
Nutritional assessment of a jackfruit (*Artocarpus heterophyllus*) meal

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(Index words: *Artocarpus heterophyllus*, jackfruit, glycaemic index, nutritional properties)

Abstract

Objectives The mature jackfruit (*Artocarpus heterophyllus*) is consumed in Sri Lanka either as a main meal or a meal accompaniment. However, there is no scientific data on the nutrient compositions of cooked jackfruit meals. Thus, the objective of the study was to carry out a nutritional assessment of a composite jackfruit breakfast meal comprising seeds and flesh.

Design A jackfruit meal comprising of flesh (80% available carbohydrate) and seeds (20% available carbohydrate) was included in the study. The study was carried out in a random cross over design.

Setting University of Sri Jayewardenepura.

Study participants Healthy individuals (n=10, age: 20-30 yrs).

Measurements The macronutrient contents, rapidly and slowly available glucose (SAG) contents, water solubility index of the jackfruit meal were determined according to standard methods. The GI of the meal was calculated according to FAO/WHO guidelines.

Results The moisture content of the boiled jackfruit flesh was high (82% FW). Jack seeds contained 4.7% protein (FW), 11.1% total dietary fibre (FW) and 8% resistant starch (FW). Jackfruit meal elicited a GI of 75. The

Glycaemic Load (GL) of the normal serving size of the meal is medium. The slowly available glucose (SAG) percentage of jackfruit meal (30%) was twice that of the standard. The boiled jackfruit flesh contained disintegrated starch granules while seeds contained intact swollen and disintegrated granules.

Conclusions The jackfruit seeds are a good source of starch (22%) and dietary fibre. The meal is categorized as a low GI meal. The low GI could be due to the collective contributions from dietary fibre, slowly available glucose and un-gelatinised (intact) starch granules in the seeds.

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Introduction

Jackfruit (*Artocarpus heterophyllus*) is reported to have originated in India and Malaysia [1]. The jackfruit is a species of the mulberry family (*Moraceae*) [1]. In Sri Lanka it is known as "*Kos*" (Sinhala) and "*Pala*" (Tamil).

The fruit contains fleshy bulbs and starchy seeds both of which are used as foods in Sri Lanka. The mature jackfruit is consumed either as a main meal or a meal accompaniment with rice and the ripe flesh as a fruit. Jackfruit is reported to possess many medicinal properties. The phenolic compounds isolated from jackfruit are

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reported to exhibit anti-inflammatory effect [1]. The prenylflavones present in jackfruit had shown strong antioxidant properties and is expected to act against lipid peroxidation of biological membranes [2]. The hot water extract of mature leaves are utilised in Ayurvedic treatment for hyperglycaemia and diabetes [1]. The flavanoids present in the extract have been identified to be responsible for the non-toxic hypoglycaemic action [3]. Lectins present in the seeds have shown antifungal properties while the crude methanolic extracts from root bark and stems have shown broad spectrum antibacterial activity [4].

Raw jackfruit flesh is regarded as a good source of carbohydrate (25%), vitamin A and a fair source of protein (1.6%) [6]. The postprandial glycaemic response to raw and ripe jackfruit elicits low glycaemic index (GI) [7]. However, research has not focused on studying the nutritional parameters of cooked jackfruit meals. This could be due to the low consumption of cooked jackfruit meals in other countries except in Sri Lanka and Bangladesh [1]. Although jackfruit is widely available and is liked by most, many Sri Lankans do not consider it to be a suitable meal or an accompaniment to rice in the diabetic food regime due to the belief that it is high in digestible carbohydrate and yields high energy. However, data is not available to confirm this belief. Therefore the objective of this study was to carry out a nutritional assessment on a jackfruit breakfast meal.

Methods

Jackfruit meal

Jackfruit meal served for determination of GI comprised of boiled jackfruit flesh (400g), jackfruit seeds (~50g), coconut scrapings (25g) and an onion sambol (10g). The flesh (800g) was boiled with water (100ml) under high heat for 10 minutes and under low heat till all the water was removed. Seeds (200g) were boiled with water (200ml) till soft.

Determination of Glycaemic Index

GI was estimated with healthy individuals ($n=10$, age – 20-30 years, BMI – 24 ± 3 kgm²) according to the guidelines given by FAO/WHO [8]. White sliced bread (mass production) bought from retail outlets were used as the standard food and given twice to the volunteers. Informed, written consent was obtained from study participants prior to the start of the study. Approval for the study was obtained from the Ethics Committee, Faculty of Medical Sciences, University of Sri Jayewardenepura.

