

## Development and Organoleptic Evaluation of Food Preparations Incorporated with Selected Antidiabetic Medicinal Plants

Sonali Goel, G.K.Kochar and Tarvinderjeet Kaur

*Department of Home Science, Kurukshetra University, Kurukshetra 136 119, Haryana, India*

**KEYWORDS** Overall Acceptability Scores. Most Acceptable. Organoleptic Characteristics. ADPHM

**ABSTRACT** Worldwide, the prevalence of diabetes is projected to rise from 171 million in 2000 to 366 million in 2030. Several medicinal plants possess anti-diabetic properties, and to avail their hypoglycemic effect, these are used as medicine by diabetics. Medicinal plants have rarely been incorporated in food preparations. Keeping this in view, Antidiabetic Polyherbal Mixture (ADPHM) was prepared by using three medicinal plants with hypoglycemic properties, namely, fenugreek seeds, bitter melon and *gudmar* leaves. Commonly consumed salty food preparations for diabetic patients were developed by incorporating ADPHM at different levels (1 to 7%). All the developed food preparations were organoleptically evaluated by a panel of twelve judges using nine point Hedonic scale. In all the developed food preparations, maximum (7%) level of incorporation was in *namakpara* and minimum (1%) in *idli* and vegetable soup. Amongst the developed ADPHM incorporated food preparations, the mean scores for overall acceptability were highest for *idli* ( $8.20 \pm 0.90$ ) and minimum for vegetable soup ( $5.83 \pm 1.13$ ). Significant difference ( $p \leq 0.05$ ) appeared in scores for flavor of *idli* and *missi roti*, whereas in texture score of *poha*, within different level of incorporation of ADPHM. Significant difference ( $p \leq 0.05$ ) was found in score for overall acceptability within different level of incorporation of ADPHM in *idli*, *poha*, *missi roti*, *dhokla* and biscuits. All the developed ADPHM incorporated food preparations contained appreciable amount of energy (100.48 Kcal to 294.87 Kcal/serving), protein (2.60 g to 12.65 g/serving), carbohydrate (13.69 g to 54.66 g/serving) and fibre (0.14 to 2.25 g/ serving).

### INTRODUCTION

Diabetes is a group of diseases characterized by high blood glucose concentrations due to defects in insulin secretion, insulin action or both (Marion 2000). Long standing diabetes mellitus causes chronic complications including microvascular, macrovascular and neuropathic disorders. Worldwide, the prevalence of diabetes is projected to rise from 171 million in 2000 to 366 million in 2030. At present, approximately 31.7 million people are diabetic in India and it is estimated that by 2030, the number would be more than double (Wild et al. 2004).

Oral Hypoglycemic drugs are the mainstay of treatment of diabetes but these have prominent side-effects (Rang and Dale 1991). In comparison to conventional drugs, medicinal plants and herbs possess no or fewer side effects, are easily available and have relatively

low cost (Momin 1987; Valiathan 1998). The ethno-botanical information reports about 800 plants that may possess anti-diabetic potential (Alarcon Aguilera et al. 1998). Various researchers have reviewed several Indian medicinal plants that have been reported to possess antidiabetic activity. In relation to diabetes and its complications, medicinal plants, namely, *Gymnema sylvestris*, *Momordica charantia* and *Trigonella foenum graecum* are amongst some of the most effective and commonly studied antidiabetic medicinal plants (Grover et al. 2002; Mukherjee et al. 2006). Several studies with humans have shown the hypoglycemic effect of fenugreek seeds (Sharma and Raghuram 1990), bitter melon (Leatherdale et al. 1981; Ahmad et al. 1999) and *gudmar* leaves (Baskaran et al. 1990; Shanmugasundaram et al. 1990).

The diabetic patients are acquainted with the antidiabetic properties of the plants but monotony in consumption of medicinal plants in form of powder leads to rejection in their intake. Also, diabetics are not aware of the form in which the antidiabetic medicinal plants can be incorporated in their basic food preparations. Various Indian recipes incorporated with plant food material such as fenugreek seeds and gum acacia possessing hypoglycemic potential have been

---

*Corresponding author:*

Ms. Sonali Goel

*Research Scholar*

Department of Home Science

Kurukshetra University

Kurukshetra, Haryana, India

Telephone: 09896622068 (M), 01744-260384 (R)

E-mail: sonaligoel22@gmail.com

developed earlier (Neeraja and Rajyalakshmi 1996; Thakkar and Kapoor 2007) but there are very few studies on the development of food preparations by adding antidiabetic medicinal plants in mixture form. So, the present study was undertaken to develop commonly consumed salty food preparations for diabetics by incorporating antidiabetic polyherbal plant mixture and evaluate their acceptability.

