Chestnuts, a "Comfort" Healthy Food?

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Abstract

Chestnut has been a staple food since ancient times and after being set aside for several centuries, it has finally regained appreciation within the group of patisserie connoisseurs and has been expanded among health conscious consumers. Being relatively cheap in a modern agricultural practice, a chestnut deserves a better appreciation as a source of valuable nutrients and in terms of its composition and properties which positively affect human health when included in various modern foods. Also, it contains a very large amount of vitamin C, considerable vitamin B_6, thiamin, folate and riboflavin, large amounts of manganese, potassium, copper, phosphorus, magnesium and iron, a small amount of valuable unsaturated fatty acids and 40% of its dry matter is composed of non-resistant and resistant starch. Chestnut is gluten-free and that makes it useful as a food for celiac patients who suffer from gluten intolerance manifested in stomach discomfort and diarrhea, fatigue and many other symptoms. On the other hand, resistant starch, which survives the small intestines and decomposes in the rectum, serves as a bulking agent to provide a feeling of satiety and it transfers sugar to the blood via a sort of controlled-released mechanism. Results from investigations on the health benefits of chestnuts in modern foods in general and the effects on the well-being of celiac patients in particular are reviewed: patient's comfort, satiety, and blood sugar levels. The effect of storage conditions and the chestnut cultivar on starch digestibility are studied in a two-month period. A decrease of up to 30% regarding resistant starch composition is observed for some cultivars when stored at 20°C as opposed to storage at -18°C. This study shows that different storage conditions affect the content of non-resistant and resistant starch.

INTRODUCTION

Classical celiac disease (CD), (glutensensitive enteropathy, or GSE) is a small intestinal inflammatory disease that is characterized by global malabsorption of nutrients, minerals, and vitamins. It is triggered by the gluten proteins of wheat, barley, and rye (Schuppan et al., 2005). In patients with celiac disease ingestion of the gliadin fraction of wheat gluten and similar molecules (prolamins) causes damage to the intestinal epithelium. Therapy of CD is a lifelong gluten-free diet. The National Food Authority has recently redefined the term "gluten-free", and now that term now means no gluten, and <0.02% is currently labelled "low gluten" (Fassano and Catassi, 2001).

An association of diabetes with GSE has been observed since the late 1960s. In recent years, it has become clear that the incidence of GSE in patients with type 1 diabetes is substantial. The incidence of type 1 diabetes and celiac disease occurring together is about 7 to 12% in persons with either celiac disease or diabetes (Aktay et al., 2001; Cronin et al., 1997). Both diseases require dietary modifications for proper management. The control or elimination of certain foods will keep the person with either disease healthy.

The glycemic index or GI describes difference by ranking carbohydrates

according to their effect on blood glucose levels. Choosing low GI carbs, the ones that produce only small fluctuations in our blood glucose and insulin levels, provoke reducing risk of heart disease and diabetes.

Chestnuts are very low in fat (99% fat free and no cholesterol), low in salt contain and are a great source of smart carbohydrates (mostly starch). They are also high in dietary fibre and rich in minerals like potassium and calcium and in B group vitamins, all of which enhance health in general. Chestnuts have low glycemic index (GI 54 for crushed uncooked chestnut kernels), and no gluten (ion the starch). There is the added advantage of providing specific health benefits for diabetics and coeliacs.

Dietary starch that escapes digestion in the small intestine may be quantitatively more important than dietary fiber as a substrate for fermentation (Cummings and Englyst, 1987). Resistant starch and other types of starch that escape digestion in the small intestine may quantitatively be more important as substrates of fermentation than non starch polysaccharide (NSP). Also, resistant starch is the major substrate for colonic butyrate production. This compound is probably the short-chain fatty acid with the strongest protective effect against colorectal cancers. Furthermore, recent epidemiological data show a negative relationship between starch and colorectal cancer risk (Cassidy et al., 1994).

