Original article

Nutritional content of gluten free foods in the northern side of Cyprus

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Abstract. *Background:* Gluten free (GF) foods -which are the main part of the GF diets- are produced from grains without gluten protein. They have an important place in the food market. Depending of the type of GF foods, it may cause to nutrient deficiency in long term unconscious consumption. Nutrient deficiencies are related with some health problems thus evaluation of the GF foods contents has importance for the nutrition science. *Methods and Study Design:* The current study was conducted in Cyprus. Authors visited six diffirent supermarkets and determined 99 different GF foods. After the determination, they evaluated nutrient contents of GF foods from food labels and compared with reference foods which include gluten protein. They used TurKomp and BeBiS programme to determine reference foods nutrient content. *Results:* There were two main groups in this study. In the study group; there were 99 GF foods and 34 gluten containing foods in the control group. The mean energy, carbohydrate, fat, saturated fatty acid and sugar contents of the GF foods were higher, their protein contents were lower than control group ($p<0.05$). *Conclusion:* This study have brighten nutrition science to provide diet diversity for patients who need to consume GF products for long-term.

Keywords: Gluten free foods, gluten free diet, gluten, nutrient quality, food labels

Introduction

Gluten free (GF) diet is a nutrition treatment method which is necessary for patients with 'Celiac' and 'Dermatitis Herpetiformis' diseases. These health problems are associated with the gluten protein (1). And also, it has beneficial effects for children with autism spectrum disorder and patients with lower gastrointestinal system problems. In recent years, besides therapeutic effects, it has become one of the popular diets which support weight loss, feeling healthier and fitter etc. (2). One of the main components of GF diets is manufactured GF grain-based products (3). United States Food and Drug Administration (FDA) has described that only product which include <20 mg/kg or <20 ppm/million gluten can be considered as 'gluten free' (4). GF food sales have an important place in the food market (5).

It is known that long term unconscious consumption of GF foods may cause to macro and micronutrient deficiencies. The total fat, saturated fatty acid and therefore the calorie content of GF foods are usually higher and protein content is generally lower than standard foods. Depending on the type of food, there may be differences in salt and fiber contents (6-8). Long term unconscious GF nutrition may cause to protein, dietary fiber deficiencies and high fat intake. These are related with some clinical problems such as growth failure, immune diseases, blood glucose regulation imbalances, constipation, dyslipidemia and obesity etc (7,9). In order to prevent adverse effects of GF diet, diet diversity is very important. Thus, people should consume other sources -which include essential nutrients- to provide diet diversity (6).

From this point, the presented study aimed to determine energy, carbohydrate, protein, total fat,

saturated fatty acids, sugar, salt and dietary fiber contents of the GF foods in the northern side of Cyprus. In addition, these contents compared with reference foods which include gluten.

Materials and Methods

Data Collection

The current study was conducted in the northern side of Cyprus. Data was collected between January 2020-March 2021. Researchers visited six large supermarkets in the northern side of Cyprus and 99 different products with 'gluten free' label were included in the study.

Grouping Data

There were ten GF food subgroups in the presented study. GF products with similar nutritional contents were listed in the same group. The study group of this research (all GF foods which sale in the Northern side of Cyprus, n: 99) were compared with a control group (all gluten containing foods in the TurKomp and/or BeBis national database which are corresponding to GF foods, n: 34). The foods in the control group were selected from the National Food Composition Database- TurKomp and/or Nutrition Information System- BeBis national databases. Gluten containing foods were also listed under eight subgroups. The foods in the 'corn and rice crackers' and 'oilseeds and nuts' subgroups have not been compared with a control group because they naturally do not include gluten protein. Table 1 shows study and control subgroups in 'Results' section.

Identification of Nutritional Contents

Nutrient labels of GF products have been evaluated during the supermarket visit and the energy, carbohydrate, protein, fat, saturated fatty acids, sugar, salt and fiber contents listed on the labels were analysed within the scope of the study.

