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► To cite this version:

Peio Touyarou, Claire Sulmont-Rossé, Aude Gagnaire, Sylvie Issanchou, Laurent Brondel. Monotonous consumption of fibre-enriched bread at breakfast increases satiety and influences sub-sequent food intake.. Appetite, 2012, 58 (2), pp.575-81. 10.1016/j.appet.2011.11.026 . hal-00787919

HAL Id: hal-00787919 https://hal.science/hal-00787919

Submitted on 6 Jan 2022

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1 MONOTONOUS CONSUMPTION OF FIBRE-ENRICHED BREAD

2 AT BREAKFAST INCREASES SATIETY AND INFLUENCES

3 SUBSEQUENT FOOD INTAKE

4 Authors

- 5 Peio Touyarou^a, Claire Sulmont-Rossé^a, Aude Gagnaire^a, Sylvie Issanchou^a and Laurent
- 6 Brondel^{a,b}

7 Addresses

- 8 ^aCentre des Sciences du Goût et de l'Alimentation, UMR6265 CNRS, UMR1324
- 9 INRA, Université de Bourgogne, Agrosup Dijon, Dijon, France
- 10 ^bCHU de Dijon, Service d'Hépato-Gastroentérologie and UFR de Médecine de
- 11 l'Université de Bourgogne, Dijon, France.

12 Corresponding author

- 13 Peio Touyarou
- 14 Centre des Sciences du Goût et de l'Alimentation,
- 15 17 rue Sully, 21000 Dijon, France.
- 16 E-mail: Peio.Touyarou@dijon.inra.fr
- 17 Tel: +33 (0)380693410, Fax: +33 (0)380693227

18

20 ABSTRACT

21 This study aimed to observe the influence of the monotonous consumption of two 22 types of fibre-enriched bread at breakfast on hedonic liking for the bread, subsequent 23 hunger and energy intake. Two groups of unrestrained normal weight participants were 24 given either white sandwich bread (WS) or multigrain sandwich bread (MG) at 25 breakfast (the sensory properties of the WS were more similar to the usual bread eaten 26 by the participants than those of the MG). In each group, two 15-day cross-over 27 conditions were set up. During the experimental condition the usual breakfast of each 28 participant was replaced by an isocaloric portion of plain bread (WS or MG). During 29 the control condition, participants consumed only 10 g of the corresponding bread and 30 completed their breakfast with other foods they wanted. The results showed that bread 31 appreciation did not change over exposure even in the experimental condition. Hunger 32 was lower in the experimental condition than in the control condition. The consumption 33 of WS decreased energy intake while the consumption of MG did not in the 34 experimental condition compared to the corresponding control one. In conclusion, a 35 monotonous breakfast composed solely of a fibre-enriched bread may decrease 36 subsequent hunger and, when similar to a familiar bread, food intake.

37 Keywords

Dietary fibre, weight loss, monotony, variety, staple foods, bread, food intake, satiety,
satiation, breakfast

40

42 Introduction

43 Several studies have shown that a high-fibre diet may increase satiety and decrease 44 energy intake (for recent studies see Lyly et al., 2009; Schroeder, Gallaher, Arndt, & 45 Marquart, 2009; Willis, Eldridge, Beiseigel, Thomas, & Slavin, 2009). Several 46 mechanisms have been put forward to explain the lower hunger/energy intake following 47 the ingestion of dietary fibre (Burton-Freeman, 2000; Heaton, 1973; Howarth, 48 Saltzman, & Roberts, 2001; Tungland & Meyer, 2002). Dietary fibre increases 49 chewing, which is thought to reduce the rate of ingestion (Heaton, 1973). It increases 50 saliva and gastric juice production and therefore increases gastric volume (Norton, 51 Anderson, & Hetherington, 2006; Rolls & Roe, 2002). Furthermore, the gel-forming 52 capacity of soluble fibre increases gastric distension (Burton-Freeman, 2000). This 53 distension is involved in producing satiation during a meal (de Graaf, Blom, Smeets, 54 Stafleu, & Hendriks, 2004) and satiety between meals (Wang et al., 2008). Fibre 55 decreases nutrient absorption in the intestine and thus reduces the metabolisable energy 56 from available food (Baer, Rumpler, Miles, & Fahey, 1997; Wisker, Maltz, & Feldheim, 57 1988). Fibre, particularly soluble fibre, also increases chyme viscosity, thereby slowing 58 transit time in the small intestine which triggers the secretion of Glucagon Like Peptide-59 1 (Reimer & McBurney, 1996), of cholecystokinin, of ghrelin (Weickert et al., 2006) 60 and of peptide YY (Reimer et al., 2010). 61

