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## Is abnormal 25 g fructose breath test a predictor of symptomatic response to a low fructose diet in irritable bowel syndrome?

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1                   **IS ABNORMAL 25 G FRUCTOSE BREATH TEST A PREDICTOR OF**  
2                   **SYMPTOMATIC RESPONSE TO A LOW FRUCTOSE DIET IN IRRITABLE**  
3                   **BOWEL SYNDROME?**

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14 **Key words:** Fructose breath test; irritable bowel syndrome; predictive factor; low fructose  
15 diet; Irritable Bowel Syndrome-Symptom Severity Score

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## ABSTRACT

**BACKGROUND:** Fructose malabsorption may trigger gastrointestinal symptoms in irritable bowel syndrome patients and a low fructose diet seems to improve digestive symptoms.

**AIM:** The aim of our study was to determine whether fructose malabsorption detected by a 25g fructose breath test could be a predictor of the efficacy of a low fructose diet.

**METHODS:** 88 patients (73 women, median age, 45.5 years, range 18-69) with irritable bowel syndrome according to Rome III criteria were included in this prospective, controlled study. All 88 patients had a 25 g fructose breath test; 37 had a positive test result defining fructose malabsorption. All 88 patients followed a low fructose diet for 2 weeks, blinded to their test results. Patients filled self validated-questionnaires before and at the end of the dietary period. The main outcome measurement was the Irritable Bowel Syndrome-Symptom Severity Score.

**RESULTS:** Irritable Bowel Syndrome-Symptom Severity Score significantly decreased in fructose absorbers and fructose malabsorbers after a low fructose diet (-68.0 [-137 ; 0] vs -73.5 [-173 ; -11.5]) with no difference according to fructose breath test result (adjusted p=0.984).

**CONCLUSION:** A positive 25 g fructose breath test is not a predictor of the efficacy of a low fructose diet in irritable bowel syndrome.

**Registered clinical trial :** [www.clinicaltrials.gov](http://www.clinicaltrials.gov) (NCT02188680)

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## INTRODUCTION

45 Irritable bowel syndrome (IBS) is the main functional disorder worldwide and is characterized  
46 by chronic abdominal pain associated with transit disorders. The underlying pathogenesis of  
47 IBS is considered complex and several functional alterations have been described. These  
48 include altered visceral sensitivity, bowel dysmotility and secretory dysfunctions, immune  
49 intestinal activation, gut dysbiosis, brain gut alterations, somatic and psychiatric co-  
50 morbidities. A link between food intake and the occurrence or the exacerbation of IBS  
51 symptoms has been reported (1). Recently, Gibson *et al* underlined the deleterious  
52 symptomatic role of poorly absorbable and rapidly fermentable carbohydrates (FODMAPs)  
53 (2). Among FODMAPs, fructose commonly present in fruit (mainly pears and apples),  
54 vegetables, honey and sweeteners, is of particular interest. Indeed, dietary intake of fructose  
55 has increased dramatically during the last decades (4). Fructose is absorbed from the intestinal  
56 lumen by facilitated diffusion through the glucose transporter 5 (GLUT5) in the mucosa,  
57 whereas glucose facilitates this transport (3). Consequently, excessive dietary intake of  
58 fructose, in excess of glucose, can easily exceed the absorptive capacity of the small bowel,  
59 leading to incomplete absorption of fructose and, finally, causing fructose malabsorption  
60 (FM) (2). The unabsorbed fructose may play a role in osmotic load and is therefore rapidly  
61 propelled into the colon, where its contact with anaerobic microbiomes causes fermentation  
62 and the production of a gaseous feeling, abdominal bloating, and even diarrhea (4, 5). A low  
63 fructose diet is therefore recommended. Open label studies have demonstrated the  
64 effectiveness of reducing fructose in patients with IBS, achieving adequate symptom relief in  
65 70-80% of patients (6-8). At present, it is unclear which IBS patients will benefit from a low  
66 fructose diet. The current test for FM diagnosis is the fructose breath test (FBT) (2) performed  
67 with a 25 g load of fructose as recommended by the North American consensus on breath test

68 (9). However, the ability of this 25 g FBT to predict the efficacy of a low fructose diet in IBS  
69 patients is still debated (6, 10).

70 Our objective was to study the predictive value of a 25 g FBT on the outcome of a low  
71 fructose diet in a cohort of patients with IBS using controlled, simple-blind, parallel groups.

