

Original

Human ration does not alter weight and body composition, but improves the lipid profile of overweight woman

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Abstract

Background: In Brazil, a mixture of cereals known as “Human Ration” (HR) has been consumed as a substitute for meals due to effects in satiation and weight loss.

Methods: This paper evaluated the effect of HR consumption for 45 days as a breakfast replacement, on body composition, biochemical profile and eating behavior in women (n = 20) between 18-45 years old and with BMI between 27-35 kg/m².

Results: The intake of HR did not promote significant changes in the body composition as well as in the mean serum values of glucose, HDL, VLDL, TC/HDL, AST and ALT. However, a significant change was noticed in the levels of TC, LDL and triglycerides (p < 0.05). Average daily intake of calories and macronutrients of the volunteers during the period of HR consumption did not differ from their habitual ingestion (p > 0.05). Regarding the consumption of total fibers, there was a significant increase (p < 0.05) in intake at breakfast during the period of HR consumption when compared to the usual intake. The consumption of HR did not intervene in the sensations of satiation, hunger and prospective intake among the subjects, presenting only instantaneous significant alterations throughout the study.

Conclusion: The results are clinically relevant, since they may contribute to the reduction of risk factors for chronic noncommunicable diseases.

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Key words: *Obesity. Body composition. Dietary fiber. Dietary supplements.*

RACIÓN HUMANA NO MODIFICA EL PESO NI LA COMPOSICIÓN CORPORAL PERO MEJORA EL PERFIL LIPÍDICO DE MUJERES CON SOBREPESO

Resumen

Introducción: En Brasil, una mezcla de cereales conocidos como “Ração Humana” (HR) se ha consumido como sustituto de las comidas debido a los efectos en la saciedad y en la pérdida de peso.

Métodos: Se evaluó el efecto del consumo de HR durante 45 días, sustituyendo el desayuno, en la composición corporal, perfil bioquímico y en la conducta alimentaria en mujeres (n = 20) entre 18-45 años de edad y con IMC entre 27-35 kg/m².

Resultados: La ingesta de HR no promovió cambios significativos en la composición corporal, así como en los valores medios de glucosa, colesterol HDL, VLDL, CT/HDL, AST y ALT en el suero. Sin embargo, se observaron cambios significativos en las concentraciones de CT, LDL y los triglicéridos (p < 0,05). La ingesta media diaria de calorías y macronutrientes de los voluntarios durante el periodo de consumo de HR no difirieron de su ingesta habitual (p > 0,05). Respecto al consumo de fibras total, se observó un aumento significativo sólo para el desayuno (p < 0,05) en el periodo de consumo de HR en comparación con la ingesta habitual. El consumo de la HR no intervino en las sensaciones de saciedad, en el hambre y en la ingesta prospectiva entre los sujetos, presentando solamente alteraciones significativas durante todo el estudio.

Conclusión: Los resultados son clínicamente relevantes, ya que pueden contribuir a la reducción de factores de riesgo para enfermedades crónicas no transmisibles.

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Palabras clave: *Obesidad. Composición corporal. Fibra de la dieta. Suplementos dietéticos.*

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Abbreviations

ALT: Alanine aminotransferase.
AST: Aspartate aminotransferase.
AUC: Area under the curve.
BMI: Body mass index.
DEXA: Dual energy x-ray absorptiometry.
g: gram.
HDL: High density lipoprotein.
HR: Human Ration.
IPAQ: International Physical Activity Questionnaire.
kcal: Kilocalories.
kg/m²: Kilogram/square meter.
LAMECC: Laboratory of energy metabolism and body composition.
LDL: Low density lipoprotein.
AbP: Abdominal perimeter.
TC/HDL: Castelli index.
TC: Total cholesterol.
TFEQ: Three Factor Eating Questionnaire.
TG: Triglycerides.
UFV: Federal University of Viçosa.
VAS: Visual analogy scale.
VLDL: Very Low density lipoprotein.

Introduction

The increasing prevalence of overweight and obese individuals currently registered in the developed and developing countries, is recognized by the World Health Organization (WHO) as a global epidemic.¹ Due to the difficulty of obese patients to adhere to hypo-caloric diets and food reeducation programs, several “stylish” products and diets have been launched on the market with the purpose of helping in this process.

