

Efficacy of supplementation of bael (*Aegle marmelos* L.) and nutrition counselling on food and nutrient intake of the non-insulin dependent diabetics

UTTARA SINGH AND ANITA KOCHHAR

One hundred twenty non-insulin dependent diabetic subjects were selected from Punjab Agricultural University and Civil Hospital of Ludhiana. The selected subjects were divided into four groups viz., group I, II, III and IV having thirty subjects each. The subjects of group I were not given any treatment. The nutrition education was given for three months after fifteen days interval to the subjects of group II, III and IV through individual and group contact and gain in nutrition knowledge was assessed after the study. The mean daily intake of green leafy vegetables, other vegetables and fruits increased significantly ($P=0.01$) in the subjects of group II, III and IV and a non-significant increase ($P=0.01$) was seen in the subjects of group I. The mean energy, carbohydrates, protein and fat intake decreased significantly ($P=0.01$) in the subjects of group II, III and IV and a non-significant decrease ($P=0.01$) was seen in the subjects of group I. Therefore, it can be reported from the results that supplementation of bael (*Aegle marmelos* L.) leaf, pulp and seed powder along with nutrition counseling significantly improved the food and nutrient intake of the diabetic patients.

Key Words : Bael, *Aegle marmelos* L., Pulp and seed powder, Blood glucose, Lipid profile, Energy, Nutrition counseling

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INTRODUCTION

Diabetes is a chronic disease that occurs either when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin it produces (WHO, 2009). Diabetes is fast becoming a leading cause of morbidity, mortality and disability across the world. Diabetes mellitus is a global metabolic epidemic affecting essential biochemical activities in almost every age group (Gupta *et al.*, 2008).

According to International Diabetic Federation the estimated diabetes prevalence for 2010 has risen to 285 million, representing 6.4 per cent of the world's adult population, with

a prediction that by 2030 the number of people with diabetes will have risen to 438 million corresponding to 7.8 per cent of the adult population (IDF, 2008).

India has been declared as the "Diabetic capital of world". By 2030 there would be 366 million diabetics throughout the world and 79.44 million diabetics in India alone (WHO, 2007). It is estimated that by the year 2030, diabetes is likely to be the seventh leading cause of death accounting 3.3 per cent of total deaths in the world (WHO, 2008).

Aegle marmelos family Rutaceae is highly reputed medicinal tree commonly known as the bael. It is medium sized tree growing throughout the forest of India of altitude 1200 meter. It is found all over India, from sub-Himalayan forest, Bengal, central and south India. The different parts of this plant contain number of coumarins, alkaloids, sterols and essential oils. Various parts of this plant such as leaves, fruit and seed possess hypoglycaemic, hypolipidemic and blood pressure lowering property (Lambole *et al.*, 2010). The peel of the fruit which is a very hard shell and green to brown in colour depends on ripening stage. The appearance of yellow or orange edible

MEMBERS OF RESEARCH FORUM

Author for correspondence :

UTTARA SINGH, Department of Food and Nutrition, College of Home Science, Punjab Agricultural University, LUDHIANA (PUNJAB) INDIA
Email: usuttarasingh@gmail.com

Associate Authors' :

ANITA KOCHHAR, Department of Food and Nutrition, College of Home Science, Punjab Agricultural University, LUDHIANA (PUNJAB) INDIA
Email: dranitakochhar@yahoo.com

pulp is like a boiled pumpkin, possesses a slightly sweet taste and a characteristic floral, terpene-like aroma, very fragrant and pleasantly flavoured. Seeds are surrounded by slimy transparent mucilage (Suvinol and Pranee, 2008).

Bael (*Aegle marmelos*) is an important medicinal plant of India. Biochemical compounds of bael leaves, fruits and seeds have been used in several diseases like diabetes, cardiovascular and anti-inflammatory (Maity *et al.*, 2009). The most important ingredients present in plants are alkaloids, terpenoids, steroids, phenols glycosides and tannins (Venkatesan *et al.*, 2009). The bael leaf contain seven monoterpene hydrocarbons (90.7%), three oxygenated monoterpenes (2.9%), four sesquiterpene hydrocarbons (3.1%) and one phenolic compound (0.2%). Limonene (82.4%) is the main constituent of bael (Kaur *et al.*, 2006). *Aegle marmelos* leaf extract (200 mg/dl for 35 days) significantly affect the activity of lipid peroxidase, lipoprotein and antioxidant enzymes in isoproterenol treated rats (Rajadurai and Prince, 2005).