The population of Bosnia and Herzegovina and Croatia mainly used cereals in nutrition, as well as flour of cereals origin. As a result, for people who suffer from celiac disease it is very difficult to find appropriate food. At the same time, special products assigned for diabetics are often too expensive. In consideration that chestnuts are wide-spread in the investigated area, we investigated the possibility of applying chestnuts and chestnuts flour as crude material in making dietetics products for patient who suffer from diabetes and celiac disease. Previously, we investigated the influence of three different storage regimes (-18°C, 4°C and 20°C) on digestibility of starch in three chestnut cultivars, grown in different locations in Croatia and Bosnia and Herzegovina. The examination of action of products gained from chestnut floor occurred in two target populations of patients who suffer from diabetes (planned diet experiment) and celiac disease (sensory evaluation of products).

MATERIAL AND METHODS

The objects of our study were three separate investigations of application and characterization of chestnut and chestnut products.

Experiment 1 - Influence of Storage Period and Storage Conditions on Starch Properties

In the investigation of digestibility of starch, three *Castanea sativa* Mill. cultivars were included: chestnut grown in north-western part of Bosnia (Bosnian chestnuts), chestnut grown in Slavonija (Slavonian chestnuts), and marrone grown in the north-western part of Bosnia (Bosnian marron). Influence of storage period and conditions on starch properties was determined by analysis of chestnut samples at the beginning of storage, after a period of one and two months, at three temperatures: 20°C, 4°C and -8°C. Dry matter content was determined by drying at 70°C in a vacuum oven. Before analysis chestnuts were peeled and grinded.Resistant starch content was determined by AOAC Method 2002.02. Samples were incubated with α-amylase (Sigma no. A3306; Sigma Chemical Co., St. Louis, MO) and amyloglucosidase (Sigma no. A3514; Sigma Chemical Co., St. Louis, MO) (AMG) (37°C, 16h). Samples were washed with ethanol, and resistant starch (RS) residues were melted in 2M KOH and incubated with AMG (50°C, 30 min). Resulting glucose was determined colorimetrically by spectrophotometer Hewlett Packard 8452, after reaction with GOPOD (glucose oxidase-peroxidase-4-aminoantipyrine) reagent (also purchased from Sigma Chemical) (50°C, 20 min). All the other used chemicals and solvents were of a high analytical grade and obtained from commercial providers.

Experiment 2 - Planned Diet for Patients Who Suffer from Diabetes

1. Preparation of Chestnut Products. Premium nuts were selected and peeled before use, then boiled and crumbled. Preparation of samples was performed by previously defined recipes. Preparation of diet products based on chestnut flour was made by using the artificial sweeteners and the fats of vegetable origin (margarine and olive oil), with the intention to obtain products of low caloric value, which will cause minimum oscillations of blood glucose. Two types of cake were made: honeycomb with jam and chestnut cake.

2. The Planned Diet of Patients. A group of six patients who suffer from *diabetes mellitus*, of different age and sex participated in the experiment. The examination was conducted to determine the effects of chestnut flour in parameters of blood analysis before and after the diet. The planned diet of the examinee took a total of 12 days. The following schedule was applied:

Diet scheme:

a) The first four days the patients consumed products made of chestnut flour as follows: before food intake, in the morning at 7pm a blood sample were taken. Then 30 g products of chestnut flour were consumed (the first two days the patients ate the honeycomb with dietary jam, and next two days they consumed chestnut cake). After two hours, the procedure of blood sampling was repeated. The 30 g sample of cookies contained 1.70 g resistant starch.
b) During the next four days, they consumed 30 g of rye bread, containing 0.055 g resistant starch. The procedure of blood sampling before and after the meal was the same. In that manner we compared the effects of chestnut and rye to the level of blood glucose in diabetes. The rye was taken according to its low glycemic index.
c) During the last four days the patients consumed food of their normal diet. The monitoring schedule was kept the same.

3. Monitoring of Blood Glucose, Cholesterol and Triglycerides Levels Before and After Chestnut Diet. The blood samples were analyzed for blood glucose and cholesterol level, and content of triglycerides by standard clinical blood tests.

Experiment 3 - Sensory Evaluation of Chestnut Biscuits of Patient Who Suffer from Celiac Disease

This experiment included:

a) preparing gluten-free product based on chestnut flour by previously established recipes.
b) sensory analysis and assessment of acceptability of products by patients who suffer from celiac disease.

