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Association between processing method and Glycemic Indices of South Indian food

Nehal Chavda[1], Richa Soni [2*], Hiral Gohel[3], Vidhi Shah[4], and Tarun Yogi[5]
[1,2,3,4,5] Department of Life Science and Food Science and Nutrition, University School of Sciences, Gujarat University, Navrangpura, Ahmedabad, Pin code: 380009, India.
Email id: nehalb@gujaratuniversity.ac.in, shah.vidhi.g@gmail.com, tarunyogi98@gmail.com, richasoni@gujaratuniversity.ac.in

ABSTRACT
The study was conducted to find Associate between the composition and processing method of South Indian food with glycemic indices. For this four recipes namely Parboiled Rice Idly and Brown Rice Idly cooked by two different methods (traditional steaming and microwave steaming) were selected for the study. The recipes were standardized for equal carbohydrate levels (i.e. 50 g). Both methods of cooking were performed to see the effects of the cooking method on the composition and Glycemic index and Glycemic load of the idly. Overall four recipes were standardized Parboiled Steamed (PS), Parboiled Microwaved (PM), Brown Rice Steamed (BS), and Brown Rice microwaved (BM). Eight healthy female volunteers not suffering from any disease were selected purposely. Subjects were given a 50g carbohydrate portion of the different idlies in random order after an overnight fast, their fasting blood glucose and blood glucose level every half an hour for two hours after consuming test food were measured for each recipe. 50 g glucose served as the reference food. The results indicated that the Glycemic index of four types of idlies was 57.65 ± 26.71, 46.96 ± 26.37, 50.57 ± 26.44, 36.26 ± 21.47 PS, PM, BS, and BM respectively. The glycemic index value of the parboiled microwave decreased up to 10.69 points and the value of the brown rice microwave decreased by 21.39 points because of changing the cooking method (i.e. Microwave cooking). Statistical analysis showed that microwave cooking had significantly reduced the Glycemic index, Glycemic load of both parboiled and brown rice idlies (p< 0.05). Therefore, microwave cooking significantly alters the Glycemic index and Glycemic load as compared to conventional preparation of idly.
Keywords: *Glycemic index, Glycemic Load, Traditional cooking, Microwave cooking*

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INTRODUCTION

Asia has a significantly high yield (95%) of the cereal crop Rice (*Oryza sativa*). It accounts for about 21, 14, and 2% of the world's protein, fat, and energy supply, according to Kennedy and Burlingame, (2003), making it a significant staple meal and a good source of micronutrients [1]. Rice's high starch content (75-80%) significantly influences its consumption [2]. Though millions of people worldwide consume white rice as their primary source of carbohydrates, white rice consumption is associated with high glycemic load (GL), which is associated with the prevalence of type II diabetes mellitus (Kempner, Peschel, and Schlayer 1958). The Glycemic Index is defined as "the incremental area under the blood glucose response curve of a 50 g digestible carbohydrate portion of a test food expressed as a percentage of the response to the same amount of carbohydrate in a standard food taken by the same subject."[3]. Amylose- amylopectin ratio of a cereal (e.g. rice) plays a dramatic effect on its GI value. The ratio is found to be inversely proportional to the glycemic response of the food [4]. Digestion of carbohydrates in foods occurs at varying rates depending on several factors. It is primarily affected by the carbohydrate content and the properties of the monosaccharide & starch components. Secondarily, cooking or food processing methods and other components of food are said to produce variations in digestion rates. Thus, depending upon these intrinsic and extrinsic factors, foods have been classified as having a low GI (55 or less), a medium GI (56-69), or a high GI (70 or greater) [4]. Although some studies designate GI to be an unreliable indicator of blood glucose response and its role in health and diagnosis (as physiological variations among individuals greatly

impact the average ranking of high to low GI food), given the acceptability of glycemic index as a global standard/ diagnostic tool, we use GI for this study. The effect of cooking methods has been extensively studied and found to play a vital role in the Glycemic index of food. For example, Jung *et al.* [4] observed that cooked rice has a higher postprandial blood glucose response compared to uncooked rice powder. In a similar vein, Wolever *et al*. [16] reported an increased GI value for boiled rice (for a duration of 15 min) than those boiled for 5 min, correlating increased cooking time with higher GI values. To further understand the influence of cooking methods and cooking time on the GI values of food, the following study was planned. This study aimed to evaluate the effect of the modified cooking method (microwave method) for idly and compare its GI and GL to that of the idly prepared via a traditional cooking method.

