



# IMPORTANCE OF FOOD SELECTION FOR CELIAC SPRUE DISEASE\*

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A questionnaire survey was conducted among people with celiac disease. Questions were focused on dietary foods available and the preference of suitable grain food species. A one-week diet menu was prepared for the participants of the survey. Daily intake of major nutrients and energy was determined. Supermarkets have the largest selection of dietary foods, although in a narrow range. Celiac patients often rely on themselves to make and prepare food. The majority of respondents (57%) considered dietary restrictions as burdening; 43% have adapted to this situation. Food made of rice was the most popular among cereal foods for 50% of respondents, corn for 39%, and buckwheat and millet for only 7% of respondents. Nobody classified amaranth as the most popular food. The model diet for people with celiac disease exceeded the recommended daily intake of protein and undervalued lipid ingestion. This problem was mainly caused by the food composition of the evening meal. Total daily energy intake of 9900 kJ met the women's needs. There were still 2100 kJ missing for men. The terms 'gluten-free food or diet' and 'gliadin content', which generally relate to the products of wheat, rye, oats, and triticale, are not accurate.

celiac diet, gluten-free products, nutritional value, nutrient balance



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## INTRODUCTION

The celiac disease diet has specific requirements for food composition. It is an autoimmune disease, whose symptoms are caused by the presence of gluten and/or its components (toxic peptides) in the intestine of genetically predisposed individuals (Fasano, 2009). These peptides penetrate through mucous membrane. They are deaminated by transglutaminase tissue and other enzymes. After that, antibodies with cross-reactivity to antigens of the small intestine are formed in lymphatic tissue. The mucous membrane of the intestine, namely enterocytes, is damaged by these antibodies. The damage reaches a different extent in different people, and after this damage, clinical symptoms can occur (Kohout, 2008).

Celiac disease is a disease of the small intestine mucosa caused by toxic effects of gluten on intestinal cells. The digestive tract may also suffer from allergy

to gluten (manifested by vomiting, diarrhoea, bloating, cramps), but the intestinal walls are not affected like in the case of celiac disease. Symptoms of allergy to gluten are often parenteral (hives, subcutaneous tissue swelling, atopic eczema, respiratory problems) (Kucerova, Pelikan, 2008).

Gluten is a mixture of two wheat grain protein fractions: gliadin (prolamin) and glutenin. Glutenins probably do not have an important role in the pathogenesis of celiac disease, whereas prolamins are known as proteins that induce intestinal lesions. The prolamins are called gliadins in wheat, secalins in rye, hordeins in barley, and avenins in oat. In the study of Silano et al. (2007), all the varieties of oats tested were immunogenic. Avenins from the Lampton and Ave varieties induced lymphocyte activation similar to that activated by wheat gliadin; Astra and Nave avenins showed lower but still measurable immunogenicity. There are still many controversies surrounding oats

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Table 1. Examples of model celiac diet (nutritional and energy values)

Dish	Food	Weight (g)	S (g)	F (g)	P (g)	E (kJ)
<b>Example 1</b>						
Breakfast	gluten free bread	80	89.0	9.1	8.4	1961.5
	vegetable margarine	10				
	apricot jam	30				
	tea	200				
Morning snack	apple puree with yoghurt	190	37.0	1.5	1.5	648.7
Lunch	beef soup with rice	200	63.0	16.0	29.6	2152.8
	baked fish fillets	120				
	potatoes	220				
	vegetable margarine	10				
	lettuce	30				
Afternoon snack	gluten free Czech-style vanilla-chocolate cake (babovka)	30	49.5	5.1	2.9	1010.7
	orange juice	150				
Dinner	gluten free stuffed potato dumplings	230	53.6	40.4	37.4	2855.4
	sour cabbage salad	120				
	apple	100				
<b>Example 2</b>						
Breakfast	gluten free Czech-style vanilla-chocolate cake (babovka)	100	82.2	18.2	10.4	2188.8
	white chicory coffee	200				
Morning snack	bananas	100	20.3	0.2	1.2	368.3
Lunch	gluten free pizza – dough	100	83.2	29.9	24.0	2900.2
	spinach stuffing	100				
	beetroot salad	100				
Afternoon snack	pudding with cottage cheese (quark)	150	16.3	4.5	28.7	703.5
Dinner	soy meat with mushrooms	140	82.5	11.2	48.2	1570.2
	potatoes	200				
	fruit salad	80				

S = sugars, F = fat, P = protein, E = energy value

source: Kohout, Pavlickova (2010)

and celiac disease as well as concerns about the suitability of including oats in a gluten-free diet.