61 The aim of the present experiment was to assess whether replacing the usual 62 breakfast of normal bodyweight participants by an isocaloric portion of fibre-enriched 63 bread over several days would affect subsequent satiety and food intake. At first sight, 64 it was expected that a fibre-enriched breakfast would reduce hunger sensation during the

65 morning and decrease food intake during subsequent meals. However, it was unclear 66 whether or not this effect would persist over several days (e.g. over repeated 67 consumption) of fibre-enriched bread. In fact, several studies have shown that repeated -68 monotonous - consumption of a food induces a decrease in pleasure for that food (Rolls 69 & de Waal, 1985; Schutz & Pilgrim, 1958; Siegel & Pilgrim, 1958). Thus, the repeated 70 consumption of fibre-enriched bread may lead to a reduction in pleasure, which in turn 71 may have an adverse effect on subsequent food intake. This question is obviously of 72 particular interest to those who wish to promote better weight management through the 73 consumption of "functional" food such as fibre-enriched foods.

74 This study was conducted using two types of fibre-enriched sandwich bread. In 75 both types, the quantity of fibre was about five times higher than in a traditional French 76 baguette. The ratio of soluble/insoluble fibre was similar between the two breads but 77 the source of the fibre differed. One bread (White Sandwich - WS) was formulated to 78 look like white sandwich bread because French consumers are used to eat white bread 79 (75% of the bread eaten in France in 2009 was white bread). The other (Multigrain -80 MG) bread actually looked like a multigrain bread with inclusions and was less familiar 81 to French consumers. The choice of exposing participants to sandwich bread at 82 breakfast was motivated by the work of de Castro (2007) who observed that a high level 83 of carbohydrate consumed during the morning reduced total food intake for the rest of 84 the day.

The present experiment aimed to assess whether or not the effect of monotonous consumption of fibre-enriched bread could influence subsequent satiety and food intake, and whether such an effect depended on the type of bread eaten by the participants.

88 Materials and methods

89 Design

90 The two types of bread were tested in a between-subject design. For each group, the study consisted in two periods of 15 days. In one period, the experimental 91 92 condition, the participants' breakfast consisted exclusively of fibre-enriched bread (*i.e.* 93 WS or MG, depending on the group). For each participant, the quantity of bread 94 consumed provided an energy intake that was similar to that of the participants' usual 95 breakfast according to food diaries (see below). In the other period, the control 96 condition, participants ate a small portion of fibre-enriched bread (10 g) and then 97 completed their breakfast with the food of their choice. The quantity of fibre in such a 98 small portion was negligible, but it allowed controlling for a possible effect of repeated 99 exposure to the sensory characteristics of the bread that was independent from the effect 100 of the fibre. For each condition, liking, hunger and food intake were measured and 101 recorded at regular intervals (see below).

102 Participants

Participants were recruited by a local advertisement. All were bread eaters. To participate, candidates had to be aged between 20 and 45, have a Body Mass Index (BMI) between 19 and 25 kg/m² and be in the habit of eating breakfast, including at least one solid food, every day. Candidates also had to obtain a restriction score equal to or below 9 (Stunkard & Messick, 1985). Finally, any candidates with food allergies, or who were undergoing medical treatment, or who smoked more than five cigarettes a day were excluded. The characteristics of both groups are presented in Table 1.

Individual informed consent was obtained before the experiment. The protocol was
approved by the ethics committee of Dijon, France (CPP-Est-I). Participants received a
€100 fee for their participation.