In Brazil, the consumption of a mixture of cereals known as “Ração Humana” (HR), with the literal translation to English as “Human Ration” (Human Food Supply), as a substitute for meals is increasing every day. The HR is composed of 14 ingredients: flaxseeds, oat flakes, defatted soy flour, brown sugar, sesame seeds with the husk, wheat germ and fiber, quinoa, unflavored gelatin, cocoa powder, guaraná powder, whole rice flour, beer yeast and white cornmeal yeast. Makers of human health products claim that the main effects are the increase in satiation and weight loss, however, to date no scientific studies have been encountered that corroborate with these effects.

These foods are sources of fiber, which can contribute in the induction of satiation, and control of blood glucose and cholesterol levels.² Moreover, some of the ingredients have been associated with the reduction of cardiovascular risk, and anti-inflammatory and antioxidant effects.³ Although the excessive consumption of some components of HR can increase blood pressure and contain saturated fats (guaraná powder and cocoa powder, respectively), the amount used in the study of these products is too small to offer health

risks. Consumption of the ingredients of HR associated with a balanced diet can benefit the individual, however the effects of a combination of these components are unknown, as well as when substituting meals. The objective of the present study was to evaluate the effects of HR consumption on body composition, biochemical profile and eating behavior in overweight/obese women as a breakfast substitute.

Methodology

Experimental design

This work was setup as a longitudinal study conducted at the Laboratory of Energetic Metabolism and Body Composition (LAMECC) of the Department of Health and Nutrition, Federal University of Viçosa (UFV). The sample was calculated in accordance to Weyne⁴ using data previously obtained by Saltzman and collaborators⁵, adding a 10% margin of error. The study was performed with female individuals between 18 and 45 years old and Body Mass Index (BMI) between 27 and 35 kg/m², who consumed HR as a breakfast replacement for 45 days.

Volunteers were interviewed by trained nutritionists, in which a structured questionnaire was used to investigate socio-demographic and health information as well as inclusion and exclusion criteria. The exclusion criteria were: pregnancy and lactating, practitioners of intense physical activity, use of medicine for the treatment of any chronic illness and practice of a restrictive diet over the past 3 months or gain/loss of \pm 5 kg during this period. The Three Factor Eating Questionnaire (TFEQ)⁶ was used to evaluate three factors: dietary restriction, dietary disinhibition and hunger. The volunteers who had high scores for dietary restriction factors (> 14) were not included in the study to ensure the exclusion of non-restrained eaters. All women had the habit of eating breakfast and drinking milk, none presented allergies/intolerance to any of the components of the food and all were advised to maintain their eating habits and usual physical activity.

Thirty-two women who met the inclusion criteria were selected for this study, however, 5 refused to participate at the beginning of the study and 7 were excluded (4 did not consume the HR regularly and 3 quit due to adverse effects: intestinal constipation and disgust of the product). At the end, 20 women consumed the HR during the entire period of study (45 days).

Preparation of the “Human Ration”

The product was prepared at the LAMECC of the UFV using the following ingredients and their respective quantities: quinoa (25 g), unflavored gelatin (50 g), brown sugar (100 g), oat flakes (100 g), cocoa powder (25 g), wheat fiber (250 g), whole rice flour (100 g), white cornmeal (100 g), defatted soy flour (125 g),

Table I
Composition of macronutrients and total fiber in HR

	Portion	
	100 g	25 g
Carbohydrates (g)	29.3	7.32
Proteins (g)	21.9	5.47
Lipids (g)	15.2	3.8
Total Fiber (g)	22.2	5.55
Calories (kcal)	341.6	85.4

Adapted from Alves et al.⁷

sesame seeds with husks (100 g), wheat germ (75 g), guaraná powder (25 g), beer yeast (25 g) and flaxseeds (125 g). This proportion respects the composition of the pioneer brand that fabricates the product in Brazil. Data on the centesimal composition were compiled from the study of Alves et al.⁷ (table I).

