ORIGINAL ARTICLE

Nutritional Composition and Cost Differences between Gluten-Free and Gluten-Containing Food Products in Kuala Lumpur, Malaysia

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ABSTRACT

Introduction: The demand for commercial gluten-free food products are increasing due to rising prevalence of lifestyle-related diseases. The market growth is forecasted to increase in numbers. However, to date nutritional comparison of gluten-free and gluten-containing food products is not done extensively in Malaysia. Therefore, this study aimed to investigate the nutritional composition and cost per 100 g between gluten-free and gluten-containing food products in selected grocery stores in Kuala Lumpur. **Methods:** A total of 106 food products comprising of gluten-free food products (n=41) and gluten-containing food products (n=65) were determined and compared for its nutritional composition and cost per 100 g. The products were obtained from 4 main grocery stores in Kuala Lumpur that supply gluten-free food products. The differences in nutritional composition and cost between both products were analysed by using independent samples t-test. **Results:** The results showed no difference in energy content between both products. Across the food products, 15 % of gluten-free food products showed higher carbohydrate content compared to its counterparts. Protein content in gluten-free products was 63 % lower than gluten-containing products. Among all gluten-free food products included in this study, only lasagne sheet has lower content of dietary fibre compared to its counterparts. The cost for majority of gluten-free food products was significantly higher, which was two- to four-fold higher compared to gluten-containing products. **Conclusion:** This study indicated that gluten-free food products showed no nutritional advantage especially in its macronutrients, hence, avoidance of gluten for healthy population may not be beneficial and rather costly.

Keywords: Nutritional composition, Gluten-free, Gluten-containing, Food, Cost

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INTRODUCTION

Recently, the demand for gluten-free baked products has increased worldwide due to the rising awareness of celiac disease (1). Wheat flour-based baked goods such as bread mix and cake mix, and other food products including pasta products and biscuits are common foods that contain gluten (2). Under the Code of Federal Regulations the term “gluten-free” can be classified as a nutrient content claim and defined as any food product that contains less than 20 ppm (parts per million) of gluten in food, regardless of whether the nourishment is normally free from gluten or has been prepared to expel gluten from its formulation (3).

Recently, more healthy populations are seeking out gluten-free options, thus the emergence of gluten-free products in the market (4). The popularity of gluten-free food products raised because consumers perceived gluten-free food products as healthier compared to its conventional food products (5). Due to the demand for gluten-free food products, food manufacturers have been encountering elevated sale pattern for gluten-free items from USD 5.14 billion in 2016 to USD 21.61 billion in 2019 and forecasted to grow at 9.2% compound annual growth rate (CAGR) from 2020 to 2027 (6). The growth of gluten-free products is driven by increasing prevalence of non-communicable diseases resulted from unhealthy lifestyles. Apart from that, increased awareness of healthy dietary practices and prevention of health disorders such as coronary heart disease, diabetes mellitus, metabolic syndrome and obesity were reported as factors for emergence of gluten-free products (6).

Gluten-free diet is embellished further due to elevated number of celiac patients in the world. Celiac disease is a hereditary immune disorder that occurs in the small intestinal mucosa of vulnerable patient due to reaction of gluten resulted from inflammation in the intestinal mucosa of small intestine (7). Many consumers in the world have an immense interest for gluten-free diet and believed that gluten-free food products could add to their general wellbeing in various ways, ranging from weight reduction and prevention of diseases such as irritable bowel syndrome and inflammation (8). Recent study by Newberry et al (2017) reported that gluten-free food products turned out as a trend to consumers due to uncontrollable consumption by healthy people that do not even need any medical priorities (9). In addition, consumers also believed that gluten-free food products were beneficial for them because of impression that gluten-free food products were more nutritious, can reduce body weight and safe for health.

Gluten-free food products have low content of protein and dietary fibre but higher content of carbohydrate, sugar and fat as these components were used in enormous quantities to balance the texture and imply the binding forces due to absence of gluten in the dough products (10). In addition, gluten-free food products were more costly than gluten-containing food products (11). Gluten-free food products are expensive because almost all of the products were imported from overseas depending on the exchange rate to Ringgit Malaysia and it is also because of the demand from the consumers as it is perceived as healthier food products compared to it counterparts. Therefore, this study was conducted to investigate the differences between gluten-free and gluten-containing products in selected grocery stores in Kuala Lumpur, Malaysia on nutrient composition and cost per 100 g.

