Journal of Pharmaceutical Research International

21(2): 1-5, 2018; Article no.JPRI.37915
ISSN: 2456-9119
(Past name: British Journal of Pharmaceutical Research, Past ISSN: 2231-2919, NLM ID: 101631759)

Glycemic Index Profiling of Quinoa (*Chenopodium quinoa* Willd) Variety

M. Priyanka[1], W. Jessie Suneetha[1*], K. Uma Maheswari[1], K. B. Suneetha[2] and B. Anila Kumari[1]

[1]Post Graduate and Research Centre, Department of Foods and Nutrition, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad – 500 030, India.
[2]Department of Agronomy, College of Agriculture, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad – 500 030, India.

Authors' contributions

Author MP carried out the proposed research work as part of Post graduate thesis and performed the statistical analysis. Author WJS designed the research work and wrote the first draft of manuscript. Author KUM has over seen the carrying of this work. Author KBS helped in procuring the sample and monitored the processing of grains. Author BAK helped in calculations and managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI:10.9734/JPRI/2018/37915
Editor(s):
(1) Mahadeva Rao, Professor, School of Basic Medical Sciences, Faculty of Medicine, Universiti Sultan Zainal, Abidin, Malaysia.
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Complete Peer review History: http://www.sciencedomain.org/review-history/23409

Original Research Article

Received 1st November 2017
Accepted 21st January 2018
Published 3rd March 2018

ABSTRACT

Quinoa has proteins of high biological value, carbohydrates of low glycemic index and phytosteroids with ω - 3 and 6 fatty acids that provide health benefits. The main advantage of quinoa is that along with being a protein supplement in the flour industry, it meets the increasing international demand for gluten-free products in cakes, pastries, pasta and baked goods. Studies on glycemic index (GI) profiling of newly released quinoa varieties are lacking and so the present study was taken up to assess its GI. Cooked quinoa was given to the 10 subjects, their blood glucose levels were determined every 15 min up to 60 min and again at 90 and 120 min

**Corresponding author: E-mail: wjsuneetha@yahoo.com*

respectively. The blood glucose levels after consumption of quinoa ranged from 78.30 to 120.20 mg/dl with an average fasting level of 96.51 mg/dl. The glycemic index of quinoa ranged from 51.28 to 78.25 with an average of 63.37 and the glycemic load was from 25.64 to 39.12 with an average of 31.68. Hence, this quinoa variety can be categorized as a medium glycemic index and high glycemic load food.

Keywords: Quinoa; gluten-free; glycemic index and glycemic load.

1. INTRODUCTION

Glycemic index (GI) describes the blood glucose response after consumption of carbohydrate-containing test food relative to a carbohydrate-containing reference food, typically glucose. GI helps people with diabetes and obesity in the selection of low GI foods. The foods with low GI or GL benefit by controlling blood glucose levels in diabetics along with lipid management. At times, low GI and GL foods can be energy dense with substantial amounts of sugars or undesirable fats that contribute to a diminished glycemic response there by questioning the health claims [1].

The GI is the ranking of carbohydrates on a scale of 0 to 100 as per their impact on blood sugar levels during the 2 hrs following the consumption of food. Low GI foods produce a gradual rise in blood sugar levels and are considered healthy particularly in the prevention of life style diseases [2]. They regulate lipid profile and help in weight management by controlling appetite due to slow gastric emptying. These diets reduce insulin resistance by improving blood glucose levels along with the risk of obesity, cardiovascular diseases, diabetes and certain types of cancers [3].

Quinoa carbohydrates can be used as nutraceuticals due to its hypoglycemic effect, reduction of free fatty acids and triglycerides. Studies in individuals with celiac disease showed that the GI of quinoa was comparatively lower than the common gluten free pasta and bread [4].

Low GI foods are associated with a greater feeling of satiety due to delayed emptying of the stomach. The foods rich in dietary fibre can induce a low glycemic response and prolong gastric distension increasing the peptides associated with satiety. The whole grain pasta showed lower glycemic response than the refined grain pasta with greater satiety [5].

Quinoa milk can be consumed directly or in milky products in near future due to its proteins with high biological value, carbohydrates of low glycemic index and phytosteroids with ω - 3 and 6 fatty acids. It can be consumed by people who are lactose or casein intolerant [6]. Quinoa milk has low GI than rice milk due to its complete protein content which slows down the digestion and gastric emptying [7].

Few studies on the glycemic index of quinoa grain and its products are available and hence the present study was under taken for glycemic index profiling along with popularization in this rain-fed region.

2. MATERIALS AND METHODS

Preparation of sample: The quinoa variety analyzed was one of the accession lines of EC series brought from Peru and tested at Agricultural Research Station, Anantapur. Quinoa seeds were cleaned; washed 5 to 6 times until no frothing appeared to remove the saponins and pressure cooked with 3 times the water.

Selection of subjects: Initially fifteen college-going students from D hostel annexe of PJTSAU campus in the age group of 19-22 years were selected. Subjects were excluded if they reported any history of gastrointestinal disorders or were taking medication for any chronic disease conditions or intolerant or allergic to any of the foods. Finally, 10 healthy subjects were identified for study from initial 15 members and consent was taken from the subjects to proceed further with the study. Before starting the GI trial, subjects were given necessary instructions about the study. This study was sent to the university for approval and the End. No. B-148/PG/A2/2015 was given to proceed further.

