

Intake of antioxidant dietary fiber from spent coffee grounds improves the circadian rhythm and body weight management in human adults

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ABSTRACT

The aim of the present study was to evaluate the effects of acute and repeated intake of biscuits, containing as source of dietary fiber either spent coffee grounds (SCG, added with fructooligosaccharides) or extracted coffee antioxidant dietary fiber (ADFSC) obtained by ohmic procedure, on body weight management and CR of human volunteers. Nutritional composition of biscuits (TC, C-ADFSCG and C-SCG) was determined confirming a total fiber content of 5, 3.4 and 1.7 g of fiber/45 g (administered portion), respectively. Satiety increased after C-ADFSCG consumption compared with TC and C-SCG, with high area under the curve (AUC) ($p < 0.05$). *Ad libitum* food intake measured at breakfast decreased energy intake ($p < 0.05$), but no difference was observed at lunch. However, total energy intake was significantly ($p < 0.05$) lower with C-ADFSCG compared with C-SCG and TC. ADFSCG was well tolerated. Physical activity, sleep quality and biological chronotype (morningness/eveningness) with melatonin has been used as a biological marker were improved by C-ADFSCG and C-SCG, suggesting its positive effect on CR regulation. In the absence of other lifestyle changes, the new ADFSCG show promise to positively impact body weight management thus improving health, and could be considered as a potentially healthy functional ingredient for application in the food industry.

Keywords: Spent coffee Grounds; Dietary Fiber; chronodisruption, circadian rhythms, satiety.

