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Cinnamon and turmeric – its effect on hyperlipidemic diabetics

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To analyze the nutritive value and active principles of cinnamon and turmeric, prepare respective spice capsules and to supplement the diets of hyperlipidemic diabetic adults with the spice capsules for a period of three months. A group of 45 mild to moderate hyperlipidemic diabetics were selected for the supplementation study and were divided into three groups (15 each), two supplementation groups and one control group. To one group, cinnamon and to the other turmeric, both in the form of capsules were supplemented. Clinical examination and biochemical parameters were evaluated before and after supplementation. Most of the clinical symptoms experienced by the cinnamon supplemented group disappeared whereas only few symptoms disappeared in turmeric supplemented group. Cinnamon supplemented group of hyperlipidemic diabetics showed a maximum reduction in lipid and blood sugar levels which were significant at one per cent level. No change was observed in the turmeric supplemented and control group. A positive trend in the control of lipid profile and blood sugar levels was evident in cinnamon supplemented group and longer periods of dietary supplementation of spices could help to maintain the lipid and blood sugar levels.

Keywords: Spices, cinnamon, turmeric, total cholesterol, blood sugar, hyperlipidemia, diabetes mellitus.

INTRODUCTION

The global burden of type 2 diabetes mellitus (T2DM) as estimated for 2010 was 285 million people (2010) which is projected to increase to 438 million in 2030; a 65 % increase. Similarly, for India this increase is estimated to be 58%, from 51 million people in 2010 to 87 million in 2030 (Snehalatha and Ramachandaran, 2009). This burden of diabetes is to a large extent the consequence of macrovascular - coronary artery disease, peripheral vascular disease and atherosclerosis and microvascular - retinopathy, neuropathy and nephropathy - complications of the disease (Permutt et al., 2005). T2DM patients have elevated levels of total cholesterol, LDL Cholesterol, VLDL Cholesterol, hypertriglyceridemia and reduced levels of HDL Cholesterol (Laasko et al., 1987; Demant, 2001; Petersen et al., 2002 and Eschwege, 2003). Food consumption patterns, trade and agricultural policies have changed, encouraging over-consumption of

unhealthy foods and under-consumption of healthy foods (Siegel et al., 2008). The compounds present in certain spices are more effective in controlling diabetes mellitus and serum lipids.

Ever since mankind felt the first pangs of pain or suffered illness and malaise, spices have been used as remedies to treat maladies. Despite modern medical practice with its high tech methods and synthesized drugs people still hold to more traditional methods of treatments and cures using spices. Every spice, from black pepper seeds through cinnamon to mango; banana and foxglove are in the practice of alternative medicine. Herbs and spices are excellent antioxidants, which work to neutralize the attacks made by free radicals against the body. Spices contain phyto nutrients, which may prevent the mutation of healthy cells into cancerous cells. Spices are the powerhouse of pleasure and health (Zak, 2006). A great advantage that the use of herbal remedies has over commercial drugs is the reduced side effects, since the concentration of active ingredients in spices is very much lower. Cinnamon (*Cinnamomum zeylanicum*), has been used to treat diarrhoea and other problems of

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digestive system (Charles,1998) and had traditionally been used to treat toothache and fight bad breath. Its regular use is belived to stave off common cold and aid in digestion (Archer, 1988). Half teaspoon of cinnamon per day can lower LDL cholesterol and has anti diabetic activity (Khan et al., 2003). It is a great source of manganese, fiber, iron and calcium (Palmel et al., 1998). Turmeric, known as 'Indian saffron' due to its brilliant yellow color, is considered the best spice in the world. Turmeric, a multifaceted wonder spice helps to detoxify the liver, balance cholesterol levels, fight allergies, stimulate digestion, boost immunity and enhance complexion. It is also an antioxidant, recognizing turmeric as a healing spice, contributing bitter, pungent and astringent tastes. Activities of turmeric include alterative, analgesic, antibacterial, anti-inflammatory, anti-tumor, anti-allergic, antioxidant, antiseptic, antispasmodic, appetizer, astringent, carminative, cholagogue, digestive, diuretic and stimulant (Shankar and Srivastava, 2007).