Energy and nutritional content of gluten containing foods were identified using the TurKomp and/or BeBis databases. TurKomp is a national database which includes the detailed nutritional contents of the foods produced and consumed by the Turkish society, which are identified as a result of various analyses (10).

BeBis is a national database presented for the use of specialists, where energy, macro and micronutrient contents of the foods which are consumed widely in Turkish society are identified according to their consumption amount and frequency (11).

Statistical Analysis

In order to detect the mean and standard deviation (SD) values of the energy and nutritional contents of the foods in both groups and to compare the nutritional contents of the foods, version 21.0 of Statistical Package for the Social Sciences - SPSS packaged software was used. Descriptive statistics were used to determine the minimum, maximum, mean and standard deviation values of quantative data and frequencies (n) and percentages (%) of qualitative data. The compliance of the data to normal distribution was evaluated by the Levene test. In addition, 'Independent sample t test' (when the compliance of the data had normal distribution) and 'Mann Whitney U test' (when the compliance of the data did not have normal distribution) analysis techniques were applied to the statistical evaluation of the differences between the values. p value shows significance degree and <0.05 means the data is statisticaly significant.

Results

In the northern side of Cyprus -where import is limited- the most accessible GF products in terms of variety were sweet biscuits (22.2%). This was followed by GF pasta (15.2%) and salted biscuits (13.1%). In terms of variety, the most limited GF product was found as flour (4%) (Table 1).

When compared energy and nutrient contents of the GF products and the products in the control group there was a statistically significant difference. GF foods had higher energy, carbohydrate, fat, saturated

Table 1. Subgroups of study and control groups

	Study group (GF)		Control group	
Subgroups	**n**	**%**	**n**	**%**
Flours	4	4	5	14.7
Pastas	15	15.2	2	5.9
Breads	10	10.1	8	23.5
Cereals for breakfast and mueslis	9	9.1	5	14.7
Sweet biscuits	22	22.2	6	17.6
Salted biscuits	13	13.1	3	8.8
Bars	9	9.1	2	5.9
Cakes	8	8.1	3	8.8
Corn and rice crackers	5	5.1	-	-
Oilseeds and nuts	4	4	-	-
Total	**99**	**100**	**34**	**100**

Table 2. Comparison of GF foods energy, macro nutrients, fiber, sugar and salt contents to the references foods

Energy and nutrients (for 100 g)	**Study (n: 99)**		**Control (n: 34)**		
	Mean	**SD**	**Mean**	**SD**	**p**
Energy (kcal)	419.74	80.89	359.47	88.21	**0.00****
Carbohydrates (g)	65.04	14.58	57.99	15.80	**0.01***
Protein (g)	6.35	3.04	9.48	3.60	**0.00****
Fats (g)	13.53	10.62	9.38	10.30	**0.05***
Saturated fatty acids (g)	6.79 (n: 74)	6.17	3.76 (n: 21)	5.11	***0.02****
Fiber (g)	4.22 (n: 90)	3.52	5.11 (n: 33)	4.10	*0.32*
Sugar (g)	15.06 (n: 93)	14.54	9.09 (n: 25)	12.79	***0.01****
Salt (g)	0.62 (n: 95)	0.69	0.88 (n: 33)	1.02	0.10

p: Independent sample t test
p: Mann Whitney U test
*: Statistically significant difference. ($p<0.05$)
*: Statistically significant difference. ($p<0.01$)

fatty acid, sugar and lower protein contents. These differences were statistically significant ($p<0.05$, Table 2). Although the fiber content of GF products was lower than the reference products this difference was not statisctically significant ($p>0.05$, Table 2).

When evaluations were done according to the subgroups were made, the energy, carbohydrate, protein, fat and saturated fatty acid contents of the GF products in almost all groups were found higher and their protein content were lower (Table 3). When more detailed analysis was made, the protein contents of GF flours, pastas, breads, sweet biscuits, and cakes were found significantly lower compared to the reference products ($p<0.05$, Table 3). In addition, the energy content of the products in the GF biscuits, bars and cereals for breakfast and muslies group were found to be significantly higher compared to the reference products, saturated fatty acid content of the GF biscuits, and fat contents of the bars were also found to be higher ($p<0.05$, Table 3).

