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ACCEPTABILITY AND GLYCEMIC RESPONSE EVALUATION OF CEREAL-LEGUME BASED TRADITIONAL SWEET PREPARATION INCORPORATED WITH ASHWAGANDHA *(WITHANIA SOMNIFERA)* FOR SUITABILITY IN DIABETES

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ABSTRACT The present study was undertaken to evaluate the acceptability and glycemic response of cereal legume based sweet balls (*laddo*) incorporated with ashwagandha (*Withania somnifera*) root powder along with its control. Two types of sweet balls were prepared. The control product termed as BSW contained 30 % barley, 30% low fat soy flour, 40 % wheat flour. The test product, BSWA contained 5% of ashwagandha root powder in the same cereal legume of blend. Both the products were found to be acceptable. A significant difference was found in the IUAC of the BSW and BSWA sweet balls (P = 0.01). The GI of BSW and BSWA was 46.21 and 44.90 respectively, which fell in the low GI category indicating suitability of inclusion both sweet balls in diabetic diet. Addition of ashwagandha in BSWA had no adverse effect on glycemic response and it reduced the GI further. Therefore, it can be concluded that traditional sweets can be redesigned by prudent combination of cereal and legumes to develop low GI sweets for diabetics. Incorporation with ashwagandha in the product may contribute to lower GI further and improving the nutritional value and health benefit.

KEYWORDS : ashwagandha ladoo, cereal legume based ladoo, diabetics, barley-soy sweet balls

INTRODUCTION

A multitude of investigations have demonstrated the beneficial effect of beta- glucan rich barley and soybean in diabetes (Casiraghi et al., 2013; Xiao, 2008; Yang et al., 2011). Ashwagandha (*Withania somnifera*) is considered one of the most important herb and best adaptogenic in the *Ayurvedic* and indigenous medical system. Ashwagandha and its extracts are used in herbal tea powders, tonics, chavanaprash, and tablets (Acharya and Shrivastava, 2008). It is safe for human consumption (Aphale A, 1998; Mishra 2000) besides being good source of nutrients (Kumari & Gupta, 2016).

Sweets are generally restricted in diabetes, but studies indicate that sucrose intake by diabetics in a controlled manner within a balanced diet do not have harmful effect on glycemic control (Manders et al., 2009; Montonen et al., 2007; Black et al., 2006; Lau et al., 2005). Traditionally sweet balls are made up of either cereal like wheat or with gram flour. The value addition of sweet balls with cereal-legume mix, containing barley, soybean and wheat can improve the nutritional composition in terms of protein and increase the fiber content. Incorporation of ashwagandha has an added advantage of providing health benefits due to, antioxidant (Panda & Kar, 1997), antistress (Bhattacharya, 2004), anti-inflammatory (Chandra et al., 2012) hypoglycemic and hypolipidaemic (Andallu & Radhika, 2000) effects. Low GI foods provide several health benefits, such as improving glycemic control, reducing blood triglycerides and blood pressure levels (Jarvi et al 1999) .Consumption of low GI foods is associated with improved carbohydrate metabolism in type 2 diabetes patients (Brand et al, 1991).There is very limited data on glycemic response of ashwagandha incorporated sweet preparations for evaluating suitability in diabetics. The present study was therefore, done to redesign the traditional sweet balls by judicious combination of barley, soybean, wheat and ashwagandha root powder and to evaluate their acceptability and glycemic response to cater to the needs of diabetics.

MATERIALS & METHODS

Raw material collection: Ashwagandha roots were obtained from Medicinal and Aromatic Plant Research and Development Centre, of G.B Pant University. The roots were washed, dried and then pulverized in an electric grinder. Low fat soy flour was obtained from S.P solvents, Rudrapur. All other ingredients for preparation of food products were purchased from the local market of Pantnagar.

Product Development: Two types of blends were prepared**.** In BSW (Control Sweet Balls Blend) 30% barley, 30% low fat soy flour and 40% wheat flour was used whereas in BSWA (Test Sweet Balls Blend) ashwagandha root powder at the level of 5% was added to the same blend. Rest of the ingredients jaggery (60%), ghee (5%), water (70%) were similar in both the sweet balls. For preparation of sweet balls an equal quantity of flour was taken from both the blends. To prepare the product, jaggery was dissolved in water and cooked to one thread consistency and to this 100 g of roasted flour blends were added. The balls were shaped in round shape by hand and packed in polythene bags.