The botanicals available in our country have been proved to be safe and effective, through several hundred to thousand years of use. Many actions associated with herbal supplements may help prevent or potentially alleviate hyperlipidemia and diabetes mellitus. With this background the present study was undertaken with the following objectives:

Objectives

➢ To analyze the nutrient content and active principles of the spices namely cinnamon and turmeric.
➢ To prepare the respective spice capsules.
➢ Study the effect of supplementation of hyperlipidemic diabetics with the spice capsules.

METHODS

The study was carried out in an industrial concern in Coimbatore city in Tamil Nadu state where nearly 2000 adults are employed. From this, 500 adults in the age group of 40 to 60 years with hyperlipidemia and diabetes were identified. The controlled nature of the disease condition and their willingness to participate and co-operate in the three months feeding trial formed the basis for selection of adults. One group of 45 mild to moderate hyperlipidemic diabetics were selected for the supplementation study. Details regarding the socio-economic characteristics were gathered through interview method using a pre-tested questionnaire. Questions also included getting information on their lifestyle pattern, health status physiological symptoms experienced and other diseases if any. Five hundred adults including the selected adults for supplementation study and control groups were interviewed. Nutritional assessment was carried out using anthropometric measurements (height,

weight, body mass index (BMI), Waist–hip ratio (WHR)), clinical examination (blood pressure, clinical examination), biochemical assessment (blood haemoglobin, lipid profile, total cholesterol, triglycerides, high density lipoprotein (HDL), low density lipoprotein (LDL) and very low density lipoprotein (VLDL) cholesterol) and food and nutrient intake. After an extensive appraisal of literature pertaining to spices, cinnamon and turmeric were selected. These spices were chosen as they hold great scope for controlling blood cholesterol and blood sugar and are widely practised in Ayurveda system of medicine but lacks strong scientific evidence. The spices cinnamon and turmeric were procured and cleaned. The cleaned spices were then spread in trays and dried in a cabinet drier at 40°C for one hour and allowed to cool. The process was continued until the spices had moisture content less than 10%. The dried spices were then pulverized using a pulveriser, sieved and then stored in air tight containers. The spices in the form of capsules were prepared. Each capsule had approximately 500 mg of spice powders to facilitate easy distribution of appropriate dosage. The nutrients present in the selected spices namely cinnamon and turmeric were analysed using the standard procedures (NIN, 1983). The selected 45 hyperlipidemic diabetics were divided into three groups consisting of 15 adults in each group. Thirty adults (two groups of 15 adults in each group) constituted the experimental group who were given each two grams of cinnamon (HDA) and turmeric (HDD) in the form of capsules daily for a period of three months. The remaining 15 adults constituted the control group (HDE). To the hyperlipidemic diabetic control group, two grams of roasted Bengal gram flour in the form of capsules were given daily till the end of the supplementation period. The adults were asked to consume four capsules per day. The data collected were consolidated and statistically analysed for arriving at the results of the effect of supplementation of cinnamon and turmeric on hyperlipidemic diabetics for various parameters. The Human Ethical Committee approval number is HEC.2007.08.

