Nutritional Communication

BBRC Bioscience Biotechnology Research Communications

Biosc.Biotech.Res.Comm. Vol 13 (3) July-Aug-Sep 2020 Pp-1561-1565

Effect of Incorporation of Roasted *Ocimum basilicum* L. Seeds on the *In vitro* Glycemic Index of Steamed Rice Cake

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ABSTRACT

The most populous South Indian staple food, steamed rice cake or idli is high in glycemic index. Still, the consumption frequency of idli is very high, at least twice a day, even by people with diabetes. *O.basilicum*, also called as basil or sabja seeds are effective in controlling diabetes by slowing down the conversion of carbohydrates to glucose. It is unfortunate that the basil seeds are not commonly used by the Indian community. As a primitive measure, the role of unexploited basil seeds in controlling diabetes by supplementing into the frequently consumed food product, steamed rice cake or idli has been determined in this study.This study aims to study the efficacy of incorporation of roasted *O.basilicum* seeds on the in vitro glycemic index values of steamed rice cake. Roasted Ocimum basilicum seeds in proportions of 5% (RV1), 10% (RV2), 15% (RV3) and 20% (RV4) of the black gram have been incorporated into the traditional high glycemic South Indian food, steamed rice cake. All the variations of roasted Ocimum basilicum seed incorporated steamed rice cakes were subjected to carbohydrate profile evaluation and estimation of in vitro glycaemic index. The results depicted that the composition of detected parameters of the roasted *O.basilicum* seed incorporated steamed rice cake showed significant difference ($p<0.05$) in all the variations, on comparison with control. As the proportion of *O.basilicum* seeds increased the total carbohydrate and sugar values showed a decline, whereas the cellulose, hemicellulose and resistant starch values increased. The mean in vitro glycemic index of the control steamed rice cake was 68.67 ± 0.02, while the mean estimated glycemic index value of RV1, RV2, RV3 and RV4 were 56.73 ± 0.01, 54.78 ± 0.02, 52.63± 0.02 and 51.66 ± 0.01 respectively. Thus, the roasted seeds of *O. basilicum* can be effectively used in steamed rice cake preparation as a means to lower glycemic index at an affordable cost.

KEY WORDS: DIABETES MELLITUS, GLYCEMIC INDEX, IDLI, OCIMUM BASILICUM, ROASTING.

INTRODUCTION

The diabetes indices of global population is in rise alarmingly every other day. In each part of the universe several studies and researches are being carried out to find solutions to keep diabetes at bay. Indeed, meek measures like lifestyle changes and simple and economical dietary modification is the need of the hour to control diabetes and pre diabetes. Rice is a major food source in the dietary pattern of the South Indians. Though rice is a prime energy provider, and has many vital components like B vitamins in it, the lack of fibre and high glycemic index (GI=73) makes rice a foe to people with sedentary life style and diabetes. Glycemic index is considered as an important indicator of glycemic response (Jenkins et al, 1981). The rate at which the blood sugar levels raise after ingestion of a particular food in an observed period of time in comparison with the controls like glucose or

ARTICLE INFORMATION

*Corresponding Author: naznip@gmail.com
Received 15th July 2020 Accepted after revision 10th Sep 2020
Print ISSN: 0974-6455 Online ISSN: 2321-4007 CODEN: BBRCBA

Thomson Reuters ISI Web of Science Clarivate Analytics USA and Crossref Indexed Journal

NAAS Journal Score 2020 (4.31) SJIF: 2020 (7.728)
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Online Contents Available at: http//www.bbrc.in/
DOI: http://dx.doi.org/10.21786/bbrc/13.3/84

white bread is termed as Glycemic Index. The lower the GI of a food the better it is for diabetics to consume.

Foods with GI value less than 55 can be categorized as low GI foods, while with GI values between 56 and 69 are termed as medium GI foods and foods with GI value more than 70 are grouped as high GI foods. There are several studies which have been undertaken to reduce the glycemic index of rice incorporated food products, either by adopting change in the rice processing methods or addition of ingredients which are high in fibre or fat to counter act the impact of glycemic response of rice. One such example is optimizing cooking temperature and the ratio of water to rice reduced in vitro starch digestibility and GI of instant rice, (Ritudomphol et al. 2019).