MATERIAL AND METHOD

Recipe standardization

Idly was selected as a staple food for the study with two different types of rice such as parboiled and brown rice with two different cooking methods.

Steam method: Parboiled rice idly cooked by steaming method (PS) and brown rice idly cooked by traditional steaming manner (BS). For both types of idly, rice and black gram dal were used. Both the ingredient were soaked for 8 hours after that it was grinded in a mixer for making a nice paste (batter). Then the batter was fermented for 8-12 hrs. After 12 hrs. Idly were prepared using idly mould in a traditional manner.

Microwave Method: The Second recipe was cooking both in the microwave. batter preparation was the same as the first recipe but the cooking method is used differently for this recipe batter was poured into greased idly mould (microwave safe) and put in a container half filled with water and cooked in a microwave at 180 degrees in Samsung CE 104 VD for 5 minutes. Parboiled rice idly cooked by microwave method is referred to as PM and brown rice idly cooked by microwave method is referred to as BM in this paper.

Preparation of Coconut chutney: All the ingredients: coconut, green chilies, ginger, garlic chilies, coriander leaves, onion, and salt were grinded in a mixer. After that the paste was then fried with some oil, mustard seeds, and curry leaves.

Standardization of test food

PS, PM, BM, and BS were standardized for equi-carbohydrate content. The procedure and environmental conditions for the estimation of GI (room temperature and timings for the test) were also standardized to minimize the effect of unaccounted variability. All selected four recipes were standardized according to carbohydrate content and serving size.

Equi carbohydrate content of idly. Table:1

Selection of Participants

For the assessment of GI and GL eight healthy volunteers were selected from the university considering follow inclusion criteria. Eight healthy women in the range of 21-35 years old and BMI ranges [(19–35 kg/m^2)] were recruited. The purpose and methodology of the study were explained to each participant in the local language and their written informed consent was obtained. All subjects were natives of Ahmedabad and were recruited via word of mouth. T h e individual who was morbidly obese (BMI>35 kg/m^2), with a history of diabetes/ prediabetes, had a fasting blood sugar >125mg/dl, or was on any medication that could interfere with glucose metabolism, gastric mortality, and lipid metabolism were excluded. Also, individuals having renal, liver, pancreatic, or cardiovascular disease; uncontrolled hypertension; inflammatorybowel disease; disorders of esophageal and gastrointestinal motility; gastric history of gastric surgeries, autoimmune disorders; hypo- or hyperthyroidism were also excluded. Other exclusion criteria included smoking, weight gain or loss up to 5 kg within the prior 6 months, consuming alcohol, pregnant or breastfeeding women, and those unwilling to adhere to study protocol.

Anthropometric measurements

Anthropometric measurements such as body mass index (BMI): height (m), and weight (kg) were measured using Karada Scan ™ (HBF-375, Gurgaon, Haryana, India) of all selected subjects before the study trial.

Assessment of sensory properties of developed idlies

Panel members were master's students of Food Science and Nutrition. The aim of the study and procedure of assessment of glycemic index was explained to them and those who showed a willingness to participate in the study were selected. Informed consent was obtained from each participant. Selected subjects were asked not to: Eat anything after 7 PM a day before the assessment, indulge in any strenuous physical exercise before the assessment, and follow all exclusion criteria.

Blood Glucose Measurement Participants were allocated a reference food and test food on alternate days and were advised to consume it within 10 minutes. In the present, a study of 50 g glucose was taken as a reference food for the assessment of Glucose to fasting. The fasting blood glucose of selected subjects was assessed. For the assessment of blood glucose, Glucometer (Dr. Morepen® Gluco one BG-03) was used. Blood was drawn by the finger prick method. The first drop of blood was removed by cotton and the second drop was used for glucose assessment. 50 g glucose dissolved in 100 ml of water was served to the panel member. After 30 minutes of finishing the glucose drink, the second reading was taken and sequent readings were taken every 30 minutes the next two hours were: fasting, 30 minutes, 60 minutes, 90 minutes, and 120 minute

For Test food, keeping the carbohydrate value constant (50gm) in one serving: four recipes namely Parboiled rice Steamed idly, Parboiled rice Microwave idly, Brown rice Steamed idly, Brown rice Microwave idly with chutney were served to the same subjects on different days. The method for blood glucose measurement was repeated the same as above.