Glycemic index (GI) profiling: The method used for measuring and calculating the GI of the quinoa was in accordance with WHO/FAO recommendations [8]. Subjects attended each testing session after 10 hrs overnight fast but not exceeding 16 hrs and were informed not to consume unusually large meals and exercise vigorously on the previous night. On the first

occasion, the subjects were given the standard reference food which is usually 'glucose'. Glucose of 50.0 g was added to 250 ml water and given to subjects as a drink. Next day, 70.0 g of cooked test quinoa containing 50.0 g of carbohydrates was given to each subject. On both the occasions, blood glucose levels were measured by using one-touch glucometer in capillary whole blood obtained by finger prick at 15, 30, 45, 60, 90 and 120 min after consumption.

Determination of GI and glycemic load (GL): The incremental area under 2-hour glucose response curve (IAUC) was calculated as per the formula is given by [9]. The calculations of GI and GL were as follows:

$$GI = \frac{\text{IAUC of test food}}{\text{IAUC of reference food}} \text{ X } 100$$

$$GL = \frac{GI}{100} \text{ X Dietary carbohydrate content of test sample}$$

The relationship between GI and GL is not straightforward. A high GI food can have a low GL if eaten in small quantities and a low GI food can have a high GL if eaten in bulk. The GI and GL are dependent upon the portion size eaten and on the carbohydrate content of the foods taken [10].

3. RESULTS AND DISCUSSION

The fasting insulin is lower in individuals with higher dietary fibre intake and the ingestion of complex carbohydrates promotes longevity. Glucose is used as reference food and is rated as 100. As per GI classification, high GI foods have values > 70, medium GI foods have values between 56 - 69 and low GI foods have values ≤ 55 [11]. The GI profiling of quinoa in this sent study was presented in Table 1 and the mean scores of blood glucose levels in Fig. 1.

It was observed that the glucose levels were lower initially at 83.90 mg/dl as the subjects have not taken any food for at least the last 10 hrs before the test. But 15 min after consumption of cooked quinoa, there was an increase in blood glucose level to 120.20 mg/dl and 2 hrs after consumption it gradually lowered to 78.30 mg/dl indicating that slow release into the blood. The mean fasting blood glucose level was 96.51 mg/dl and blood glucose levels after consumption of quinoa ranging from 78.30 to 120.20 mg/dl. The GI ranged from 51.28 to 78.25 with an average of 63.37. Results showed that quinoa can be classified under medium GI food as given by [11]. The glycemic load of quinoa ranged from 25.64 to 39.12 with an average of 31.68 and classified as high GL food as per [12]. The high GL foods have values ≥20, medium GL foods have values between 11-29 and low GL foods have values ≤ 10.

Recent studies have shown the ability of lower GI meals to help improve glycemic levels in diabetics. Studies in healthy individuals, adults with type II diabetes and youth with type I diabetes has shown that the use of GI methodology in the selection of carbohydrates may have beneficial implications on blood glucose responses. The GI concept may be of particular benefit to Indians as the incidences of impaired glucose tolerance and diabetes are on the raise [13].

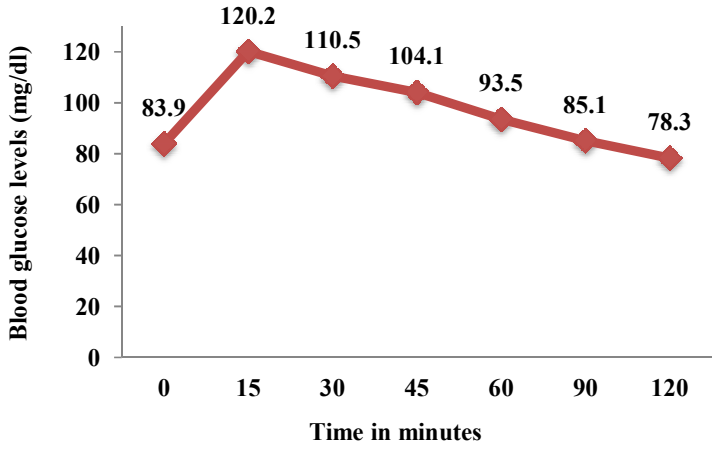

Fig. 1. Mean blood sugar levels after consumption of cooked quinoa

Table 1. Glycemic index and glycemic load of quinoa

S. No.	GI	GL
1.	56.11	28.05
2.	78.25	39.12
3.	60.11	30.05
4.	65.72	32.86
5.	57.61	28.80
6.	51.28	25.64
7.	67.32	33.66
8.	74.71	37.35
9.	56.53	28.26
10.	66.08	33.04
Mean	**63.37**	**31.68**

Note: Values for ten subjects shown in the table.
GI - Glycemic index
GL - Glycemic load

Another study showed that daily consumption of 50.0 g of gluten-free quinoa over a six week period was safely tolerated by celiac patients without any deterioration in health condition and with improved histological and serological parameters along with mild hypocholesterolemic effect [14].

The low GI diets help in the prevention of diabetes and coronary heart diseases [15]. The subjects with type 2 diabetes showed improved metabolic control when the conventional high GI breakfast was replaced with low GI meal [16].

4. CONCLUSION

The GI provides a good summary of postprandial glycemia. Low GI diets have been shown to improve glucose levels, regulate lipid profile, remove free fatty acids and control weight gain as they help in managing appetite by extending gastric emptying. These diets can reduce insulin resistance and the risk of life style diseases like CVD, diabetes and certain cancers.

CONSENT

As per University procedure, subject's oral consent has been taken by the authors before the start of study.

ETHICAL APPROVAL

As per University procedure, approval of for the study was taken by the authors (Endt. No. B-148/PG/A2/2015).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/23409