Similarly, Steamed rice cake or idli, a cereal legume based spongy and soft textured fermented food consumed by South Indians (Sonawane etal, 2019) as their diurnal diet which is high in GI, has been modified by various measures. The nutritive value of idli was enhanced by addition of sorghum and pearl millet (Nazni et al, 2010). Amarant grain flour had been incorporated to develop value added idli (Nazni et al, 2014). Heat treatment of rice was chosen for the preparation of low-GI Idli, (Chelliah et al, 2019). Oats flour and guargum flour incorporation reduced the GI of idli (Giri, 2017). Research study on addition of jowar to idli has shown a low glycemic response compared to rice rawa idli, (Jahan, 2018). Leaves and seeds of *Ocimum* species due to their medicinal properties is in use in traditional medicine for treating various ailments. Basil leaves lowered blood glucose levels and advanced glycation end products in diabetic rats (Widjaja et al, 2019).

The presence of polyphenols and flavonoids showcases *O. basilicum* seeds as a vital part of the daily food regime (Sestili et. al, 2018). The aqueous extract *O.basilicum* or basil or sabja seeds either by antioxidant or by α-glucosidase and α-amylase inhibiting activities, offered positive benefits to control diabetes (El-Beshbishy et al, 2012). Renal damage induced by diabetes was reverted by *O. basilicum* in albino rats and has been proven biochemically and histo pathologically, (Almalki 2019). In this context, this study has aimed at studying the effect of roasted *O.basilicum* or basil or sabja seeds on the *in vitro* glycemic index values of steamed rice cake.

MATERIAL AND METHODS

Procurement and Processing of Raw Material: The raw materials required for the study such as parboiled rice, dehulled black gram and basil or sabja seeds (*Ocimum basilicum* L.) were purchased from the local market of Salem district, Tamilnadu. The ingredients rice and black gram were hand sorted, to make sure that only quality grains are used and the impurities were removed by washing with water. The basil seeds were hand sorted and sieved to ensure quality. The seeds were dry roasted at 1150 C for 6-8 minutes and cooled, roasting beyond this temperature charred the seeds, while roasting lesser than 1150 C did not bring about changes in the colour and aroma. Roasting was done as it improves antioxidant capacity and oxidative stability, (Durmaz et al, 2010).

Table 1. Ingredients in the Preparation of Control and Roasted *O.basilicum* Seeds Incorporated Steamed rice Cake

Ingredients	Control Steamed Rice Cake	Level of Incorporation			
		O.basilicum Seeds Incorporated Steamed rice Cake			
		RV1	RV2	RV3	RV4
Rice (gms)	100	100	100	100	100
Black gram (gms)	100	23.75	22.5	21.25	20
Roasted *O.basilicum* seeds (gms)	-	1.25	2.5	3.75	5

RV1—Roasted Variation 1, RV2—Roasted Variation 2, RV3—Roasted Variation 3, RV4—Roasted Variation 4

Formulation of Roasted *Ocimum basilicum* L. Seed Incorporated Steamed Rice Cake: The cleaned parboiled rice and dehulled black gram were soaked for 5 hrs in water at room temperature separately in the ratio of 4:1 (Ghosh et al, 2011), for control and in different proportions for respective variations of steamed rice cakes as shown in Table 1 and ground to batter. The batter was allowed to ferment for 7 hours (Nagarjuna et al. 2000). The batter was beaten well and roasted *O. basilicum* seeds at 5, 10, 15, and 20% levels of black gram were incorporated into the respective proportions of batter and was allowed to stand for a period of 15 minutes (Samateh et al, 2018) for the seeds to gel. The batter was poured in an idli steamer and steamed till doneness which approximated to 5 to 8 minutes. The roasted *O. basilicum* seed incorporated steamed rice cake is done. Simultaneously the control steamed rice cake was prepared by following the same procedure without the addition of basil seeds.