Leaf extract of *Aegle marmelos* (Bilva) was effective in restoring blood glucose, body weight to normal values and significantly reversed the altered (histological and ultra structural) parameters in tissues of streptozotocin induced diabetic rats seen by light and electron microscopy to near normal and improved the functional state of pancreatic beta cells. The hypoglycemic effects of this plant drug appears to be mediated through regeneration of damaged pancreas (Dahanukar *et al.*, 2000). Bael leaf enhances ability to utilize the external glucose load in the body by stimulation of glucose uptake similar to insulin. Bael extract significantly lowers blood urea, reduction in lipid peroxidation and cholesterol and increased levels of super dioxide dismutase, catalase, glutathione peroxidase and glutathione level in serum as well as in liver in experimental diabetic animals (Sharma *et al.*, 2007). Keeping in view the beneficial effects of *Aegle marmelos* leaves, fruit and seeds in the management of diabetes present study was planned with following objectives:

- To check food intake of the subjects
- To know mean daily nutrient intake of the subjects

METHODOLOGY

One hundred twenty male diabetic subjects were selected from Punjab Agricultural University Hospital and Civil hospital of Ludhiana and divided into four groups *viz.*, Group I, Group II, Group III and Group IV having thirty subjects each. The subjects of group I were not given any treatment. The subjects in group II, III and IV were supplemented with bael (*Aegle marmelos* L.) leaf, pulp and seed powder, respectively for a period of three months and supplementation was continued along with nutrition counseling for the next three months. The nutrition education was given for three months after fifteen days interval to the subjects of group II, III and IV through

individual and group contact and gain in nutrition knowledge was assessed by using diabetic knowledge questionnaire.

A dietary survey was conducted to assess the existing dietary pattern of the subjects for 3 consecutive days by 24 hour recall cum weight method. The average daily intake of nutrient was calculated from the actual amount of each food consumed daily by MSU Nutriguide (Song *et al.*, 1992).

Statistical analysis:

The data on all the parameters *viz.*, food, nutrient intake and nutritional knowledge were analyzed statistically. The mean standard error, percentages, paired t-test and their statistical significance was ascertained using a computer programme package.

OBSERVATIONS AND ASSESSMENT

The results of the present study as well as relevant discussion have been summarized under following heads:

Mean food intake:

Table 1 shows the mean food intake of the selected subjects before and after the study. The mean daily food intake of cereals, pulses, milk/milk products, roots/tubers, meat/poultry, fats/oil, sugar/jaggery decreased significantly ($P=0.01$) by the subjects of group II, III and IV after the study and no significant improvement by the subjects of group I. The mean daily intake of green leafy vegetables, other vegetables and fruits were increased significantly ($P=0.01$) by the subjects of group II, III and IV, respectively. This shows that nutrition counseling is essential to improve the food intake by the subjects. The increase seen could be due to nutrition education given to the subjects telling them the importance of green leafy vegetables which are a good source of vitamins, minerals and fibres.

Mean nutrient intake:

Table 2 shows the mean nutrient intake of the selected subjects before and after the study. In the mean daily intake of nutrients it was found that there was a significant decrease ($P=0.01$) in intake of energy by the subjects of group II, III and IV after nutrition counseling and a non-significant ($P=0.01$) decrease in the subjects of group I. Similarly, there was a significant decrease ($P=0.01$) in intake of carbohydrates, protein and fats by the subjects of group II, III and IV after the study. Reduction in carbohydrate intake was due to avoidance of refined flour (*maida*) used in *samosa* and other fried/fast foods. Reduction in protein intake by the subjects could be due to the effect of nutrition counseling given to include high quality proteins in their diet like egg white, sprouted *dal*, legumes etc. Decreased fat intake could be due to impact of nutrition counseling given to subjects about the ill effects of saturated fat and fried foods and beneficial effects of unsaturated fats.

