules is fundamental to use cashew fiber as a functional food with possible health benefits.

1. Introduction

Dietary fiber has a major role in nutrition and health, reducing risk factors associated in the development of various chronic diseases, such as obesity, cardiovascular disease and type 2 diabetes, by promoting weight, blood glucose and lipid profile reduction (American Ditetic Association, 2008). Fiber is the most used ingredient in the elaboration of functional foods, representing more than 50% of the total ingredients on the market. Fiber products are also expanding as a dietary and pharmacological supplement (Saura-Calixto, 2006). In this context, fruit by-products from industrial processes are potential sources of dietary fiber that can be incorporated into food products or used in the manufacture of supplements (Mildner-Szkudlarz et al., 2016; Tańska et al., 2016).

Compared with the dietary fiber of cereals, fruit fiber is reported to have a better quality due to its higher content of total and soluble fibers, water and oil retention capacity and colon fermentability, as well as its lower levels of phytic acid and caloric value (Zhang et al., 2017). In addition, fruit fiber has significant amounts of secondary compounds associated with it, such as polyphenols and other bioactive compounds (Martín-Carrón, Goñi, Larrauri, García-Alonso, & Saura-Calixto, 1999). Studies have determined that fruit bagasse could be used as a potential food ingredient to develop healthy, safe, tasty, sustainable and socially acceptable food products. This is mainly due given that fruit bagasse is rich in total dietary fiber with high content in phenolic compounds and flavonoids that provide interesting technological and antioxidants properties (Cerda-Tapia, Pérez-Chabela, Pérez-Álvarez, Fernández-López, & Viuda-Martos, 2015; Mildner-Szkudlarz et al., 2016; Tańska

* Corresponding author.
E-mail addresses: dianacarvalhoufc@gmail.com (D.V. Carvalho), fasufc@gmail.com (F.A. Santos), renan1647@edu.unifor.br (R.P. de Lima), said@ufc.br (S.G.C. Fonseca), tiagosousam@gmail.com (T.S. de Melo), izabelgallao@ufc.br (M.I. Gallão), edy.brito@embrapa.br (E.S. de Brito).

https://doi.org/10.1016/j.bcdf.2017.12.001
Received 31 July 2017; Received in revised form 16 November 2017; Accepted 20 December 2017
2212-6198/

Please cite this article as: Carvalho, D.V., Bioactive Carbohydrates and Dietary Fibre (2017), https://doi.org/10.1016/j.bcdf.2017.12.001

Table 1
Proximate composition of the Integral Cashew Fiber (IcF), the Cashew Fiber without low molecular weight metabolites (cFSM), the ND + IcF (10%) and the ND + cFSM (10%).

Amostra	Humidity %	Fat%	Protein %	Ash %	Carbohydrates %	Energy (kcal/100 g)	Fiber %
IcF	4.4	3.0	12.3	1.8	78.4	390.2	13.1
cFSM	14.1	0.7	13.3	1.1	70.8	342.6	11.6
ND + IcF (10%)	7.8	4.8	21.4	6.8	59.2	365.6	5.3
ND + cFSM (10%)	7.0	3.7	21.6	6.7	60.9	363.7	4.6

ND – normal diet.

et al., 2016).

Research of rats fed an isocaloric diet demonstrate biological properties of apple pomace, orange bagasse and passion fruit peel as alternative sources of dietary fiber. The results suggest that fruit by-products have a positive influence on lipid and glucose metabolism, promoting a significant reduction in triglycerides and hepatic cholesterol serum levels; they also showed important effects in the control of post prandial glucose (Macagnan et al., 2015).

The in vivo studies (Lecumberri et al., 2007; Martín-Carrón et al., 1999) and human trials (Pérez-Jiménez et al., 2008) have evaluated the effect of non-extractable polyphenols associated with fiber on intestinal health and the risks of cardiovascular diseases. Studies refer to cocoa fiber, bagasse and grape seed and the antioxidant dietary fiber of the grape. In relation to cardiovascular diseases, animal studies have demonstrated a reduction in lipid peroxidation, reduction of cholesterol, LDL and triglycerides, as well as atherogenic index reduction, as well as increased stool weight and increased excretion of protein and fat in feces (Lecumberri et al., 2007; Martín-Carrón et al., 1999). Tests in humans also showed a significant reduction of cholesterol and LDL, reduced risk of cardiovascular disease, and reduced blood pressure (Pérez-Jiménez et al., 2008).