RESULTS

The results pertaining to the present study are discussed as below:

Demographic and Lifestyle Pattern

Among the 500 adults surveyed, a majority of 30.4 per cent belonged to the age group of 40 to 45 years. The findings of the study revealed a higher prevalence of hyperlipidemic diabetics among adults of 40 to 45 years. All the adults were literates and are sedentary workers. It is clearly seen that 47 per cent of the families were joint

and 53 per cent of them were of nuclear type. Seventy two per cent of the males and 58 per cent of the females were from high income group (> Rs. 7500). Yoga was practised by 45 per cent of the adults either daily, weekly once or twice and 55 per cent of the adults were not practising yoga. Thirty- five per cent of the adults reported that they did exercise regularly from half an hour to one hour in order to keep their body fit and to control the disease condition. Seventy- four per cent of the males had the habit of cigarette smoking. Among them, 55 per cent of the adults were regular smokers and 43 per cent of the adults developed the habit of smoking in the past ten years. Only 26 per cent of the adults did not have the habit of smoking. One hundred and ten adults were not taking alcohol and 60 per cent consumed for the past 10 years and 31 per cent consumed regularly and 34 per cent occasionally. After the onset of the disease, about 34 per cent of adults stopped consuming alcohol. Among the males, 67 per cent did not have the habit of chewing neither tobacco, *pan masala* nor betel leaves. Among females, 60 per cent had the habit of chewing and only 40 per cent did not have this habit. None of the women had the habit of chewing *pan masala,* but a majority (77 %) of women consumed betel leaves.

Dietary Pattern and Medical History

A majority of the male and female adults (61 % and 62 % respectively) were non- vegetarians. When the meal pattern of the adults was considered, 80 % of the adults consumed rice based food items for their breakfast and very less percentage (20 %) of the adults consumed either wheat or *ragi* based food items. Fruits were consumed by 53 per cent of the adults. About 55 per cent of the adults had wheat based and the remaining 45 per cent had rice based preparations for dinner. A great percentage of the adults avoided roots and tubers as they were very much concerned about their disease condition. Data collected regarding the consumption of beverages revealed that majority of the adults consumed both tea and coffee either with (17 %) or without sugar (19 %) depending on their disease condition. About 17 per cent of the adults consumed tea without sugar.

Out of 255 hyperlipidemic diabetics, majority of the adults avoided junk foods, bakery items and snacks (77 %) and sweets (74 %) saying that it may raise the sugar level. Coconut (66 %), non-vegetarian items (71 %) and fried foods (59 %) were avoided by many adults.   Nuts and oil seeds were avoided by 67 per cent adults. Poor diet (no fruit and vegetable consumption), smoking, heavy alcohol consumption and physical inactivity are all associated with higher odds of the syndrome (Science Daily, 2006).

Among the hyperlipidemic diabetics, it is found that 179 adults had diagnosed the condition within ten years, 49 within 10 to 15 and 27 within 15 to 20 years. Only 34

per cent of males and 18 per cent of females did not have the familial history of the condition. All others had either mother, father, grandparents or other relatives suffering from either diabetes mellitus or hyperlipidemia. It is evidently seen that 39 males and 26 females' parents had suffered from the disease condition. Moreover fathers of 34 males and 9 females; mothers of 19 males and 12 females, grandparents of 13 males and 24 females and other relatives of 8 males and 19 females had suffered from either of the disease. Forty seven per cent went for allopathic treatment and 30 per cent took ayurvedic treatment. Siddha treatment was taken by 15 per cent of the hyperlipidemic diabetic adults.

Nutritional Awareness on the Consumption of Spices

The spice cabinet proves to be a source of help for many disease conditions. Only 43.7 per cent males and 46.3 per cent females were aware that spices could help to control or fight against disease conditions. About 56 per cent of males and 54 per cent females with an overall percentage of 55 did not have any idea regarding the medicinal properties of spices. About 53 males and 50 females were aware that fenugreek mixed with jeera could control diabetes mellitus.