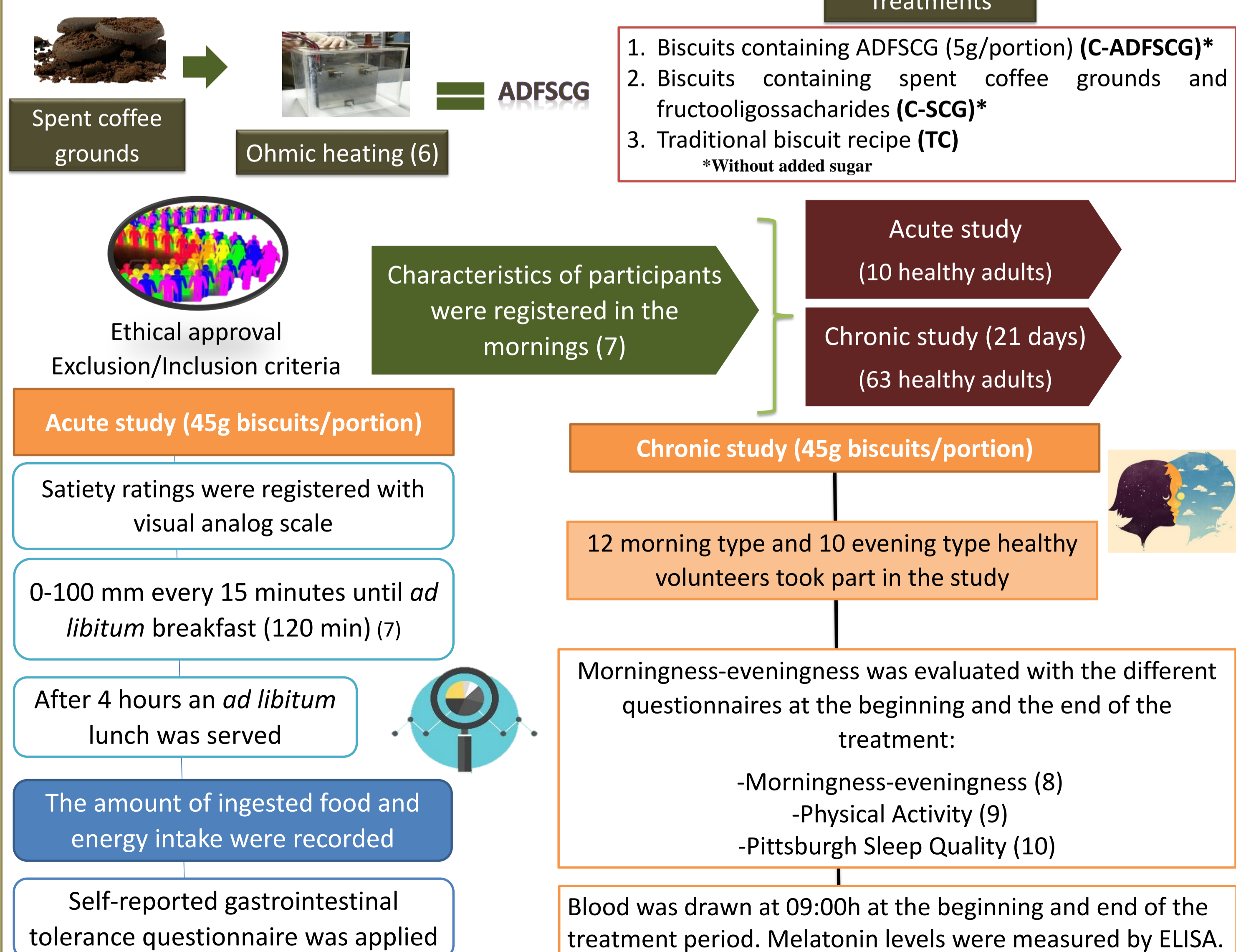
BACKGROUND

Disruption of circadian rhythms (CR), called chronodisruption, especially in the evening chronotype, is associated with an increased risk of non-communicable diseases such cancer, overweight and obesity. Recently, foods have been considered as powerful modulators of the CR. However, there is a lack of evidence on the effect of the intake of dietary fiber or antioxidants on CR parameters like locomotor activity (1). Spent coffee grounds (SCG) have been proposed as new functional food ingredient due to their large amount of dietary fiber and high antioxidant capacity which provide several health benefit effects (2, 3, 4). Recently, a dietary fiber ingredient from spent coffee grounds, possessing improved technological and antioxidant properties, was extracted by employing ohmic heating approach (5).

OBJECTIVE

To evaluate the effect of acute and repeated intake of biscuits, containing as source of dietary fiber either SCG (added with fructooligosaccharides) or extracted coffee antioxidant dietary fiber obtained by ohmic procedure, on body weight management and CR of human volunteers.

METHODS



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RESULTS

Biscuits formulation

Table 1. Biscuits formulation

Ingredients (g/100g)	TC	C-SCG	C-ADFSCG
Wheat flour	79.11	59.4	66.68
Maltodextrin	13.96	-	11.77
Baking powder	0.56	0.58	0.47
Salt	0.47	0.39	0.39
Stevia	-	0.20	0.20
Sucrose	17.90	-	-
Sunflower oil	5.91	8.20	4.98
Soy lecithin	0.00	0.35	-
Water	30.00	21.20	30.00
Fructooligosaccharides	-	3.50	-
SCG	-	4.20	-
ADFSCG	-	-	15.70

Table 2. Nutritional composition of the biscuits.

g/45 g of cookies	ADFSCG			CSCG			TC		
	Mean	SD	t Test	Mean	SD	t Test	Mean	SD	t Test
Moisture	2.98 ± 0.03 ^d			4.74 ± 0.03 ^d			3.55 ± 0.08 ^d		
Ash	1.71 ± 0.07 ^{ab}			1.46 ± 0.00 ^a			2.09 ± 0.47 ^a		
Proteins	12.23 ± 0.10 ^b			11.42 ± 0.30 ^a			7.85 ± 0.13 ^d		
Lipids	7.53 ± 0.28 ^{bc}			9.43 ± 1.70 ^b			5.14 ± 0.25 ^c		
Carbohydrates	79.61 ± 0.06 ^a			72.93 ± 1.92 ^{ab}			81.35 ± 0.54 ^a		
Total dietary fiber	5 ± 0.32 ^a			3.24 ± 0.28 ^b			1.7 ± 0.08 ^d		

Data represent the mean ± SD.

According with the Codex Alimentarius (1997), C-ADFSCG and C-SCG have a high fiber and protein content (Table 1 and 2).

