

*Full Length Research Paper*

# Effect of cinnamon and garlic on hyperlipidemics

Balasarikha, R.\* and Lakshmi, U. K.

Department of Food Science and Nutrition, Avinashilingam Deemed University for Women Coimbatore – 641 043, Tamil Nadu, India.

Accepted 01 July, 2011

Spices have been used to preserve food, enhance their flavour and as remedies for a long list of ailments and are effective in controlling serum lipids. The objectives were to analyze the nutritive value and active principles of cinnamon and garlic, prepare the respective spice capsules and to supplement the diets of hyperlipidemics with the spice capsules for a period of three months. A group of 45 mild to moderate hyperlipidemics were selected for the supplementation study was divided into three groups (15 each), two supplementation and one control group. To one group, cinnamon in the form of capsules and to the other garlic capsules was supplemented. Cinnamon and garlic after a series of processing steps were made to capsules of 500 mg each. Clinical examination, biochemical parameters were analysed before and after supplementation. The results revealed that the clinical symptoms experienced by the cinnamon supplemented group disappeared whereas only few symptoms disappeared in garlic supplemented groups. Cinnamon supplemented group of hyperlipidemics showed a maximum decrease in total cholesterol, triglycerides, LDL and VLDL cholesterol and an increase in the HDL cholesterol which were significant at 1% level. No change was observed in the control group.

**Key words:** Spices, cinnamon, garlic, hyperlipidemics.

## INTRODUCTION

Spices have been used to preserve food, enhance their flavour and as remedies for a long list of ailments. There is now a much renewed interest in these alternative medicines, with many new medicinal uses of spices and herbs coming to light. Today the pendulum is swinging back and researchers are confirming what herbalists have known all along that, the spice rack can be as potent as a medicinal chest. 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 herbs is much lower.

Cinnamon (*Cinnamomum zeylanicum*), has been used to treat diarrhoea and other problems of digestive system (Charles, 1998). Cinnamon had traditionally been used to treat toothache and fight bad breath and its regular use is believed to stave off common cold and aid in digestion (Archer, 1988). Half teaspoon of cinnamon per day can lower LDL cholesterol (Khan et al., 2003). Cinnamon has shown an amazing ability to stop medication resistant yeast infections ([www.herbwisdom.com](http://www.herbwisdom.com)). Smelling cinnamon boosts cognitive function and memory. It is a great source of manganese, fiber, iron and calcium (Palmer et al., 1998).

Garlic the dried root of *Allium sativum*, has been used throughout recorded history for both culinary and medicinal purposes. Garlic supplementation reduced accumulation of cholesterol on vascular walls of animals (Sovova and Sova, 2004). Garlic is used for treatment of intestinal worms, both orally and as an anal suppository, remedy for infections, digestive disorders and fungal infections (Sivam, 2001). Garlic also has been successful in treating cryptosporidium in AIDS patients (Fareed et al., 2007) and in treating toxoplasmosis, another

---

\*Corresponding author. E-mail: [balasarikhar@yahoo.co.in](mailto:balasarikhar@yahoo.co.in).

**Abbreviations:** BMI, Body mass index; WHR, waist-hip ratio; HDL; high-density lipoprotein; LDL, low-density lipoprotein; VLDL, very-low-density lipoprotein; ICMR, international center for materials research; RDA, recommended dietary allowance.

protozoal disease (John, 1988).

Cardio vascular diseases are the number one cause of death globally; more people die annually from cardio vascular diseases than from any other cause. By 2015, almost 20 million people will die from cardio vascular disease mainly from heart disease and stroke (World Health Report, 2004). The causes of cardio vascular diseases are well established and well known which include unhealthy diet, inadequate physical activity (may show up in individuals as raised blood pressure, blood glucose, blood lipids and overweight and obesity which are called intermediate risk factors) and tobacco use which are called modifiable risk factors.

The compounds present in certain spices are more effective in controlling serum lipids. 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.

With this background the study on "Effect of Cinnamon and Garlic on Hyperlipidemics" was undertaken with the following objectives:

1. To analyze the nutritive value and active principles of the selected spices namely, cinnamon and garlic.
2. To prepare the respective spice capsules.
3. To supplement the diets of selected hyperlipidemics with the spice capsules for a period of three months and analyze the effect of supplementation.