Nutrient Analysis of the Selected Spices

The nutrient analysis of the selected spices, namely, cinnamon and turmeric revealed that cinnamon had a moisture content of 6.11 g/100g. The energy content was high in turmeric with 310 Kcal and cinnamon with 190 Kcal per 100 g. Fat content in turmeric was 1.54 g in 100g. Carbohydrate content was found to be highest in turmeric with 44.25 g per cent. Minerals like phosphorus, sodium, potassium and iron were high in turmeric with 71 mg, 0.035 mg, 0.031 mg and 0.009 mg respectively, whereas calcium was high in cinnamon (580 mg). The trace elements like lead, zinc, arsenic and chromium were found to be below the detectable limits, whereas only copper was found among the spices in traces ranging from 0.001 to 0.003. The active principles present in cinnamon included 24 mg of cinnamaldehyde, 0.1 mg of eugenol, 5.14 mg of allicin and 0.03 mg of curcumin. Maximum quantities of curcumin was present in turmeric (0.21 mg %), cinnamaldehyde (36 mg %) and allicin (9.32 mg %). The nutrient content of cinnamon and turmeric could not be compared with the standard ICMR values because ICMR values were analysed for fresh samples whereas in the present study the dried spice powders were analysed.

Mean Food and Nutrient Intake

An increase of only two per cent was seen in the intake of cereals and 25 per cent increase in pulses among the hyperlipidemic diabetics. There was an excess percentage of 40 and seven in the consumption of fats and oils and fleshy foods. Intake of green leafy vegetables and other vegetables were severely deficit compared to the RDA to the tune of 33 and 45 per cent respectively. The consumption of fruits and milk and milk products was also deficit in the range of 60 and 31 per cent respectively. The general observation with regard to food intake is that cereals, pulses, fleshy foods and fats and oils were consumed in excess whereas protective foods such as greens, other vegetables, fruits and milk and milk products were consumed inadequately.

The calorie intake of hyperlipidemic diabetics was three per cent excess than the RDA. There was an eight per cent excess in the intake of both proteins and fats which might be due to increased intake of fleshy foods and pulses. The calcium intake was very high compared to the RDA to the tune of 63 per cent. The carotene intake was markedly deficit among the diabetics with 35 per cent. There was a marked deficit in the intake of vitamin C and fibre with 43 and 63 per cent respectively. The B vitamins i.e. riboflavin was deficit by seven per cent whereas thiamine was taken adequately.

Effect of Supplementation of cinnamon and turmeric on the Symptoms by the hyperlipidemic diabetics

Initially, the triad symptoms of diabetes namely polyuria, polyphagia and polydypsia and other symptoms experienced by hyperlipidemic diabetics i.e. insomnia, oedema, headache, excessive sweating, nocturia, weight loss, constipation, fatigue, giddiness, shivering, burning sensation during micturition, frequency and hesitancy during micturition, breathlessness, palpitation, hypertension, inability to work were not seen after a period of three months of supplementation with cinnamon. Among the group supplemented with turmeric very few adults reported to have no symptoms after supplementation. The symptoms like oedema, headache, excessive sweating, constipation, fatigue, giddiness, shivering, breathlessness and palpitation disappeared on supplementation with turmeric whereas other symptoms did not show any change. Supplementation with cinnamon and turmeric revealed that 12 adults experienced no symptoms in cinnamon group and six in turmeric supplemented group after a period of three months. No change was observed in the clinical symptoms in the control group.

Effect of Supplementation of cinnamon and turmeric on the Nutritional Status of the hyperlipidemic diabetics

Body Weight

Among the hyperlipidemic diabetics it was observed that the initial body weight was 70.73 kg in cinnamon supplemented group, 76.13 kg in turmeric and 75.87 kg in control group. There was a reduction of 2.6 kg in turmeric group (significant at one per cent level) and 1.6 kg in cinnamon group (significant at five per cent level). A reduction of 0.4 kg was observed in the control group which was not significant. When compared between the groups and control group it was observed that the adults supplemented with turmeric showed weight reduction significant at five per cent level respectively. The group supplemented with cinnamon and control groups was not significant. The overall observation revealed that cinnamon supplementation resulted in appreciable weight loss. The U.K. Prospective Diabetes Study (UKPDS) illustrated that individuals newly diagnosed with type 2 diabetes experienced a 2 per cent reduction in hemoglobin A1 results, the largest reduction observed in the study through diet therapy and weight loss (UKPDS Study Group, 1990).