Acute study

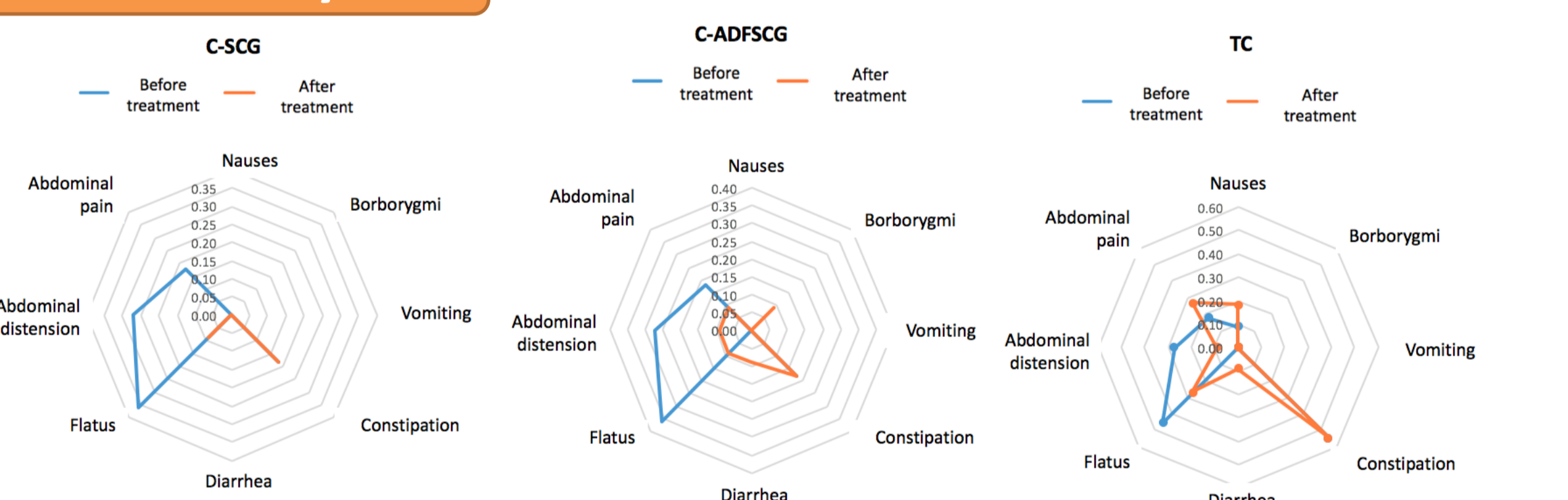


Figure 1. Self-reported gastrointestinal tolerance symptoms after spent coffee grounds antioxidant dietary fiber-biscuit (C-ADFSCG), spent coffee grounds-biscuit (C-SCG) and traditional biscuit (TC) consumption. Symptom change using a four-point Likert scale (0, absent; 4, severe).

Intake of biscuits did not cause gastrointestinal side effects (Figure 1) and the sensorial quality of the foods was well accepted.