## MATERIALS AND METHODS

The study was carried out in an industrial concern in Coimbatore city in Tamilnadu state where nearly 2000 adults are employed. From this, 500 adults in the age group of 40 to 60 years with hyperlipidemia 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 hyperlipidemics 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 garlic were selected. These spices were chosen as they hold great scope for controlling blood cholesterol and are widely practised in Ayurveda system of medicine but lacks strong scientific evidence. The spices cinnamon and garlic were procured and cleaned. The cleaned spices (garlic dried as a whole clove) 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 490 to 500 mg of spice powders to facilitate easy distribution of appropriate dosage.

The nutrients present in the selected spices namely cinnamon and garlic were analysed using the standard procedures (NIN, 1983). The selected 45 hyperlipidemics 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 (HA) and garlic (HC) in the form of capsules daily for a period of three months. The remaining 15 adults constituted the control group (HE). To the hyperlipidemic control group, two grams of powdered sugar 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 garlic on hyperlipidemics for various parameters.

## RESULTS AND DISCUSSION

The results pertaining to the present study entitled "Effect of cinnamon and garlic on Hyperlipidemics" is discussed under the following headings:

### Demographic and lifestyle pattern

The background information of the hyperlipidemics such as age and sex, educational status, occupation, type of family, monthly income and life style pattern of the adults such as doing yoga, exercise, habit of smoking, alcohol consumption, chewing habits, consumption of tea, coffee and health drinks are discussed below (Tables 1 and 2).

### Age

A majority of 33.2% of the males were in the age group of 51 to 55 years, whereas only 19% of the males were in the age group of 56 to 60 years. Among the females a majority of 36.1% were in the age group of 40 to 45 years with a minority of 16.1% in the age group of 56 to 60 years. Among the 500 adults surveyed a majority of 30.4% belonged to the age group of 40 to 45 years. The findings of the study revealed a higher prevalence of hyperlipidemia was among adults of 40 to 45 years.

### Educational status

All the adults were literates. It is a welcome observation that about 51% of males and 61% of females are graduates and 25% of males have completed professional courses.

### Occupational status

Twenty three percent of the males are engineers. 41% of

**Table 1.** Demographic pattern of the adults.

Age in years	Male		Female		Total	
	Number	Percent	Number	Percent	Number	Percent
40 – 45	78	26.4	74	36.1	152	30.4
46 – 50	63	21.4	61	29.8	124	24.8
51 – 55	98	33.2	37	18.0	135	27.0
56 – 60	56	19.0	33	16.1	89	17.8
<b>Level of education</b>						
Primary School	2	0.7	16	7.8	18	3.6
High School	27	9.2	21	10.2	48	9.6
Higher Secondary	40	13.5	43	21.0	83	16.6
Graduate	151	51.2	125	61.0	276	55.2
Professional Degree	75	25.4	0	0	75	15.0
<b>Occupation</b>						
Engineers	69	23.4	0	0	69	13.8
Government / Private concern	121	41.0	59	28.8	180	36.0
Business	78	26.4	19	9.3	97	19.4
Retired adults	27	9.2	14	6.8	41	8.2
Home-makers	0	0	113	55.1	113	22.6
<b>Type of the family</b>						
Joint	103	35	133	64.9	236	47.2
Nuclear	192	65	72	35.1	264	52.8
<b>Size of the family</b>						
3 - 5	260	88.1	154	75.1	414	82.8
Above 5	35	11.9	51	24.9	86	17.2
Total	<b>295</b>	<b>100</b>	<b>205</b>	<b>100</b>	<b>500</b>	<b>100</b>

N=500.

males and 29% of females are employed either in government or private concerns. Twenty six percent males are engaged in business and 9% are retired adults. Nine percent of the females are self-employed, 7% retired and majority of 55% of the females are housewives. All the adults are sedentary workers.

### Type and size of the family

It is clearly seen from the table that 47% of the families are joint and 53% of them are nuclear type. Among the males, 88% are living in 3 to 5 membered families whereas remaining 12% are having more than five membered families. Among the females, 75% have 3 to 5 membered families and 25% of them are having more than five membered families.

### Monthly income

Housing status is an indicator of social position that is

linked to household income. 72% of the males and 58% of the females are from high income group (> Rs. 7500). Among the males, 23 and 5% are from middle and low income group respectively. 14% of females are from low and 29% of females are from middle income group according to the HUDCO classification.

### Yoga practice

Physical activity is a medium for fitness and good health which keeps away a heart specialist from an individual. Yoga is practised by 45% of the adults either daily, weekly once or twice and 55% of the adults are not practising yoga.

