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BETA-GLUCAN IN DIET OF STUDENTS IN SARAJEVO CANTON

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Abstract

The focus of this research is on beta-glucan, its health benefits and daily consumption of beta-glucan-containing foods and supplements among student population. Beta-glucan is an important soluble dietary fiber found in cereals, certain types of mushrooms and seaweed that has been associated with reduced presence of: insulin resistance, dyslipidemia, hypertension, and obesity due to its multiple functional and bioactive properties.

This paper explores dietary habits and intake of beta-glucan among students in primary schools, high schools and universities on the area of Sarajevo Canton. The survey included a total of 100 participants. Food frequency questionnaire was used to estimate dietary intake of oat and barley products (breakfast cereals, meals, and crackers), baking products (bread), mushrooms and dietary supplements containing beta-glucan. Food frequency questionnaire consisted of questions about the frequency (daily, weekly, monthly, yearly) and the amount of consumption of certain types of beta-glucan-containing foods and supplements. Statistical analysis (mean, standard deviation, chi-square test) was carried out using the Excel.

The results of this research showed that five (19.23%) respondents from primary schools had inadequate dietary intake of beta-glucan, two (15.38%) respondents from high schools had inadequate dietary intake of beta-glucan, and seven respondents from universities had inadequate dietary intake of beta-glucan which is 20.59% of total examined population.

Despite the fact that usual diet contains of foods rich in beta-glucan, insufficient intake of dietary fiber beta-glucan is evident among students on a daily basis. Continuously monitoring of beta-glucan intake through diet is essential in order to determine dietary habits of daily fiber consumption.

***Key words**: Beta-glucan, Dietary habits, Supplements.*

1. Introduction

Nutrition should meet certain nutritional and health conditions i.e. it should meet the principles of a balanced diet [1]. Rapid development of science of nutrition and particularly the possibility of preventing various illnesses by food, as well as epidemiological studies that showed a relation between nutritional habits and chronic illnesses influenced the development of the concept of proper nutrition. A diverse nutrition provides the neccessary nutrients to the human body which are required for proper functioning. However, there are certain foodstuffs which in themselves, due to the structure and unique functioning have generally recognized therapeutical effects. One of the positive examples are dietary fibers. Dietary fibers are carbohydrate polymers with three or more monomeric units that are not absorbed in the small intenstine [2]. According to the type of monosaccharide units which are part of polymers' structure and adsorption ways, dietary fibres can be split into different factions: resistent

starch, beta glucan, arabinoxylan, cellulose and fructans. Beta glucans are structural homopolysaccharides isolated from the cell wall of a bakers' or beer yeast and they are present in grains such as: barley, oats, rye and wheat, and in mushrooms such as: *Reishi, Shitake* and *Maitake* and certain types of algae and bacteria. In 2008, the US Food and Drug Administration (FDA) gave the GRAS status to the yeast beta glucans *Saccharomyces cerevisiae* and in 2011 to the beta glucans isolated from mushrooms. GRAS is the status for food and food ingredients which are *"generally recognised as safe."* There is an officially approved healthcare statement of the relevant institutions of the European Food Safety Agency (EFSA) and the FDA for beta glucans. However, although their application is connected to modulation of an immunological response, the only approved health claim is linked to their potentially favourable effect with hypercholesterolaemia i.e. reduction of cardiovascular disease risk [3]. Scientific opinion of the EFSA Panel on dietetic products, nutrition and allergies on the substantiation of health claims related to beta-glucans from oats and barley and maintenance of normal blood LDL-cholesterol concentrations (ID 1236, 1299), increase in satiety leading to a reduction in energy intake (ID 851, 852), reduction of post-prandial glycaemic responses (ID 821, 824), and "digestive function" (ID 850) pursuant to Article 13(1) of Regulation (EC) No 1924/2006 defines the following:

- „Taking beta glucans from oats or barley as part of a meal contributes to post-prandial blood glucose rush": the claim can be used only for food that contains at least 4 g of beta glucans from oats and barley for every 30 g of available carbohydrates per serving as part of a meal. To use the claim, consumers should be provided with a pieace of information that the beneficial effect is achieved with taking of beta glucans from oats and barley as part of a meal.