Satiety

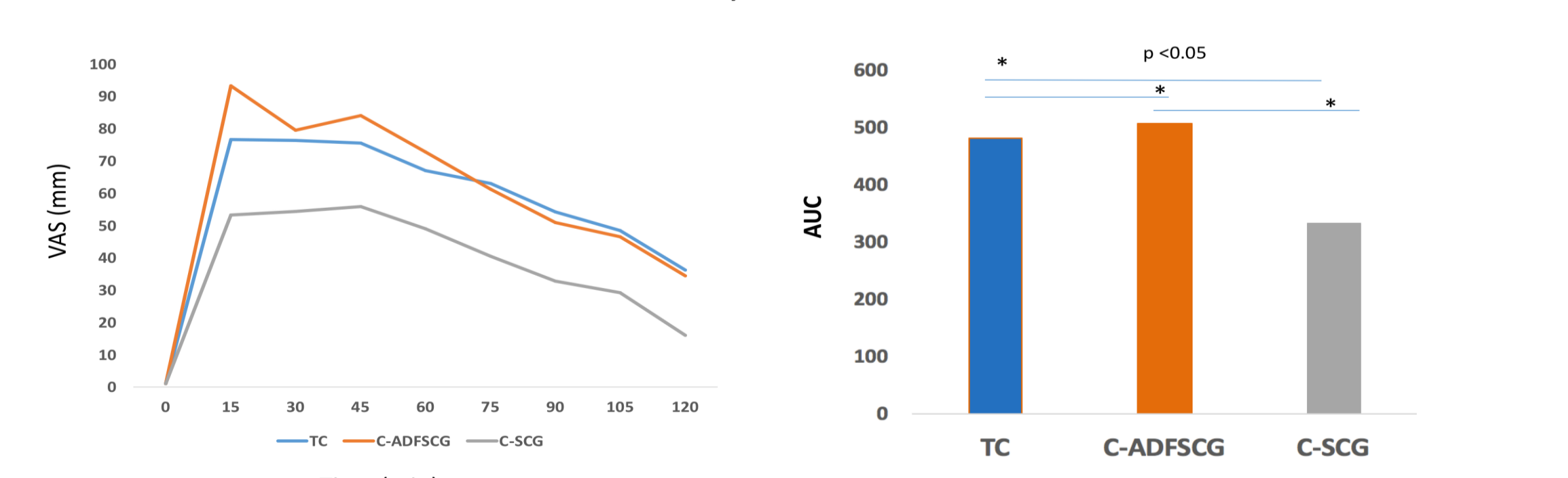


Figure 2. Self-reported satiety average ratings and their corresponding area under the curve (AUC) after spent coffee grounds antioxidant dietary fiber-biscuit (C-ADFSCG), spent coffee grounds-biscuit (C-SCG) and traditional biscuit (TC) consumption. Data represent the mean. * $p < 0.05$ (Tukey test).

Satiety was significantly ($p < 0.05$) increased by acute intake of biscuits containing extracted coffee fiber compared with that caused by the other biscuits (Figure 2).

Table 3. Characteristics of the participants in both studies.

Parameter	Acute study	Chronic study
Age	24.37 ± 0.29	25.73 ± 2.99
Weight	71.46 ± 9.80	64.68 ± 11.57
Height	1.69 ± 0.04	1.64 ± 0.09
BMI	25.23 ± 2.90	24.00 ± 2.73

Data represent the mean ± SD.

Table 4. General characteristics of the population and changes in the anthropometric parameters by group, after 21 days of intervention (Chronic study).

Anthropometry	C-ADFSCG		TC		C-SCG	
	Mean ± SD	t Test	Mean ± SD	t Test	Mean ± SD	t Test
Weight (kg)	-0.14 ± 1.55**	0.66	0.12 ± 0.94	0.54	0.00 ± 1.37	0.99
BMI (kg/m ²)	-0.08 ± 0.52**	0.45	0.04 ± 0.33	0.57	-0.00 ± 0.50	0.97
% of fat	-0.61 ± 1.24**	0.02*	0.3 ± 1.28	0.29	0.54 ± 1.39	0.10
Fat (kg)	-0.12 ± 1.17**	0.61	0.22 ± 0.95	0.28	0.71 ± 1.94	0.12
Total body water	-0.14 ± 1.47	0.63	-0.19 ± 0.98	0.38	0.15 ± 0.95	0.48
Visceral fat	-0.05 ± 0.38**	0.48	0.06 ± 0.46	0.51	-0.15 ± 0.48	0.18
Waist circumference (m)	-0.01 ± 0.03**	0.04*	-0.002 ± 0.057	0.86	-2.70 ± 0.08	0.16

The data presented as increase or decrease (-) comparing the final values vs the basal values. * $p < 0.05$ significant intragroup difference. ** $p < 0.05$ significant intergroup difference.

Repeated intake of C-ADFSCG significantly ($p < 0.05$) reduced total energy intake, waist circumference and body fat accumulation compared to baseline values and other treatments (Table 4).