## MATERIAL AND METHODS

**Material:** The medicinal plants fenugreek seeds (*Trigonella foenum graecum*) and bitter gourd fruit (*Momordica charantia*) were purchased in bulk from local market of Kurukshetra, whereas *gudmar* leaves (*Gymnema sylvestre*) were purchased from the cultivator of medicinal plants in Kurukshetra, Haryana.

### Processing of the Samples

**Fenugreek Seeds:** Fenugreek seeds were sorted and cleaned to remove impurities and grounded to fine powder in an electric grinder. The fine powder of fenugreek seeds was stored in an airtight plastic container for further use.

**Bitter Gourd Fruit:** Fresh, immature bitter gourd were washed thoroughly in water to remove adhering foreign materials, surface water was removed by spreading on filter paper sheets followed by drying in hot air oven at 45°C till complete drying. The dried bitter gourd was ground to fine powder and stored in an airtight plastic container till further use.

**Gudmar Leaves:** The *gudmar* leaves were separated from the stalk, cleaned of foreign materials, washed in clean water and surface water was removed by spreading on filter paper sheets. Thereafter, they were dried in hot air oven at 45°C till complete drying. The dried leaves were ground to fine powder and stored in an air tight plastic container.

**Development and Standardization of Food Preparations:** Powdered form of medicinal plants, namely, *gudmar* leaves, bitter gourd fruit and fenugreek seeds was mixed together by adding them respectively in the ratios of 1:1:1, 2:1:1, 1:2:1, 2:1:2, 1:2:2, 2:2:1. From the above mixtures, the most organoleptically acceptable proportion was 1:1:1. Hence, it was used to prepare antidiabetic polyherbal mixture (ADPHM). Antidiabetic polyherbal mixture was incorporated

at different levels in commonly consumed salty food preparations made by using different cooking methods (Table 1). Level of incorporation of ADPHM in different food preparations ranged from 1 to 7 per cent.

**Table 1: Salty food preparations prepared with different methods of cooking by incorporating Antidiabetic Polyherbal Mixture (ADPHM)**

Food preparations	Method of processing
Idli	
Dhokla	Steaming
Roti	
Missi roti	Roasting
Khichdi	
Sambhar	
Vegetable soup	
Vegetable dalia	Pressure cooking
Besan chilla	
Moong dal pancake	Shallow fat frying
Namakpara#	Deep fat frying
Poha	Stir frying
Biscuits#	Baking

# Biscuits and *Namakpara* have been prepared with whole wheat flour

**Sensory Evaluation:** All the developed food preparations were organoleptically evaluated using nine point Hedonic scale (Amerine et al. 1965). The evaluation was done by a panel of twelve judges comprising of Faculty of Department of Food and Nutrition and diabetic people.

**Nutrient Content:** Nutrient content per serving of the most acceptable antidiabetic polyherbal mixture incorporated salty food preparations were calculated from the values given in nutritive value of Indian foods (Gopalan et al. 2004).

**Statistical Analysis:** The data were subjected to statistical analysis using Statistical Package for Social Sciences (SPSS) version 16.0. ANOVA and Tukey HSD (Honestly significant difference) test were used to obtain the differences in organoleptic scores, within different level of incorporation of ADPHM in food preparations. Level of significance was accepted at  $p \leq 0.05$ .

## RESULTS AND DISCUSSION

**Sensory Evaluation:** All the food products incorporated with antidiabetic polyherbal mixture (ADPHM) were found to be organoleptically acceptable. However, the acceptable level of incorporation of ADPHM varied in different food preparations. It has been found that when the level of incorporation of ADPHM increased

beyond the accepted levels in any food preparation, the mean scores for all organoleptic characteristics decreased.

In antidiabetic polyherbal mixture (ADPHM) incorporated food preparations (Table 2), namely, *idli* and vegetable soup, the most acceptable level of incorporation was 1.5 per cent and the mean scores for overall acceptability were  $8.20 \pm 0.90$  and  $6.28 \pm 1.29$ , respectively. In *idli*, significant differences appeared in scores for flavor and overall acceptability. Analysis by Tukey HSD test, further revealed that in scores for flavor and overall acceptability of *idli*, significant differences ( $p \leq 0.05$ ) appeared within 1.5 and 2.0 per cent level of incorporation of ADPHM. However, scores for all organoleptic characteristics of vegetable soup within 1.0, 1.5 and 2.0 per cent level of incorporation were found non-significantly different.