Sensory evaluation of Sweet balls (ladoo)

The sweet balls were evaluated for sensory quality by a trained panel of 10 members. A 9 point hedonic scale (Belle Lowe, 1961) was used for this purpose. The judges were requested to taste the sweet balls and award a score with reference to a number of attributes viz. appearance, texture, colour, flavour and overall acceptability. This procedure was repeated two times. The similar scores obtained in both replications were considered acceptable.

Nutritional Composition Analysis

The nutritional analysis was carried out by AOAC (1996) method. Protein content was determined by Kjeldahl method and crude fat by Soxhlet method. Total carbohydrate content was calculated by difference (Southgate, 1991). Total dietary fiber (TDF) (Asp & Johansson, 1981). Available carbohydrate was calculated by total carbohydrate minus TDF. The nutrient composition mentioned is calculated in terms of carbohydrate portion containing 50 g glucose.

Glycemic response to sweet balls

Selection of samples

Ten healthy females aged between 23-26 years and body mass index ranging between 20.00-23.4 kg/m^2, with normal blood pressure, not suffering from any other ailment and food allergies, were randomly selected from the girl's hostel of the University. The purpose of the study was explained to each subject and written consent to participate in the study was taken.

All the subjects were asked to attend the testing session after a 10-12 hour overnight fast on the day test was performed. The subjects were given general instructions to avoid any physical exertion, medication, fasts and feasts during the experimental period. On the first day subjects were given the standard or reference carbohydrate i.e. 50 g glucose dissolved in 200 ml of water. Blood glucose was measured in the fasted state at 0 and after 30, 60, 90 and 120 minutes. Thereafter, both the BSW (control) and BSWA (test) sweet balls containing 50 g of available carbohydrate were served on separate occasions (5 days apart). Table 2, shows the macronutrient composition of the sweet balls. The subjects were asked to finish eating within 10-15 minutes. Blood glucose level was measured in capillary whole blood obtained by finger prick (Accu-Chek Roche Diagnostics India Pvt. Ltd, Mumbai).

Calculation of Glycemic Index

Blood glucose curves were constructed and the incremental area under the curve (IAUC) was calculated by the method of Wolever et al., 1990. The glycemic index was calculated by dividing the IAUC for the test food by the IAUC for the reference food and multiplying by 100 for each individual. The final glycemic index for each test food was calculated as the mean of the respective GI's of the ten individuals. The following formula was used:

$$GI = \frac{\text{IUAC of Test Food}}{\text{IUAC of Reference Food}} \times 100$$

Where IUAC denotes Incremental area under the blood glucose response curve.

Statistical Analysis

Mean and SD (Standard Deviation) of sensory scores and GI was calculated. Students t –test was used to analyze the difference in data obtained by sensory analysis. Paired t test was done to find out the difference in glycemic response of test and control sweet balls. Significance level considered was $P< 0.05$.Statistics was performed IBM SPSS Statistics Package 16 and GraphPad Software Version 5.

RESULT & DISCUSSION

Mean scores for each sensory attributes of the sweet balls are presented in Table 1. The Sensory evaluation of the products revealed that there was no significant difference in the scores of test and control sweet balls except in flavor for which test sweet balls received lower score. This could be due to the reason that aswagandha has a strong smell which affected the overall flavor of the test product as there was no flavoring agent added. No significant difference was found in other parameters like taste and overall acceptability as the bitter taste of ashwagandha was masked by addition of jaggery. Hence both the products were found to be acceptable.

Table 1. Mean scores of sensory attributes of sweet balls (*ladoo*)

	Product (Sweet ball)	Mean	t-value
Appearance	BSW	7.40±0.14	1.823
	BSWA	7.31±0.06	
Colour	BSW	7.40±0.76	1.905
	BSWA	7.33±0.10	
Flavor	BSW	7.25±0.08	2.937*
	BSWA	7.20±0.05	
Texture Taste	BSW	7.31±0.07	0.279
	BSWA	7.30±0.13	
Taste Texture	BSW	7.24±0.12	0.948
	BSWA	7.18±0.13	
Overall acceptability	BSW	7.40±0.14	1.970
	BSWA	7.30±0.08	

*BSW (control) sweet balls: Barley, soy, wheat sweet ball
*BSWA (test) sweet balls: Barley, soy, wheat + ashwagandha .

