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LUANA MENDONÇA CERCATO

EFEITO DO EXTRATO AQUOSO DA CASCA DE *Hancornia speciosa* GOMES (MANGABEIRA) SOBRE A OBESIDADE INDUZIDA EM CAMUNDONGOS

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Dissertação apresentada ao Programa de Pós-graduação em Ciências da Saúde da Universidade Federal de Sergipe como requisito à obtenção do grau de Mestre em Ciências da Saúde.

Orientador: Prof. Dr. Enilton A. Camargo

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PARECER

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CERCATO, LM. **Efeito do Extrato Aquoso da Casca de *Hancornia speciosa* Gomes (Mangabeira) Sobre a Obesidade Induzida em Camundongos** 2015. p. 69. Dissertação (Programa de Pós-graduação em Ciências da Saúde), Universidade Federal de Sergipe, São Cristóvão**.**

RESUMO

A obesidade é uma condição endêmica, de grande importância nos dias atuais e para seu tratamento muitas alternativas farmacológicas ou não-farmacológicas são utilizadas. Dentre estas alternativas, encontram-se as plantas medicinais. Várias plantas são utilizadas para este fim no Brasil, mas os estudos etnobotânicos são restritos a regiões isoladas e não há na literatura estudos integrando estas informações para direcionar os estudos científicos. Neste contexto, no presente estudo foi realizada uma revisão sistemática sobre o uso de plantas medicinais no Brasil para a obesidade e perda de peso. Foram feitas buscas em bases de dados científicos com os termos "ethnobotanical", "obesity", "weight loss", "Brazil" e suas variações em inglês e português e foram identificados 31 estudos que indicaram 43 espécies utilizadas popularmente para o fim proposto. As principais espécies encontradas foram *Baccharis trimera* (Less.) DC. ("carqueja", 14 citações), *Annona muricata* L. ("graviola", 6 citações) e *Hancornia speciosa* Gomes ("mangabeira", 4 citações). Poucas evidências científicas foram encontradas para a maioria das plantas citadas nos estudos etnobotânicos, alertando para a necessidade de pesquisas para este fim. De forma interessante, a *H. speciosa* foi a terceira planta mais citada e os estudos etnobotânicos têm demonstrado que a casca do caule desta planta é a parte utilizada pela população para tratar a obesidade ou produzir perda de peso corpóreo. Como não há estudos que comprovem as ações desta planta sobre a obesidade e/ou perda de peso, o presente trabalho teve como objetivo principal investigar o potencial terapêutico do extrato aquoso da casca do caule da *H. speciosa* (EAHS) no perfil glicêmico e adipogênico de camundongos obesos. Para cumprir este objetivo, foram utilizados camundongos Swiss divididos em 4 grupos que receberam dieta padrão (DP), dieta padrão associada ao EAHS (DPE), dieta hiperlipídica (DH) e dieta hiperlipídica associada ao EAHS (DHE). O EAHS foi administrado na água de beber durante as 8 últimas semanas de um período total de 18 semanas em que os animais receberam as respectivas dietas. Ao final do experimento foram avaliados o consumo hídrico e de ração, peso corporal, peso dos coxins adiposos, glicemia, sensibilidade à insulina e tolerância à glicose. Foi observado o desenvolvimento de obesidade nos animais do grupo DH, associado à resistência à insulina e intolerância à glicose, pois este grupo apresentou maior área sob a curva nos testes de tolerância à insulina ($p < 0{,}001$) e à glicose ($p < 0{,}001$), além de maior glicemia de jejum ($p < 0{,}05$), quando comparado ao grupo DP. Além disso, o grupo DH mostrou aumento da massa dos coxins retroperitoneal ($p < 0{,}05$), perirenal ($p < 0{,}001$) e periepididimal ($p < 0{,}05$), bem como elevou o índice de adiposidade ($p < 0{,}05$) em comparação ao grupo DP. A adição do EAHS não alterou a ingestão hídrica ou consumo de ração dos animais, porém não foi possível observar diferença entre os grupos DH e DHE na grande maioria dos parâmetros avaliados. Este tratamento apenas reduziu significativamente a massa do coxim adiposo perirenal, sem afetar o índice de adiposidade. Dessa forma, o EAHS não alterou os efeitos causados pela indução da obesidade em camundongos, contrastando com os estudos etnobotânicos que indicam o uso da casca da *H. speciosa* na obesidade e na perda de massa corpórea.

Descritores: Obesidade, perda de peso, resistência à insulina, glicemia, dieta hiperlipídica, *Hancornia speciosa*, estudos etnobotanicos.

CERCATO, LM. **Effect of aqueous extract of bark of *Hancornia speciosa* Gomes ("Mangabeira") on obesity induced in mice.** 2015. p. 69. Dissertação (Pós-graduação em Ciências da Saúde), Universidade Federal de Sergipe, São Cristóvão.

ABSTRACT

Nowadays, obesity is an endemic condition of great importance and the treatment of obesity includes many pharmacological or non-pharmacological alternatives. Medicinal plants are found between these alternatives and many plants are used for this purpose in Brazil, but the ethnobotanical studies are restricted to isolated regions and no study was performed to integrate these information, in order to give direction to scientific studies. In this context, in the present study it was conducted a systematic review about the use of medicinal plants in Brazil for obesity and weight loss. We have used the terms "ethnobotanical", "obesity", "weight loss", "Brazil" and their variations in English and Portuguese for searching for papers in scientific databases. Thirty-one studies were identified and indicated 43 species popularly utilized to this purpose. The main species found were *Baccharis trimera* (Less.) DC. ("carqueja", 14 citations), *Annona muricata* L. ("graviola", 6 citations) and *Hancornia speciosa* Gomes ("mangabeira", 4 citations). Scarce scientific evidence was found for the majority of plants referred by the ethnobotanical surveys, which strengthened the need for more studies in this field. Interestingly, *H. speciosa* was the third plant more cited and the ethnobotanical surveys have demonstrated that the bark of *H. speciose* is the part of the plant that is popularly used to treat obesity or induce body weight loss. As there are no study that support the possible actions of this plant on obesity and/or weight loss, the present study aimed to investigate the therapeutic potential of aqueous extract of the stem bark of *H. speciosa* (AEHS) on the glycemic and adipogenic profiles of obese mice. For this purpose, Swiss mice were divided into four groups that received standard diet (SD), standard diet plus AEHS (SDE), high-fat diet (HD) and high-fat diet plus AEHS (HDE). The EAHS was administered in the drinking water for the last 8 weeks of a total period of 18 weeks that animals received their diets. At the end of the experiment, the water and food intake, body weight, weight of adipose tissue pads, blood glucose levels, insulin sensitivity and glucose tolerance were evaluated. Data demonstrated the development of obesity in animals of group HD, which was associated to insulin resistance and glucose intolerance, since this group showed increased area over the curve for insulin ($p < 0.01$) and glucose ($p < 0.001$) tolerance tests, along with augmented fasting blood glucose levels ($p < 0.05$) when compared to SD group. Besides, HD group showed increased weight of retroperitoneal ($p < 0.05$), perirenal ($p < 0.001$) and periepididymal ($p < 0.05$) adipose pads, as well as augmented the adiposity index ($p < 0.05$), in comparison with SD group. The addition of AEHS to mice did not changed the liquid or food intake, but it was not possible to observe difference between HD and HDE groups in the majority of the parameters evaluated. This treatment only caused a reduction in the weight of perirenal adipose pad, without affection the adiposity index. In this way, AEHS did not change the effects caused by the induction of obesity in mice, in contrast to ethnobotanical studies that indicate the use of the bark of *H. speciosa* in obesity and body weight loss.

Keywords: Obesity, weight loss, insulin resistance, glicemia, high-fat diet, *Hancornia speciosa*, ethnobotanical survey.

LISTA DE ABREVIATURAS E SIGLAS

DH – Dieta hiperlipídica

DHE – Dieta hiperlipídica mais extrato

DP – Dieta padrão

DPE – Dieta padrão mais extrato

EAHS – Extrato aquoso da casca do caule da *Hancornia speciosa*

HDL – Lipoproteína de alta densidade

IBGE - Instituto Brasileiro de Geografia e Estatística

OMS – Organização Mundial da Saúde

UFPA – Universidade Federal do Pará

SUMÁRIO

1 INTRODUÇÃO

O Brasil, assim como outros países em desenvolvimento, convive com a transição nutricional, determinada frequentemente pela má-alimentação. Ao passo em que se observa o decréscimo dos casos de desnutrição, são ressaltadas prevalências crescentes de excesso de peso, contribuindo com o aumento das doenças crônicas não transmissíveis (COUTINHO, GENTIL, TORAL, 2008). Segundo a Organização Mundial da Saúde (OMS) (2004), dentre tais doenças, a hipertensão arterial e a obesidade correspondem aos dois principais fatores de risco para a maioria das mortes e doenças no mundo.

A obesidade vem aumentando de forma alarmante e é considerada uma epidemia mundial, que atinge todas as faixas etárias e pode ser consequência de fatores endógenos e/ou exógenos. Este último comporta a maioria dos casos, relacionados a fatores ambientais, principalmente a falta de atividade física e hábitos alimentares inadequados (ARAÚJO et al., 2009). Trata-se de uma patologia crônica, multifatorial que consiste em alterações fisiológicas, bioquímicas, metabólicas, anatômicas, psicológicas e sociais, sendo caracterizada pelo acúmulo excessivo de tecido adiposo no organismo e aumento do peso corporal (ANGELIS, 2003).

A OMS (2004) estima que o sobrepeso atinge cerca de 1,6 bilhões de indivíduos acima de 15 anos, dos quais pelo menos 400 milhões apresentam obesidade. A prevalência desta vem crescendo de forma muito rápida nas últimas décadas, sendo responsável, em média, por cerca de 2% a 6% do total de recursos financeiros destinados à saúde (OMS, 2004). As consequências econômicas da obesidade e doenças associadas não se limitam aos elevados custos médicos, mas incluem também os custos indiretos ou sociais, tais como: diminuição da qualidade de vida, problemas de ajustes sociais, perda de produtividade, incapacidade com aposentadorias precoces e mortes (BAHIA; ARAÚJO, 2014).

Projeções baseadas em inquéritos realizados nas últimas décadas estimam que a obesidade atinja, em 2025, 40% da população nos EUA, 30% na Inglaterra, e 20% no Brasil (HU, 2008).

No Brasil, a Pesquisa de Orçamento Familiar 2008-2009 revela que o excesso de peso e obesidade surgem com maior frequência a partir dos 5 anos de idade, em todas as regiões brasileiras. Para cada três crianças de 5 a 9 anos, uma encontra-se acima do peso recomendado pela OMS. Na população adulta, duas pesquisas nacionais com dados de peso e estatura autorreferidos (VIGITEL 2006 e 2010) mostraram que as taxas de prevalência de sobrepeso e obesidade têm aumentado ao longo dos últimos quatro anos, de 43% para 48,1%, e de 11% para 15%, respectivamente, atingindo cerca de metade dos homens e mulheres, sendo que entre os homens o percentual passou de 18,5% para 50,1%, ultrapassando o das mulheres, que foi de 28,7% para 48% (BRASIL, 2010).

Como preditor de diversas patologias relacionadas à obesidade, a síndrome metabólica é caracterizada por um conjunto de anormalidades metabólicas e hemodinâmicas que acometem um mesmo organismo e está fortemente associada aos indivíduos obesos. Os seus principais componentes são obesidade abdominal, hipertensão arterial sistêmica, dislipidemia (aumento das concentrações de triglicérides e diminuição das concentrações de HDL-colesterol) e distúrbios relacionados à glicemia (anormalidade da glicemia de jejum, tolerância diminuída à glicose ou presença de diabetes mellitus) (GOODMAN, DANIELS, DOLAN, 2007; DEMACKER, 2007). Estima-se que esta síndrome atinja entre 20-25% da população mundial, com comportamento crescente nas últimas décadas (DUNSTAN et al., 2002).

Em meio aos problemas crônicos de saúde que ameaçam a vida associados à síndrome metabólica e à obesidade, os mais importantes são o desenvolvimento de outras doenças crônicas não transmissíveis, como diabetes tipo 2 e as doenças cardiovasculares, tendo como consequência maior risco de morte prematura ou redução da qualidade de vida do indivíduo (VEDANA et al., 2008).

Outras comorbidades também podem estar correlacionadas com a obesidade, como certos tipos de câncer, principalmente os relacionados a hormônios (endometrial, ovariano, mama, colo do útero e prostático) e do intestino grosso, às colecistopatias, dificuldades respiratórias, problemas músculo-esquelético crônicos, disfunções de pele e infertilidade. Igualmente, problemas psicológicos também estão associados, como a discriminação, preconceito, insatisfação com a forma corpórea e distúrbios alimentares (OMS, 2004).

Com o reconhecimento da obesidade como doença epidêmica que atinge a população mundial, emerge a necessidade de novos tratamentos que favoreçam a melhora na saúde e qualidade de vida do indivíduo, por meio da redução significativa e duradoura de peso, promovendo diminuição dos fatores de risco para comorbidades e melhorando o desempenho nas atividades do cotidiano.

Na literatura estão disponíveis vários tratamentos, devidamente estabelecidos e avaliados, para obesidade. Entre os mais citados encontram-se as alterações alimentares, a atividade física, a modificação comportamental, a terapia farmacológica e o tratamento cirúrgico. A combinação de diferentes terapias é muitas vezes necessária. (McTIGUE et al., 2003).

Existem evidências de que muitos produtos naturais podem auxiliar no tratamento da obesidade, atuando em cinco diferentes mecanismos distintos descritos por Yun (2010), como substâncias que (1) diminuem a absorção de lipídios, (2) diminuem a absorção de carboidratos, (3) aumentam o gasto energético, (4) diminuem a diferenciação e proliferação de pré-adipócitos, e (5) diminuem a lipogênese e aumentam da lipólise (YUN, 2010; MANENTI, 2012).

Dados da OMS mostram que cerca de 80% da população mundial depende das plantas medicinais ou medicamentos à base de plantas para os cuidados de saúde primários. Os países em desenvolvimento têm a maioria (67%) da biodiversidade vegetal do planeta, destacando dessa forma sua elevada participação na utilização de plantas medicinais referentes aos cuidados à saúde (BRASIL, 2006a).

No Brasil, o uso de plantas medicinais pela população com a finalidade de tratar enfermidades foi sempre expressivo, principalmente devido à extensa e diversificada flora. Ainda hoje nas regiões mais pobres do país e até mesmo nas grandes cidades, plantas medicinais são comercializadas em feiras, mercados populares e encontradas em quintais de residências (PASA, 2011).

O Ministério da Saúde reconhece esse saber popular, e busca implementar ações terapêuticas aos usuários do Sistema Único de Saúde, com vistas em garantir o acesso às plantas medicinais, com segurança, eficácia e qualidade, na perspectiva da integralidade da atenção à saúde (BRASIL, 2006a). Em junho de 2006, através do Decreto nº 5.813, foi aprovada a Política Nacional de Plantas Medicinais e Fitoterápicos, a qual tem como objetivo garantir à população o acesso seguro e o uso racional de plantas medicinais e fitoterápicos, promovendo o uso sustentável da biodiversidade, o desenvolvimento da cadeia produtiva e da indústria nacional (BRASIL, 2006b).

Dentro de novas espécies, a *Hancornia speciosa* Gomes vem sendo estudada por ser amplamente citada em levantamentos etnobotânicos de plantas utilizadas tradicionalmente por uma variedade de populações (MACEDO; FERREIRA, 2005; SOUZA, FELFILI, 2006; SILVA et al., 2010; CONCEIÇÃO et al., 2011)

A *H. speciosa* é uma espécie de planta pertencente à classe das Eudicotiledoneas, ordem Gentianales, família Apocynaceae. Popularmente conhecida como mangabeira, mangaba, mangava, mangabeira-do-norte e fruta de doente. Originária do Brasil, a mangabeira apresenta ampla distribuição geográfica, ocorrendo em diversos ecossistemas do país como Amazônia, Mata Atlântica e Cerrado (LORENZI, 2002).