At 2 per cent level of incorporation ADPHM, *poha* and vegetable *dalia* were best acceptable and the scores for their overall acceptability awarded by the panel of judges were  $7.50 \pm 0.70$  and  $7.0 \pm 0.84$ , respectively. Non-significant difference was noticed in scores for all organoleptic characteristics of vegetable *dalia* within 1.5, 2.0 and 2.5 per cent level of incorporation of ADPHM (Table 2). Significant differences were found in score for texture and overall acceptability of *poha*. Subsequent analysis of the data by Tukey HSD, indicated that significant differences ( $p < 0.05$ ) were found in texture score within 1.5 and 2.0 per cent while for overall acceptability within 1.5 and 2.0, and 1.5 and 2.5 per cent.

For *khichdi*, *roti*, *missi roti*, *besan chilla* and *dhokla*, the most acceptable level of incorporation of ADPHM was 2.5 per cent and the respective scores for overall acceptability ranged from  $6.50 \pm 0.77$  (*khichdi*) to  $7.50 \pm 0.83$  (*besan chilla*). Non-significant differences were found in scores for all organoleptic characteristics of *khichdi*, *roti* and *besan chilla*. At different level of incorporation that is, 2.0, 2.5 and 3.0 per cent, non-significant difference was obtained within all organoleptic characteristics of *dhokla* except for overall acceptability (Table 2). Further analysis revealed significant difference ( $p \leq 0.05$ ) for overall acceptability within 2.5 and 3.0 per cent. However, in *missi roti*, non-significant difference was obtained within 2.0, 2.5 and 3.0 per cent level of incorporation of ADPHM in scores for colour, appearance, texture and taste. Significant differences were noticed for flavor

and overall acceptability in *missi roti*. Further analysis by Tukey HSD test showed that significant difference ( $p \leq 0.05$ ) was found in flavour score within 2.0 and 2.5, and 2.5 and 3.0 per cent level of incorporation of ADPHM, while within 2.5 and 3.0 per cent for overall acceptability score.

Antidiabetic polyherbal mixture incorporated *sambhar* scored highest scores at 3.0 per cent level of incorporation and the best scores for overall acceptability awarded by the panel of judges was  $7.70 \pm 0.82$ . Organoleptic differences were found in scores of all characteristics of *sambhar*, but statistically they were found non-significantly different.

*Moong dal* pancake and biscuits were best acceptable at 4.5 per cent and the respective scores for overall acceptability were  $6.83 \pm 0.80$  and  $7.71 \pm 0.78$ . In biscuits, non-significant difference appeared within 4.0, 4.5 and 5.0 per cent level of incorporation of ADPHM for color, texture, appearance, taste and flavor while significant difference was found for overall acceptability scores (Table 2). Multiple comparisons with Tukey HSD (Table 2) test further revealed significant difference ( $p \leq 0.05$ ) for overall acceptability score within 4.5 and 5.0 per cent level of incorporation of ADPHM in biscuits. Most acceptable level of incorporation of ADPHM in *namakpara* was 6.5 per cent and the score for overall acceptability was  $7.15 \pm 0.79$ . Non-significant difference was noticed in scores for all organoleptic characteristics of *namakpara*.

Limited literature is available on the development of food preparations by incorporating antidiabetic medicinal plants used in the present study. Kochhar et al. (2007) prepared mixture of powdered bitter gourd fruit (*Momordica charantia*), fenugreek seeds (*Trigonella foenum graecum*) and *jambu* seeds (*Eugenia jambolana*) in ratio of 1:1:1 and using 500 mg to 2 g of this powder developed salty biscuits for diabetics. They found that the most acceptable level of incorporation of the mixture in biscuits was 500 mg. Neeraja and Rajyalakshmi (1996) developed different types of *pongal*, a traditional Indian recipe by incorporating powdered seeds of raw, boiled and germinated fenugreek seeds at different levels separately i.e. 12.5, 15, 18 and 20 g. The most acceptable level of incorporation of germinated, raw and boiled fenugreek seeds in recipe *pongal* was 18, 12.5 and 12.5 g respectively.

In the present study, the most acceptable level

**Table 2: Sensory evaluation of salty food preparations incorporated with Antidiabetic Polyherbal Plant Mixture (ADPHM)**

