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# Effect of Nisha Amlaki on the glycemic index to two Indian foods

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## ABSTRACT

**Background:** The glycemic index (GI) classifies carbohydrate-containing foods based on their immediate impact on blood glucose levels. The GI of foods can be modified by varying the contents of protein, fat, fiber, and bioactive components. Nisha Amlaki, a mixture of turmeric (*Curcuma longa*) and amla (*Emblica Officinalis*) is indicated in traditional Ayurvedic texts for the management of prediabetes and diabetes. The present study examined the effect of Nisha Amlaki on the GI response to rava sheera and potato-poha tikki.

**Methods:** Six healthy volunteers received four treatments providing 75g of glucose, rava sheera, or potato-poha tikkis, with and without Nisha Amlaki. A one-week washout period was maintained between two consecutive treatments.

**Results:** The GI of rava sheera and tikkis was 68±16 and 70±24, respectively. The GI was lower with Nisha Amlaki: 49±23 for rava sheera and 50±23 for tikkis. To predict GI *in vitro*, a chemical method based on starch digestion was tested since human GI studies are laborious and expensive. The predicted GI values were 78±2 for rava sheera and 86±4 for potato-poha tikki, higher than the observed.

**Conclusions:** The findings suggest that Nisha Amlaki is useful for lowering the GI of food, particularly in carbohydrate-rich foods. The GI values predicted *in vitro* were higher than those observed in vivo.

## KEYWORDS

Glycemic index; Nisha Amlaki; *Curcuma longa*; *Emblica officinalis*; Glycemic index; Blood glucose

## ARTICLE HISTORY

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## Introduction

The effect of carbohydrates on blood glucose and blood insulin levels holds significance, particularly because health benefits are associated with low glycemic index (GI) and low glycemic load. Prolonged hyperglycemia and hyperinsulinemia are associated with non-communicable diseases such as type 2 diabetes, cardiovascular disease, and possibly cancer [1]. Therefore, concerted efforts aim to lower the GI of foods [2].

The addition of foods or additives such as olive oil [3], black tea [4], and cinnamon [5] was found to help reduce glycemic response. A considerable proportion of Indian foods comprises high carbohydrate content, often containing sugar or ingredients that rapidly elevate blood sugar, such as white rice, rice flakes, or potatoes. One such product is sheera/halwa, made with semolina or rava and sugar. Therefore, it may be worth to determine whether its GI can be reduced.

In Ayurveda, various plants are used for different treatment regimens. Nisha Amlaki is a formulation of Nisha, i.e., turmeric (Curcuma longa) and Amlaki (Phyllanthus emblica/Emblica officinalis), recommended in the management of prediabetes and diabetes [6]. Therefore, the current study examines the potential effect of Nisha Amalaki powder (churna) on the glycemic and insulinemic responses to two preparations-rava/semolina sheera/halwa and potato-poha tikkis and measures *in vitro* starch digestibility.

## Materials and Methods

Six healthy volunteers who fulfilled the exclusion and inclusion criteria were recruited after obtaining informed written consent. All subjects underwent a physical health check-up before the study.

### Inclusion criteria

Participants between 18 and 25 years of age have a normal BMI as per the WHO criteria for Asians and a normal complete blood count with a hemoglobin level above 11 g/dl [7].

### Exclusion criteria

Participants were excluded if they were suffering from any chronic illness, such as type 1/type diabetes mellitus, metabolic syndrome, thyroid problems, metabolic syndrome, hypertension if they had a first-degree relative with diabetes, recent episodes of diarrhoea or cold 15 before the study, food allergies, recent weight loss, alcohol consumption, smoking.