Body Mass Index

It is a welcome observation that the number of obese I category decreased from 37 to 31 after supplementation among hyperlipidemic diabetics. Surprisingly the number of at risk of obesity increased to 32 from 28 in hyperlipidemic diabetics. A BMI > 25 kg/m^2 is associated with several metabolic abnormalities and diseases, including type 2 diabetes, which in turn is associated with cardiovascular diseases (Beebe, 2003).

Waist Hip Ratio

Before supplementation among the hyperlipidemic diabetics 45 were in the normal WHR category of ≤ 0.95 and 30 were in the obese WHR category of ≥ 0.95. But after a period of three months of supplementation with spice capsules it is observed that only 19 were of obese WHR category. The number of normal category WHR adults increased to 56 from 45.

Effect of Supplementation of cinnamon and turmeric on the Biochemical Profile of Hyperlipidemic diabetics

Total Cholesterol

The total cholesterol levels of the Hyperlipidemic diabe-

Table 1. present the total cholesterol levels of the hyperlipidemic diabetics.

Groups	Total cholesterol (mg / dl) Mean ± SD			't' value	
	Initial (I)	Final (F)	Difference	I Vs F	Between Groups
Cinnamon	249.67	195.93	-53.73	20.44**	**HDA Vs HDE**
HDA	± 10.1	± 8.87	± 10.17		17.94**
Turmeric	251.2	217.00	-34.2	16.86**	**HDD Vs HDE**
HDD	± 12.05	± 11.03	± 7.85		13.96**
Control II	253.07	252.4	-0.67	0.59 NS	
HDE	± 7.59	± 8.86	± 4.37		

Desirable   : <200 mg / dl
Borderline high : 200 to 239 mg / dl
High risk   : > 239 mg / dl (18)
** $P < 0.01$; Significant at 1 per cent level
NS Not significant

Table 2. Depicts the mean triglyceride levels of the hyperlipidemic diabetics before and after spice supplementation.

Groups	Triglyceride (mg / dl) Mean ± SD			't' value	
	Initial (I)	Final (F)	Difference	I Vs F	Between Groups
Cinnamon	174.87	138.67	-36.2	13.83**	**HDA Vs HDE**
HAD	± 12.71	± 10.97	± 10.13		11.98**
Turmeric	170.8	158.87	-11.93	10.58**	**HDD Vs HDE**
HDD	± 10.97	± 10.33	± 4.37		6.78**
Control II	177.07	178.67	+1.6	1.02 NS	
HDE	± 12.12	± 12.74	± 6.06		

Normal : < 150 mg / dl ; Borderline high : 150 to 199 mg / dl
High : 200 to 499 mg / dl ; Very high : > 499 mg / dl (18)

tics in the cinnamon supplemented group was 249.67 mg/dl, turmeric group was 251.2 mg/dl and control group was 253.07 mg/dl before supplementation which were above the normal desirable level of < 200 mg/dl and placed in high risk group. A reduction in total cholesterol levels by 195.93 mg/dl and 217 mg/dl was observed among the cinnamon and turmeric supplemented groups but no significant change was observed in the control group after a period of three months. The reduction in the supplemented groups were significant at one per cent level (P<0.01). A comparison between the groups revealed that cinnamon group was more effective followed by turmeric group and was significant at one per cent level. However, the trend of supplementation with spices in lowering the total cholesterol levels gradually is a promising indication that longer periods of supplementation could probably bring down the value to normal values garlic and turmeric supplemented group.(Table 1)