Food preparation	%level of incorporation	Colour	Appearance	Flavour	Texture	Taste acceptability	Overall acceptability
<i>Idli</i>	1.0	8.0 ± 0.89 <sup>a</sup>	7.85 ± 0.89 <sup>a</sup>	8.14 ± 0.37 <sup>ab</sup>	7.85 ± 0.69 <sup>a</sup>	8.28 ± 0.48 <sup>a</sup>	8.02 ± 0.61 <sup>ab</sup>
	1.5	8.0 ± 1.21 <sup>a</sup>	8.14 ± 0.69 <sup>a</sup>	8.42 ± 0.78 <sup>a</sup>	7.85 ± 1.06 <sup>a</sup>	8.42 ± 0.78 <sup>a</sup>	8.20 ± 0.90 <sup>a</sup>
	2.0	7.85 ± 0.69 <sup>a</sup>	7.71 ± 0.95 <sup>a</sup>	7.42 ± 0.78 <sup>b</sup>	7.57 ± 0.53 <sup>a</sup>	7.71 ± 0.71 <sup>a</sup>	7.65 ± 0.72 <sup>b</sup>
	F-ratio	0.831*	0.641*	0.036**	0.744*	0.151*	0.011**
<i>Vegetable soup</i>	1.0	6.41 ± 1.37 <sup>a</sup>	6.83 ± 1.11 <sup>a</sup>	5.41 ± 0.79 <sup>a</sup>	6.41 ± 1.44 <sup>a</sup>	5.16 ± 0.71 <sup>a</sup>	6.05 ± 1.26 <sup>a</sup>
	1.5	6.0 ± 0.85 <sup>a</sup>	6.83 ± 0.93 <sup>a</sup>	6.50 ± 1.44 <sup>a</sup>	6.75 ± 1.48 <sup>a</sup>	5.33 ± 1.15 <sup>a</sup>	6.28 ± 1.29 <sup>a</sup>
	2.0	6.0 ± 1.20 <sup>a</sup>	6.16 ± 0.57 <sup>a</sup>	6.08 ± 1.31 <sup>a</sup>	5.83 ± 1.40 <sup>a</sup>	5.08 ± 0.79 <sup>a</sup>	5.83 ± 1.13 <sup>a</sup>
	F-ratio	0.605*	0.130*	0.104*	0.303*	0.343*	0.176*
<i>Poha</i>	1.5	6.83 ± 0.71 <sup>a</sup>	7.08 ± 1.08 <sup>a</sup>	7.25 ± 0.75 <sup>a</sup>	7.16 ± 0.57 <sup>a</sup>	7.33 ± 0.65 <sup>a</sup>	7.13 ± 0.76 <sup>a</sup>
	2.0	7.33 ± 0.88 <sup>a</sup>	7.58 ± 0.90 <sup>a</sup>	7.66 ± 0.65 <sup>a</sup>	7.50 ± 0.52 <sup>b</sup>	7.41 ± 0.51 <sup>a</sup>	7.50 ± 0.70 <sup>b</sup>
	2.5	7.0 ± 0.81 <sup>a</sup>	7.16 ± 0.83 <sup>a</sup>	7.16 ± 1.02 <sup>a</sup>	6.5 ± 1.0 <sup>ab</sup>	7.0 ± 0.73 <sup>a</sup>	6.96 ± 0.90 <sup>b</sup>
	F-ratio	0.329*	0.392*	0.297*	0.007**	0.257*	0.002**
<i>Vegetable dalia</i>	1.5	7.08 ± 0.79 <sup>a</sup>	7.08 ± 0.90 <sup>a</sup>	6.75 ± 0.96 <sup>a</sup>	7.0 ± 0.85 <sup>a</sup>	6.83 ± 0.93 <sup>a</sup>	6.95 ± 0.87 <sup>a</sup>
	2.0	7.25 ± 0.86 <sup>a</sup>	7.0 ± 0.60 <sup>a</sup>	6.66 ± 0.98 <sup>a</sup>	7.16 ± 0.71 <sup>a</sup>	6.91 ± 0.99 <sup>a</sup>	7.0 ± 0.84 <sup>a</sup>
	2.5	7.0 ± 0.73 <sup>a</sup>	6.91 ± 0.66 <sup>a</sup>	6.41 ± 0.66 <sup>a</sup>	6.83 ± 0.71 <sup>a</sup>	6.66 ± 0.98 <sup>a</sup>	6.76 ± 0.76 <sup>a</sup>
	F-ratio	0.41*	0.858*	0.634*	0.572**	0.815*	0.332**
<i>Khichdi</i>	2.0	7.0 ± 0.73 <sup>a</sup>	6.66 ± 0.65 <sup>a</sup>	6.25 ± 0.62 <sup>a</sup>	6.41 ± 0.79 <sup>a</sup>	6.08 ± 0.79 <sup>a</sup>	6.48 ± 0.77 <sup>a</sup>
