

## A COMPARISON OF DIETS WITH AND WITHOUT OATS IN ADULTS WITH CELIAC DISEASE

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**Abstract Background.** Wheat, rye, and barley damage the small-intestinal mucosa of patients with celiac disease; maize and rice are harmless. The effects of a diet containing oats are uncertain.

**Methods.** In a randomized trial, we compared the effects of gluten-free diets without oats and with oats (with a goal of 50 to 70 g per day from three sources: two types of wheat-starch flour mixed with an equal amount of oats, muesli containing 60 percent oats, and rolled-oat breakfast cereal). Fifty-two adults with celiac disease in remission were followed for 6 months and 40 with newly diagnosed disease for 12 months. Endoscopy with duodenal biopsy was performed at the beginning and end of the study.

**Results.** The mean ( $\pm$ SD) oat intake in the oat group

was  $49.9 \pm 14.7$  g per day at 6 months for patients in remission and  $46.6 \pm 13.3$  g per day at 12 months for patients with newly diagnosed disease. The oat and control groups did not differ significantly in nutritional status, symptoms, or laboratory measures. Patients in remission, regardless of diet, did not have worsening architecture of the duodenal villi or increased mononuclear-cell infiltration. All the patients with new diagnoses were in remission at one year, except for one in the control group. Six patients in the oat group and five in the control group withdrew from the study.

**Conclusions.** Moderate amounts of oats can be included in a gluten-free diet for most adult patients with celiac disease without adverse effects. (N Engl J Med 1995;333:1033-7.)

SINCE the classic work of Dicke in 1950 it has been known that wheat and rye damage the small-intestinal mucosa of patients with celiac disease.<sup>1</sup> The injurious constituent is  $\alpha$ -gliadin.<sup>2-4</sup> Although wheat, rye, and barley are harmful to the small-intestinal mucosa of patients with celiac disease, maize and rice are harmless. In general, it is recommended that patients avoid wheat, rye, and barley, as well as oats. However, the place of oats in the diet of patients with celiac disease is controversial.<sup>5-9</sup>

Adherence to a strict gluten-free diet is difficult.<sup>10</sup> Therefore, any relief of dietary restrictions, such as those on oats, could make the diet more acceptable to patients. Most previous studies of the suitability of oats for patients with celiac disease focused on children,<sup>2,5-8</sup> and the numbers of patients were small (1 to 12 patients) and the follow-up periods short (1 to 45 days, except for one child followed for 96 days<sup>5</sup>).

We investigated whether adults with celiac disease in remission could consume oats without impairment to their condition and whether patients with newly diagnosed celiac disease could be treated with a diet containing oats.

### METHODS

#### Patients

We studied two groups: patients with previously diagnosed celiac disease and those with newly diagnosed disease. The criteria for inclusion of patients with a previous diagnosis were that they be 18 years of age or older and have normal or almost normal duodenal vil-

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lous architecture while eating a gluten-free diet for at least 12 months. In these patients, the original diagnosis of celiac disease was based on the presence of subtotal or total villous atrophy of the duodenal mucosa before the introduction of the gluten-free diet.

All new patients with subtotal or total villous atrophy diagnosed at the Kuopio University Hospital between December 1, 1988, and December 31, 1990, were included in the study. Patients were excluded if they had any medical conditions that were considered sufficiently serious to interfere with the trial or to constitute an unacceptable risk to the patient.

Exclusion criteria for both groups were previous or current corticosteroid therapy; a history of complications of celiac disease; any neurologic, cardiovascular, pulmonary, metabolic, hematologic, or endocrine disorder that could hinder participation; a history of drug or alcohol abuse; mental impairment; lack of cooperation; and refusal to take part. Patients were also excluded if their diagnosis was not definite — for example, if there was any other reason for villous atrophy such as cancer, previous irradiation, collagenous disease, or inflammatory bowel disease. Patients who consumed oats were also excluded.

#### Study Design

Patients were randomly assigned according to sex to either the oat group or the control group. If there was more than one participant in a family, all received the diet randomly selected for the first participant (in one family, a father and son participated). The physicians in charge of examining the patients did not know the diets of the patients. To prevent group assignments' being revealed, any discussions between physicians and patients regarding the patients' diets or adverse events were forbidden.

