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ASIAN JOURNAL OF
SCIENCE AND TECHNOLOGY

ISSN: 0976-3376

Asian Journal of Science and Technology
Vol. 5, Issue 11, pp.661-664, November, 2014

RESEARCH ARTICLE

EFFECT OF SWEETENER ON THE GLYCEMIC INDEX AND SENSORY PROPERTIES OF HOMEMADE PEANUT BUTTER

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ARTICLE INFO

Article History:
Received 03rd August, 2014
Received in revised form
16th September, 2014
Accepted 26th October, 2014
Published online 19th November, 2014

Key words:

Available carbohydrates,
Glycemic index,
Peanut, Peanut butter,
Sweetener

ABSTRACT

In this study, three formulations of peanut butter were developed using refined sugar, coconut sugar and Stevia sweetener. The glycemic index (GI) values of the three peanut butters were calculated using the available carbohydrates (ACHO) and GI of each ingredients used in the formulation. As calculated, GI values of peanut butter with refined sugar, coconut sugar and stevia sweetener were 43.58, 19.46 and 14.0 respectively, and classified as low glycemic foods. Color, aroma, mouth-feel, taste and general acceptability of the three peanut butters were evaluated by 50 consumer type panelists using the 7-point hedonic scale. Consumer's degree of liking on all sensory parameters falls between "neither like nor dislike" to "like slightly". Moreover, peanut butter formulated with refined sugar was significantly preferred in terms of taste and general acceptability compared with the two other formulations.

INTRODUCTION

Peanuts are inexpensive, yet nutritionally powerful food source for people worldwide (Chang, Sreedharan, & Schneider, 2013). They are energy dense and provide satiety, low energy absorption, and increased energy expenditure consumption (Mattes, Kris-Etherton, & Foster, 2008). Frequent peanut consumption had been linked to improved indices of cardiovascular health (Alper and Mattes, 2003; Hu and Stampfer, 1999; Kris-Etherton, Hu, Ros, & Sabate, 2008), glucose metabolism, weight management (Jenkins, Hu, Tapsell, Josse, & Kendall, 2008; Jiang *et al*., 2002; Lovejoy, 2005), and overall diet quality (Griel, Eissenstat, Juturu, Hsieh, & Kris-Etherton, 2004). In fact, increased on frequency of nut consumption was recently recommended as part of a healthy diet in the United States (Jones *et al*., 2014). Generally, nuts have glycemic index (GI) values of ≤55, and they are classified as low GI foods; specifically, peanuts have a GI value of 14 (Foster-Powell, Holt, & Brand-Miller, 2002). Due to their low carbohydrate, high monounsaturated and polyunsaturated fatty acids and protein contents, nuts may also decrease the risk of CVD and diabetes by reducing postprandial blood glucose (PBG) excursions (Kendall *et al*., 2011). According to several studies, low GI diet had shown beneficial effect in certain chronic diseases like diabetes (Ma *et al*., 2008; Rovner, Nansel, & Gellar, 2009) cardiovascular diseases (CVD) (Retterstol, Hennig, & Iversen, 2009; Bailey, Westman, Marquart, & Guyton, 2010) and obesity (Klemsdal, Holme, Nerland, Pedersen, & Tonstad, 2010; Schwingshackl and Hoffmann, 2013)

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Peanuts alone already served as a food commodity, but they can also be processed to make peanut butter, oil, and other peanut derived products such as flour, granules, meal, paste and protein (Chang *et al*., 2013). The most common product from peanuts is the peanut butter. Peanut butter contains no less than 90 grams of peanut paste per 100 grams of peanut butter, similar product that contains less than 90 grams of peanut paste is called peanut spreads (21 CFR 164.150). Peanut butter is considered as a favorite food for many children and adults and could play a significant role in delivery of nutrients as it is said to be a good source of protein (McWatters *et al*., 2006). Peanut alone is rich in protein and low in carbohydrates which make it suitable for people with recommended low carbohydrate diet. Other ingredients such as sugar, salt and emulsifier are added to peanut paste to improve quality of the peanut butter. However, the addition of other ingredients, specifically sweetener on the formulation may alter the nutritive value of peanut butter. The objectives of this study are: a) to formulate three types of peanut butter using refined sugar, coconut sugar and Stevia sweetener; b) to calculate the GI values of the three formulations of peanut butter using proportional available carbohydrates (ACHO) and glycemic index values of ingredients used and assess the effect of sweetener used on the GI of peanut butter; and c) to evaluate effect of sweetener used on the sensory properties of peanut butter.

