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Quinoa or Corn Flakes to Prevent Peripheral Inflammation after Menopause?

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Abstract

Background: Postmenopausal women are susceptible to develop chronic diseases due to the hypoestrogenism. Considering that whole grains contain bioactive components, the present study aimed to investigate the effect of quinoa and corn flakes intake on blood inflammatory markers and urinary enterolignans of a group of sedentary overweight postmenopausal women.

Methods and Findings: A prospective and double-blind study was conducted on 34 women who daily consumed 25 grams of quinoa or corn flakes during 4 weeks. At the beginning (T1) and at the end (T2) of the intervention, dietary intake, anthropometric data, serum inflammatory markers and urine enterolignans were measured. Women were 61 ± 7 year-old, and were classified as overweight (28.6 ± 0.8 kg/m²) according to their body mass index (BMI). There was no difference in body weight, BMI, waist circumference and waist-to-hip ratio between groups at T1 and T2. Only body fat was decreased at T2 (44.5 ± 0.9) compared to T1 (43.7 ± 0.9%) in the corn flakes group (p=0.008). They presented similar intake of calories, carbohydrates, protein and fat at T1 and at T2, with predominance of carbohydrates. Interestingly, corn flakes group presented a decrease in lipids intake at T2 (39.3 ± 6.7) compared to T1 (48.4 ± 7.8 g/d) (p=0.02). Quinoa presented a higher intake of fibers at T2 (17.1 ± 1.7) compared to corn flakes group (9.6 ± 1.0) (p<0.001), which was also different from its intake at T1 (10.0 ± 1.2 g/d) (p=0.001). Regarding inflammatory markers, quinoa presented higher interleukin-6 (IL-6) at T1 (3.6 ± 0.8) compared to corn flakes group (1.9 ± 0.3 pg/ml). However, at T2, they presented similar levels, indicating that the supplementation with quinoa was able to decrease IL-6, which is a marker of inflammation.

Conclusion: In conclusion, our results suggest that an acute quinoa flakes intake during 4 weeks reversed IL-6 serum levels in a group of overweight postmenopausal women, indicating that it can be considered for the treatment of inflammatory process of postmenopausal women.

Keywords: Quinoa intake; Corn flakes intake; Menopause; Obesity; Inflammation.

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Introduction

Postmenopausal women present a high amount of body fat mass after menopause due to the estrogen deficiency associated with sedentarism and elevated intake of lipids [1,2], which is associated with increased inflammatory markers levels, such as interleukin-6 (IL-6) and tumor necrosis factor-α (TNF-α). Both hypoestrogenism and aging process are also related with a high sensibility of cells to this cytokines due to an increase of the number of receptors and co-factors that favors the cytokine action, which contribute to a pro-inflammatory state [3]. Daily consumption of cereals and grains provide nutrients with antioxidant, anti-inflammatory and lipid-lowering effects [4]. Corn, a widely consumed grain, is considered a rich-food nutrient, since it contains great amounts of carbohydrates, proteins, B vitamins, carotene, tocopherol, iron, phosphorus, potassium, zinc and lignans. Carotenoids,

especially lutein and zeaxantin, tocopherols and lignans have an antioxidant characteristic, which promotes prevention for several diseases, such as inflammation [5,6]. Quinoa (*Chenopodium quinoa*), another seed cereal widely consumed, contains high concentration of carbohydrates, proteins, tocopherols, fibers and antioxidant factors. Besides, quinoa is considered a food source of phytoestrogens such as isoflavones, lignans and genistein [7]. Since inflammatory processes are highly prevalent during the postmenopausal phase and some cereals present anti-inflammatory effects, we aimed here to investigate the role of an acute dietary intake of quinoa or corn flakes on inflammatory markers and enterolignans in a group of overweight postmenopausal women.