A mangabeira é uma árvore de porte médio, possuindo de 2 a 15 m de altura, dotada de copa irregular, tronco tortuoso, bastante ramificada e áspera, com ramos lisos e avermelhados. Toda a planta exsuda látex. Apresenta folhas opostas, simples, pecioladas, glabras, brilhantes e coriáceas. Sua inflorescência possui de 1 a 7 flores perfumadas e de coloração branca. O fruto do tipo baga é elipsóide ou arredondado, com 2,0 a 6,0 cm, exocarpo amarelo, com manchas avermelhadas, polpa bastante doce, carnoso-viscosa, ácida, contendo geralmente 2 a 15 sementes discóides, com 7 a 8 mm de diâmetro, castanho claras, delgadas e rugosas (SOARES et al., 2007).

Os frutos aromáticos, saborosos e nutritivos da *H. speciosa* possuem ampla aceitação de mercado, tanto para o consumo *in natura*, quanto para a indústria, na fabricação de doces, compotas, geleias, licores, xaropes, vinhos e vinagres. Os maiores produtores da fruta são os Estados de Sergipe, Minas Gerais e Bahia, com produções respectivas de 524, 478 e 170 toneladas de mangaba no ano de 2000 (SOARES et al, 2007). Dentre estes, o Estado de Sergipe se destaca, ao longo dos anos, por ser o maior produtor de mangaba do país. Pesquisas da Embrapa e UFPA apontam para 2.500 toneladas produzidas no Estado, valor bastante superior ao estimado pelo IBGE (SILVA JÚNIOR et al., 2012).

Na medicina popular, a *H. speciosa* é usada para várias finalidades. As cascas são empregadas no combate de dermatoses, no tratamento de doenças que acometem o fígado. Utilizadas também como anti-inflamatória, para o tratamento do diabetes e no auxílio à perda de peso. As raízes são usadas no tratamento de luxações, reumatismo, como estomático e como anti-hipertensivo. O látex e as folhas são usadas como adstringente, para o tratamento de cólicas menstruais, dermatoses, tuberculose, úlceras, herpes, e verrugas e no tratamento de doenças que acometem o fígado. Os frutos são usados como digestivo e fonte alimentar (GRANDI et al., 1989; RODRIGUES;

CARVALHO, 2001; MACEDO; FERREIRA, 2005; SOUZA; FELFILI, 2006; CONCEIÇÃO et al., 2011; PASA, 2011; RIBEIRO et al., 2012).

É importante ressaltar que na literatura científica, as informações sobre usos populares desta planta para o tratamento relacionado à síndrome metabólica são de grande importância clínica, assim como a obesidade (efeito anorexígeno) e as hiperlipidemias, têm sido extensivamente citadas nos levantamentos etnobotânicos em diferentes regiões brasileiras (GRANDI et al., 1989; RODRIGUES; CARVALHO, 2001; MACEDO; FERREIRA, 2005; SILVA et al., 2010; SILVA; MIRANDA; CONCEIÇÃO, 2010), entretanto, poucas atividades biológicas foram avaliadas.

Além da *H. speciosa*, os estudos etnobotânicos mostram que outras plantas são utilizadas em território brasileiro para produzir perda de peso e potencialmente tratar a obesidade (YUN et al., 2004, BOSE et al., 2008; MARTINS et al., 2010). Entretanto, estes estudos geralmente são focados em determinadas regiões, o que pode ser entendido como um fator limitante, considerando a riqueza cultural e biodiversidade brasileiras. Não há na literatura estudos delineados para descrever em dimensão nacional os achados etnobotânicos relacionados ao tratamento da obesidade e perda de peso, o que foi alvo de exploração do presente estudo e está exposto na forma de revisão sistemática, no artigo 1: “Medicinal plants used in the treatment of obesity or body weight loss in brazil: a systematic review”.

Diante do exposto, este estudo teve o propósito de investigar o potencial terapêutico do extrato aquoso da casca do caule da *H. speciosa* (EAHS) na redução de peso corpóreo, bem como a avaliação do efeito do EAHS sobre o perfil glicêmico em camundongos obesos, buscando assim confirmar os estudos etnobotânicos relacionados a esta planta e descrever uma nova opção de tratamento para a obesidade.

2 OBJETIVOS

2.1 Objetivo Geral

Investigar o efeito do EAHS em camundongos obesos por ingestão de dieta hiperlipídica.

2.2 Objetivos Específicos

Revisar sistematicamente estudos etnobotânicos envolvendo o uso de plantas medicinais em território brasileiro para tratar a obesidade ou levar a perda de peso corpóreo;

Avaliar o efeito do EAHS sobre a evolução ponderal de camundongos obesos;

Investigar o efeito do EAHS sobre o perfil glicêmico, resistência à insulina e tolerância à glicose em camundongos obesos;

Verificar o efeito do EAHS sobre composição do tecido adiposo em camundongos obesos.

3 ARTIGO 1

MEDICINAL PLANTS USED IN THE TREATMENT OF OBESITY OR BODY WEIGHT LOSS IN BRAZIL: A SYSTEMATIC REVIEW

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Medicinal plants used in the treatment of obesity or body weight loss in Brazil: a systematic review

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Review Article

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Abstract

Nowadays, obesity is an important pandemic disease that reaches about 27% of adults and 47% of children and its prevalence is still increasing, which generates important costs to public health. In Brazil, the population use many plants to treat obesity or overweight, but there is a lack of scientific basis for this usage. Many ethnobotanical studies have been published aiming to detect this usage, but they are still limited by the region considered or the diversity of the popular knowledge found in this country. The present study was undertaken to systematically review the ethnobotanical surveys regarding to species utilized by traditional medicine to treat obesity or overweight. After the search was conducted, 32 studies were included in this review. In these studies, 43 species were popularly indicated to treat obesity or lose weight and the species more cited were *Baccharis trimera*, *Annona muricata* and *Hancornia speciosa*. The scientific basis for the use were also described and we found that for the majority of species cited there are no studies assuring their biological effects on obesity or weight loss. Many studies have demonstrated important effects of the plants cited in this review on glycemia, serum lipid levels or body weight in obese or non-obese conditions, but they are still not enough to ascertain the use of the plants indicated for population in the studies considered in this review. We purpose that this review can guide new experimental studies considering species used in Brazil to treat obesity and for weight loss.

Key-words: ethnobotanical survey, obesity, weight loss, Brazil, medicinal plants.

1. Introduction

Obesity is a worldwide disease that reaches 27.5% of adults and 47.1% of children. The number of obese and overweight people has increased from 587 million in 1980 to 2.1 billion in 2013, which makes obesity one of the diseases with the highest costs to public health. Besides, obese people presents physical restrictions and are exposed to high mortality rate, not only because of obesity, but also due to the comorbidities associated with this condition, such as diabetes, osteoarthritis, cancer and others. Nevertheless, the control of obesity is questionable and in 2010 about 3.4 millions of deaths around the world were attributed to obesity (Ng et al., 2014).

The Brazilian Survey on Family Budgets (*Pesquisa de Orçamentos Familiares* - POF) 2008-2009 has shown that obesity and overweight have quickly increased in all age groups. According to this research, in that period, 50% of men and 48% of women were overweight and 12.5% of men and 16.9% of women were obese.

Prevention and treatment of obesity include the healthy lifestyle, such as regular physical activity and balanced diet accompanied, in some cases, of pharmacological therapy and/or surgery procedures (McTigue et al., 2003). Nowadays, natural products represent an increasing option chosen by people to help treating obesity and overweight, since many of them are considered efficient, safe and, in many cases, less expensive in comparison with drugs traditionally used to treat obesity (Manenti, 2010). Some species were described for the treatment of obesity such as *Chitin- chitosan* (Han et al., 1999), *Camellia sinensis* (green tea) (Bose et al., 2008), *Ilex paraguariensis* (“erva mate") (Martins et al., 2010), wild Ginseng (Yun et al., 2004), *Glycyrrhiza uralensis* (Mae et al., 2003) and *Exodia rutaecarpa* (Kobayashi et al., 2001).

In Brazil, it was shown that more than 90% of the population has already used any medicinal plant and it is estimated that about 1 billion of reais per year by the phytotherapy industry (Correa and Alves, 2008). Although there are various medicinal plants in current use with scientific validation for treatment of obesity and overweight, there is a lack of botanical surveys integrating the diverse parts of Brazil. The scientific background about new species can benefit both the use by population and the efficient management of medicinal plants and their subproducts that can be commercialized by food, phytotherapy and pharmaceutical industries in order to help treating obesity.

In this way, this study was undertaken in order to review the ethnobotanical species with medicinal value that are described as useful in the treatment of obesity and/or body weight loss in Brazil.

2. Methodology

Search strategy

Three data basis were used to search for articles to be included in this study: MEDLINE, LILACS and Scopus. The following descriptors were used: “ethnobotanical”, “obesity”, “weight loss”, “Brazil” and their MeSH variations. The structure of the search strategy was designed to include all articles containing the descriptors that were published until 2015 February 27st. There was no restriction of language for the articles identified.

Study selection and inclusion/exclusion criteria

All titles, abstracts and complete articles were independently revised by at least two collaborators (LMC and PASW). The selected articles must considered the ethnobotanical application or use of any medicinal plant for treating obesity or overweight. Articles in regions outside Brazil or studies directed for any specific disease or vegetal species not related with obesity or overweight were excluded.

Extraction of Results

Data were extracted by one collaborator by using a standardized form and were verified according to their integrity and precision by a second collaborator. Information extracted included the species and family of the plants, the traditional use, the part of the plant, the procedure of preparation and the region where the use was described.

3. Results and discussion

A total of 361 articles were found during the search performed. After the removal of duplicates and screening of relevant titles and abstracts, 83 complete articles were analyzed, generating 32 articles that were included in the present review (Figure 1).

In the 32 studies selected were detected 43 species that can be used for treating obesity or losing weight, according to the popular knowledge (Table 1). The states of

Brazil that presented higher ethnobotanical diversity for this purpose were Mato Grosso (15 species), Minas Gerais (13 species), Bahia and Pernambuco (9 species each), Santa Catarina (7 species) and Mato Grosso do Sul (6 species).

The species (followed by popular name) that showed higher number of citation were *Baccharis trimera* (Less.) DC. (“carqueja” / “carqueja amarga”) with 14 citation, *Annona muricata* L. (“graviola”) with 6 citation and *Hancornia speciosa* Gomes (“mangaba”) with 4 citation (Table 2).

Baccharis trimera (Less.) DC.

Baccharis trimera (Less.) DC (Ateraceae) is traditionally known as “carqueja” and is found in tropical regions. All parts of the plant are widely used in the traditional medicine, as infusion, for the treatment of obesity and body weight loss in various Brazilian states (de Souza et al., 2012). Also, this plant is popularly used for climaterium, hypertension, anemia, fever, rheumatism, urinary infection, gallstones, diabetes, hepatic obstruction, helminthic infection and scalp diseases (Albertasse et al., 2010; Albuquerque, 1997; Bieski et al., 2012; Costa and Mayworm, 2011; dos Santos and de Lima, 2008; Grandi et al., 1989; Lopes and Pantoja, 2013; Meyer et al., 2012; Moreira et al., 2002; Nunes et al., 2003; Rodrigues and Carvalho, 2001; Zeni and Bosio, 2011).

Some of the main bioactive compounds obtained from fractions or the ethanol or water extract of *B. trimera* are saponins, mainly the echinocystic acid and the flavonoids rutin (Gene et al., 1996), quercetin, luteolin, eupafolin, apigenin and hispidulin (Soicke and Leng-Peschlow, 1987).

Besides it was the specie with high number of citation of popular use for the purpose of this review, *B. trimera* was also found to present the higher diversity of pharmacological actions between the plants evaluated. Studies have shown that *B. trimera* possesses antimicrobial action against *Cryptococcus neoformans* (Fabri et al., 2011), *Staphylococcus aureus* and *Streptococcus uberis* (Avancini et al., 2000), hypoglycemiant action in diabetic mice (Oliveira et al., 2005), antiulcer effect by inhibiting cholinergic and histaminergic gastric secretion in mice (Biondo et al., 2011; Dias et al., 2009), antioxidant effect (de Oliveira et al., 2012), anti-inflammatory and analgesic effect, partly due to the inhibition of prostaglandin biosynthesis (Gene et al., 1996).

Regarding to the antiobesity or body weight loss effect, in the study by De Souza et al. (2012) it was observed the inhibition of weight gain and reduction of serum cholesterol concentration in obese rats treated with the methanol extract of the bark of *B. trimera*. Besides, by using the same extract, Souza et al. (2011) have observed the inhibition of pancreatic lipase, an enzyme that hydrolyses triglicerols, and inhibition of β-glicosidase, which catalyses the hydrolyses of glucosidic bounds, generating glucose. These studies indicate that this extract is promising to treat obesity and body weight loss, however, more in vivo and in vitro studies are needed to completely evaluate this potential.

Annona muricata Linn.

Annona muricata Linn. (Annonaceae), popularly known as "graviola", is found in Central and South America, including the North, Northeast and Southeast regions of Brazil. Studies about the traditional use of *A. muricata* were developed in Rondônia, Ceará, Pernambuco, Bahia and Minas Gerais. It was verified a widespread use of this plant for body weight loss, treatment of infections, snake bite, cancer, dyspnea, hypertension, diabetes, fever, inflammation, low back pain and dizziness (dos Santos and de Lima, 2008; Grandi et al., 1989; Liporacci and Simão, 2013; Macêdo et al., 2013; Moreira et al., 2002; Santos et al., 2012). Although these studies described the use of infusion or decoction of the leaves by people in order to lose weight, there was no published scientific evidence that this effect of leaves of *A. muricata* were found neither in laboratory animals nor in in vitro investigations.

Between the chemical components found in *A. muricata*, some alcaloids (reticuline, coreximine, coclaurine e atherosperminine, stepharine) (Leboeuf et al., 1981) and essential oils (β-caryophyllene, δ-cadinene, epi-α-cadinol and α-cadinol) were identified (Kossouoh et al., 2007). Also, some acetogenins were isolated from different parts of this plant and presented cytotoxic properties against tumoral and normal cell lines (George et al., 2012; Rupprecht et al., 1990; Wu et al., 1995), as well as molluscicidal activity (Luna Jde et al., 2006).

Hancornia speciosa Gomes

Hancornia speciosa Gomes (Apocinaceae) possesses a great potential as a fruitful and rubber producing plant and is found in Brazilian Cerrado (Soares et al., 2007). The pulp and the peel of the fruit are consumed in natura in ice creams, jellies, candies and liqueurs and the latex is used for rubber production (da Rosa et al., 2007).

According to Silva, Miranda and Conceição (2010) the leaves of *H. speciosa*, as well as the bark, presented alcaloids, flavonoids and tanins. Santos et al. (2013), in an ethnobotanical survey, have verified the use of this species in the treatment of diabetes, tuberculosis, low back pain, hypertension, menstrual cramps, respiratory and venereal diseases, dislocation, dermatosis and ulcers, besides obesity. Anti-obesity property was cited in four studies about the popular use of this plant and the more common use was the decoction of the innerbark (da Silva et al., 2010; Grandi et al., 1989; Santos et al., 2013; Silva et al., 2010). In this way, this plant can represent a good candidate for future researches focused on treating obesity. It was one of the most cited plants in Nova Xavantina (Mato Grosso) and in many cities of Minas Gerais state (Grandi et al., 1989; Silva et al., 2010).

On spite of the popularity of the innerbark for treating obesity, there were no study found in literature that assure this use. However, pharmacological studies have provided data about other actions of *H. speciosa*. It was shown that the hydroalcohol extract of the bark of *H. speciosa* reduced the gastric ulcer, due to increased formation of gastric mucus and probably the antioxidant properties of polymeric proantocianidins (Moraes Tde et al., 2008). Also, the ethanol extract of the leaves of *H. speciosa* induced endothelium-dependent vasodilation of rat aortic rings, through activation of phosphatidyl-inositol 3-kinase (Ferreira et al., 2007) or induced hypotension in rats due to inhibition of angiotensin-converting enzyme and increase of nitric oxide (Silva et al., 2011). Besides, Marinho et al. (2011) have demonstrated the anti-inflammatory effect of the latex of the tree trunk of *H. speciosa* in rodents, via inhibition of prostaglandin E_2 and cytokine production. Endringer, Pezzuto and Braga (2009) described that the ethanol extract of the leaves contains rutin, bornesitol and quinic acid and these compounds caused nuclear factor-κB inhibition in cells stimulated in vitro.