Triglyceride

Serum triglyceride levels of Hyperlipidemic diabetics sup-

plemented with cinnamon, turmeric and control groups were found to be in the borderline high category of 150 to 200 mg/dl initially ranging from 169.33 mg/dl to 177.07 mg/dl. After a period of three months of supplementation with cinnamon and turmeric, there was a mean reduction in the serum triglyceride levels by 36.2 mg/dl and 11.93 mg/dl respectively which was found to be statistically significant at one per cent level. A greater reduction was observed in the cinnamon supplemented group which brings out the potential benefits of cinnamon in lowering the triglyceride levels among the Hyperlipidemic diabetics. No significant change was observed in the control group with regard to triglyceride levels. Lowering triglycerides and increasing HDL cholesterol is associated with a reduction in cardiovascular events in patients with type 2 diabetes mellitus (Klausen et al., 2004). (Table 2)

HDL Cholesterol

HDL cholesterol levels initially in the cinnamon and turmeric supplemented group of Hyperlipidemic diabetics were 36.95 mg/dl and 39.06 mg/dl respectively which

Table 3. The mean HDL cholesterol levels of the hyperlipidemic diabetics before and after supplementation are presented in Table 3.

Groups	HDL Cholesterol (mg / dl) Mean ± SD			't' value	
	Initial (I)	Final (F)	Difference	I Vs F	Between Groups
Cinnamon	36.95	44.08	+7.13	13.72**	**HDA Vs HDE**
HAD	± 2.22	± 2.28	± 2.01		12.10**
Turmeric	39.06	40.36	+1.30	6.68**	**HDD Vs HDE**
HDD	± 1.62	± 1.54	± 0.75		4.06**
Control II	38.93	38.91	-0.02	0.33 NS	
HDE	± 1.74	± 2.17	± 0.85		

Low : < 40 mg / dl
High : > 60 mg / dl (18)

Table 4. The changes in the LDL cholesterol levels of the hyperlipidemic diabetics before and after spice supplementation are presented in Table 4.

Groups	LDL Cholesterol (mg / dl) Mean ± SD			't' value	
	Initial (I)	Final (F)	Difference	I Vs F	Between Groups
Cinnamon	177.74	124.12	-53.62	19.93**	**HDA Vs HDE**
HDA	± 9.66	± 8.45	± 10.41		17.48**
Turmeric	177.98	144.87	-33.11	15.77**	**HDD Vs HDE**
HDD	± 11.47	± 10.03	± 8.12		13.10**
Control II	178.73	177.76	-0.31	0.26 NS	
HDE	± 8.18	± 9.16	± 4.67		

Optimal : < 100 mg / dl
Near optimal : 100 to 129 mg / dl
Borderline high : 130 to 159 mg / dl
High : 160 to 189 mg / dl
Very high : > 189 mg / dl (18)

were closer to the lower range of normal values of <40 mg/dl. After three months of supplementation an increase of 7.13 mg/dl and 1.3 mg/dl were observed in the HDL levels among cinnamon and turmeric supplemented groups with a highest increase in cinnamon (7.13 mg/dl) supplemented group. The increase in HDL levels was at one per cent level. There was no significant difference in increase in the control group. A comparison of the groups with the control group with regard to the increase in HDL values revealed a statistically significant difference at one per cent level. Maximum increase was seen in the cinnamon supplemented group followed by turmeric group. Results of the study revealed greater scope for increasing the HDL cholesterol levels by supplementing spices such as cinnamon and turmeric. Elevated levels of HDL cholesterol actually lower the risk of CHD (greater than or equal to 60 mg/dl) and is considered a negative risk factor for CHD (Block et al., 2007). (Table 3)

LDL Cholesterol

LDL cholesterol levels in the cinnamon and turmeric groups of hyperlipidemic diabetics were found to be in the high risk category of 160 to 189 mg/dl initially ranging from 177.74 mg/dl to 184.79 mg/dl. After supplementation with spices for three months there was a reduction in the LDL cholesterol levels in the cinnamon group by 53.62 mg/dl and was found to be significant at one per cent level. A lower reduction was found in the turmeric group (33.11 mg/dl). LDL cholesterol level in the control group did not show any change. The reduction in the LDL cholesterol levels in the spices supplemented groups compared with control group was found to be significant at one per cent level. Maximum reduction between groups was seen in the cinnamon supplemented group. (Table 4)