Volunteers received the product every fifteen days, properly packaged and proportioned for daily consumption, as well as a measuring cup for standardized proportioning with milk and a list of fruit for supplementation. Each portion contained 25 g of HR (approximately 2 full soup spoons) weighed on a precision scale (Biometrix®) and was consumed as a breakfast substitute. Participants were guided to maintain their eating habits and consume the portion of HR with 150 mL of whole milk and fruit, without adding sugar, as commonly consumed by Brazilian who utilize this product.

Anthropometric evaluation

Measurements of weight, height and abdominal perimeter, and calculation of the BMI were used for monitoring and to determining possible effects of HR on these parameters. Body weight was measured on a digital scale (TOLEDO®) with capacity of 150 kg and precision of 50 g and height was assessed using a vertical stadiometer (SECA model 206®), according to Jelliffe (1966)⁸. From the values of body weight and height the BMI was calculated (kg/m²), using the cut-off points established by the WHO⁹ for the classification of nutritional status.

The abdominal perimeter (AbP) was assessed using a non-flexible tape measure and abdominal obesity in women was categorized as values above 80 cm.¹⁰

The body components of fat-free mass and fat mass were evaluated via dual energy x-ray absorptiometry (DEXA) at the beginning and the end of the study. The equipment used was a GE® Lunar Densitometry with Encore 2010 software, version 13.3.

Dietary assessment

The participants were instructed to create their own dietary record of all solid and liquid foods ingested

during 3 non-consecutive days, 2 during the work-week and 1 on the weekend. The 3-day food log was constructed at the beginning of the study in order to assess typical intake (baseline), and at 15, 30 and 45 days after the beginning the experiment to check adherence to HR consumption and possible alterations in eating behavior. Chemical composition of the HR prepared for this study was evaluated and the data used for verifying the ingestion of macronutrients and fiber. The intake data was analyzed using the Dietpro® software, version 4.0 (Agromídia, Viçosa, MG).

Also, a visual analogue scale (VAS) was used, adapted from the methodology of Flint et al.¹¹, to assess the sensations of hunger, satiation and prospective ingestion of foods (desire to eat more food). The VAS was used to for the baseline (day before beginning intake) and at 15, 30 and 45 days after beginning the experiment with the objective of identifying possible alterations of food behavior. Each participant in the study was instructed to fill out the VAS on a scheduled day, 30 minutes before and after each meal and even afternoon snacks, totaling 5 questionnaires over the course of the day. Sensations of hunger, satiation and desire to eat more were measured, after correction for the baseline, as the area under the curve (AUC) calculated via the trapezoidal method adapted from Wolever (2004).¹²

Assessment of physical activity

To determine the level of physical activity during the study, the participants answered the International Physical Activity Questionnaire (IPAQ), version 6, validated by Pardini et al. (2001).¹³ Questionnaires were applied at the start of the experiment and after 30 and 45 days, with the objective of verifying possible alterations in physical activity.

Biochemical assessment

For biochemical assessment, 15 ml of blood were collected intravenously in disposable syringes by a trained technician at the beginning and end of the study for analysis of total cholesterol (TC) and its fractions (HDL, LDL, VLDL), as well as the concentrations of triglycerides, fasting blood glucose, aspartate aminotransferase (AST) and alanine aminotransferase (ALT) using enzymatic kits and colorimetric methods.

Statistical analysis

The statistical analysis was calculated with the aid of the SPSS Statistics software 17.0. Normality of the continuous variables was tested using the Kolmogorov-Smirnov test. All anthropometrics and biochemical variables were normally distributed. For comparison

Table II
Anthropometric data of the volunteers at the initial and final periods of the study

Body composition	Period		p
	Initial	Final	
Weight (kg)	77.7 ± 8.6	77.6 ± 8.7	0.712
BMI (kg/m ²)	30.3 ± 2.8	30.2 ± 2.8	0.693
AbP (cm)	87.5 ± 6.8	87.3 ± 7.0	0.538
% BF DEXA	39.9 ± 4.4	39.7 ± 4.3	0.616
LW DEXA (kg)	44.1 ± 4.3	44.4 ± 3.6	0.422

Data expressed in mean ± standard deviation. *p < 0.05; Paired t Test.
BMI: Body Mass Index; AbP: Abdominal perimeter; %BF: % of Body Fat; LW: Lean weight; DEXA: Dual energy x-ray absorptiometry.

between the initial and final times of these variables, the paired t-test was used. The repeated Anova measures were used to compare food intake in the 4 periods of the study; the level of significance considered was 5% (p < 0.05).