Other species

Besides the species described above, other species were also cited in a considerable amount of studies and can be highlighted: *Camellia sinensis*, *Cynara scolymus* L. and *Rudgea virbunoides*.

Camellia sinesis (Theaceae), popularly known as green tea, possesses catechins as main compounds, such as epigallocatechin-3-gallate, as well as quercetin, theorubigins, theoflavins, theanine, caffeine, chlorogenic acid and gallic acid (Astell et al., 2013). The effect of green tea on obesity and body weight loss is extensively described in literature. Studies have suggested that the inhibition or reduction of body weight, adipose tissue and serum lipids caused by this tea are related to the inhibition of α-amylase (Pereira et al., 2010) and activation of lipolysis by increasing intracellular mechanisms that enhances the activation of hormone-sensible lipase (Cunha et al., 2013).

Cynara scolymus L. (Asteraceae), popular named as artichoke, has presented promising activities such as reduction of glycemia in rats (Fantini et al., 2011), reduction of the serum triglyceride and cholesterol levels in rats submitted to a high cholesterol diet (Kusku-Kiraz et al., 2010). Interestingly, artichoke treatment decreased the total cholesterol and LDL levels and increased HDL levels in humans with hypercholesterolemia (Rondanelli et al., 2013). Also a high molecular weight inulin isolated from this plant present a prebiotic effect (Lopez-Molina et al., 2005).

Rudgea virbunoides (Cham.) Benth. (Rubiaceae) known as "congonha-de-bagre", has shown contradictory effects. The aqueous extract of the leaves of this plant reduced the plasma trigliceride concentrations in rats, but it was related to the increase of deposits of hepatic fat (Monteiro et al., 2009). Other studies are necessary to clarify the potential of this plant.

Between the species with one citation, some can be detached: *Achyrocline satureoides, Allium sativum, Anacardium occidentalis, Annona montana, Asparagus officinalis, Cinnamomum zeylanicum, Citrus lemon, Cymbopogon citratus, Guazuma ulmifolia, Mimosa pudica* and *Stevia rebaudiana*.

Popularly known as "marcela", *Achyrocline satureoides* possesses quercetin and luteolin as bioactive compounds. The anti-inflammatory activity of this plant was described (Simoes et al., 1988), as well as its antioxidant activity and the inhibitory effect on the apolipoprotein B and oxidation of LDL (Gugliucci and Menini, 2002).

Largely used as a condiment, *Allium sativum* or garlic, is widely known by population. Innumerous properties of garlic were described such as the reduction of hyperglycemia, polydipsia and polyphagia in diabetic rats (Bokaeian et al., 2010) and the decrease of serum cholesterol, hepatocyte degeneration and Langerhan's islet atrophy in diabetic rats (Masjedi et al., 2013). Also, in spontaneous hypertensive rats, garlic diminished the mean arterial pressure and triglyceride concentrations (Elkayam et al., 2013).

Anacardium occidentalis or “cajueiro”, was shown to cause protection against the increase of glucose levels, polidpsy and poliphagy in diabetic rats (Kamtchouing et al., 1998), and to reduce lipid metabolism leading to reduction of serum and tissue (heart, adipose and liver) lipids (Prabha and Rajamohan, 1998).

Annona montana is also called “jaca-de-pobre” or “falsa graviola” and is rich in acetogenins (Mootoo et al., 2000). In a study conducted by Barbalho et al. (2012) it caused the reduction of serum glucose and lipids, as well as body weight and increase of serum HDL in naive rats.

Asparagus officinalis or “aspargo” also reduced body weight in humans (Chrubasik et al., 2008), blood glycemia and triglyceride levels in diabetic rats (Zhao et al., 2011), total cholesterol and LDL, besides produced a protective effect in liver in rat fed with rich cholesterol diet (Garcia et al., 2012).

Cinnamomum zeylanicum or “canela-da-índia” is rich in polyphenols (Im et al., 2014). Ranasinghe et al. (2012) have revised the efficacy and safety of this plant to treat diabetes and indicated that it improved glycemia due to postprandial absorption of glucose, increased the translocation of GLUT-4, inhibited gluconeogenesis, stimulated insulin release, and induced increase in HDL concentrations in blood. Also, Shatwan et al. (2013) demonstrated that treatment with crude *C. zeylanicum* reduced serum lipid and leptin and increased adiponection levels in diabetic rats .

Studies with the juice of *Citrus limon* or aqueous extract of the fresh leaves of *Cymbopogon citratus* (“capim cidreira”) have demonstrated the reduction of the serum cholesterol and trigliceride levels by these natural products (Adeneye and Agbaje, 2007; Trovato et al., 1996). Adittionally, Adeneye and Agbje (2007) showed that the above mentioned preparation of *Cymbopogon citratus* decreased the glucose levels of normoglycemic rats .

An interesting effect was demonstrated for *Guazuma ulmifolia*, popularly known as “chico-magro”. Alonso-Castro and Salazar-Olivo (2008) have demonstrated that the aqueous extract of the bark of this plant altered the uptake of glucose, improving the glucosis homeostasis, both in 3T-F442A adipocytes insulin-sensible and insulin-resistant, without interfering with adipogenesis.

The chlorophorm extratc of the leaves of *Mimosa pudica* (“dorme-dorme”) has presented a reducing effect of serum lipids, total cholesterol, LDL, VLDL, triglyceride, besides it increased the serum HDL levels (Rajendran and Krishnakumar, 2010).

Stevia rebaudiana Bertoni, stevia, is an alternative source of natural sugar and its use in obesity or weight loss remains controversial. In mice fed with high fat diet, the treatment with the sucrose from *S. rebaudiana* (stem and leaves) reduced body weight gain, serum cholesterol and triglyceride levels, fat in liver and increased the concentration of free carnitine, an enzyme responsible for the oxidation of free fat acid (Park and Cha, 2010). Kujur et al. (2010) has observed the reduction of glycemia in diabetic rats treated with the crude extract of the leaves of stevia. However, no effect was observed by Oliveira-Filho et al. (1989) on the glycemia, body weight, thyroxine (T4) and triiodothyronine (T3) concentrations or other endocrine parameters in rats chronically treated with the aqueous extract of the leaves of *S. rebaudiana*.

Concerning to the other species identified in the present study, although they were cited in ethonobotanical studies as useful for the treatment of obesity and overweight, it was not found any scientific evidence that correlated these plants with obesity, weight loss, hyperglycemia or dyslipidemias. The activites found for these plants referred to their effect on nociception (*Vernonia condensate* and *Solanum cernuum*; (da Silva et al., 2013; Frutuoso et al., 1994; Lopes et al., 2014), inflammation (*Vernonia condensata*, *Echinodorus macrophyllus*, *Symphytum officinale*, *Solanum cernuum*; (Araujo et al., 2012; da Silva et al., 2011; Lopes et al., 2014; Tanus-Rangel et al., 2010), gastric ulcer (*Vernonia condensata*; (Frutuoso et al., 1994), kidney damage (*Echinodorus macrophyllus;* (Nascimento et al., 2014), wound repair (*Symphytum officinale;* (Araujo et al., 2012), microbial infection and cancer (*Senna occidentalis*; (Lombardo et al., 2009).

4. Final Considerations

Considering the species described in this review, it is possible to verify that some plants are indicated by many ethnobotanical studies as useful for treating obesity or causing weight loss, such as *Camellia sinensis*, *Baccharis trimera* and *Aspargus officinalis*. Other species were found to be less described, but showed potential effects to treat these conditions, such as *Anacardium occidentalis*, *Annona montana* and *Stevia rebaudiana*. Although there is a lack of scientific studies that validate the potential of the species emphasized in this review, for many of them it was shown relevant effects on glycemia, serum lipids and/or body weight in experimental animals, which are factors that do not directly correspond to obesity or overweight, but usually are altered in these conditions.

It is worthwhile also considering that the majority of studies with these species were performed in experimental models. Thus, studies that assure their effectiveness and underlying mechanisms of action are obviously needed to permit their appropriate use in humans.

In this way, in spite of the number of studies or the lack of scientific basis, it would be of value if more in vivo or in vitro pharmacological studies were developed for many of the species cited in this review. This could strengthens their use by the population and permit new alternatives based on phytotherapy to treat obese and overweight people.

5. References

Adeneye, A.A., Agbaje, E.O., 2007. Hypoglycemic and hypolipidemic effects of fresh leaf aqueous extract of Cymbopogon citratus Stapf. in rats. J Ethnopharmacol 112, 440-444.

Albertasse, P.D., Thomaz, L.D., Andrade, M.A., 2010. Plantas medicinais e seus usos na comunidade da Barra do Jucu, Vila Velha, ES. Revista Brasileira de Plantas Medicinais 12, 250-260.

Albuquerque, U.P.d., 1997. Etnobotânica: uma aproximação teórica e epistemológica. Revista Brasileira de Farmácia 78, 60-64.

Alonso-Castro, A.J., Salazar-Olivo, L.A., 2008. The anti-diabetic properties of Guazuma ulmifolia Lam are mediated by the stimulation of glucose uptake in normal and diabetic adipocytes without inducing adipogenesis. J Ethnopharmacol 118, 252-256.

Alves, E.O., Mota, J.H., Soares, T.S., Vieira, M.d.C., Silva, C.B.d., 2008. Levantamento etnobotânico e caracterização de plantas medicinais em fragmentos florestais de Dourados-MS. Ciência e Agrotecnologia 32, 651-658.

Araujo, L.U., Reis, P.G., Barbosa, L.C., Saude-Guimaraes, D.A., Grabe-Guimaraes, A., Mosqueira, V.C., Carneiro, C.M., Silva-Barcellos, N.M., 2012. In vivo wound healing effects of Symphytum officinale L. leaves extract in different topical formulations. Pharmazie 67, 355-360.

Astell, K.J., Mathai, M.L., Su, X.Q., 2013. A review on botanical species and chemical compounds with appetite suppressing properties for body weight control. Plant Foods Hum Nutr 68, 213-221.

Avancini, C.A.M., Wiest, J.M., Mundstock, E., 2000. Atividade bacteriostática e bactericida do decocto de Baccharis trimera (Less.) D.C., Compositae, carqueja, como desinfetante ou anti-séptico. Arquivo Brasileiro de Medicina Veterinária e Zootecnia 52, 230-234.

Barbalho, S.M., Soares de Souza Mda, S., dos Santos Bueno, P.C., Guiguer, E.L., Farinazzi-Machado, F.M., Araujo, A.C., Meneguim, C.O., Pascoal Silveira, E., de Souza Oliveira, N., da Silva, B.C., Barbosa Sda, S., Mendes, C.G., Goncalves, P.R., 2012. Annona montana fruit and leaves improve the glycemic and lipid profiles of Wistar rats. J Med Food 15, 917-922.

Batalha, M.O., Nantes, J.F.D., Alcântara, R.L.C., 2003. Plantas medicinais no estado de São Paulo: situação atual, perspectivas e entraves ao desenvolvimento. Florestar Estatístico 6, 9.

Bieski, I.G.C., Rios Santos, F., de Oliveira, R.M., Espinosa, M.M., Macedo, M., Albuquerque, U.P., de Oliveira Martins, D.T., 2012. Ethnopharmacology of medicinal plants of the pantanal region (Mato Grosso, Brazil). Evidence-Based Complementary and Alternative Medicine 2012.

Biondo, T.M., Tanae, M.M., Coletta, E.D., Lima-Landman, M.T., Lapa, A.J., Souccar, C., 2011. Antisecretory actions of Baccharis trimera (Less.) DC aqueous extract and isolated compounds: analysis of underlying mechanisms. J Ethnopharmacol 136, 368-373.

Bokaeian, M., Nakhaee, A., Moodi, B., Farhangi, A., Akbarzadeh, A., 2010. Effects of garlic extract treatment in normal and streptozotocin diabetic rats infected with Candida albicans. Indian Journal of Clinical Biochemistry 25, 182-187.

Bose, M., Lambert, J.D., Ju, J., Reuhl, K.R., Shapses, S.A., Yang, C.S., 2008. The major green tea polyphenol, (-)-epigallocatechin-3-gallate, inhibits obesity, metabolic syndrome, and fatty liver disease in high-fat-fed mice. J Nutr 138, 1677-1683.

Chrubasik, C., Maier, T., Dawid, C., Torda, T., Schieber, A., Hofmann, T., Chrubasik, S., 2008. An observational study and quantification of the actives in a supplement with Sambucus nigra and Asparagus officinalis used for weight reduction. Phytother Res 22, 913-918.

Correa, C.C., Alves, A.F., 2008. Plantas medicinais como alternativa de negócios: caracterização e importância, 46th Congress, July 20-23, 2008, Rio Branco, Acre, Brasil. Sociedade Brasileira de Economia, Administracao e Sociologia Rural (SOBER).

Costa, V., Mayworm, M., 2011. Plantas medicinais utilizadas pela comunidade do bairro dos Tenentes-município de Extrema, MG, Brasil. Revista Brasileira de Plantas Medicinais 13.

Cunha, C.A., Lira, F.S., Rosa Neto, J.C., Pimentel, G.D., Souza, G.I.H., Gonçalves da Silva, C.M., de Souza, C.T., Ribeiro, E.B., Sawaya, A.C.H.F., Oller do Nascimento, C.M., Rodrigues, B., de Oliveira Carvalho, P., Oyama, L.M., 2013. Green Tea Extract Supplementation Induces the Lipolytic Pathway, Attenuates Obesity, and Reduces Low-Grade Inflammation in Mice Fed a High-Fat Diet. Mediators of Inflammation 2013, 8.

Cunha Lima, S., Rodrigues, E., Melo, T., Nascimento, A., Guedes, M., Cruz, T., Alves, C., Meyer, R., Toralles, M., 2008. Levantamento da flora medicinal usada no tratamento de doenças metabólicas em Salvador, BA-Brasil. Revista Brasileira de Plantas Medicinais 10, 83-89.

da Rosa, M.E.C., Naves, R.V., de Oliveira Júnior, J.P., 2007. Produção e crescimento de mudas de mangabeira (Hancornia speciosa Gomez) em diferentes substratos. Pesquisa Agropecuária Tropical (Agricultural Research in the Tropics) 35, 65-70.

da Silva, J.A., Bündchen, M., 2011. Conhecimento etnobotânico sobre as plantas medicinais utilizadas pela comunidade do Bairro Cidade Alta, município de Videira, Santa Catarina, Brasil. Unoesc & Ciência-ACBS 2, 129-140.

da Silva, J.B., Temponi Vdos, S., Fernandes, F.V., de Assis Dias Alves, G., de Matos, D.M., Gasparetto, C.M., Ribeiro, A., de Pinho Jde, J., Alves, M.S., de Sousa, O.V., 2011. New approaches to clarify antinociceptive and anti-inflammatory effects of the ethanol extract from Vernonia condensata leaves. Int J Mol Sci 12, 8993-9008.

da Silva, J.B., Temponi Vdos, S., Gasparetto, C.M., Fabri, R.L., Aragao, D.M., Pinto Nde, C., Ribeiro, A., Scio, E., Del-Vechio-Vieira, G., de Sousa, O.V., Alves, M.S.,

2013. Vernonia condensata Baker (Asteraceae): a promising source of antioxidants. Oxid Med Cell Longev 2013, 698018.

da Silva, N.L.A., Miranda, F.A.A., da Conceição, G.M., 2010. Triagem fitoquímica de plantas de Cerrado, da área de proteção ambiental municipal do Inhamum, Caxias, Maranhão. Scientia Plena 6.

de Albuquerque, U.P., Monteiro, J.M., Ramos, M.A., de Amorim, E.L., 2007. Medicinal and magic plants from a public market in northeastern Brazil. J Ethnopharmacol 110, 76-91.

de Oliveira, C.B., Comunello, L.N., Lunardelli, A., Amaral, R.H., Pires, M.G.S., da Silva, G.L., Manfredini, V., Vargas, C.R., Gnoatto, S.C.B., de Oliveira, J.R., Gosmann, G., 2012. Phenolic Enriched Extract of Baccharis trimera Presents Anti-inflammatory and Antioxidant Activities. Molecules 17, 1113-1123.

de Souza, S.P., Pereira, L.L.S., Souza, A.A., de Souza, R.V., dos Santos, C.D., 2012. Estudo da atividade antiobesidade do extrato metanólico de Baccharis trimera (Less.) DC. Rev. Bras. Farm 93, 27-32.

