ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

Post –Prandial Glucose Response to *Ficus religiosa* Based Products in Normal Subjects and their Outcome on Glycemic Index

*** Neelam Chaturvedi[1] , Kalpana Shukla[2] and Ashwariya Singh[3]**

1. Associate Professor, Department of Food Science and Nutrition, Banasthali University, Dist- Tonk, Rajasthan. 304022, India.

2,3.Research Scholar, Department of Food Science and Nutrition, Banasthali University, Dist- Tonk, Rajasthan. 304022, India

Manuscript Info

Manuscript History:

Received: 11 January 2014
Final Accepted: 22 February 2014
Published Online: March 2014

Key words:
Ficus religiosa, Post prandial glucose Response, Glycemic Index, Glycemic Load.

***Corresponding Author**

Neelam Chaturvedi

Abstract

The glycemic index (GI) provides an indication of carbohydrate quality whereas glycemic load (GL) provides carbohydrates quantity in a food and the insulin demand. Diet with low glycemic index and load have been shown to improve glucose tolerance on normal healty subjects so there is a need for a more diversified range of foods with a low glycemic response. The objective of present work was to formulate *Ficus religiosa* based food products by utilizing their leaves and bark powder *as* an ingredient and their post prandial responses on normal healthy subjects. The products (Biscuits, Dal samose and Bati) were developed by incorporated 5 % and 10% *religiosa* leaves, bark and their equiproportioned blends. The result showed that the products with 10% leaves and 5% bark were insignificant (P≤0.05 level) which were comparable with standard and acceptable by semi trained panels. Further, study was conducted on randomly selected 25 healthy subjects were fed two most acceptable test recipes; Dal samose, and Bati and their post prandial glucose response were anticipated. GI and GL values were found to be lowest for 10% leaves incorporated Dal Samose (35 & 13) when compared to 5% bark incorporated Bati (53 &20). While comparing test products with standard products (wheat flour) it was found that dal samose had GI (41) and GL (15). Thus the inclusion of *religiosa* powder as an ingredient can be used to achieve a wider range of low glycemic functional foods possessing sensory attributes that could be valuable for managing the diabetes mellitus.
.

INTRODUCTION

Functional and therapeutic food which affects beneficially one or more target functions in the body, beyond adequate nutritional effects, in a way that is relevant to either improved state of health and well-being and/or reduction of risk of diseases (Henson, *et al.*, 2008).The development of food products that provide benefits beyond their traditional nutritional value has raised academic, industrial and public interest. Recent studies have shown that the high Glycemic Index (GI) food is positively associated with the risk of developing type II diabetes **(**Villegas, *et al.,* 2007) and coronary heart diseases (Mente, *et al.,* 2009). Low-GI foods might play a significant role as functional foods in reducing the risk of such chronic diseases such as diabetes, cardiovascular diseases, obesity and cancer etc.

The glycemic index (GI) is an important parameter of food quality which compares the hyperglycemic effect of a tested meal with pure glucose or another defined standard food (Queiroz , *et al.,* 2012) . Foods with carbohydrates that break down quickly during digestion and release glucose rapidly into the bloodstream tend to have a high GI whereas foods with carbohydrates that break down more slowly, releasing glucose more gradually into the bloodstream, tend to have a low GI. A low glycemic index suggests slow rates of digestion and absorption of the food's carbohydrates and may also indicate greater extraction from the liver and periphery of the products of carbohydrate digestion (Brouns, *et al*., 2005). A lower glycemic response usually equates to a lower insulin demand but not always, and may improve long-term blood glucose control and blood lipids (Jenkins, *et al.,* 1981). Epidemiological data indicate that a low GI diet protects against the development of type II diabetes (Jenkins, *et al.*, 1982; Wei, *et al.,* 2000)**,** coronary heart disease and metabolic syndrome (Wannamethee, *et al.,* 2002).

Plants are always an exemplary source of drugs in fact many of the currently available drugs were derived either directly or indirectly from them (Arayne, *et al.,* 2007). A variety of ingredients present in medicinal plants are thought to act on a variety of targets by various modes and mechanisms which impart potential therapeutic effect in complicated chronic disorders and its complications (Donga, *et al.,* 2011).The current interests in natural therapies and traditional medicines have motivated the investigation into plants that have traditionally been used in relation to metabolic disorders such as diabetes, cardio vascular diseases etc (Sharma, *et al.,* 2007). Plant drugs are frequently considered to be less toxic and free from side effects than synthetic one. Although, there are numerous traditional medicinal plants reported to have antidiabetic and hypoglycemic properties (Nilson, *et al.,* 2007).

