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Development of pulse based product for diabetics and evaluation of its glycemic index

Radha Banka*, Bhawana Sharma[1] and Shilpi Sharma

Department of Foods and Nutrition,
Mahatma Jyoti Rao Phule University, Jaipur-302 004, Rajasthan, India.
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ABSTRACT

Conventional treatment of diabetes mellitus occurs through diet, insulin and oral hypoglycaemic drugs. Glycemic index is a major indicator of potential glucose lowering of various food products. The present study was conducted with the objective of developing mix and its low energy dense product *i.e.* modified vada using black gram, green gram, soybean and guar gum. Four vada mixes were formulated using different ratios of black gram, green gram, soybean *i.e.* 1:1:1; 2:1:1; 1:2:1; 1:1:2 respectively and 5per cent guar gum was added in each vada mix. Instead of deep fat frying baking was used for development of product. Vada were developed and sensory evaluation was done using nine point hedonic scale for determining the overall acceptability of the vada. Among the four types of vada, vada made with mix 1 had the highest acceptability mean score 8.3 and liked very much by 30 panel members. Best modified vada had all sensory attributes in between 7.3 to 8.3 and liked very much. Only best modified vada evaluated for nutrient composition which contained 30.10±0.05% moisture, 1.4±0.05% ash, 16.80±.02% protein, 2.0±00.02% fat, 3.3±0.05% fiber, 46.40±0.88% carbohydrate, and 270.0±0.45 Kcal/100g energy. It is also evaluated for suitability for diabetic patient by assessing the glycemic index. Therefore 10 healthy female were selected. All the subjects provided 25 gm of carbohydrates .The glycemic index of test vada and standard vada was 20.71mg/dl and 82.70mg/dl respectively. Glycemic index value for modified vada was lower than standard vada. Therefore it is good for diabetic patient.

Key words: Diabetes, Glycemic index, Modified vada, Standard vada.

INTRODUCTION

Diabetes mellitus is affecting human societies at all stages of development. As the world health organization (WHO) points out that numbers of cases has been taken increasing rapidly with the aging population due to change in the life style and decreased physical activity . This complex condition of mutifactorial origin is considered to be scourge of modern affluent societies, both in developed and developing countries (Nalwade *et al.*, 2003). A hormone produce by â cells of pancreas that is necessary for the use of storage of body fuels without effective insulin hyperglycemia occurs which can lead to both the short term and long term complication of diabetes (Franz, 2002).

The treatment with pharmacological agent may lead to micro vascular and neurological complication. Insulin has also been reported to increase cholesterol synthesis and secretion of very low density lipoprotein (Naik and Subbulakasmi, 2003). According to diabetic diet principle, enough calories to be provided for maintaining ideal body weight , complex carbohydrate diet , high in protein for supplying amino acids for tissue repairs and fat providing 20 per cent calories should be consumed since they cannot be oxidized as readily carbohydrate (Jenkins, 1999). Since the diet remains the corner stone for diabetic patients especially non insulin dependent diabetes mellitus, glycemic index is a concept that ranks food on the basis of their acute glycemic impart.

The glycemic index (GI) is a component referenced index defined as the effect on blood glucose of glycemic carbohydrate in a food as a percentage of the effect of an equal amount of glucose (Monro, 2003). The glycemic index of food is a scale used to classify quality of carbohydrate consumed and rank carbohydrate according to its potential to increasing the blood glucose level (Davis *et al.*, 2004). Among five food groups system legumes intake reduce the risk of diabetes, in the same way it protects against obesity because legumes are high in fibre, low in fat and have low glycemic response. Beans particularly are slowly digested and have low glycemic and insulin response. The glycemic response of different legumes like chick peas, pigeon peas, black beans, moong bean, white bean and soybean have a low glycemic effect (Thomson *et al.*, 1999). Therefore in this study pulses with low GI values were selected to developed low energy dense food product.

METHODS AND MATERIALS

This study was conducted to develop a pulse based product for diabetics and evaluated for its organoleptic and nutritional qualities. Study was conducted in the three phases.

