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RESEARCH ARTICLE

Development of food products incorporating dry powdered figs to explore their hypercholesterolemic potential

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ABSTRACT

Plants have been associated with the health of mankind from time immemorial and also the important source of medicines since the dawn of human civilization. Traditional medicines remain a potential resource for discovering of new compounds with valuable pharmacological activities and are being integrated to the field of food and food additives. The present study was an effort to investigate the reduction of hyperlipidemia by supplementing dry figs (150g/day) for a period of 8 weeks and to develop acceptable food products from dry figs to enhance its nutritional and therapeutic application. Five products were prepared *viz., Idli, Biryani,* cake, *Gujiya* and *Ladoo* by incorporating dry fig powder at 5, 10 and 15% levels along with the standard without incorporation of dry fig powder. Organoleptic analysis of these products was done using nine point hedonic scale by a panel of semitrained personals. Results revealed a significant difference in lipid profile of hypercholesterolemic subjects of the experimental group as compared to the ones belonging to control group. Organoleptic evaluation showed that all the products formulated by incorporating fig powder were well accepted as standard in terms of all the sensory attributes. Thus, it can be inferred that figs, despite having medicinal properties also contribute towards several taste attributes and can be consumed in daily diet by the communities for nourishment and health enhancement.

Key words : Hypercholesterolemia, Fig, Sensory evaluation, Hedonic scale

INTRODUCTION

Hypercholesterolemia is one of the major risk factors in the development of coronary artery disease (CAD) (Bok *et al.*, 1999; Evans and Charles, 2002). Nowadays; many non-prescribed treatments have been made available for lowering the cholesterol. In this regard, traditional medicines are pursued as alternative drugs for treatment of hypercholesterolemia. So far many traditional medicines have been investigated for their therapeutic effects both in humans and in experimental animals (Perez *et al.*, 1999a; Perez *et al.*, 1999b; Evans and Charles, 2002). Fig (*Ficus carica*) commonly called *Anjeer* has been used for several therapeutic effects such as hypoglycaemia (Seccaclara *et al.*, 1998), cancer supperesive (Rubnov *et al.*, 2000), anthelmintic (De-Amorin *et al.*, 1999), hypotriglyceridemia (Asadi *et al.*, 2006; Perez *et al.*, 1999a) and bovine papilomatosis (Hemmatzadeh *et al.*, 2003). Canal *et al.* (2002) showed that chloroform extract obtained from a decoction of fig leaves improved the blood cholesterol in streptozotocin induced diabetic rats. The present study was an endeavour to extend the findings on the effects of dry fig powder on the lipid profile of hypercholesterolemic subjects to determine the proximate composition of dry fig powder and organoleptic evaluation of food products incorporating fig powder.

MATERIALS AND METHODS

The study was conducted in two phases, the first phase involved biochemical evaluation of lipid profile of hypercholesterolemic subjects in pre-and-post intervention states. Thirty hyperlipidemic subjects between the age groups 45-60 years were selected from Jindal Hospital and Research Centre, Sri Ganga Nagar, Rajasthan, India. Appropriate approval was procured from the Institution Review Board and informed consent was obtained from all the patients. Selected sample was further divided in

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two groups *viz.,* Group-A and Group-B of fifteen each by random sampling. The former served as control and the latter as experimental group. No dietary restriction or exercise schedule was prescribed to the subjects.

Serum lipid profile of all the subjects was estimated after overnight fasting on 0 day. Thereafter, the experimental group was supplemented with dry figs, 150g/ day (4-5 pieces) daily for a period of 60 days. The intake of dry figs by all the subjects was monitored regularly. The investigators ensured the intake by the subjects by personally visiting them. Post supplementation biochemical evaluation of blood lipid profile for all the selected subjects was conducted on 60th day.

Serum total cholesterol (TC), triglycerides (TG) and HDL-cholesterol were estimated by using diagnostic kits (Span diagnostic). VLDL and LDL-cholesterol were calculated as per Friedewald's (1972)equation:

VLDL-C = TG/5
LDL-C =TC – (HDL-C + VLDL-C)

The second phase of the study involved proximate analysis of dry fig powder, product development incorporating fig powder and their sensory evaluation.

Processing and preparation of fig powder:

Figs were sun dried for 2-3 days, thereafter oven dried (60±5 ^{0}C for 2 min). They were then ground into fine powder in a semi-automatic grinder and the powder was stored in airtight containers for further use.

Proximate analysis of dry fig powder involved the various nutrients *viz.,* protein (Kingsley, 1942), fat (Folch, 1957), moisture, crude fibre, vitamin- C and ash content (Sharma, 2007).