Ficus religiosa belongs to *moracae* family, ethno medicinal tree used in Ayurveda and commonly known as "Peepal and Ashathawa" (Hassan, *et al.*, 2009). Various parts such as stem bark, aerial roots, vegetative buds, leaves, fruits, latex are used in diabetes, diarrhea, skin disease, ulcers, inflammation, asthma and nervous disorders. It can be a good nutritional supplement because its leaves and fruits contain carbohydrates, protein, lipids, calcium, sodium, potassium and phosphorous (Wangkheirakpam and Laitonjam , 2012). So, it is vitally important to identify the most important approach for the easy management of diabetes.

Nowadays growing nutritional knowledge of consumers forces the food industry to manufacture products with lower GI values. Dietary modification, weight control, and regular exercise are the main approaches in the management of diabetes, diet being the sheet anchor. Because the risk of developing long term complications can be dramatically reduced with appropriate glycemic control, food ingredients that can attenuate postprandial glucose in persons with diabetes would be useful. New research findings in this area indicate the potential value of *religiosa* has good nutritional and nutraceutical profile but its potential role as low GI food has remained unrealized and unexploited in prevention of such disorders. Thus, the present study was taken up to investigate the effect of low GI products based on *religiosa* plant powder on blood glucose in healthy subjects.

METHODOLOGY

- **Sample Collection**

  Leaves and barks of *Ficus religiosa* were collected in around August- September month and identified, confirmed and authenticated by Dravyaguna department, National Institute of Ayurveda, Jaipur. The leaves and barks were washed and sun dried after which they were reduce to fine powder by grinding and packed in air container and stored at refrigeration temperature.
- **Product Development**

  In the present study, Biscuit, Dal samose and Bati were developed with variation in each food products. The appropriate amounts of *F. religiosa* leaves (FRL) and *F. religiosa* bark (FRB) powder were weighed by using an electronic balance to give the various ratios of the composite flour and stored in air tight containers for use of best acceptable products. Each product was prepared using 5% & 10% leaves and bark powder singly and their equiproportioned blends.
- **Sensory Evaluation**

  The sensory evaluation was carried out in order to get consumer response for overall acceptability of the *religiosa* powder based products which were compared with control product**.** These test products were evaluated by 15 semi-trained panels for different sensory quality characteristics such as color, appearance, taste, after taste and overall acceptability by structured hedonic scale (1; dislike extremely to 9; extremely liked) was used for the evaluation (Almeida, *et al.,* 2002 and Desai, *et al.,* 2010)**.** The best selected products were further investigated post prandial glucose response.
- **Study Subjects**

  Twenty five normal healthy subjects of the age 24-32y, height 157-162cm, weight 52-55 kg and BMI 22-25 kg/m$^{2)}$ were randomly selected from Banasthali University campus.

  The purpose of the study was explained to each subject and consent to participate in the study was taken. The subjects were given general instructions to avoid any physical exertion, medication, fasts and feasts during the experimental period. The present study was approved by the Banasthali University research Ethics Board.
- **Assessment of Post prandial glycemic response and glycemic index**

On the first day of the study, glucose tolerance test (GTT) was conducted on overnight fasted subjects. A 50g glucose dissolved in 200ml water was given to the subjects. The subjects were instructed to finish the glucose solution within 15 min and to avoid physical exertion during the experimental period. The blood glucose level was measured at 0, 30, 60, 90 and120 min with the help of a glucometer using glucostix which is based on the action of glucose oxidase. The tests on the reference food should be repeated two times in order to reduce the variability within the subjects (Wolever, 2003). The food products Dal samose (10% *FRL*) and Bati (5% *FRB*), based on their respective powder were evaluated in two consecutive days. The subjects were asked to follow the same instructions as for the glucose tolerance test. The incremental area under the blood glucose curve is calculated for each blood glucose response curve geometrically by the trapezoid rule, disregarding the area below baseline using methods described by Wolever and others (1991). Briefly, areas below baseline values were subtracted from total area under the curve. If blood glucose values fell below baseline, IAUC at those data points were also subtracted from the total.