The prolamin content is minimal in rice, maize, and millet, which are used in gluten-free diets. It is assumed that, as an antigen, gliadin has a direct cytotoxic effect on the small intestine mucosa or indirect via other mediators triggering an inflammatory process. A cascade of immunological responses starts in genetically susceptible organisms after exposure to antigens of gliadine (Prokopova, 2008).

Sufficient information about celiac disease and the possibilities of targeted screening methods leading to early detection of the disease is a necessary condition for its successful diagnosis by the general medical community. The clinical spectrum is wide, including cases with both typical intestinal and atypical extraintestinal features as well as silent forms (Lionetti, Catassi,

2011). Unrecognized and untreated celiac disease leads to the progressive damage of the small intestine mucosa. Appropriate diet with an optimal intake of essential nutrients and energy is therefore very important. The only known cure for celiac disease is a gluten-free diet. The aim of this study was therefore to determine, on the basis of the questionnaire, where celiacs buy their food and what problems they have when buying it. Nutritional and energy value was subsequently calculated in the model diets for celiacs and compared with an ordinary balanced diet.

## MATERIAL AND METHODS

A questionnaire among celiac patients was organized in cooperation with the Association of Celiac

Table 2. The questionnaire survey of dietary food sources

Question	Response rate (%)			
	very often/very satisfied	often/satisfied	sometimes/non-decided	never/non-satisfied
1. How often do you do your shopping in supermarkets?	32.1	57.1	10.8	0.0
2. How often do you do your shopping in specialized shops?	7.1	32.1	53.6	7.2
3. How often do you buy food via the Internet?	0.0	3.6	35.7	60.7
4. How often do you buy food in pharmacies?	3.6	3.6	35.7	57.1
5. How satisfied are you with the food products offer in stores?	3.6	39.2	42.9	14.3

Table 3. The questionnaire survey monitoring the effect of dietary restrictions on everyday life situations

Question	Yes (%)	No (%)
6. Is it a problem for you to choose the appropriate meal in restaurants?	67.9	32.1
7. Do you make your bread by yourself?	89.3	10.7
8. Do you prefer ready-made mixtures to producing your own bread?	60.5	39.5
9. Do hosts meet your meal dietary restrictions during the visit?	75.1	25.0
10. Do you usually eat your own meal during holiday?	96.4	3.6
11. Do you choose a meal at a restaurant according to staff recommendations?	17.9	82.1
12. Do you think that celiac disease makes your life more difficult?	57.1	42.9

Table 4. The order of 'grain' food popularity, questionnaire survey

Question	Hedonic evaluation of food/response rate (%)			
	most frequent consumption	occasional consumption	exceptional consumption	no consumption
Rice	61.2	28.2	5.9	4.7
Corn	41.2	42.4	9.4	7.0
Buckwheat	20.0	45.9	17.6	16.5
Amaranth	5.9	16.5	36.5	41.1
Millet (polished)	21.3	16.4	30.6	31.7

Table 5. The daily intake of nutrients and energy in a model diet for celiac disease

Day	Daily nutrients intake (g)			Energy (kJ)
	protein	sugars	fat	
1	79.7	292.1	72.1	8 988.3
2	112.5	284.5	64.0	9 117.0
3	84.5	335.9	79.4	10 084.6
4	84.3	339.1	66.7	9 665.7
5	100.3	304.6	71.6	9 532.5
6	195.8	345.6	65.6	11 631.0
7	134.5	335.8	58.9	10 174.4
Daily average	113.1	319.7	68.3	9 884.7
Total	791.6	2237.6	478.3	69 193.5

Conversion of nutrients to energy: 1 g of protein = 17 kJ, 1 g of sugars = 17 kJ, 1 g of fat = 37 kJ (Gunt her et al., 2011).

Patients. The aim was to monitor people's experience and knowledge about celiac disease diets. The questionnaire was sent electronically to fifty members of the Association in the city of Hradec Králové and its surrounding area. Fifty-six per cent of respondents (85 people) sent their responses. Respondents were asked about their frequency of purchases in supermarkets, specialized stores, and pharmacies or via the Internet, and about their satisfaction with the goods in stores. Other questions were focused on the popularity and palatability of foods produced from suitable cereals (rice, maize, and millet) and pseudo-cereals (buckwheat and amaranth).