72

## 73 **MATERIALS & METHODS**

### 74 **Patients**

75 All consecutive IBS patients referred to the Physiology Unit of Rouen University Hospital  
76 (France) for FBT from January 2014 to January 2018 were invited to participate in the trial.

77 Inclusion criteria were: IBS according to Rome III criteria (11), age  $\geq 18$  years, normal clinical  
78 examination, standard biological tests (including C Reactive Protein) and colonoscopy (with  
79 colonic biopsies) performed in the last 6 months. Exclusion criteria were: small intestinal  
80 bacterial overgrowth (SIBO) as determined by breath testing, a history of abdominal surgery  
81 (except for appendectomy), systemic scleroderma, diabetes, metabolic syndrome, anorexia  
82 and pregnancy. Other exclusion criteria were changes to IBS medication during the trial.

83 The study was approved by the Haute-Normandie Ethics Committee (2013-AOO116-39) on  
84 the 23<sup>rd</sup> May 2013 and was registered at [www.clinicaltrials.gov](http://www.clinicaltrials.gov) (NCT02188680). Patients  
85 gave written informed consent before participation. The study protocol conforms to the ethical  
86 guidelines of the 1975 Declaration of Helsinki and has received IRB approval.

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### 89 **Study design**

90 All 88 patients included in the study had a 25 g FBT and were distributed in two balanced  
91 groups of patients: a group with positive FBT results and a group with negative FBT results.

92 Then, all patients had a consultation with a dietician who instructed them to follow a low

93 fructose diet carefully during a period of 2 weeks. Improvements in digestive symptoms were  
94 recorded at the end of the diet and compliance was evaluated at 1-week and 2-week dietary  
95 periods in the two groups. Patients had to fill their dietary notebook daily while on the diet for  
96 assessment of dietary compliance (patients only filled the type of food but not the quantity).

97

#### 98 **Breath tests**

99 Each patient had two breath tests. First, a glucose breath test was carried out in order to rule  
100 out SIBO (2). Second, if negative, a FBT was then performed with a 25 g fructose load  
101 following a methodology previously described (12). Both dieticians and participants were  
102 blinded to FBT results during the entire study duration. In contrast, the investigators were not  
103 blinded to FBT results in order to balance the number of patients in the two groups (i.e;  
104 patients with positive or negative FBT results).

105

#### 106 **Dietary advice**

107 All included patients were referred to our experienced dieticians (M.M. and E.G.) for a  
108 standardized dietary adaptation. The initial consultation comprised an interview during which  
109 a qualitative patient-defined typical day dietary intake was recorded. Then, individual  
110 instructions for the low fructose diet were given both verbally and through written  
111 information (supplementary files, annex 1). Patients were advised to eat a maximum dose of  
112 100 g of fruit and 200 g of vegetables per day (containing <2% of fructose), corresponding to  
113 a fructose intake of less than 6 g/day. Patients were able to contact the dieticians during the  
114 dietary period for further information. Patients with IBS already on a diet were eligible to  
115 participate in the study as long as they agreed to abandon their diet for the study duration.  
116 Dietary compliance was assessed by live telephone interview by the investigators, one week  
117 after initiation of the dietary change and during the last assessment visit by retrieving the

118 patient's dietary notebook of the 2-week diet. Dietary compliance was roughly assessed by  
119 the physician and not by the dietician. Dietary compliance categories were adapted from a  
120 previous work (8) : never/rarely (<25% of the time), sometimes (25%-50% of the time),  
121 frequently (51%-75% of the time) or always (76%-100% of the time). Compliance was  
122 considered adequate if patients confirmed they had adhered to the dietary guidelines for at  
123 least 50% of the meals consumed.

124

### 125 **Assessments and end points**

126 The primary endpoint was a decrease in the clinical severity of IBS symptoms, self-evaluated  
127 using the irritable bowel severity scoring system (IBS-SSS) (13) before and at the end of the  
128 2-week dietary period.

129 Secondary endpoints were assessed before and at the end of the dietary intervention. They  
130 included: quality of life, severity of anxiety and/or depression, stool consistency, weight and  
131 body mass index (BMI). The quality of life was assessed using the Gastrointestinal Quality of  
132 Life Index (GIQLI) (14). Anxiety and depression levels were assessed using the hospital  
133 anxiety and depression scale (HAD) (15). In addition, patients gave a description of stool  
134 quality on a scale from 1 to 7 (Bristol stool scale) (16). Patients' opinions of the low fructose  
135 diet were also recorded using two questions: "Do you think that the diet has improved your  
136 digestive symptoms?" and "Do you think you will stay on the diet at the end of the study?".  
137 Adverse events of any kind were monitored throughout the study period.