$$\frac{\mathrm{At}}{2}+\mathrm{At}+\frac{(\mathrm{B}-\mathrm{A})\mathrm{t}}{2}+\mathrm{Bt}+\frac{(\mathrm{C}-\mathrm{B})\mathrm{t}}{2}+\mathrm{Ct}+\frac{(\mathrm{D}-\mathrm{C})\mathrm{t}}{2}+\mathrm{Dt}+\frac{(\mathrm{E}-\mathrm{D})\mathrm{t}}{2}+\mathrm{Et}\ldots\ldots..\mathrm{etc}$$

Where A, B, C, D and E represent positive blood glucose increments; t is the time interval between blood samples. If the blood glucose increments D is positive (i.e. greater than baseline) only the area between D and E above the baseline is included.

The Glycemic index (GI) of different selected test (Dal Samose and Bati) products was determined by feeding the healthy subjects. The GI of each food was expressed as % mean glucose response of the test food divided by the standard food taken by the same subject and was determined by the following formula:

$$\mathrm{GI}=\frac{\text{IAUC of Food}}{\text{IAUC of Glucose}}\times 100$$

The glycemic load was calculated based on the quantity of the recipe per serving and the respective available carbohydrate content.

$$\mathrm{GL}=\text{Available Carbohydrate (g)}\times\text{Glycemic Index}/100$$

- **Statistical analysis:**

All data were triplicate and expressed as mean ± standard deviation. The results of the study were statistically analyzed to ascertain its significance. The analytical data obtained for *Ficus religiosa* based products were subjected to paired *t*-test. The significant difference at ($p \leq 0.05$ level) was estimated.

RESULTS AND DISCUSSION

Table (1) Overall acceptability of Biscuits, Dal Samose and Bati based *F. religiosa* (leaves, Bark and its equiproportioned mixture) powder.

Food Product	Standard	Leaves		Bark		Mixture	
		Variant A	Variant B	Variant C	Variant D	Variant E	Variant F
Biscuit	8.66±0.83	8.00±0.48^b	7.80±0.84^a	7.60±0.84^a	7.86±0.74^a	7.93±0.96^b	6.2±0.75^a
Dal Samose	8.73±0.79	8.23±0.74^b	8.46±0.70^b	8.2±0.84^b	7.9±0.74^a	8.06±0.79^a	6.9±0.79^a
Bati	8.77±0.83	7.53±0.83^a	8.3±0.81^b	8.2±0.48^b	6.73±0.59^a	7.20±1.01^a	6.20±0.86^a

Data is reported as MEAN±SD group of 15 panels each. All test recipes groups (A, B, C, D, E, F) compared to standard recipe. ^{a}significance and ^{b} insignificance $P \leq 0.05$ level

9 point hedonic scale- 6(Like Slightly), 7(Like Moderately, 8(Like very much), 5(Neither like nor dislike).

Variant S: 100% refined wheat flour

Variant a, C &E: 5% incorporation FRL, FRB and equiproportioned FRL and FRB powder.

Variant B, D & F: 10% incorporation FRL, FRB and equiproportioned FRL and FRB powder.