#### Diets

A clinical nutritionist gave both oral and written instructions about the diet. Before the study, a voluntary cooking demonstration was offered to the participants. Control patients received gluten-free cereal products (a mixture of low-protein flours containing 0.74 mg of gluten per gram of foodstuff) (Raisio Factories, Melia, Raisio, Finland). The oat group received products (Raisio Factories) supplemented with oats: two types of gluten-free wheat-starch flour mixed with an equal amount of oats, muesli containing 60 percent oats, and rolled-oat breakfast cereal. The goal for the daily intake of oats was 50 to 70 g. Patients were not charged for these products.

#### Examinations

Before the study, a screening esophagogastroduodenoscopy was performed with an Olympus GIF Q20 end-viewing gastroscope (Tokyo, Japan), and duodenal-biopsy specimens were obtained. If villous atrophy had been verified during the previous six months by routine

duodenal biopsy during gastroscopy but a gluten-free diet had not been started, endoscopy was not repeated.

Endoscopic-biopsy specimens were obtained at the duodenal bulb and at 5-cm intervals thereafter as far down as possible — two specimens at each level, with the use of jumbo forceps (Olympus FB-13K). Specimens were fixed in 10 percent buffered formalin and processed by standard methods. The staining method used was van Gieson's.<sup>11</sup> A score was assigned to the degree of villous atrophy as follows<sup>12</sup>: 1, partial; 2, subtotal; and 3, total; normal specimens were assigned a score of 0. In partial atrophy, villi were broadened and shortened. In subtotal atrophy, villi were more damaged and almost completely absent. No villous projections from the surface were seen in total atrophy. Mononuclear-cell infiltration was graded as follows: 0, none; 1, mild; 2, moderate; and 3, severe. The same pathologist conducted the histopathological examinations twice at least three months apart from coded slides, without knowledge of the clinical state of the patient. If the readings were different, the mean of the two results was used.

The same biopsy specimens were also examined histomorphometrically with the Quantimet 570 image analyzer (Leica, Cambridge, United Kingdom), operated in an interactive mode with a cursor used to draw on a digitizing table at an objective magnification of  $\times 25$  (Olympus Vanox T light microscope). The same observer performed the measurements without knowledge of the patient's clinical state, according to the procedure of Corazza et al.<sup>13</sup> The surface length and the area of the lamina propria of a fixed field of duodenum were measured, and the ratio of the surface length to the area of the lamina propria was calculated for three random fields from each level of the biopsy specimen. The level index was the mean of all three calculated ratios, and the final index was the mean of all level indexes.

Patients with new celiac disease were considered to be in remission when the villous atrophy had healed so that the duodenal architecture was normal or almost normal.

Findings of symptom assessments and physical examinations were recorded. The body-mass index was calculated as the weight in kilograms divided by the square of the height in meters. During the three days before a visit, abdominal pain, abdominal distention, flatulence, and general well-being were measured with the use of a 100-mm scale ranging from 0 (no symptoms at all) to 100 (extremely severe symptoms). Blood samples were taken after an overnight fast, and blood hemoglobin and serum albumin, iron, calcium, and erythrocyte folate were measured.

Before the study, a clinical nutritionist interviewed the participants about their diets and recorded their nutritional states. Four-day food records were kept by all patients before the study and at 4, 13, and 26 weeks. Adherence to the recommended level of oat intake was checked at 4, 13, and 26 weeks. Clinical assessments and laboratory tests were carried out at base line and at 4, 13, and 26 weeks. Endoscopy, duodenal biopsies, and anthropometric measurements were performed at base line and 26 weeks. Studies were also repeated at 52 weeks for patients with newly diagnosed celiac disease.

#### Adverse Events and Patient Withdrawals

A patient was withdrawn and the celiac disease was regarded as relapsed if any of the following criteria was fulfilled: marked worsening of the symptoms, a weight loss of 10 percent or more, or a decrease in the serum albumin concentration to less than 3 g per deciliter or in the serum calcium concentration to less than 8.4 mg per deciliter (2.1 mmol per liter).

If there were symptoms or signs indicating a relapse, an unscheduled assessment that included a physical examination, laboratory tests, and endoscopy was arranged. A physician outside the clinical study group judged whether, according to the aforementioned criteria, the patient should be withdrawn from the study.

#### Informed Consent

The study protocol was approved by the Ethics Committee of the University of Kuopio. All patients received written information concerning the trial, and each provided verbal consent before starting the diet. At the time of the trial, ethics committees in Finland did not require written consent for studies such as this, even when invasive pro-

cedures — such as endoscopy and biopsy — were included, because these procedures were part of routine investigations in patients with celiac disease.