*Corresponding author's e-mail and address: bankaradha123@yahoo.co.in.
[1] Department of Foods and Nutrition, Maharana Pratap University of Agriculture and Technology,Udaipur-313 001, Rajasthan

In phase I a pulse based product was selected, standardized for its acceptability and was evaluated for its nutritional quality. A list of commonly consumed pulse based food products rich in energy content was prepared *i.e*. bhujia, dahivada, kachori, masala butter chakali, pakodi, fried papad and gathiya. Recipes of these products were taken from the book of khanna *et al*., (1998) and these products were scrutinized in laboratory, evaluated for suitability in diabetic diet, possibility of necessary modification, organoleptic characteristics and portion size before selection. Energy densities of recipes were calculated using food composition tables (Gopalan *et al*., 1995). Further three products were selected and prepared in view of their organoleptic characteristics and possibility of modification in energy density. The selected preparations were dahi vada, kachori, and bhujia as three recipes contain highest amount of energy. Among these products dahi vada was selected as modification in energy density was maximum possible in it. Standard dahi vada (*Phaselus mungo roxb and green gram phaseolus*, 3:1) was evaluated for its sensory characteristics (appearance, colour, flavor, texture, taste, and overall acceptability) by panel members using 9 point hedonic scale .The panel members were selected on the basis of threshold test as suggested by potter quoted by Swaminathan (1987).

In phase II modification of product for its energy density was done by change in type and quality of ingredients, technique of preparation and method of cooking. Potent hypoglycemic agents *i.e*. black gram *(Phaselus mungo roxb)*, soybean *(glycine max)*, green gram (G*reen gram phaseolus*) and guar gum *(Cyamopsis tetragonalobus) were* chosen to develop modified dahi vada for diabetics. Commonly dahi vada is prepared by black gram and green gram in ratio of 3:1 however for modified vada different ratio (Table1) of selected pulses were tried. And 5 per cent of guar gum was added in all four mixes.

Green gram, black gram, and soybean seeds were soaked separately for 12 hours at 37°C and allowed germinating for 48 hours at same temperature. Separately all the pulses were ground in to the grinder and make a paste. All the separate pastes were mixed and air was incorporated in to the paste by continuously whisking it in circular motion to make it light and fluffy and added a pinch of salt. Domestic oven toaster grill (OTG) was used for baking. Oven was pre-heated for 5minutes at 200°C. Tray was greased lightly and batter was poured with the help of a scoop. It was kept inside the oven for 15 minutes. A toothpick was inserted to check if it is cooked. Vadas were taken out from the oven after 15 minutes and allowed them to cool. Thus four types of vada were made by this procedure.

Both standard vada and best modified vada were analyzed for its nutrient composition *i.e*. moisture, total ash, crude fiber, carbohydrate, fat, and minerals (iron, calcium, phosphorous, and zinc). Minerals were estimated by using atomic absorption spectrophotometer. The analysis of products was done in triplicate using AOAC (1995) standardized procedures.

In phase III evaluation of hypoglycaemic response of the developed low energy dense product was done. The glycemic response of modified low energy dense vada was studied in 10 healthy subjects. The general information about the selected subjects like name, age, educational qualification, address and nutritional status was gathered through a questionnaire. In the present study all the subjects were between the age group 20-25 years. The mean age of subjects was 19 ± 0.24 years and the weight of selected subjects was measured using plate form spring balance and it was noted that the mean weight of the subjects was 53.5± 0.97kg. The mean height of the study group was 1.58± 1.01m with a BMI was 21.38± 0.46kg/m² revealed that the group was in normal category as the WHO, (2001) categories suggested for Body mass index. All the subjects did not suffer from any disease and meal pattern of the subjects was shown that 60 percent of subjects had three meals in a day, which included breakfast, lunch, and dinner, where as remaining 20 percent had two meals only included breakfast and dinner.