For the VAS analysis, the means were compared to the baseline by the paired t-test for each phase of the day and the experiment. The areas under the curve (AUC) were compared by repeated measures using the Friedman test for those without normal distribution. Means of the AUC were correlated to the ingestion of macronutrients using the Pearson Correlation.

Ethical aspects

The project was submitted to and approved by the Ethics Committee in Research of the UFV, certified by document number 127/2010. All participants received and signed the explained Consent Forms after orientation on the procedures of the study.

Results

Ingestion of HR for 45 days as a breakfast substitute did not promote significant alterations in body weight, BMI and abdominal perimeter of the volunteers. There

Table III
Biochemical parameters evaluated at the initial and final period of nutritional intervention

Body composition	Period		p
	Initial	Final	
Glucose (mg/dL)	86.1 ± 6.9	84.6 ± 5.9	0.277
TC (mg/dL)	193.2 ± 31.1	182.3 ± 39.5	0.041*
HDL (mg/dL)	53.3 ± 13.9	52.0 ± 14.3	0.371
LDL (mg/dL)	117.9 ± 28.5	108.8 ± 31.1	0.041*
VLDL (mg/dL)	21.9 ± 9.8	21.4 ± 14.2	0.848
TG (mg/dL)	109.4 ± 50.4	94.5 ± 43.6	0.011*
CT/HDL	3.8 ± 0.9	3.6 ± 0.9	0.099
AST (U/L)	24.3 ± 4.4	22.7 ± 5.9	0.310
ALT (U/L)	18.8 ± 5.7	18.9 ± 7.5	0.910

Data expressed in mean ± standard deviation. *p < 0.05; Paired t Test.
TC: Total cholesterol; HDL: High Density Lipoprotein; LDL: Low Density Lipoprotein; VLDL: Very Low Density Lipoprotein; AST: Aspartate aminotransferase; ALT: Alanine aminotransferase; TG: Triglycerides; CT/HDL: Castelli Index.

was also no significant alteration in the percentage of body fat and lean weight, assessed by DEXA (table II).

Regarding the evaluated biochemical parameters, after intake of HR no changes were observed in the mean values of glucose, HDL, VLDL, TC/HDL, ALT and AST. However, there was a significant reduction in levels of total cholesterol (p = 0.041), LDL (p = 0.041) and triglycerides (p = 0.011) (table III).

The mean daily intake of calories, macronutrients and fiber of the volunteers during the period of HR consumption did not statistically differ from typical ingestion (p > 0.05) (table IV). Analysis conducted considering the meals (breakfast, snack and lunch) revealed no changes in the ingestion of lipids and proteins throughout the period of HR consumption. However, there was significant reduction of caloric (kcal) and carbohydrate (g) intake during breakfast at days 15 and 30 (T15: 209.22 ± 48.65 and 86.00 ± 4.28; T30: 207.52 ± 34.02; and 23.00 ± 6.73; p < 0.001, respectively) when compared to the baseline ingestion (320.25 ± 84.10; 49.23 ± 13.22, respectively). In the meals following breakfast (snack and lunch), there was no significant difference on energy and carbohydrates

Table IV
Average daily consumption of energy, macronutrients and total fibers

	Energy (kcal)	CHO (g)	Fiber (g)	Lip. (g)	Ptn. (g)
Baseline	1,732.26 ± 501.64	236.85 ± 72.78	13.90 ± 4.5	57.93 ± 23.53	62.98 ± 16.88
T15	1,584.66 ± 323.68	200.33 ± 47.80	16.37 ± 3.58	56.77 ± 14.41	62.54 ± 13.94
T30	1,580.42 ± 311.86	197.02 ± 45.84	15.93 ± 4.36	56.17 ± 14.95	67.87 ± 11.25
T45	1,718.89 ± 456.85	220.89 ± 65.82	16.50 ± 4.45	60.86 ± 19.09	71.61 ± 25.10

Data expressed in mean ± standard deviation; Kcal: Kilocalories; CHO: Carbohydrates; Fiber: Total fibers; Lip: Lipids; Ptn: Proteins; T0: Usual intake; T15: 15 days after the beginning of the study; T30: 30 days after the beginning of the study; T45: 45 days after the beginning of the study.