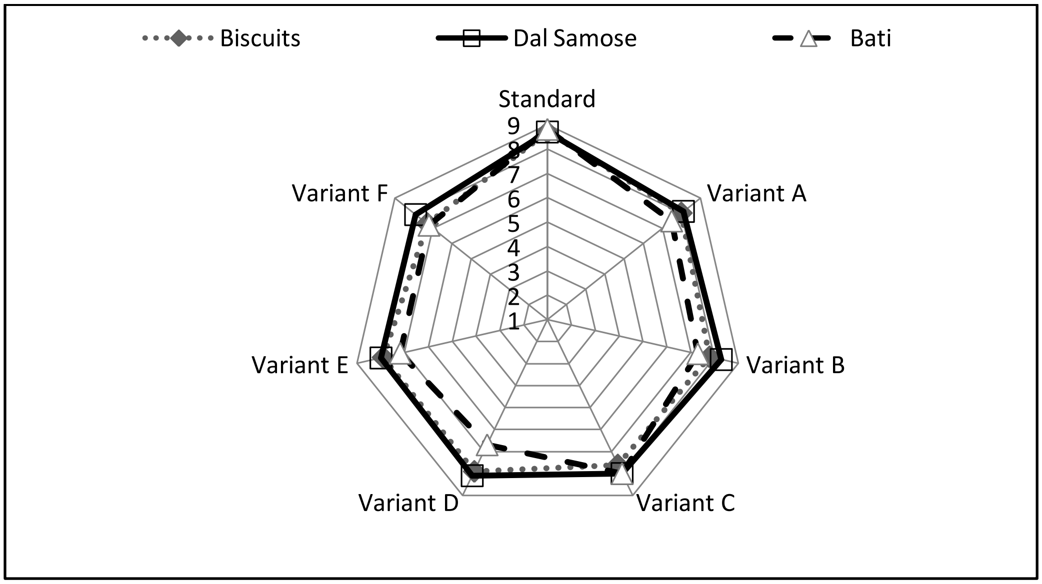


Figure (1) Overall acceptability of Food Products (Biscuits, Dal Samose and Bati).

All fifteen panels completed sensory assessment of test and standard products (Biscuits, Dal samose and Bati) of *Ficus religiosa* leaves (FRL) and *Ficus religiosa* bark (FRB) powder. Result comparing sensory characteristics (Overall acceptability) of corresponding food products is summarized in Table1and Figure1. Although food products scored higher than 7 (slightly liked) for all the products except for FRB(10%) based Bati (6.73±0.59) and 10% equiproportioned mixture based products for Biscuit (6.2±0.75), Dal samose (6.9±0.79) and Bati (6.20±0.86). Sensory analysis revealed that all products with FRL (5 and 10%) and FRB (5%) powder based products were comparable to corresponding standard product. However, the panelist scores for the Overall acceptability were insignificant at P≤0.05 when associated with the standard product. Among all the products, 10% *FRL* incorporated Dal samose*;* Variant *B* (8.46±0.70) and 5% *FRB* incorporated Bati*;* Variant *C* (8.2±0.84) was most acceptable and had no significant difference (P≤0.05). Whereas Dal samose and Bati made from incorporation of other variant (D, E, and F) had significant difference at p≤0.05 level. It can be visualized from Figure1 that there is significantly decrease in the overall acceptability of all the products while moving from standard to variant A, B, C followed by variant D, E and than variant F.

Table (2) Clinical profile of the subjects.

Gender	Age	Height(cm)	Weight (kg)	BMI Wt (kg) /Ht(m)^2
Female	24-32	157.62±4.14	55.36±4.72	22.30±1.98

Participants completed demographic profile regarding age, date of birth, weight, height, carbohydrate metabolism deficiencies, smoking habits, carbohydrate source, physical activity, and medical history. The average age range was 24-32 year and mean BMI among participants were 23.30 ± 1.98 kg/m^2 which is considered as normal healthy BMI.

Table (3 A) Incremental Area Under Curve (IAUC), Glycemic Index (GI) and Glycemic Load (GL) For Food Products.

IAUC(mmol/L) Glucose (Control)	IAUC(mmol/L) Dal samose (10% *F. religiosa* leaves)	GI	GL	IAUC(mmol/L) Bati (5% *F. religiosa* bark)	GI	GL
242.25±0.20	85.74±0.30^a (64.60%↓)	35	13	129.89±0.20^{ns} (46.42%↓)	53	20

Units for IAUC values are mmol.min/L. Values are mean±SD, n= 5, Percentage ↓ in parenthesis.
[a] values are significantly different at P≤0.05 when test products compared with the control (Glucose).

Table (3 B) Incremental Area Under Curve, Glycemic Index and Glycemic Load of test Food products corresponding to standard products.

IAUC(mmol/L) Dal samose (standard)	IAUC(mmol/L) Dal samose (10% *F. religiosa* leaves)	GI	GL	IAUC(mmol/L) Bati (standard)	IAUC(mmol/L) Bati (5% *F. religiosa* bark)	GI	GL
195.62±0.17	85.74±0.30[a] (56.17%↓)	41	15	198 .4 ±0.23	129.89±0.20[ns] (34.53%↓)	58	22

Units for IAUC values are mmol.min/L. Values are mean±SD, n= 5, Percentage ↓ in parenthesis.
[a] values are significantly different at P≤0.05 when test products compared with standard group.