For organoleptic evaluation, the recipes were selected with the motive to make it suitable for persons suffering from hypercholesterolemia keeping in mind availability of ingredients, ease of preparation. Five products namely *Idli, Biryani,* cake, *Gujiya* and *Ladoo* were prepared incorporating figs as raw or powder form. Three variants incorporating dry figs at 5%, 10%, 15%, levels along with the control, without incorporation of dry figs were prepared fresh and were subjected to organoleptic evaluation through a panel of semitrained personals (n=15), on 'Nine Point Hedonic Scale' for the attributes like appearance, colour, texture, flavour and overall acceptability.

Statistical analysis:

Values are presented as mean ± SD. Statistical significance was analyzed using paired- t test for clinical trials. One way-ANOVA was used for organoleptic evaluation. Differences at $p< 0.05$ were considered significant.

RESULTS AND DISCUSSION

Lipid and lipoprotein abnormalities play a major role in the development and progression of coronary artery disease. Low levels of HDL-C and high levels of LDL-C have been identified as independent coronary risk factors (Wilson *et al.*, 1988)

Studies have shown that about 70% of adults over 50 years suffered from atherosclerosis. Hyperlipidemia is a well known risk factor for atherosclerosis (Castelli *et al.*, 1977). To prevent this disease, a number of hypolipidemic drugs have been administered. However, they all have potential side effects to some extent (Takao, 1999). Traditional medicines have been effectively used against hyperlipidemic conditions. Maghrani *et al.* (2004a) reported that aqueous extract of *Ratama reatem* decreased the levels of cholesterol in streptozotocin induced diabetic rats. Likewise, Yang *et al.* (2004) showed that paenoflorin isolated from methanolic extract of *Paeonia lactifora* lowered serum cholesterol, LDL-C and triglyceride levels in experimentally induced hyperlipidemic rats.

The results of the present study showed that there was significant decrease ($p<0.05$) in total cholesterol, triglyceride and LDL-C of the experimental group as compared to the control group. On the other hand, there was marked increase ($p<0.05$) in HDL-C levels of hypercholesterolemic subjects of experimental groups. However, no significant change was observed in VLDL-C levels of both the groups. These findings are in good agreement with earlier studies (Canal *et al.*, 2002; Maghrani *et al.*, 2000a and 2004b).

Total cholesterol:

Changes in the mean total cholesterol levels of the

Table 1 : Serum mean cholesterol of hypercholesterolemic subjects in pre-and-post intervention stages

Groups	Mean total cholesterol (mg/dl)			t-value	
	Initial (I)	Final (F)	Difference (F-I)	I vs F	Between groups
Control (I)	166.3 ± 0.95	165.9 ± 1.22	+0.45±1.22	0.85 ^{NS}	0.55*
Experimental (II)	213.5 ± 2.84	194.1 ± 0.84	+19.39±0.84	9.18*	

* Significant ($p<0.05$) NS = Non-significant

hypercholesterolemic subjects are shown in Table 1. The mean cholesterol levels of control (I) and experimental (II) groups in pre- supplementation stage (initial/0day) were 166.3 ± 0.95 and 213.5 ± 2.84, respectively. After 60 days of supplementation, a significant decrease ($p<0.05$) was observed in group II (194.1 ± 0.84), while no significant change was observed in group I (165.9 ± 1.22). The decrease in total cholesterol levels in the experimental group could be attributed to the hypocholesterolemic effect of figs. Inter-comparison between the two groups revealed a significant difference as shown in Table 1.

Triglyceride levels:

Mean triglyceride levels of hypercholesterolemic subjects revealed a significant decrease ($p<0.05$) in group II, however, no change was observed in group I as evident from Table 2. A significant difference was observed on inter-comparison between the two groups as shown in Table 2.

HDL-cholesterol levels:

A significant increase in mean HDL-C levels was observed in group II supplemented with dry figs. Mean HDL-C levels increased from 42.8 ± 1.03 to 45.4 ± 0.42. On the other hand, no marked change was shown in the HDL-C levels of hypercholesterolemic subjects belonging to control group. A significant difference was observed on comparison between the two groups as evident from Table 3.

LDL-cholesterol levels:

The mean LDL-C levels of hypercholesterolemic subjects of group II revealed a significant decrease after supplementation where as no significant change was observed in group I. Inter-comparison between the two groups revealed a significant difference as depicted in Table 4.