Determination of chemical composition

The insoluble and soluble dietary fibre [9], protein [10], fat [11], rapidly and slowly available glucose contents

[12], and water solubility indices (WSI) [13] of the jackfruit meal were determined. The degree of gelatinisation of the starch granules of raw and processed jackfruit flesh and seed flour were examined under light microscope (10×10) by staining with KI/I₂ solution [13].

Statistical analysis

The GI and Incremental Area Under Curve (IAUC) values are presented as mean [standard error of mean (SEM)]. The results were analysed using Microsoft Excel (2003).

Results

The nutritional parameters of the jackfruit flesh, seeds and the meal are presented in Table 1. The moisture content of boiled jackfruit flesh and seeds were 82% and 53% [fresh weight (FW)] respectively and significantly different ($p<0.005$). The available digestible carbohydrate contents of the flesh and the seeds were 10% and 22% (FW) respectively. The protein content of the meal was 6.8% with a higher contribution from the seeds while the fat content of the meal was 11.5% (FW). Jack seeds contained high total dietary fibre (TDF) (11.1% FW) compared to flesh (2.6% FW). Jackfruit seeds also contained 8% (FW) resistant starch (undigestible starch).

The average postprandial glycaemic response of the jackfruit meal is presented in Figure 1. The jackfruit meal maintained the satiety levels even at 2 hours from ingestion unlike with the standard. The 50g available carbohydrate portion of jackfruit meal contained 40g available carbohydrate from jackfruit flesh (400g) and 10g from seeds (~50g). The proportions of flesh and seeds were selected according to palatability tests conducted by varying the ratios. Due to the high moisture content of jackfruit flesh the total meal portion given for determination of GI was rather large (450g). According to the participants (80%) the portion was difficult to consume and the normal serving size (NSS) would be two thirds of the meal served in determining GI.

The GI, IAUC and GL of the meal are presented in Table 1. Jackfruit meal elicited a GI of 75 and can be categorised as a low GI food. When analysing individual glycaemic responses to the meal, 80% of individuals elicited low glycaemic responses (low GI) while other two, medium GI values.

The slowly available glucose percentage of jackfruit meal was 30%. Jackfruit flesh elicited a water solubility index of 28.7. Boiled jack flesh contained disintegrated starch granules while seeds contained intact swollen and disintegrated granules (Figure 2). Jackfruit meal contained two sources of carbohydrates from jackfruit flesh and seeds (vegetable and seeds).

Table 1. Nutritional parameters of jackfruit flesh, seed, meal and the standard

Parameter	¹ Jackfruit flesh	¹ Jackfruit seeds	² Jackfruit meal	² Standard
Carbohydrate (SD)	10.0(0.3)	21.9(0.8)	50 g	50 g
IDF (SD)	1.5 (0.1)	7.9 (0.5)	13.5	0.8
SDF (SD)	1.1 (0.1)	3.2 (0.3)	6.5	2.4
TDF	2.6	11.1	20.0	3.2
Protein	0.9	4.7	6.8	8.2
Fat (SD)	0.8(0.1)	1.3 (0.3)	11.5	3.2
Resistant starch	0.3	8.0	5.2	0.7
SAG%	17%	33%	30%	16%
Amylose	29	54	31	15
GI(SEM)	ND	ND	75 (11)	100
IAUC (SEM)	ND	ND	132 (19)	181 (18)
GL(NSS)	ND	ND	13	20

¹Values are given as g/100g fresh weight; ²Values are given in the 50g available carbohydrate portion; SD – Standard Error; SEM – Standard Error of Mean; IDF – Insoluble Dietary Fibre; SDF – Soluble Dietary Fibre; TDF – Total Dietary Fibre; SAG – Slowly Available Glucose; GI – Glycaemic Index; IAUC – Incremental Area Under Curve; GL – Glycaemic Load; $GL = [(GI / 1.4) * \text{available carbohydrate content in NSS}] / 100$; NSS – Normal Serving Size.