Determination of Carbohydrate profile: The developed variations of steamed rice cake and control were subjected to estimate the carbohydrate profile indices namely total carbohydrate, sugars, cellulose, hemicellulose and

resistant starch. Carbohydrate and sugar content was assessed by IS 1656 and IS 6287 procedures respectively, while cellulose, hemicellulose and resistant starch in steamed rice cake samples were analyzed using standard procedure by Mathews et.al (1993) and AOAC, (2002).

Estimation of In Vitro Glycemic Index: Starch Hydrolysis percentage, (C∞ %) corresponds to the concentration at equilibrium (t180) and k is the kinetic constant. The hydrolysis index (HI) was derived by dividing the area under the hydrolysis curve of each variation by the corresponding area of a reference sample (glucose). The estimated glycemic index (EGI) was calculated using the equation, EGI =39.71 + (0.549HI).

RESULTS AND DISCUSSION

The results and discussion pertaining to the study, Effect of incorporation of roasted *Ocimum basilicum* L. seeds on the *in vitro* glycemic index of steamed rice cake are presented below.

Table 2. Carbohydrate Profile of Roasted *Ocimum basilicum* L. Seed Incorporated Steamed Rice Cake

Variations	Carbohydrate (%)	Sugar (%)	Cellulose (%)	Hemicellulose (%)	Resistant Starch (%)
Control	21.49±0.37^{a}	0.22±0.02^{a}	1.02±0.47^{c}	1.04±0.054^{c}	0.67±0.64^{c}
RV1	19.72±0.17^{b}	0.18±0.04^{c}	1.73±0.081^{b}	1.89±0.110^{b}	0.84±0.030^{b}
RV2	18.10±0.12^{c}	0.19±0.03^{b}	1.54±0.090^{b}	2.11±0.035^{a}	0.86±0.010^{b}
RV3	18.78±0.22^{c}	0.13±0.03^{e}	2.10±0.020^{a}	2.63±0.081^{a}	0.91±0.030^{a}
RV4	14.79±0.31^{d}	0.14±0.03^{d}	2.14±0.056^{a}	2.66±0.122^{a}	0.98±0.045^{a}

Each value in the table are represented as Mean ± SD. Means with same superscript are not significantly different using Duncan's Multiple Range Test ($P < 0.05$).

Carbohydrate Profile of Roasted *Ocimum basilicum* L. Seed Incorporated Steamed Rice Cake: The most common and abundant forms of carbohydrates are sugars, fibers, and starches (McMacken et al, 2017). Table 2 depicts the carbohydrate profile indices of the developed variations of roasted *O. basilicum* seeds incorporated steamed rice cake and control steamed rice cake. The mean carbohydrate value in the control steamed rice cake was 21.49 and the carbohydrate percentage has decreased gradually as the incorporation quantity of basil seeds increased (RV4<RV3<RV2<RV1). It is to be noted that the sugar composition is inversely proportion to roasted *O. basilicum* seed composition. The parameters viz. resistant starch and the non-starch polysaccharides, like cellulose and hemicellulose are undigested, but are the major components of dietary fiber that are fermented by the colon microbiota to produce short chain fatty acids (Lovegrove et al.2017). The values of cellulose, hemicellulose and resistant starch have amplified when compared with standard proportionally and is statistically significant at ($P < 0.05$).