CALCULATION OF INCREMENTAL AREA UNDER CURVE:

Analysis was done on the blood samples by calculating the glycemic index described using the methods described by (Jenkins *et al*, 1981) this was done by determining the ratio of the area under the glucose response curve.

CALCULATION OF GLYCEMIC INDEX:

"The glycemic index (GI) is calculated as the incremental area under the curve (IAUC) for blood glucose after consumption of a test food divided by the IAUC of a reference food containing the same amount of carbohydrate." [5]

The Glycemic index (GI) = IAUC of test food/IAUC of reference food x 100

CALCULATION OF GLYCEMIC LOAD

The glycemic load uses to find the grams of available carbohydrates (i.e. Total carbohydrate minus fiber) in the food, we can calculate the food's glycemic load. Here's the calculation formula: (Jenkins *et al*, 1981)

Glycemic load = glycemic index X carbohydrate content/100

STATISTICAL ANALYSIS:

Mean, the standard error was calculated for blood glucose values at different five intervals for each recipe. T-test analysis was used to assess the difference in GI and GL values of different recipes. All the statistical analysis was done using SPSS.17 version (USA).

RESULTS AND DISCUSSION

Table: 2; A; The sensory attributes of the developed recipes were evaluated by a panel of selected experts point a hedonic scale and multiple rating tests.

The overall acceptability of Brown rice (steamed) was the highest (i.e. 7.16 ± 1.26) which was followed by brown rice (microwave) with a value of 6.16 ± 1.46. The least acceptable was the parboiled (steamed) with the value 6.0 ± 1.27.

Table: 2; B; Most of the panelists observed slight differences in the microwave-cooked idlies as compared to traditional steaming according to multiple sample difference tests. Whereas flavors of the brown rice idly (steamed) were found to be moderately different from the control sample.

Table: 3, For assessing the Glycemic index, eight-panel members were on the basis of pre-decided criteria. The mean age of the panel members was 23 years, height was 158.62 cm, weight was 52.92 kg, calculated BMI was 21.16 kg/m^2, all the panel members were female and they all fulfilled in inclusion criteria 87.50% females were vegetarian and 12.50% were nonvegetarian.

ASSESSMENT OF GLYCEMIC INDEX:

Table 4, Fasting blood glucose readings were taken after an overnight fast (12 hrs) by finger pricking method, and the concentration of glucose in blood was measured by glucometer. The fastingreading was (88±4.96) mg/dl with a range between 81-96 mg/dl. Subject 3 has highest fasting blood glucose (i.e. 96 mg/dl) while subject 1 had the lowest fasting blood glucose (i.e. 81 mg/dl). After consuming 50 gm of glucose in 100 ml water within 10 minutes. The first reading was taken after 30 minutes. The mean of the first reading was (148.5 ± 26.35 mg/dl) with a range between 92-182mg/dl subject 1 had the highest blood glucose (i.e.182 mg/dl) while subject 5 had the lowest blood glucose (i.e.92 mg/dl). The second reading was taken after 60 minutes with a mean value of (124.12 ± 13.96 mg/dl) and ranging between 105-148 mg/dl. Subject 7 had the highest blood glucose(i.e.148 mg/dl) while subject 5 had the lowest blood glucose (i.e.105 mg/dl). The third reading was taken after 90 minutes. The mean of the third reading was (110.12 ± 11.80 mg/dl with a range between 98-139 mg/dl. Subject 7 had the highest blood glucose (i.e.139 mg/dl)

while subject 3 had the lowest blood glucose (i.e.98 mg/dl). The fourth reading was taken after 120 minutes. The mean of a fourth reading was (98.625 ± 12.94 mg/dl) with a range between 84-128 mg/dl subject 7 had the highest blood glucose (i.e. 128 mg/dl) while subject 1 had the lowest blood glucose (i.e. 84 mg/dl

Figure 1, the mean fasting reading for the Parboiled steam rice (PS) group was (91.62 ± 9.45 mg/dl) with a range of 77 to 102 mg/dl. After consuming gm of Idli in 10 minutes, reading was taken every 30 minutes till 120min. Utilization of glucose after 120min was (100.5 ± 11.03mg/dl) with the range between 86 to 123 mg/dl. The mean fasting reading for Parboiled Microwave rice (PM) was (94.12 ± 10.06 mg/dl) a range of 82 to 118 mg/dl. The utilization of glucose after the 120-minute reading was (104.25 ± 9.61 mg/dl) with a range between 93 to 124 mg/dl.