MATERIALS AND METHODS

Sample selection

This study was conducted in four major grocery stores in Kuala Lumpur namely Cold Storage, Jaya Grocer, Sam's Groceria and Mark and Spencer. The four grocery stores were selected based on specific criteria by which these grocery stores stock organic and healthy foods including gluten-free food products. In fact, Kuala Lumpur is the capital city of Malaysia where high number of grocery stores are strategically located. From these four grocery stores, food products labelled with "gluten-free" followed by another gluten-containing food products based on the same category were chosen as samples in this study. There were eight types of food product chosen which were bread mix, brownies mix, chocolate cake mix, all-purpose flour, spaghetti, macaroni, lasagne sheet and biscuits. The selection of these products was based on Malaysian Dietary Guidelines by Ministry of Health Malaysia that stated cereals and cereals-based products contain the most valuable source of energy.

Determination of samples in the grocery stores was assessed directly during data collection and the number of samples was added based on type of food products from the four different grocery stores. The gluten-free food products and gluten-containing food products such as bread mix, brownies mix, chocolate cake mix, all-purpose flour, spaghetti, macaroni, lasagne sheet and biscuits were categorised accordingly into gluten-free or gluten-containing type. The total number of samples was 106 food products comprising gluten-free food products (n=41) and gluten-containing food products (n=65) available from grocery stores.

Identification of nutritional composition and cost of food products

The nutritional composition (energy, carbohydrate, protein, fat and dietary fibre) was identified based on nutrition information panel on the food products. The mandatory nutrients that must be declared based on the regulations in the Malaysia Food Act 1983 and Food Regulation 1985 are energy, protein, carbohydrate and fat. The other nutrients were optional and the data on dietary fibre was collected when available. The data on micronutrients such as vitamins and minerals were not collected as it is not within the scope of this study. Cost per 100 g between gluten-free and gluten-containing food products were determined and recorded to compare the differences between both food products. The nutrition information panel and price were photographed according to the types of food product.

Statistical analysis

The statistical analysis was performed using IBM SPSS Version 23.0. Independent samples t-test was used to compare the differences between nutritional composition (energy, carbohydrate, protein, fat and dietary fibre) based on nutrition information panel and cost per 100 g of gluten-free food products and gluten-containing food products. The results were expressed as mean and standard deviation. The level of statistical significance was set at $p<0.05$.

RESULTS

A total of 106 food items in terms of nutritional composition and cost were determined and compared. There were 41 gluten-free food products and 65 gluten-containing food products available at the grocery stores. The food items include bread mix, chocolate cake mix, flour, pastas (macaroni and lasagne) and biscuits (shortbread, biscotti, digestive biscuit). Table I shows the differences in mean for energy, carbohydrate, protein, fat and dietary fibre between gluten-free and gluten-containing food products (n=106).

Generally, the energy content between gluten-free and gluten-containing bread mix, chocolate cake mix, all-purpose flour, macaroni, lasagne sheet and biscuits were slightly similar. However, gluten-free brownie mix and spaghetti were found to have higher energy content compared to gluten-containing brownie mix

Table I: Differences in mean for energy, carbohydrate, protein, fat and dietary fibre between gluten-free and gluten-containing food products