### Exercise pattern

Thirty five percent of the adults reported that they do exercise regularly from half an hour to one hour in order to keep their body fit and to control the disease condition.

**Table 2.** lifestyle pattern of the adults.

Yoga practice	Male		Female		Total	
	Number	Percent	Number	Percent	Number	Percent
Yes	145	49.2	81	39.5	226	45.2
Daily (1/2 to 1 hour)	67	22.7	48	23.4	115	50.9
Weekly once	56	19.0	18	8.8	74	32.7
Weekly twice	22	7.5	15	7.3	37	16.4
No	150	50.8	124	60.5	274	54.8
<b>Exercise pattern</b>						
Yes	157	53.2	18	8.8	175	35
No	138	46.8	187	91.2	325	65
Total	295	100	205	100	500	100
<b>Duration of exercise</b>						
0 – 30	129	82.2	16	88.9	145	82.8
30 – 60	13	8.3	2	11.1	15	8.6
> 60	15	9.5	0	0	15	8.6
<b>Habit of chewing</b>						
Yes	98	33.2	123	60	221	44.2
No	197	66.8	82	40	279	55.8
<b>Duration of chewing (in years)</b>						
< 10	12	12.2	33	26.8	45	20.4
11 – 20	44	44.9	47	38.2	91	41.2
21 - 30	15	15.3	21	17.1	36	16.2
> 30	27	27.6	22	17.9	49	22.2
Total	157	100	18	100	175	100

N=500.

All the adults who exercised either go for walking or jogging. Gardening, cycling, swimming and games like playing shuttle cock, tennis or playing cricket with children, climbing stairs were also practised. All the females are engaged in household work and 52 males do household work.

### Smoking pattern and alcohol consumption

74% of the males have the habit of cigarette smoking. Among them 55 %of the adults are regular smokers, 15 %occasional smokers and 30% are ex-smokers. 43% of the adults developed the habit of smoking in the past ten years and about 15 %of them from their college days, that is, for the past 21 to 30 years. About 31% of adults use 5 to 10 cigars per day, whereas 10% of adults use more than 20 cigars per day. Only 26% of the adults do not have the habit of smoking.

110 adults are not used to alcohol. With regard to the duration of alcohol consumption, 60% consumed for the past 10 years and 31% consumed regularly and 34%

occasionally. After the onset of the disease, about 34% of adults stopped consuming alcohol.

### Habit of chewing

The habit of chewing is practised by a substantial portion of the world's adult population due to its stimulant activity.

Among the males, 67% did not have the habit of chewing neither tobacco, pan masala nor betel leaves. 23 males stopped chewing after the onset of the disease. Among females, 60% had the habit of chewing and only 40% did not have this habit. None of the women had the habit of chewing pan masala, but a majority of 77% of women consumed betel leaves. 28% of males and 18% of females had the habit of chewing for the past 30 years.

### Dietary pattern and medical history of the adults

The dietary pattern of the selected adults such as food consumption pattern, meal pattern, cooking methods

**Table 3.** Dietary pattern of the selected adults.

	Male		Female		Total	
	Number	Percent	Number	Percent	Number	Percent
Vegetarian	86	29.2	56	27.3	142	28.4
Ova-vegetarian	29	9.8	23	11.2	52	10.4
Non-vegetarian	180	61.0	126	61.5	306	61.2
Total	295	100	205	100	500	100

N=500

adopted, type of fats and oils used, consumption of beverages and the medical history such as duration of the disease, familial trait, mode and duration of treatment are discussed (Table 3).

### Food consumption pattern

A majority of the male and female adults sixty one and sixty two percent respectively were non – vegetarians. Pure vegetarians among the males accounted for 29% and among the females 27%. A group of 10% of males and 11% of females consumed only egg along with the vegetarian diet and are considered as Ova vegetarians.

All the male and female adults consumed three meals a day. 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 which is comparatively lower. All the adults consumed full lunch. Fruits were consumed by 53% of the adults in the evening. About 55% of the adults had wheat based and the remaining 45% 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.

### Methods of cooking and types of fats and oils used

53% of adults included raw salad, that is, chopping vegetables to pieces and adding salt, lime and pepper to have along with their diet. All the adults used steaming, roasting and boiling as a method of cooking. About 53 and 61% of adults adopted frying and stewing methods for cooking. Bakery items were used by 56% adults. Majority of the adults used moist heat methods for various food preparations.