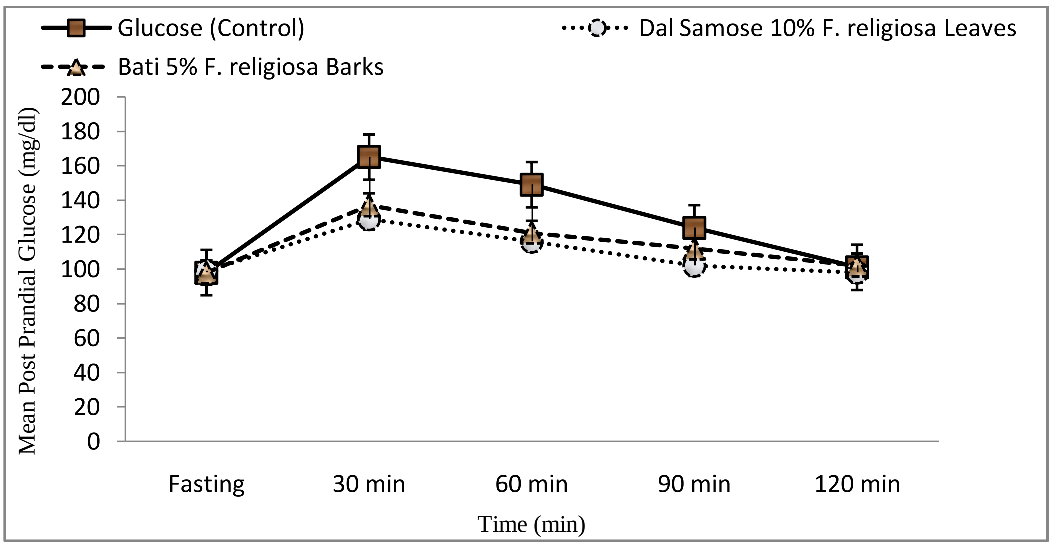
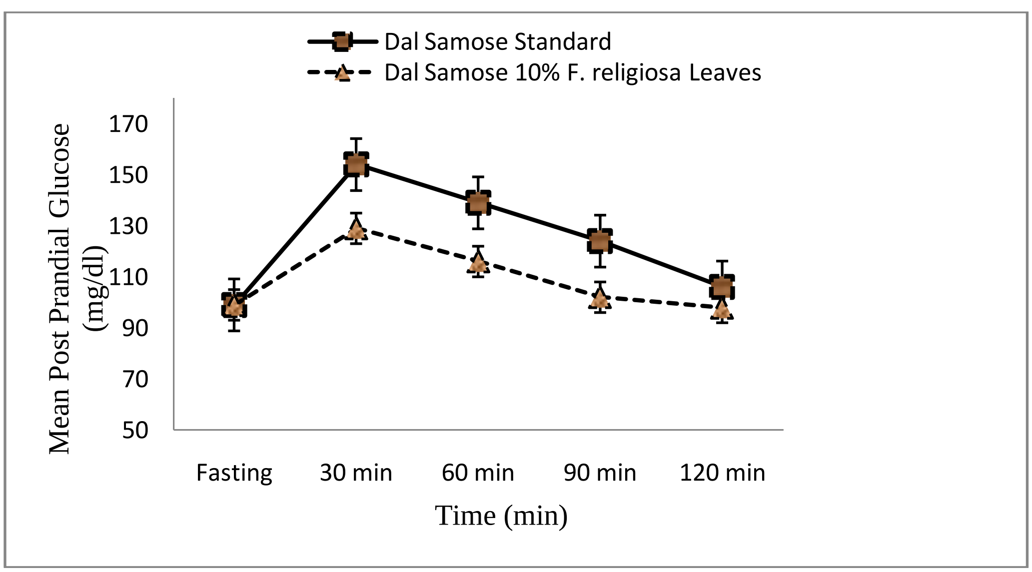


Figure (2) Mean post prandial glucose response curve in healthy normal subjects after oral administration for Glucose (Control), Dal samose (10% *F. religiosa* leaves) and Bati 5% *F. religiosa* bark).