1. Chestnut Biscuits. Five types of biscuits were made from chestnut flour: honey cake, peanut biscuit, snow cookies, vanilla cookies and chocolate truffles. The producer of chestnut flour is "Mulino di Zanonova Zanonova Giamalmigi" from Italy. Flour was bought on the market of Croatia. Some sorts of cookies were prepared using chestnut flour composited with wheat flour in the following proportions: 85:15%. In preparation adding of artificial sweetener was included if necessary.

2. Sensory Analysis and Assessment of Acceptability. In the sensory analysis and assessment of acceptability, seven celiac patients of different age and sex were included. The sensory evaluation was conducted at a specialized laboratory and tasting was done according to methods of ISO Sensory analyses. The sensory rating included estimation of appearance, colour, texture, aroma and taste. The assessment of products was graded as totally acceptable, acceptable, nor acceptable nor not acceptable, not acceptable and totally not acceptable.

RESULTS AND DISCUSSION

The formation of RS is influenced by: crystallinity of starch, granular structure, amylose:amylopectin ratio, retro gradation of amylose, moisture, presence of other nutrients, processing and storage conditions (Sajilata et al., 2006). The results of investigation of digestibility of starch in *Castanea sativa* Mill. cultivars stored at different

temperatures are shown in Table 1.

The most considerable changes of dry matter and starch content were detected during storage at 20°C. At this temperature Slavonian chestnuts were stable for one month only. At 20°C within a 2-month period, non resistant starch content in some cultivars increased even 30%. During a 1-month period, changes in starch and dry matter content are not marked, but in the second month non resistant starch content decreased for 35-40%, excluding Bosnian chestnut. Also, changes in resistant starch content were observed. Since the lowest changes in dry matter content and starch digestibility occurs at -18°C, this is the most suitable temperature regime for storage of all cultivars.

A small preliminary study (6 patients) of the effects of systemic use of chestnut products on the level of some parameters in blood analysis was done (Fig. 1, Table 2).

After conducting systematic nutrition it seems that resistant starch from chestnut and rye decrease the glycemic index of food. Blood tests of patients show positive results of glucose level (Table 2).

In the investigated group 83.33% patients showed a decrease for glucose level (66.44%), (Fig. 1). The influence of planned diet was not so distinctive in cholesterol and triglycerides content in blood samples (Figs. 2 and 3).

Results in Table 3 and Figure 4 express judgement of consumer (celiac patient) about sensorial properties of cakes made with chestnut flour.

In Figure 5 the final results of sensory rating of the products acceptability is shown. The maximum estimation for sensory characteristics got honey cake (119), then vanilla cookies (118), while the lowest score had snow cookies (104), (Fig. 4). The estimation of acceptability following this trend, honey cake graded as totally acceptable (100%) and vanilla cookies TA (85.71%). Snow cookies were described as acceptable (57.14%). Toward opinon of celiac patients who participated in evaluation, all the investigated samples demonstrated considerable good sensorial prorerties.

Chestnuts and chestnut flour have low GI, high RS content and represent gluten free products. The preliminary results of our research of possible application of chestnuts and chestnuts flour in celiac and diabetic patients nutrition were promising and demand further investigation.

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ISO Sensory analysis; ISO 11037:2002 (E), General guidance and test method for assessement of the colour of foods; ISO 3972:2002 (E), Methodology-Method of investigating sensitivity of taste; ISO 5496:1992 (E), Methodology-Initiation and training of assessors in the detection and recognition of odours; ISO 6564:2002 (E), ISO 4121:1987 Methodology-Evaluation of food products by methods using scales; Methodology-Flavour profile methods.

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Tables

Table 1. Digestibility of starch in chestnut cultivars stored at different temperatures.