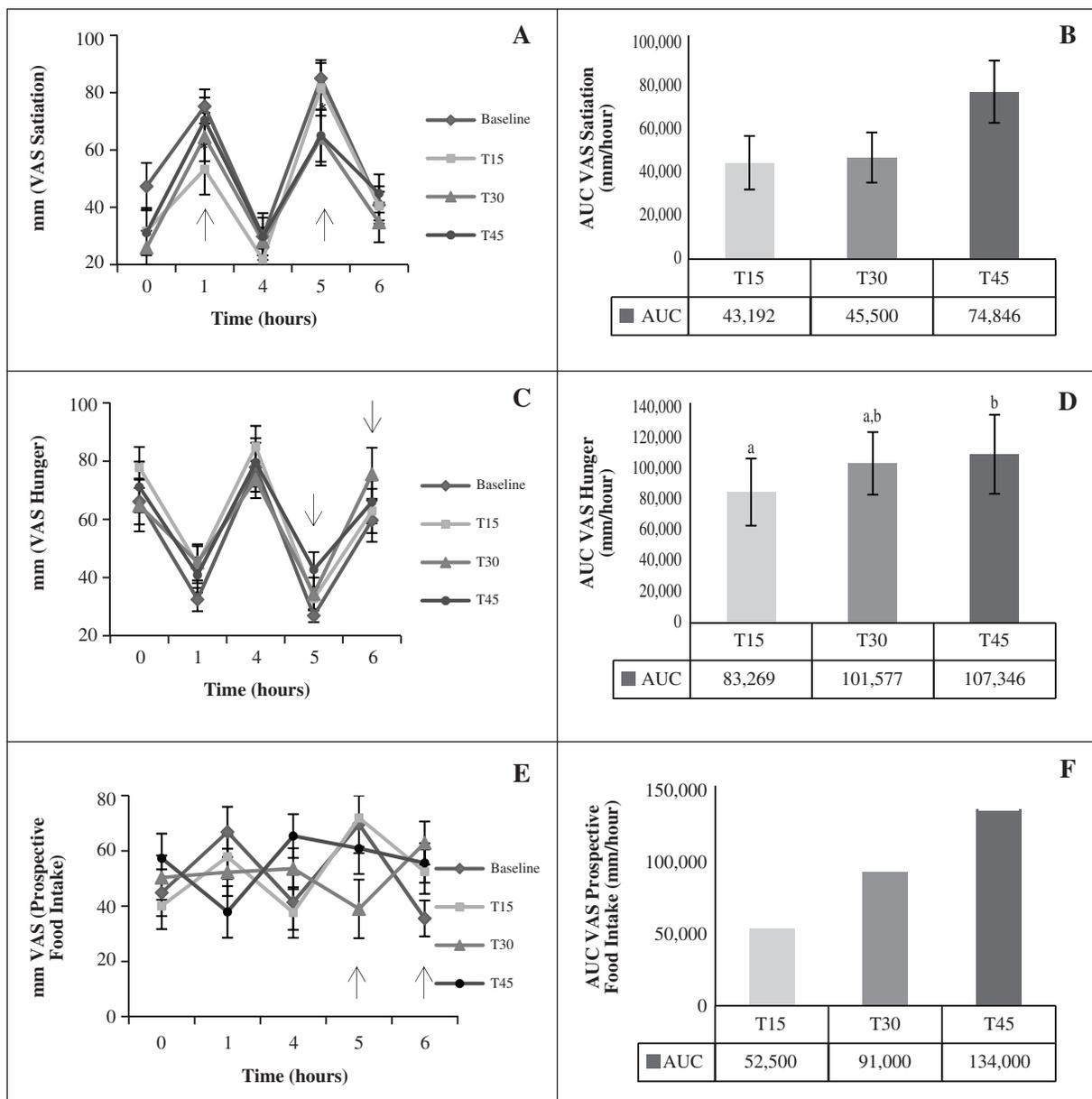


Fig. 1.—Means and Standard Error in the alterations of VAS after 15, 30 and 45 days of intake of “Human Ration” replacing a usual breakfast (baseline). A, C and E: Alterations of VAS between 30 minutes before Human Ration ingestion (Time 0) and 30 minutes before afternoon snack (Time 8) for Hunger, Satiation and desire to Eat More, respectively. B and D: Means and Standard Error of the AUC of VAS for Satiation and Hunger, respectively. F: Medians of the AUC of VAS for desire to eat more. In Figures A, C and E, the values identified with an arrow present the statistical difference in relation to the baseline by the paired t-test ($p < 0.05$). In Figure F, different letters represent the statistical difference by the Friedman test ($p < 0.05$).

ingested by volunteers. Regarding consumption of total fibers, there was a significant increase in ingestion at breakfast during the entire period of HR intake (T15: 4.87 ± 0.68 g; T30: 4.55 ± 0.46 g; T45: 4.98 ± 0.65 g; $p < 0.001$) when compared to usual intake during this meal (1.36 ± 0.85 g). On the other hand, in the following meals there was no statistical difference in fiber consumption.

With the aim to evaluate the sensations of satiety, hunger and prospective intake of foods before, during and at the end of the experiment, the VAS question-

naire was used, attributing values of 0 to 100 mm for these sensations. Generally, the intake of HR did not interfere in the sensations of satiety, hunger and prospective intake among the subjects, presenting only instantaneous significant alterations throughout the study (fig. 1). The consumption of HR resulted in an increase ($p = 0.034$) in the sensation of hunger after lunch at day 45 of the study (fig. 1C), as well as the decrease ($p = 0.034$) in satiety after breakfast at day 15 and after lunch ($p = 0.021$) at day 45 of experimentation. Regarding the prospective intake of foods, based

on the desire to “eat more”, the intake of HR reflected a decrease of appetite after lunch ($p = 0.013$) at 30 days, and increase before the afternoon snack ($p = 0.046$) after 45 days of consumption (fig. 1E). The desire to eat more was higher at 45 days when compared to the first 15 days of experimentation ($p = 0.013$) (fig. 1F).