- „Beta glucans contribute to maintenance of a normal blood cholesterol level": the claim can be used only for food that contains at least 1 g of beta glucans from: oats, oat bran, barley, barley bran or a mixture of these sources per dosage. To use the claim the consumers should be provided with a piece of information that the beneficial effect is achieved with the daily intake of 3 g of beta glucans from: oats, oat bran, barley, barley bran or from a mixture of these beta glucans [4].

2. Materials and Methods

A questionnaire was used to compile information about the quantity and frequency of intake of foodstuffs rich in beta glucans, additional intake of beta glucans through food supplements and health statuts of the examined population. The questionnaire included 100 pupils and students from the Sarajevo Canton area in Bosnia and Herzegovina in the following educational institutions: the Mehmedbeg Kapetanovic Ljubusak Primary School, the Bosniak Grammar School, the Sarajevo Secondary School of Denistry, the Faculty of Economy, the Faculty of Traffic and Communications and the Faculty of Pharmacy of the University of Sarajevo. The poll was carried out from March to May 2016.

The Food Frequency Questionnaire (FFQ) included questions on consumption of foodstuffs that naturally contain beta glucans, such as: oat products (oatmeal, oat flakes, oat crackers), barley products (barley mash, barley flakes), bread (whole wheat bread, white bread, semi-white bread) and questions about consumption of food supplements that contain beta glucans. The calculation of the daily intake of beta glucans was done on the basis of beta glucan percentage in various types of consumed food products in the following way (g of beta glucans in 100 g of products): barley flakes 4.31, oat flakes 4.62, white bread 0.12, semi-white bread 0.27, whole wheat bread 0.20 [2]. The statistical data analysis (the average, standard deviation, chi-square test) was done in Excel.

3. Results and Discussion

3.1 Results

Out of total of 100 respondents, 87 surveys were processed, while 13 surveys were not satisfactory. The age distribution of participants showed that the highest number of responses (a total of 41) was from the student population from universities (over 18 years old). A group of primary school students had 31 respondents (6 - 14 years old), while 15 respondents were high school students (15 - 18 years).

The average age of respondents from primary schools was 8.8 ± 2 years, from the group of high school students, 17.23 ± 0.56 years, and the respondents from the university students were 20.43 ± 1.68 years old. The average weight of respondents from primary schools was 33.38 ± 10 kg, from the group of high school students 60.8 ± 6.08 kg, and the respondents from the university student population were 66.78 ± 8.82 kg. The group of primary school students consisted of 16 male respondents and 15 female respondents, the high school students had 3 male respondents and 12 female respondents, and the group of university student participants contained 15 male respondents and 26 female respondents. The health status of 80 respondents, out of total of 87, was satisfactory, while seven respondents had certain health problems: two respondents had pollen allergies, three had weakened immunity, one respondent had emphysema and one had chronic gastritis.

3.1.1 Respondents from primary schools

Only four respondents from this group consume oat products daily, whilst three respondents consumed them once a day in the amount of 50 g, and one respondent twice a day in the amount of 100 g. When it comes to barley products, only one respondent in this group consumes barley products in the amount of 50 g on a daily basis, thereby providing a daily amount of beta-glucan of 2155 mg. 13 respondents from this group consume integral bread daily, whilst 19 respondents consumed white/semi-white bread daily. Three respondents from the primary school group take dietary supplements daily (80 mg of beta-glucan) (Table 1).

3.1.2 Respondents from high schools

Only one respondent in this group consumes oat products in the amount of 50 g on a daily basis, thereby providing a daily amount of beta-glucan of 2310 mg. As far as barley products are concerned, no respondents from this group consumes barley products on a daily basis. Four respondents of this group consume integral bread daily, white/semi-white bread daily consumes 13 respondents. Three respondents from the group of high school students daily take dietary supplements (80 mg of beta-glucan) (Table 2).