#### Statistical Analysis

All the analyses were carried out according to the intention-to-treat principle. Statistical analyses were performed with the use of the SPSS-PC (SPSS, Chicago) and CIA<sup>14</sup> programs. Nonparametric tests were used when variables did not have normal distributions and equal variances. Differences between the groups were assessed by Student's *t*-test (two-tailed) or the Mann-Whitney *U* test. The results are presented as means  $\pm$ SD. The 95 percent confidence intervals were calculated for the differences in the changes between the two groups.<sup>14</sup>

#### RESULTS

One hundred four adult patients with a previous diagnosis of celiac disease and 50 with newly diagnosed disease were originally asked to participate. Sixty-two patients were excluded: in 10 patients the diagnosis of celiac disease was not definite; in 14, the celiac disease was not in remission; 1 had celiac disease graded as serious at the time of diagnosis; 3 did not follow a strict diet; 1 consumed oats; 1 was too old for the study; and 1 was pregnant. Fourteen patients had other diseases causing exclusion: epilepsy (one), sarcoidosis (one), dementia (one), psychosis (one), diabetes mellitus (one), rheumatoid arthritis (one), alcoholism (two), tumor (two), dermatomyositis (two), and Down's syndrome (two). Seventeen patients declined to participate in the study. One woman, with a 20-year history of celiac disease, had never observed any gluten restriction. She participated in the study as a patient with newly diagnosed disease.

The final study group consisted of 52 patients with celiac disease in remission (9 men and 17 women in the oat group and 8 men and 18 women in the control group) and 40 patients with newly diagnosed disease (7 men and 12 women in the oat group and 5 men and 16 women in the control group). The mean ( $\pm$ SD) ages of the patients with celiac disease in remission were  $48 \pm 12$  years in the oat group and  $42 \pm 10$  in the control group. The diagnosis of celiac disease in these patients had been established  $8 \pm 7$  and  $6 \pm 6$  years earlier, respectively. The mean age of the patients with newly diagnosed disease was  $42 \pm 14$  years in the oat group, and  $48 \pm 11$  in the control group.

The mean oat intake in the oat group was  $49.9 \pm 14.7$  g per day at 6 months for the patients with celiac disease in remission, and  $43.6 \pm 11.3$  g per day at 6 months and  $46.6 \pm 13.3$  g per day at 12 months for the patients with newly diagnosed disease. Twenty-one (81 percent) of the patients in remission and 14 (74 percent) of the patients with newly diagnosed disease were consuming more than 30 g of oats per day by the end of the study. The oat-consuming group did not differ from the control group with respect to nutritional status, symptoms, or blood values except for the serum albumin concentration, which was slightly lower in patients with newly diagnosed disease in the control group at base line and at 12 months of follow-up. No differences were found in

these variables between the patients with newly diagnosed disease and those in remission (Table 1).

### Histology and Histomorphometry

Altogether, 1599 biopsy specimens were taken in 213 endoscopic procedures (1 procedure was performed in 5 patients, 2 in 53 patients, and 3 in 34 patients). An average of 8 samples were taken per endoscopic procedure. The initial grade (on a scale of 0 to 3) of duodenal villous atrophy for patients in remission was 0.57 in the oat group and 0.54 in the control group, indicating nearly normal structure (Table 2). There was no worsening of the villous architecture in either of the diet groups after six months.

Patients with newly diagnosed celiac disease had a

mean grade of villous atrophy at the beginning of the study of 1.85 in the oat group and 1.89 in the control group (Table 2), and after 12 months on the diet the values were 0.79 and 0.84, respectively. There were no differences between the diet groups in the changes in mononuclear-cell infiltration in the duodenal-biopsy specimens in either the patients in remission or the patients with newly diagnosed celiac disease (Table 2). Only one woman with newly diagnosed celiac disease in the control group did not enter remission.