138

### 139 **Statistical analysis**

140 The sample size calculation was based on the primary end-point (i.e. the mean change of IBS-  
141 SSS between the beginning and the end of the low fructose diet period). The mean IBS-SSS in  
142 a cohort of 241 IBS patients was estimated at  $298 \pm 85$  (personal unpublished data). Based on

143 this standard deviation, 40 subjects had to be included in each group (patients with or without  
144 FM) to highlight a difference of 60 in the variation of IBS-SSS between the two groups with a  
145 two-sided 0.05 type I error and to obtain at least 80% power.

146 The effect of diet was assessed before and after diet using paired sample t-test. Per protocol  
147 analysis was performed for the primary outcome using data from all patients completing the  
148 study who did not violate the protocol. Patients who did not complete the study were replaced  
149 by other patients, limited to 10% of the overall population (8 patients).

150 Otherwise, demographic and clinical characteristics, GIQLI, Bristol stool scale, anxiety and  
151 depression HAD at baseline were compared between IBS patients with or without FM using a  
152 Mann–Whitney test. The same test was also used for comparison of score variations (IBS-  
153 SSS, GIQLI, Bristol stool scale and HAD) between groups and between the beginning and the  
154 end of the diet. These comparisons were adjusted for sex and age (<40 and  $\geq$ 40) variables  
155 using a logistic regression.

156 Results are presented as median with first and third quartile (Q1-Q3). A P value below 0.05  
157 was considered significant. These analyses were carried out using SAS 9.3 software (SAS  
158 Institute Inc., Cary, NC, USA).

159



## RESULTS

160  
161 A total of 88 patients (73 women, median age 45.5 [18-69] years) were included in the study.  
162 Eleven patients (12.5%) were withdrawn from the trial and seventy-seven patients (87.5%)  
163 completed their dietary course (Figure 1). The different size of the groups was due to the  
164 limited number of possible replacements (8 patients).

165 The demographics and the baseline characteristics of the two groups are shown in Table 1.  
166 The sex ratio was significantly different between groups ( $P=0.02$ ). Patients in the group with  
167 positive FBT were significantly older than those with negative FBT ( $P=0.02$ ). As age and sex  
168 ratio were different between the two groups, further analyses were performed to adjust  
169 comparisons for age and sex. There was no other significant difference in any demographic or  
170 baseline characteristic between the two groups of patients (Table 1).

171 Sixty-eight patients (77%) attributed their IBS symptoms to food, with high-carbohydrate  
172 foods, dairy, beans, foods rich in fats and spices, and lentils most commonly cited. Twenty-  
173 three patients among the 88 included (26%) were on special therapeutic diets at the start of the  
174 study: a low lactose diet (10 patients); a low fructose diet (4 patients); a hypo-caloric diet (5  
175 patients); and a gluten free diet (4 patients). There was no difference concerning the frequency  
176 of food-related disorders and alimentary restrictions between the group with positive FBT and  
177 the group with negative FBT ( $P=0.96$  and  $P=0.48$ , respectively).

178

### 179 **Effects of a low fructose diet**

180 There was a significant improvement in symptoms between baseline and follow-up after  
181 dietary intervention. There was a significant decrease in IBS-SSS and HAD scores and a  
182 significant increase in GIQLI after a low fructose diet, whereas no change was observed for  
183 stool consistency (Table 2). This improvement in symptoms was concomitant with patients'  
184 feelings regarding the diet. Fifty-five of 88 patients (62.5%) reported an improvement in

185 symptoms following their diet. Nevertheless, among them, only 34 patients (62%) were  
186 prepared to continue the low fructose diet after the end of the study, because they considered  
187 the diet to be too restrictive. In addition, the diet was associated with significant weight loss  
188 (Table 2).

189

#### 190 **Associations between breath test results and outcome of dietary programme**

191 Figure 2 shows the effects of a low fructose diet on IBS-SSS in the two groups. The median  
192 changes at week 2 versus baseline were -73.5 [-173; -11.5] in the group with positive FBT  
193 versus -68.0 [-137; 0] in the group with negative FBT (P=0.98).

194 No effects of the low fructose diet were detected on quality of life, Bristol Stool Scale, or  
195 HAD scores between the two groups (Table 3). 64.9% of patients in the group with positive  
196 FBT and 72.1% of patients in the group with negative FBT reported an improvement  
197 following the diet (P=0.32).

