Page 292 to 299

Volume 2 • Issue 2 • 2017

Research Article

Nutrition and Food Toxicology

ISSN: 2573-4946

Use of Chia (Salvia Hispanica L.) in Cooking: a Strategy to Reduce the Glycemic Index and the Glycemic Load of the Preparations

Lilia Zago[1]*, Carolyne Pimentel Rosado[2] Andreia Ana da Silva[3] and Natalia Soares Leonardo Vidal[4]

[1]Professor of the Basic and Experimental Nutrition Department, University of the State of Rio de Janeiro, Brazil

[2]Doctor Student of the Postgraduate Program in Food, Nutrition and Health, University of the State of Rio de Janeiro, Brazil

[3]Master's Degree Student of the Postgraduate Program in Food, Nutrition and Health, University of the State of Rio de Janeiro, Brazil

[4]Clinical Nutritionist

***Corresponding Author:** Lilia Zago, Basic and Experimental Nutrition Department, University of the State of Rio de Janeiro Brazil.

Received: November 13, 2017; **Published:** November 16, 2017

Abstract

The excessive consumption of food or culinary preparation with high glycemic index and high glycemic load are important factors that contribute to the epidemic of obesity. In this context, Chia (Salvia hispánica L.) seed has been used in human nutrition because of its beneficial properties on health. The incorporation of Chia into preparations has been a well-studied strategy in reducing risks and in controlling excess weight and associated diseases such as cardiovascular diseases and diabetes., the objective of the present study was to develop and standardize culinary preparations added by chia (Salvia hispánica L.) with low glycemic index and glycemic load in order to characterize them as culinary preparations with possible claim of functional and/or health properties. Six preparations were developed: two options for main dishes: chicken cake and mashed cassava stuffed with jerked beef, two options for garnishing dishes: leek soufflé and gnocchi with tomato sauce and two options for desserts: banana and cacao cream and cocoa brownie. Glycemic index ranged from 18 to 36, and glycemic load from 1 to 6, being all preparations classified as low glycemic index and glycemic load. The addition of chia has been an important factor for the adequacy of GI and GL of the preparations, most probably because of their fiber content and bioactive compounds. All the culinary preparations developed presented GI and GL adequate and compatible with diets for the prevention and control of obesity and associated diseases.

Keywords: *Functional food; Bioactive compounds; Soluble fibers; Glucose response; Cooking skills; Culinary*

Abbreviations: GI: glycemic index; GL: glycemic load; CHI: chicken cake; CAS: mashed cassava stuffed with jerked beef; SUF: leek soufflé; NHO: gnocchi with tomato sauce; BAN: banana and cacao cream; BRO: cocoa brownie; PREP: preparation; ING: ingredients; REF: reference; CHO: carbohydrate

Volume 2 Issue 2 November 2017

Introduction

It is estimated that more than three million deaths worldwide are caused every year by overweight and obesity. The etiology of obesity is multifactorial, being influenced by genetic, metabolic, environmental, behavioral and sociocultural factors that contribute to an imbalance between ingested and spent energy. Within the food context, it can be said that the excessive consumption of products with a high content of carbohydrates with high glycemic index are important factors that contribute to the epidemic of overweight and associated diseases (World Health Organization, 2017; ZANOTTI, 2010; World Health Organization, 2014; World Health Organization, 2003). According to the 2010 Dietary Guidelines for Americans there are strong and consistent evidence that indicate the association between glycemic index and body weight (Chen., *et al*. 2010; USDA & HHS, 2010).

The blood glucose content has important physiological impact. The rate of elevation of glycemia as well as the patterns of reduction at basal levels are directly influenced by the quantity and quality of the carbohydrate consumed. The curve that characterizes the pattern of elevation and removal of blood glucose is called the glycemic response, which can be influenced by factors such as: (1) composition and structure of the food matrix, (2) the degree and type of food processing and (3) the presence of fat, fiber and protein (Wolever., *et al*. 1991; Wolever & Bolognesi, 1996; Jones, 2012).