Chronic study

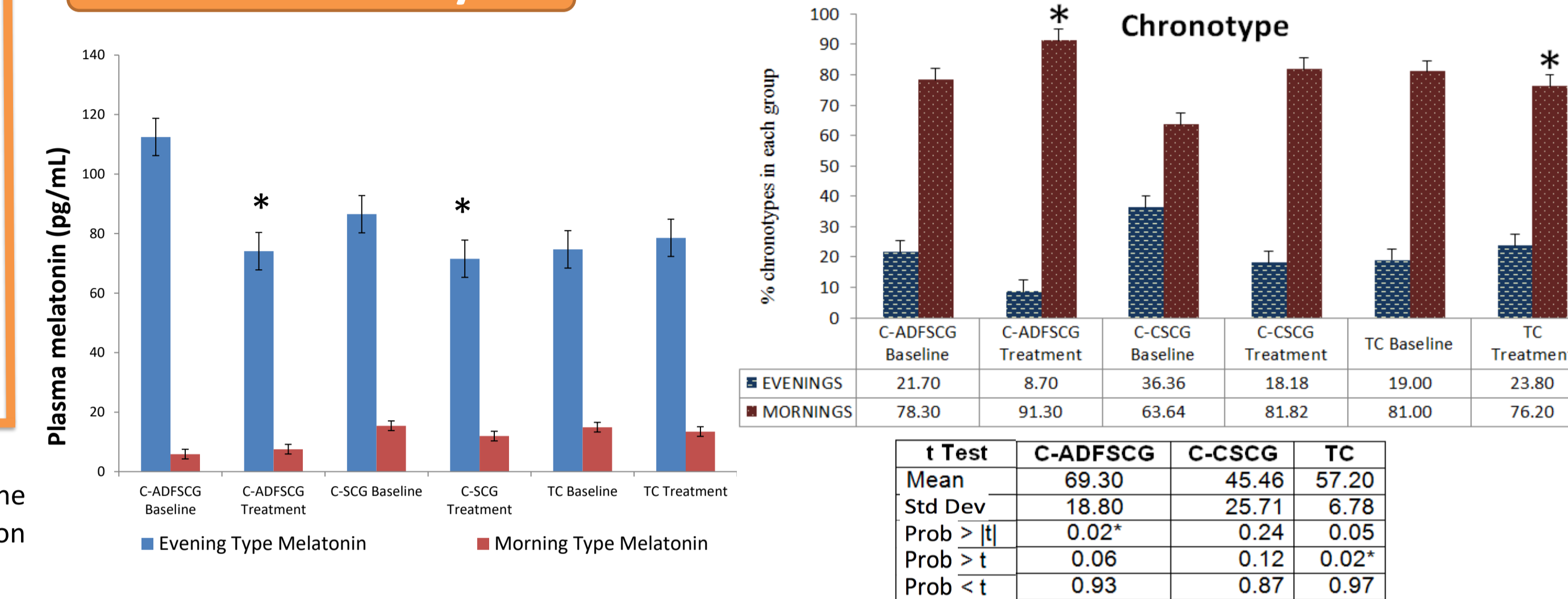


Figure 3. Comparison of melatonin plasma levels by chronotype measured at 09:00h. Data represent the mean ± SD. Values above 28pg/mL of serum melatonin at this time represent the evening chronotype. * $p < 0.05$ (t Test) baseline vs treatment per group.

Figure 4. Changes in the chronotype by group measured (Horne-Östberg) after 21 days of intervention. Data represent the mean ± SD. * $p < 0.05$ (t Test), baseline vs treatment per group.

- Melatonin levels in plasma (9:00 am) of volunteers with the evening chronotype, treated with biscuits containing dietary fiber or SCG, were significantly decreased after 21 days of treatment (Figure 3).
- Consumption of C-ADFSCG ($p < 0.05$) and C-SCG increased morning chronotypes, which was proportional to the decrease of evening chronotypes, demonstrating their effect on circadian synchronization (Figure 4).