The glycemic index of developed food product was determined for 3 consecutive days by glucose tolerance test (GTT). Subjects who were willing to participate and free from any disease had scientific view were selected. Each vada weigh 25g, so for the ease of comparison, same amount of glucose was administered in test subjects. Glucose tolerance test was conducted on overnight fasted subjects; on the first day 25 gm of glucose was given to the subjects and asked not to perform any physical exertion. In second and third day same over night fasted subjects were given the standard and modified vada respectively. The blood glucose levels were measured after 0, 30, 60, 90 and 120 minutes with the help of glucometer (EZ smart diabetes monitoring system ce0537). Then the area of graph was calculated using the formula given by Jenkins *et al.,* (1981).

The data were statistically analyzed as per the study. The mean, standard deviation and standard error values were calculated for sensory scores of the developed product. ANOVA tables were also used for the interpretation of the result.

RESULTS AND DISSCUSSION

Selection, Standardization and acceptability of standard vada and modified vada: Pulses contain most of essential amino acids and most of the people used pulses to make different products in all parts of the country. Pulses and legumes are used in the daily diet in India. Vada is used as a side dish with meal but the vada is a deep fried product and diabetics cannot eat it because of high energy density and diabetics need to control the body weight .Therefore modification in energy density was done in fried vada's .

For the making of modified vada four types of mixes were prepared and from these, 4 vada's were developed by baking method and analyzed their sensory attributes through 9 point hedonic scale by a panel of 30 judges. Mix -1 had the highest score *i.e*. 8.3 revealed that it was liked very much (Table 1). However rest three made from mixes 2, 3, and 4 were also acceptable and mean score was 7.8, 6.9, 5.6 respectively and significant difference (P<0.05) was observed among these vada's.

TABLE-1 overall acceptability score for organoleptic characteristics of all four modified vada

Samples	Green gram	Black gram	Soybean	Overall Acceptability Score	Inference
Mix-1	1	1	1	8.3	Liked very much
Mix-2	2	1	1	7.8	Liked very much
Mix-3	1	2	1	6.9	Liked moderately
Mix-4	1	1	2	5.6	Liked slightly

Selected preparation *i.e*. standard vada and modified vada were standardized in the laboratory for their protion size, cooking characteristics and organoleptic characteristics. Standard vada and all four modified vada were served to group of selected panel members for the sensory evaluation. Organoleptic evaluation was done by using nine point hedonic scale for all sensory attributes. The mean score of standard vada for all attributes like appearance was 8.3 ± 0.76, colour 8.1 ± 0.95, taste 7.3 ±1.14, texture 8.0 ± 1.02, flavor 8.3 ± 0.93 and overall acceptability 7.8 ± 1.16 (Table 2). The results were on positive side and the vada was liked very much in terms of all attributes. Modified vada-1obtained mean score for appearance 7.8 ± 0.06, colour 7.4 ± 0.08, taste 7.8 ± 0.22, flavor 7.1 ± 0.19, texture 7.3 ± 0.25, and overall acceptability 8.3 ± 0.25 revealed that it was also liked very much by the panelist. Modified vada1 had highest acceptability score then modified vada-2, 3, 4. Thus modified vada-1 was considered as final modified product.

Nutritive value of the standard and modified vada: Nutrient evaluation is one of the most important aspects of any product development study. In present study the developed mix was assessed for its proximate composition and minerals using the standardized techniques of AOAC (1995). The moisture content of standard and modified vada was 19.63 ± 0.88 and 30.10 ± 0.05 percent respectively and significant difference (P< 0.05) was observed. Amount of moisture content is similar to the designed low glycaemic food for diabetics by Mundra *et al*., (2010).