In this context, Chia (Salvia hispánica L.) seed has been used in human nutrition because of its beneficial properties on health. The incorporation of Chia into preparations has been a well-studied strategy in reducing risks and in controlling excess weight and associated diseases such as cardiovascular diseases and diabetes. Many of these properties are attributed to the high fiber content, particularly the soluble fibers, with high water absorption and retention capacity forming a gel capable of reducing the glycemic index of the diet. The choice for foods with low glycemic index has been pointed out as a beneficial strategy for health promotion (Nyambe-Silavwe and Williamson., 2016; Sociedade Brasileira de Diabetes, 2016; Salas., *et al*. 2017). Glycemic index (GI) of a food is defined as the area under the glycemic response curve two hours after the consumption of 50 grams of carbohydrate of a test food, by the area under the glycemic response curve corresponding to the consumption of the same portion of carbohydrates of the reference food (white bread or glucose), expressed as a percentage (Wolever., *et al*. 1991). Foods can be classified in low (≤ 55), moderate (56-69) and high GI (≥ 70) according to Brand-Miller., *et al*. (2003).

Associated to a GI concept it was used recently the glycemic load (GL) concept, since it is an overall indicator of the glycemic response and consequent insulin demand after consumption of a portion of food. GL is obtained by the GI product of the food/meal/preparation and its respective digestible carbohydrate content. A diet, a meal or a culinary preparation can be classified as low (≤ 10), moderate (11-19), or high GL (≥ 20) (Sampaio., *et al*. 2007; Venn and Green., 2007).

A very important aspect regarding to overweight determinants concerns increasing consumption of ultraprocessed foods and convenience products. Current trends show that people have spent less time preparing their own meal, often because they lack the culinary skills. Recent researches have demonstrated important positive results from acquiring cooking skills and preparing one's own meals at home, which include improved diet quality and weight loss. They also show that individuals with higher levels of cooking skills are less likely to opt for convenience products. Hence the importance of producing technical-scientific knowledge regarding culinary preparations in order to provide information about the interaction between the ingredients that make them is very important and above all needful (Lahne, Wolfson, and Trubek., 2017; Lavelle., *et al*. 2017; Louzada., *et al*. 2017; Trubek., *et al.* 2017).

Taking into account the negative impact of excessive consumption of ultra processed foods and convenience products, associated with the importance of encouraging the acquisition of cooking skills, the objective of the present study was to develop and standardize six culinary preparations added by chia (Salvia hispanica L.) with low glycemic index and glycemic load in order to characterize them as culinary preparations with possible claim of functional and/or health properties for use in diets for the control of overweight and associated diseases.

Materials and Methods

Considering the types of dishes that will compose a specific menu (ABREU, E. S., SPINELLI, M. G. N., PINTO, 2007), the culinary preparations were chosen in order to characterize three categories of dishes: main dish; garnishing dishes, and desserts. Six preparations were developed: two options for main dishes: chicken cake (CHI) and mashed cassava stuffed with jerked beef (CAS), two options for garnishing dishes: leek soufflé (SUF) and gnocchi with tomato sauce (NHO) and two options for desserts: banana and cacao cream (BAN) and cocoa brownie (BRO). All preparations were added by chia, in whole seed, powdered seed or flour, in amounts ranging from 1.5 to 21% relative to the total weight prepared.

Development and standardization of culinary preparations: six preparations were developed in the Laboratory of Dietary Technique of the Institute of Nutrition of University of the State of Rio de Janeiro, which were standardized using our own Standard Recipe Model, elaborated based on the definition of the terms "standard recipe" and "technical file" by the Chain Thesaurus Food (Brasil. Ministério da Saúde, 2017). For the establishment of the portion size of the culinary preparations, the Food Portion Table for Nutrition Labeling (ANVISA, 2003) was taken as reference, taking into account the average energy value per serving of the Food Group which normally belongs to the main dishes, garnishing dishes and desserts.

Determination of nutritional composition: protein analysis was performed according to method 942.05 described by AOAC (AOAC, 1995). Total lipids were determined by Bligh; Dyer (Bligh and Dyer., 1959). Total dietary fiber was calculated using the Brazilian Food Composition Table as the data base (NEPA. Núcleo de Estudos e Pesquisas em Nutrição, 2011).