VLDL Cholesterol

The mean initial VLDL cholesterol levels in the experimental and control groups of adults with hyperlipidemic diabetics was 34.97 mg/dl (cinnamon group), 34.16 mg/dl (turmeric group) and 35.41 mg/dl (control group) which were closer to the higher range of normal values. On supplementation with spices, the cinnamon group showed a reduction of 7.24 mg/dl being the maximum, which was in the desirable range bringing

Table 5. gives the VLDL cholesterol levels of the hyperlipidemic diabetics before and after supplementation of spices.

Groups	VLDL Cholesterol (mg / dl) Mean ± SD			't' value	
	Initial (I)	Final (F)	Difference	I Vs F	Between Groups
Cinnamon	34.97	27.73	-7.24	13.83**	**HDA Vs HDE**
HDA	± 2.54	± 2.19	± 2.03		12.38**
Turmeric	34.16	31.77	-2.39	10.58**	**HDD Vs HDE**
HDD	± 2.19	± 2.07	± 0.87		7.45**
Control II	35.41	35.73	0.48	1.61[NS]	
HDE	± 2.42	± 2.55	± 1.15		

Normal value   : 5 to 40 mg / dl (18)

Table 6. presents the fasting blood sugar levels among hyperlipidemic diabetics before and after supplementation of spices.

Groups	Fasting Blood Sugar (mg/dl) Mean ± SD			't' value	
	Initial (I)	Final (F)	Difference	I Vs F	Between Groups
Cinnamon	161.00	113.93	-47.07	19.03**	**HDA Vs HDE**
HDA	± 9.51	± 6.3	± 9.57		18.10**
Turmeric	165.07	149	-16.07	8.28**	**HDD Vs HDE**
HDD	± 9.91	± 9.66	± 7.51		7.89**
Control II	165.87	165.33	+0.4	0.72[NS]	
HDE	± 9.24	± 9.48	± 2.16		

Desirable level : 80 to 115 mg / dl (21)

out the potentials of cinnamon and cloves. The mean VLDL cholesterol levels reduced by 2.39 mg/dl respectively among the turmeric supplemented group. The decrease in the VLDL cholesterol levels between initial and final values was significant at one per cent level in the experimental groups whereas the difference in the control group was not significant. Differences in the VLDL cholesterol levels in the spices supplemented groups with control group were also statistically significant at one per cent level. The findings revealed that the spices had the potential of lowering the risky VLDL cholesterol levels among adults. (Table 5)

Fasting Blood Sugar

The initial mean fasting blood sugar level in the control and experimental groups of hyperlipidemic diabetics were 161 mg/dl in the cinnamon group, 165.07 mg/dl in the turmeric group and 165.87 mg/dl in the control group which were well above the normal range of 80 to 115 mg/dl (21). Adults in the supplementation group improved their fasting blood sugar levels after three months period. A maximum reduction of fasting blood sugar level was seen among the cinnamon group with 47.07 mg/dl followed by turmeric group with 16.07 mg/dl. The fasting blood sugar levels were brought to normal among cinnamon bringing out the impact of supplementation of

spices whereas in turmeric group the levels remained slightly higher. This decreases in the initial and final values in the experimental groups with regard to fasting blood sugar levels were significant at one per cent level whereas the difference in the control group was not significant. Difference in the fasting blood sugar levels between the experimental and control groups also revealed a statistically significant reduction at one per cent level. (Table 6)