The next part of the study was focused on compiling examples of daily menus suitable for celiacs. They were based on model examples of the recommended composition of foods for gluten free diet given by Kohout, Pavlickova (2010). Two examples of this model celiac diet are given in Table 1. The selection of food was focused on balanced nutrient and energy intake. The meal should of course be free of components bringing adverse health reactions to consumers diagnosed with celiac disease. The daily intake was divided into five portions: breakfast, morning snack, lunch, afternoon snack, and dinner. A proposed amount of food in grams or millilitres was designed for each food component. Composition and energy balanced diets were evaluated in relation to individual portions after each day and after a period of one week and compared with the ordinary, rational diet suggested by Kohout, Starnovska (2006).

## RESULTS

### The results of the questionnaire

The answers showed that people buy dietary foods for celiac disease mainly in big shopping centres (Table 2). They go to some special shops for 'healthy food' less frequently. This may be related to differences in the frequency and availability of both types of stores. Interest in online sales and sales of dietary food in pharmacies was minimal. Satisfaction with the availability of these special foods in ordinary markets was rather worse.

Specific eating conditions and limited food supply result in the need of homemade prepared meals in everyday life, as well as outside the home, on holiday or on a visit (Table 3). More than half of respondents (57.1%) consider the consequences of their disease as a life burden. On the other hand, the complications with catering are surprisingly 'well tolerated' by 43% of respondents.

Answers to questions focused on the popularity and palatability of foods produced from suitable cereals (rice, maize, and millet) and pseudo-cereals

(buckwheat and amaranth) are given in Table 4. The response rate of those who put the food on a certain level of popularity are arranged gradually in the columns from the first to fifth place. The responses show that majority of respondents preferred rice products, then corn products, and buckwheat and millet. Amaranth dishes are the least popular among the Czech patients.

### Nutritional value of the model diet

The proposed one-week model diet was prepared for each day and individual meal. Food selection met the requirements of dietary supplements for celiac disease. Breakfast consisted of bread or sweet bakery cakes. Morning and afternoon snacks were of a similar basis. Fruit (bananas, tangerines, and apples) were designed as one dish or as a supplement of, for example, milk products. Lunch consisted of soup and the main dish: chicken or fish, soy protein or cooked vegetables, mainly with boiled potatoes. Lunch was completed with raw or canned vegetables. Legumes, bread or potatoes or potato dumplings with vegetables and fruit were suggested for dinner. Table 5 gives a summary of the material composition and energy balance of dietary supplements for celiac disease patients. The average consumption of nutrients in different daily doses and their contribution to the total daily intake of energy in the model menu (for 1 week) are shown in Table 6. Finally, the average weekly nutrition and energy balance composition of the food in the celiac disease diet and the ordinary, rational diet were calculated and expressed in Table 7. The nutritional values of the food were taken from Kohout, Pavlickova (2010).

## DISCUSSION

The results of the model diet showed some disproportions in the intake of nutrients and energy. A protein intake of 80–195 g per day significantly exceeds the recommendations of the Czech Society for Nutrition – 59 g for men and 47 g for women per day (Dostalova et al., 2012). The recommended daily intake of lipids is 70–80 g. The average daily intake of 68.3 g of lipids in our model diet approaches this limit. These deviations from the recommended values lead to the differences in proportions of nutrients in total received daily energy. Recommended daily energy intake should be composed of 10–15% protein, 50–55% sugars, and 30–35% fat (Dostalova et al., 2012). Gluten-free diet must be rational and diverse. It must provide sufficient energy according to the patient's age, sex, and physical activity (Garcia-Manzanares, Lucendo, 2011). The model diet energy intake consists of 19.4% protein, 55.0% sugars, and 25.6% lipids. According to Gunther et al. (2011), the recommended daily energy intake is 12 000 kJ for men and 9500 kJ for women. The celiac

Table 6. Average consumption of nutrients in different daily doses and their contribution to the total daily intake of energy in the model menu (for 1 week)

Dish	Protein (g)	Sugars (g)	Fat (g)	Energy (kJ)	Total energy proportion (%)
Breakfast	23.8	67.4	10.2	1770.4	21.0
Morning snack	7.5	55.2	6.2	1200.3	14.2
Lunch	36.6	66.5	21.6	2168.2	25.7
Afternoon snack	7.6	40.3	7.5	1018.7	12.2
Dinner	37.6	90.2	22.9	2267.7	26.9

Table 7. Average weekly nutrition composition and energy balance of the food in the celiac disease diet and the ordinary, rational diet