When correlating the area under the curve to the parameters of hunger, satiation and the desire to eat more, and macronutrients and calories intake, a negative correlation was observed ($r = -0.6028$) between the carbohydrate contents at breakfast and the desire to eat more. At day 30, a negative correlation was verified between the carbohydrate content present in lunch and satiation ($r = -0.4996$). Corroborating with this result, was verified a positive correlation between the carbohydrate content at lunch and hunger ($r = 0.5235$). After 45 days of experiments, a negative correlation was observed between satiation and content of carbohydrates, fibers and calories at breakfast ($r = -0.5628$, $r = -0.4937$, $r = -0.7031$ and $r = -0.5693$, respectively).

Discussion

The anthropometric parameters of body weight and BMI did not change at the end of 45 days in the present study, suggesting that the portion of HR proposed was not capable of significantly reducing these measurements, despite studies showing an inverse association between the intake of fibers and weight gain.¹⁴ Also, no decrease in AbP was observed, different from population studies in which the consumption of whole grains has been associated with smaller perimeters.¹⁴ A transversal study with roughly 2000 women evaluated the relationship between intake of whole grains and the BMI. The authors demonstrated that the women who regularly consume whole grains had lower BMI and AbP, and were less likely to be overweight.¹⁵

In relation to the body fat percentage assessed by DEXA, a small, insignificant increase was observed. This was different from Thompson et al.¹⁶ who evaluated the effects of a fiber-rich diet on weight loss in obese adults and found a reduction in body fat, assessed by the same method, after intake of a diet enriched with fibers and caloric restriction. These results may have been due to the caloric restriction, not included in the present study.