Table 3. Percentage of Starch Hydrolysis, Hydrolysis Index and Estimated Glycemic Index of Roasted *Ocimum basilicum* L. Seeds Incorporated Steamed Rice Cake during an In vitro Ingestion Process

Sample	C∞ (%)	K	Calculated HI (%)	EGI (%)
Control	59.13 ± 0.03^{e}	0.0395 ± 0.00^{a}	52.75 ± 0.03^{e}	68.67 ± 0.02^{e}
RV1	42.77 ± 0.02^{d}	0.4998 ± 0.00^{b}	31.00 ± 0.02^{d}	56.73 ± 0.01^{d}
RV2	38.75 ± 0.04^{c}	0.9854 ± 0.00^{c}	27.44 ± 0.03^{c}	54.78 ± 0.02^{c}
RV3	33.36 ± 0.04^{b}	0.9840 ± 0.00^{d}	23.53 ± 0.03^{b}	52.63 ± 0.02^{b}
RV4	30.84 ± 0.03^{a}	0.9056 ± 0.00^{e}	21.77 ± 0.02^{a}	51.66 ± 0.01^{a}

Each value in the table are represented as Mean ± SD. Means with same superscript are not significantly different using Duncan's Multiple Range Test ($P < 0.05$). C∞, equilibrium starch hydrolysis percentage; k, kinetic constant, HI, hydrolysis index and EGI, Estimated glycemic index.

It is also evident that the variation 4 with 20% of the basil seeds possess low sugar, high cellulose, hemicellulose and resistant starch compared to the control and the rest of the variations of steamed rice cake. The dietary

fibres, short chain fatty acids and microbiota improve the immune cell functioning and also regulates blood sugar levels (Chang, 2018). Moreover, the study of Praznik et al, (2016) states that the polysaccharides in basil seed brands them to be considered as an excellent prebiotic medium inducing the growth of lactobacilli strains, the probiotics that play a key role in controlling blood sugar levels. It is also established that the Ocimum basilicum L. seed with the manifestation of resistant starch, promises as a functional ingredient (Fuentes-Zaragoza et al, 2010). Hence, the variation 4, steamed rice cake with 20% of roasted *O. basilicum* seeds can be subjected to further studies for glycemic index and impact on diabetic profile.

In vitro Glycemic Index of Roasted *Ocimum basilicum* L. Seeds Incorporated Steamed Rice Cake: An *in vitro* starch hydrolysis method was carried out in this study, to simulate the in vivo situation of carbohydrate digestion characteristics and to estimate the metabolic glycaemic response.

Table 3 indicates the hydrolysis index (HI) and assessed GI values of the control and *O. basilicum* seeds added steamed rice cake variations. At a higher *O.basilicum* seed substitution level, there was significantly lower ($p < 0.05$) in vitro starch hydrolysis. Overall, with an increase in the proportions of the *O. basilicum* seeds, from 5% to 20%, the HI values declined from 31% to 21.77%, with drop in estimated glycemic index values from 56.73 to 51.66 which were statistically significant at $p < 0.05$. A similar anti- hyperglycemic effect was studied by ingesting aqueous extract of *Ocimum basilicum* seeds in Streptozotocin induced diabetic rats (Chaudhary et. al 2016), Goñi et al. (1997) have also proved that in vitro methods of GI estimation correlate well with the in vivo method.

CONCLUSION

O. basilicum seeds are food materials, with pharmaceutical properties, which have been used to dispel many diseases from ancient times. Considerable amount of mucilage appears around the basil seeds when they soak in water, which is a rich source of hydrocolloid with outstanding functional properties. The mucilaginous and anti-diabetic properties of the *O.basilicum* seeds had been utilized in the steamed rice cake preparation. From the study conducted, in vitro starch hydrolysis of steamed rice cake variations was significantly affected ($p < 0.05$) by the amount of *O. basilicum* seeds added in the steamed rice cake formulation. Resistant starch content increased significantly ($p < 0.05$) in 15% and 20% steamed rice cake variations, compared with the control. Hence, in vitro starch hydrolysis is closely related to the amount of resistant starch present in steamed rice cake variations. Also, resistant starch content is inversely related with hydrolysis index value, which resulted in lower estimated glycemic index values at higher added *O. basilicum* seed levels. It can be concluded that the roasted *O.basilicum* seeds incorporated rice cakes can be effectively utilised as an anti-diabetic food and the micro vascular and macro vascular complications allied with diabetes can also be prevented to a larger extent.

Conflict of Interest: The authors declare no conflict of interest

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