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## DISCUSSION

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In this controlled simple-blind prospective study of patients with IBS, a low fructose diet reduced symptom scores independently of FBT results. Of note, even in the group with negative FBT, most patients had a significant reduction in their symptom scores.

As far as the authors know, only one study has reported the predictive value of the FBT for a symptomatic response to a low fructose diet in IBS patients (6). Bert et al. previously demonstrated that FBT did not discriminate well between IBS patients with or without an effect of the low fructose diet (6), but they used a relatively high dose of 50 g of fructose to reduce the risk of false-negative (6). However, the ability of the human intestines to absorb fructose is limited (17). Specific intestinal fructose transporters in the intestines of humans may be easily overwhelmed by fructose >50 g (4) leading to a variety of gastrointestinal symptoms. When healthy subjects were administered 50 g fructose and had breath tests, 80% had FM (5). The higher the dose and the concentration of fructose, the greater the chance of including a false-positive and biasing the capacity of the FBT to identify the best candidates for a low fructose diet. The optimal dose for FM diagnosis is unclear (17). However, we chose a dose of 25 g because it is closer to the daily intake and has been demonstrated to be effective in FM diagnosis (4). This dose has also been recently recommended by an expert consensus [9]. We expected that lower doses of fructose would allow us to identify subjects with severely restricted fructose absorptive capacity who would benefit more from a low fructose diet. As suggested by others (6), we cannot exclude the fact that a low dose of fructose increased the risk of false-negative results in the group with negative FBT explaining the improvement in symptoms in this group.

The lack of predictive value of the 25 g FBT to identify the best candidates for a low fructose diet is hard to explain. It is possible that it is a useful test but improperly used. Indeed, the

224 heterogeneity of methodologies used, particularly concerning the cut-off value for breath gas  
225 concentration and the ingested dose of fructose, is obvious. A previous study (6) and our  
226 present study demonstrated that 50 g and 25 g doses of fructose were not the optimum choice  
227 to discriminate IBS patients who would benefit from a low fructose diet and those who would  
228 not. However, de Roest et al. demonstrated that a positive FBT performed with a 35 g load of  
229 fructose was strongly associated with the efficacy of a low FODMAP diet that also included a  
230 low fructose diet (10). We can hypothesize that the choice of the dose should not be  
231 determined intuitively, but from a load that best discriminates responders and non-responders  
232 to diet (2). There is a need for further large studies assessing different doses of ingested  
233 fructose and cut-off values for breath gas during FBT to determine their value to discriminate  
234 the best candidates for a low fructose diet.

235 Another explanation for the low predictive value of the 25 g FBT could be that FM is not the  
236 right target. The prevalence of FM in healthy populations appears to be similar to that in  
237 populations with IBS (2). The main difference between symptomatic and asymptomatic  
238 populations is the frequency of symptoms induced after fructose absorption (i.e fructose  
239 intolerance) suggesting that the sensitivity of the bowel to the change in luminal conditions  
240 induced by FM is the key difference rather than the malabsorption itself (2). However,  
241 previous studies have shown responses to a low-FODMAP diet to be similar in patients with  
242 fructose intolerance with or without malabsorption (18, 19). The beneficial effect of a low  
243 fructose diet could also be due to the dietary restriction of fermentable carbohydrates.  
244 Polymerized forms of fructose (inulins, fructans and fructo-oligosaccharides) are considered  
245 as natural prebiotic fibers with a potential beneficial effect on gut microbiota that confers health  
246 benefits to the host (20). However, the beneficial effect of prebiotics in IBS remains  
247 controversial, probably related to the type and dose of prebiotics used (20). Prebiotic  
248 supplementation studies have shown some promise at low doses for modulation of the gut

249 bacteria and reduction of symptoms in IBS; however, larger doses may have a neutral or a  
250 negative impact on symptoms (20). In case of a beneficial effect of fructose as prebiotics, the  
251 reduced intake of fructose polymers should have a negative impact on bowel symptoms. That  
252 was not the case in our study because the low fructose diet led to a decrease in abdominal  
253 symptoms, as for the low FODMAP diet in other studies (10, 21).

254 Finally, it is not possible to exclude a placebo effect for the low fructose diet recordings in  
255 some patients, which could explain the poor predictive value of FBT. The improvement in  
256 anxiety and depression scale scores during the short period of low fructose diet could be an  
257 additional argument for the placebo effect.