### Study protocol

Subjects reported to the laboratory by 9 am, following a minimum 10- hour overnight fast. Subjects consumed either standard or test food, both with and without the Nisha Amlaki. Glucose (75g) served as the reference and the test food was to be consumed. The 75 gm of glucose was administered with 250 ml of water. 2 ml of venous blood samples (0 (baseline), 30, 60, 90 and 120 mins) were collected after test food consumption. For Nisha Amlaki, a 2:3 mixture of turmeric and Amlaki powder (4g and 6g, respectively) was consumed with 250 ml water. The turmeric powder was procured from an organic farm, while the Amlaki powder was obtained from an Ayurvedic chemist (DG Ayurvedya Sangraha). The subjects consumed 10g of the mixture followed by either glucose the reference food or the test food

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i.e. rava sheera/ tikkis. A minimum of one week was maintained between consecutive test days.

For each subject, a precisely measured amount containing 75g of available carbohydrates was administered for the two test foods. The subjects were instructed to consume the food (265 g of the rava sheera and 240 gm equivalent to four tikkis) 10 minutes post-consumption of Nisha Amlaki. Two distinct groups of six healthy subjects each were assigned to receive the respective test foods.

## Measurements

Blood glucose was measured using the GOD/POD method (Accurex Biomedical Pvt. Ltd).

## Analysis of the test foods

The test foods were analysed for the proximate constituents-moisture, protein, crude fat, dietary fat, and *in vitro* starch digestion. Moisture was measured by the method described by Ranganna [8]. For rava sheera, since the sugar content was high, moisture was measured in a vacuum oven, whereas for the potato-poha tikkis, the moisture was measured in a hot air oven at 105 0C. Protein and fat were estimated using the macro-Kjeldahl method given by AOAC [9]. Dietary fiber was estimated by the method described in IS 11062-1984 [10]. Total carbohydrate was calculated by the difference method. *in vitro* starch digestibility was measured and the predicted GI was calculated by the method given by Goni et al., [11]. It was calculated from the percentage of starch hydrolyzed at 90 mins, using the formula proposed by Goni et al., GI=39.21+0.803. All chemicals used are AR grade and all foods were analysed in triplicate.

## Calculation of glycemic index

GI was calculated as the incremental area under the curve (iAUC) as given by Wolever and Jenkins [12].

## Statistical analysis

The data was entered in Microsoft Excel and statistical analysis was done using SPSS version 18. Means and standard deviations were calculated for the glycemic indices. Student's two-tailed t-test determined group differences. Pearson's correlation coefficient was applied to determine the strength of the relationship between the GI determined with the human subjects and observed GI and the GI values obtained using the *in vitro* chemical method. A p-value of <0.05 was established statistically significant.

## Ethics approval

The study was approved by the Intersystem Biomedical Ethics Committee.

## Results and Discussion

Both foods were designed and prepared to provide approximately 75g of available carbohydrate, similar to the reference glucose dose (75g) (Table 1).

**Table 1.** Macronutrient Composition of the Rava Sheera and Potato-Poha Tikkis (per portion)

| Measurement | Rava Sheera (263g/ portion) | Potato-Poha Tikkis (240g/ portion) |
|---|---|---|
| Moisture (g) | 52±1.9[1] (73-75.5)[2] | 65.4±0.9 (64.3-66.5) |
| Protein (g) | 7.9±0.1 (7.7-8.1) | 4.8±0.4 (4.5-5.2) |
| Total fat (g) | 31.3±0.7 (30.2-32.0) | 12.3±0.2 (12.1-12.5) |
| Dietary fibre (g) | 3.1±0.2 (2.8 -3.3) | 4.0±0.2 (3.7-4.2) |
| Carbohydrate (g) | 74.2±0.9 (73.0-75.5) | 75.0±1.0 (73.6-75.8) |
| Slowly digestible starch | 32.7±0.6 (32.1-33.2) | 18.6±0.21 (18.4-18.9) |
| Rapidly digestible starch | 10.2±0.30 (9.8-10.6) | 22.3±0.16 (22.1-22.5) |

[1]Mean±standard deviation; [2]Minimum-Maximum

The protein content of the rava sheera was higher because the preparation contained rava/semolina naturally richer in protein than potato, along with the addition of milk.