The mean histomorphometric index of the patients in remission was initially 0.021 in both groups (Table 2). There were no differences in the changes in this variable between the diet groups in remission after six months. Patients with newly diagnosed celiac disease had a mean

Table 1. The Effect of Oats in the Diets of Patients with Celiac Disease on Body-Mass Index, Symptom Score, and Laboratory Values.\*

VARIABLE	CELIAC DISEASE IN REMISSION			NEWLY DIAGNOSED CELIAC DISEASE		
	OAT GROUP (N = 26)	CONTROL GROUP (N = 26)	P VALUE†	OAT GROUP (N = 19)	CONTROL GROUP (N = 21)	P VALUE†
Body-mass index‡						
Base line	24.1±4.2	24.6±3.8		23.2±2.7	25.4±6.2	
6 Mo	24.3±4.0	24.9±4.0		23.9±2.6	26.6±5.6	
12 Mo	—	—		23.7±2.7	26.1±6.1	
Change	0.1±0.8	0.4±0.8		0.7±1.3	1.0±1.1	
Difference (95% CI)	-0.3 (-0.7 to 0.1)		0.09	-0.3 (-1.2 to 0.5)		0.47
Symptom score§						
Base line	15.6±13.7	24.9±23.1		35.3±20.2	26.6±21.4	
6 Mo	19.8±15.3	26.8±23.0		23.7±19.1	17.5±15.5	
12 Mo	—	—		24.7±17.0	20.0±16.7	
Change	6.7±17.5	2.1±10.8		-8.2±26.6	-8.4±22.7	
Difference (95% CI)	4.6 (-3.5 to 12.8)		0.45	0.2 (-15.6 to 16.0)		0.78
Hemoglobin (g/dl)						
Base line	13.4±0.9	13.8±9.0		13.6±1.6	13.2±1.4	
6 Mo	13.4±1.2	13.6±10.0		13.6±1.3	13.6±2.8	
12 Mo	—	—		13.7±1.1	13.2±1.2	
Change	-0.1±0.7	-0.2±0.5		0.1±1.0	0.0±1.2	
Difference (95% CI)	0.1 (-0.3 to 0.4)		0.44	0.1 (-0.7 to 0.9)		0.78
Serum iron (μg/dl)¶						
Base line	87.1±30.4	102.3±45.7		84.5±46.8	90.3±33.9	
6 Mo	99.5±40.8	86.2±32.8		108.2±29.4	85.2±41.7	
12 Mo	—	—		78.5±28.8	92.9±30.5	
Change	13.1±38.4	-15.1±52.0		0.34±39.4	0.0±38.4	
Difference (95% CI)	28.2 (2.7 to 53.8)		0.09	0.3 (-24.6 to 25.2)		0.55
Serum calcium (mg/dl)¶¶						
Base line	9.1±0.4	9.3±0.4		9.1±0.5	9.1±0.5	
6 Mo	9.3±0.5	9.2±0.4		9.4±0.5	9.3±0.6	
12 Mo	—	—		9.2±0.3	9.2±0.4	
Change	0.1±0.5	-0.1±0.4		0.2±0.4	0.2±0.5	
Difference (95% CI)	0.2 (0.0 to 0.5)		0.07	0.1 (-0.4 to 0.3)		0.81
Erythrocyte folate (ng/ml)**						
Base line	224.7±98.1	252.5±84.5		166.9±75.2	175.9±106.0	
6 Mo	243.8±75.5	238.6±88.0		222.3±74.8	228.8±78.6	
12 Mo	—	—		230.2±101.9	240.9±84.2	
Change	2.2±72.8	-14.8±56.4		71.3±56.9	60.0±68.0	
Difference (95% CI)	17.0 (-19.3 to 53.3)		0.21	10.7 (-29.8 to 51.1)		0.90
Serum albumin (g/dl)						
Base line	4.7±0.4	4.6±0.4		4.9±0.5	4.4±0.3	
6 Mo	4.7±0.4	4.6±0.4		4.6±0.3	4.4±0.6	
12 Mo	—	—		4.5±0.3	4.2±0.5	
Change	0.0±0.5	0.0±0.3		-0.3±0.6	-0.2±0.4	
Difference (95% CI)	-0.1 (-0.3 to 0.2)		0.70	-0.1 (-0.4 to 0.2)		0.50

\*Values are means ±SD, except for the difference values, which are the differences in the changes between the groups, with the 95 percent confidence intervals (CI) shown in parentheses. For patients with newly diagnosed celiac disease, the changes are for 12 months.

†P values were calculated with the Mann-Whitney U test.

‡The body-mass index is the weight in kilograms divided by the square of the height in meters.

§The symptom score is the average for four variables graded on a 100-mm scale (see the Methods section). The variables assessed were flatulence, abdominal pain, abdominal distention, and a feeling of general well-being.

¶To convert values for serum iron to micromoles per liter, multiply by 0.1791.