Methods

Study design

The study was an interventional, prospective, randomized, and double-blind, conducted with sedentary overweight postmenopausal women. Enrolled the study those women in at least 2 years without menses, not using estrogenic hormone therapy, with serum estradiol (E_2) levels between 10 and 20 pg/ml, and follicle-stimulating hormone (FSH) of at least 35 µI U/ml [8]. Also, they were not smokers and were regularly assisted at the Multidisciplinary Climacteric Outpatient Clinic- Clinical Hospital/University of São Paulo (HCFMRP/USP). The study was approved by the Ethics Committee of HCFMRP/USP, protocol number 7896/2009, and all subjects signed the written informed consent to participate. The intervention consisted of daily ingestion of 25 g of quinoa flakes (quinoa flakes group) or 25 g of corn flakes (corn flakes group) for 4 weeks. Neither volunteers nor researchers knew the groups (double-blinded study). The 25 g cereals amount was considered as the best tolerated by the volunteers based on a previous pilot study. Experimental subjects were evaluated at two stages: baseline (T1) and after 4 weeks of intervention (T2). The subjects were their own control (T1 against T2). Anthropometric assessment, fasting biochemical measurements, and 24h-urine samples were collected at T1 and T2.

Dietary cereals intake

The cereals grains were placed in metallized Trad Pouch® packages, and each volunteers received 28 packages containing 25 grams of cereal (quinoa or corn). They were weekly contacted by phone in order to monitor the intake of the cereal and to clarify doubts. They were instructed to ingest the full content of one package daily. It could be added in fruits, juice, fruit milkshakes, and/or during their lunch or dinner. They were requested to not consume other food sources of lignans, such as flaxseed and soy.

Food intake evaluation

Food intake was assessed through a 24-hour dietary record at T1 and T2 referring to the previous day. Caloric intake, macronutrients (carbohydrates, proteins and lipids) and dietary fiber content of their registrations were evaluated by DietPro® version 4.0 software [9].

Anthropometric evaluation

Body weight and height were measured as previously described, and the body mass index (BMI) was calculated as previously described [10]. Waist circumference (WC) was measured with an inextensible tape around the smallest abdominal circumference, and hip circumference was measured as the greatest circumference between abdomen and legs [11].

Biochemical analysis

Blood was collected into 5 mm tubes containing separator and clot-activating gel at T1 and T2 after 8-hour fasting. 24-hour urine samples were collected one day before T1, and at the ast day T2. The samples were stored in -80°C freezer until the analysis. Serum cytokines IL-6 and TNF-α were determined by immunochemiluminescence enzymatic method (Immulite®). Urinary ENL levels were quantified by high-performance liquid chromatography (HPLC), according to the method described by Sicilia et al. [12].

Statistical analysis

Data were presented as mean ± SEM. Unpaired T-test was used to compare results between groups, and 2-tailed paired t-test was used to compare T1 and T2 within the same group. $p<0.05$ was considered statistical significant. SAS 9.0 software was used [13].

Results

Thirty-four women enrolled the study; 17were assigned to quinoa and 17 to the corn flakes group. They were 61 ± 7year-old. Anthropometric data was presented in **Table 1**. According to their body mass index (BMI), all volunteers were classified as overweight at T1 (28.2 ± 0.9 kg/m²) and T2 (29.2 ± 0.7 kg/m²). They presented similar body weight (BW) (67.1 ± 3.1 corn; 71.0 ± 2.7 kg quinoa), BMI (28.1 ± 1.3; 29.2 ± 1.0 kg/m²), waist circumference (85.3 ± 2.7; 87.2 ± 1.8 cm) and waist-to-hip ratio circumference (0.81 ± 0.02; 0.81 ± 0.01) at baseline (T1). Volunteers presented similar anthropometric data after

Table 1 Anthropometric features of corn flakes and quinoa groups.