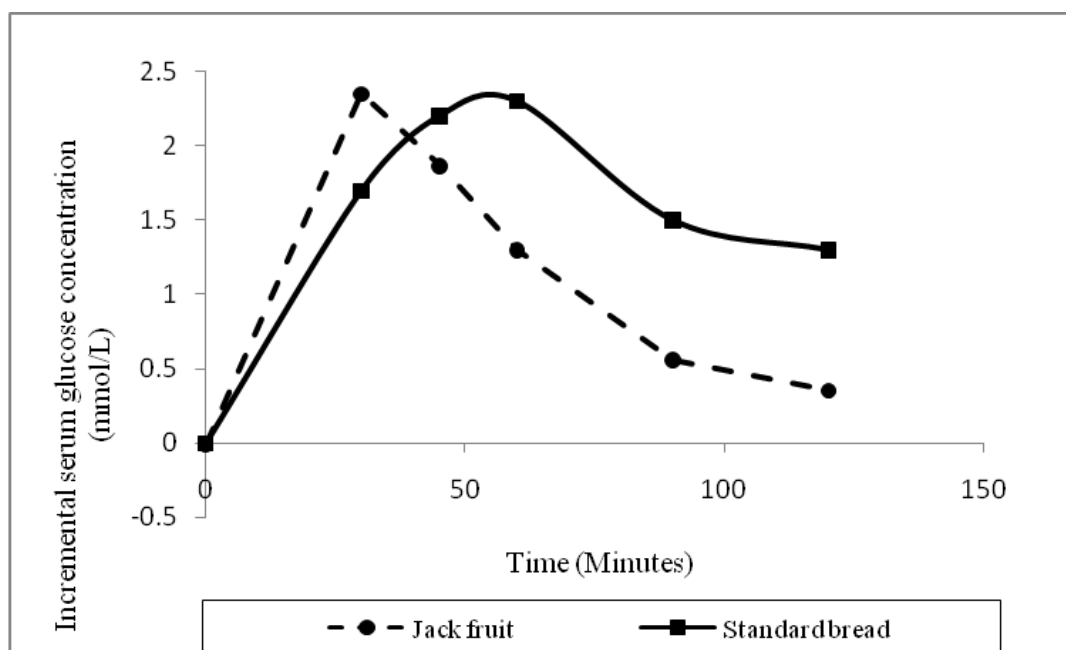
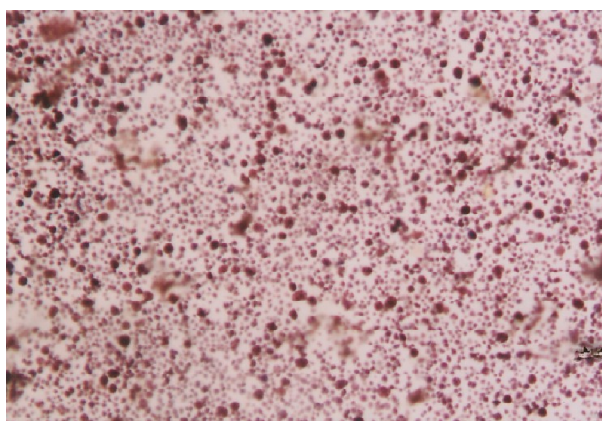
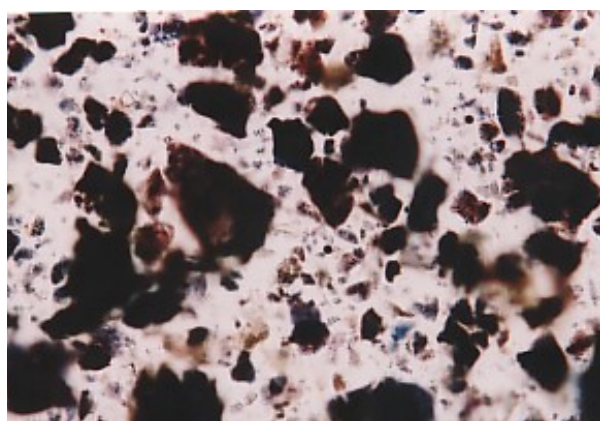


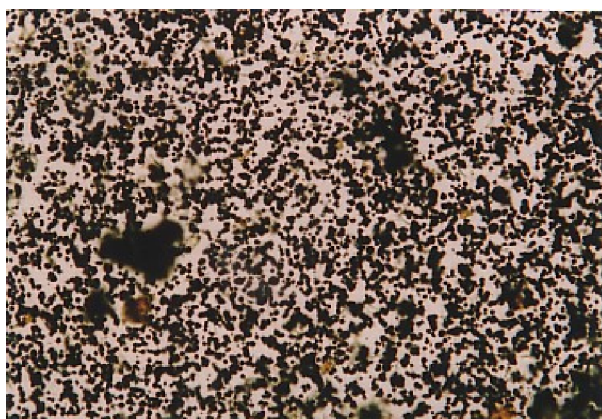
Figure 1. Glycaemic response to jackfruit meal and the standard. Each point represents an average of 10 values.