3.1.3 Respondents from universities

In the group of university students, 11 respondents consume oat products daily, out of which nine respondents ingest once a day an average amount of 60 g, and two respondents twice a day in the amount of 100 g. Only one respondent in this group daily consumes barley products in the amount of 50 g, thereby providing a daily amount of beta-glucan of 2155 mg. Integral bread daily is consumed by 21 respondents of this group, whilst white/semi-white bread is consumed daily by 32 respondents. Only one student daily takes dietary supplements (500 mg of beta-glucan) (Table 3).

There is no statistically significant difference in the daily frequency of consumption of oat products among the respondents from the three groups ($x^2 = 3.05$ and $p = 0.22$). The groups examined do not differ in the frequency of their daily consumption of barley products. Nor is there a statistically significant difference in the frequency of daily intake of integral bread among the respondents of the examined groups ($x^2 = 2.75$ and $p = 0.25$). Respondents from high schools and universities are statistically more likely to consume white/semi-white bread on a daily basis than respondents from primary schools ($x^2 = 7.36$ and $p = 0.03$). Regarding the daily intake of beta-glucan, there is no statistically significant difference between the respondents of the examined groups ($x^2 = 0.11$ and $p = 0.94$).

Table1. Intake of beta-glucan by primary school students

Parameters	Oat products Oat meal/Oat cereals		Barley products Barley meal/Barley cereals		Bread Integral/White/Semi-white	
Frequency of consumption	1x day	2x day	1x day	2x day	1x day	2x day
	3	1	1	/	10	22
Daily intake (g)	50	100	50	/	110	163.5
Intake of beta-glucan (mg)	2310	4620	2155	/	176	261.6

Table2. Intake of beta-glucan by high school students

Parameters	Oat products Oat meal/Oat cereals		Barley products Barley meal/Barley cereals		Bread Integral/White/Semi-white	
Frequency of consumption	1x day	2x day	1x day	2x day	1x day	2x day
	1	/	/	/	7	10
Daily intake (g)	50	/	/	/	178,57	285
Intake of beta-glucan (mg)	2310	/	/	/	285,71	456

Table3. Intake of beta-glucan by university students

Parameters	Oat products Oat meal/Oat cereals		Barley products Barley meal/Barley cereals		Bread Integral/White/Semi-white	
Frequency of consumption	1x day	2x day	1x day	2x day	1x day	2x day
	9	2	1	/	25	28
Daily intake (g)	60	100	50	/	154	279,25
Intake of beta-glucan (mg)	2770	4620	2155	/	246	447

3.2 Discussion

Previous studies have established a recommended human dosage of a minimum of 2 mg of beta-glucan daily per kilogram of body weight, and the proposed dosage by the manufacturers for minimum efficiency is a recommended dose of 2 - 4 mg/kg body weight. There is a lack of clinical data in the literature for a dose of less than 2 mg/kg of body weight per day [5].

Based on the above, the results of this study showed that out of 31 respondents from primary schools, 26 of them had a daily intake of beta-glucan within the recommended dosage (for the age up to 12 years, the recommended daily dose is about 80 mg - 2 mg of beta-glucan/kg for a person of an average of 40 kg of body weight). From a group of high school students, 13 out of 15 respondents take daily the recommended dosage of beta-glucan, and from the group of university students, 34 out of 41 respondents daily take the recommended dosage of beta-glucan (for the age over 12 years, the recommended daily dose is about 250 mg - 4 mg of beta-glucan/kg for a person of an average of 60 kg of body weight). In this study, average daily intake of beta-glucans by the primary school students, high school students and universitiy students was estimated at 9.2 mg/kg, 3.3 mg/kg and 3.7 mg/kg respectively. It can be concluded that, despite the fact that the usual diet contains foods rich in beta-glucan, a certain number of respondents in the examined student population do not consume beta-glucan in sufficient quantity everyday. In primary schools five respondents out of 31 had an inadequate dietary intake of beta-glucan, which is 19.23%. In high schools, two respondents out of 15 had inadequate dietary intake of beta-glucan, which is 15.38%, whilst from the university students, seven respondents out of 41 had inadequate dietary intake of beta-glucan, which is 20.59% of the total examined population. When the results of many studies on the effects of beta-glucan on human health are taken into account, it is clear that this percentage of the vulnerable population is exposed to health risks. Beta-glucans belong to a group of soluble dietary fibers. In the United States, based on the results of food group and nutrient intakes study, reported a daily fiber intake of 13.7 g in total, comprising 4.2 g of water-soluble fiber [6]. In Japan, total dietary fiber intake was estimated at 18.3 g/day, comprising 3.2 g of water-soluble fibers. The contribution of cereals to total dietary fiber and water-soluble fiber intake was 3.1 g/day and 0.3 g/day respectively [7]. According to a study in the UK, the average intake of non-starch polysaccharide (NSP) dietary fibers from cereals, including beta-glucans, was calculated at 4.4 g/day [8]. In Mexico, the average daily intake of total NSP was estimated at 17.4 g, and about 41% of this was soluble. Mean intake of soluble NSP by rural and urban men was about 8.84 g/day and 6.67 g/day, and mean intake of soluble NSP by rural and urban women was 7.32 g/day and 5.93 g/day respectively [9]. Contribution of cereal products to fibre intakes in UK by adults aged 19 - 64 years was estimated at 19% by bread (of which white bread 9%, wholemeal bread 5%, brown bread 4%, other breads 6%), and by breakfast cereals 6% [10].