Cultivar	Parameter	Stored at 20°C			Stored at 4°C		Stored at -18°C	
		0	1 month	2 month	1 month	2 month	1 month	2 month
Bosnian chestnuts	Dry matter (%)	48.14	72.41	93.51	44.85	49.22	47.03	47.17
	RS** (% d.m.*)	26.84	27.33	16.34	27.30	26.88	27.30	28.12
	NRS*** (% d.m.)	27.69	20.77	27.12	31.71	31.03	31.71	32.66
	TS**** (% d.m.)	54.53	48.10	43.46	59.01	57.91	59.01	60.78
	RS/TS (%)	49.22	56.82	37.60	46.26	46.42	46.26	46.26
Bosnian marron	Dry matter (%)	42.78	73.45	93.96	43.27	43.40	41.48	40.30
	RS (% d.m.)	11.28	12.05	8.56	15.54	12.38	5.99	8.97
	NRS (% d.m.)	53.33	34.72	32.31	63.22	34.49	65.89	59.47
	TS (% d.m.)	64.61	46.76	40.87	78.77	46.87	71.88	68.45
	RS/TS (%)	17.46	25.76	20.94	19.73	26.41	8.33	13.11
Slavonian chestnuts	Dry matter (%)	56.47	88.53		52.30	57.61	56.44	54.07
	RS (% d.m.)	22.52	6.04		39.85	40.91	31.39	35.60
	NRS (% d.m.)	30.68	60.71		31.59	18.14	17.83	12.43
	TS (% d.m.)	53.19	66.75		71.44	59.05	49.22	48.03
	RS/TS (%)	42.33	9.05		55.78	69.28	63.77	74.12

*d.m.- dry matter
**RS - resistant starch
***NRS - nonresistant starch
****TS – total starch

Table 2. The results of glucose, cholesterol and triglyceride content in blood before and after diet.

Patient	Glucose (mmol/L)		Cholesterol (mmol/L)		Triglyceride (μmol/L)	
	Before ex*	After ex	Before ex	After ex	Before ex	After ex
1.	20.7	17	5.1	6.1	1.35	2.20
2.	17.6	9.1	6.5	6.8	2.26	1.76
3.	13.8	13.6	4.8	5.8	7.01	5.16
4.	18.1	9.8	7.9	7.0	3.17	3.78
5.	6.0	4.6	6.2	5.3	1.92	1.43
6.	12.7	17.9	5.7	6.5	1.09	2.06

*ex - experiment

Table 3. Sensory rating of chestnut cakes.

Sensory characteristics	(points)	Honey cake	Vanilla cookies	Peanut biscuit	Chocolate truffles	Snow cookies
Appearance	(max 14)	14	14	12.5	13	13.5
Colour	(max 21)	21	21	18.5	19.5	20.5
Texture	(max 28)	28	27.5	26	25.5	20
Aroma	(max 21)	21	21	20	20	19.5
Taste	(max 35)	35	34.5	34.5	33	30.5
Total score	(max 119)	119	118	111.5	111	104

Figures

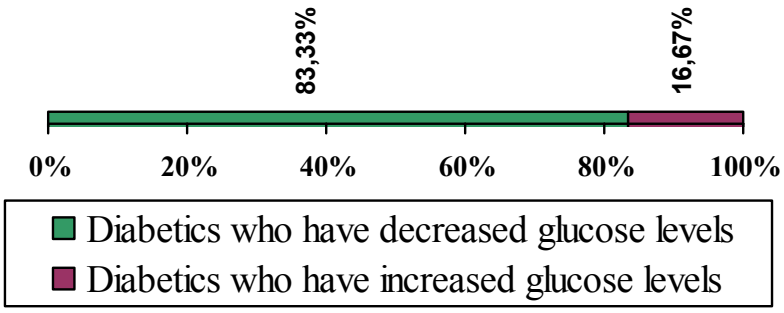

Fig. 1. The ratio of diabetics with reduced blood glucose levels after the final testing.

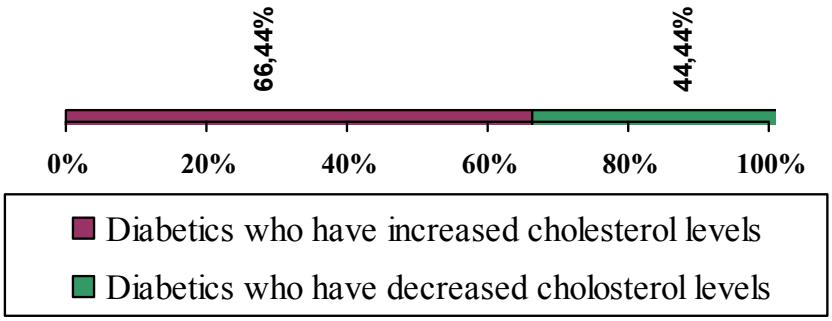

Fig. 2. The ratio of diabetics with reduced content of triglycerides in blood after the final testing.