When the fiber and sugar content of GF product subgroups and control subgroups were analysed,

Table 3. Comparison of GF subgroups energy and macro nutrients contents to the references foods (for 100 g)

	Energy (kcal)		Carbohydrates (g)		Protein (g)		Fats (g)		Saturated fatty acids (g)	
Subgroups	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
GF Flours (n: 4)	361.33	31.99	73.11	15.52	2.77	1.57	6.04	9.72	0.30 (n: 1)	
Control (n: 5)	340.40	9.30	64.76	8.55	8.92	2.43	3.51	2.49	0.35 (n: 2)	0.07
p	0.26		0.33		**0.003****		*0.38*		*0.48*	
GF Pastas (n: 15)	361.66	8.33	75.6	3.02	7.27	1.62	1.99	0.92	0.85 (n: 9)	0.53
Control (n: 2)	362.50	9.19	74.78	0.59	10.47	2.87	1.52	0.45	-	-
p	0.89		0.69		**0.02***		0.49		-	
GF Breads (n: 10)	313.80	96.59	55.48	17.43	4.46	2.92	7.14	6.58	2.37	3.65
Control (n: 8)	267.62	34.58	44.99	4.20	10.68	4.25	3.77	2.19	-	-
p	*0.75*		*0.47*		**0.002****		0.32		-	
GF Sweet biscuits (n: 22)	499.18	39.87	64.99	6.24	5.01	1.58	22.76	7.31	12.02 (n: 20)	5.24
Control (n: 6)	451.50	27.60	63.11	10.17	7.03	2.69	19.23	5.22	5.76	5.22
p	**0.01***		0.57		**0.02***		0.28		**0.01***	
GF Salted biscuits (n: 13)	405.92	82.42	68.29	14.72	6.15	4.18	11.59	7.23	5.90 (n: 9)	3.61
Control (n: 3)	356.43	212.87	39.9	31.82	9.16	6.61	17.63	23.55	7.96	10.50
p	0.49		*0.12*		0.32		*0.83*		*0.78*	
GF Bars (n: 9)	469.66	37.56	41.33	9.27	8.14	4.08	24.91	4.74	9.72 (n: 5)	7.25
Control (n: 2)	384.50	9.19	51.60	13.29	11.15	4.03	14.35	7.00	1.60	0.56
p	**0.01***		0.21		0.37		**0.02***		0.19	
GF Cakes (n: 8)	408.12	51.84	72.02	13.64	6.31	2.89	9.95	9.59	4.48	6.22
Control (n: 3)	438.00	73.36	65.93	15.86	11.66	4.18	15.33	15.55	3.40	2.25
p	0.46		0.54		**0.03***		0.49		0.78	
GF Cereals for breakfast and muslies (n: 5)	395.77	36.55	67.82	16.32	8.90	2.81	9.30	8.19	2.53	2.34
Control (n: 5)	358.60	20.10	67.82	11.96	8.90	2.28	5.08	4.55	1.30	1.88
p	**0.05***		1.00		1.00		0.31		0.34	

p: Independent sample t test
p: Mann Whitney U test
*: Statistically significant difference. ($p<0.05$)
**: Statistically significant difference. ($p<0.01$)
-: There was no data on the food label.

the fiber content of almost all of the products in GF subgroups was found to be lower and the sugar content was higher. On the other hand, salt content of each groups could be change. Even though there were numerical differences between the fiber contents of all GF product groups and the control groups, a statistically significant difference was only observed in the GF cakes subgroup. GF cakes had hihger fiber content than control group ($p<0.05$). Similarly, while the sugar contents of all of the GF product subgroups were higher, analysis results showed a significant difference only in the GF sweet and salty biscuits ($p<0.05$, Table 4).