Regarding the serum lipid profile, concentrations of TC, LDL and triglycerides, presented significant reductions of 5.64%, 7.72% and 13.62%, respectively. Some studies corroborate with these findings, indicating that fiber intake can alter the profile of serum lipoproteins.^{17,18} Solà et al.¹⁷ found a reduction of 21.6% in the levels of triglycerides and 6% reduction of TC and LDL in hypercholesterolemic subjects after 56 days of intervention with fibers. These variations could have been due to the sample size of these studies, as well as the presence of chronic diseases pre-established prior to intervention. Also observed in an intervention

with cereals was an association between the consumption of cereals and the reduction in plasmatic levels of TC (4.5%) and LDL (5.3%).¹⁸ Such reductions found in intervention studies with cereals may be attributed to the increase in average intake of fibers. In another intervention with whole grains associated to a diet with caloric restriction, Maki et al.¹⁴ observed a reduction in serum levels of LDL in overweight and obese men and women with hypercholesterolemia. The reduction by only 1% in serum levels of LDL has been associated with the decrease of 1-2% in occurrence of coronary events.¹⁹ Therefore, it may be considered that the consumption of HR, even without caloric restriction, can contribute to reduce one of the main risk factors associated with cardiovascular diseases.

Animal studies have illustrated that the main effects of fibers, particularly soluble fiber, is due to the fecal loss of biliary acids²⁰ resulting in reduction of the hepatic pool of cholesterol, modification of enzyme activity that regulates homeostasis, up-regulation of the hepatic receptors of LDL²¹ and greater removal of LDL from the plasma.²² Moreover, the intake of fibers reduces the glycemia rate of foods, increasing their beneficial effects on the lipid profile.²³ Regarding HDL no statistical differences were observed after intervention, but may be attributed to the short period of the study. Thompson et al.¹⁶ observed an increase in HDL levels and reduction in cholesterol levels for a diet rich in fibers and caloric deficit of 500 calories. In the present study, no alteration was observed in fasting glycemia after the intake of HR, however, studies found in literature have reported an improved glycemic profile with the increase of fiber intake associated with the decrease in occurrence of type 2 diabetes.²⁴

The ratio between TC and HDL, denominated as Castelli index,²⁵ was not altered after intervention. This ratio is used in the classification of coronary risk and is an important predictor of cardiovascular risk since it analysis two risk components.²⁶

It has been suggested that fiber intake acts favorably on hepatic functions.²⁷ For this purpose, markers of hepatic function were quantified, AST and ALT, but presented no differences after the intake of HR, suggesting the absence of alterations in hepatic function of the volunteers and indicating that the product does not present short-term risk of hepatotoxicity. Moreover, the sesame seed, one of the HR components, has some nutraceutical and hepatoprotector characteristics.²⁷ It should also be mentioned that the HR is a mix of ingredients to which allegations of functionality are attributed. However, when considering the recommendations the total quantity ingested daily of each is very small (HR consumption of 25 g/day). Thus, careful considerations are necessary when recommending the use of HR, considering functionality allegations of its ingredients separately.

Upon analyzing the eating behavior, it was observed that HR intake as a breakfast substitute did not modify

the average intake of macronutrients and fiber throughout the day. Scientific literature lacks studies that discuss the influence of fiber-rich substitutes on the intake of carbohydrates, lipids and proteins in the diet. Regarding caloric ingestion, some studies reported that fiber supplementation corroborate with the results obtained herein, in which the total caloric ingestion over 24 hours was not altered.²⁸

Substitution of the typical breakfast for that of HR decreased the caloric ingestion for this meal without altering caloric intake of the subsequent meals. Similar results were found by Hamendani et al.²⁹ in a study which the intake of an insoluble fiber-rich breakfast (26 g in 120 kcal) reduced the caloric ingestion at breakfast in relation to a low-fiber breakfast, however, without interfering in caloric intake during lunch. Other studies indicate that the intake of insoluble fibers (33 g) reduces appetite, and consequently the short term ingestion of foods.³⁰ Despite the high volume, fibers present low caloric density, limiting the energetic intake.³¹ Pre-lunch meals of 250 mL containing 3% of soluble- and 1% of insoluble fiber had also decreased the ingestion at lunch in relation to the placebo group, however, the caloric density of this pre-lunch meal was higher than the placebo, generating confusion.²⁸

As expected, the substitution of a typical breakfast for HR increased the daily intake of fibers of the participants only during the first meal of the day (3.62 g on average; $p < 0.05$). The results showed a fiber intake below the recommended value, even with the addition of fibers from HR. In Brazil, the intake of fiber-rich foods has decreased in recent decades due to the change in the social-economical profile of the population, which has resulted in changes in lifestyle and eating habits.³²