Post Prandial Blood Sugar

The mean post prandial blood sugar levels before supplementation was 262.6 mg/dl, 261.27 mg/dl and 259.53 mg/dl in the cinnamon and turmeric supplemented groups with control group which was much higher than the normal range of 120 to 160 mg/dl (Bamji et al., 200). There was a reduction observed in the post prandial blood sugar levels due to supplementation with spices over a period of three months. The reduction in the post prandial blood sugar levels were found to be 56 mg/dl and 21.8 mg/dl among the cinnamon and turmeric supplemented groups which were found to be statistically significant at one per cent level. Even the control group showed a reduction in the post prandial sugar levels of 4.87 mg/dl which was negligible. This reduction in the supplemented groups was significant at one percent

Table 7. gives the post prandial blood sugar levels of the hyperlipidemic diabetics before and after supplementation with spices.

Groups	Post Prandial Blood Sugar (mg / dl) Mean ± SD			't' value	
	Initial (I)	Final (F)	Difference	I Vs F	Between Groups
Cinnamon	262.6	206.6	-56.0	22.65**	**HDA Vs HDE**
HDA	± 11.69	± 9.7	± 9.57		17.56**
Turmeric	261.27	239.47	-21.8	9.17**	**HDD Vs HDE**
HDD	± 15.74	± 19.4	± 9.2		5.99**
Control II	259.53	254.67	-4.87	3.62**	
HDE	± 13.31	± 14.97	± 5.21		

Desirable level: 120 to 160 mg / dl (21)

Table 8. presents the blood glycosylated haemoglobin levels among hyperlipidemic diabetics before and after supplementation of spices.

Groups	Glycosylated Haemoglobin (per cent / 100 ml) Mean ± SD			't' value	
	Initial (I)	Final (F)	Difference	I Vs F	Between Groups
Cinnamon	7.91	5.96	-1.95	11.29**	**HDA Vs HDE**
HDA	± 0.52	± 0.55	± 0.67		10.78**
Turmeric	8.15	7.95	-0.2	4.97**	**HDD Vs HDE**
HDD	± 0.45	± 0.41	± 0.16		4.07**
Control II	7.85	7.84	-0.01	0	
HDE	± 0.43	± 0.41	± 0.07		

Non diabetic : 4 to 5.6 per cent
Good control : 5.6 to 7 per cent
Fair control : 7 to 8 per cent
Poor control : above 8 per cent (22)

level. Comparison of post prandial blood sugar levels between the experimental and control groups showed that all the groups were significant at one per cent level. But cinnamon was more effective in reducing the post prandial sugar level than turmeric over the supplementation period of three months. (Table 7)

Glycosylated Haemoglobin

The mean glycosylated haemoglobin levels of Hyperlipidemic diabetics were 7.91 per cent/100 ml, 8.15 per cent/100 ml and 7.85 per cent/100 ml among cinnamon, turmeric supplemented groups and control groups respectively which were nearer to poor control levels of more than 8 per cent/100 ml initially (Trivedi et al.,1978). A reduction of 1.95 per cent / 100 ml was observed in the cinnamon group. The decrease in experimental group was found to be statistically significant at one per cent level (P<0.01). No change was observed in the control group. A comparison of all the groups with the control group revealed a statistically significant reduction at one per cent level with regard to glycosylated haemoglobin levels. (Table 8)

CONCLUSION

Variety is the spice of life and enjoying a variety of spices helps us live a healthier life as well. The interest generated by the health effects of spices might contribute to the introduction of the changing food habits of the population thus pointing to the increasing need for incorporation of spices into the daily dietaries. The results of supplementation with cinnamon and turmeric to Hyperlipidemic diabetics indicated the probable role of spices in the management of Hyperlipidemia and diabetes and its associated symptoms. A positive trend in the control of lipid profile and sugar levels was evident in cinnamon supplemented group and longer periods of dietary supplementation of spices could help to maintain the lipid and blood sugar levels. This positive impact on Hyperlipidemic diabetics is encouraging and being a dietary intervention it is devoid of other possible side effects, proving that spices supplementation is a cost effective and sustainable strategy.

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