Conversely, the potato-poha tikki displayed lower fat content. However, both preparations showed similar total dietary fiber content. Rava sheera contained over twice the amount of slowly digestible starch (SDS) compared to the potato-poha tikki, while its rapidly digestible starch (RDS) content was approximately half the amount present in the potato-poha tikki.

## Effect of Nisha Amlaki on blood glucose response:

The 75 g of glucose(reference) as well as the test food were given to the subjects with and without the Nisha Amlaki. The glucose responses to the two test foods differed slightly at different time points after consumption (Table 2).

**Table 2.** Blood Glucose Levels at Different Intervals in Response to Consumption of Glucose (Reference) or Test Foods without and with Nisha Amlaki (Mean±SD).

| Test Food | Test Food alone | | | | | Test Food +g Nisha Amlaki | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Time (minutes) | | | | | | | | | |
| | 0 | 30 | 60 | 90 | 120 | 0 | 30 | 60 | 90 | 120 |
| *Rava Sheera* | | | | | | | | | | |
| Glucose | 77.4 ±6.4 | 134.1 ±13.1 | 123.6 ±13.3 | 108 ±11.2 | 92.4 ±14.3 | 74.4 ±8.7 | 107.9 ±13.6 | 85.6 ±12.8 | 79.1 ±13.2 | 72.9 ±11.5 |
| Sheera | 80.7 +12.5 | 112.9 ±14.4 | 106.6 ±18.5 | 104.5 ±18.4 | 92.5 ±12.8 | 79.3 ±5.8 | 108.7 ±8.2 | 97.6 ±11.8 | 88.5 ±12.4 | 79.9 ±4.7 |



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| Potato-Poha tikki | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Glucose | 73.0 | 118.4 | 107.8 | 88.1 | 91.1 | 73.7 | 100.7 | 82.0 | 84.6 | 88.4 |
| | ±5.2 | ±20.6 | ±21.1 | ±14.0 | ±21.5 | ±4.3 | ±14.9 | ±22.9 | ±11.6 | ±17.9 |
| Tikki | 72.4 | 111.6 | 90.8 | 88.0 | 81.0 | 72.2 | 99.6 | 77.7 | 81.8 | 78.6 |
| | ±6.7 | ±12.9 | ±13.7 | ±12.3 | ±7.2 | ±3.6 | ±19.9 | ±18.6 | ±9.6 | ±8.3 |

At 30, 60 and 90 minutes, blood glucose levels were higher for rava sheera compared to mean values observed after consumption of potato-poha tikki. However, at 120 minutes, the mean blood glucose values were similar. The blood sugar levels were slightly higher for rava sheera than for potato-poha tikki, throughout except at 120 minutes. The addition of Nisha Amlaki resulted in lower blood glucose values at all the time points for both food products.

Paired t-tests indicated a significant effect of the Nisha Amlaki on the glucose response to both food preparations (Table 3).

**Table 3.** Results of paired t-test for glucose response to consumption of the food preparation with or without Nisha Amlaki (NA).

| Comparison Between | Rava sheera | | Potato-poha tikkis | |
|---|---|---|---|---|
| | T statistic | p-value | T statistic | p-value |
| Glucose *vs*. glucose +NA | 4.225 | 0.008* | 3.179 | 0.014* |
| Glucose *vs*. Food Preparation | 4.565 | 0.006* | 2.325 | 0.068 |
| Glucose+NA *vs*. Food Preparation | -2.865 | 0.035* | -1.663 | 0.157 |
| Glucose *vs*. Food Preparation +NA | 18.152 | 0.000* | 3.611 | 0.015* |
| Food Preparation Alone *vs*. Food Preparation +NA | 2.827 | 0.037* | 2.619 | 0.047* |
| Glucose +NA *vs*. Food Preparation +NA | -0.186 | 0.860 | -.0720 | 0.044* |

The repeated measures analysis of variance revealed a statistically significant difference only between the glycemic response between glucose and glucose+Nisha Amlaki (F=32.76, p=0.030) and glucose vs. potato-poha tikki+Nisha Amlaki tended to be significantly different (F=30.14, p=0.053). In rava sheera, there was no significant difference between the glycemic responses to the various combinations of glucose and the food preparation with or without Nisha Amlaki.