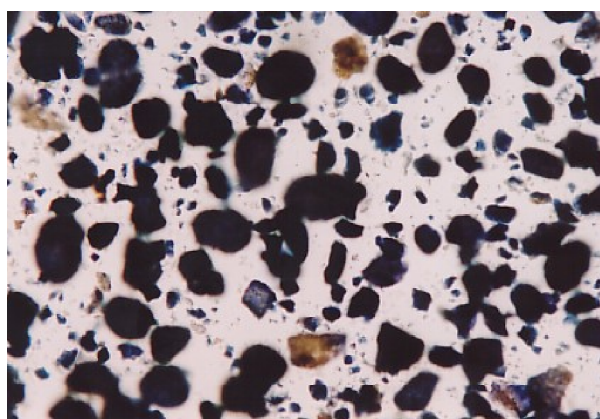
(a) Jackfruit flesh (raw)



(b) Jackfruit flesh (boiled)



(c) Jackfruit seeds (raw)



(d) Jackfruit seeds (boiled)

Figure 2. Starch granules of raw and boiled jackfruit flesh and seeds (10x10)

Discussion

The moisture and protein content of boiled jackfruit (Table 1) are similar to reported raw values [6]. The total energy contribution of the meal is 1370 kJ. Jackfruit meal provides 20% of daily energy requirement of a moderately active individual. Jack seeds contained high amount of resistant starch (undigestible starch). RS is categorised into four types (RS1-RS4) [14] and jackfruit seeds may contain RS1 type. The undigestible starch escapes digestion in the small intestine, passes into the colon and is reported to act like dietary fibre [14]. The postprandial glycaemic response (Figure 1) and GI of the jackfruit meal were determined. Jackfruit meal elicited a low GI (Table 1). This is the first reported data on GI of a jackfruit meal in spite of having 2487 data on GI of different foods in the recent "International Tables of Glycaemic Indices and Glycaemic Load Values" [15].

Jackfruit meal elicited a low inter individual variation. This is a positive aspect of this commonly available food item as inter individual variation to the same food is reported to vary widely [16] making it difficult to recommend foods that are even low GI to individuals who

need to control postprandial blood sugar levels. The GI of the jackfruit meal is significantly lower ($p < 0.05$) than the other Sri Lankan meals tested previously in the same laboratory except for the rice mixed meal containing red rice, lentil curry, boiled egg, 'gotukola' sambol (*Centella asiatica*), 'kiri hodi' [17], and legumes [18]. Thus, the low GI of the jackfruit meal confirms its suitability as a main meal or an accompaniment with rice.

Protein, fat and dietary fibre contents of foods have been reported to elicit significant negative relationships with GI ($p < 0.05$) [16]. However, during our previous studies, only the dietary fibre content of Sri Lankan meals elicited a significant negative relationship with GI [17]. Thus, the high fibre content of the jackfruit meal (20 g) could be contributing to a lower GI of the meal. Influence of dietary fibre on GI will be more applicable and beneficial for the Sri Lankan population as the commonly eaten Sri Lankan meals comprise of many vegetables and green leaves which are natural sources of fibre.

High SAG content of jackfruit meal (30%) when compared with most of the Sri Lankan foods (3-51% – unpublished data) could also have contributed in part to

the low GI. Most Sri Lankan foods have a high gelatinisation point with correspondingly low SAG [unpublished data]. This confirms the suitability of jackfruit as a meal for individuals controlling the postprandial glycaemic response.

The amount of soluble substances leached out following processing is reflected by water solubility index (WSI). Jackfruit flesh contained high WSI values (28.7) indicating hydrolysis and leaching of more soluble substances (proteins, amylose etc.) during cooking. The low GI of the meal indicates that leached out substances could be molecules other than amylose and amylopectin. Boiled jackfruit flesh contained disintegrated starch granules while seeds contained intact swollen and disintegrated granules indicating the effect of wet processing on granules (Figure 2).

Sources of carbohydrates available in a meal also influence plasma glucose and insulin responses [16]. Jackfruit meal contained two sources of carbohydrates (eg: vegetable and seeds). The inclusion of 10% carbohydrate from seeds or presence of other compounds in the seeds such as α -D-Galactose specific lectin which have the capacity to bind mono- and oligosaccharides as reported for another species of *Moraceae* family, *Artocarpus integra* (also called as jackfruit) might also be responsible for low GI of this meal [20]. The presence of compounds of this nature that can bind glucose would either reduce the absorption of glucose or slow the process of digestion thereby yielding a low glycaemic response.

Conclusion

Jackfruit has beneficial nutritional parameters and a low GI. This could be due to the collective contributions of dietary fibre, slowly available glucose, intact starch granules in seeds and influence of different sources of carbohydrates.

Acknowledgements

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