Dias, L.F.d.T., Melo, E.S.d., Hernandes, L.S., Bacchi, E.M., 2009. Atividades antiúlcera e antioxidante Baccharis trimera (Less) DC (Asteraceae). Revista Brasileira de Farmacognosia 19, 309-314.

Dias Souza, R.K., Alcantara Morais Mendonça, A.C., Pessoa da Silva, M.A., 2013. Aspectos etnobotânicos, fitoquímicos e farmacológicos de espécies de Rubiaceae no Brasil. Revista Cubana de Plantas Medicinales 18, 140-156.

dos Santos, M.R.A., de Lima, M.R., 2008. Levantamento dos recursos vegetais utilizados como fitoterápicos no município de Cujubim, Rondõnia, Brasil. Saber Científico 1, 58-74.

Elkayam, A., Peleg, E., Grossman, E., Shabtay, Z., Sharabi, Y., 2013. Effects of allicin on cardiovascular risk factors in spontaneously hypertensive rats. Isr Med Assoc J 15, 170-173.

Endringer, D.C., Pezzuto, J.M., Braga, F.C., 2009. NF-kappaB inhibitory activity of cyclitols isolated from Hancornia speciosa. Phytomedicine 16, 1064-1069.

Fabri, R.L., Nogueira, M.S., Dutra, L.B., Bouzada, M.L.M., Scio, E., 2011. Potencial antioxidante e antimicrobiano de espécies da família Asteraceae. Revista Brasileira de Plantas Medicinais 13, 183-189.

Fantini, N., Colombo, G., Giori, A., Riva, A., Morazzoni, P., Bombardelli, E., Carai, M.A., 2011. Evidence of glycemia-lowering effect by a Cynara scolymus L. extract in normal and obese rats. Phytother Res 25, 463-466.

Feijó, E.V.R.S., Pereira, A.S., Souza, L.R., Silva, L.A.M., Costa, L.C.B., 2013. Levantamento preliminar sobre plantas medicinais utilizadas no bairro Salobrinho no município de Ilhéus, Bahia. Revista Brasileira de Plantas Medicinais 15, 595-604.

Ferreira, H.C., Serra, C.P., Lemos, V.S., Braga, F.C., Cortes, S.F., 2007. Nitric oxide-dependent vasodilatation by ethanolic extract of Hancornia speciosa via phosphatidyl-inositol 3-kinase. J Ethnopharmacol 109, 161-164.

Frutuoso, V.S., Gurjao, M.R., Cordeiro, R.S., Martins, M.A., 1994. Analgesic and anti-ulcerogenic effects of a polar extract from leaves of Vernonia condensata. Planta Med 60, 21-25.

Fuck, S.B., Athanázio, J.C., de Lima, C.B., Ming, L.C., 2005. Plantas medicinais utilizadas na medicina popular por moradores da área urbana de Bandeirantes, PR, Brasil. Semina: Ciências Agrárias 26, 291-296.

Gallotte, D.C., Ribeiro, L.F., 2005. Levantamento etnobotânico das plantas medicinais do horto da Escola Superior São Francisco de Assis–ESFA, Santa Teresa, ES3.

Garcia, M.D., De la Puerta, R., Saenz, M.T., Marquez-Martin, A., Fernandez-Arche, M.A., 2012. Hypocholesterolemic and hepatoprotective effects of "triguero" asparagus from andalusia in rats fed a high cholesterol diet. Evid Based Complement Alternat Med 2012, 814752.

Gene, R.M., Cartana, C., Adzet, T., Marin, E., Parella, T., Canigueral, S., 1996. Anti-inflammatory and analgesic activity of Baccharis trimera: identification of its active constituents. Planta Med 62, 232-235.

George, V.C., Kumar, D.R., Rajkumar, V., Suresh, P.K., Kumar, R.A., 2012. Quantitative assessment of the relative antineoplastic potential of the n-butanolic leaf extract of Annona muricata Linn. in normal and immortalized human cell lines. Asian Pac J Cancer Prev 13, 699-704.

Grandi, T.S.M., Trindade, J.A.d., Pinto, M.J.F., Ferreira, L.L., Catella, A.C., 1989. Plantas medicinais de Minas Gerais, Brasil. Acta Botanica Brasilica 3, 185-224.

Gugliucci, A., Menini, T., 2002. Three different pathways for human LDL oxidation are inhibited in vitro by water extracts of the medicinal herb Achyrocline satureoides. Life Sci 71, 693-705.

Han, L.K., Kimura, Y., Okuda, H., 1999. Reduction in fat storage during chitin-chitosan treatment in mice fed a high-fat diet. Int J Obes Relat Metab Disord 23, 174-179.

Im, K., Issac, A., Nm, J., Ninan, E., Maliakel, B., Kuttan, R., 2014. Effects of the polyphenol content on the anti-diabetic activity of Cinnamomum zeylanicum extracts. Food Funct 5, 2208-2220.

Kamtchouing, P., Sokeng, S.D., Moundipa, P.F., Watcho, P., Jatsa, H.B., Lontsi, D., 1998. Protective role of Anacardium occidentale extract against streptozotocin-induced diabetes in rats. J Ethnopharmacol 62, 95-99.

Kobayashi, Y., Nakano, Y., Kizaki, M., Hoshikuma, K., Yokoo, Y., Kamiya, T., 2001. Capsaicin-like anti-obese activities of evodiamine from fruits of Evodia rutaecarpa, a vanilloid receptor agonist. Planta Med 67, 628-633.

Kossouoh, C., Moudachirou, M., Adjakidje, V., Chalchat, J.-C., Figuérédo, G., 2007. Essential oil chemical composition of Annona muricata L. leaves from Benin. Journal of Essential Oil Research 19, 307-309.

Kujur, R.S., Singh, V., Ram, M., Yadava, H.N., Singh, K.K., Kumari, S., Roy, B.K., 2010. Antidiabetic activity and phytochemical screening of crude extract of Stevia rebaudiana in alloxan-induced diabetic rats. Pharmacognosy Res 2, 258-263.

Kusku-Kiraz, Z., Mehmetcik, G., Dogru-Abbasoglu, S., Uysal, M., 2010. Artichoke leaf extract reduces oxidative stress and lipoprotein dyshomeostasis in rats fed on high cholesterol diet. Phytother Res 24, 565-570.

Leboeuf, M., Legueut, C., Cave, A., Desconclois, J.F., Forgacs, P., Jacquemin, H., 1981. [Alkaloids of Annonaceae. XXIX. Alkaloids of Annona muricata]. Planta Med 42, 37-44.

Leitão, S.G., 2002. A etnobotânica e a etnofarmacologia como ferramentas para a busca de novas drogas de origem vegetal.

Liporacci, H.S.N., Simão, D.G., 2013. Levantamento etnobotânico de plantas medicinais nos quintais do Bairro Novo Horizonte, Ituiutaba, MG. Revista Brasileira de Plantas Medicinais 15, 529-540.

Lombardo, M., Kiyota, S., Kaneko, T., 2009. Aspectos étnicos, biológicos e químicos de Senna occidentalis (Fabaceae). Revista de Ciências Farmacêuticas Básica e Aplicada 30, 9-17.

Lopes, G.F.G., Pantoja, S.C.d.S., 2013. Levantamento das espécies de plantas medicinais utilizadas pela população de Santa Cruz–Rio de Janeiro–RJ. Revista Eletrônica Novo Enfoque 16, 62-80.

Lopes, L.C., de Carvalho, J.E., Kakimore, M., Vendramini-Costa, D.B., Medeiros, M.A., Spindola, H.M., Avila-Roman, J., Lourenco, A.M., Motilva, V., 2014. Pharmacological characterization of Solanum cernuum Vell.: 31-norcycloartanones with analgesic and anti-inflammatory properties. Inflammopharmacology 22, 179-185.

Lopez-Molina, D., Navarro-Martinez, M.D., Rojas Melgarejo, F., Hiner, A.N., Chazarra, S., Rodriguez-Lopez, J.N., 2005. Molecular properties and prebiotic effect of inulin obtained from artichoke (Cynara scolymus L.). Phytochemistry 66, 1476-1484.

Luna Jde, S., De Carvalho, J.M., De Lima, M.R., Bieber, L.W., Bento Ede, S., Franck, X., Sant'ana, A.E., 2006. Acetogenins in Annona muricata L. (annonaceae) leaves are potent molluscicides. Nat Prod Res 20, 253-257.

Macêdo, M.S., Ribeiro, D.A., de Almeida Souza, M.M., 2013. Uso de plantas medicinais cultivadas em uma área de caatinga em Assaré – Ceará. Cadernos de Cultura e Ciência 12, 36-45.

Mae, T., Kishida, H., Nishiyama, T., Tsukagawa, M., Konishi, E., Kuroda, M., Mimaki, Y., Sashida, Y., Takahashi, K., Kawada, T., Nakagawa, K., Kitahara, M., 2003. A licorice ethanolic extract with peroxisome proliferator-activated receptor-gamma ligand-binding activity affects diabetes in KK-Ay mice, abdominal obesity in diet-induced obese C57BL mice and hypertension in spontaneously hypertensive rats. J Nutr 133, 3369-3377.

Manenti, A.V., 2010. Plantas medicinais utilizadas no tratamento da obesidade: uma revisão. Universidade do Extremos Sul Catarinense (UNESC).

Marinho, D.G., Alviano, D.S., Matheus, M.E., Alviano, C.S., Fernandes, P.D., 2011. The latex obtained from Hancornia speciosa Gomes possesses anti-inflammatory activity. J Ethnopharmacol 135, 530-537.

Martins, F., Noso, T.M., Porto, V.B., Curiel, A., Gambero, A., Bastos, D.H., Ribeiro, M.L., Carvalho Pde, O., 2010. Mate tea inhibits in vitro pancreatic lipase activity and has hypolipidemic effect on high-fat diet-induced obese mice. Obesity (Silver Spring) 18, 42-47.

Masjedi, F., Gol, A., Dabiri, S., 2013. Preventive Effect of Garlic (Allium sativum L.) on Serum Biochemical Factors and Histopathology of Pancreas and Liver in Streptozotocin- Induced Diabetic Rats. Iran J Pharm Res 12, 325-338.

McTigue, K.M., Harris, R., Hemphill, B., Lux, L., Sutton, S., Bunton, A.J., Lohr, K.N., 2003. Screening and interventions for obesity in adults: summary of the evidence for the U.S. Preventive Services Task Force. Annals of internal medicine 139, 933-949.

Meyer, L., Quadros, K.E., Zeni, A.L.B., 2012. Etnobotânica na comunidade de Santa Bárbara, Ascurra, Santa Catarina, Brasil. Revista Brasileira de Biociências 10, 258.

Monteiro, J.C., Matta, S.L.P.d., Predes, F.d.S., Oliveira, T.T.d., 2009. Liver morphology and morphometry and plasma biochemical parameters of Wistar rats that received leaf infusion of Rudgea viburnoides Benth. (Rubiaceae). Brazilian Archives of Biology and Technology 52, 407-412.

Mootoo, B.S., Ali, A., Khan, A., Reynolds, W.F., McLean, S., 2000. Three novel monotetrahydrofuran annonaceous acetogenins from Annona montana. J Nat Prod 63, 807-811.

Moraes Tde, M., Rodrigues, C.M., Kushima, H., Bauab, T.M., Villegas, W., Pellizzon, C.H., Brito, A.R., Hiruma-Lima, C.A., 2008. Hancornia speciosa: indications of gastroprotective, healing and anti-Helicobacter pylori actions. J Ethnopharmacol 120, 161-168.

Moreira, R.d.C.T., Costa, L.d.B., Costa, R.C.S., Rocha, E.A., 2002. Abordagem etnobotânica acerca do uso de plantas medicinais na Vila Cachoeira, Ilhéus, Bahia, Brasil. Acta Farmacéutica Bonaerense 21, 205-211.

Nascimento, E.L.d., Watanabe, M., Fonseca, C.D.d., Schlottfeldt, F.d.S., Vattimo, M.d.F.F., 2014. Renoprotective effect of the Echinodorus macrophyllus in induced renal injury. Acta Paulista de Enfermagem 27, 12-17.

Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., Margono, C., Mullany, E.C., Biryukov, S., Abbafati, C., Abera, S.F., 2014. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the Global Burden of Disease Study 2013. The Lancet.

Nunes, G.P., Silva, M.F.d., Resende, U.M., Siqueira, J.M.d., 2003. Plantas medicinais comercializadas por raizeiros no Centro de Campo Grande, Mato Grosso do Sul. Revista Brasileira de Farmacognosia 13, 83-92.

Oliveira-Filho, R.M., Uehara, O.A., Minetti, C.A., Valle, L.B., 1989. Chronic administration of aqueous extract of Stevia rebaudiana (Bert.) Bertoni in rats: endocrine effects. Gen Pharmacol 20, 187-191.

Oliveira, A.C., Endringer, D.C., Amorim, L.A., das Gracas, L.B.M., Coelho, M.M., 2005. Effect of the extracts and fractions of Baccharis trimera and Syzygium cumini on glycaemia of diabetic and non-diabetic mice. J Ethnopharmacol 102, 465-469.

Park, J.E., Cha, Y.S., 2010. Stevia rebaudiana Bertoni extract supplementation improves lipid and carnitine profiles in C57BL/6J mice fed a high-fat diet. J Sci Food Agric 90, 1099-1105.

Pereira, L.L.S., Souza, S.P., Silva, M.C., Carvalho, G.A., Santos, C.D., Corrêa, A.D., Abreu, C.M.P., 2010. Activity of glycosidases in the presence of green tea and black tea. Revista Brasileira de Plantas Medicinais 12, 516-518.

Pinto, A.Z.d.L., de Assis, A.F.S., Pereira, A.G., Pasa, M.C., 2013. Levantamento etnobotânico de plantas medicinais comercializadas no mercado do porto em Cuiabá, Mato Grosso, Brasil. FLOVET-Boletim do Grupo de Pesquisa da Flora, Vegetação e Etnobotânica 1.

Prabha, S.P., Rajamohan, T., 1998. Effect of inclusion of cashew globulin (Anacardium occidentale) to a casein diet on lipid parameters in rats. Plant Foods Hum Nutr 53, 83-92.

Rajendran, R., Krishnakumar, E., 2010. Hypolipidemic Activity of Chloroform Extract of Mimosa pudica Leaves. Avicenna J Med Biotechnol 2, 215-221.

Ranasinghe, P., Jayawardana, R., Galappaththy, P., Constantine, G.R., de Vas Gunawardana, N., Katulanda, P., 2012. Efficacy and safety of 'true' cinnamon (Cinnamomum zeylanicum) as a pharmaceutical agent in diabetes: a systematic review and meta-analysis. Diabet Med 29, 1480-1492.

Ribeiro, A.O., Silva, A.F., Castro, A.H.F., 2010. Identificação de espécies da família Asteraceae, revisão sobre usos e triagem fitoquímica do gênero Eremanthus da Reserva Boqueirão, Ingaí-MG. Revista Brasileira de Plantas Medicinais 12, 456-465.

Rodrigues, V.E.G., Carvalho, D.d., 2001. Levantamento etnobotânico de plantas medicinais no domínio do cerrado na região do Alto Rio Grande-Minas Gerais. Ciência e Agrotecnologia 25, 102-123.

Rondanelli, M., Giacosa, A., Opizzi, A., Faliva, M.A., Sala, P., Perna, S., Riva, A., Morazzoni, P., Bombardelli, E., 2013. Beneficial effects of artichoke leaf extract supplementation on increasing HDL-cholesterol in subjects with primary mild hypercholesterolaemia: a double-blind, randomized, placebo-controlled trial. Int J Food Sci Nutr 64, 7-15.

Rupprecht, J.K., Hui, Y.H., McLaughlin, J.L., 1990. Annonaceous acetogenins: a review. J Nat Prod 53, 237-278.

Santos, A., Silva, M., Santos, M., Leite, T., 2013. Levantamento etnobotânico, químico e farmacológico de espécies de Apocynaceae Juss. ocorrentes no Brasil. Rev. Bras. Pl. Med 15, 442-458.