Gingelly oil (56%) and groundnut oil (60%) were used for cooking. 10% of the adults used olive oil for various food preparations. 45% adults used ghee and 18% used butter for consumption by adding to several dishes.

### Consumption of beverages

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% of the adults consumed tea without sugar. 12% of the adults did not consume any beverage.

### Foods included and foods avoided

Out of the 245 hyperlipidemic adults, a majority of 42 and 32% of consumed green leafy vegetables, vegetables and fruits as special food items. This was followed by pulses and grams and oats kanji (32 and 23%). Many adults expressed that they included oats to reduce or maintain their body weight

Eighty five and 74% of hyperlipidemic adults avoided coconut and salt in their diet. 66% of adults avoided nuts and oil seeds and 54% avoided deep fat fried foods as they contain more oil. It was also observed that many adults avoided junk foods (40%), milk and milk products (42%) and non-vegetarian items (35%). About 17% of the hyperlipidemic adults did not follow any dietary modifications.

### Duration of the disease and familial trait

It is observed that among the 500 adults, 245 adults had hyperlipidemia. It is found that 44 males and 19 females had hyperlipidemia for the past five years. About 32 males and 24 females had this problem for about 10 to 15 years. Twenty three males and 18 females had the symptoms for the past one year and 23 males and 19 females for about 15 to 20 years. Regarding the familial trait, majority of the males (37) and females (29) both parents had either hyperlipidemia or diabetes mellitus. About 27 males and 23 females did not show any familial history of hyperlipidemia.

### Type and duration of treatment

A total of 8% of the hyperlipidemic adults were taking treatment for a period of 1 to 5 years. This finding revealed that when people are suffering from twin or more diseases, they are very much concerned about

**Table 4.** Awareness about spices by the selected adults.

Awareness about the spices	Male		Female		Total	
	Number	Percent	Number	Percent	Number	Percent
Aware	129	43.7	95	46.3	224	44.8
Not aware	166	56.3	110	53.7	276	55.2
Total	295	100	205	100	500	100
Spices* (Number of adults)						
Honey + Cinnamon	11		12		23	10.3
Garlic	13		19		32	14.3
Khus khus	5		4		9	4.0
Cloves	6		5		11	4.9
Ginger	6		10		16	7.1
Badam	7		2		9	4.0
Pepper + Cumin	8		13		21	9.4
Fenugreek + Jeera	53		50		103	46.0

N=500. \* Multiple response.

treatment options and durations. It is evident that among the hyperlipidemic adults about 80% of males and 92% of females did not take any treatment to control the disease. They were maintaining their lipid levels through the diet modification. With regard to the type of treatment a majority (12%) of hyperlipidemic adults went for allopathic treatment with three percent taking ayurvedic treatment.

### Nutritional awareness on the consumption of spices

The spice cabinet proves to be a source of help for many disease conditions. Only 43.7% males and 46.3% females were aware that spices could help to control or fight against disease conditions. About 56% of males and 54% females with an overall percentage of 55 did not have any idea regarding the medicinal properties of spices. The medicinal value of garlic was reported by 13 males and 19 females (overall 14%). It is evident that some awareness is found among the public about the role of spices in medicine (Table 4).

### Nutrient analysis of the selected spices

The nutrients present in the spice powders namely cinnamon and garlic were analyzed in the laboratory and the results are presented in Table 5. The nutrient analysis of the spices cinnamon and garlic revealed that cinnamon had moisture 6.11 g/100 g and energy 190 Kcal per 100 g. The protein content was high in garlic with 11.23 g and a fat content of only 0.2 g%. Carbohydrate content was found to be 26.56 g% in garlic. Mineral calcium was high in cinnamon (580 mg). B complex vitamins like thiamine were maximum in garlic with 0.21 mg and niacin with 0.59 mg in cinnamon. Vitamin A was found to be high in

garlic with 106 µg. 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 0.002. The active principles present in cinnamon included 24 mg of cinnamaldehyde, 0.1 mg of eugenol, 3.68 mg of allicin and 0.03 mg of curcumin. With regard to garlic, 5.14 mg of allicin and 14 mg of cinnamaldehyde, 0.18 mg of eugenol and 0.14 mg of curcumin were present. The nutrient content of the spices i.e. cinnamon and garlic could not be compared with the standard International Center for Materials Research (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

The mean food and nutrient intake of the hyperlipidemics is given in Table 6. It was observed that the consumption of cereals was more than the recommended allowance by 53.6% among the hyperlipidemic adults. Consumption of pulses followed the same trend with 16.7% among the adults. The intake of green leafy vegetables and other vegetables was deficit by 55 and 26.7%, respectively. The consumption of roots and tubers was in excess among the hyperlipidemic adults by 55%. The intake of fruits (40%), milk and milk (5%) products was also generally inadequate among the males. The consumption of fleshy foods, fats and oils were in excess of 20 and 33%, respectively. The findings revealed that a high intake of fleshy foods and fats and oils might have predisposed the selected adults for hyperlipidemic conditions.