The mean Fasting reading of Brown rice Microwaved (BM) was (94.12 ± 10.06 dl) with a range of 82 to 118 mg/dl. After consuming 170 gm of idly in 10 minutes, the first reading was taken after 30 minutes. The mean reading was (110.5 ± 10.08 mg/dl) with a range between 92 to 126 mg/dl.

The mean fasting reading of Brown rice Steamed (BS) was (90.62 ± 6.24 mg/dl) with a range of 81 to 98 mg/dl. After consuming 180 gm of idly in 10 minutes first reading was taken after 30 minutes. The ma first reading was (116.87 ± 7.52 mg/dl) with a range between 108 to 128 mg/dl.

Table: 5: The glycemic index was calculated by determining the ratio of the area under the glucose response curve of the test food and the area for the glucose tolerance test. The mean value of glycemic index & glycemic load for parboiled (steamed) (57.65 ± 26.71) & (28.82 ±13.35) Statistical analysis showed that the difference observed was significant ($p<0.05$). The highest GI & GL value in Parboiled (steamed) was 95.2 & 47.6 shown in subject 2 and the lowest was 28.44 & 14.22 shown in subject 8. The mean value of GI & GL in Parboiled (microwave) was (46.96 ± 26.37) & (23.48 ±13.18) Statistical analysis showed the difference. The Observed was significant ($p<0.05$). The highest GI & GL value in parboiled (microwave) was 8.5 & 49.25 shown in subject 2 and the lowest was 16.16 & 8.08 shown in subject 8. The mean value of GI & GL in Brown Rice (steamed was (50.57 ± 26.44) & (25.28 ±13.22) Statistical analysis showed that the difference observed was significant ($p<0.05$). The highest GI & GL value in Brown Rice (steamed) was 90 & 45 shown insubject 2 and the lowest was 22 & 11 shown in subject 4. The mean value of GI &GL in Brown Rice (microwave) was (36.26 ± 21.47) & (18.13 ±10.73). Statistical analysis shows the difference observed was significant ($p<0.05$). The highest GI & GL value in Brown Rice (microwave) was 81 & 40.5 shown in subject 2 and the lowest was 18 & 9 shown in subject 4. Similarly, microwave cooking significantly reduced the GI and GL valuesof the parboiled (microwave) ($p<0.05$). There was no significant change observed in the parboiled (steamed) and brown rice (steamed)which shows that the composition of the idly had no significant effect on the Glycemic index and Glycemic load values but microwave cooking significantly reduced ($p<0.05$)

Table: 1: The composition of idlies

Ingredient	Weight (gm)	Protein (gm)	Fat (gm)	Fibre (gm)	Carbohydrate (gm)	Energy (kcal)
Parboiled Rice	40	3.12	0.2	1.4	33.65	140.5
Urad Dal	23.5	5.4	0.3	2.8	11.9	76
Brown Rice	45	4.3	1.125	1.12	33.75	157
Coconut	25	0.9	10	2.6	1.65	102
Green Chillies	8	0.17	-	0.4	0.32	3
Garlic	2	0.1	-	0.1	0.4	2.3
Coriander leaves	5	0.1	-	0.2	0.09	1.5
Onion	10	0.1	0.02	0.2	0.94	4.7
Ginger	5	0.1	0.04	0.2	0.4	2.6
Curry Leaves	3	0.2	0.03	0.5	0.13	1.88
Mustard seed	3	0.5	1.2	0.4	0.5	15

Table: 2: ACCEPTABILITY OF DEVELOPED PRODUCT

A. Hedonic test

SENSORY ATTRIBUTES	MEAN HEDONIC VALUE			
	PARBOILED (STEAMED)	PARBOILED (MICRO)	BROWN RICE (STEAMED)	BROWN RICE (MICRO)
TASTE	5.5 ± 1.62	5.5 ± 1.55	6.33 ± 1.61	6.08 ± 1.37
TEXTURE	6.16 ± 0.93	5.5 ± 1.78	7.33 ± 0.98	6.25 ± 1.35
FLAVOUR	6.25 ± 1.81	6.0 ± 1.59	7.0 ± 1.59	6.0 ± 1.41
APPEARANCE	6.58 ± 0.99	6.33 ± 0.98	6.83 ± 2.03	6.5 ± 1.44
OVERALL ACCEPTABILITY	6.0 ± 1.27	6.08 ± 1.31	7.16 ± 1.26	6.16 6.16 ±1.46