Table 1: Mean daily food intake of the subjects before and after bael (*Aegle marmelos* L.) leaf, pulp and seed powder supplementation and nutrition intervention

Food group (g/day)	Before 1	After		Change (%)		Paired t-value		Suggested intake
		2	3	Between 1 and 2	Between 1 and 3	Between 1 and 2	Between 1 and 3	
Control		3 months	6 months					
Group I								
Cereals	299.6±0.36	297.8±5.21	295.3±6.56	0.6	1.4	0.91 ^{NS}	1.13 ^{NS}	225 [?]
Pulses	71.2±0.28	71.0±0.34	71.1±0.39	0.2	0.1	0.94 ^{NS}	0.84 ^{NS}	60 [?]
Green leafy vegetables	44.3±0.68	44.4±0.76	45.0±0.95	0.2	0.7	0.84 ^{NS}	1.63 ^{NS}	200 [?]
Other vegetables	68.8±0.18	68.8±0.22	68.9±0.23	0.1	0.1	0.85 ^{NS}	0.88 ^{NS}	200 [?]
Roots/tubers	68.5±0.30	68.2±0.31	68.1±0.34	0.3	0.5	1.26 ^{NS}	1.38 ^{NS}	100 [?]
Fruits	56.4±1.13	56.7±1.22	56.9±0.96	0.6	0.9	0.79 ^{NS}	0.91 ^{NS}	100 [?]
Milk and milk products	318.8±1.43	317.3±2.28	316.6±2.34	0.5	0.7	1.23 ^{NS}	1.48 ^{NS}	300 [?]
Meat/poultry	48.4±0.37	48.3±0.37	47.9±0.36	0.2	1.1	0.93 ^{NS}	1.86 ^{NS}	30 [#]
Fats/oils	42.1±0.32	42.0±0.89	41.5±0.36	0.2	2.2	0.87 ^{NS}	2.36*	15 [?]
Sugar/jaggery	41.9±0.29	41.5±0.50	41.7±0.74	1.2	0.5	1.48 ^{NS}	0.93 ^{NS}	NA
Experimental		SB	NI					
Group II								
Cereals	303.1±0.77	302.8±6.49	264.5±5.06	0.1	12.7	0.71 ^{NS}	7.65**	225 [?]
Pulses	74.2±0.36	73.1±0.78	66.2±0.49	1.4	10.8	1.44 ^{NS}	14.09**	60 [?]
Green leafy vegetables	55.2±0.37	56.0±0.69	68.5±0.66	1.5	24.0	1.58 ^{NS}	17.45**	200 [?]
Other vegetables	99.6±0.90	99.8±0.89	125.2±0.77	0.2	25.7	0.79 ^{NS}	22.60**	200 [?]
Roots/tubers	72.7±0.81	71.4±0.91	44.8±0.21	1.8	38.4	1.36 ^{NS}	34.58**	100 [?]
Fruits	68.5±0.42	68.6±0.46	78.1±0.57	0.2	13.9	0.87 ^{NS}	13.01**	100 [?]
Milk and milk products	358.0±4.03	357.6±3.29	326.2±6.46	0.1	8.9	0.85 ^{NS}	4.37**	300 [?]