Santos, S.L.D.X., da Nóbrega Alves, R.R., Santos, S.L.D.X., Barbosa, J.A.A., Brasileiro, T.F., 2012. Plantas utilizadas como medicinais em uma comunidade rural do semi-árido da Paraíba, Nordeste do Brasil. Rev. Bras. Farm 93, 68-79.

Shatwan, I.A., Ahmed, L.A., Badkook, M.M., 2013. Effect of barley flour, crude cinnamon, and their combination on glycemia, dyslipidemia, and adipose tissue hormones in type 2 diabetic rats. J Med Food 16, 656-662.

Silva, G.C., Braga, F.C., Lima, M.P., Pesquero, J.L., Lemos, V.S., Cortes, S.F., 2011. Hancornia speciosa Gomes induces hypotensive effect through inhibition of ACE and increase on NO. J Ethnopharmacol 137, 709-713.

Silva, M.A.B.d., Melo, L.V.L., Ribeiro, R.V., de Souza, J.P.M., Lima, J.C.S., Martins, D., Silva, R.M.d., 2010. Levantamento etnobotânico de plantas utilizadas como anti-hiperlipidêmicas e anorexígenas pela população de Nova Xavantina-MT, Brasil. Rev Bras Farmacogn 20, 549-562.

Simoes, C.M., Schenkel, E.P., Bauer, L., Langeloh, A., 1988. Pharmacological investigations on Achyrocline satureioides (LAM.) DC., Compositae. J Ethnopharmacol 22, 281-293.

Soares, F.P., Paiva, R., Alvarenga, A.A.d., Nogueira, R.C., Emrich, E.B., Martinotto, C., 2007. Organogênese direta em explantes caulinares de mangabeira (Hancornia speciosa Gomes). Ciência e Agrotecnologia 31, 1048-1053.

Soicke, H., Leng-Peschlow, E., 1987. Characterisation of flavonoids from Baccharis trimera and their antihepatotoxic properties. Planta Med 53, 37-39.

Souza, S.P.d., Pereira, L.L.S., Souza, A.A., Santos, C.D.d., 2011. Inhibition of pancreatic lipase by extracts of Baccharis trimera (Less.) DC., Asteraceae: evaluation of antinutrients and effect on glycosidases. Revista Brasileira de Farmacognosia 21, 450-455.

Tanus-Rangel, E., Santos, S.R., Lima, J.C., Lopes, L., Noldin, V., Monache, F.D., Cechinel-Filho, V., Martins, D.T., 2010. Topical and systemic anti-inflammatory effects of Echinodorus macrophyllus (Kunth) Micheli (Alismataceae). J Med Food 13, 1161-1166.

Teixeira, S.A., Melo, J., 2006. Plantas medicinais utilizadas no município de Jupi, Pernambuco, Brasil. Iheringia, Série Botânica 61, 5-11.

Tomazzoni, M.I., Negrelle, R.R.B., Centa, M.d.L., 2006. Fitoterapia popular: a busca instrumental enquanto prática terapêuta. Texto & Contexto - Enfermagem 15, 115-121.

Trovato, A., Monforte, M.T., Barbera, R., Rossitto, A., Galati, E.M., Forestieri, A.M., 1996. Effects of fruit juices of Citrus sinensis L. and Citrus limon L. on experimental hypercholesterolemia in the rat. Phytomedicine 2, 221-227.

Vasudeva, N., Yadav, N., Sharma, S.K., 2012. Natural products: a safest approach for obesity. Chinese journal of integrative medicine 18, 473-480.

Vendruscolo, G.S., Rates, S.M.K., Mentz, L.A., 2005. Dados químicos e farmacológicos sobre as plantas utilizadas como medicinais pela comunidade do bairro Ponta Grossa, Porto Alegre, Rio Grande do Sul. Revista Brasileira de Farmacognosia 15, 361-372.

Wu, F.E., Zeng, L., Gu, Z.M., Zhao, G.X., Zhang, Y., Schwedler, J.T., McLaughlin, J.L., Sastrodihardjo, S., 1995. Muricatocins A and B, two new bioactive monotetrahydrofuran Annonaceous acetogenins from the leaves of Annona muricata. J Nat Prod 58, 902-908.

Yun, S.N., Moon, S.J., Ko, S.K., Im, B.O., Chung, S.H., 2004. Wild ginseng prevents the onset of high-fat diet induced hyperglycemia and obesity in ICR mice. Arch Pharm Res 27, 790-796.

Zeni, A.L.B., Bosio, F., 2011. Use of medicinal plants in a rural community of the Atlantic Forest–Nova Rússia, SC. Neotropical Biology and Conservation 6, 55-63.

Zhao, J., Zhang, W., Zhu, X., Zhao, D., Wang, K., Wang, R., Qu, W., 2011. The aqueous extract of Asparagus officinalis L. by-product exerts hypoglycaemic activity in streptozotocin-induced diabetic rats. J Sci Food Agric 91, 2095-2099.

TABLES AND FIGURES

Table 1: Species with anti-obesity and body weight loss properties cited by ethnobotanical studies in Brazilian regions.

Specie	**Family**	**Popular name**	**Part of the plant**	**Way of preparation**	**Region of Brazil**	**Number of citations**	**Reference**
Abarema cochliocorpos (Gomez)	Fabaceae	Barbatimão	Whole plant	Decoction	Salvador - BA	1	Cunha Lima et al. (2008)
Achyrocline satureioides	Asteraceae	Macela	Whole plant	Infusion	Porto Alegre - RS	1	Vendruscolo et al. (2005)
Allium sativum L.	Liliaceae	Alho	Fruit	Decoction, infusion or licking	Assaré - CE	1	Macêdo et al. (2013)
Anacardium occidentale L.	Anacardiaceae	Cajueiro	Leaves	Decocto	*MG	1	Grandi et al. (1989)
Annona montana Macfad	Annonaceae	Jaca-de-pobre	Leaves	Decocto	Salvador - BA	1	Cunha Lima et al. (2008)
Annona muricata L.	Annonaceae	Graviola	Leaves	Decoction or infusion	*MG; Vila Cachoeira – BA; Cujubim – RO; Queimadas - PB; Ituiutaba - MG; Assaré – CE	6	Grandi et al. (1989); Moreira et al. (2002); Santos & Lima (2008); Santos et al. (2012); Liporacci & Simão (2013); Macêdo et al. (2013)
Asparagus officinalis L.	Lilliaceae	Aspargo, milindre	Whole plant	Decoction, infusion or dyeing or tincture	*MG	1	Grandi et al. (1989)

Baccharis trimera (Less.) DC.	Asteraceae	Carqueja, carqueija amarga	Whole plant	Infusion	*MG; Alto Rio Grande - MG; Vila Cachoeira – BA; Campo Grande - MS; Recife – PE; Cujubim – RO; Ingaí-MG; Vila Velha - ES; Nova Rússia - SC; Extrema - MG; Poconé - MT; Ascurra –SC; Santa Cruz – RJ; São Gabriel - RS	14	Grandi et al. (1989); Rodrigues & Carvalho (2001); Moreira et al. (2002); Nunes et al. (2003); Albuquerque et al. (2007); Santos & Lima (2008); Ribeiro et al. (2010); Albertasse et al. (2010); Zeni & Bosio (2011); Costa & Mayworm (2011); Bieski et al. (2012); Meyer et al. (2012); Lopes & Pantoja (2013); Lobler et al. (2014)
Bauhinia rufa Steud.	Caesalpiniaceae	Unha-de-vaca, pata-de-vaca	Whole plant or leaves	Decoction or infusion	*MG; Alto Rio Grande - MG; Nova Xavantina – MT	3	Grandi et al. (1989); Rodrigues & Carvalho (2001); Silva et al. (2010)
Bidens bipinnata L.	Asteraceae	Carrapixo-de-agulha	Leaves	Decoction	Salvador - BA	1	Cunha Lima et al. (2008)
Byrsonima sericea DC.	Malpighiaceae	Murici	Leaves	Decoction	Salvador - BA	1	Cunha Lima et al. (2008)
Camellia sinensis (L.) Kuntze	Theaceae	Chá-verde	Leaves	Infusion	Cuiabá- MT; São José dos Cordeiros – PB; São Gabriel - RS	3	Pinto et al. (2013); Leite et al. (2013); Lobler et al. (2014)
Caryocar brasiliense A. St.-Hil.	Caryocaraceae	Pequizeiro	-	-	Poconé - MT	1	Bieski et al. (2012)
Cinnamomum zeylanicum Breyne	Lauraceae	Canela-da-india	-	Infusion	Poconé - MT	1	Bieski et al. (2012)
Citrus limon	Rutaceae	Limão, limão-bergamota	Fruit	Infusion	Porto Alegre - RS	1	Vendruscolo et al. (2005)
Cordia salicifolia / Cordia ecalyculate (Vell.)	Theophrastacea and / Boraginaceae	Porangaba	Leaves	-	Campo Grande - MS; Recife – PE; Santa Cruz - RJ	3	Nunes et al. (2003); Albuquerque et al. (2007); Lopes & Pantoja (2013)
Cleome aculeata L.	Capparaceae	Xinxim-de-galinha	Whole plant	Infusion	Vila Cachoeira – BA; Ilhéus - BA	2	Moreira et al. (2002); Feijó et al. (2013)

Coffea arabica L.	Rubiaceae	Café, cafeeiro	Leaves	Infusion	*MG	1	Grandi et al. (1989)
Cymbopogon citratus	Poaceae	Cana-cidreira, capim-cidreira	Leaves	Infusion	Porto Alegre - RS	1	Vendruscolo et al. (2005)
Cynara scolymus	Asteraceae	Alcachofra	Flowers or leaves	-	Videira – SC; Ascurra - SC; Santa Cruz - RJ	3	Silva & Bündchen (2011); Meyer et al. (2012); Lopes & Pantoja (2013)
Echinodorus macrophyllus (Kunth) Micheli	Alismataceae	Chapéu-de-couro	Leaves	Infusion	Campo Grande - MS; Nova Xavantina - MT	2	Nunes et al. (2003); Silva et al. (2010)
Emilia sonchifolia (L.) DC.	Asteraceae	Vassourinha	Leaves	Infusion	Jupi- PE	1	Teixeira & Melo (2006)
Erythrina dominguezii Hassl.	Leguminosae Faboideae	Maleitoso	-	-	Campo Grande - MS	1	Nunes et al. (2003)
Guazuma ulmifolia Lam.	Sterculiaceae	chico-magro	Bark	Infusion	Dourados - MS	1	Alves et al. (2008)
Hancornia speciosa Gomes	Apocynaceae	Mangaba	Bark	Decoction, infusion or ointment	*MG; Nova Xavantina - MT Caxias - MA	4	Grandi et al. (1989); Silva et al. (2010); Silva et al. (2010) a; Santos et al. (2013)
Mimosa pudica L.	Fabaceae	Dorme-Dorme	Leaves	Decoction or infusion	Ascurra- SC	1	Meyer et al. (2012)
Oxalis aff. hirsutissima Mart. ex Zucc.	Oxalidaceae	Azedinha	-	Infusion	Poconé – MT	1	Bieski et al. (2012)
Palicourea coriacea (Cham.) K. Schum	Rubiaceae	Douradinha	-	-	Alto Paraíso de Goiás - GO; Nova Xavantina – MT	3	Souza & Felfili (2006); Silva et al. (2010); Souza et al. (2013)
Pfaffia glomerata (Spreng.) Pedersen	Amaranthaceae	Ginseng-brasileiro	-	Infusion	Poconé – MT	1	Bieski et al. (2012)
Rubus brasiliensis Mart.	Rosaceae	Amoreira	-	Infusion or dyeing or tincture	Poconé – MT	1	Bieski et al. (2012)

Rudgea viburnoides (Cham.) Benth.	Rubiaceae	Congonha-de-bugre	Leaves or root	-	Campo Grande - MS	2	Nunes et al. (2003); Souza et al. (2013)
Senna occidentalis (L.) Link	Caesalpiniaceae	Manjerioba	Leaves	Infusion	Bandeirantes – PR; Recife - PE	2	Fuck et al. (2005); Albuquerque et al. (2007)
Sida rhombifolia L.	Malvaceae	Guaxuma	-	Infusion	Poconé – MT	1	Bieski et al. (2012)
Simaba ferruginea A. St.-Hil.	Simaroubaceae	Calunga	-	Maceration	Poconé – MT	1	Bieski et al. (2012)
Solanum cernuum Vell	Solanaceae	Panaceia, pata de mono	Leaves or root	-	Santa Teresa – ES; Santa Cruz - RJ	2	Gallotte & Ribeiro (2005); Lopes & Pantoja (2013)
Spondias mombim L.	Anacardiaceae	Cajá	Leaves	Juice	Vila Velha - ES	1	Albertasse et al. (2010)
Stevia rebaudiana Bertoni	Asteraceae	Estévia	-	-	Santa Teresa - ES	1	Gallotte & Ribeiro (2005)
Syagrus romanzoffiana (Cham.) Glassm.	Arecaceae	Coqueiro	Leaves	-	Nova Rússia - SC	1	Zeni & Bosio (2011)
Symphytum officinale L.	Boraginaceae	Confrei	Leaves	-	Nova Rússia - SC; Poconé – MT	2	Zeni & Bosio (2011); Bieski et al. (2012)
Syzygium cumini (L.) Skeels	Myrtaceae	Jamelão	Leaves	Decoction	Salvador – BA	1	Cunha Lima et al. (2008)
Terminalia catappa L.	Combretaceae	Castanhola	Leaves	Infusion	Queimadas - PB	1	Santos et al. (2012)
Vernonia condensata Backer.	Asteraceae	Boldo	Leaves	Infusion	Recife - PE; Queimadas - PB; Ituiutaba – MG	3	Albuquerque et al. (2007); Santos et al. (2012); Liporacci & Simão (2013)
Vochysia rufa Mart.	Vochysiaceae	Pau-doce	-	Decoction or Infusion	Poconé – MT	1	Bieski et al. (2012)

The sinal - indicates the lack of the specific information in the refererence. * City not specified, the whole state of MG was considered.

Table 2: Ethnobotanical species with higher number of citations related to the treatment of obesity and body weight loss.

Ethnobotanical specie	**Number of citation**	**Percentage of species found**
Baccharis trimera (Less.) DC.	14	25%
Annona muricata L.	6	11%
Hancornia speciosa Gomes	4	7%
Bauhinia rufa Steud.	3	5%
Clavija nutans (Vell.) B. Stahl	3	5%
Cynara scolymus	3	5%
Palicourea coriacea (Cham.) K. Schum	3	5%
Vernonia condensata Backer.	3	5%
Camellia sinensis (L.) Kuntze	3	5%
Cleome aculeata L.	2	3%
Echinodorus macrophyllus (Kunth) Micheli	2	3%
Rudgea viburnoides (Cham.) Benth.	2	3%
Senna occidentalis (L.) Link	2	3%
Solanum cernuum Vell	2	3%
Symphytum officinale L.	2	3%

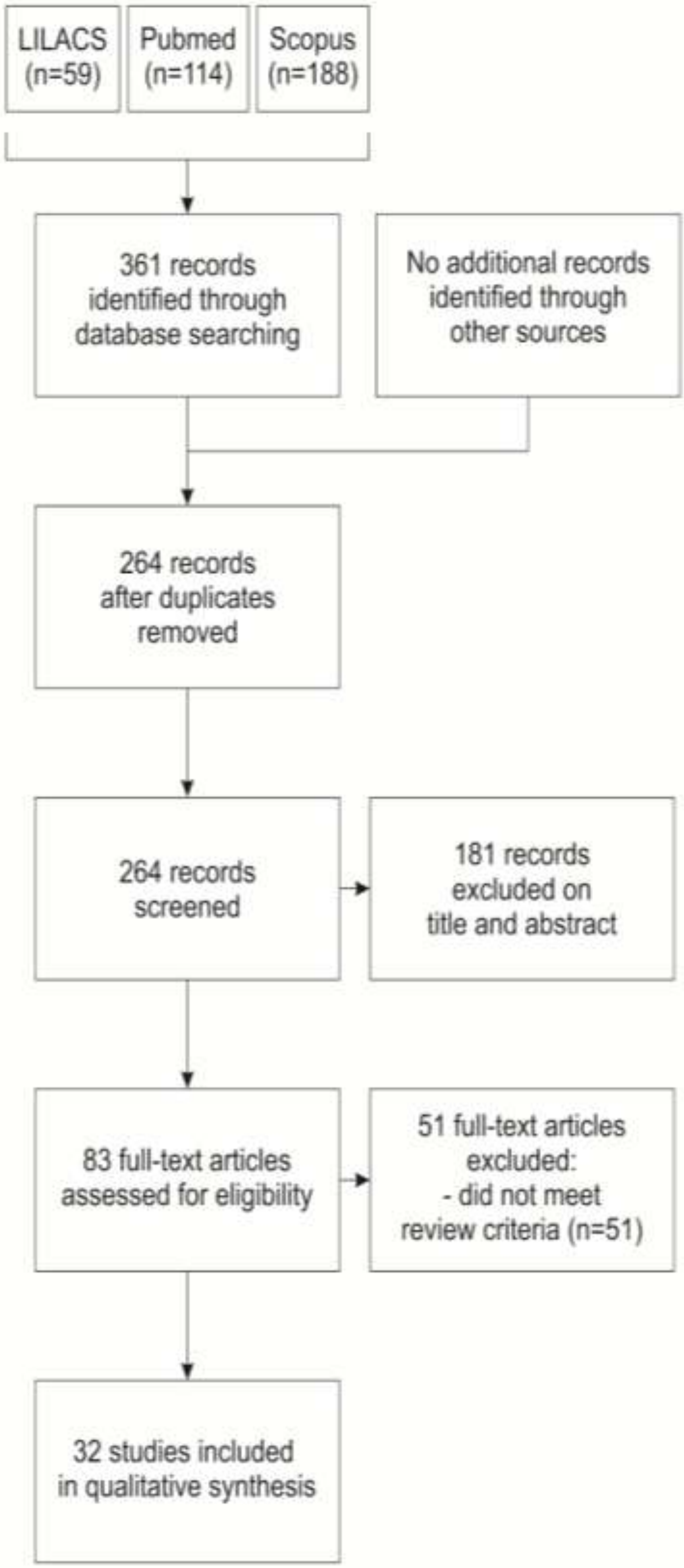

Figure 1: Study flow diagram.