Values are mean ± standard deviations.*Significant difference $p < 0.05$

Table 2. Nutrient composition of sweet balls for equi carbohydrate portion of 50 g glucose

Food Product	Portion size (g)	Energy (Kcal)	Protein (g)	Fat (g)	Dietary Fibre (g)	Available CHO (g)
BSW Sweet ball	79	258.95	10.70	1.71	15.44	50
BSWA Sweet ball	80	260.00	10.90	1.89	16.72	50

*BSW (control) sweet balls: Barley, soy, wheat sweet ball
*BSWA (test) sweet balls: Barley, soybean, wheat + ashwagandha

Data on nutrient composition of sweet balls for equicarbohydrate portion of 50 g glucose is presented in Table 2. Nutrient evaluation revealed that the energy content of BSWA sweet ball was 260 Kcal, crude protein 10.90 g, fat 1.89 g and dietary fiber 16.72 g which was slightly higher than that of its control which could be due to incorporation of ashwagandha root powder which contributed to the increase in all nutrients. However, BSWA had a lesser available carbohydrate as 80 g of the product contained 50g carbohydrate as compared to control.

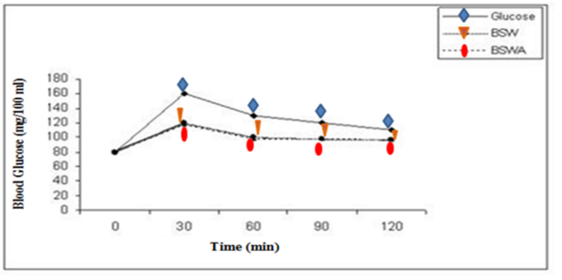
Table 3. IUAC& GI in normal subjects

Food Product	IUAC	GI	% Reduction in IUAC of sweet balls compared with IUAC of glucose
Glucose	253.96±3.53	100	
BSW Sweet Ball	117.38*±2.60	46.21	53.79
BSWA Sweet ball	114.05*±2.70	44.90	55.1

*BSW (control) sweet balls: Barley, soy, wheat sweet ball
*BSWA (test) sweet balls: Barley, soybean, wheat + ashwagandha

Values are given in mmol/L (mean) (*Significant change $p = 0.01$, t value 2.81)

Figure 1. Mean plasma glucose level on consumption of reference, control and test sweet balls at 30 minute interval for 2 hours



The mean blood glucose response after ingestion of glucose, BSW (control) and BSWA (test food) in normal as well as diabetic subjects is shown in Fig.1. The IUAC of both the test and control product was lower than that of glucose, indicating that ashwagandha incorporation in sweet ball has no adverse effect on glycemic response. A significant difference (p=0.01) in IAUC of BSW (117.38±2.60) and BSWA (114.05±2.70) was observed (table 3). After intake of BSWA a narrow but consistent decrease in blood glucose response was observed as compared to the control and reference. Foods may be divided into three groups: foods with low GI (GI= 55 or less), medium GI (GI= 55-69) and high GI (GI=70 or more) (Foster-Powell et al., 2002). Glycemic index of test and control sweet ball was found to be 44.90 and 46.21 respectively, which was in low GI range. The BSWA sweet ball exhibited maximum reduction (55%) of GI (Table 3) in comparison to glucose. Addition of ashwagandha lowered the GI of sweet ball by 1.3%. Although this difference was not very profound, which could be due to the fact that GI estimation takes into account mainly the carbohydrates and the blood glucose response over a two hour period whereas the phytochemicals present in ashwagandha, may act at cellular level to bring hypoglycemic effect in blood on long term intake, which warrants a separate clinical trial.

Protein and fat both tend to delay stomach emptying, thereby slowing the rate of carbohydrate digestion and absorption (Flint et al., 2004; Hatönen,et al.,2011). Fiber slows down metabolism of carbohydrates and their digestion (Jenkins, 1985). Therefore, it may be presumed that the reason for lower GI of BSWA (test) product could either be due to available carbohydrate, slightly higher fat and dietary fiber content (Table 2) as compared to its control (BSW) or due to some of the phytochemicals present in ashwagandha root powder that may have affected carbohydrate absorption.. Thus, it can be concluded that high fiber cereals like barley, along with commonly used wheat and high protein soy flour can be effectively used to develop low GI sweet for diabetics. Addition of ashwagandha has added advantage of improving the nutrient content and lowering the GI in addition to imparting medicinal benefit. Consuming low-GI foods is associated with improved carbohydrate metabolism in type 2 diabetes Therefore, ashwagandha root powder may be used effectively as an ingredient in developing acceptable, low GI sweets and other food products for diabetics.

CONCLUSION

In conclusion, this study showed that the ashwagandha root powder can be used to develop low GI, acceptable products with good nutritional value. In this study no long term clinical trial was carried and neither the active phytonutrient components in the ashwagandha root powder responsible for the effect on peak postprandial glucose were determined. Therefore, further researches are warranted to identify the phytonutrients in the products (as these vary according to the variety of plant) as well as a case control clinical trial, to find the effect of inclusion of these products in diabetic diet on long term basis.

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