The mean value for total ash content for standard, modified vada was 0.78 ± 0.22 and 1.4 ± 0.05 percent respectively. There was significant difference (P<0.01) observed in ash content because in modified vada the whole pulses were used rather then splitted. The mean values of protein content of standard vada was 10.43 ± 0.05per cent however for modified vada it was 16.8 ± 0.02 and significant difference was observed (P<0.05), may due to high protein content of soybean used in the development of modified vada. Protein value of modified vada was similar to the pulse based noodles developed by Surekha *et al*., (2013)

The mean value for crude fat was 20.00 ± 0.01 per cent for standard vada, while modified vada contain 2.00 ± 0.22 per cent of fat and significant difference (P<0.05) was found. The difference in fat content was due to the difference in method of cooking. Standard vada was prepared by traditional cooking method *i.e*. deep fat frying while modified vada was baked. Mundra *et al*., (2010) also developed food products for diabetic which contain similar amount of fat.

The fibre content of any food decreases the glycemic index of that particular food and delays the gastric emptying. Crude fibre in standard vada was 0.2 ± 0.001per cent however modified vada contain 3.3 ± 0.05per cent by the consequences of using whole pulses and significant difference (P<0.05) was found. Mundra *et al*., (2010) designed a low glycaemic food for diabetics and also reported 1.31g/100g of fibre in it.

The mean value of carbohydrate in standard vada was 43.85 ± 0.04 per cent while the modified vada contain 46.40 ± 0.01 per cent and no significant difference (P<0.01) was found in carbohydrate content of both the vada's . The mean value of energy content of standard vada was 413 ± 0.46 Kcal/100g and for modified vada 270.8 ±0.04 Kcal/100g and the significant difference was found (P<0.05)

TABLE-2 Mean+ SE score for organoleptic characteristics of standard and modified vada

Characteristics	Standard Vada	Modified Vada-1	Modified Vada-2	Modified Vada-3	Modified Vada-4
Appearance	8.3±0.16	7.8±0.06	6.5±0.09	6.2±0.95	5.7±1.02
Colour	8.1±0.95	7.4±0.08	7.3±0.08	6.4±0.87	4.9±0.95
Taste	7.8±1.14	7.8±0.22	7.2±0.95	6.1±0.93	5.2±1.93
Flavour	8.3±0.93	7.1±0.19	7.0±0.78	6.5±0.95	5.9±0.93
Texture	8.00±1.02	7.3±0.25	7.2±0.38	6.3±1.02	5.9±1.02
Overall acceptability	7.8±1.16	8.3±0.23	7.8±0.25	6.9±0.25	5.6±0.95
Mean score	8.05±0.99	7.6±0.17	7.1±0.42	6.4±0.78	5.53±1.13

in energy content of both the vada's. Calorific value of modified vada is supported by calories of vada given in NIN manual for Dietary Guideline (2011). Mundra *et al*., (2010) also developed chapattis for diabetic which contain similar amount of calories.

The mineral content of both the vada's was also estimated as it is an important factor which is effective in controlling diabetes. Mineral content of developed product assessed using the atomic absorption spectrophotometer. The phosphorous content of standard and modified vada was 335 ± 0.25mg, 613 ± 0.35 , Calcium 319 ± 0.01, 217 ± 0.93, Zinc 3.8 ± 0.08 , 3.2 ± 0.10, Iron 3.2 ± 0.05 , 4.8 ± 0.88 and significant difference was observed which shown in Table 3.

TABLE 3- Nutritional composition of standard and modified low energy dense

	(I) Proximate composition (%)		
Nutrients	Standard	Modified	T value
Moisture**	19.63 ± 0.88	30.10 ± 0.05	13.55
Total Ash**	0.78 ±0.02	1.4 ±0.05	12.4
Crude Protein**	10.43 ± 0.05	16.8 ± 0.02	7.8
Crude Fibre**	0.2 ± 0.001	3.3 ± 0.88	818.18
Crude Fat**	20.00 ±0.01	2.00 ±0.22	124.00
Carbohydrate	43.85 ±0.04	46.40 ±0.01	2.89
Physiological ** Energy	413.0 ± 0.46	270.8 ± 0.04	194.94
	(II) Minerals (mg/ 100 g)		
Phosphorous**	335± 0.25	613± 0.35	646.51
Calcium**	319± 0.01	217±0.93	109.67
Zinc**	3.8±0.08	3.2±0.10	4.38
Iron*	3.2±0.05	4.8±0.88	1.81