¶¶To convert values for serum calcium to millimoles per liter, multiply by 0.2495.

\*\*To convert values for erythrocyte folate to nanomoles per liter, multiply by 2.266.

Table 2. The Effect of Oats in the Diets of Patients with Celiac Disease on Duodenal Histopathological and Histomorphometric Values.\*

VARIABLE	CELIAC DISEASE IN REMISSION			NEWLY DIAGNOSED CELIAC DISEASE		
	OAT GROUP (N = 26)	CONTROL GROUP (N = 26)	P VALUE†	OAT GROUP (N = 19)	CONTROL GROUP (N = 21)	P VALUE†
Villous atrophy (mean histopathological grade)‡						
All samples						
Base line	0.57±0.43	0.54±0.39		1.85±0.68	1.89±0.65	
6 Mo	0.58±0.42	0.51±0.42		0.85±0.35	0.92±0.33	
12 Mo	—	—		0.79±0.38	0.84±0.34	
Change	0.01±0.36	-0.06±0.31		-1.07±0.58	-1.20±0.42	
Difference (95% CI)	0.08 (-0.12 to 0.26)		0.53	0.11 (-0.23 to 0.43)		0.74
Worst sample						
Base line	0.77±0.45	0.75±0.45		2.08±0.79	2.12±0.67	
6 Mo	0.73±0.45	0.63±0.45		0.91±0.36	1.00±0.32	
12 Mo	—	—		0.88±0.34	1.00±0.38	
Change	-0.04±0.42	-0.10±0.42		-1.30±0.68	-1.30±0.55	
Difference (95% CI)	-0.07 (-0.17 to 0.30)		0.86	0.0 (-0.40 to 0.40)		0.91
Best sample						
Base line	0.48±0.50	0.42±0.49		1.64±0.79	1.64±0.64	
6 Mo	0.50±0.47	0.48±0.50		0.88±0.33	0.88±0.39	
12 Mo	—	—		0.81±0.40	0.81±0.35	
Change	0.02±0.54	0.02±0.50		-0.89±0.66	-0.94±0.57	
Difference (95% CI)	0.00 (-0.30 to 0.30)		0.87	0.06 (-0.33 to 0.45)		0.71
Histomorphometric index§						
Base line	0.021±0.003	0.021±0.003		0.015±0.003	0.015±0.003	
6 Mo	0.021±0.003	0.021±0.003		0.018±0.003	0.019±0.002	
12 Mo	—	—		0.019±0.003	0.019±0.002	
Change	0.0±0.003	0.0±0.003		0.004±0.002	0.004±0.003	
Difference (95% CI)	0 (-0.02 to 0.02)		0.85	0 (-0.002 to 0.002)		0.82
Mononuclear-cell infiltration (mean histopathological grade)¶						
Base line	0.69±0.52	0.67±0.45		2.05±0.66	2.00±0.58	
6 Mo	0.65±0.48	0.72±0.65		1.12±0.61	1.20±0.57	
12 Mo	—	—		0.89±0.46	0.94±0.48	
Change	-0.05±0.45	0.04±0.54		-1.25±0.58	-1.14±0.55	
Difference (95% CI)	-0.08 (-0.36 to 0.20)		0.58	-0.12 (-0.48 to 0.24)		0.51

\*Values are means ±SD, except for the difference values, which are the differences in the changes between the groups, with the 95 percent confidence intervals (CI) shown in parentheses. For patients with newly diagnosed celiac disease, the changes are for 12 months.

†P values were calculated with the Mann-Whitney U test.

‡Villous atrophy was graded as 1, partial; 2, subtotal; or 3, total. A grade of 0 indicates the absence of villous atrophy.

§The histomorphometric index was calculated as the mean of the indexes based on the biopsy specimens obtained 5, 10, 15, 20, and 25 cm behind the duodenal bulb.

¶Duodenal mononuclear-cell infiltration was graded as 1, mild increase in the number of cells; 2, moderate increase; or 3, heavy increase. A grade of 0 indicates normal infiltration.

histomorphometric index of 0.015 in both groups at the beginning of the study (Table 2). After six months, the indexes in the oat and control groups were 0.018 and 0.019, respectively, and after 12 months, 0.019 and 0.019.

#### Withdrawals and Adverse Events

Eleven patients withdrew from the study. Among patients in remission, three with dermatitis herpetiformis (one in the control group and two in the oat group) reported worsening of itching without any signs of dermatitis. One patient in the oat group withdrew because of abdominal symptoms, and two in the control group refused to continue, without giving reasons.