258

259 One of the strengths of our study is its controlled single-blind design which meant that  
260 patients and dieticians could not be influenced by the results of their FBT. In addition, in this  
261 study, we chose global relief assessment as the broadest main outcome measure, as changes in  
262 specific symptoms incompletely assess the impact of treatment in IBS or changes in quality of  
263 life (19). Lastly, the single center characteristic of this study ensured the consistency of all  
264 dietary advice for all included patients.

265

266 Nevertheless, our study has several limitations. First, our two groups of patients were not  
267 identical. Patients in the group with positive FBT were older and more frequently male than  
268 patients in the group with negative FBT. In a previous paper, we already found that male  
269 gender was more frequent in patients with malabsorption (12). To our knowledge, these  
270 findings have never been reported in the literature and we do not have any clear explanation  
271 for this. However, we have taken these differences into consideration in our statistical  
272 analysis. Considering the sample size and the low number of men in the study (n=15) our  
273 results should only be applied in women with IBS. Second, we performed a diet of short

274 duration to limit the risk of non-compliance and withdrawals whereas a 6-week dietary period  
275 is recommended (22). Third, we did not calculate the precise amount of fructose in patients'  
276 diets before and during the study. Based on the first interview with the dietician, we were able  
277 to determine if patients were on a specific diet. Four patients who were on a low fructose diet  
278 before the study linked the ingestion of some fruit and vegetables to their abdominal  
279 symptoms. However, it has been demonstrated that people who identify themselves as  
280 severely food-intolerant (to lactose for example) may mistakenly attribute a variety of  
281 abdominal symptoms to food intolerance (23). Indeed, none of the 4 patients who attributed  
282 their abdominal symptoms to fructose and who were on a low fructose diet before the study,  
283 had a positive fructose breath test. As our main objective was to determine the usefulness of  
284 the fructose breath test and not the efficacy of the low fructose diet, we chose to include these  
285 patients. During the study, we asked patients to follow a restrictive diet with less than 6 g/day  
286 of fructose guided by dietary recommendations. However, we did not prepare the meals and  
287 patients only recorded information on the type of food and not on the exact quantity of  
288 fructose or its weight. Dietary compliance was self-reported during telephone calls and the  
289 last assessment visit.

290

291

### **Conclusion**

292 We have demonstrated that a 2-week low fructose diet significantly improved the bowel  
293 symptoms and the quality of life of IBS patients whatever their fructose absorption status  
294 defined by a FBT with a 25 g load of fructose. The 25 g FBT as performed in this study  
295 cannot be used to predict the beneficial effect of a low fructose diet. Further studies are  
296 needed to identify the best predictive test for dietary changes in IBS patients with the goal of  
297 achieving better control of symptoms.