Meat/poultry	53.3±0.29	53.3±0.36	44.1±0.39	0.1	17.3	0.74 ^{NS}	19.55**	30 [#]
Fats/oils	40.1±0.24	39.6±0.39	35.4±0.35	1.2	11.5	2.24*	12.68**	15 [?]
Sugar/jaggery	39.8±0.29	39.4±0.45	32.2±0.24	1.2	19.2	1.38 ^{NS}	15.92**	NA
Group III								
Cereals	309.8±0.19	309.7±1.30	280.2±2.50	0.1	9.6	0.74 ^{NS}	12.05**	225 [?]
Pulses	76.9±0.34	76.6±0.32	65.9±0.27	0.4	14.2	1.03 ^{NS}	23.27**	60 [?]
Green leafy vegetables	45.8±0.21	46.0±0.39	57.9±0.61	0.5	26.3	1.20 ^{NS}	18.64**	200 [?]
Other vegetables	83.9±0.96	84.1±1.01	98.0±0.67	0.3	16.8	0.90 ^{NS}	12.16**	200 [?]
Roots/tubers	69.6±0.33	68.2±0.68	49.9±0.48	2.0	28.3	2.02*	32.14**	100 [?]
Fruits	62.9±0.63	63.2±0.98	78.1±0.67	0.5	24.2	0.91 ^{NS}	22.18**	100 [?]
Milk and milk products	355.4±5.08	354.2±4.83	316.3±2.06	0.4	11.0	0.94 ^{NS}	8.68**	300 [?]
Meat/poultry	52.8±0.60	52.6±0.57	40.1±0.30	0.5	24.1	1.47 ^{NS}	19.97**	30 [#]
Fats/oils	39.6±0.33	38.9±0.45	33.7±0.22	1.9	14.8	1.75 ^{NS}	17.98**	15 [?]
Sugar/jaggery	36.9±0.47	36.4±0.48	28.6±0.60	1.4	22.5	1.93 ^{NS}	10.45*	NA
Group IV								
Cereals	310.3±0.21	309.7±0.92	286.4±1.89	0.2	7.7	1.13 ^{NS}	12.50**	225 [?]
Pulses	79.0±1.15	78.7±0.93	66.9±0.21	0.3	15.2	0.79 ^{NS}	10.40**	60 [?]
Green leafy vegetables	46.6±0.91	46.9±0.90	54.1±0.29	1.8	16.1	1.42 ^{NS}	7.66**	200 [?]
Other vegetables	73.7±0.81	73.9±1.26	113.7±1.12	0.2	54.2	2.39*	26.82**	200 [?]
Roots/tubers	62.3±1.06	62.0±0.85	52.2±0.57	0.4	19.9	0.68 ^{NS}	8.24**	100 [?]
Fruits	60.4±1.05	61.4±1.35	75.7±0.84	1.6	24.4	2.11 ^{NS}	12.55**	100 [?]
Milk and milk products	336.7±1.30	330.6±4.14	311.8±0.43	1.8	7.4	1.93 ^{NS}	19.03**	300 [?]
Meat/poultry	56.6±0.26	55.6±0.89	46.9±0.29	1.8	17.1	1.57 ^{NS}	23.93**	30 [#]
Fats/oils	40.5±1.28	38.9±1.08	33.0±0.29	4.0	18.5	1.92 ^{NS}	5.79**	15 [?]
Sugar/jaggery	39.3±1.03	37.9±0.89	28.5±0.50	3.6	27.4	1.68 ^{NS}	9.73	NA