Calculation of the glycemic index (GI): the GI of the preparations was determined using the protocol proposed by the World Health Organization (World Health Organization, 1998) according to the following equations and steps:

$$IGing|prep = \frac{IGref}{\%CHOing|total}$$

$$\%CHOing|total = \frac{CHOing\,(g)x100}{CHOtotal\,(g)}$$

1. Identification of the total glycemic carbohydrate (in grams) of each ingredient in the preparation.
2. Determination of the proportion of glycemic carbohydrate of each ingredient in relation to the total glycemic carbohydrate of the preparation (%CHO ing|total).
3. Location of the GI of each ingredient (using white bread as reference) in a specific table (Foster-Powell, Holt, and Brand-Miller., 2002).
4. Determination of the contribution of each ingredient to the GI of the preparation: GIref of the ingredient by the proportion of its glycemic carbohydrate, relative to the glycemic carbohydrate of the preparation: GIing|prep.
5. Determination of the GI of the preparation, by the sum of the values obtained in the previous item.

Calculation of the glycemic load (GL): the GL of the preparations was determined according to the protocol proposed by Liu Willett (Liu and Walter C Willett., 2008) according to the equation below:

$$GL = \frac{GIprep\ x\ CHOportion\ (g)}{100}$$

Results and Discussion

Portion size, nutritional composition, glycemic index and glycemic load of the culinary preparations are described in Table 1.

Although GI is usually determined in individual foods, there are methods by which the GI and GL of usual diet, meals or culinary preparations can be estimated mathematically (Wolever and Jenkins., 1986; Salmerón., *et al*. 1997). World Health Organization (World Health Organization, 1998) recommends a protocol for calculating GI of meals and diets, in which it uses GI data of foods available in theoretical tables. In the present work, the GI values of the preparations were estimated according to the WHO protocol from the GI values (Theoretical and available in the tables) of each ingredient used in the culinary preparation. It is worth mentioning that the present work is the first to present estimates of GI and GL of culinary preparations. We find in the literature only a work by Portero-McLellan (Portero-McLellan., *et al*. 2010) which, using the same methodology, estimated the GI and GL of hospital diets for patients with diabetes mellitus. The authors concluded that it is extremely important to consider dietary GL in addition to the GI, considering carbohydrate quality and carbohydrate content in foods, resulting in a more precise monitoring of glycemic control.

Preparation	Portion (g)	Energy (Kcal)	CHO (g)	Protein (g)	Lipids (g)	Fiber (g)*	IG**	CG***
CHI	80	125	5.7	15.5	4.5	1.9	18	1
CAS	55	125	16.3	6.5	3.8	1.1	36	6
SUF	95	150	12.6	7.8	7.5	1.9	18	2
NHO	185	150	21.9	4.8	4.8	6.6	27	6
BAN	40	100	15.9	3.0	2.7	1.0	20	3
BRO	25	100	8.7	2.0	6.3	0.9	24	1

CHO: carbohydrate. GI: glycemic index. GL: glycemic load. CHI: chicken cake. CAS: mashed cassava stuffed with jerked beef (CAS). SUF: leek soufflé. NHO: gnocchi with tomato sauce. BAN: banana and cacao cream. BRO: cocoa brownie. *Calculated (NEPA. Núcleo de Estudos e Pesquisas em Nutrição, 2011). **All preparations were classified as low glycemic index: ≤ 55 low GI, 56-69 moderate GI, ≥ 70 high GI (Brand-Miller, J.C.; Burani, J.; Foster-Powell, K.; Holt., 2003). ***All preparations were classified as low GL: ≤ 10 low GL, 11-19 moderate GL, ≥ 20 high GL (Sampaio., *et al.* 2007).

Table 1: *Portion size, nutritional value (per portion), glycemic index and glycemic load of the culinary preparations. Rio de Janeiro/RJ/Brazil.*

Figure 1 illustrates all preparations, which consist of rereadings of the traditional preparations, ie there was a concern to keep both the ingredients and the preparation techniques as close as possible to the originals. The idea was to improve the quality of the preparations for GI and GL by adding an ingredient known to have functional potential due to its high content of soluble fibers and other bioactive compounds.