VLDL-cholesterol levels:

The mean VLDL-C levels of hypercholesterolemic subjects of group II decreased after supplementation, though the decrease was not significant and there was no change in group-I. Inter comparison between the two groups revealed a significant difference as shown in Table 5.

Table 2 : Serum mean triglyceride levels of hypercholesterolemic subjects in pre-and-post intervention stages

Groups	Triglyceride (mg/dl)			t-value	
	Initial	Final	Difference (F-I)	I vs F	Between groups
Control	127.8 ± 0.92	127.0 ± 1.74	+0.86±1.74	1.46 ^{NS}	15.65*
Experimental	164.1 ± 0.99	152.0 ± 1.06	+12.08±1.06	20.07*	

* Significant ($p<0.05$) NS =Non-significant

Table 3 : Serum mean HDL-cholesterol levels of hypercholesterolemic subjects in pre-and-post intervention stages

Groups	HDL-C (mg/dl)			t-value	
	Initial	Final	Difference (F-I)	I vs F	Between groups
Control	42.0 ± 0.92	41.9 ± 0.34	+0.09 ±0.34	0.46 ^{NS}	7.98*
Experimental	42.8 ± 1.03	45.4 ± 0.42	-2.62±0.42	7.33*	

* Significant ($p<0.05$) NS=Non-significant

Table 4 : Serum mean LDL-cholesterol levels of hypercholesterolemic subjects in pre-and-post intervention stages

Groups	LDL-C (mg/dl)			t-value	
	Initial	Final	Difference (F-I)	I vs F	Between groups
Control	98.7 ± 0.32	98.5 ± 0.42	+0.19±0.42	3.4 ^{NS}	90.94*
Experimental	137.8±0.03	118.2± 0.79	+19.6±0.79	42.72*	

* Significant ($p<0.05$) NS = Non-significant

Table 5 : Serum mean VLDL-cholesterol levels of hypercholesterolemic subjects in pre-and-post intervention stages

Groups	VLDL-C (mg/dl)			t-value	
	Initial	Final	Difference (F-I)	I vs F	Between groups
Control	25.5 ± 0.70	25.4 ± 1.26	+0.17±1.26	0.23 ^{NS}	4.9*
Experimental	32.8± 0.79	30.4± 0.48	+2.41±0.48	3.15 ^{NS}	

* Significant ($p<0.05$) NS=Non-significant

Table 6 : Proximate composition of dry figs

Nutrient	Mean ± SD
Moisture (g/100g)	23.6 ± 3.51
Ash (g/100g)	0.5 ± 0.75
Crude fiber (g/100g)	2.7 ± 0.30
Protein (g/100g)	2.7 ± 0.30
Fat (g/100g)	0.4 ± 0.03
Vitamin C (g/100g)	0.6 ± 0.11

fat, crude fiber, vitamin C and ash contents were 2.79±0.30; 0.42±0.03; 2.73±0.30; 0.62±0.11; 0.5±0.75, respectively.

Organoleptic evaluation of three variants of the products *viz., Idli, Biryani,* cake*, Gujiya* and *Ladoo* revealed that, they were acceptable (Table 7-11). Mean scores for colour, appearance, flavour, texture, taste and over all acceptability showed no significant differences

Table 7 : Effect of different levels of powdered dry figs on sensory quality of *Idli*

Attributes	Standard	Sample A	Sample B	Sample C
Appearance	8.4 ± 0.51	8.3 ± 0.48	8.3 ± 0.67	8.0 ± 0.47
Colour	8.2 ± 0.42	8.0 ± 0.66	8.4 ± 0.51	8.3 ± 0.48
Texture	8.1 ± 0.73	8.1 ± 0.56	8.1 ± 0.73	7.9 ± 0.56
Taste	8.8 ± 0.42	8.7 ± 0.48	8.3 ± 0.67	7.9 ± 0.87
Flavour	8.5 ± 0.52	8.5 ± 0.52	8.2 ± 0.78	7.9 ± 0.56
Overall acceptability	8.7 ± 0.48	8.6 ± 0.51	8.6 ± 0.51	8.1 ± 0.56

Standard recipe without incorporation of fig powder
Sample A - Test recipe incorporated with 5%fig powder
Sample B -Test recipe incorporated with10%fig powder
Sample C -Test recipe incorporated with 15% fig powder

Table 8 : Effect of different levels of powdered dry figs on sensory quality of *Biryani*