113 Breads

114 The bread WS was enriched with fibres from wheat bran and formulated to look 115 like a white sandwich bread. The bread MG was enriched with fibres from other cereals 116 (oat, rye) and formulated to look like a multigrain bread with inclusions. Both breads 117 were provided by Gustalis (Longvic, France). Their composition is shown in Table 2. 118 Prior to the study, a Flash Profile (Dairou & Sieffermann, 2002) was carried on the 119 two breads and on four branded breads belonging to the same product range with 32 120 participants different from the participants of the present study. Results showed that the 121 sensory characteristics of WS and MG breads were similar to the ones of the branded 122 breads. Specifically, the WS bread was characterized by a light colour, a soft texture 123 and a slightly sweet taste, while the MG bread was characterized by a slightly darker 124 colour and a larger number of inclusions corresponding to the grain particles. Given the 125 habits of French participants and the results of the Flash Profile, the WS bread 126 corresponded more to a "white bread" while the MG bread corresponded more to a 127 "multigrain bread".

128 *Procedure*

129 Food diaries

Before the study, participants recorded and weighed all foods and beveragesconsumed at three consecutive regular breakfasts eaten at home (precision required was

± 1g). These diaries were then analysed using Bilnut software (S.C.D.A. Nutrisoft,
Cerelles, France) in order to calculate the usual energy intake for each participant at
breakfast and subsequently to determine the amount of bread (WS or MG) to be
consumed by each individual during the experimental period.

136 *Phases of exposure*

137 For each group (WS or MG), there were two periods of a fortnight each. During 138 the experimental condition, participants were required to consume the equivalent in 139 bread (WS or MG) of their usual energy intake. Participants were requested to eat the 140 bread plain, without butter or jam in order to avoid inter-individual differences. In fact, 141 without this constraint, some participants would have chosen to eat the bread with jam, 142 others with butter (or margarine) or with both jam and butter. In addition to the bread, 143 the participants were allowed to drink their usual beverage (e.g. coffee or tea). It should 144 be noted that in the experimental condition, the mean breakfast intake of dietary fibre 145 was not different between the WS group (M=14.9; σ =6 g) and the MG group (M=21.6; σ =10 g). During the control condition, participants were required to consume 10 g of 146 147 WS or MG bread at each breakfast. They could complete their breakfast with their 148 usual food and drink choices.

The participants received their daily bread ration in separate freezing bags. They were instructed to thaw the bread by placing it at room temperature the evening before consumption. Breakfasts were eaten at home and participants were instructed not to share their rations with other family members. They were also instructed to consume all the bread provided at breakfast. In order to check compliance, participants were asked to bring back their freezing bags each time they came to the laboratory for new

supplying. Six participants (5 for the bread MG; 1 for the bread WS) brought back a
small portion of non-eaten bread during the first days of the experiment but after further
discussion, they adapted themselves to the ration.

158 At each breakfast, participants were required to give a hedonic rating for the bread

159 at the first mouthful. Participants were also asked to rate their sensation of hunger

160 before breakfast, immediately after breakfast, at 10 am and at noon. These assessments

161 were made on visual analogue scales of 10 cm anchored at each end ("Extremely

162 unpleasant" / "Extremely pleasant" and "I am not hungry at all" / "I am extremely

163 hungry", respectively). On the second, sixth, tenth and fourteenth day of each phase of

164 exposure (D2, D6, D10, D14), participants were also required to record and accurately

165 weigh all foods and beverages consumed during the day (Clatronic KW204 scale,

166 Kempen, Germany, precision required: 1 g).

167 Data analysis

168 The grades on the scales were converted into scores from 0 to 10 by measuring the 169 distance between the left anchor and the mark made by the participant. The food diaries 170 filled in during the two periods were analysed using Bilnut software (S.C.D.A.

171 Nutrisoft, Cerelles, France) to determine the total energy intake per meal and per day

172 (breakfast, lunch and dinner).

The evolution of various parameters (hunger, pleasure, energy, carbohydrate, fat and protein intakes) during the periods was modelled using a linear mixed model with *condition* as a fixed effect, and *exposure* and *participant* as random effects. For the random element, an appropriate correlation structure was sought to account for possible correlations between measurements taken at different times for a given participant. A 178 compound symmetry (CS) correlation structure was chosen because it led to the lowest

179 Akaike criterion (AIC) for most of the parameters. Only linear factors were retained in

180 the final models (Table 3), as the quadratic factors (*exposure*² and *exposure*² \times *condition*)

181 were not significant. Statistical analyses were performed using the MIXED procedure

182 of SAS software (SAS Institute Inc., Cary, NC, USA).