The results obtained in the present study have shown that the intake of HR did not alter the sensations of hunger, satiation and prospective ingestion among the subjects. It was expected that the larger quantity of fibers at breakfast by means of ingesting the HR would result in reduced hunger and increase in satiation. This could be explained by the effects of fibers on satiation by action of volume and viscosity, increase in gastric distention and longer chewing time (cephalic phase).³³ Fibers also alter palatability, leading to a reduction in caloric intake.³⁴

An analysis conducted by Mathern et al.³⁴ with 18 healthy obese subjects consuming 8 g of fenugreek fiber for breakfast showed an increase in averages attributed to satiation and plenitude, and reduction in the averages of hunger and intention to eating more. Such effects were attributed to the presence of soluble fiber which decreases the rate of gastric emptying. Individuals that consumed beverages supplemented with guar-gum or β -glucan also showed a greater perception of satiation and less desire to eat more.³⁵ However, other studies agree with the results of the present study. Hamedani et al.²⁹ did not observe differ-

ences regarding the subjective sensation of satiation and food intake during lunch after breakfast (60 g) composed of cereals rich in soluble fiber. Hlebowicz et al.³⁶ observed no differences in post-prandial glucose concentration and sensation of satiation in healthy subjects ($n = 12$) that received corn flakes, cereal flakes and oatmeal.

The sensations assessed by the VAS may have also been influenced by the macronutrient content present in the previous and subsequent meals for fulfilling of the scale. Studies have shown that the macronutrient content in a meal can influence the sensations of hunger and satiation, and apparently the effect of proteins on satiation is greater when compared to lipids and carbohydrates.^{37,38} However, the correlations found among macronutrient intake, caloric value and the sensations of satiation, hunger and prospective ingestion of foods were controversial. Only carbohydrate intake differed statistically in relation to the usual intake, where reduction in consumption was verified only during breakfast at 15 and 30 days after initiating the experiment, with no differences in intake of proteins and lipids. Moreover, the intake of HR as a breakfast substitute did not result in the alteration of satiation. Unlike expected, at day 45 the content of proteins and fibers at breakfast when consuming HR was negatively correlated with the sensation of satiation.

There are other versions of HR with little variations in the number and quantity of ingredients and the results of this study cannot be extrapolated to all products since nutritional composition can vary significantly.

This pioneering study with HR presents some limitations that must be considered. Although the sample calculation ensure good statistical power, it is necessary that studies be performed with a greater number of participants of both genders in order to obtain more extrapolated results for the population. It is important to note that daily intake of the product was not tolerated by most of the volunteers due to the "food monotony", which especially restricted the intervention time that was initially planned for 60 days. The short period of HR intake may have limited the results on anthropometric parameters. The TFEQ is widely used in studies conducted in Brazil that allows for assessing restrictive eating behavior. Lack of validation for the Brazilian population can be considered a methodological limitation of this study, however, this questionnaire was only used as a criterion for inclusion and exclusion. Lack of difference regarding sensations assessed by the VAS can be explained by the difficulty of perceiving hunger and satiation as reported by many of the volunteers. Consumption of the recommended daily HR portion was not sufficient to significantly modify the daily ingestion of fibers; however, larger quantities are not also accepted making it is unknown until what point the product is toxicologically acceptable.

Conclusions

Despite the limitations of this study, the results that were found did not agree with allegations in the media and popular consensus regarding the beneficial effects to health, especially weight reduction and increased satiation. Intake of HR did not modify the sensations of satiation, hunger and prospective ingestion among the participants. The HR used as a breakfast substitute during 45 days did not promote alterations in body composition, concentrations of glucose, HDL, VLDL, TC/HDL, AST or ALT. Intake of HR reduce the concentrations of TC, LDL and triglycerides, while maintaining the consumption of calories, macronutrients and fibers by the volunteers. The results are clinically relevant among individuals that are overweight and obese, since they can contribute to reduced risk of cardiovascular diseases and other chronic non-communicable diseases; however, consumption of the product as a meal substitute should not be encouraged. Therefore, further studies must be performed in order to determine the potential long term health effects, as well as evaluate other population groups.

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