Glycemic index and glycemic response of developed product: The glycemic index of food is a scale used to classify the quality of carbohydrate consumed and ranks carbohydrate according to its potential to increase in the blood glucose level. Glycemic index may play a role in preventing the risk for obesity and metabolic diseases. Glycemic index is based on the area under glucose response curve after a standard amount of carbohydrate is given compared with the area under the curve after consumption of a control food. Thus it reflects post prandial glucose and it concentration (Davis *et al.*, 2004) .The glycemic index of vada were evaluated on 10 normal healthy adult females. Glycemic index was determined by glucose tolerance test with the help of glucometer. Twenty five gram carbohydrate was supplied in the form of glucose, standard vada and modified vada (Test vada) to overnight fasted subjects in three subsequent days. The blood glucose was measured at 0, 30, 60, 90, and 120 minutes. The mean blood glucose level in normal subjects reached to a peak value of 102.8 mg/dl, after 30 minutes of the consumption of the test vada. A sharp decline was observed thereafter till 120 minutes. The value of glycemic index for modified vada (Test vada) was for was 20.71 , quiet low in comparison to standard vada(control; GI 82.70).The value for under blood glucose curve for mix 1 modified vada and control vada were found to be 737.154 and 3785.25 respectively. The mean blood glucose response of normal subjects to the food product *i.e.* standard vada in comparison to glucose and control vada is depicted in fig1.

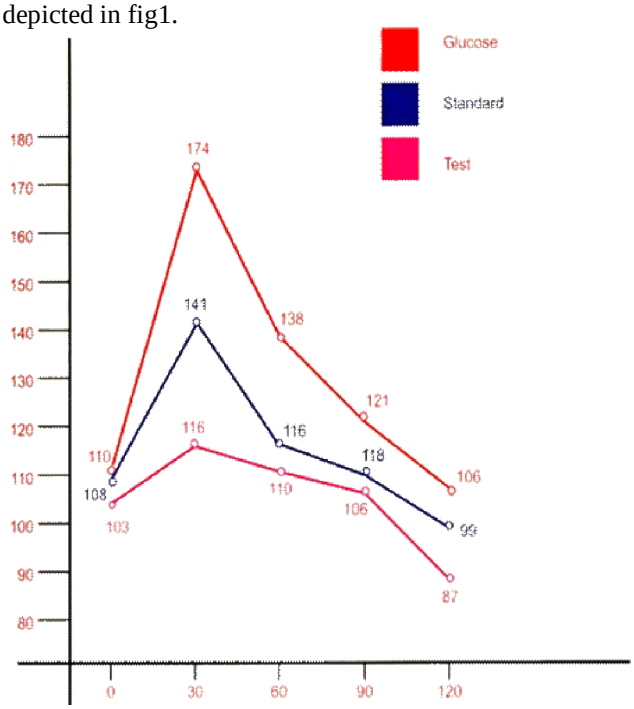

FIG 1: Glucose Tolerance Curve for Glucose, Standard & Modified Vada

Similarly Fatima and Kapoor (2003) compared glycemic index value of bean starches, wheat starches it showed that average glycemic index values were 30.69 ± 2.28 for double bean, 31.6 ± 1.8 for field bean and 54.63 ± 3.54 for moong bean while 98.2 ± 9.01 for wheat starch and had beneficial for diabetics. The present investigation revealed that food stuff incorporated in the present study had shown hypoglycaemic effect. Hence a combination of above food stuffs in the form of food products for low glycemic index values may be the reason the hypoglycemic effect of these products and there by their therapeutic value in diabetic diet. The slight higher glycemic index value for standard vada could be attributed to different method of preparation of product and type and amount of ingredients. The results were interesting and need to be confirmed on large number of diabetic subjects.