183 **Results**

184 Effect of repeated consumption of a fibre-enriched bread at breakfast on the hedonic

185 *liking of this bread*

186 Fig. 1 shows the evolution of liking scores during consumption of the first 187 mouthful of bread at breakfast, according to the condition and the bread consumed. 188 Marginal ANOVA obtained with the general linear model did not reveal any condition 189 effect for the WS bread (Table 3). No difference in liking for the first mouthful of bread 190 at breakfast between the experimental condition and the control condition for the WS 191 bread (experimental condition: M = 5.1, S.D. = 2.6; control condition: M = 4.9, S.D. = 192 2.6) was observed. In contrast, a significant condition effect was observed for the MG 193 bread: participants appreciated this bread less in the experimental condition (M = 5.1,194 S.D. = 2.7) than in the control condition (M = 6.0, S.D. = 2.7). As, in both conditions, 195 participants gave their hedonic rating at the first mouthful, this difference may be 196 related to what they have to eat. So, their expectations were lower when they had to eat 197 a large quantity than when they had to eat just a mouthful. Liking for the breads did not decrease over repeated consumptions: in fact regardless of the bread consumed, the 198

199 *exposure* effect was not significant. Moreover, the *exposure*condition* interaction was200 not significant.

Effect of repeated consumption of a fibre-enriched bread at breakfast on subsequent sensation of hunger

203 Fig. 2 shows the evolution of the sensation of hunger at four times of the day: 204 before breakfast, after breakfast, at mid-morning and at noon, for both the WS and MG bread. For the WS bread, ANOVA did not reveal any significant condition effect before 205 breakfast: the sensation of hunger in the experimental condition (M = 4.9, S.D. = 2.7) 206 was not different from that in the control condition (M = 5.0, S.D. = 2.7). In contrast, a 207 208 condition effect was observed immediately after breakfast, at 10 am and at noon. At 209 each of these times, the sensation of hunger was rated lower in the case of the 210 experimental condition (after breakfast: M = 1.0, S.D. = 1.5; at 10 am: M = 1.7, S.D. = 211 1.7; at noon: M = 4.4, S.D. = 3.9) than for the control condition (after breakfast: M =212 2.0, S.D. = 2.2, at 10 am: M = 2.7, S.D. = 2.5; at noon: M = 5.2, S.D. = 2.8). A significant exposure effect was also observed for measurements at 10 am and at noon, 213 214 showing an increase in hunger ratings at both of these times over subsequent days of the 215 study. 216 For the MG bread, a condition effect was observed before breakfast: the hunger rating was slightly lower in the experimental condition (M = 5.3, S.D. = 2.4) than in the 217 218 control condition (M = 5.6, S.D. = 2.8). This effect was nonetheless slight compared to the significant condition effect observed at 10 am and at noon. Once again, at each of 219 220 these times, the sensation of hunger was rated lower in the experimental condition (at 10

am: M = 2.4, S.D. = 2.4; at noon: M = 6.0, S.D. = 2.7) than in the control condition (at

10 am: M = 3.5, S.D. = 2.7; at noon: M = 6.8, S.D. = 2.1). An *exposure* effect was also observed for the evaluations before breakfast, immediately after breakfast and at noon, showing a decrease in hunger ratings just before and just after breakfast over subsequent days of the study on the one hand, and an increase at noon on the other.

Effect of repeated consumption of a fibre-enriched bread at breakfast on energy intake throughout the day

Fig. 3 shows the evolution of the total energy intake at breakfast and for the rest of

the day during each period of exposure (D2, D6, D10 and D14). For intake at breakfast,

230 marginal ANOVA did not reveal any significant *condition*, *exposure* or

231 *exposure*condition* effect, regardless of the group considered (Table 3). The energy

intake for the experimental condition (WS bread: M = 392 kcal, S.D. = 173; MG bread:

233 M = 393 kcal; S.D. = 148) was not different from the energy intake for the control

234 condition (WS bread: M = 394 kcal; S.D. = 241; MG bread: M = 354 kcal; S.D. = 207).

235 These results therefore demonstrated that at breakfast, energy intake for the

236 experimental condition was equivalent to the energy intake for the control condition,

237 during which participants supplemented the required consumption of 10 g of bread with

their usual food and beverage choices.