The physical-chemical and functional properties of the chia seeds, as well as their by-products, motivate the use of this food with nutritional and technological potential, considering the current trend in increasing the consumption of functional foods, making them important ingredients for use, both in the industrial sphere and in culinary preparations, in the production of desserts, beverages, breads, jellies, emulsions, biscuits, cooked foods, among others, and their relation with health promotion (Ferreira., *et al*. 2015; Capitani., *et al*. 2012). Chia have been investigated and recommended since the 1980s due to their lipid, protein, antioxidants, and dietary fiber content (Lin, Daniel, and Whistler., 1994; Taga, Miller, and Pratt., 1984; Bushway, Belyea, and Bushway., 1981) and, for some time, has focused heavily on the nutritional composition of oil and mucilage (Vázquez-Ovando., *et al*. 2009; Weber., *et al*. 1991; Ayerza., 1995). The outer layer of the chia seeds contains mucilage which upon being hydrated expands and envelops it with a thick layer. This characteristic would be responsible, not only for the functional potential of chia as a body agent in foods, but also for the sense of

sacity attributed to the consumption of seeds in humans, indicating a great potential as an ingredient with claim of functional and health properties (Vuksan., *et al*. 2010; Julio., *et al*. 2016).

Figure 1: *Images of the preparations. CHI: chicken cake. CAS: mashed cassava stuffed with jerked beef. SUF: leek soufflé. NHO: gnocchi with tomato sauce. BAN: banana and cacao cream. BRO: cocoa brownie. Rio de Janeiro/RJ/Brazil.*

Our preparations have values of gycemic index in a range between 18 and 36, which is, all classified as low glycemic index according to Brand-Miller (Brand-Miller, J.C.; Burani, J.; Foster-Powell, K.; Holt., 2003). The glycemic load values ranged from 1 to 6, being all preparations classified as low glycemic load. It is important to note that when the GI and GL are used together, it is possible to obtain more tangible information about the food in its real portions. Diets containing low GI and GL, as well as an important role in the treatment of diabetes, have also been recently recommended for the treatment of risk factors and prevention of chronic diseases such as obesity, cancer and cardiovascular disease (Jones., 2012; Sampaio., *et al.* 2007; Venn and Green., 2007). Our findings suggest that the set of ingredients in the preparations not only resulted in a lower GI, but also in a lower GL. These findings indicate that the incorporation of chia in the preparations may have contributed to the reduction of GI since many of the original ingredients of these preparations have been retained, most of which are high glycemic index.

The important technological functional property of chia of forming a thick gel when hydrated is possibly responsible for the reduction of the GI of the preparations containing them, whether in the form of whole seed, powdered seed or flour. This is due to the fact that this thick layer that surrounds the alimentary bolus in the intestinal lumen creates a physical barrier making digestive enzymes access to their respective substrates, thus reducing the absorption of macronutrients, including carbohydrates (Julio., *et al*. 2016; Lin, Daniel, and Whistler., 1994).

A very strong aspect of the present work is the production and availability of technical-scientific information to contribute to the research in the context of the rescue of the cooking skills and reinforcement of contemporary traditional food standards based on consumption of fresh and minimally processed foods. It is a work that supports assessments on the glycemic response of a complex food matrix since people consume foods within a pattern of combinations between them, which certainly influences the glycemic response of the diet as a whole. Knowing the GI and GL of culinary preparations, even if it is by mathematical estimation, is extremely important to subsidize healthy food choices that are related to the prevention of obesity and associated diseases.

Conclusion

All the culinary preparations developed presented GI and GL adequate and compatible with diets for the prevention and control of obesity and associated diseases. The addition of chia has been an important factor for the adequacy of GI and GL of the preparations, most probably because of their fiber content and bioactive compounds. It was concluded that it was possible to develop and standardize six preparations, to compose options of main dishes, garnishing dishes and desserts of a menu, added by chia, in various concentrations, with low glycemic index and low glycemic load.

Acknowledgements

This research was supported by Carlos Chagas Foundation for Research Support of the State of Rio de Janeiro, Brazil.