298

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305

306 **Statement of authorship**

307 CM and AML designed the research study

308 CM, CD, GG, MM, PD and AML performed the research,

309 CM, CD, LB, LAD, GG and AML collected the data,

310 EH, CM, GG, AML and PD analysed the data,

311 CM, GG, AML, and PD wrote the paper,

312 All authors approved the final version of the article.

313

314 **Conflict of interest statement**

315 No competing interest to declare.

316

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319

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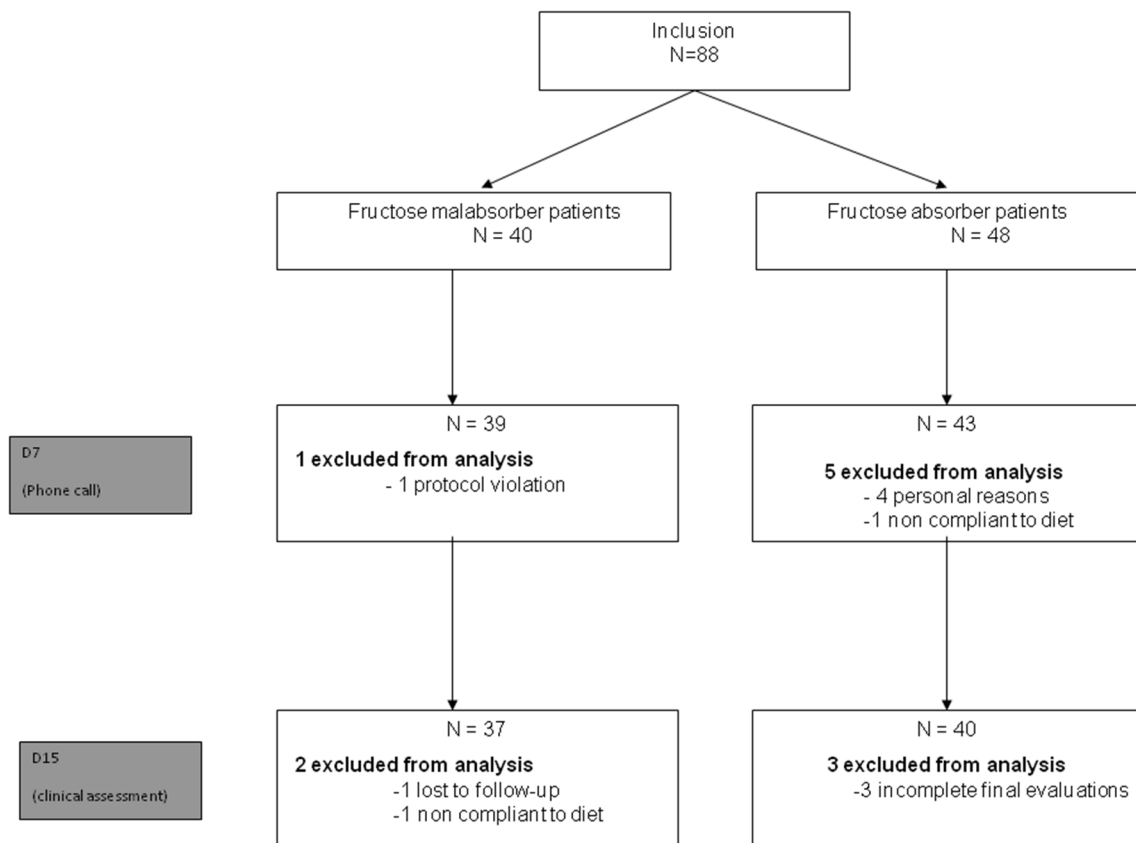


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- 387
- 388

389 **Figure legends:**

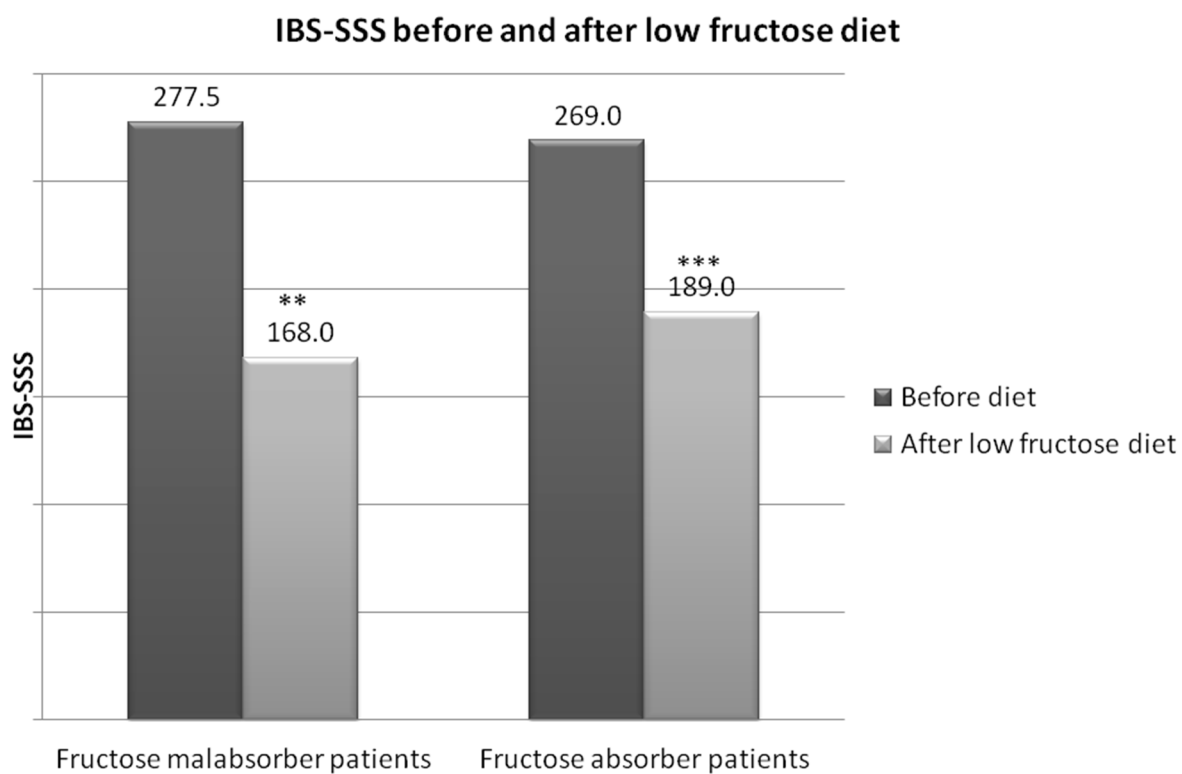
390 Figure 1: Flow diagram



391

392 Figure 2: Comparison of post-diet change from baseline for IBS symptom severity score

393 between absorber and malabsorber groups.