Macronutrient	Energy			Carbohydrate			Protein			Fat			Dietary Fibre		
Food products (n)	Mean (kcal)	*SD*	*p*-value	Mean (g)	*SD*	*p*-value	Mean (g)	*SD*	*p*-value	Mean (g)	*SD*	*p*-value	Mean (g)	*SD*	*p*-value
Bread mix															
GF (n = 7)	329	52.36	0.287	69.94	15	0.985	6.73	3.99	0.02	1.8	1.55	0.869	4.27	1.92	0.316
GC (n = 9)	352	25.51		70.05	5.23		11.48	1.92		1.68	1.32		3.29	1.74	
Brownie mix															
GF (n = 5)	418	10.31	0.045	83.95	3.54	0.778	3.59	0.93	0.49	6.65	2.45	0.266	3.8	1.22	0.18
GC (n = 6)	393	19.63		83.95	1.65		4.18	1.18		4.42	1.97		3.13	0.42	
Chocolate cake mix															
GF (n = 3)	380	1.53	0.501	84.97	4.37	0.339	3.57	0.85	0.037	1.67	1.65	0.253	3	0.72	0.742
GC (n = 4)	383	5.5		81.88	3.42		5.43	0.87		3.3	1.66		3.33	1.47	
All-purpose flour															
GF (n = 3)	323	62.18	0.943	82.73	2.53	0.001	3.57	2.71	0.001	0.6	0.6	0.1	1.33	1.19	0.566
GC (n = 7)	320	67.95		71.6	3.11		10.91	1.68		1.46	0.69		2.13	2.11	
Spaghetti															
GF (n = 12)	368	15.04	0.002	77.88	4.04	<0.001	8.54	1.28	<0.001	2.1	1.45	0.107	2.63	1.85	0.388
GC (n = 18)	355	7.03		71.56	3.47		12.27	1.12		1.36	0.36		3.42	2.72	
Macaroni															
GF (n = 5)	357	8.44	0.494	73.78	4.21	0.422	9.18	2.43	0.064	1.82	1.25	0.372	2.52	1.29	0.403
GC (n = 10)	354	7.07		71.85	4.27		11.93	0.58		1.25	0.4		3.14	1.32	
Lasagne sheet															
GF (n = 3)	363	7.81	0.085	74.63	2.47	0.081	9.73	2.25	0.246	2.3	1.04	0.249	2.47	0.06	0.023
GC (n = 6)	354	5.49		72.23	1.2		11.83	0.41		1.33	0.21		2.97	0.29	
Biscuits															
GF (n = 3)	473	63.5	0.287	71.93	11.05	0.229	2.87	0.4	0.001	19.07	11.64	0.388	1.1	1.05	0.966
GC (n = 5)	509	25.99		64.34	5.43		7.18	1.26		24.42	5.05		1.06	1.32	

GF: Gluten-free; GC: Gluten-containing food products; n: Number; SD: Standard deviation

and spaghetti.

Across the food products, 15 % of gluten-free food products showed higher carbohydrate content compared to its counterparts which were coming from gluten-free all-purpose flour and spaghetti. Meanwhile, there were no differences in carbohydrate content between gluten-free and gluten-containing bread mix, brownie mix, chocolate cake mix, macaroni, lasagne sheet and biscuits.

A significantly lower content of protein was observed in gluten-free bread mix, chocolate cake mix, all-purpose flour, spaghetti and biscuits with respect to gluten-containing counterparts. There were no differences in protein content of gluten-free brownie mix, macaroni and lasagne sheet compared to gluten-containing counterparts.

As expected, there were no significant differences in fat content across all food products. As for dietary fibre content, only lasagne sheet showed a significantly higher content in gluten-containing items compared with gluten-free.

In overall, this study determined that the cost for most gluten-free food products were significantly higher as compared to gluten-containing food products as shown in Table II, except for all-purpose flour and biscuits. The price for gluten-free bread mix, spaghetti, macaroni, lasagne sheets and biscuits were at least 4-fold higher compared to gluten-containing items.

DISCUSSION

The findings were in accordance with previous finding that stated significant differences in energy content of gluten-free brownie mix and spaghetti in comparison to gluten-containing counterparts respectively (2). The higher energy content in gluten-free food products could be attributed to other ingredients used in the formulation especially on alternative flours and starches such as maize, rice, corn, potato, cassava and rice starches that could improve the viscosity and elasticity, as well as creating favourable texture (12).
The usage of alternative flours and starches such as maize flour, rice flour, corn starch and rice starch as additives in gluten-free food products could also affect the carbohydrate content (13). Previous studies have shown

Table II: Differences in mean for cost between gluten-free and gluten-containing food products

Food products	Mean (RM)	*SD*	*p*-value
Bread mix			
Gluten-free	4.05	2.5	0.017
Gluten-containing	0.97	0.52	
Brownie mix			
Gluten-free	5.24	0.41	0.029
Gluten-containing	3.12	1.71	
Chocolate cake mix			
Gluten-free	4.33	0.78	0.004
Gluten-containing	1.92	0.46	
All-purpose flour			
Gluten-free	3.33	1.53	0.086
Gluten-containing	0.61	0.44	
Spaghetti			
Gluten-free	5.71	2.29	<0.001
Gluten-containing	1.38	1.5	
Macaroni			
Gluten-free	4.46	2.11	0.02
Gluten-containing	0.92	0.16	
Lasagne sheet			
Gluten-free	6.17	0.58	<0.001
Gluten-containing	2.22	0.37	
Biscuits			
Gluten-free	7.24	5.59	0.329
Gluten-containing	3.12	1.46	

GF: Gluten-free; GC: Gluten-containing food products; SD: Standard deviation, RM: Ringgit Malaysia

similar observation by which gluten-free food products used alternative flours and starches in its formulations, causing gluten-free food products to contain higher amount of carbohydrate than gluten-containing food products (14). Furthermore, the addition of starches in the formulation of gluten-free food products was shown to improve the viscoelasticity and texture of the dough and overall finished products (15). This was reflected in high utilisation of various grains to formulate new and better quality sans of gluten-free food products (16).