4 ARTIGO 2

TREATMENT WITH THE AQUEOUS EXTRACT OF BARK OF *Hancornia speciosa* GOMES DOES NOT INFLUENCE OBESITY INDUCED BY HIGH-FAT DIET IN MICE

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Treatment with the aqueous extract of bark of *Hancornia speciosa* Gomes does not influence obesity induced by high-fat diet in mice

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Abstract

Background: Etnhopharmacological surveys have shown tnat the inner bark of *Hancornia speciosa* Gomes (mangabeira) is popularly used to treat obesity and diabetes. However, there is no experimental evidence that supports this use. **Objective:** This study investigated the therapeutic potential of aqueous extract of the stem bark of *H. speciosa* (AEHS) on the glycemic and adipogenic profiles of obese mice. **Methods:** Mice were divided into four groups that received standard diet (SD), standard diet plus AEHS (SDE), high-fat diet (HD) and high-fat diet plus AEHS (HDE). The administration of AEHS (estimated dose of 200 $mg.kg^{-1}.day^{-1}$) was performed in the drinking water for the last 8 weeks of a total period of 18 weeks that animals received the diets. Whole body weight, liquid intake and food consumption were measured during the whole experiment. Blood glucose levels, insulin sensitivity, glucose tolerance and adipose pads weight were evaluated. **Results:** Animals from HD group presented higher body weight in comparison to animals from SD group. This was associated with insulin resistance and glucose intolerance, as well as the increase in blood glucose level ($p<0.05$) and weight of adipose tissue pads ($p<0.05$), when compared to SD group. Treatment with AEHS did not high fat diet-induced obesity, since no significative difference between HD and HDE groups was observed for virtually all of the parameters evaluated. **Conclusions:** In this way, these data permitted to conclude that AEHS did not reverse the alterations observed by using high-fat diet in mice, in the conditions tested in the present study, which disagrees with the popular use of this plant.

Keywords: *Hancornia speciosa*; obesity; high-fat diet, insulin resistance; glucose intolerance; adipose pads.

INTRODUCTION

Obesity can be defined as a multifactorial syndrome consisting of biochemical, metabolic and anatomical alterations, such as an increase in adipose tissue and body weight (Wanderley and Ferreira, 2010). It is an important risk factor for several types of diseases that lead to poor quality of life, considerable morbidity and premature death (Flegal et al., 2012).

Obesity is increasing at an alarming rate and is considered a worldwide epidemic condition that affects all age groups. It is a chronic and multifactorial disease and may be a result of endogenous and / or exogenous factors. It is important to mention that the exogenous ones hold the majority of cases related to environmental factors, especially the lack of physical activity and negligible eating habits (Araújo et al., 2009).

Disappointing results after attempts to lifestyle modification or pharmacotherapy have indicated the need of other treatment modalities to produce better results in terms of weight loss (Abdollahi and Afshar-Imani, 2003). Nevertheless, herbal supplements and diet-based therapies for weight loss are among the most common treatments in complementary and alternative medicine (Barnes et al., 2007). Equally, a wide variety of these natural and herbal products, including crude extracts and compounds isolated from plants can be used to induce weight loss and preventing diet-induced obesity. Furthermore, in recent decades, medicinal plants have been widely used in the treatment of obesity (Han et al., 2005; Barnes et al., 2007). These plants contain a variety of components that may interfere in the metabolism and oxidation of fat acids, thus presenting anti-obesity and antioxidant properties. Some herbs have been investigated and disclosed as being useful in the treatment of obesity, diabetes and other chronic diseases (Hasani-Ranjbar et al., 2009; 2010), but various plants have not been considered for the scientific evaluation.

Hancornia speciosa Gomes (*Apocynaceae*) is a tree naturally found in Brazil, where it is distributed throughout the Midwest, Southeast, North and Northeast region, with higher abundance in the areas of coastal plains and plateaus of the Northeast. In popular medicine, *H. speciosa* or “mangabeira” is used in various ways; the bark is used to treat dermatoses, diseases affecting the liver and diabetes, also used as anti-inflammatory and for weight loss; the roots are utilized in the treatment of dislocations, rheumatism, as stomatic and antihypertensive; the latex and leaves are used as astringent, in the treatment of menstrual cramps, dermatitis, tuberculosis, ulcers, herpes and warts, and in the treatment of diseases affecting the liver; the fruits are used as a food source (Grandi et al., 1989; Rodrigues and Carvalho, 2001; Macedo and Ferreira, 2005; Souza and Felfili, 2006; Conceição et al., 2011; Pasa, 2011; Ribeiro et al., 2012).

It is important to highlight that scientific information related to the popular uses of this plant for the treatment of metabolic syndromes, as obesity and hyperlipidaemia, would be of great clinical importance. These popular uses have been extensively cited in ethnobotanical surveys in different regions from Brazil; however, few biological activities have been evaluated (Grandi et al., 1989; Rodrigues and Carvalho, 2001; Macedo and Ferreira, 2005; Silva et al., 2010a; 2010b).

Therefore, an intense popular use of *H. speciosa* for several conditions, including for body weight loss, is observed, but there is a lack of research analysing its potential to the treatment of important conditions, like obesity. In this way, this study aimed to verify the likely therapeutic action of the aqueous extract of the stem bark of *H. speciosa* on glycemic and adipogenic profile of obese mice in the high-fat diet model.

MATERIAL AND METHODS

Plant material and preparation of the stem bark aqueous extract

For this study, the stem bark of *H. speciosa* was collected in the municipality of Pirambu-SE, Brazil, in March 2012. The identification of the plant was confirmed by Dra. Ana Paula Prata, Federal University of Sergipe and an exsiccate was deposited in the Herbarium of Federal University of Sergipe (ASE30170). The samples were grinded and subjected to extraction by infusion in distilled water at 100°C. The obtained solution was kept and cooled to room temperature (25°C) for 30 minutes. It was then filtered through filter paper, lyophilized and stored at -20°C for later use. The yield of this extraction was 10.5%.

Animals for experimentation and experimental conditions

Male Swiss mice (21-23 days) were obtained from the Central Animal Facility of the Federal University of Sergipe. After one week of adaptation in the laboratoy, animals were randomly divided in 4 groups of animals that received: (i) standard diet for 18 weeks (SD), (ii) standard diet for 18 weeks and aqueous extract of bark *H. speciosa* (AEHS) in the last 8 weeks, (iii) high-fat diet for 18 weeks (HD) and (iv) high-fat diet for 18 weeks and AEHS in the last 8 weeks (HDE). These animals were maintained on identified polypropylene boxes with 4 animals each, with diet and water *ad libitum*. In the groups supplemented with AEHS, the administration was carried *ad libitum* in the drinking water. The temperature remained at 22 ± 2°C range, with light / dark cycle of 12 hours.

The Ethics Committee on Animal Research of the Federal University of Sergipe approved the experimental protocol of this study, under the reference number 81/12. During all experimental procedures, the ethical principles for animal testing were adopted, following the National Council for Animal Experiments Control (CONCEA).

Induction of obesity

For the induction of obesity in mice, a high-fat diet was offered *ad libitum* to animals during 18 weeks (HD and HDE groups), according to White et al. (2013). Control groups received a standard diet (normal lipid content) for the same period (SD and SDE groups). The diets were commercially obtained from PragSoluções (São Paulo, Brazil) and their compositions are specified in Table 1.

Table 1 (insert here)

Supplementation with aqueous extract

The aqueous extract of bark of *H. speciosa* was offered *ad libitum* to mice of groups HDE and SDE, at room temperature, during the 8 weeks of the experiment at a concentration of 0.3 $mg.mL^{-1}$, which resulted in an estimated dose of 200 $mg.kg^{-1}$ based on the daily water consumption of the animals.

Evaluation of water intake, food intake and weight gain of animals

The evaluation of both water intake and food consumption was performed daily for each box of animals during the entire period of the experiment. Body weight, in turn, was measured once a week.

Evaluation of glycemic profile

Insulin tolerance test (ITT)

The blood glucose was measured after 5 h of fasting animals at the end of the 18 weeks, 3 days before euthanasia. It was used the blood supply obtained from animal's tail vein using Accu-check® (Roche) glucometer, according to the manufacturer's specifications. The insulin was intraperitoneally injected in the proportion of 0.7 $U.kg^{-1}$ and blood glucose levels were measured after 20, 40 and 60 min post-injection (Ali et al., 2011). The total area under the curve was calculated from 0 to 60 min.

Glucose tolerance test (GTT)

At the end of 18 weeks, with 2 days before ITT, D-glucose (1 $g.kg^{-1}$, prepared in saline solution) was administered intraperitoneally to animals submitted to 12 h of fasting and blood glucose levels were measured before and after 5, 15, 30, 45, 60 and 120 min post-injection (Faulhaber-Walter et al., 2011). The total area under the curve was calculated from 0 to 120 min. The blood supply was obtained from the tail vein of the animals and glucose levels were measured using the blood Accu-check® glucometer, according to the manufacturer's specifications.

Blood glucose

Blood glucose was measured with the animals fasted for 5 hours. For this determination, the blood of the animal's tail vein was collected and glucose levels were measured by using the Accu-check® glucosemeter, according to the manufacturer's specifications.

Removal of adipose tissue and determination of adiposity index

After anaesthesia and euthanasia of animals and blood collection, a longitudinal incision in the abdomen was performed to remove the periepididymal, perirenal and retroperitoneal adipose pads. Then, adipose tissues were immersed in saline solution, the excess solution was taken up with gauze and tissues were immediately weighted. The adiposity index was obtained by dividing the sum of the animal's pads by the total animal body mass (White et al., 2013).

Statistical Analysis

The results were presented as mean ± SEM and the comparison between them performed by one or two-way analysis of variance (ANOVA) followed by Bonferroni's post-test. Values of $p < 0.05$ were considered significant.

RESULTS

Figure 1 shows that at the beginning of the experiment there was no significant difference in body weight between the groups (10.7 ± 1.2, 11.5 ± 0.5, 11.6 ± 0.2 and 11.5 ± 0.4 g respectively for SD, SDE, HD and HDE group). In the 10^{th} week of the experiment, the body weight of animals did not differed statistically, but there was a clear tendency for higher values for animals of group HD and HDE (41.4 ± 0.9 and 39.4 ± 0.6 g, respectively) in comparison with animals of SD and

SDE groups (36.3 ± 1.0 and 37.8 ± 0.7 g, respectively). After 14 weeks of treatment with high-fat diet, a significant difference between HD and SD groups was found ($p < 0.05$, Fig. 1), but no difference was observed for groups treated with AEHS (SDE or HDE) when compared with their respective control for diets.

The diet consumption and liquid intake were measured during the 18 weeks of the experiment. These parameters were not altered in the groups evaluated (data not shown), both before and after animals receiving standard or high-fat diet were exposed to AEHS (in the last 8 weeks).

Insert Figure 1 here

Figure 2 shows the weight of adipose pads and adiposity index. The animals of group HD had significantly higher adipose retroperitoneal ($p < 0.05$; Fig. 2A), perirenal ($p < 0.001$; Fig. 2B) and periepididymal ($p < 0.05$; Fig. 2C) pads weight when compared to SD group, which resulted in higher adiposity index in HD group ($p > 0.05$; Fig. 2D), when compared to SD group. Treatment with AEHS lessened the weight pad of the perirenal pad ($p < 0.05$; Fig. 2B), without affecting epididymal or retroperitoneal pads (Fig. 2A and C). However, this difference did not reflect on alteration in the adiposity index (Fig. 2D), thus indicating no influence of AEHS on total fat mass.

Insert Figure 2 here.

At the end of the 18 weeks of the experiment, ITT and GTT were also carried out. Figure 3A shows that glucose levels of mice from HD group were significantly increased when compared to animals of SD group, at 0, 20 or 60 min post-injection of insulin, which was also confirmed by higher values of AUC in HD group than in SD group ($p < 0.01$, Fig. 3B). Treatment with AEHS, in the last 8 weeks, did not modify the glucose levels or AUC after intraperitoneal injection of insulin, when compared to the respective control for diet.

Insert Figure 3 here.

After a challenge with intraperitoneal injection of glucose, animals from HD group showed significantly increased levels of blood glucose from 15 to 60 min post-injection, in comparison to SD group (Fig. 4A). This resulted in augmented AUC

($p < 0.001$) in HD group, when compared to SD group (Fig. 4B), indicating a glucose tolerance in mice treat with high-fat diet for 18 weeks. However, the treatment with AEHS in the last 8 weeks did not significantly altered the effect of high-fat diet on the glucose intolerance.

Insert Figure 4 here.

Basal glucose levels were increased in mice from HD group after a 5 h-period of fasting ($p < 0.05$), when compared to SD group (Fig. 5). However, the treatment with AEHS caused no change in basal blood glucose levels both in animals submitted to standard or high-fat diet.

Insert Figure 5 here.

DISCUSSION

Data presented here showed that AEHS did not alter the body weight gain, the adiposity index, the blood glucose levels, the sensitivity to insulin and the tolerance to glucose in mice fed with high-fat diet, which is consistent with the lack of anti-obesity effect of AEHS in the conditions applied in the present study. In addition, animals fed with standard diet did not present any change on these parameters.

The hypothesis that the aqueous extract from the bark of *H. speciosa* could present such activity was based on the ethnobotanical surveys describing that population in Brazil use this typical plant to treat obesity or to promote body weight loss. This is the case of the study published by Conceição et al. (2011), which described that people from Nova Xantina (MT), Brazil, indicated the use of infusion or decoction of the bark of *H. speciosa* as anorectic, representing an alternative to appetite control and thus reducing food consumption. Other ethnobotanical studies have also demonstrated similar popular uses for the bark of *H. speciosa*, such as for weight loss and/or obesity, in different regions of Brazil (Grandi et al., 1989; Da Silva et al., 2010a; Silva et al., 2010b; Santos et al., 2013).

In spite of these descriptions, data from the present study failed to show any effect that could corroborate the ethnobotanical description that the bark of *H. speciosa* can be useful both to treat obesity and to produce weight loss. Thus, mice treated with high-fat diet plus AEHS did not show important alteration of the parameters evaluated, as well as any change was observed in mice treated with standard diet plus AEHS.