Among the patients with newly diagnosed celiac disease, one patient in the control group reported itching without objective signs of dermatitis, and one in the oat group had abdominal symptoms. Three patients, one in the control group and two in the oat group, refused to continue.

#### DISCUSSION

We found that the use of oats by patients with celiac disease as part of a gluten-free diet had no unfavorable

effects on adult patients in remission and did not prevent symptomatic and mucosal healing in patients with newly diagnosed disease. Healing in the new patients was fast: after 6 months of the diet, symptoms and laboratory values showed almost the same improvement as after 12 months. Improvement of villous architecture also occurred mainly during the first six months.

The injurious constituent of wheat in patients with celiac disease is  $\alpha$ -gliadin in the prolamin fraction of wheat gluten.<sup>2-4</sup> Oats do not yield gliadin.<sup>5</sup> The counterpart of gliadin in oats is avenin.<sup>9</sup> In wheat, rye, and barley, prolamins constitute 40 to 50 percent, 30 to 50 percent, and 35 to 45 percent of total proteins, respectively, but in oats, they constitute only 10 to 15 percent.<sup>15</sup> Sixty grams of oats is estimated to contain 1.2 g of avenin. Many cereals contain small amounts of peptides suspected to be toxic to the small-intestinal mucosa of patients with celiac disease.<sup>16</sup> These possible toxic constituents of cereal prolamins consist of the amino acid sequence proline-serine-glutamine-glutamine or glutamine-glutamine-glutamine-proline, according to in vitro studies of biopsy specimens of jejunal

mucosa.<sup>16</sup> One molecule of wheat prolamins ( $\alpha$ -gliadin) contains 5 units of these structures; one molecule of barley ( $\beta$ -1-hordein) and oats (avenin), 2 units; and one molecule of maize ( $\alpha$ -zein), none.<sup>17</sup> Because there is much more prolamins per unit of weight in wheat and barley than in oats,<sup>18</sup> the amount of such sequences is much smaller in oats. Although oats contain these amino acid sequences, there is no antigenic relation of wheat gliadin to oat avenin.<sup>19-21</sup> On the other hand, rye secalins and barley hordeins have definite antigenic structures in common with wheat gliadins. This may explain why oats do not seem to be toxic to most patients with celiac disease, in contrast to wheat, rye, and barley.

Generally, in patients with celiac disease the removal of gluten from the diet results in epithelial healing and the gradual reformation of intestinal villi. The older the patient, the longer the healing time. Some mucosal abnormality may remain, although the clinical response to the gluten-free diet is fast.<sup>22</sup> Acute gluten challenge causes histologic changes in intestinal mucosa within hours or days, both in children and in adults.<sup>17,23</sup> The gluten intolerance, however, is variable: in some patients with celiac disease in remission, mucosal relapse occurs after several years or does not occur at all.<sup>10,24</sup> Montgomery et al.<sup>25</sup> found that a low-gluten diet containing 2.5 to 5.0 g of gluten per day induced no gross morphologic change in the intestinal mucosa in treated patients with celiac disease.

Our data suggest that most patients with celiac disease, whether in remission or newly diagnosed, can add moderate amounts of oats to their otherwise gluten-free diets without any harmful subjective side effects or laboratory abnormalities. Furthermore, among the newly diagnosed patients the improvement of mucosal architecture and the disappearance of mononuclear-cell infiltration were similar, regardless of the use of oats.

Compliance with a strict gluten-free diet is not very high among patients with celiac disease. Kumar et al.<sup>26</sup> found that only 44 percent of 102 adult patients maintained strict diets, despite physicians' repeated recommendations. The inconvenience of purchasing and preparing gluten-free foods, as well as the higher prices of gluten-free products, are reasons for poor cooperation.<sup>27</sup> Cereal products, ready-made foods, and typical Finnish-food recipes include wheat, rye, barley, or oats. Adding oats to the celiac diet could increase compliance with a gluten-free diet by providing patients with more alternatives and reducing the otherwise high cost of gluten-free foods.

In conclusion, moderate amounts of oats can be included in a gluten-free diet in adult patients with celiac disease in remission and a conventional celiac diet containing oats can allow the intestinal mucosa of patients with newly diagnosed disease to heal. Since we excluded

patients with severe celiac disease, we cannot make recommendations about the use of oats in their diets.

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