3



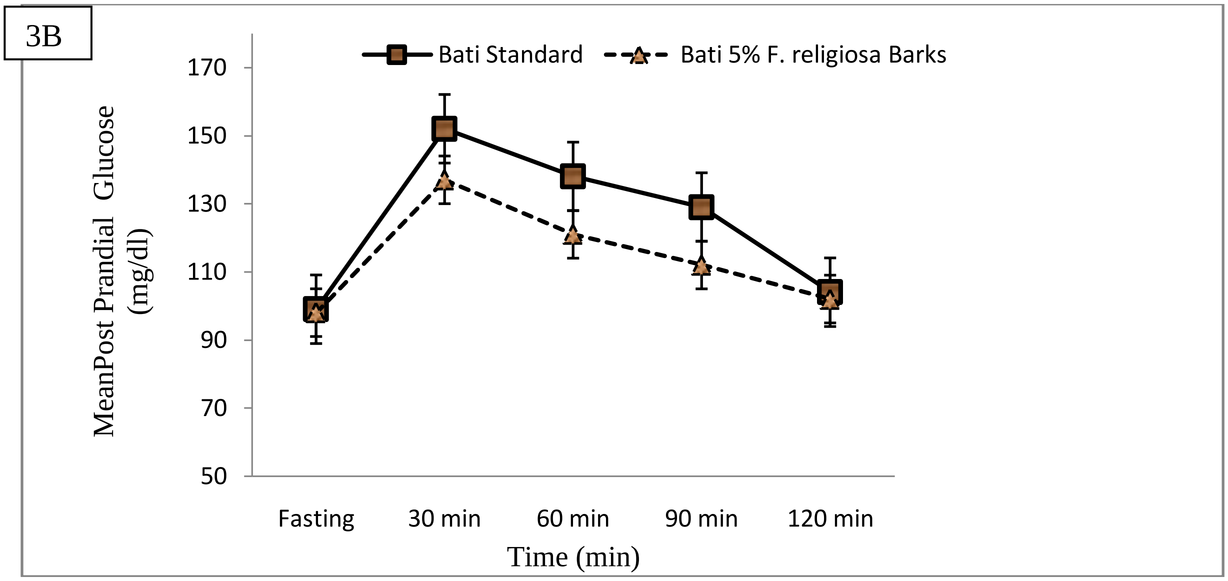


Figure (3A) and (3B) Mean post prandial glucose response curve comparing Dal samose (10% *F. religiosa* leaves) and Bati 5% *F. religiosa* bark) with respective standard Products.

Multitude of empirical investigations has proved that different carbohydrates exert different effects of glucose absorption and metabolism. Absorption pattern of carbohydrate is reflected by difference in glycemic response. Glycemic index of a food is considered a useful indicator for its suitability in diabetic diet and is helpful in lowering the fat and increasing the fiber content of the diet (Frost, *et al.*, 1994).

Twenty five normal subjects recruited and completed glycemic response testing. Five subjects dropped out because of time commitment restrictions. Comparisons of postprandial glucose responses for test recipes i.e. Dal Samose10% FRL and Bati 5% FRB with control (50 g glucose powder dissolve in 200ml water) are summarized in Figure 2. Postprandial glucose responses comparing Standard products to corresponding test food products (Dal Samose and Bati) are depicted in figure 3A and 3 B. Results show IAUC values for product 10% *FRL* incorporated Dal Samose were 85.74±0.30 mmol/L (64.60%) lower when compared to IAUC value for glucose 242.25±0.20mmol/L. Conversely, IAUC for Bati 5% bark incorporated was129.89±0.20 mmol/L (46.42%) lower than control .The GI and GL values were found to be lesser in 10% FRL incorporated Dal Samose (35 and 13) compared to 5% FRB incorporated Bati as shown in table.3A. Similarly, IAUC for Dal samose; 10 % *FRL* (195.62±0.17) and Bati 5% FRB (198 .4 ±0.23) was 56.17% and 34.53% significantly lower at $P \leq 0.05$ than their respective standard products respectively shown in table 3 B. Calculated GI and GL value of the test Dal samose (41and 15) and Bati (58 and 22) determined from the incremental area under the glucose response curve from their respective standard products (WF).

The overall results obtained in the present investigation provides supportive scientific evidence in favor of the view that *Ficus religiosa* (leaves and bark) powder based food products posses significant lowering effect in glucose level and therefore shows low glycemic index and load. The study results showed that even at a constant amount of available carbohydrate in the test foods (50 g available carbohydrate), there was a significant variation in the GI, confirming that equi-carbohydrate portions of different foods may not necessarily have the same glycemic effect in human subjects (Wolever, *et al.*, 1994). The blood glucose response may be influenced by insulin responses in the presence of protein (Gannon, *et al.*, 1988), and differences in the rates of digestion and absorption influenced by the presence of dietary fibre, fat, anti-nutrients, and starch structure (Wursch, *et al.*, 2002 and Wolever, 1990). The protein content of the test foods fed to the subjects ranged from 3-8 g. Therefore, the Dal Samose; 10% FRL may have some effect on the variability of GI and GL when compared to the Bati; 5% FRB. Protein in the diet has been shown to stimulate insulin secretion, thereby, lowering the postprandial glucose concentration (Spiller, *et al.*, 1987).