MATERIALS AND METHODS

Preparation of Homemade Peanut Butter

Three formulations of peanut butter were produced using different types of sweetener, i.e. peanut butter with refined sugar (PBRS), peanut butter with coconut sugar (PBCS) and peanut butter with Stevia sweetener (PBSS). Each formulation of peanut butter was prepared using 300 grams of deskinned peanuts; amount of sweeteners added were 31.5 grams of refined sugar, 31.5 grams of coconut sugar, and 4 grams of commercially available Stevia sweetener. All raw materials were bought from the local supermarket. The amount of Stevia sweetener used was based on the serving suggestion in substitution for refined sugar found on its packaging label. For each formulation, the peanuts were roasted in the pan using medium fire for 15 minutes. Roasted peanuts were homogenized using Osterizer blender (Model 4172) at speed of 8. Sweetener was added gradually on the homogenized peanut butter while blending for additional of 3 minutes at speed 5. Peanut butter were filled in sterilized glass jars and closed with metal caps with rubber lining.

Determination of GI values

GI values of each formulation of peanut butter were calculated base on the procedure developed by Schakel, Schauer, Himes, Harnack, & Heel (2008). ACHO and GI values of each ingredient used were obtained from published literatures. ACHO values of peanut without skin and refined sugar were calculated using the difference between total carbohydrates (CHO) and total dietary fiber (DF); total CHO and total DF were obtained from The Philippine Food Composition Table (FNRI – DOST, 1997). ACHO of coconut sugar was based from published literature (Trinidad, Mallillin, Sagum, & Encabo, 2010). GI values of each ingredient were also obtained from published literature (Foster-Powell *et al*., 2002).

Sensory Evaluation

The three formulations of peanut butter were evaluated for color, aroma, mouth-feel, taste and general acceptability using 50 consumer type panelists with age ranging from 16 to 51 years old. 7-point hedonic scale was used to determine panelists degree of liking over the samples; 7 – like very much, 6 – like moderately, 5 – like slightly, 4 – neither like or dislike, 3 – dislike slightly, 2 – dislike moderately, and 1 – dislike very much. Results of sensory evaluation was statistically analyzed using one-way analysis of variance (ANOVA) and Duncan multiple range test (DMRT).

RESULTS AND DISCUSSION

In this study, the glycemic index of the three different formulation of peanut butter was calculated to determine the effect of the type of sweetener added, using the calculation established by Schakel, Schauer, Himes, Harnack, & Heel (2008) wherein the glycemic index of a food item was calculated using the available carbohydrate (ACHO) and GI values of each ingredient used. Table 1 shows the ACHO per 100 gram of each ingredient used. Since no published literatures indicating the ACHO values of peanuts and refined sugar, the ACHO were computed as the difference between the total CHO and total DF (Schakel *et al*, 2008; Martin, Murphy, & Au, 2008); total CHO and total DF values were obtained from published literatures. The ACHO value used for coconut sugar was the calculated ACHO based on inulin and fiber content (Trinidad, Mallillin, Sagum, & Encabo, 2010). For Stevia sweetener, values for total CHO and total DF were based on the food label.

Table 1. Total Carbohydrates (CHO), total Dietary Fiber (DF) and available Carbohydrates (ACHO) per 100 grams of each ingredient

Ingredient	Total CHO	Total DF	ACHO
Peanut w/o skin, roasted	7.6 [a]	0[a]	7.6[b]
Refined Sugar	99.90[a]	0[a]	99.90[b]
Coconut Sugar	94.00[c]	4.6[c]	25.00[c]
Stevia Sweetener	0[d]	0[d]	0

[a] The Philippine Food Composition Table (FNRI – DOST, 1997).
[b] Calculated Available Carbohydrates (ACHO) = Total Carbohydrates (CHO) – Total Dietary Fiber (DF)
[c] Trinidad *et al*. (2010)
[d] From food label

Table 2 shows the calculation for the total GI of three formulations of peanut butter. As shown on Table 2, GI values of three formulations of peanut butter differ depending on the type of the sweetener used, but all three formulations were still classified as low GI foods. Peanut has a GI value of 14, while the sweeteners added had GI values of 0, 35 and 65 for stevia sweetener, coconut sugar and refined sugar, respectively. Stevia is a natural sweetener with no glucose; thus, do not contribute to the available carbohydrate, and also with the glycemic index of the peanut butter. Coconut sugar had lower GI values compared with refined sugar; thus, peanut butter with coconut sugar was expected to have a lower GI value than with that of the refined sugar.