Rava sheera had a medium GI of 68 which was slightly lower than the GI of the tikki. As a result of treating subjects who consumed rava sheera with Nisha Amlaki along with 75g of glucose, the GI was reduced significantly to 49 in those subjects and to 43 in the subjects who fed with tikkis (Table 4).

**Table 4.** Mean Glycemic Index Values for Rava Sheera and Potato-Poha Tikkis without and with Nisha Amlaki.

| Glucose + Nisha Amlaki | Product Alone | Product + Nisha Amlaki |
|---|---|---|
| | Rava Sheera | |
| 49±23[1] | 68±16 | 46±13 |
| 24-83[2] | 46-90 | 30-62 |
| 48[3] | 24 | 29 |
| | Potato-Poha Tikki | |
| 43±14 | 70±24 | 50±23 |
| 24-66 | 28-94 | 13-81 |
| 32.5 | 34.3 | 46.4 |

[1]Mean±SD; [2]Minimum-Maximum; [3]Coefficient of Variation

Ingestion of the Nisha Amlaki powder before food consumption led to a substantial lowering of the GI. In rava sheera, the GI was lowered from 68 to 46. Similar results were observed with the potato-poha tikki when this snack was consumed along with the Nisha Amlaki.

The observations in the present study show that the use of Nisha Amlaki lowers the glycemic response considerably. This effect may be attributed to several mechanisms. Nisha Amlaki may increase insulin sensitivity and/or inhibit digestive enzymes in addition to its action on insulin secretion. El-Moselhy et al., [13] observed that administration of curcumin (80mg/kg) improved glucose tolerance and increased insulin sensitivity. Earlier, Mohankumar et al., [14] showed increased insulin secretion in cell cultures of the pancreas of adult mice. Cheng et al., [15] observed that when the skeletal muscle in Wistar rats was incubated with 0.1-1m curcumin, there was an increase in glucose uptake and GLUT 4 across the membrane.

In healthy individuals, ingestion of *C. longa* was associated with significantly higher insulin levels [16]. Also, turmerin, a water-soluble peptide present in the turmeric rhizome, shows inhibitory activity against α-amylase and α-glucosidase in a dose-dependent manner.

Turmeric demonstrated potential benefits including reduced thiobarbituric acid reactive substances, increased NADPH/NADP ratio and elevated glutathione peroxidase activity. It hinders the conversion of sorbitol to fructose [17]. In Type 2 diabetics, consumption of 10g amla powder improved the glycemic and lipid profile. Yamauchi et al., [18] reported a decrease in NF-κB activity in liver tissue, and macrophage infiltration and further increase in adiponectin. Best et al., [19] suggested that the increased insulin response resulting from



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ingestion of C.longa may be due to the stimulation of beta cell function by curcumin.

Similarly, *E. officinalis* was reported to lower blood sugar levels in both normal and alloxan-induced diabetic rats. Dawane et al., [20] attributed the benefits of Nisha Amlaki to its insulin-mimetic properties, enhancing glucose uptake and improving insulin sensitivity, and reducing hepatic glucose production.

## Conclusions

This study showed that ingestion of 10g Nisha Amlaki can effectively improve the glycemic response to high carbohydrate foods and can help persons with either insulin resistance or diabetes. This nutraceutical also confers other valuable health benefits.

## Disclosure statement

No potential conflict of interest was reported by the authors.

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