	2.5	6.83 ± 0.71 <sup>a</sup>	6.50 ± 0.79 <sup>a</sup>	6.33 ± 0.77 <sup>a</sup>	6.58 ± 0.90 <sup>a</sup>	6.25 ± 0.62 <sup>a</sup>	6.50 ± 0.77 <sup>a</sup>
	3.0	6.66 ± 0.65 <sup>a</sup>	6.33 ± 0.65 <sup>a</sup>	6.25 ± 0.72 <sup>a</sup>	6.33 ± 0.65 <sup>a</sup>	6.0 ± 0.73 <sup>a</sup>	6.31 ± 0.70 <sup>a</sup>
	F-ratio	0.517*	0.517*	0.948*	0.313*	0.374*	0.334*
<i>Roti</i>	2.0	6.75 ± 0.75 <sup>a</sup>	7.08 ± 0.90 <sup>a</sup>	6.83 ± 0.71 <sup>a</sup>	7.0 ± 0.73 <sup>a</sup>	6.66 ± 0.49 <sup>a</sup>	6.86 ± 0.72 <sup>a</sup>
	2.5	6.83 ± 0.83 <sup>a</sup>	7.16 ± 0.86 <sup>a</sup>	7.25 ± 0.86 <sup>a</sup>	6.75 ± 0.62 <sup>a</sup>	6.83 ± 0.71 <sup>a</sup>	6.96 ± 0.80 <sup>a</sup>
	3.0	6.66 ± 0.65 <sup>a</sup>	6.91 ± 0.90 <sup>a</sup>	7.08 ± 0.51 <sup>a</sup>	6.75 ± 0.75 <sup>a</sup>	6.58 ± 0.79 <sup>a</sup>	6.80 ± 0.73 <sup>a</sup>
	F-ratio	0.863*	0.793*	0.367*	0.611*	0.421*	0.476*
<i>Missi roti</i>	2.0	7.50 ± 0.67 <sup>a</sup>	8.0 ± 0.60 <sup>a</sup>	6.83 ± 0.83 <sup>a</sup>	6.50 ± 1.0 <sup>a</sup>	6.91 ± 0.49 <sup>a</sup>	7.15 ± 0.89 <sup>ab</sup>
	2.5	7.66 ± 0.77 <sup>a</sup>	7.91 ± 0.90 <sup>a</sup>	7.83 ± 0.94 <sup>b</sup>	6.83 ± 1.02 <sup>a</sup>	7.16 ± 0.38 <sup>a</sup>	7.48 ± 0.91 <sup>a</sup>
	3.0	7.41 ± 0.90 <sup>a</sup>	7.75 ± 0.72 <sup>a</sup>	6.75 ± 0.72 <sup>a</sup>	6.66 ± 1.02 <sup>a</sup>	6.75 ± 0.62 <sup>a</sup>	7.06 ± 0.91 <sup>b</sup>
	F-ratio	0.734*	0.718*	0.006**	0.73*	0.155*	0.031**
<i>Besan chilla</i>	2.0	7.50 ± 0.79 <sup>a</sup>	7.33 ± 0.88 <sup>a</sup>	7.33 ± 0.77 <sup>a</sup>	7.08 ± 0.99 <sup>a</sup>	7.41 ± 0.90 <sup>a</sup>	7.33 ± 0.85 <sup>a</sup>
	2.5	7.75 ± 0.96 <sup>a</sup>	7.41 ± 0.90 <sup>a</sup>	7.50 ± 0.79 <sup>a</sup>	7.16 ± 0.71 <sup>a</sup>	7.66 ± 0.77 <sup>a</sup>	7.50 ± 0.83 <sup>a</sup>
	3.0	7.41 ± 1.08 <sup>a</sup>	7.25 ± 0.75 <sup>a</sup>	7.16 ± 1.02 <sup>a</sup>	6.83 ± 1.11 <sup>a</sup>	7.08 ± 0.95 <sup>a</sup>	7.15 ± 0.98 <sup>a</sup>
	F-ratio	0.677*	0.891*	0.651*	0.678*	0.292*	0.104*
<i>Dhokla</i>	2.0	7.08 ± 0.51 <sup>a</sup>	7.75 ± 0.86 <sup>a</sup>	7.16 ± 0.57 <sup>a</sup>	7.41 ± 0.99 <sup>a</sup>	6.66 ± 1.30 <sup>a</sup>	7.21 ± .94 <sup>ab</sup>
	2.5	7.41 ± 0.66 <sup>a</sup>	7.75 ± 0.75 <sup>a</sup>	7.50 ± 0.79 <sup>a</sup>	7.33 ± 0.77 <sup>a</sup>	7.25 ± 1.05 <sup>a</sup>	7.45 ± 0.81 <sup>a</sup>