GI is a concept to quantify blood glucose response to an ingested quantity of carbohydrate in a food as compared to a response using a standard reference food, typically glucose or white bread (Jenkins *et al*., 1981; Martin *et al*., 2008). It is basically the blood glucose raising potential of carbohydrates in foods (Nayak, Berrios, & Tang, 2014). Foods are classified as high, medium or low glycemic depending on the ability of the of carbohydrate content to increase blood glucose; high, medium and low GI foods have GI values of ≥70, 56 – 69, and ≤55, respectively. The GI has proven to be a more useful nutritional concept than is the chemical classification of carbohydrate as simple or complex, as sugars or starches, or as available or unavailable. Hence, it permits new insights into the relation between the physiologic effects of carbohydrate-rich foods and health (Foster-Powell, 2002). As described by Martin *et al*. (2008), GI determination involves feeding the study participants with a specified amount of a reference food and their blood glucose level is measured and plotted over the following two hours, creating a glucose response curve. The same amount of carbohydrate from a comparison or test food is then consumed and the blood glucose levels are again measured and plotted over time. The GI is computed as the percentage of the area under the curve comparing the test food

Table 2. Calculation of the total glycemic index (GI) of three formulation of peanut butter using ingredient available carbohydrates (ACHO), proportion of total available carbohydrates (ACHO) and glycemic index (GI) values of each ingredient

Formulation	ACHO	Proportion of Total ACHO (Ingredient ACHO/ ACHO total for food)	Ingredient GI (Glucose reference)	Proportional GI (Proportion of Total ACHO X Ingredient GI)
1. PBRS				
Peanut, 90.36 %	6.87	0.42	14[a]	5.88
Refined Sugar, 9.64%	9.63	0.58	65[b]	37.70
Total for Food	16.50	1.00		43.58
2. PBCS				
Peanut, 90.36 %	6.87	0.74	14[a]	10.36
Coconut Sugar, 9.64%	2.41	0.26	35[c]	9.10
Total for Food	9.28	1.00		19.46
3. PBSS				
Peanut, 98.68 %	7.50	1.00	14[a]	14.00
Stevia Sweetener, 1.32%	0.00	0.00	0	0.00
Total for Food	7.50	1.00		14.00

[a] International Table of Glycemic Index and Glycemic Load Values:2002 (Foster-Powell et al., 2002)
[b] International Tables of Glycemic Index and Glycemic Load Values: 2008 (Atkinson et al., 2008)
[c] Trinidad et al. (2010)

to the reference food; thus, a food with a higher GI will cause a higher rise in blood glucose levels than a food with a lower GI, if the carbohydrate content is equal. Testing for the GI value of a specific food item is complex, time-consuming and costly. However, Schakel *et al*. (2008) developed a database indicating the calculation of GI of food items using only the available data for ACHO and GI of each ingredient used. This method is useful for dietary assessment: first, for estimation of GI values of mixed diets; second, for ranking the GI values of different food items. However, the calculated GI values may differ significantly on actual GI when food is tested analytically. GI values are limited only to several food items. Several published studies on GI values of foods are available online. The International Table of Glycemic Index and Glycemic Load Value: 2002 (Foster-Powell *et al*., 2002) is a compilation of around 750 food items with their corresponding GI values; additional food items were included on the International Table of Glycemic Index and Glycemic Load Value: 2008 (Atkinson, Foster-Powell, & Brand-Miller, 2008). Several diet books contain extensive lists of the GI values of individual foods. However, many people have raised concerns about the variation in published GI values for apparently similar foods. This variation might be associated to differences in the physical and chemical characteristics of the foods. Moreover, changes in the ingredients and processing methods used in the commercially available processed foods may affect their GI values (Foster-Powell, 2002).

Table 3. Mean scores on the sensory evaluation of peanut butter with different types of sweetener

PARAMETERS	PEANUT BUTTER		
	REFINED SUGAR	COCONUT SUGAR	STEVIA SWEETENER
Color	5.38 [a]	4.94 [a]	5.2 [a]
Aroma	5.02 [a]	4.96 [a]	4.84 [a]
Mouth-feel	4.66 [a]	4.18 [a]	4.24 [a]
Taste	5.06 [a]	4.36 [b]	3.98 [b]
General acceptability	5.12 [a]	4.64 [b]	4.4 [b]

The three formulations of peanut butter were subjected to sensory evaluation to determine the effect of the type of sweetener on consumer's degree of liking. Based on the results as shown on Table 3, color, aroma and mouth-feel of the three formulations were not significantly different from each other; however, for taste and general acceptability, PBRS was significantly preferred compared with PBCS and PBSS. The PBSS had the lowest mean score for taste. This may be due to the aftertaste contributed by the Stevia sweetener. According to the study of Medeiros de Melo, Bolini, & Efraim (2009) and Belscak-Cvitanovic *et al*. (2015), replacement of refined sugar with either artificial sweeteners like aspartame, sucralose and stevia or natural sugar alternatives like honey, molasses and saps (eg. coconut sugar) became a recent trend; however, the addition of Stevia sweetener on chocolate products resulted to the bitter aftertaste.

Conclusion

Peanut is classified as low glycemic food with GI value of 14. The addition of refined sugar, coconut sugar and Stevia sweetener in the production of peanut butter will vary the calculated GI values of the finished products, but were still classified as low glycemic food. Though the calculation method is a helpful method for the estimation of the GI of the food items, this method must be further validated. Consequently, GI values of different food items vary depending on the raw materials and type of processing used.

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