The following cut-off limits between low, middle and high GI have been proposed: <55 % (low), 55-70 % (medium), > 70 % (high) (Brand Miller, *et al.*, 2003). Consumption of high GI diet have been associated with hyperinsulinemia, While low GI dies have been shown to associated with lower post prandial rise in insulin. Glycemic load is the product of the GI and the amount of available carbohydrate. The result combines quality and quantity factors of carbohydrate in a food. There is a scale to classify glycemic load(GL) similar to that of GI that are Low≤10, medium 11-19 and ≥20 (Foster Powell, *et al.*, 2002).

Thus maintaining insulin sensitivity (Ludwig, 2002).The present study demonstrated that low GI and acceptable food products prepared from *F. religiosa* leaves and bark powder used as effective supportive therapy in the treatment of diabetes mellitus.

CONCLUSION

Ficus religiosa leaves and bark can be used as a functional ingredient to produce low glycemic food products with favorable sensory characteristics. Results of the present study support the use of *Ficus religiosa* powder as a tool for healthy and nutritious products which had low glycemic index and medium glycemic load that help in prevention and management of Type II Diabetes. In view of various study on *Ficus religiosa,* more research work could be done on humans so that a plant with multifarious effects would be available in the future market. It is recommended that the plant extract of *Ficus* species can be successfully utilized for the cure of diabetes and related diseases due to their hypoglycemic action.

REFERENCES

1. Almeida, S.B., Aparecida, M., and Da Silva, A.P. (2002): Hedonic scale with reference: Performance in obtaining predictive models. Food Quality and Perferences, 13: 57-64.
2. Arayne, MS., Sultana, N., Mirza, AZ., Zuben, MH., and Siddiqui, F.A. (2007): In vitro hypoglycemic activity of methanolic extract of some indigenous plants. Pakistan Journal of Pharmaceutical Sciences, 20: 261-268.
3. Brand-Miller, J., Petocz, P., Hayne, S., and Colagiuri, S. (2003): Low glycemic index diet in the management of diabetes. Diabetes Care,26: 2261-2267.
4. Brouns, F., Bjorck, I., Frayn, K.N., Gibbs, A.L., Lang, V., Slama, G., and Wolever, T.M.S. (2005): Glycaemic index methodology. Nutrition Research Review, 18:145-171.
5. Desai, A. D., Kulkarni, S. S., Sahoo, A. K., Ranveer, R. C. and Dandge, P. B. (2010): Effect of supplementation of malted ragi flour on the nutritional and sensorial quality characteristics of cake. Advance Journal of Food Science and Technology, 2: 67-71.
6. Donga J.J., Surani V.S., Sailor G.U., Chauhan S.P., Seth A.K. (2011): A Systematic review on natural medicine used for therapy of diabetes mellitus of some Indian medicinal plants**.** International Journal of Pharmaceutical Sciences, 2:36-72.
7. Foster-Powell, K., Holt, S.H.A., and Miller, J.C. (2002): International table of glycemic index and glycemic load values. The American Journal of Clinical Nutrition, 76:5-56.
8. Frost, G., Wilding, J., and Beecham, J. (1994): Dietary advice based on the glycaemic index improves dietary profile and metabolic control in type 2 diabetic patients. Diabetic Medicine, 11:397-401.
9. Gannon, M.C., Nuttsll, F.Q., Saeed, A., Jordan, K., and Heidi, H., (2003): An Increase in dietary protein in improves the blood glucose response in persons with type2 diabetes. The American Journal of Clinical Nutrition, 78:734-741.
10. Hassan, A.K.M., Afroz, F., Jahan, M., and Khatun, R. (2009): In *vitro* regeneration through apical and axillary shoot proliferation of *Ficus religiosa L*.- a multipurpose woody medicinal plant. Plant Tissue Culture & Biotechnology, 19:71-78.
11. Henson, S., Masakure, O., and Cranfield, J. (2008): The propensity for consumers to offset health risks through the use of functional foods and nutraceuticals: The case of lycopene. Food Quality and Preference, 19:395-406.
12. Jenkins, D.J.A., Ghafari, H., and Wolever, T.M.S. (1982): Relationship between the rate of digestion of foods and postprandial glycemia. Diabetologia, 22: 450-455.
13. Jenkins, D.J.A., Wolever, T.M.S., Taylor, R.H., Barker, H., Fielden, H., Baldwin, J.M., Bowling, A.C., Newman, H.C., Jenkins, A.L., and Goff, D.V. (1981). Glycemic index of foods: a physiologic basis for carbohydrate exchange. The American Journal of Clinical Nutrition., 34:362–366.
14. Mente, A., Koning, L., Shannon, H.S., and Anand, S.S. (2009): A systematic review of the evidence supporting a causal link between dietary factors and coronary heart disease. Archives of Internal Medicine, 169:659-669.
15. Nilsson, C., Ursing, D., and Torn, C. (2007). Presence of GAD Antibodies During Gestational Diabetes Mellitus Predicts Type 1 Diabetes. Diabetes Care, 30:1968-1971.
16. Queiroz, K.C., Novato Silva, I., de., Cássia Gonçalves Alfenas, R., (2012): Influence of the glycemic index and glycemic load of the diet in the glycemic control of diabetic children and teenagers. Nutricion Hospitalaria, 27: 510-515.