	3.0	6.91 ± 0.66 <sup>a</sup>	7.58 ± 0.64 <sup>a</sup>	7.08 ± 0.51 <sup>a</sup>	7.0 ± 0.73 <sup>a</sup>	6.33 ± 0.98 <sup>a</sup>	6.98 ± 0.81 <sup>b</sup>
	F-ratio	0.150*	0.829*	0.257*	0.451*	0.145*	0.013*
<i>Sambhar</i>	2.5	7.50 ± 0.52 <sup>a</sup>	7.66 ± 0.77 <sup>a</sup>	7.83 ± 0.93 <sup>a</sup>	7.16 ± 0.71 <sup>a</sup>	7.33 ± 1.12 <sup>a</sup>	7.50 ± 0.83 <sup>a</sup>
	3.0	7.66 ± 0.49 <sup>a</sup>	8.16 ± 0.71 <sup>a</sup>	7.66 ± 0.98 <sup>a</sup>	7.50 ± 0.79 <sup>a</sup>	7.50 ± 0.98 <sup>a</sup>	7.70 ± 0.82 <sup>a</sup>
	3.5	7.41 ± 0.66 <sup>a</sup>	8.0 ± 0.85 <sup>a</sup>	7.66 ± 0.77 <sup>a</sup>	7.08 ± 0.77 <sup>a</sup>	7.0 ± 0.73 <sup>a</sup>	7.43 ± 0.85 <sup>a</sup>
	F-ratio	0.551*	0.296*	0.874*	0.420*	0.430*	0.196*
<i>Moong dal pancake</i>	4.0	6.75 ± 0.62 <sup>a</sup>	7.16 ± 1.19 <sup>a</sup>	6.83 ± 1.11 <sup>a</sup>	7.0 ± 0.95 <sup>a</sup>	6.66 ± 0.88 <sup>a</sup>	6.93 ± 0.95 <sup>a</sup>
	4.5	6.91 ± 0.90 <sup>a</sup>	7.33 ± 0.77 <sup>a</sup>	6.75 ± 0.62 <sup>a</sup>	6.25 ± 0.62 <sup>a</sup>	6.91 ± 0.75 <sup>a</sup>	6.83 ± 0.80 <sup>a</sup>
	5.0	6.58 ± 0.79 <sup>a</sup>	6.91 ± 0.90 <sup>a</sup>	6.41 ± 0.83 <sup>a</sup>	6.33 ± 0.77 <sup>a</sup>	6.33 ± 0.98 <sup>a</sup>	6.51 ± 0.89 <sup>a</sup>
	F-ratio	0.583*	0.414*	0.511*	0.109*	0.317*	0.060*
<i>Biscuit</i>	4.0	7.83 ± 0.89 <sup>a</sup>	7.58 ± 0.79 <sup>a</sup>	7.66 ± 0.77 <sup>a</sup>	7.41 ± 0.66 <sup>a</sup>	7.25 ± 0.96 <sup>a</sup>	7.55 ± 0.83 <sup>ab</sup>
	4.5	8.08 ± 0.51 <sup>a</sup>	7.91 ± 0.66 <sup>a</sup>	7.66 ± 0.88 <sup>a</sup>	7.50 ± 0.79 <sup>a</sup>	7.41 ± 0.90 <sup>a</sup>	7.71 ± 0.78 <sup>a</sup>
	5.0	7.50 ± 0.90 <sup>a</sup>	7.33 ± 0.65 <sup>a</sup>	7.41 ± 0.90 <sup>a</sup>	7.41 ± 0.79 <sup>a</sup>	7.0 ± 0.85 <sup>a</sup>	7.33 ± 0.81 <sup>b</sup>
	F-ratio	0.223*	0.144*	0.714*	0.863*	0.533*	0.027**
<i>Namakpara</i>	6.0	7.0 ± 0.60 <sup>a</sup>	7.16 ± 1.19 <sup>a</sup>	6.83 ± 1.11 <sup>a</sup>	7.0 ± 0.95 <sup>a</sup>	6.66 ± 0.88 <sup>a</sup>	6.93 ± 0.95 <sup>a</sup>
	6.5	7.25 ± 0.62 <sup>a</sup>	7.58 ± 0.66 <sup>a</sup>	7.08 ± 0.66 <sup>a</sup>	7.0 ± 0.85 <sup>a</sup>	6.83 ± 1.02 <sup>a</sup>	7.15 ± 0.79 <sup>a</sup>
	7.0	7.16 ± 0.83 <sup>a</sup>	7.08 ± 1.08 <sup>a</sup>	6.66 ± 1.07 <sup>a</sup>	6.75 ± 0.75 <sup>a</sup>	6.41 ± 0.99 <sup>a</sup>	6.81 ± 0.96 <sup>a</sup>
	F-ratio	0.671*	0.437*	0.578*	0.714*	0.578*	0.128*