Among the fruits with high fiber content, we can mention the cashew apple for its richness in nutrients and socioeconomic importance for Africa, India, Vietnam and Brazil. Cashew bagasse, a by-product of peduncle processing, has high dietary fiber content, as well as antioxidant compounds (Rufino et al., 2010). Cashew bagasse has been employed in the manufacture of different products such as cereal bars (de Oliveira, Malta, de Jesus, Cruz, & Cardoso, 2013), hamburgers (Lima, 2008), biscuits (de Santana & Silva, 2008) or simply dehydrated and grinded, constituting a raw material used in blends with cereal flours (Barros et al., 2012). However, there is a lack of scientific evidence on what are the specific health benefits of cashew bagasse fiber consumption. There are also no in vivo studies on the physiological effect of cashew bagasse fiber that guarantee its effectiveness in dietary prescription of a healthy diet. It should also be noted that the American Dietetic Association (2008) recommends looking for physiological efficacy studies before selecting functional fibers in dietetic practice.

The objective of this study was to evaluate the physiological effect of cashew fiber on the lipid profile, abdominal adiposity, glycemia and insulinemia, and the serum concentration of ghrelin and leptin hormones from normal mice. The cashew fiber was evaluated in its integral form, refered so forth as Integral Cashew Fiber (IcF) and the fiber after being submitted to the process of extraction of low molecular weight metabolites (fatty acids, waxes, pigments, sugars and phenolic compounds), refered as Cashew Fiber without Low Molecular Weight Metabolites (cFSM).

2. Materials and methods

2.1. Integral Cashew Fiber (IcF)

Cashew bagasse, obtained after the extraction of cashew juice, came from the juice industry Natvita located in the state of Ceará, Brazil. Approximately 300 g of cashew bagasse was immersed in water (1: 2, w/v) and exposed to ultrasonic waves using an Ultrasonic Cleaner 1450 USC (THORNTON / UNIQUE) for 1 h. The fiber was drained, frozen (−80 °C) and freezedryed. The dried fiber was ground in a willye-type mill with a mesh of 0.595 mm in diameter, obtaining the integral cashew fiber (IcF).

2.2. Cashew fiber without low molecular weight metabolites (cFSM)

The IcF was subjected to sequential extraction with organic solvents (hexane and methanol) resulting in cashew fiber without low molecular weight metabolites (cFSM). Approximately 100 g of the IcF powder was extracted with hexane to remove the fatty acids, waxes and pigments in the proportion of 1:12 (m/v), in a soxhlet for 8 h. Subsequently, an extraction with methanol was carried out to remove the low molecular weight phenolic compounds and sugars, in the ratio of 1:12 (m/v), in soxhlet for 72 h. The residue obtained from this extraction was left in the hood (72 h) to a complete evaporation of the residual solvent and grinded on a mortar, resulting in cFSM. The cFSM obtained was stored under refrigeration until the feed formulation. The proximal composition of the IcF and cFSM fibers are shown in Table 1.

2.3. Scanning electron microscopy (SEM)

The morphology of IcF and cFSM was observed by scanning electron microscopy (SEM) using a TM-3000 tabletop microscope (Hitachi, Japan). Prior to the observation, samples were stuck on stubs with double-face tape and coated with a gold palladium layer. The determination was performed at an accelerating voltage of 15 kV.

2.4. Diet composition

Experimental diets were prepared by mixing IcF or cFSM with a normal diet (ND). The ND used was a pelleted feed obtained from a commercial source (Nuvilab, Colombo, PR, Brazil). By weight it consisted of: Humidity (max.) 12.5 g/100 g – Total Protein (min.) 22 g/100 g – Ethereal extrac (min.) 5 g/100 g - Minerals (max.) 9 g/100 g - Fiber (max.) 7 g/100 g - Calcium (min-max.) 1 a 1.4 g/100 g - Phosphorus (min.) 600 mg/100 g. The ND was supplemented with 10% (dry weight) of IcF or cFSM. The proximate composition of the ND feed added IcF (10%) and cFSM (10%) are shown in Table 1.

2.5. Animals

Male Swiss albino mice (n = 10 / group), weighing between 19–23 g, from the Nucleus of Experimental Biology (NUBEX) of the University of Fortaleza (UNIFOR) were used. Throughout the experimental period, the animals remained in controlled conditions of light (12 h light − 12 h dark) and average temperature of 23–24 °C, humidity 55 ± 5%, receiving water and food (chow) ad libitum. The Federal University of Ceará Institutional Committee on Care and Use of Animals approved experimental protocols (number 21/15) for experimentation, in accordance with the guidelines of the National Institutes of Health, Bethesda, MD.