	Corn flakes group		Quinoa group	
	T1	T2	T1	T2
Weight (kg)	67.1 ± 3.1 [a]	67.4 ± 3.1[a]	71.0 ± 2.7[a]	71.2 ± 2.7[a]
BMI (kg/m²)	28.1 ± 1.3[a]	28.2 ± 1.2[a]	29.2 ± 1.0[a]	29.2 ± 1.0[a]
WC (cm)	85.3 ± 2.7[a]	84.6 ± 2.6[a]	87.2 ± 1.8[a]	87.0 ± 1.8[a]
WHR	0.81 ± 0.02[a]	0.80 ± 0.02[a]	0.81 ± 0.01[a]	0.82 ± 0.01[a]
Body fat (%)	44.5 ± 0.9[a]	43.7 ± 0.9[b]	46.1 ± 0.8[a,b]	45.7 ± 0.7[a,b]

Data was reported as mean ± SEM. T1 (beginning of the intervention) and T2 (after 4 weeks of intervention). Different letters mean $p<0.05$. BMI=body mass index; WC= waist circumference; WHR=waist to hip ratio

Table 2 Food intake of corn flakes and quinoa groups.

	Corn flakes group		Quinoa group	
	T1	T2	T1	T2
Calories (kcal/d)	1423 ± 116.8[a]	1286 ± 103.3[a]	1345 ± 90.7[a]	1455 ± 88.6[a]
CHO (g/d)	185.4 ±13.8[a]	175.4 ± 11.7[a]	182.8 ± 14.4[a]	189.2 ± 12.4[a]
CHO (% TCV)	53.0 ± 2.2[a]	55.4 ± 2.2[a]	54.5 ± 2.2[a]	53.2 ± 2.7[a]
Ptn (g/d)	61.4 ± 5.5[a]	58.7 ± 4.9[a]	63.2 ± 5.7[a]	66.0 ± 5.2[a]
Ptn (% TCV)	17.3 ± 1.0[a]	19.3 ± 1.9[a]	18.9 ± 1.2[a]	18.2 ± 1.2[a]
Lip (g/d)	48.4 ± 7.8[a]	39.3 ± 6.7[b]	40.3 ± 4.2[a,b]	48.3 ± 5.8[a,b]
Lip (% TCV)	29.7 ± 2.5[a]	25.8 ± 2.2[b]	26.8 ± 1.8[a.b]	28.6 ± 2.3[a.b]
Fiber (g/d)	11.3 ±1.4[a,b]	9.6 ± 1.0[a]	10.0 ± 1.2[a]	17.1 ± 1.7[b]

Data was reported as mean ± SEM. T1 (beginning of the intervention) and T2 (after 4 weeks of intervention). Different letters mean p<0.05. CHO= carbohydrates; Ptn= proteins; Lip= Lipids; TCV= total caloric value

Table 3 Inflammatory markers and urinary enterolactone in corn flakes and quinoa groups

	Corn flakes group		Quinoa group	
	T1	T2	T1	T2
IL-6 (pg/ml)	1.9 ± 0.3[a]	2.4 ± 0.4[a,b]	3.6 ± 0.8[b]	2.7 ± 0.5[a,b]
TNF-α (pg/ml)	10.1 ± 0.8[a]	9.7 ± 0.8[a]	9.8 ± 1.2[a]	9.7 ± 1.0[a]
Urinary ENL (nm/ml)	2.0 ± 0.3[a]	2.2 ± 0.3[a]	2.9 ± 0.4[a]	3.4 ± 0.7[a]

Data was reported as mean ± SEM. T1 (beginning of the intervention) and T2 (after 4 weeks of intervention). Different letters mean p<0.05. IL-6= interleukin-6; TNF-α= tumor necrosis factor α; ENL= enterolactone