Values are mean ± S.D. of twelve replicates,

\* Non-significant

\*\* Level of significance  $p \leq 0.05$

Values with different superscript letters in the same column for each recipe are significantly different at the 0.05 level ( $p \leq 0.05$ )

**Table 3: Nutrient content of the most acceptable Antidiabetic Polyherbal Mixture (ADPHM) incorporated food preparations**

Food preparations	Cooked weight/serving	Energy kcal/serving	Protein g/serving	Fat g/serving	CHO g/serving	Fibre g/serving
<i>Idli</i>	65 g	143.02	5.07	0.34	33.62	0.14
<i>Veg. soup</i>	200 g	100.48	4.69	2.57	13.69	1.97
<i>Poha</i>	145 g	276.03	6.40	4.91	48.52	1.99
<i>Veg. dalia</i>	200 g	245.07	8.74	3.92	44.17	2.21
<i>Khichdi</i>	363 g	294.87	12.65	3.73	54.66	0.44
<i>Roti</i>	74 g	195.91	6.31	3.24	35.36	1.07
<i>Missi roti</i>	80 g	199.6	7.56	3.98	34.58	1.09
<i>Besan chilla</i>	96 g	240.17	10.58	7.24	29.04	2.20
<i>Dhokla</i>	94 g	157.56	6.74	3.87	23.18	1.55
<i>Sambhar</i>	272 g	131.80	5.72	3.58	17.28	1.30
<i>Dal pancake</i>	105 g	229.36	12.51	6.75	29.14	2.25
<i>Biscuit</i>	26 g	141.71	2.60	5.24	19.10	0.46
<i>Namakpara</i>	40 g	163.97	3.47	8.51	18.25	0.69

of incorporation of antidiabetic polyherbal mixture (ADPHM) in *idli* and vegetable soup was 1.5 per cent. Overall acceptability scores were highest for *poha*, vegetable *dalia* and *khichdi*, *roti*, *missi roti*, *besan chilla*, *dhokla* respectively, at 2.0 and 2.5 per cent level of incorporation of ADPHM. *Sambhar* and *moong dal* pancake, biscuit, respectively were most acceptable at 3.0 and 4.5 percent level of incorporation of ADPHM. Overall acceptability scores were highest for *namakpara* at 6.5 per cent level of incorporation of ADPHM.

**Nutrient Content:** Energy content of all the food preparations prepared by incorporating antidiabetic polyherbal mixture (ADPHM) varied from 100.48 Kcal of vegetable soup to 294.87 Kcal per serving of *khichdi* (Table 3). Protein content was highest in *khichdi* (12.65 g/serving) and lowest in biscuits (2.60 g/serving). Fat content ranged between 0.34 g in *idli* to 8.51 g per serving in *namakpara*. Carbohydrate content of ADPHM incorporated food preparations varied from 13.69 g of soup to 54.66 g per serving of *khichdi*. The highest fibre content was found in *moong dal* pancake (2.25 g/serving) and minimum in *idli* (0.14 g/serving).

### CONCLUSION

Antidiabetic polyherbal mixture (ADPHM) was found bitter in taste but with its incorporation in various recipes the bitterness decreased. All the food preparations developed by incorporating antidiabetic polyherbal mixture (ADPHM) were found to be organoleptically acceptable by the trained as well as the diabetic panel. The acceptable level of incorporation of ADPHM

varied in different food preparations ranging from 1.0 per cent (*idli* and vegetable soup) to 7.0 per cent (*namakpara*). Amongst the ADPHM incorporated food preparations, the mean scores for overall acceptability was highest for *idli* and minimum for vegetable soup.

### RECOMMENDATIONS

Antidiabetic polyherbal mixture (ADPHM) possesses hypoglycemic properties and its incorporation in various recipes was found to be organoleptically acceptable, so diabetic patients can easily incorporate ADPHM into their commonly consumed food preparations to avail their hypoglycemic effects. This study provides further scope to see the impact of supplementation of antidiabetic polyherbal mixture (ADPHM) incorporated recipes on blood glucose level of diabetic people.

### REFERENCES

- Ahmad N, Hassan MR, Halder H, Bennoor KS 1999. Effect of *Momorodica charantia* (Karela) extracts on fasting and postprandial serum glucose levels in NIDDM patients. *Bangladesh Med Res Council Bull*, 25: 11-13.
- Alarcon Aguilera FJ, Roman Ramos R, Perez Gutierrez S, Aguilar Contreras A, Contreras Weber CC, Flores Saenz JL 1998. Study of the anti-hyperglycemic effect of plants used as antidiabetics. *Journal of Ethnopharmacology*, 61(2): 101-110.
- Amerine MA, Pangborn RM, Roessler EB 1965. *Principles of Sensory Evaluation of Food*. New York: Academic Press.
- Baskaran K, Kizar Ahamath B, Shanmugasundaram KR, Shanmugasundaram ER 1990. Antidiabetic effect of a leaf extract from *Gymnema sylvestre* in non-insulin dependent diabetes mellitus patients. *Journal of Ethnopharmacology*, 30(3): 295-300.

