Comparative effects of brown and golden flaxseeds on body composition, inflammation and bone remodelling biomarkers in perimenopausal overweight women

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Abstract

Flaxseed may improve the adverse effects of the lack of oestrogens. This study compared the effects of brown and golden flaxseed intake on body composition, inflammation and bone biomarkers in overweight perimenopausal women. The participants were divided into groups: control, brown, and golden flaxseed and received a calorie-restricted diet plan of 250 kcal per day. The brown and golden flaxseed groups consumed 40 g of the respective flaxseed per day for 12 weeks. Both flaxseeds reduced waist circumference, but the golden flaxseed also reduced body weight, body mass index, and fat mass. Flaxseed supplementation, irrespective to the variety, had no significant effect on pro-inflammatory (TNF-α, IL-1β, and IL-6) and anti-inflammatory (IL-10) biomarkers, hormones (25(OH)D3 and 17β-oestradiol) or on the bone formation (osteocalcin) and resorption (N-terminal telopeptide of type I collagen - NTX-I) biomarkers. Brown flaxseed was less effective than the golden flaxseed in modifying body composition of perimenopausal women.

1. Introduction

Perimenopause comprises the period from the beginning of the first changes in the menstrual cycle up to 12 months after the permanent cessation of menses, which usually occurs after 40 years of age. This period is characterised by a decrease in ovarian hormonal secretion, resulting in significant physiological changes that may contribute to the development of several complications in women’s health, such as increased fat mass and bone loss, which may result in increased risk of bone fracture, and osteoporosis (Mendoza et al., 2013; Munir et al., 2012; Zhao et al., 2007).

Menopause and ageing are considered the main risk factors associated with reduced bone mass and non-communicable diseases (NCD) (Pinheiro et al., 2010). According to the World Health Organization (WHO, 2003), osteoporosis affects approximately 70% of women with advanced age and approximately 75 million people in Europe, Japan, and the United States, causing more than 2.3 million fractures each year in Europe. The latest epidemiological study on osteoporosis conducted in Brazil showed that 11.5% of Brazilian women over 40 years of age suffered fractures due to bone fragility and 33% had osteoporosis (Pinheiro et al., 2010). Moreover, 121,000 hip fractures are estimated to occur per year due to osteoporosis in the Brazilian population, with projections of 140,000 fractures in 2020 (International Osteoporosis Foundation, 2012).

The high prevalence of osteoporosis and its consequences raised the interest for preventive strategies to reduce the metabolic complications resulting from oestrogen deficiency, such as increased visceral fat deposition and oxidative stress. These complications can cause endothelial dysfunction, vascular inflammation, and increased risk of cardiovascular diseases (Al-Anazi, Qureshi, Javid, & Qureshi, 2011; Dubey, Imthurn, Barton, & Jackson, 2005; Mittal & Kant, 2009; Rosano, Vitale, Marazzi, & Volterrani, 2007), in addition to changes in bone metabolism that favour a
negative balance and consequently bone demineralisation (WHO, 2003).

Flaxseed is a rich source of lignans, polyunsaturated fatty acids, and soluble and insoluble dietary fibres. Therefore, it may reduce the risk of osteopenia and/or osteoporosis, systemic inflammation, cardiovascular disease and improve the adverse effects of the lack of oestrogen, which starts during perimenopause (Arango et al., 1996; Dodin et al., 2005; Fukumitsu, Aida, Shimizu, & Toyoda, 2010; Hutchins, Martini, Olson, Thomas, & Slavin, 2001; Rallidis et al., 2003; Steeve, Marc, Sandrine, Dominique, & Yannick, 2004). Lignans are phytoestrogens with a diphenoic structure (Cordeiro, Fernandes, & Barbosa, 2009) and are present in large amounts in flaxseed, mainly as secoisolariciresinol diglucoside (SDG), which is the precursor of the active forms enterodiol and enterolactone (Dodin et al., 2003; Ganorkar & Jain, 2013; Touré & Xueming, 2010). These phytoestrogens have a similar structure to endogenous oestrogens (Arango et al., 2011; Dodin et al., 2005) and may act as female sex hormones (Arango et al., 2011). According to Lemay, Dodin, Kadri, Jacques, and Forest (2002), the intake of flaxseed (40 g/day) causes a decrease in the menopause symptoms, similarly to that observed with hormone replacement therapy. SDG (40 mg/100 g diet) provided during lactation was effective in increasing bone density in adult rats, suggesting that dietary SDG may potentially benefit bone development (Figueiredo, Maia, Guarda, Lisboa, & de Moura, 2017).

Furthermore, the intake of the n-3 α-linolenic acid (ALA) present in flaxseed can contribute to inhibiting the production of pro-inflammation markers, such as tumour necrosis factor (TNF-α), interleukin-1beta (IL-1β), and interleukin-6 (IL-6) (Caughy et al., 1996; Rallidis et al., 2003). This reduces the risk of bone loss resulting from oestrogen deficiency by inhibiting the formation and function of osteoclasts (Pacifici, 2010; Ross, 2003). In this context, flaxseed may have a beneficial effect on bone health and metabolic changes resulting from menopause.