The model of high-fat diet used in this study was previously standardized in our conditions (White et al., 2013). This previous study had demonstrated a difference in body weight of Swiss mice after ten weeks of exposition to the same high-fat diet utilized in the present study. In fact, a clear tendency for higher values of body weight was found in animals from HD group in the 10^{th} week, but even eight weeks of treatment with AEHS (~ 200 $mg.kg^{-1}.day^{-1}$) in the drinking water did not modify the body weight and other parameters of mice.

The amount of adipose tissue, measured as the mass of periepididymal, retroperitoneal and perirenal adipose pads, was increased in animals treated with high-fat diet, along with the augmented whole body mass. These results are consistent with the previous study from our group (White et al., 2013). Treatment with AEHS did not affect the mass of periepididymal or retroperitoneal pads, but interestingly, it reduced the weight of perirenal adipose pad. Unfortunately, this was the lower adipose pad and it did not cause a significative effect of AEHS on the adiposity index, which permitted us to conclude that AEHS, in the conditions used in this study, was not effective to promote body weight loss in mice.

It is worthwhile noting that the via of administration chosen in the present study was the drinking water, in order to avoid gavage for eight weeks, which could cause any damage related to the administration that could interfere in the swallowing of mice. One could suggest that the treatment with AEHS in the drinking water could change the liquid intake or the consumption of food, but AEHS did not promote alteration of neither liquid intake, which demonstrates that it was well tolerated by the animals, nor food intake. Animals continued to consume the same amount of liquid and food that they used to before the AEHS had been introduced. Therefore, there was no significant difference in consumption in grams and absolute consumption in kcal between the treated groups and their respective controls.

Another possibility of bias of the present study could be the dose of AEHS used. The estimated dose was 200 $mg.kg^{-1}.day^{-1}$, which was considered a dose high enough to cause any possible effect that AEHS could induce and could be of biological relevance to the treatment of obesity. Unfortunately, there is no description of how much bark of *H. speciosa* is used by the population in the preparation of decoction or infusion. Besides, other studies have shown that treatment with similar doses of extracts of plants can alter the induction of obesity or other associated conditions. For example, the study from Song et al. (2014) demonstrated that the methanol extract from the stem of *Sasa borealis* (150 mg/kg) reduced the body weight and hepatic steatosis in rats made obese by a high-fat diet consumption. Kim et al. (2014) showed that treatment with the ethanol extract from the rhizomes of *Boesenbergia pandurata* (200 mg/kg) decreased the whole body and adipose pads weight of C57BL/6J mice submitted to a high-fat diet through activation of AMP-activated protein kinase and regulation of lipid metabolism. However, differences in species of animals, composition of extracts or via of administration do not permit a direct comparison between the studies.

Concerning to the effects of AEHS on the glycemic profile, it was observed that AEHS did not reverse glucose intolerance and insulin resistance, and did not normalize the basal blood glucose levels in HDE group. A study carried out in fifteen traditional communities (non-indigenous) in the Upper Paraguay River Basin and two in the Guaporé Valley collected data about hypoglycemic plants through qualitative approach and with the aid of semi-structured and opened interviews. Among the seventeen identified species, the bark of *H. speciosa* was cited as medicinal and used by community leaders, traditional healers, midwives and other plant users for the treatment of diabetes (Macedo and Ferreira, 2004). Many plants that have been used to reduce blood glucose, and were pharmacologically evaluated, have their hypoglycemiant activity confirmed. Among their constituents, the steroid and triterpenoid glycosides are bioactive substances present in many of them (Rao and Gurfinkel, 2000). Some saponins derived from triterpenoid have hypoglycemic action and their possible effect involve the stimulation of pancreatic β-cells with subsequent secretion of insulin (Ojewole, 2002; Connolly and Hill, 2001). The studies by Rodrigues et al. (2007), Costa et al. (2008) and Santos et al. (2013) have indicated the presence of organic acids and derivatives, xanthones, proanthocyanidins, volatile compounds, flavonoids, triterpenes and cyclitols in parts of *H. speciosa*, as well as rutin and cyclitol L-(+)-bornesitol were identified in the bark of this plant (Pereira et al., 2012), which are considered primary bioactive compounds. In spite of the presence of triterpenes and other components that could possess a hypoglicemiant activity, this effect was not observed in animals receiving AEHS from groups treated with both standard and high-fat diets, probably due to the difference in the solvents used to extract (ethanol *vs.* water).

Altogether, these results demonstrate that AEHS administered to obese mice did not cause reduction in weight gain, reversion of insulin resistance or glucose intolerance and inhibition of hyperglycemia. Data obtained in the present study does not exclude the possibility that other parts of *H. speciosa* could affect obesity, however, these results disagree with the popular uses demonstrated in the ethnobotanical surveys about the bark of this plant and claim for attention for this use.

REFERENCES

Abdollahi M, Afshar-Imani B (2003). A review on obesity and weight loss measures. Middle East Pharmacy 11:6–10.

Ali TK, Al-Gayyar MM, Matragoon S (2011). Diabetes-induced peroxynitrite impairs the balance of pro-nerve growth factor and nerve growth factor, and causes neurovascular injury. Diabetologia 54:657-668.

Araújo GG, Araújo MB, Dangelo RA, Manchado FB, Mota CSA, Ribeiro C, Mello, MAR (2009). Maximal lactate steady state in obese rats of both genders. Braz. J. Sports Med. 15(1):46-49.

Barnes PM, Powell-Griner E, Mcfann K, Nahin R (2004). Complementary and alternative medicine use among adults: United States. Adv. Data 343:1–19.

Conceição GM, Ruggieri AC, Araújo MFV, Conceição TTMM, Conceição MAM (2011). Plantas do cerrado: comercialização, uso e indicação terapêutica fornecida pelos raizeiros e vendedores. Scientia Plena 7(12).

Connolly JD, Hill RA (2001). Triterpenoids. Nat. Prod. Report. 18:560-578.

Costa ES, Hiruma-Lima CA, Lima EO, Sucupira GC, Bertolin AO, Lolis SF, Andrade FDP, Vilegas W, Souza-Brito ARS (2008). Antimicrobial Activity of Some Medicinal Plants of the Cerrado, Brazil. Phytother. Res. 22:705–707.

Faulhaber-Walter R, Jou W, Mizel D, Li L, Zhang J, Kim SM, Huang Y, Min Chen M, Briggs JP,2 Gavrilova O, Schnermann JB (2011). Impaired Glucose Tolerance in the Absence of Adenosine A1 Receptor Signaling. Diabetes 60:2578-2587.

Flegal KM, Carroll MD, Kit BK, Ogden CL (2010). Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999–2010. JAMA 307:491–497.

Grandi TSM, Trindade JA, Pinto MJF, Ferreira LL, Catella AC (1989). Plantas medicinais de Minas Gerais, Brasil. Acta Botanica Brasilica 3(2):185-224.
Han L, Kimura Y, Okuda H (2005). Anti-obesity effects of natural products. Studies in Natural Products Chemistry 30:79–110.

Hasani-Ranjbar S, Larijani B, Abdollahi M. (2009). A systematic review of the potential herbal sources of future drugs effective in oxidant-related diseases. Inflamm Allergy Drug Targets 8:2–10. doi: 10.2174/187152809787582561.

Hasani-Ranjbar S, Nayebi N, Moradi L, Mehri A, Larijani B, Abdollahi M (2010). The efficacy and safety of herbal medicines used in the treatment of hyperlipidemia; a systematic review. Curr. Pharm. Design. 16:2935–2947.

Kim DY, Kim MS, Sa BK, Kim MB, Hwang JK. Boesenbergia pandurata attenuates diet-induced obesity by activating AMP-activated protein kinase and regulating lipid metabolism (2012). Int. J. Mol. Sci. 13(1):994-1005. doi: 10.3390/ijms13010994.

Macedo M, Ferreira AR (2004). Plantas hipoglicemiantes utilizadas por comunidades tradicionais na Bacia do Alto Paraguai e Vale do Guaporé, Mato Grosso Brasil. Rev. Braz. J. Pharmacognozy 14(1):45-47.

Ojewole JAO (2002). Hypoglycaemic effect of Clausena anisata (willd) Hook methanolic root extract in rats. J. Ethnopharmacol. 81:231-237.

Pasa MC (2011). Saber local e medicina popular: a etnobotânica em Cuiabá, Mato Grosso, Brasil. Boletim do Museu Paraense Emílio Goeldi. Ciências Humanas 6(1):179-196.

Pereira ABD, Veríssimo TM, de Oliveira MA , de Araujo IA, Alves RJ, Braga FC Development and validation of an HPLC-DAD method for quantification of bornesitol in extracts from *Hancornia speciosa* leaves after derivatization with *p*-toluenesulfonyl chloride (2012). Journal of Chromatography B 888:133–137.

Rao AV, Gurfinkel DM (2000). The bioactivity of saponins: triterpenoid and steroidal glycosides. Drug Metabol. Drug Interact. 17:211-235.

Ribeiro SS, De Jesus AM, Dos Anjos CS, Da Silva TB, Santos ADC, De Jesus JR, Andrade MS, Sampaio TS, Gomes WF, Alves PB, Carvalho AA, Pessoa C, De Moraes MO, Pinheiro ML, Prata NPN, Blank AF, Silva-Mann R, Moraes VRS, Costa EV, Nogueira PCL, Bezerra DP (2012). Evaluation of the cytotoxic activity of some Brazilian medicinal plants. Rev. Bras. Pl. Med. 78(14):1601-1606.

Rodrigues CM, Rinaldo D, Santos LC, Montoro P, Piacente S, Pizza C, Hiruma-Lima CA, Brito ARMS, Vilegas W (2007). Metabolic fingerprinting using direct flow injection electrospray ionization tandem mass spectrometry for the characterization of proanthocyanidins from the barks of *Hancornia speciosa*. Mass Spectrom. 21:1907-1914.

Rodrigues VEG, Carvalho DAC (2001). Levantamento etnobotânico de plantas medicinais no domínio do cerrado na região do Alto Rio Grande-Minas Gerais. Ciência e Agrotecnologia 25(1):102-123.

Santos A, Silva M, Santos M, Leite T (2013). Levantamento etnobotânico, químico e farmacológico de espécies de Apocynaceae Juss. ocorrentes no Brasil. Rev. Bras. Pl. Med. 15:442-458.

Silva MAB, Melo LVL, Ribeiro RV, Souza JPM, Lima JCS, Martins DTO, Silva RM (2010a). Ethnobotanical survey of plants used as anti-hyperlipidemic and anorexigenic by the population of Nova Xavantina-MT, Brazil. Braz. J. Pharmacognozy, 20(4):549-562.

Silva NLA, Miranda FAA, Conceição GM (2010b). Triagem fitoquímica de plantas de cerrado, da área de proteção ambiental municipal do Inhamum, Caxias, Maranhão. Scientia Plena 6(2).

Song Y, Lee SJ, Jang SH, Ha JH, Song YM, Ko YG, Kim HD, Min W, Kang SN, Cho JH. Sasa borealis stem extract attenuates hepatic steatosis in high-fat diet-induced obese rats (2014). Nutrients 6(6):2179-95.

Souza CD, Felfili JM (2006). The utilization of medicinal plants in the region of Alto Paraíso of Goiás, GO, Brazil. Acta Bot. Bras. 20(1):135-142.

White PAS, Cercato LM, Araújo JMD, Souza LA, Soares AF, Barbosa APO, Neto JMR, Marçal AC, Machado UF, Camargo EA, Santos MRV, Brito LC (2013). Modelo de obesidade induzida por dieta hiperlipídica e associada à resistência à ação da insulina e intolerância à glicose. Arq. Bras. Endocrinol. Metab. 57(5):339-345.

TABLES AND FIGURES

Table 1. Composition of diets

	Standard Diet		**High-fat diet**	
Ingredients	**U (g/kg)**	**kcal**	**U (g/kg)**	**kcal**
corn starch	415.0	1,660	14.3	57.2
soybean meal	305.0	1,281	410.0	1,722
sucrose	80.0	320	80.0	320
maltodextrin	70.0	280	70.0	280
lard	0.0	0	302.0	2,718
soybean oil	0.0	0	0.0	0
soybean fatty acid	50.0	350	50.0	350
microcrystalline cellulose	31.7	0	25.4	0
L-cystine	1.8	7,2	1.8	7.2
choline chloride	1.5	0	1.5	0
buty-hydroxytoluene	0.014	0	0.028	0
mix min. mod 50 gps	35.0	0	35.0	0
vitamin mix	10.0	40	10.0	40
Total	**1,000.0**	**3,938**	**1,000.0**	**5,494**

Standard diet (SD): 73.9% of carbohydrate, 14.8% of protein and 9.8% of lipid. High-fat diet (HD): 26.3% of carbohydrate, 14.4% of protein and 57.6% of lipid.

Figure 1

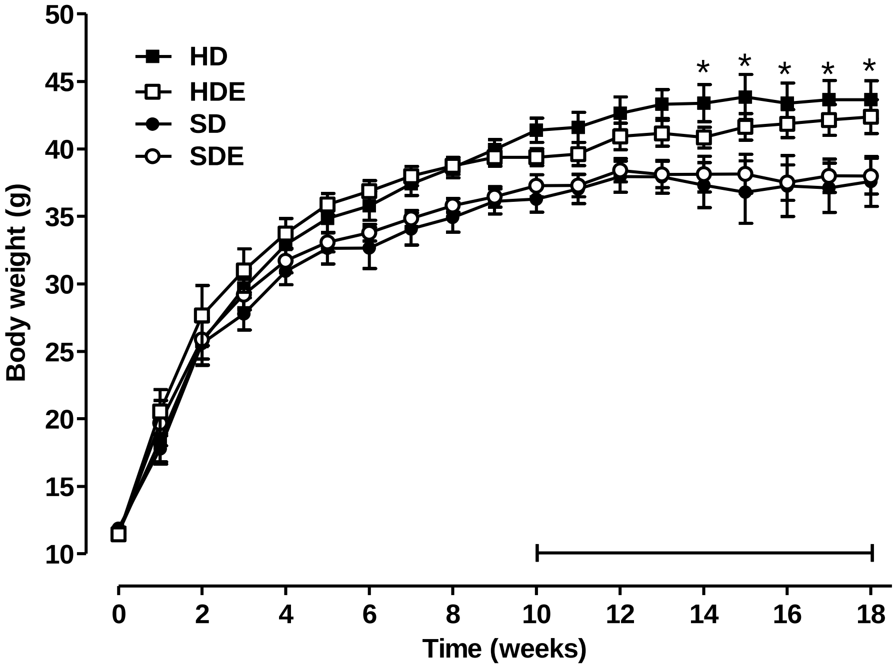

Figure 1: Body weight of the groups treated with standard diet (SD) or high-fat diet (HD) for 18 weeks and the respective groups that received standard diet plus AEHS (SDE) or high-fat diet plus AEHS (HDE), N = 8. The horizontal bar between the 10^{th} and 18^{th} weeks is the period in which SDE and HDE groups received the treatment with AEHS instead of water. * $p < 0.05$ for HD vs. SD group; Two-Way ANOVA followed by Bonferroni´s post-test.

Figure 2

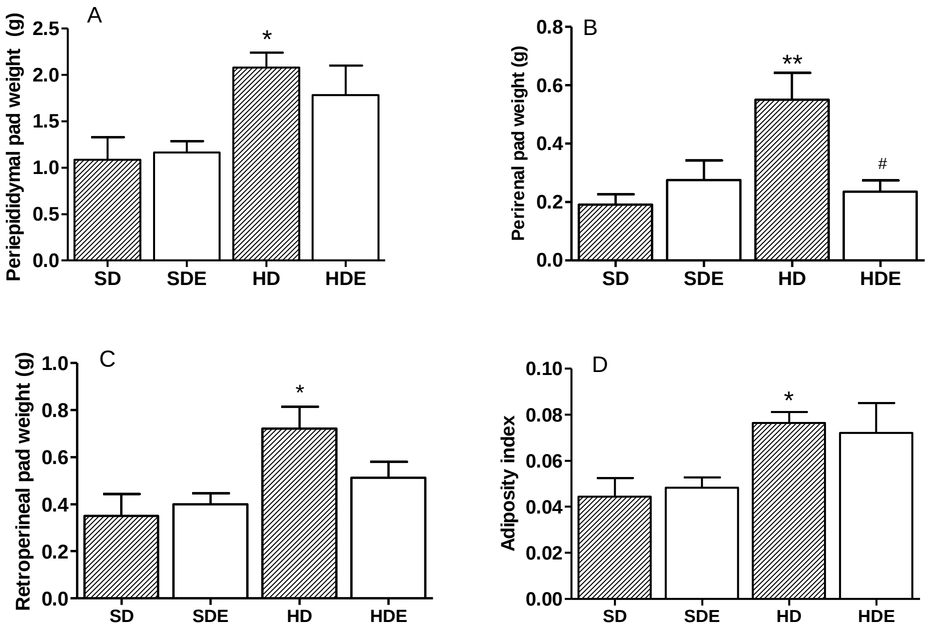

Figure 2: Weight of adipose tissue (g) for periepididymal (A), perirenal (B) and retroperitoneal (C) pads and adiposity index (D) of the groups treated with standard diet (SD) or high-fat diet (HD) for 18 weeks and the respective groups that received standard diet plus AEHS (SDE) or high-fat diet plus AEHS (HDE), N = 8. * $p < 0.05$ for SD vs. HD groups, # $p < 0.05$ for HD vs. HDE groups. One way ANOVA followed by Bonferroni's post test.