Regarding the energy intake calculated for the rest of the day, data analysis

240 revealed a significant *condition* effect for both the WS bread and the MG bread, but

these effects were opposite (Table 3 and Figure 3). In fact, for the WS bread the

242 experimental condition reduced energy intake for the rest of the day compared to the

243 control condition (mean 4 days values M = 1263 kcal; S.D. = 120 and M = 1424 kcal;

S.D. = 120 respectively). In contrast, for the MG bread the experimental condition

increased energy intake for the rest of the day compared to the control condition (M =1408 kcal; S.D. = 85 and M = 1261 kcal; S.D. = 85 respectively). The *exposure* and *exposure*condition* effects were not significant for either type of bread. The same pattern of results was observed when intakes were analysed per meal (lunch, dinner) (data not shown).

250 **Discussion**

In accordance with the hypotheses, replacing the participants' breakfast with a monotonous consumption of fibre-enriched bread (WS or MG) led to a decrease in the sensation of hunger during the morning. However, the decrease in hunger coincided with a decrease in subsequent energy intake for the WS bread, but an increase in energy intake for the MG bread. Results also showed that repeated consumption of these types of bread at breakfast did not lead to decreased liking for the breads over the course of the study, even in the experimental condition.

258 Data in the literature has shown that repeated - monotonous - consumption of a 259 food generated a decrease in intake and/or in liking for that food (Cabanac & Rabe, 260 1976; Rolls & de Waal, 1985; Zandstra, de Graaf, & van Trijp, 2000). For instance, 261 Cabanac and Rabe (1976) observed a reduction of 25 to 50% in food intake when 262 normal weight subjects were given a complete liquid diet everyday, at each meal, for 263 three consecutive weeks. In an unpublished study conducted in our laboratory, ten 264 unrestrained participants of normal weight ate the same food exclusively - ravioli - at 265 every meal for three consecutive days (for breakfast, lunch and dinner). The results 266 showed a significant reduction in overall food intake (-33% on the third day) compared

267 to a control situation. Zandstra et al. (2000) observed that consumption of a savoury 268 sauce once a week for ten consecutive weeks resulted in a decrease in the amount of 269 sauce consumed, even though the participants could combine the sauce with the food of 270 their choice. Concurrent with this decrease, Zandstra and colleagues (2000) observed a 271 decrease in hedonic liking for these sauces. However, several authors have observed 272 that repeated consumption of "staple foods" did not affect their hedonic liking 273 (Hetherington, Pirie, & Nabb, 2002; Kamen & Peryam, 1961; Meiselman, de Graaf, & 274 Lesher, 2000). The FAO defines staple foods as foods that are eaten regularly and in 275 such quantities as to constitute the dominant part of the diet and supply a major 276 proportion of energy and nutrient needs. Staple foods are generally cereal products that 277 constitute a major part of a diet and are culture-specific (e.g., bread in France, rice in 278 Southeast Asia). Meiselman et al (2000) focused on the evolution in liking for a food 279 which is initially highly palatable - chocolate - compared to a moderately palatable food 280 belonging to the staple food category - buttered bread - over the course of repeated 281 consumption (once a day for 22 days). The results showed that liking for chocolate 282 decreased greatly over the course of subsequent consumption, while liking for buttered 283 bread remained close to its initial level. Consequently, Meiselman and colleagues 284 suggested characterising staple foods as "staple components of a diet [that] are resistant 285 to monotony effects". Due to their predominance in a population's diet and to their 286 resistance to the monotony effect, it has been suggested that staple foods could be used 287 to fight against certain food disorders. Bouis (2000) and Welch and Graham (2004) 288 suggested enriching staple foods with macronutrients in order to combat nutritional 289 deficiencies caused by under-nutrition. Conversely, improving the nutritional quality of 290 staple foods could be a useful means to prevent and/or treat diabetes and obesity (Franz