B: Multiple rating test:

SENSORY ATTRIBUTES	MULTIPLE SAMPLE DIFFERENCE TEST			
	PARBOILED (STEAMED)	PARBOILED (MICRO)	BROWN RICE (STEAMED)	BROWN RICE (MICRO)
TASTE	1.83 ± 0.93	1.58 ± 1.08	1.66 ± 1.15	1.5 ± 1.0
TEXTURE	1.75 ± 0.96	2.16 ± 0.83	1.25 ± 1.21	1.33 ± 0.88
FLAVOUR	1.91 ± 1.16	2.08 ± 0.51	2.0 ± 1.20	1.41 ± 0.79

Table: 3: BACKGROUND INFORMATION OF PANEL MEMBERS

BACKGROUND INFORMATION		MEAN
AGE		23.87
HEIGHT (cm)		158.62
WEIGHT(kg)		52.92
BMI(kg/m^2		21.16
GENDER		FEMALE
FOOD HABIT	VEGETARIAN	87.50%
	Non- vegetarian	12.50%

Table: 4: Blood glucose response of subjects in oral glucose tolerance test (OGTT):

GLUCOSE RESPONSE TO GLUCOSE DRINK (OGTT)					
Code	0 min	30 min	60 min	90 min	120 min
SUB 1	81	182	115	107	84
SUB2	93	137	115	109	91
SUB 3	96	155	133	98	94
SUB 4	86	163	128	102	93
SUB 5	90	92	105	108	109
SUB6	84	130	138	104	98
SUB7	94	166	148	139	128
SUB	86	163	111	114	92
MEAN ± SD	88.75 ± 4.96	148.5 ± 26.35	124.12 ± 13.96	110.12 ± 11.80	98.62 ± 12.94

Table: 5: Glycemic Index & Glycemic Load of South Indian Staple Dish: Idly

GLYCEMIC INDEX & GLYCEMIC LOAD								
CODE	PARBOILED (STEAMED)		PARBOILED (MICROWAVE)		BROWN RICE (STEAMED)		BROWN RICE (MICROWAVE)	
	GI	GL	GI	GL	GI	GL	GI	GL
SUBJECT 1	58.15	29.075	58.8	29.4	38	19	37	18.5
SUBJECT 2	95.2	47.6	98.5	49.25	90	45	81	40.5
SUBJECT 3	77.94	38.97	66.15	33.07	58	29	53.8	26.9
SUBJECT 4	40.43	20.21	36.1	18.05	22	11	18	9
SUBJECT 5	35.	17.6	26.4	13.2	47	23.5	28	14
SUBJECT 6	90	45	38.97	19.48	89	44.5	31	15.5
SUBJECT 7	35.9	17.95	34.6	17.3	30.6	15.3	21.3	10.65
SUBJECT 8	28.44	14.22	16.16	8.08	30	15	20	10
mean ± SD	57.65 ± 26.71[a]	28.82 ± 13.35[a]	46.96 ± 26.37[b]	23.48± 13.18[b]	50.57 ± 26.44[a]	25.28 ± 13.22[a]	36.26 36 .26 ± 21.47[c]	18.13 ± 10.73[c]