Physical activity

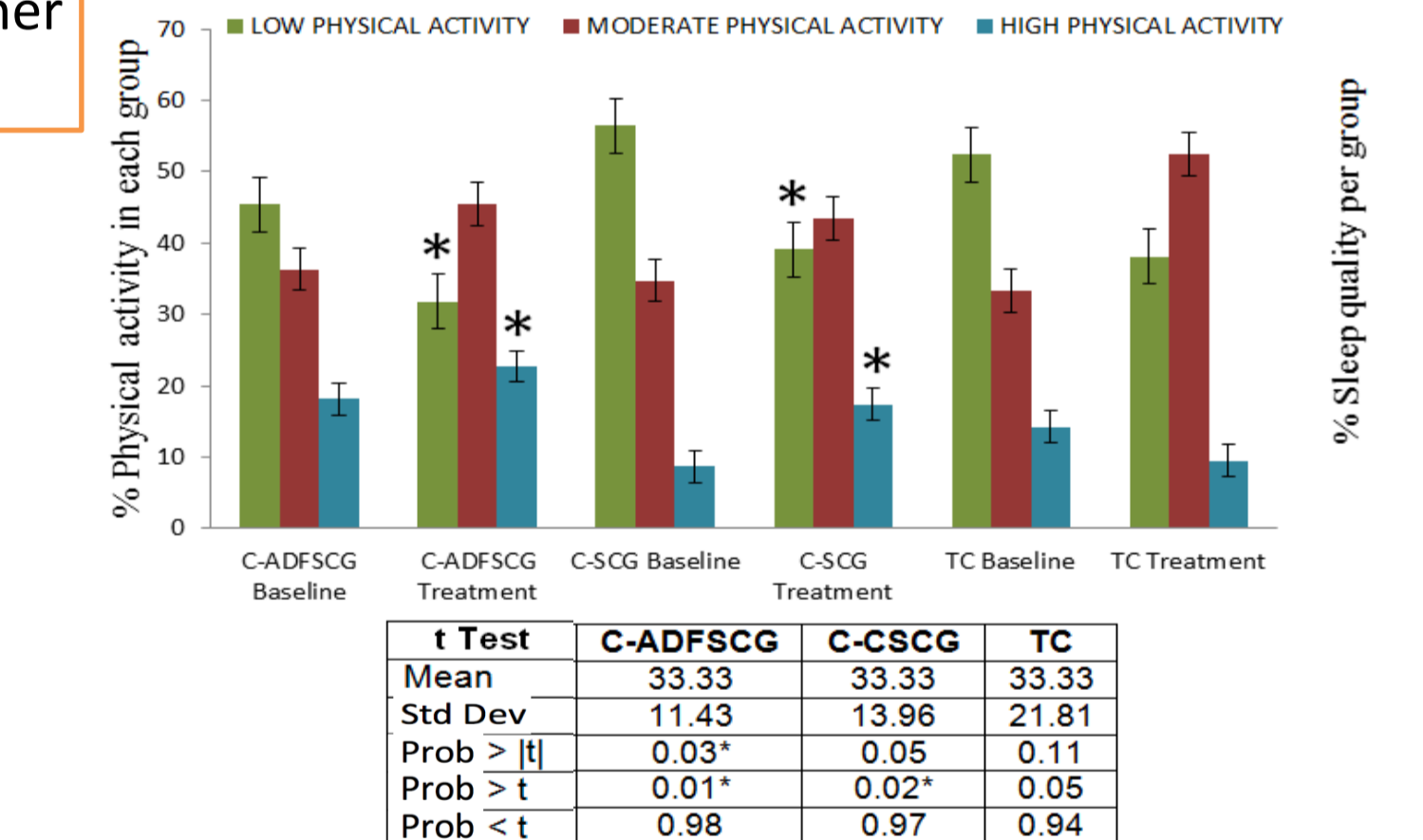


Figure 5. Effects of the treatments on physical activity. Data represent the mean ± SD. * $p < 0.05$, baseline vs treatment per group