Figure 3

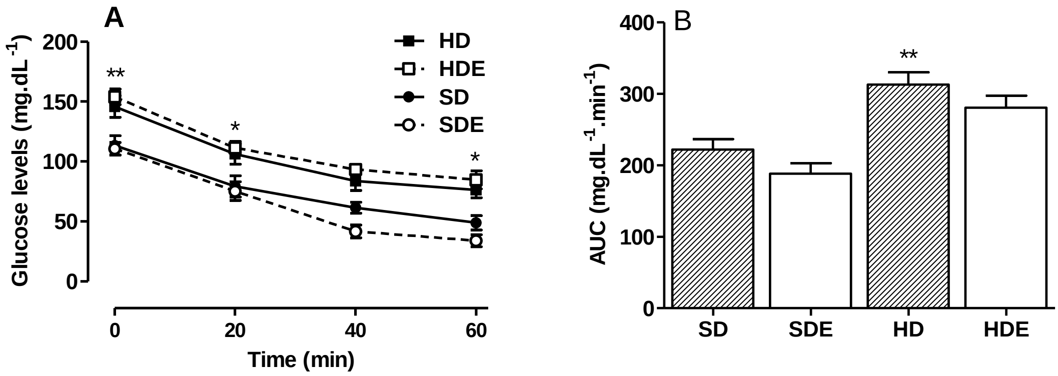

Figure 3: Insulin Tolerance Test (ITT, Panel A) for groups treated with standard diet (SD) or high-fat diet (HD) for 18 weeks and the respective groups that received standard diet plus AEHS (SDE) or high-fat diet plus AEHS (HDE), N = 8. Glucose levels ($mg.dL^{-1}$) were measured at 0 (baseline) and 20, 40 and 60 minutes post-intraperitoneal insulin injection. * $p < 0.05$ or ** $p < 0.001$ for HD vs. SD groups. Two-way ANOVA followed by Bonferroni's post-test. (B) Panel B shows the values of area under the curve (AUC) of the same groups. ** $p < 0.001$ for HD vs. SD groups. One-way ANOVA followed by Bonferroni's post-test.

Figure 4

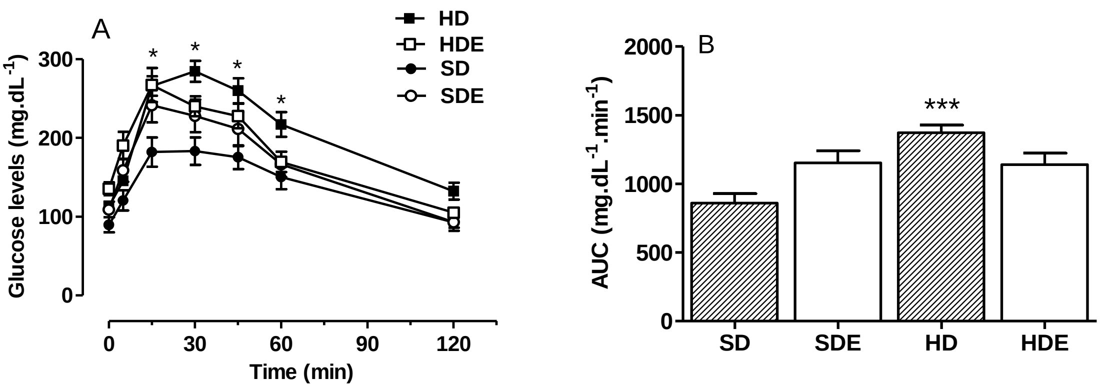

Figure 4: Glucose Tolerance Test (GTT, Panel A) for groups treated with standard diet (SD) or high-fat diet (HD) for 18 weeks and the respective groups that received standard diet plus AEHS (SDE) or high-fat diet plus AEHS (HDE), N = 8. Glucose levels (mg.dL^{-1}) were measured at 0 (baseline) and 20, 40 and 60 minutes post-intraperitoneal glucose injection. * $p < 0.05$ for HD vs. SD groups. Two-way ANOVA followed by Bonferroni's post-test. (B) Values of area under the curve (AUC) of the same groups. *** $P < 0.001$ for HD vs. SD groups. One-way ANOVA followed by Bonferroni's post-test.

Figure 5

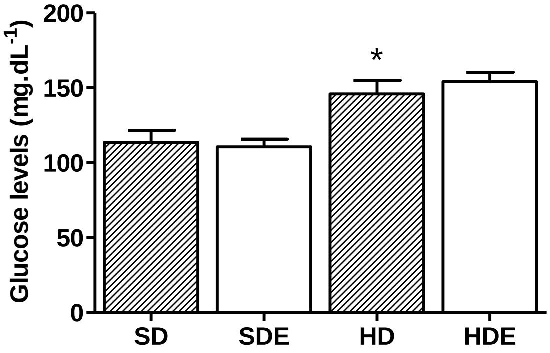

Figure 5: Blood glucose levels after 5 h of fasting in the groups treated with standard diet (SD) or high-fat diet (HD) for 18 weeks and the respective groups that received standard diet plus AEHS (SDE) or high-fat diet plus AEHS (HDE) after 5 h of fasting (N=8). * $P < 0.05$ for HD vs. SD group. One-way ANOVA followed by Bonferroni’s post-test.

5 CONCLUSÕES

Com o desenvolvimento deste estudo foi possível realizar um levantamento sobre espécies vegetais utilizadas no tratamento da obesidade e/ou para fins de perda de peso, citadas popularmente em estudos etnobotânicos de regiões brasileiras. A revisão apresenta espécies com uso bastante discutido na literatura, a exemplo da *Camellia sinensis, Baccharis trimera* e o *Aspargus officinalis,* assim como outras plantas menos populares, mas que mostram efeito terapêutico promissor para fins de tratamento da obesidade e perda de peso, a exemplo da *Anacardium occidentalis, e Annona montana, Stevia rebaudiana*. No caso da *H. speciosa* foram observadas 4 citações relacionando seu uso popular para estes fins.

A partir dos resultados apresentados na segunda parte deste estudo, também foi verificado que o extrato aquoso da entrecasca da *H. speciosa* não alterou o ganho de massa corpórea ou o peso dos coxins adiposos, ou afetou sensibilidade à ação da insulina e intolerância à glicose, assim como não modificou a hiperglicemia dos camundongos *Swiss* obesos induzidos por dieta hiperlipídica.

Esses achados não corroboram as descrições etnobotânicas sobre os efeitos antiobesidade com a casca do caule da *H. speciosa,* não confirmando-os em nossas condições experimentais. Porém, outras pesquisas tornam-se necessárias provavelmente utilizando outras partes da planta, utilizando tempos ou vias diferentes de tratamento ou ainda testando o efeito em outras espécies animais a fim de ratificar os achados do nosso estudo.

6 REFERÊNCIAS BIBLIOGRÁFICAS

ANGELIS, R. C. Riscos e Prevenção da Obesidade: Fundamentos Fisiológicos e Nutricionais para o Tratamento. São Paulo: Atheneu, p. 109, 2003.

ARAÚJO, G. G.; ARAÚJO, M. B.; DANGELO, R. A.; MANCHADO, F. B.; MOTA, C. S. A.; RIBEIRO, C.; MELLO, M. A. R. Máxima fase estável de lactato em ratos obesos de ambos os gêneros. Revista Brasileira de Medicina do Esporte, v. 15, n. 1, p. 46-49, 2009.

BAHIA, L. R; ARAÚJO, D. V. Impacto econômico da obesidade no Brasil. Revista HUPE, v. 13, n. 1, p. 13-17, 2014.

BRASIL. Ministério da Saúde. VIGITEL Brasil 2006: Vigilância de fatores de risco e proteção para doenças crônicas por inquérito telefônico [acesso em 19 dez 2014]. Disponível em: http://bvsms.saudegov.br/bvs/publicacoes/relatorio_vigitel_2006_ marco_2007.pdf

BRASIL. Ministério da Saúde. VIGITEL Brasil 2010: Vigilância de fatores de risco e proteção para doenças crônicas por inquérito telefônico [acesso em 19 dez 2014]. Disponível em: http://portal.saude.gov.br/portal/arquivos/pdf/vigitel_180411.pdf

BRASIL. Política Nacional de Práticas Integrativas e Complementares no SUS - PNPIC-SUS. MINISTÉRIO DA SAÚDE. SECRETARIA DE ATENÇÃO À SAÚDE. DEPARTAMENTO DE ATENÇÃO BÁSICA, Brasília, p. 92, 2006 a.

BRASIL. Decreto nº 5.813, de 22 de junho de 2006. Política Nacional de Plantas Medicinais e Fitoterápicos. MINISTÉRIO DA SAÚDE Brasília: Diário Oficial da União, Seção 1, n. 119, 2006 b.

BRASIL. Pesquisa de Orçamentos Familiares: Avaliação Nutricional da Disponibilidade Domiciliar de Alimentos no Brasil. Rio de Janeiro: IBGE, 2010.

CONCEIÇÃO, G. M.; RUGGIERI, A. C.; ARAÚJO, M. F. V.; CONCEIÇÃO, T. T. M. M.; CONCEIÇÃO, M. A. M. M. Plantas do cerrado: comercialização, uso e indicação terapêutica fornecida pelos raizeiros e vendedores, Teresina, Piauí. Scientia Plena, v. 7, n. 12, 2011.

COUTINHO, J. G.; GENTIL, P. C.; TORAL, N. A desnutrição e obesidade no Brasil: o enfrentamento com base na agenda única da nutrição. Caderno de Saúde Pública, Rio de Janeiro, v. 24, n. 2, p. 332-340, 2008.

DEMACKER, P. N. The metabolic syndrome: definition, pathogenesis and therapy. European Journal of Clinical Investigation, v. 37, n. 2, p. 85–89, 2007.

DUNSTAN, D. W.; DALY, R. M.; OWEN, N.; JOLLEY, D. D.; COURTEN, M.; SHAW, J.; ZIMMET, P. High-intensity resistance training improves glicemic control in older patients with type 2 diabetes. Diabetes Care, v. 25, n. 10, p. 1729-1736, 2002.

GOODMAN, E.; DANIELS, S. R.; DOLAN, L. M. Definition of metabolic syndrome. Journal of Pediatrics, v. 150, n. 4, p. 36–37, 2007.

GRANDI, T. S. M.; TRINDADE, J. A.; PINTO, M. J. F.; FERREIRA, L. L.; CATELLA, A. C. Plantas medicinais de Minas Gerais, Brasil. Acta Botanica Brasilica, v. 3, n. 2, p. 185-224, 1989.

HU, F. B. Obesity Epidemiology. USA: Oxford University Press, 2008.

LORENZI, H. Árvores brasileiras: manual de identificação e cultivo de plantas arbóreas nativas do Brasil. 4ª ed. Nova Odessa: Instituto Plantarum, 2002.

MACEDO, M.; FERREIRA, A. R. Plantas hipoglicemiantes utilizadas por comunidades tradicionais na Bacia do Alto Paraguai e Vale do Guaporé, Mato Grosso, Brasil. Revista Brasileira de Farmacognosia, v. 14, n. 1, p. 45-47, 2005.

MANENTI, A.V. Plantas Medicinais Utilizadas no Tratamento da Obesidade: Uma Revisão. Trabalho de Conclusão de Curso apresentado para obtenção do Grau de Bacharel no Curso de Nutrição da Universidade do Extremo Sul Catarinense, UNESC, p. 83, 2012.

McTIGUE, K. M.; HARRIS, R.; HEMPHILL, B; LUX, L.; SUTTON, S.; BUNTON, A. J.; LOHR, K. N. Screening and interventions for obesity in adults: summary of the evidence for the U. S. Preventive Service Task Force. Annals of Internal Medicine, v. 139, n. 11, p. 933-949, 2003.

OMS. Organização Mundial da Saúde: Prevenindo e controlando a epidemia global. 1ª ed. São Paulo: Roca, 256 p, 2004.

PASA, M. C. Saber local e medicina popular: a etnobotânica em Cuiabá, Mato Grosso, Brasil. Boletim do Museu Paraense Emílio Goeldi. Ciências Humanas, v. 6, n. 1, p. 179-196, 2011.

RIBEIRO, S. S.; DE JESUS, A. M.; DOS ANJOS, C. S.; DA SILVA, T. B.; SANTOS, A. D. C.; DE JESUS, J. R.; ANDRADE, M. S.; SAMPAIO, T. S.,

GOMES, W. F., ALVES, P. B., CARVALHO, A. A., PESSOA, C.; DE MORAES, M. O.; PINHEIRO, M. L.; PRATA, N. P. N.; BLANK, A. F.; SILVA-MANN, R.; MORAES, V. R. S.; COSTA, E. V.; NOGUEIRA, P. C. L.; BEZERRA, D.P. Evaluation of the cytotoxic activity of some Brazilian medicinal plants. Revista Brasileira de Plantas Medicinais, v. 78, n. 14, p. 1601-1606, 2012.

RODRIGUES, V. E. G.; CARVALHO, D. A. C. Levantamento etnobotânico de plantas medicinais no domínio do cerrado na região do Alto Rio Grande-Minas Gerais. Ciência e Agrotecnologia, v. 25, n. 1, p. 102-123, 2001.

SILVA, M. A. B.; MELO, L. V. L.; RIBEIRO, R. V.; SOUZA, J. P. M; LIMA, J. C. S.; MARTINS, D. T. O.; SILVA, R. M. Levantamento etnobotânico de plantas utilizadas como anti hiperlipidêmicas e anorexígenas pela população de Nova Xavantina-MT, Brasil. Revista Brasileira de Farmacognosia, v. 20, n. 4, p. 549-562, 2010.

SILVA, N. L. A.; MIRANDA, F. A. A.; CONCEIÇÃO, G. M. Triagem fitoquímica de plantas de cerrado, da área de proteção ambiental municipal do Inhamum, Caxias, Maranhão. Scientia Plena, v. 6, n. 2, 2010.

SILVA JÚNIOR, J. F.; VIEIRA NETO, R. D.; MOTA, D. M.; LÉDO, A. S. Agência da informação da Embrapa. Mangaba. Estatísticas de produção. Disponível em: HTTP://www.agencia.cnptia.embrapa.br/gestor/mangaba/arvore. Acesso em 11 de setembro de 2012.

SOARES, F. P.; RAÍRYS, R. P.; NOGUEIRA, C.; OLIVEIRA, L. M.; SILVA, D. R. G.; PAIVA, P. D. O. Cultura da mangaba (Hancornia Speciosa Gomes). Boletim agropecuário, n. 67, p. 1-12, 2007.

SOUZA, C. D.; FELFILI, J. M. Uso de plantas medicinais na região de Alto Paraíso de Goiás, GO, Brasil. Acta Botanica Brasilica, v. 20, n. 1, p. 135-142, 2006.

VEDANA, E. H. B.; PERES, M. A.; NEVES, J.; ROCHA, G. C.; LONGO, G. Z. Prevalência de obesidade e fatores potencialmente causais em adultos em região do sul do Brasil. Arquivos Brasileiros de Endocrinologia e Metabologia, v. 52, n. 7, p. 1156-1162, 2008.

YUN, J.W. Possible antiobesity therapeutics from nature – A review.Phytochem., v.71, p.1625–1641, 2010.

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