Diet	Nutrients content (g)/energy (kJ)			Total energy (kJ)
	protein	sugars	fat	
Celiac disease diet	792/13 464	2 238/38 046	478/17 686	69 196
Energy (%)	19.5	55.0	25.5	–
Ordinary rational diet*	553/9 401	2 254/38 318	504/18 648	66 367
Energy (%)	14.1	57.8	28.1	–

\*source: Kohout, Starnovska (2006)

diet energy intake (9884.7 kJ) is between these values. Dinner covered the highest values of nutrients and energy, which represented 26.9% of the daily energy intake (Table 6). Legumes (lentils, beans, soy) or potato dumplings were for dinner. It would be appropriate to reduce the amount of certain food in the evening to reduce the total energy intake. It would also be possible to make a correction in the choice of food at lunch by reducing the amount of proteins and increasing lipid intake.

According to Lee et al. (2009) the analysis of the standard pattern gluten-free diet (defined by experts in gluten-free diet) indicated that 38% of meals and snacks contained no grain or starch choice. Of those meals that contained a grain or starch component, rice was the grain chosen 44% of the time. The inclusion of alternative grains or grain products (an alternative gluten-free diet, which prefers oat meal for breakfast cereals, high fibre bread for lunch, and a dish of quinoa for dinner) provided a higher nutrient profile compared to the standard gluten-free dietary pattern ( $P = 0.002$ ). Several nutrients – protein (20.6 g vs 11 g), iron (18.4 mg vs 1.4 mg), calcium (182 mg vs 0 mg), and fibre (12.7 g vs 5 g) – were significantly increased by changing the grain or starch component in the dietary pattern.

From the comparison of the balance of substances in celiac and in ordinary, rational model diets in Table 7 it is evident that the example of a balanced rational diet has a better distribution of daily energy intake of individual nutrients. The intake of protein and fat respects the recommended ratio: 14% of energy from protein and 30% from fat.

According to Wild et al. (2010) there is still little information about the detailed structure of gluten-free

diet. Celiac patients have similar energy and nutrient demands as a healthy population. However, they receive a greater proportion of carbohydrates from simple sugars. A lower intake of fibre and some minerals could be also detected in the gluten-free diet. This study reinforces the need for clinicians to recognize that avoidance of gluten cannot be the sole focus of a gluten-free diet. Maintenance of adequate intakes of essential nutrients and in particular complex carbohydrates must also be the goal for patients. Food and the treatment of celiac disease (celiac sprue) are closely related. Foodstuffs suitable for eating in celiac disease diets are labelled as ‘gluten-free food’ and ‘gluten-free diet’. These terms are now ingrained but they do not accurately represent the real state. Gluten mass is neither in grain nor in wheat, rye, barley, oat flour or dough. Gluten structures are created only during the mechanical processing of wheat dough (or dough from triticale), wherein the bonds between protein components are created. Gluten is a protein, gel-like material composed of proteins containing prolamin and glutenin protein fractions and is insoluble in water and salt solutions (Prhoda et al., 2003). Regardless of the ability to form or not to form gluten structures, wheat, rye, barley, triticale, and oats contain toxic peptides in prolamin protein fraction, which can also cause problems to celiac patients. ‘Gluten-free food’ labelling for products of rye, barley, and oat is not substantively accurate. Similarly inaccurate is e.g. the label information ‘mg gluten per kg of product’ or ‘gliadin per 100 g of dry matter’. Gliadin is the name of prolamin protein fractions used only for wheat. The amount of gluten intake safe for celiac patients is 10 mg per day (Thompson et al., 2005; Kinsey et al., 2008).

## CONCLUSION

Supermarkets and specialized shops with healthy food are the main sources of dietary food for people with celiac disease. The dietary food supply is rather insufficient according to celiac patients. They often rely on themselves for food preparation. The majority of respondents considered dietary restrictions as burdening; some of them (43%) have adapted to this situation. Food made of rice was the most popular among cereal foods, followed by corn, buckwheat, and millet. Nobody classified amaranth as the most popular food. The model diet for people with celiac disease exceeded the recommended daily intake of protein and undervalued lipid intake. This problem was mainly caused by the food composition of the evening meal. Total daily energy intake of 9900 kJ met the women's needs. There were still 2100 kJ missing for men. Using the terms 'gluten-free foods or diet' and 'gliadin content' not only in wheat, but generally in rye, barley, oats, and triticale products is inaccurate. Gluten can result exclusively in the case of wheat processing. Therefore the term 'gliadin' should be used only in association with wheat.

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