CONCLUSION

Diabetic subject definitely benefit from pulses based product and it helps in controlling glucose control. The perusal of data clearly indicates that the low glycemic pulses and modification of cooking is an effective measurer to bring favorable and significant improvement in diabetic state as compared to high energy product.

REFRENCES

AOAC (1995). Official Methods of Analysis of AOAC International" 16th edition Arlington, VA-USA, Association of Analytical commission, volume 2.

Davis, M.S., Miller, C.K. and Mitchell, D.C. (2004). More favourable dietary patterns are associated with lower glycemic load in older adults. *J. Am. Diet. Assoc*., **104:**1828-1835.

Dietary Guidelines for Indians- A Manual. (2011). Retrieved from http://ninindia.org/DietaryGuidelinesforNINwebsite.pdf Accessed: 20.6.2015.

Fatima, S. and Kapoor, R. (2003). In vitro and in vivo glycemic effect of starch from beans.In proceedings of IX Asian Congress of Nutrition: Nutrition goals for Asian Vision- 2020, Feb 23-27, New Delhi. P. 310.

Franz, M., Bantle, J.P. , Beebe, C.A., Brunzell, J.D., Chiasson, J.L., Garg, A., Holzmeister, L.A., Hoogwerf, B., Mayer-Davis, E., Mooradian, A.D., Purnell, J.Q. ; Wheeler, M. (2002). Evidence based nutrition principles and recommendations for the treatment and prevention of diabetes and related complications. *Diabetes Care*, 25:148-198. ISSN: 0149-5992.

Gopalan, C., Ramasastry, B.V. and Balasubramanian, S.C. (1995). Nutritive value of Indian foods. National Institute of Nutrition, Hyderabad. p. 47-58.

Jenkins, D.J.A. (1999). Low glycemic response to traditionally processed wheat and millet products. *Am. J. Clin. Nutrition*, **43:**516-520.

Jenkins, D.J.A., Wolever, T.M.S., Taylor, H., Barker, H.M., Field, M., Baldwin, J.M., Bowling, A.C., Newman, H.C., Kenkins, A.C. and Golf., B.V. (1981). Glycemic index of foods: A physiological basis for carbohydrate exchange. *Clin. Nutrition*, **34:** 362-366.

Khanna, K., Gupta, S., Seth, R., Mahna, R. and Rekh, T. (1998). The Art and Science of Cooking: A Practical Manual. 4th ed. Phoenix Publishing House Pvt. Ltd, New Delhi.

Monro, J.A. (2003). Available carbohydrate and glycaemic index combined in new data set for managingglycaemai and diabetics.Food Composition Analysis **12:**71-82.

Mundra A., Yenagi, N.B. and Kasturiba, B. (2010). Designing of low glycaemic chapatti of dicoccum wheat for the effective management of diabetes. *Karnataka J. Agric. Sci.*, **23:** 476-479.

Naik, M. and Subbulakshmi, G. (2003). Indigenous food in the treatment of diabetes mellitus. *Ind. J. Nutr. Dietetics*, 38:24-26.

Nalwade, V.M., Reddy, S.N., Bhosale, B.S. and Swami, V.D. (2003). Glycemic index of commonly consumed Indian foods. Indian *J. Nutr. Dietetics*, **40:**341.

Surekha, N., Devi, R. and Naik, R.S. (2013). Development of Value Added Low Glycemic Index Barnyard Millet Noodles. *International Journal of Food and Nutritional Sciences*, **2:** 20-24.

Swaminathan, M. (1987) Food Science, Chemistry and Experimental Food. The Bangalore Printing and Publishing Co. Ltd, Bangalore, P.135.

Thomson, R.G., Hayford, J.T., Danny, M.M., Glucose and insulin responses to diet, effect of variations in sources and amount of carbohydrates. 1999. *Diabetes Care*, **27:**1020-1026.

World Health Organization (WHO) (2001). Obesity preventing and managing the global epidemic, WHO expert committee. World Health Organization. *Technical Report Series* **893:**253.