Attributes	Standard	Sample A	Sample B	Sample C
Appearance	8.8 ± 0.42	8.8 ± 0.42	8.8 ± 0.42	8.6 ± 0.51
Colour	8.3 ± 0.67	8.4 ± 0.63	8.1 ± 0.31	8.2 ± 0.63
Texture	8.4 ± 0.51	8.2 ± 0.63	8.1 ± 0.73	7.9 ± 0.73
Taste	8.6 ± 0.51	8.5 ± 0.52	8.3 ± 0.78	8.3 ± 0.82
Flavour	8.6 ± 0.51	8.6 ± 0.52	8.2 ± 0.78	8.3 ± 0.82
Overall acceptability	8.9 ± 0.31	8.5 ± 0.52	8.5 ±0.52	8.3 ± 0.67

Standard recipe without incorporation of fig powder
Sample A - Test recipe incorporated with 5%fig powder
Sample B -Test recipe incorporated with10%fig powder
Sample C -Test recipe incorporated with 15% fig powder

Table 9 : Effect of different levels of powdered dry figs on sensory quality of *Cake*

Attributes	Standard	Sample A	Sample B	Sample C
Appearance	7.8 ± 0.52	8.0 ± O.66	8.2 ± 0.42	8.4 ± 0.69
Colour	7.9 ± 0.44	8.3 ± 0.67	8.0 ± 0.66	8.1 ± 0.56
Texture	7.5 ± 0.70	7.7 ± 0.67	7.7 ± 0.94	7.7 ± 0.82
Taste	7.7 ± 0.52	8.2 ± 0.42	7.6 ± 0.51	8.3 ± 0.78
Flavour	7.8 ± 0.52	8.2 ± 0.42	7.8 ± 0.42	8.2 ± 0.63
Overall acceptability	7.7 ± 0.52	8.3 ± 0.48	7.8 ± 0.78	8.3 ± O.48

Standard recipe without incorporation of fig powder
Sample A - Test recipe incorporated with 5%fig powder
Sample B -Test recipe incorporated with10%fig powder
Sample C -Test recipe incorporated with 15% fig powder

The results of proximate analysis are shown in Table 6. The moisture content was 23.67± 3.51. The protein, and were equally acceptable to the panelists as standard ones.

Table :10 : Effect of different levels of powdered dry figs on sensory quality of *Gujiya*

Attributes	Standard	Sample A	Sample B	Sample C
Appearance	7.6 ± 0.52	8.3 ± 0.67	8.4 ± 0.84	8.5 ± 0.70
Colour	7.9 ± 0.51	8.3 ± 0.48	8.4 ± 0.51	8.5 ± 0.77
Texture	7.5 ± 0.52	8.0 ± 0.66	8.3 ± 0.67	7.9 ± 0.56
Taste	7.7 ± 0.52	7.9 ± 0.31	8.2 ± 0.78	7.7 ± 0.94
Flavour	7.8 ± 0.52	8.0 ± 0.47	8.0 ± 0.81	7.9 ± 1.10
Overall acceptability	7.7 ± 0.52	8.2 ± 0.67	8.2 ± 0.78	8.0 ± 1.05

Standard recipe without incorporation of fig powder
Sample A - Test recipe incorporated with 5%fig powder
Sample B -Test recipe incorporated with10%fig powder
Sample C -Test recipe incorporated with 15% fig powder

Table 11 : Effect of different levels of powdered dry rigs on sensory quality of *Ladoo*s

Attributes	Standard	Sample A	Sample B	Sample C
Appearance	7.7 ± 0.48	7.3 ± 0.67	7.6 ± 0.51	8.6 ± 0.51
Colour	7.6 ± 0.69	7.4 ± 0.51	8.0 ± 0.47	8.5 ± 0.52
Texture	7.6 ± 1.07	7.7 ± 0.67	7.5 ± 0.97	8.7 ± 0.48
Taste	8.4 ± 0.51	8.0 ± 0.81	8.1 ± 0.56	8.8 ± 0.42
Flavour	7.7 ± 1.05	7.9 ± 0.73	8.4 ± 0.51	8.8 ± 0.42
Overall acceptability	7.6 ± 0.84	7.9 ± 0.56	7.8 ±0.63	8.9 ± 0.31

Standard recipe without incorporation of fig powder
Sample A - Test recipe incorporated with 5%fig powder
Sample B -Test recipe incorporated with10%fig powder
Sample C -Test recipe incorporated with 15% fig powder

Conclusion:

Supplementation with fig powder to hypercholesterolemic subjects helped in reduction of total cholesterol, triglycerides and lipid fractions. Therefore, new innovations such as promoting the use of dry figs as a therapeutic supplement can be used to prevent the onset and progression of degenerative diseases.

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