dietary intervention (T2), with no difference between groups. Interestingly, there was a decrease in the percentage of body fat in the corn flakes group between T1 (44.5 ± 0.9) and T2 (43.7 ± 0.9%) (p=0.008). Food intake evaluation was shown in **Table 2**. In average, they presented a caloric intake of 1384±73.1 kcal/d, 53.7 ± 1.5% of carbohydrates, 18.1 ± 0.8% of proteins, 28.3 ± 1.5% of lipids, and 10.6 ± 0.9 g of fiber at T1. There was no difference between groups before and after dietary intervention. However, corn flakes group presented a decrease in lipids intake between T1 (48.4 ± 7.8) and T2 (39.3 ± 6.7 g/d) (p=0.02), and there was an increase in fiber in the quinoa group between T1 (10.0 ± 1.2) and T2 (17.1 ± 1.7 g/d) (p<0.001). Regarding inflammatory markers, serum IL-6 was higher at T1 in the quinoa (1.9 ± 0.3) than corn flakes group (3.6 ± 0.8 pg/ml) (p=0.04). Interestingly, there was no difference between groups at T2. IL-6 levels were reduced in the quinoa group with no statistical difference comparing to T1, in spite of a tendency of difference (p=0.09). Serum TNF-α levels were similar between groups at T1 (10.0 ± 0.7) and at T2 (9.8 ± 0.6 pg/ml).

Discussion

The present study aimed to investigate the role of an acute dietary intake of corn flakes and quinoa, which are cereals commonly consumed by the population, on inflammatory markers of a group of overweight postmenopausal women. It is known the prevalence of inflammation increases after menopause due to the withdrawal of ovarian estrogens [1,2,14]. Due to controversies in regard to the use estrogenic hormone therapy, novel therapies that aim to diminish the deleterious effects of inflammation without deleterious estrogenic effects should be investigated. Corn flakes and quinoa present nutritional factors with antioxidant, anti-inflammatory and lipid-lowering effects [4-7]. Our double-blinded-4-weeks intervention showed a decrease in serum IL-6 levels in quinoa group, which was not observed in corn flakes, indicating that there was an evidence that quinoa could be used in order to treat inflammation processes after menopause. There was a decrease in the percentage of body fat only in corn flakes group, which could be associated with their decrease in lipid intake during the intervention. Despite there was a decrease in their body fat mass, it was not observed a decrease on inflammatory markers, which was expected [15], indicating that neither the decrease in the body fat mass nor the intake of corn flakes led to reduced inflammatory markers. On the other hand, there was an increase in fiber intake in the quinoa group, which could be associated to quinoa´s high content of fiber. Quinoa contains about 7 g fiber/100 g grains, a relatively high content compared to corn flakes (1.1 g/100 g food) [16]. Ma et al. [17] observed that women who consumed elevated amount of fibers had lower plasma concentrations of IL-6 and TNF-α receptor 2, showing the protective effect of fiber intake, and especially fibers from grains. Other nutrients from quinoa, such as vitamins, especially vitamin E, that contain antioxidant properties, interact with free radicals and diminishes the inflammatory process [7]. De Carvalho et al. [18] showed possible benefits of quinoa intake against oxidative stress. They evaluated the effects of 25 grams of daily consumption of quinoa during 4 weeks on oxidative stress markers, total cholesterol and fractions of cholesterol in a group of postmenopausal women, and they found a reduction of total cholesterol and LDL-cholesterol. It is known that high LDL-cholesterol concentrations are related to an elevated cardiovascular risk [19]. Since quinoa intake can regulate cholesterol concentrations, as shown by De Carvalho et al. [18], we believed that, in the present study, quinoa intake was partly responsible for the reverse of the serum IL-6 levels, which could not be observed in the corn flakes group (**Table 3**). A possible limiting factor of the present study was the short length of the intervention period, which was probably insufficient to

promote significant changes in all variables studied. However, in our knowledge, we emphasize that this was the first study that evaluated inflammatory markers after a consumption of quinoa or corn flakes. Thus, the present study suggested that a daily consumption of 25 g quinoa for a period of 4 weeks reversed IL-6 serum levels in a group of overweight postmenopausal women, indicating that it can be considered for the treatment of in the inflammatory process of postmenopausal women. Other studies should be performed to investigate the effect of quinoa intake on inflammatory markers, and considering alternative amounts of quinoa intake and periods of supplementation.

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Competing interest

Authors declare there was no competing interest in the study.

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