394

395

396 **Tables:**

397 Table 1: Comparison of demographics and baseline characteristics between patients in the  
 398 absorber (negative fructose breath test) and malabsorber groups (positive fructose breath test.

	<b>Absorber group</b> <b>(n = 48)</b>	<b>Malabsorber group</b> <b>(n = 40)</b>	<b>P</b>
<b>Female n(%)</b>	44 (91.7)	29 (72.5)	0.02
<b>Age (years)</b>	41.2 [29; 51.2]	49.6 [39.9; 58.8]	0.02

	<b>Absorber group</b> <b>(n = 48)</b>	<b>Malabsorber group</b> <b>(n = 40)</b>	<b>P</b>
<b>Weight (kg)</b>	62.5 [55.5; 71]	64.5 [55; 82.5]	0.40
<b>BMI (Kg/m<sup>2</sup>)</b>	22.7 [21.1; 26]	23.3 [21.2; 28.1]	0.35
<b>Types of IBS</b>			0.084
<b>IBS-D</b>	24 (50)	26 (65)	
<b>IBS-C</b>	16 (33.3)	5 (12.5)	
<b>IBS-M</b>	8 (16.7)	8 (20)	
<b>Unclassified</b>	0	1 (2.5)	
<b>IBS-SSS</b>	277.5 [166.5;309.5]	269 [215; 303.5]	0.63
<b>Bristol Stool Scale</b>	4 [2; 6]	4 [3; 6]	0.96
<b>GIQLI</b>	88 [70; 97]	87 [66; 101.5]	0.62
<b>HAD-A</b>	11 [8; 14]	9 [6; 12.5]	0.07
<b>HAD-D</b>	5.5 [3; 8.5]	5 [2.5; 8]	0.51

399 BMI: Body mass index. IBS-SSS: IBS symptom severity score. GIQLI: Gastrointestinal

400 Quality of Life Index. HAD-A and B: Hospital anxiety and depression scale (HAD).

401 Results were presented as number (percentage) and median with first and third quartile [Q1-  
402 Q3].

403

404 Table 2: Effect of low fructose diet on IBS severity score, Bristol Stool Scale, quality of life,  
405 Hospital anxiety and depression scores, weight and body mass index for all included IBS  
406 patients.

	<b>Before diet</b>	<b>End of 2-week diet</b>	<b>P</b>
<b>Weight (kg)(n=80)</b>	66.4 ± 14.4	65.3 ± 14.2	<1.10 <sup>-4</sup>
<b>BMI (Kg/m<sup>2</sup>)(n=80)</b>	23.9 ± 4.3	23.6 ± 4.3	<1.10 <sup>-4</sup>
<b>IBS-SSS (n=77)</b>	254.5 ± 99.1	184.0 ± 98.2	<1.10 <sup>-4</sup>
<b>Bristol Stool Scale (n=77)</b>	4.0 ± 1.9	3.7 ± 1.6	0.17
<b>GIQLI (n=74)</b>	82.5 ± 20.3	96.1 ± 19.6	<1.10 <sup>-4</sup>
<b>HAD-A (n=77)</b>	10.5 ± 4.3	9.5 ± 4.2	0.01
<b>HAD- D (n=76)</b>	5.9 ± 3.9	5.0 ± 3.9	0.01

407 BMI: Body mass index. IBS-SSS: IBS symptom severity score. GIQLI: Gastrointestinal

408 Quality of Life Index. HAD-A and B: Hospital anxiety and depression scale (HAD).

409 Results are presented as mean ± standard deviation.

410

411 Table 3: Comparison of the variations of Bristol Stool Scale, quality of life, hospital anxiety  
 412 and depression scores, evaluated after 2-week low fructose diet between patients with and  
 413 without fructose malabsorption.