The average contents of corn and rice crackers and oilyseeds, which naturally have no gluten protein in their composition but are labeled as 'gluten free' for sale purposes, are shown in Table 5.

Table 4. Comparison of GF subgroups fiber, sugar, and salt contents to the references foods

	Fiber (g)		Sugar (g)		Salt (g)	
Subgroups	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
GF Flours (n: 4)	6.10 (n: 1)	-	2.00 (n: 2)	2.82	0.55 (n: 3)	0.50
Control (n: 5)	9.43	3.38	0.69	0.37	0.15	0.16
p	*0.38*		*1.00*		0.14	
GF Pastas (n: 15)	2.85	1.51	1.65	1.81	0.12 (n: 14)	0.10
Control (n: 2)	2.25	2.76	0.61	0.08	0.60	0.28
p	0.63		*0.88*		***0.02****	
GF Breads (n: 10)	5.45 (n: 7)	1.58	3.70 (n: 9)	1.92	1.18	0.47
Control (n: 8)	6.80	3.19	-	-	0.71	0.29
p	0.18		-		**0.02***	
GF Sweet biscuits (n: 22)	4.86	5.77	28.57	8.15	0.42	0.28
Control (n: 6)	2.54	3.91	13.06	7.32	0.92	0.29
p	0.40		**0.01***		**0.02***	
GF Salted biscuits (n: 13)	3.59 (n: 12)	3.16	2.74 (n: 11)	1.76	1.60 (n: 12)	0.73
Control (n: 3)	1.06	0.47	0.16	0.11	1.86	2.11
p	0.20		**0.03***		*0.42*	
GF Bars (n: 9)	4.48	1.42	32.27	10.45	0.05	0.04
Control (n: 2)	2.65	3.18	24.00	1.97	0.30	0.28
p	0.20		*0.34*		*0.07*	
GF Cakes (n: 8)	4.07	1.83	14.76	15.73	0.29	0.18
Control (n: 3)	1.00	0.75	28.13	24.51	1.06	1.15
p	**0.02***		0.30		*0.09*	
GF Cereals for breakfast and muslies (n: 5)	6.30 (n: 8)	3.94	17.54	11.66	0.69	0.74
Control (n: 5)	7.68	2.73	4.92	4.34	1.51	1.73
p	0.51		**0.04***		*0.42*	

p: Independent sample t test
p: Mann Whitney U test
*: Statistically significant difference. ($p<0.05$)
-: There was no data on the food label.

Discussion

In this study, where compared the contents of 99 GF products available for purchase in the nothern side of Cyprus. In the current study, the energy, carbohydrate, sugar, fat and saturated fatty acid contents of GF products were found statistically significantly higher compared to the reference products ($p<0.05$) (Table 2). In addition, the presented study observed that the protein, fiber and salt contents of GF products were lower compared to the reference products. However, there was statistically significance for only protein content ($p<0.05$) (Table 2). In a study conducted by Missbach et al. (2015), which used similar methods, it was found that the protein contents of GF products (n: 63) were lower and their energy, carbohydrate, fat and saturated fatty acid contents were higher (3). In another study, protein and fiber contents of GF products (n: 206) were found lower compared to gluten containing reference products, and the fat, especially saturated fatty acid contents were higher (12).

In addition, protein contents of the most commonly consumed grain based GF products -which were identified by reviewing 24 hours food consumption

Table 5. Contents of the "corn and rice crackers' and 'oilseeds and nuts' subgroups

Corn and rice crackers (n: 5)	**Mean**	**SD**
Energy (kcal)	438.70	56.58
Carbohydrates (g)	72.08	9.68
Protein (g)	7.30	0.84
Fats (g)	12.94	10.58
Saturated fatty acids (g)	13.20 (n: 3)	0.65
Fiber (g)	2.30	0.80
Sugar (g)	17.80	15.90
Salt (g)	0.15	0.10
Oilseeds and nuts (n: 4)	**Mean**	**SD**
Energy (kcal)	510.00	36.39
Carbohydrates (g)	55.25	8.12
Protein (g)	8.40	2.56
Fats (g)	27.65	3.00
Saturated fatty acids (g)	10.07	5.85
Fiber (g)	3.27	2.50
Sugar (g)	13.32	16.73
Salt (g)	1.57	0.86

records of children and adolescents with celiac disease-were found lower and the fat content was higher (13). These results support the findings of the current study. On the other hand, current literature emphasizes that the energy, carbohydrate, fat and saturated fatty acid contents of the GF products may be higher and their protein and fiber contents may be lower (8,14,15).