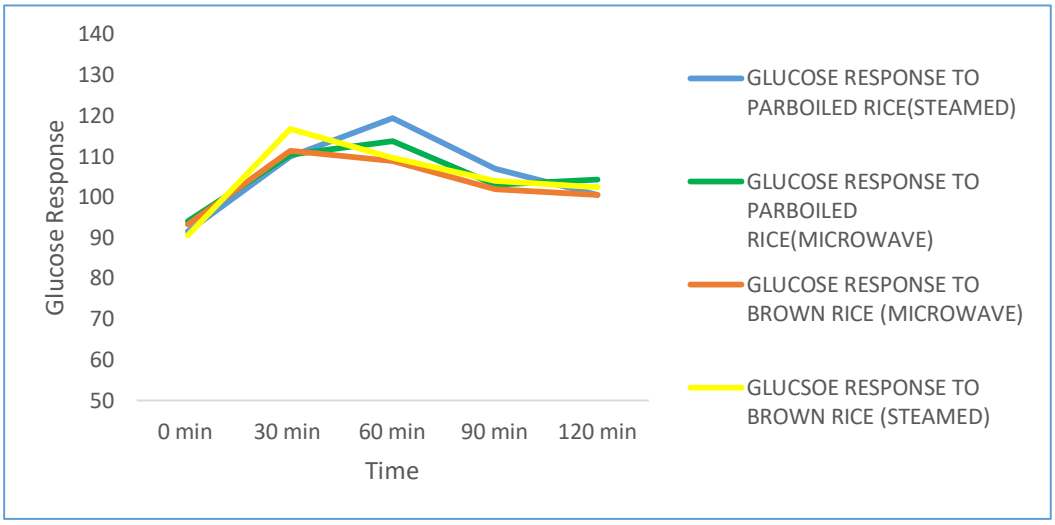

Figure: 1 Blood glucose response to Parboiled rice Steamed, Parboiled rice Microwave & Brown rice Microwave, Brown rice Steamed:

The cooking method changes the cell structure by changing the postprandial blood glucose response. Thus it increases or decreases the gelatinization of the rice products and impacts glycemic index values [6, 7]. Low gelatinization and shallow roasting increase the crystallinity, lowering the glycemic index values. [8]. Pre-treatment of grain is also responsible for the glucose content of rice [9]. Due to this, pre-treated rice (pre-gelatinized rice) shows an increased glycemic index.

During cooking, heating and stirring methods play a crucial role in increasing GI. Due to steaming, carbohydrate content in rice grains becomes more soluble and is more easily digestible by enzymatic activity. This gelatinized part of meals plays a major role in the observed post-prandial glycemic response. The presence of low GI values for microwaved meals for a small time period is attributed to either short-time processing alongside less vigorous stirring and minor particle crushing or partial exposure to gelatinization temperature. This causes the release of starch granules, which in turn releases amylose chains. Amylose chains further undergo hydrolysis by α-amylase [10].

Rice is a staple diet of most of the Indian population which contains a high amount of starch. High starchy food, directly affects the glycemic index. The amylose and amylopectin ratio depends on glycemic index variation. Recent studies reveal that the GI of rice varied widely from 48 to 92, and rice's GI is very high compared to other starchy foods so the glycemic response of rice becomes crucial for people who suffer from diabetes and other non-communicable diseases [11].

The glycemic response of the south Indian staple dish: Idly which was of two types (parboiled rice and

brown rice) with two different cooking methods (in a traditional manner and a microwave) showed a difference in their GI value. Our study also revealed that by changing cooking practices the glycemic index can be decreased. For parboiled rice, GI and GL values significantly decreased ($p<0.05$) from 57.65 ± 26.71 and 28.82 ± 13.35 (steamed cooking) to 46.96 ± 26.37 and 23.48± 13.18 (microwave cooking), respectively. Similarly, for brown rice, GI and GL values were significantly lower ($p<0.05$) from 50.57 ± 26.44 and 25.28 ± 13.22 (steamed cooking) to 36.27 ± 21.47 and 18.13 ± 10.73 (microwave cooking), respectively [12-15]. The glycemic index was shown to be significantly affected by various cooking methods [16]. For example, cooking through microwave was linked to a significant decrease in the percent GI values compared to the preparation of rice in a rice cooker, of about 12.5% for Pakistani brown rice (PBR) and 20.4% for Indian Brown Rice (IBR), respectively. In both these varieties of rice, the glycaemic load (GL) fell into the high GL category (>20).

CONCLUSION

In the everyday diets of millions of people around the world, rice plays a vital role. Given the impact of different food processing techniques on the GI of rice, the goal is to offer rice in the healthiest way possible. High GI is still a problem, however, varietal changes can change the GI. The present study was planned to see the effect of the composition method and cooking method on the Glycemic Index of the South Indian staple dish: Idly. Revealed that the composition of the idly had no significant effect on the Glycemic index and Glycemic load values, but cooking methods have significantly reduced ($p<0.05$) hence making it suitable for consumption for diabetic people.

CONFLICT OF INTEREST

There is no conflict of interest.

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