Various studies have been conducted with the aim of proving the effects of beta-glucan on human health. Increased interest in beta-glucans, as well as the expansion of new beta-glucan studies, came after revealing its multiple functional and bioactive properties. Of all fibers, its beneficial role is the most thoroughly and continuously documented, and no adverse health effects have been noted after the consumption of foods rich in beta-glucans [11]. Beta-glucans belong to a group of immunological stimulants and, according to studies, beta-glucans are one of the most effective biological activators. Beta-glucan can enhance the responsiveness and function of immune cells, and its main biological immunomodulatory activity is based on the stimulation of both humoral and cellular immunity, especially macrophage functionality [12]. Beta-glucans have been found to reduce levels of LDL-cholesterol and increase levels of HDL-cholesterol [13]. The mechanism of the hypolipidemic effect of diet rich in fiber is a delay in the absorption of cholesterol in the intestines, as well as the simultaneous increase in fecal cholesterol secretion [14, 15]. Viscosity is considered an important factor in the changes of the physical characteristics of the intestinal content, which leads to reduced rate of glucose absorption. In addition, beta-glucans reduce postprandial glucose and insulin responses, and improve insulin sensitivity, and it has been strongly implicated in the prevention of type 2 diabetes mellitus [16, 17]. Also, the effects of beta-glucan on hypertension, obesity, satiety, digestive function, and modulation of various metabolic dysregulations associated with the metabolic syndrome have been studied. Additional studies are still needed in order to fully elucidate the mechanisms underlying the protective effects of soluble beta-glucan fibers, and its beneficial role remains to be further explored [18].

4. Conclusions

- Change of lifestyle, in accordance with general recommendations of medical nutritive therapy connected with optimal nutrition style and increased physical activity, includes recommendations for dietary fibre intake among which beta glucan takes an important place. On the basis of the obtained results, average daily intake of beta-glucans by the primary school students, high school students and universitiy students was estimated at 9.2 mg/kg, 3.3 mg/kg and 3.7 mg/kg respectively.

- The results of this analysis showed that, apart from the fact that the usual diet of children and youth contained foodstuffs rich in beta glucans, a certain number of respondents in the examined population did not have a sufficient daily intake. The number of respondents with the reduced intake cannot be neglected and it ranges from 15 - 20% in the sphere of questioned category. The results of the implemented analysis give a conclusion on the importance of additional intake of beta glucans through food supplements.

- Also, due to the importance of preserving the population's health, as well as due to proved functional and bioactive effects of beta glucan, an idea imposes itself about potential food fortification with this substance.

- This research has shown that active participation of relevant institutions involved in health, development, rising and education of children and students was necessary in order to improve their health. The important action path for them is passing of adequate laws and guidelines about nutrition, educational activities aimed at raising children and adult awareness on the importance of daily intake of foodstuffs rich in beta-glucans.

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