- Gopalan C, Ramasastri BV, Balasubramanian SC, Narasinga Rao BS, Deosthale YG, Pant KC 2004. *Nutritive Value of Indian Foods*. Hyderabad: National Institute of Nutrition (ICMR).
- Grover JK, Yadav S, Vats V 2002. Medicinal plants of India with anti-diabetic potential. *Journal of Ethnopharmacology*, 81(1): 81-100.
- Kochhar A, Nagi M, Sachdeva R 2007. Effect of supplementation of traditional medicinal plants on serum lipid profile in non- insulin dependent diabetics. *J Hum Ecol*, 22(1): 35-40.
- Leatherdale BA, Panesar RK, Singh G, Atkins TW, Bailey CJ, Bignell AH 1981. Improvement in glucose tolerance due to *Momorodica charantia* (Karela). *British Medical Journal (Clinical Research Edition)*, 282(6279): 1823-1824.
- Marion JF 2000. Medical nutrition therapy for diabetes mellitus and hypoglycemia of nondiabetic origin. In: KL Mahan, SE Stump (Eds.): *Food Nutrition and Diet Therapy*. Philadelphia: W.B. Saunders Company, pp. 792-837.
- Momin A 1987. Role of indigenous medicine in primary health care. *Proceedings of First International Seminar on Unani Medicine*, New Delhi.
- Mukherjee PK, Maiti K, Mukherjee K, Houghton PJ 2006. Leads from Indian medicinal plants with hypoglycemic potentials. *Journal of Ethnopharmacology*, 106: 1-28.
- Neeraja A, Rajyalakshmi P 1996. Hypoglycemic effect of processed fenugreek seeds in humans. *J Food Sci Technol*, 33(5): 427-430.
- Rang HP, Dale MM 1991. *The Endocrine System Pharmacology*. 2nd Edition, UK: Longman Group Ltd.
- Shanmugasundaram ER, Rajeswari G, Baskaran K, Rajesh Kumar BR, Shanmugasundaram KR, Kizar Ahmath B 1990. Use of *Gymnema sylvestre* leaf extract in the control of blood glucose in insulin-dependent diabetes mellitus. *Journal of Ethnopharmacology*, 30(3): 281-294.
- Sharma RD, Raghuram TC 1990. Hypoglycemic effect of fenugreek seeds in non-insulin dependent diabetic subjects. *Nutr Res*, 10: 731-739.
- Thakkar R, Kapoor R 2007. Enrichment of rice and finger millet based preparations with gum acacia and their effects on glycemic response in non-insulin dependent diabetic subjects. *J Food Sci Technol*, 44(2): 183-185.
- Valiathan MS 1998. Healing plants. *Current Science*, 75(10-11): 1122-1126.
- Wild S, Roglic G, Grien A, Sicree R, King H 2004. Global prevalence of diabetes: Estimates for the year 2000 and projections for 2030. *Diabetes Care*, 27: 1047-1053.

#### APPENDIX: MEANING OF DIFFERENT INDIAN FOOD PREPARATIONS

- Idli* - A savory preparation made by steaming batter of fermented black gram (de-husked) and rice in the ratio of 1:3.
- Dhokla* - A Gujarati preparation made with fermented batter of gram flour, butter milk, salt and spices.
- Roti* - It is a flat, unleavened, disk-shaped bread made from whole wheat flour dough and cooked on a griddle.
- Missi roti* - It is a flat, unleavened, disk-shaped bread made from dough prepared by mixing whole wheat flour and gram flour in the ratio 2:1.
- Khichdi* - A pressure cooked food preparation made from rice and split green gram in the ratio of 2:1.
- Sambhar* - A South Indian food preparation prepared by using lentils (red gram), vegetables (bottle gourd, pumpkin, brinjal, lady finger and drumstick) and tempered with seasonings
- Vegetable Soup* - Stew made with a variety of vegetables (onion, carrot, tomato, bottle gourd, cabbage).
- Vegetable dalia* - A pressure cooked preparation made by using broken wheat, vegetables, water and seasonings.
- Besan chilla* - Savory pancake made from batter of gram flour, grated vegetables (carrot, cabbage, onion) and spices
- Moong dal pancake* - Savory pancake prepared from batter of split green gram and spices.
- Namakpara* - Deep fried ribbon like strips prepared from dough (using whole wheat flour, water, ghee and seasonings).
- Poha* - A stir fried food preparation made from flattened rice, vegetables (onion, tomato, peas, carrot) and seasonings (mustard seeds, curry leaves and lemon juice).