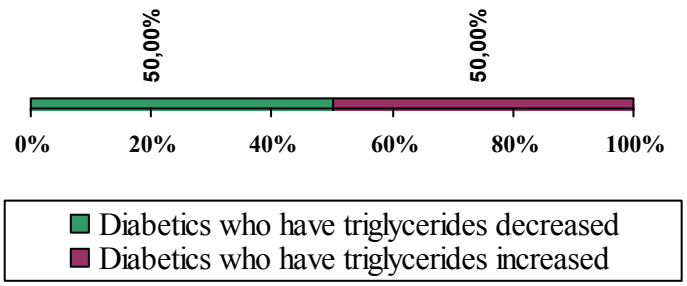

Fig. 3. The ratio of diabetics with reduced blood triglycerides levels after the final testing.

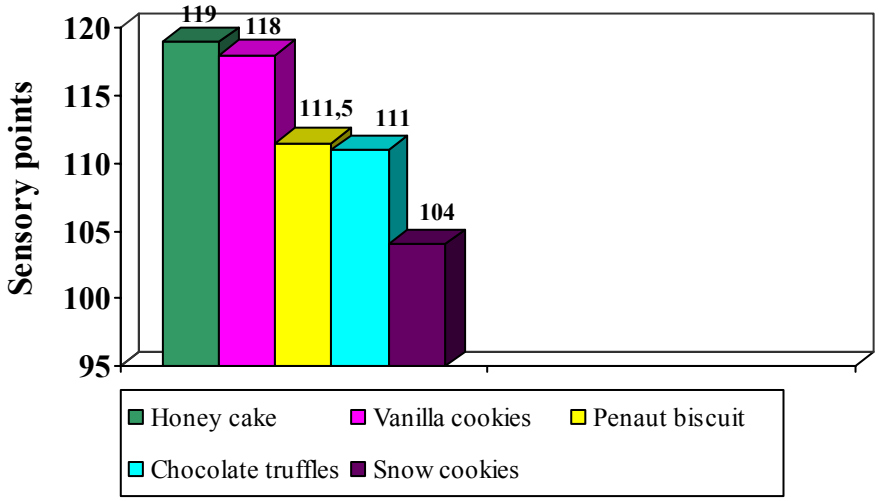

Fig. 4. Total sensory rating of chestnut cakes.

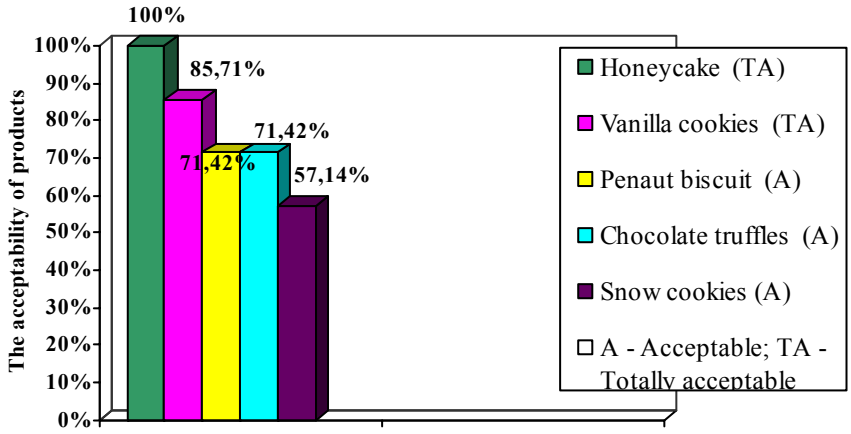

Fig. 5. Total sensory acceptability of chestnut cakes.