Sleep quality

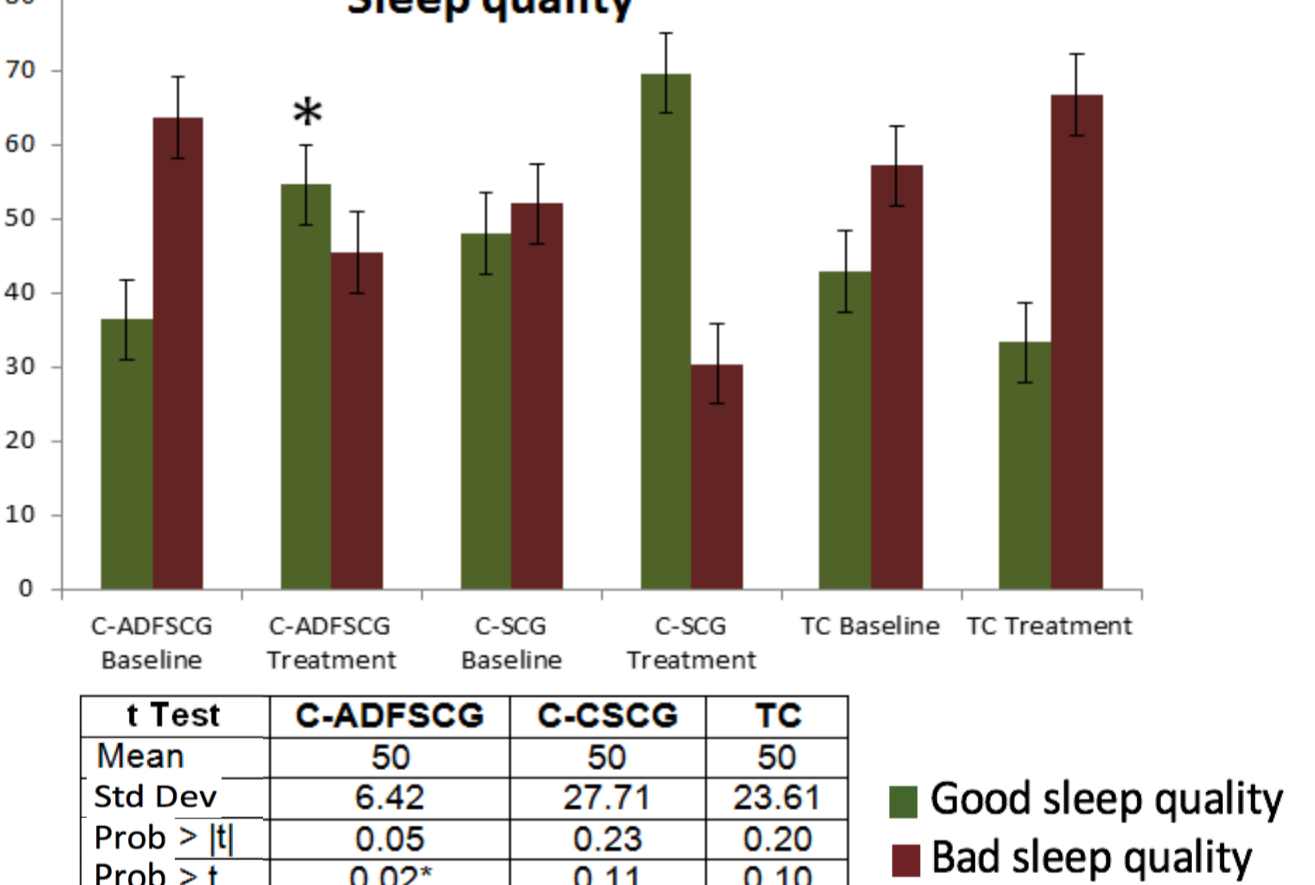


Figure 6. Effects of the treatments on sleep quality. Data represent the mean ± SD. * $p < 0.05$, baseline vs treatment per group

Physical activity, sleep quality and biological chronotype (morningness/eveningness) were improved by the intake of biscuits containing coffee fiber (Figures 5 and 6, respectively).

CONCLUSIONS

For the first time, it is reported that the use of antioxidant dietary fiber from spent coffee grounds as food ingredient in biscuits, and SCG (added with fructooligosaccharides), may have a positive impact in the circadian rhythm. Biscuits containing dietary fiber extracted using ohmic heating have higher concentration of the nutrient than those containing SCG as ingredient presented additional benefits allowing a better body weight management.

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