In a study by Barone et al. (2016), where they compared the food consumption of 39 individuals with celiac disease and the healthy individuals (n: 39) in the control group, the results showed that the energy and fat intakes of participants with GF diet were higher and their fiber intakes were lower (16). In another study with a similar design but they determined food consumption of both groups, it was observed that the carbohydrate, fat and saturated fatty acid intakes of the individuals in the group which consumed GF foods were higher and their protein, fiber and salt intakes were lower compared to the individuals in the control group (17). When Van Hees et al. (2015) evaluated the protein intakes of celiac disease patients (n: 77) compared to healthy individuals (n: 33), they found that the protein intakes of individuals with GF diet, especially grain based protein, were significantly insufficient (18). The results of a meta-analysis study (n: 105) emphasizes that fat and sugar intakes of individuals with GF diet were higher than their requirements and their protein and fiber intakes were insufficient (19). The data in the literature suggests that the energy, carbohydrate, sugar, fat, and saturated fatty acid intakes of the people with GF diet may be higher and their protein and fiber intakes may be lower (6-8,15).

Considering the findings of the current study, GF foods had high energy, carbohydrate, sugar, fat and saturated fatty acid contents and low protein and fiber contents, this supports other studies on GF foods and the data in the literature (Table 2).

The main gluten sources of a diet are grains and foods produced with grains such as breads, pasta, flour etc. Therefore, within the scope of GF diet principles, it is possible to meet the need for these foods by substituting them with the GF versions (20). When compared to the reference foods, it was observed that the GF breads, pastas, sweet biscuits, cakes and flours had lower protein content with statistically significance ($p<0.05$). On the other hand, only GF breads had higher salt ($p<0.05$). GF sweet biscuits, bars and cereals for breakfast and muslies subgroups had statistically significantly higher energy content ($p<0.05$). According to their fat and saturated fatty acid contents, only GF bars had higher fat and GF sweet biscuits had higher saturated fatty acid content with statistically significance ($p<0.05$). In addition, sugar content of GF biscuits (sweet and salted) and cereals for breakfast and muslies had statistically significantly higher sugar ($p<0.05$) (Table 3 and 4). In a study by Do Nascimento et al. (2014), conducted with similar methods, they found that the GF breads had higher fat contents and lower protein and fiber contents in comparison to the reference foods. Similar to the current study, GF pastas were found to have lower protein and differently higher salt contents (21). Another study observed that the protein contents of GF foods were lower, supporting the findings of this study. On the other hand, it was found that GF breads had high fat and saturated fatty acid (3). In addition, there are some studies which had

close findings and display that GF biscuits, bars and cakes had high energy, sugar and lower protein contents (3,21). There may be some differences between results because of the sample size of subgroups.

This study was conducted between 2020-2021 years which are known as Corona Virus Pandemic. Thus, authors could only visited northern side of Cyprus where they live. Because of the lock down they could not travel to southern side and visit supermarkets in the southern side of Cyprus.

Conclusion

This study we have conducted on limited number of GF products available in northern side of Cyprus where import is limited and local production is not possible. This is first and only study which aimed to evaluate the variety and nutritional contents of GF products in the northern side of the island. According to the study findings, it is possible to say that there are some differences between the nutrient content of GF foods and gluten containing foods. In this respect, it is necessary to ensure a diet diversity for patients who need to/have to consume GF products for a long term. Diet diversity has important benficial roles for prevention from nutritional problems and related chronic dieases. This present study sheds light on science for this matter.

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