Conflict of interest

The authors have no conflict of interest.

References

1. Abreu S., *et al.* "Planejamento de Cardápio E Receituário Padrão." Gestão de Unidades de Alimentação E Nutrição: Um Modo de Fazer. 2nd ed. São Paulo: Editora Metha, (2007): 113-112.
2. Anvisa, Agência Nacional de Vigilância Sanitária. Regulamento Técnico De Porções De Alimentos Embalados Para Fins De Rotulagem Nutricional. Brasil: N.p., (2003).
3. AOAC. Official Methods of Analysis of AOAC. 16th ed. Virginia: AOAC International, (1995).
4. Ayerza, Ricardo. "Oil Content and Fatty Acid Composition of Chia (Salvia Hispanica L .) from Five Northwestern Locations in Argentina." *Journal of the American Oil Chemists' Society* 72.9 (1995): 1079–1081.
5. Bligh EG and W J Dyer. "A Rapid Method of Total Lipid Extration and Purification." *Canadian Journal of Biochemistry and Physiology* 37.8 (1959): 911-917.
6. Brand-Miller JC., *et al.* "The New Glucose Revolution: Complete Guide to Glycemic Index Values". New York: Marlowe & Company, (2003).
7. Brasil. Ministério da Saúde. "Tesauro eletrônico. Cadeia alimentar." N.p., (2017).
8. Bushway A A., *et al.* "Chia Seed as a Source of Oil, Polysaccharide , and Protein." *Journal of Food Science* 46.5 (1981): 1349–1351.
9. Capitani MI., *et al.* "LWT - Food Science and Technology Physicochemical and Functional Characterization of by-Products from Chia (Salvia Hispanica L.) Seeds of Argentina." *LWT - Food Science and Technology* 45.1 (2012): 94–102.
10. Chen., *et al*. "The New Glucose Revolution: Is the Authoritative Guide to the Glycemic Index the Right Dietary Solution for Lifelong Health?" *International Journal of Nutrition and Metabolism* 2.5 (2010): 73–81.
11. Ferreira Cynthia De Souza., *et al.* "Effect of Chia Seed (Salvia Hispanica L .) Consumption on Cardiovascular Risk Factors in Humans : A Systematic Review." *Nutrición Hospitalaria* 32.5 (2015): 1909–1918.
12. Foster-Powell., *et al.* "International Table of Glycemic Index and Glycemic Load." *The American Journal of Clinical Nutrition* 76.2 (2002): 5–56.
13. Jones Julie Miller. "Glycemic Index." *Nutrition Today* 47.5 (2012): 207–213.
14. Julio Luciana Magdalena., et al. "Development and Characterization of Functional O/W Emulsions with Chia Seed (Salvia Hispanica L.) by-Products." *Journal of Food Science and Technology* 53.8 (2016): 3206–3214.
15. Lahne Jacob., *et al.* "Development of the Cooking and Food Provisioning Action Scale (CAFPAS): A New Measurement Tool for Individual Cooking Practice." *Food Quality and Preference* 62 (2017): 96–105.
16. Lavelle Fiona., *et al.* "Increasing Intention to Cook from Basic Ingredients : A Randomised Controlled Study." *Appetite* 116 (2017): 502–510.
17. Lin Kuei-ying., et al. "Structure of Chia Seed Polysaccharide Exudate." *Carbohydrate Polymers* 23.1 (1994): 13–18.
18. Liu Simin, and Walter C Willett. "Dietary Carbohydrates." (2008).