17. Sharma, S., Chaturvedi, M., Edwin, E., Shukla, S., and Sagrawat, H. (2007): Evaluation of the phytochemicals and antidiabetic activity of *Ficus bengalensis*. International Journal of Diabetes in Developing Countries, 27:56-59.
18. Spiller, G.A., Jensen, C.D., Pattison, T.S., Chuck, C.S., Whittam, J.H., and Scala, J. (1987): Effect of protein dose on serum glucose and insulin response to sugar.The American Journal of Clinical Nutrition, 46: 474-480.
19. Villegas, R., Liu, S., Gao, Y.T., Yang, G., Li, H., Zheng, W., and Shu, X.O. (2007): Prospective study of dietary Carbohydrates, glycemic Index, glycemic Load, and incidence of Type 2 Diabetes Mellitus in middle-aged chinese women. Archives of Internal Medicine, 167:2310-2316.
20. Wangkheirakpam, S.D., and Laitonjam, W.S., (2012): Comparative study of leaves of *Ficus pomifera*, *Ficus hispida* and *Ficus religiosa* for biochemical contents, minerals and trace elements. Indian Journal of Natural Products and Resources, 3:184-188.
21. Wannamethee, S.G., Shaper, A.G., Perry, I.J., and Alberti, K.G. (2002): Alcohol consumption and the incidence of type II diabetes. **Journal of Epidemiology and** Community Health, 56: 542–48.
22. Wei, M., Gibbons, L.W., Mitchell, T.L., Kampert, J.B., and Blair, S.N. (2000): Alcohol intake and incidence of type 2 diabetes in men. Diabetes Care, 23: 18–22.
23. Wolever, T.M., Jenkins, D.J., & Jenkins, A.L. (1991). The glycemic index: methodology and clinical implication. The American Journal of Clinical Nutrition, 54: 846-854.
24. Wolever, T.M.S. (1990). The glycemic index. World Review of Nutrition Dietetics, 62, 120–185.
25. Wolever, T.M.S., Jenkins, D.J.A., Jenkins, A.L., and Josse, R.G. (1994): The glycemic index: methodology and clinical implications. The American Journal of Clinical Nutrition, 54:846-854.
26. Wolever, T.M.S., Vorster, H.H., Bjo¨rck, I., Brand-Miller, J., Brighenti, F., Mann, J.I., Ramdath, D.D., Granfeldt, Y., Holt, S., Perry, T.L., Venter, C., and Xiaomei Wu. (2003): Determination of the glycaemic index of foods: inter laboratory study. European Journal of Clinical Nutrition, 57:475–482.
27. Wursch P., Pi-Sunyer, and F.X., (2002): The role of viscous soluble fiber in the metabolic control of diabetes: a review with special emphasis on cereals rich in beta-glucan Diabetes Care, 20:1774–1780.