291	et al., 2002; Thompson et al., 2005). The present study confirmed that repeated
292	consumption of a large quantity of bread did not induce lassitude for bread. These
293	results substantiate the advantages of bread as a way to improve the nutritional quality
294	of diets for French people.
295	The decrease in hunger after the consumption of the two breads and the lower
296	intake after the WS bread could be attributed to the presence of dietary fibre. In fact,
297	some studies have shown that repeated consumption of a fibre-enriched food can lead to
298	a reduction in energy intake and weight in obese patients (Rössner, Von Zweigbergk,
299	Öhlin, & Ryttig, 1987; Stevens et al., 1987). Pasman and colleagues (Pasman, Saris,
300	Wauters, & Westerterp-Plantenga, 1997) showed that the consumption of orange juice
301	containing a guar gum supplement (soluble fibre) for a week led to a decreased
302	sensation of hunger, resulting in reduced energy intake, compared to a control situation
303	where participants received orange juice without added fibre. In accordance with these
304	results, we observed that replacing a standard breakfast with an isocaloric amount of
305	WS bread led to a decreased sensation of hunger during the morning and a reduction in
306	subsequent energy intake. In contrast, while replacing breakfast with an isocaloric
307	amount of MG bread also led to a decreased sensation of hunger, this decrease did not
308	result in a reduced caloric intake. On the contrary, in the experimental condition for this
309	bread, participants slightly increased their caloric intake during subsequent eating
310	events.
311	The difference between the effect of WS and MG bread consumption on
312	subsequent food intake, albeit a similar decrease in hunger sensation in both conditions,

313 underlines the fact that measurement of the sensation of hunger (as performed here with

314 visual analogue scales) does not always predict actual food intake. A number of studies

315 have shown relationships between measurements of hunger and food intake (e.g. de 316 Castro & Elmore, 1988) but Mattes (1990) noted that rating the sensation of hunger is a 317 learned rather than an innate reflection of the systems that control appetite. Beyond this 318 methodological aspect, several hypotheses can be proposed to explain why the 319 decreased sensation of hunger induced inconsistent reductions in energy intake. 320 One possible explanation relates to the nature of the fibre used to formulate WS 321 and MG bread. In fact, some authors evidenced that the origin of fibre might play a role 322 in the decrease in hunger sensation or caloric intake. For example, Hlebowicz et al. 323 (2007) did not observe any difference in hunger ratings after ingestion of cereal bran 324 flakes, wholemeal oat flakes or corn flakes. On the contrary, Willis et al. (2009) 325 observed that participants were less hungry after ingestion of a preload of muffins with 326 resistant starch or corn bran than muffins with barley oat. Furthermore, some authors 327 observed that an ingestion of fibre led to a dissociation between hunger and food intake 328 (e.g., Schroeder et al., 2009) whereas others observed that a decrease in hunger 329 sensation led to a decrease in subsequent energy intake (e.g., Lee et al., 2006). Another 330 possible explanation to explain the differential effect of the two breads on energy intake 331 could be related to the difference in liking between the experimental and the control 332 conditions that was observed for the MG bread but not for the WS bread. It is possible 333 that having to eat a relatively large amount of the MG bread induced a feeling of 334 "discomfort" among participants. Participants may then have compensated for this 335 "discomfort" by increasing their subsequent food intake. A last explanation relates to 336 cognitive associations related to the appearance of the bread. Participants may have associated the MG bread with a high fibre-content (in fact, it was formulated to look 337 338 like multigrain bread), and, in turn, to low caloric foods. Thus, it is possible that

subjects ate more on the rest of day as they erroneously believed that they had a low
energy breakfast when they had MG bread in comparison to WS bread. However, those
hypotheses deserve further evaluation. A better understanding of the physiological
and/or psychological mechanisms responsible or not of the decrease of subsequent food
intake after fibre ingestion could be a challenge for future studies.

344 Conclusion

The present study indicates that the consumption of a monotonous enriched-fibre bread decrease the subsequent sensation of hunger without affecting liking for bread. However, while this decrease in hunger led to a decrease in subsequent food intake for the more familiar bread, it did not for the less familiar one. This underlines the importance of developing healthy staple foods that are not too different from the foods we are used to; otherwise they may not lead to the expected beneficial effects.

351 Acknowledgements

352 We thank Gustalis® for the production of the breads. We also thank Philip

353 Bastable ('Pôle de Recherche', Dijon University Hospital), E.P. Köster (CICS,

354 Wageningen University and Research) and Luc Pénicaud (UMR CSGA, Dijon) for

355 revising the paper. This work was financed by the French government under the FUI

356 (Fond Unique Interministériel) programme through the project Farine +.