	<b>Absorber group</b>	<b>Malabsorber group</b>	<b>Adjusted P</b>
<b>Bristol Stool Scale</b>	n=40 0 [-1.5; 1]	n=37 0 [-2; 1]	0.86
<b>GIQLI</b>	n=38 16.5 [7; 26]	n=36 8 [-2; 17]	0.10
<b>HAD-A</b>	n=40 -1.5 [-3.5; 0.5]	n=37 0 [-1; 2]	0.05
<b>HAD-D</b>	n=39 -1 [-3; 1]	n=37 0 [-2; 1]	0.14

414 GIQLI: Gastrointestinal Quality of Life Index. HAD-A and B: Hospital anxiety and  
 415 depression scale (HAD)

416 Results are presented as number (percentage) and median with first and third quartile [Q1-  
 417 Q3].

418

#### 419 **Annex:**

420 Annex 1: Low fructose diet

#### **FOOD**

#### **MILK AND DAIRY PRODUCTS**

#### **NOT RECOMMENDED**

Sweetened milk  
 Dairy based sweetened desserts  
 Dairy based fruit desserts, flavoured  
 Milk based drinks  
 Custard desserts

#### **RECOMMENDED**

Milk ( powder or liquid)  
 Yoghourt  
 Cottage cheese } natural or  
 without added sugar  
 Petits suisses/fromage blanc

	Egg custard, mousse	Unsweetened desserts Cheese
<b><u>MEAT</u></b>	Cold meats ( Ham, sausage, saucisson, pâtés, white and black pudding,), quenelles, fish mousse, ready made meals	All meat, poultry Offal Fish Eggs
<b><u>FISH</u></b>		
<b><u>EGGS</u></b>		
<b><u>CARBOHYDRATES</u></b>	Ready made meals, Manufactured cooked potato products Manufactured deep frozen fries Sweetened flour based products Dried vegetables and pulses Whole grains (oat, wheat, rye, barley, millet etc.) Whole-grain pasta, vegetable pasta Whole-grain rice	Potatoes, chips Rice, tapioca, pasta, semolina Wheat, buckwheat, oat, corn rice flour
<b><u>BREAD</u></b>	Sweetened bread, other bread crackers, toast Sweetened cereals	White bread (80 g/day), Rice crackers
<b><u>GREEN</u></b>	Raw vegetables Dried vegetables Manufactured cooked vegetables Bean sprouts	Except cooked vegetables (200g/day): Spinach, lettuce, green beans, butter beans, carrots, celery, courgettes, tomatoes, water cress, cauliflower, avocado
<b><u>VEGETABLES</u></b>		
<b><u>FRUIT</u></b>	All fresh fruit, cooked or not Fruit in syrup Stewed fruit, with or without sugar Dried fruit Candied fruit	Except (1 per day): Apricot, grapefruit, lemon, nectarine, orange, mandarin, peach, pineapple, rhubarb
<b><u>FATTY PRODUCTS</u></b>	Manufactured sauces Manufactured mayonnaise	Butter Oil Fresh cream Homemade mayonnaise
<b><u>SWEET PRODUCTS</u></b>	Sugar Honey, marmalade, jam, jelly Pastries Puff pastry, shortcrust pastry Bread pastries (brioche, croissant, pain au chocolat, pain aux raisins, etc.) Sweets biscuits, meringues, gingerbread	Unsweetened cocoa



Whipped cream  
Ice cream and sorbets  
Confectionery, dragees, nougat, fruit  
jellies  
Chestnut mousse  
Chocolate and chocolate bars  
Sweetened chocolate powder

### DRINKS

Fermented drinks (cider, beer)  
Wine, aperitifs, liqueurs  
Fruit juices  
Fruit syrup  
Soda, lemonade  
Flavoured water

Still and sparkling water

Flavoured water (with artificial  
sweeteners)

Coffee, herbal infusions, tea

Dairy based sweetened drinks

### CONDIMENTS

Manufactured sauces  
Manufactured mayonnaise  
Tomato ketchup  
Mustard  
Manufactured tomato sauce  
Flavoured vinegar  
Garlic, onion, shallots  
Pickles and capers  
Stock cubes

Salt, pepper

Gelatine

Non-flavoured vinegar

### MISCELLANEOUS

Some artificial sweeteners:  
-Sucralose

Some sugars: glucose, lactose,  
maltose and dextrine maltose  
Some artificial sweeteners:  
aspartame, saccharine, cyclamate,  
thaumatine  
polyols (mannitol, sorbitol)

421

422