19. Louzada Maria Laura da Costa., *et al.* "The Share of Ultra-Processed Foods Determines the Overall Nutritional Quality of Diets in Brazil." *Public Health Nutrition* (2017): 1-9.
20. NEPA. Núcleo de Estudos e Pesquisas em Nutrição. Tabela Brasileira de Composição de Alimentos. 4th ed. Campinas: Nepa-Unicamp, (2011).
21. Nyambe-Silavwe H and G Williamson. "Polyphenol- and Fibre-Rich Dried Fruits with Green Tea Attenuate Starch-Derived Postprandial Blood Glucose and Insulin: A Randomised , Controlled , Single-Blind , Cross-over Intervention." *British Journal of Nutrition* 1.13 (2016): 1–8.
22. Portero-McLellan., *et al*. "Determinação Do Índice Glicêmico E Da Carga Glicêmica de Dietas Hospitalares Para Indivíduos Com Diabetes Identification of Glycemic Index and Glycemic Load in Hospital Meals for Individuals with Diabetes." *Cadernos de Saúde Coletiva* 18.2 (2010): 259–265.
23. Salas Maria de Jesús Ibarra., *et al*. "Índice Glucémico Y Carga Glucémica En El Fruto de La Especie Vegetal Opuntia Ficus-Indica I Ntroducción." *Gaceta Médica de México* 153 (2017): 475–481.
24. Salmerón J., *et al.* "Dietary Fiber, Glycemic Load, and Risk of Non-Insulin-Dependent Diabetes Mellitus in Women." *Journal of the American Medical Association* 277.6 (1997): 472-477.
25. Sampaio Helena Alves de Carvalho., *et al.* "Índice Glicêmico E Carga Glicêmica de Dietas Consumidas Por Indivíduos Obesos Glycemic Index and Glycemic Load of Diets." *Revista de Nutrição* 20.6 (2007): 615-624.
26. Sociedade Brasileira de Diabetes. Diretrizes Sociedade Brasileira de Diabetes | 2015-2016. Rio de Janeiro: AC Farmacêutica LTDA, (2016).
27. Taga M Silvia., *et al.* "Chia Seeds as a Source of Natural Lipid Antioxidants." *Journal of the American Oil Chemists' Society* 61.5 (1984): 928-931.
28. Trubek Amy B., *et al.* "Empowered to Cook: The Crucial Role of 'Food Agency' in Making Meals." *Appetite* 116 (2017): 297-305.
29. USDA, U.S. Department of Agriculture, and U.S. Department of Health and Human Services HHS. Dietary Guidelines for Americans 2010. N.p., (2010).
30. Vázquez-Ovando Alfredo., *et al.* "Physicochemical Properties of a Fibrous Fraction from Chia (Salvia Hispanica L.)." *LWT - Food Science and Technology* 42.1 (2009): 168-173.
31. Venn B J and T J Green. "Glycemic Index and Glycemic Load: Measurement Issues and Their Effect on Diet – Disease Relationships." *European Journal of Clinical Nutrition* 61.Suppl 1 (2007): 122-131.
32. Vuksan V., et al. "Reduction in Postprandial Glucose Excursion and Prolongation of Satiety: Possible Explanation of the Long-Term Effects of Whole Grain Salba (Salvia Hispanica L .)." *European Journal of Clinical Nutrition* 64.4 (2010): 436-438.
33. Weber Charles W., *et al*. "The Nutritional and Chemical Evaluation of Chia Seeds." Ecology of Food and Nutrition 26.2 (1991): 119-125.
34. Wolever Thomas MS., *et al.* "The Glycemic Index : Methodology and Clinical Implications." American Journal of Clinical Nutrition 54 (1991): 846–854.
35. Wolever Thomas MS and Claudia Bolognesi. "Source and Amount of Carbohydrate Affect Postprandial Glucose and Insulin in Normal Subjects1." *The Journal of Nutrition* 126 (1996): 2798-2806.
36. Wolever Thomas MS and David JA Jenkins. "The Use of the Glycemic Blood Glucose Response." *The American Journal of Clinical Nutrition* 43 (1986): 167-172.
37. World Health Organization. "Calculation of Glycemic Index of Meals or Diets." Carbohydrates in Human Nutrition Report of a Joint FAO/WHO Expert Consultation. Roma: FAO/WHO Expert Consultation, (1998).
38. Diet, Nutrition and the Prevention of Chronic Diseases: Report of a Joint WHO/FAO Expert Consultation. Geneva: N.p., (2003).
39. Global Status Report on Noncommunicable Diseases. Geneva: N.p., (2014).
40. Obesity and Overweight Fact Sheet. N.p., (2017).
41. ZANOTTI CCC., *et al.* "Social Determinants of Health and Well-Being among Young People. Geneva": N.p., (2010).