To our knowledge, no study comparing the functional properties of brown and golden flaxseeds on bone metabolism has been reported in the literature. Furthermore, most studies performed with this seed have used the golden flaxseed (GF) variety, while the brown flaxseed (BF), which is grown in Brazil and is more affordable in the domestic market, has been poorly investigated. Accordingly, this study aimed to evaluate the effects of brown and golden flaxseed intake on anthropometric measurements, body composition, inflammation and bone biomarkers in overweight perimenopausal women.

2. Materials and methods

2.1. Raw materials

2.1.1. Supplier, storage, and distribution

Brown and golden flaxseeds were obtained from the Cerealissta São José Company, São Paulo, Brazil. They were stored in polyethylene bags at 2–8 °C before use, then, they were weekly ground and packed in individual polyethylene bags (40 g of flaxseed flour) labelled with the names of the participants and date of consumption. The packages were delivered weekly to the participant’s home, and instructed to be kept under refrigeration.

2.1.2. Composition analysis

Moisture, lipids and protein contents of the flaxseed were analyzed according to the analytical standards of the Adolfo Lutz Institute (IAL, 1985), and the ash content was determined according to the Association of Official Analytical Chemists (AOAC, 1998). Analyses were performed in triplicate. Carbohydrate was calculated by difference between 100 and the total percentage of protein, fat, moisture and ash. Calcium was determined by atomic absorption after digestion with nitric acid.

Fatty acids (FAs) were extracted using the direct transesterification (Lepage & Roy, 1986). Briefly, 100 mg of ground flaxseed was mixed with 2 mL of 4:1 methyl alcohol and benzene and slowly added by 200 µl of acetyl chloride. The tubes were kept at 100 °C for 60 min. After reaching the room temperature, 5 mL of K2CO3P (6%) was slowly added. Then, they were agitated for 30 s and centrifuged for 10 min at 2500 rpm. The FAs profile was determined by gas chromatography (Shimadzu Model 17A), by using capillary column (SP-2560) of 100 m length and 0.25 mm diameter. The initial temperature was 100 °C, heating at 1 °C per minute until reaching 180 °C and then heating at 1 °C per minute until 240 °C, remaining at that temperature for 10 min. The injector temperature was 250 °C and the detector 270 °C. The FAs were identified by comparison between the retention times of the sample peaks with the standard mixture of 37 fatty acids methyl esters containing C4:0 to C22:6 (Supelco®, Bellefonte, PA, USA).

2.2. Experimental design

The volunteers initially had a pre-selection consultation, where their clinical history, anthropometric measurements, body composition (bioimpedance analysis), and blood pressure were evaluated. In addition, capillary blood samples were collected to determine total cholesterol, triglycerides, and glycaemia. The study included women aged between 40 and 55 years and with excess body weight (BMI between 25 and 49.9 kg/m²). Women who were using drugs that could interfere with the results (hormone replacement therapy, anti-inflammatory drugs, antibiotics, antacids, cholesterol-lowering drugs, or hypoglycaemic agents); dietary supplements (calcium, vitamin D); who presented allergy to flaxseed; cancer, endometriosis, osteopenia, osteoporosis, cardiovascular disease, liver or kidney disease, diabetes mellitus, or dyslipidaemia; and who used pacemakers were excluded from the study. In addition, women who had total cholesterol ≥240 mg/dL, triglycerides ≥140 mg/dL, and fasting glucose ≥127 mg/dL were also excluded.

In total, 122 women volunteered in participating in the study, of which, 77 attended the pre-selection consultation. Of these 77 women, 46 did not meet one or more of the inclusion criteria or met at least one of the exclusion criteria. At the end, 31 women were selected, and one of them missed the last consultation. Therefore, a total of 30 women participated in the study.

The participants were divided into three groups [control group (CG) (n = 10), Brown Flaxseed (BF) group (n = 9), and Golden Flaxseed (GF) group (n = 11)] according to their body mass index (BMI) and the presence of amenorrhoea to ensure sample homogeneity. Therefore, the study comprised 3 (30%) obese class 1 women in CG, 4 (44%) in BF and 5 (45%) in GF group. The remaining were overweight women, according to WHO (2000). The study also comprised 6 (60%) of post-menopausal women in CG, 6 (67%) in BF and 7 (64%) in GF group. Due to the irregular period of most of the remaining volunteers, their ovulatory cycle was not accounted in the present study.

The intervention study lasted 12 weeks. During this period, there were four individual meetings with the participants at the first (T1), third (T3), seventh (T7), and twelfth (T12) weeks. Once a week, the participants in the BF and GF groups received seven packages of flaxseeds (40 g/pack) at home, according to their group. Participants were instructed to keep the product refrigerated (2–8 °C) and to consume one pack a day as part of their food preparations (40 g/day).

Anthropometric and body composition data were collected, blood pressure was measured, and nutritional guidelines were pro-