Values represent Mean±SE, ** and * indicate significance of values at P=0.01 and P=0.05, respectively

[?]Raguram *et al.* (2007), #ICMR 2003, NS–Non-significant, SB–Supplementation of bael (*Aegle marmelos* L.) leaf, pulp and seed powder, NI– Supplementation of bael (*Aegle marmelos* L.) leaf, pulp and seed powder + Nutrition counseling

Table 2. Mean daily nutrients intake of the subjects before and after bael (*Aegle marmelos* L.) leaf, pulp and seed powder supplementation and nutrition intervention

Nutrient	Before 1	After		Change (%)		Paired t-value		Suggested intake
		2 3 months	3 6 months	Between 1 and 2	Between 1 and 3	Between 1 and 2	Between 1 and 3	
Control								
Group I								
Energy(Kcal)	2184±40.68	2145±36.31	2116±38.67	1.8	3.1	1.40 ^{NS}	1.81 ^{NS}	1500 [?]
Carbohydrates(g)	317.8±0.37	315.8±0.55	313.6±0.55	0.6	1.3	3.54**	5.86**	233 [?]
Protein (g)	89.1±2.00	86.2±1.22	84.5±2.73	3.3	5.2	1.67 ^{NS}	2.52 *	66 [?]
Total fat (g)	61.8±0.51	59.7±1.15	58.2±1.14	3.4	5.8	1.96*	3.41**	33 [?]
Saturated fat (g)	36.9±0.26	34.7±0.37	30.4±1.05	5.9	17.6	5.96**	6.03**	15 [?]
Unsaturated fat (g)	24.9±0.15	25.0±0.16	27.8±0.15	0.4	11.6	1.81 ^{NS}	4.88**	18 [?]
Dietary fibre (g)	54.90±0.19	54.83±0.20	53.83±0.62	1.3	1.9	1.81 ^{NS}	2.12*	40 [?]
Experimental		SB	NI					
Group II								
Energy(Kcal)	2238±23.17	2183±32.12	1909±18.61	2.4	14.7	1.63 ^{NS}	13.19**	1500 [?]
Carbohydrates(g)	328.4±1.49	326.3±2.00	295.9±6.75	0.6	9.9	1.67 ^{NS}	4.60**	233 [?]
Protein (g)	95.1±1.45	91.2±1.14	78.2±2.09	4.1	17.8	3.04**	6.08**	66 [?]
Total fat (g)	60.4±0.75	56.9±0.84	46.3±0.52	5.8	23.3	4.63**	16.17**	33 [?]
Saturated fat (g)	32.0±0.17	27.9±0.69	16.2±0.77	12.8	49.4	5.88**	20.19**	15 [?]
Unsaturated fat (g)	28.4±0.32	29.0±0.39	30.1±0.22	2.3	6.0	2.23*	4.61**	18 [?]
Dietary fibre (g)	52.80±0.44	52.06±0.64	49.30±0.17	1.4	6.6	2.08*	7.93**	40 [?]
Group III								
Energy(Kcal)	2329±23.72	2246±23.54	1927±49.54	3.6	17.3	2.88**	7.03**	1500 [?]
Carbohydrates(g)	338.5±1.93	334.6±2.48	299.1±6.88	1.2	11.6	2.05*	5.49**	233 [?]
Protein (g)	97.3±1.38	92.7±0.99	73.2±1.25	4.7	24.8	3.14**	12.85**	66 [?]
Total fat (g)	65.1±0.39	59.8±0.90	48.7±0.73	8.1	25.2	6.54**	17.56**	33 [?]
Saturated fat (g)	34.9±0.25	27.7±0.61	13.9±0.67	20.6	60.2	10.53**	30.25**	15 [?]
Unsaturated fat (g)	30.2±0.38	32.1±0.64	34.8±0.38	6.3	15.1	2.59**	7.49**	18 [?]
Dietary fibre (g)	56.60±0.17	56.20±0.45	50.40±0.17	0.7	10.9	1.43 ^{NS}	22.29**	40 [?]
Group IV								
Energy(Kcal)	2286±50.91	2179±46.35	1981±46.53	4.7	13.3	1.90 ^{NS}	4.42**	1500 [?]
Carbohydrates(g)	330.7±1.47	321.9±5.14	298.7±4.82	2.7	9.7	1.99 *	7.18**	233 [?]
Protein (g)	99.2±0.92	89.2±1.36	79.3±1.69	10.1	20.1	6.25**	10.51**	66 [?]
Total fat (g)	63.0±1.17	59.3±0.55	52.1±1.40	5.9	17.3	3.19**	7.52**	33 [?]
Saturated fat (g)	35.3±0.16	29.3±0.62	19.9±1.62	16.9	43.6	9.19**	9.81**	15 [?]
Unsaturated fat (g)	27.7±0.61	30.0±0.87	32.2±1.18	7.0	16.2	3.26**	5.39**	18 [?]
Dietary fibre (g)	57.10±0.43	56.56±0.62	42.36±0.58	0.9	25.8	1.60 ^{NS}	19.48**	40 [?]

Values represent Mean±SE, ** and * indicate significance of values at P=0.01 and P=0.05, respectively Raghuram *et al.* (2007), NS – Non-significant, SB-Supplementation of bael (*Aegle marmelos* L.) leaf, pulp and seed powder, NI- Supplementation of bael (*Aegle marmelos* L.) leaf, pulp and seed powder + Nutrition counseling

Conclusion:

The investigation of the present study revealed that supplementation of bael (*Aegle marmelos* L.) leaf, pulp and seed powder along with nutrition counseling improved food intake and nutrient intake of the diabetic subjects. Hence, it can be inferred from the results that supplementation of bael (*Aegle marmelos* L.) leaf, pulp and seed powder along with nutrition counseling significantly improved the food and nutrient intake of the diabetic patients.

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