The low amount of protein content in gluten-free food products can be indicated by its formulation due to usage of poor ingredients (2, 17). The low protein content appeared to be resulted from the usage of refined flours or starches that were not generally enriched or fortified with protein (14). In addition, refined flours or starches made low contribution to the recommended daily protein intake and more towards the consumption of simple carbohydrate (12).

Current study showed contradicting results from previous findings, by which significant differences were found in fat content between gluten-containing and gluten free products. The latter had higher amount of fat level. The difference among results might be due to variability of formulations between brands of gluten-free food products and small sample size used in this study (16).

Previous finding also showed similar result by which no significant difference was observed in dietary fibre content between gluten-free and gluten-containing food products due to refining process that removed the outer layer of grain that contains a lot of fibre, only leaving the starchy inner layer (3). Similarly, another study also found that the substitution of commercial starches into flour in gluten-free food products do not significantly provide adequate amount of dietary fibre (18). This is because gluten-free food products usually used corn starch, rice flour and corn flour as it main ingredients, whereas gluten-containing food products used wheat flour or wheat semolina.

The results were in line with previous findings which found that gluten-free food products were more expensive compared to gluten-containing food products (10, 19). Similarly, one study claimed that gluten-free food products were more available online and in higher-end grocery stores than the traditional grocery store, which would give persistent financial burden (20). The premium price of gluten free food products was also showed to be associated with non-competitive market structures, small packages, brands specialized in gluten-free products, substitution of dietary fibre content and quinoa as the ingredient of the products (21). The surge of the price in gluten-free food products was also reported as a result of media attention and claims made on the potential benefits of following a gluten-free diet (22).

Thus, it is important to create awareness to the consumer on the nutritional advantages or nutritional quality of gluten-free food products. Gluten-free foods could be beneficial to celiac disease patients, however, the majority of the consumer consumed the gluten-free food products were normal population that perceived gluten-free food products as a healthier option (23). Consumer should also be empowered on the fundamental of nutritional knowledge about the ingredients used in gluten-free food products. Reading the food label on packaged foods could help in identifying the differences in the nutritional content because sometimes the claims could be misleading. Consumer could also choose foods that are naturally gluten-free (fruits, vegetables, unprocessed meat, poultry and fish) and foods without the gluten-free labelling (gluten-free substitute foods) to reduce cost of purchases. At the same time ensuring nutritional qualities of food is prioritized as natural foods are always better than processed foods.

There are some limitations of the present study that should be taken into consideration. The nutritional composition of the food products involved in this study were taken from the nutritional information panel of the finished products. The gold standard to get the nutritional composition of a food products is through proximate or direct chemical analysis. Nevertheless, previous studies indicated that indirect analysis by estimating the nutritional content of gluten-free foods is a valid method (2, 24). In addition, the latter method would be time-consuming compared to the estimation from the food label. Second limitation of this study is it include small sample size of gluten-free food items that are available from grocery stores in Kuala Lumpur. However, it is important to note that the availability of gluten-free food products is very limited in the local supermarket compared to the chosen grocery stores in this study.

CONCLUSION

This study indicated that gluten-free food items generally have similar nutritional composition with gluten-containing food products aside from protein content which was lower in gluten-free food products. The cost for most of gluten-free food products were significantly higher as compared to gluten-containing food products. Therefore, it is necessary to create awareness and knowledge on gluten-free facts especially among healthy general population. This includes the importance of reading nutrition information panel on the food label. Therefore, healthy population should consider eating healthy, balanced and varied diet rather than focusing on the avoidance of gluten.

ACKNOWLEDGEMENTS

Portions of this work were presented in abstract form at the 34th Annual Scientific Conference of Nutrition Society of Malaysia (Kuala Lumpur, Malaysia, July 3-4, 2019). This work is supported by Universiti Putra Malaysia.

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