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463 Table 1: Characteristics of the participants

WS Group (n=16)	MG Group (n=22)
8 / 8	12 / 10
25.9 ± 1.2	30.2 ± 1.5
22.8 ± 0.5	22.3 ± 0.4
4.6 ± 0.5	4.5 ± 0.4
	WS Group (n=16) 8 / 8 25.9 ± 1.2 22.8 ± 0.5 4.6 ± 0.5

464 Restriction score was determined by the "Three Factors Eating Questionnaire" (Stunkard &

465 Messick, 1985).

467 Table 2: Energy content and composition of the two types of bread.

	WS Bread	MG Bread
Energy content (kcal/100g)	211.4	228.8
Carbohydrates (g/100g)	37.7	36.8
Lipids (g/100g)	3.2	3.8
Proteins (g/100g)	8.0	11.8
Dietary fibre (g/100g)	10.4	12.8
Ratio soluble/insoluble fibre	30/70	33/67

- 470 Table 3: Hedonic score, hunger and food intake (*F* and *p* values) for the WS group and the MG
- 471 group. Significant effects are in bold characters.

Deveneter	Time of measurement	Factors	WS Group		MG Group	
Parameter			F	р	F	р
Hedonic score	First mouthful	Condition Exposure Condition×Exposure	1.81 0.00 1.05	0.20 0.98 0.31	56.82 1.19 3.58	<0.001 0.27 0.06
Hunger	Before breakfast	Condition Exposure Condition×Exposure	0.29 3.53 3.04	0.60 0.06 0.08	4.45 6.03 0.02	0.05 0.01 0.90
	After breakfast	Condition Exposure Condition×Exposure	69.7 0.07 3.28	<0.001 0.78 0.07	3.26 11.81 3.36	0.08 <0.001 0.07
	At 10 am	Condition Exposure Condition×Exposure	49.90 11.27 0.56	<0.001 0.009 0.45	39.32 2.70 0.15	<0.001 0.10 0.63
	At noon	Condition Exposure Condition×Exposure	14.77 6.08 0.22	0.002 0.01 0.64	20.73 4.16 1.56	<0.001 0.04 0.21
Food Intake	Daily	Condition Exposure Condition×Exposure	4.56 4.31 1.81	0.05 0.04 0.18	10.69 0.44 2.22	0.004 0.51 0.14
	Breakfast	Condition Exposure Condition×Exposure	0.01 0.07 0.22	0.93 0.79 0.64	3.68 1.01 0.23	0.07 0.32 0.63
	Lunch	Condition Exposure Condition×Exposure	2.79 4.49 0.22	0.12 0.04 0.64	0.34 0.07 0.34	0.57 0.80 0.56
	Dinner	Condition Exposure Condition×Exposure	5.57 0.84 0.71	0.03 0.36 0.40	3.02 0.02 1.46	0.09 0.88 0.23
	Snack	Condition Exposure Condition×Exposure	0.02 0.23 0.86	0.89 0.63 0.36	2.70 1.05 2.87	0.11 0.31 0.09
	Daily <i>minus</i> Breakfast	Condition Exposure Condition×Exposure	4.61 0.34 0.43	0.05 0.56 0.51	5.89 0.19 1.85	0.02 0.66 0.18

472 Condition levels: experimental and control.

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475

FIGURES CAPTIONS

Fig. 1. Evolution of bread liking scores during the control condition (hatched line)

476 versus the experimental condition (full line) for each type of fibre-enriched bread (white 477 sandwich bread – WS – on the left; multigrain bread – MG – on the right). Results are 478 expressed as mean and SEM. 479 Fig. 2. Evolution in hunger sensation before breakfast, after breakfast, at 10 am and at 480 noon during the control condition (hatched line) versus the experimental condition (full 481 line) for each type of fibre-enriched bread (white sandwich bread – WS – on the left; 482 multigrain bread – MG – on the right). Results are expressed as mean and SEM. 483 Fig. 3. Evolution of the energy intake at breakfast and during the rest of the day (total 484 daily energy intake minus Breakfast energy intake, Table 3) during the control condition 485 (hatched line) versus the experimental condition (full line) for each type of fibre-486 enriched bread (white sandwich bread – WS – on the left; multigrain bread – MG – on 487 the right). Results are expressed as mean and SEM. 488

FIGURE 1