There was an excess intake in the consumption of energy to the tune of 11% by the hyperlipidemic adults. Compared to the RDA there was an excess in the

**Table 5.** Nutrient content of cinnamon and garlic (in 100 g).

Nutrient	Cinnamon	Garlic
Moisture (g)	6.11	8.17
Energy (Kcal)	190	220
Protein (g)	7.15	11.23
Fat (g)	0.85	0.2
Carbohydrate (g)	39.75	26.56
Ash (g)	4.08	4.41
Calcium (mg)	580	370
Phosphorus (mg)	0.06	68
Sodium (mg)	0.028	0.032
Potassium (mg)	0.021	0.029
Iron (mg)	0.006	0.008
Thiamine (mg)	0.09	0.21
Riboflavin (mg)	0.03	0.06
Niacin (mg)	0.59	0.13
Vitamin A (µg)	49	106
Vitamin C (mg)	28	6
Crude Fibre (g)	9.59	7.38
Lead (mg)	bdl	bdl
Copper (mg)	0.001	0.002
Zinc (mg)	bdl	bdl
Arsenic (mg)	bdl	bdl
Chromium (mg)	bdl	bdl
Cinnamaldehyde (mg)	24	14
Eugenol (mg)	0.1	0.18
Allicin (mg)	5.14	3.68
Curcumin (mg)	0.03	0.14

bdl – below detectable limits.

**Table 6.** Mean food and nutrient intake.

Food groups	RDA*	Mean intake	% excess or deficit	Nutrients	RDA*	Mean intake	% excess or deficit
Cereals (g)	140	295	+53.6	Energy (Kcal)	1000	1115	+11.5
Pulses (g)	30	35	+16.7	Protein (g)	38	56	+47.4
Green leafy vegetables (g)	100	45	-55.0	Fat (g)	22	25	+13.6
Roots and tubers (g)	100	155	+55.0	Calcium (mg)	800	401	-49.9
Other vegetables (g)	150	110	-26.7	Beta carotene (µg)	4000	1600	-60.0
Fruits (g)	100	60	-40.0	Thiamine (mg)	0.9	1.2	+33.3
Milk and milk products (g)	200	190	-5.0	Riboflavin (mg)	0.9	1.2	+33.3
Fats and oils (g)	15	20	+33.3	Vitamin C (mg)	135	53	-60.7
Fleshy foods (g)	50	60	+20.0	Fibre (g)	35	15.3	-56.3

\*ICMR (2004). N = 75 each.

consumption of proteins and fat by 47 and 13%, respectively. When B vitamins namely thiamine and riboflavin were considered there was an excess of 33.3%, among both. There was a deficit of 60%, in the consumption of vitamin C. Minerals like calcium were deficit in the range of 49%. There was a severe deficit in the

consumption of fiber to the tune of 56%.

The general observation from the nutrient intake data revealed that there was an excess intake of energy, protein and fat than the recommended dietary allowance (RDA) whereas a deficit intake of beta carotene, vitamin C and fibre which requires proper diet counseling among

**Table 7.** Changes in the mean body weight.

Group	Weight (Kg) Mean $\pm$ SD			't' value	
	Initial (I)	Final (F)	Difference	I Vs F	Between groups
Cinnamon (HA)	71.73 $\pm$ 8.09	69.87 $\pm$ 7.82	-1.86 $\pm$ 1.92	3.76**	HA Vs HE 0.67 <sup>NS</sup>
Garlic (HC)	71.6 $\pm$ 10.51	71.03 $\pm$ 9.44	-0.57 $\pm$ 1.84	0.98 <sup>NS</sup>	HC Vs HE 0.02 <sup>NS</sup>
Controll (HE)	76.07 $\pm$ 8.03	75.53 $\pm$ 7.91	-0.53 $\pm$ 7.2	0.24 <sup>NS</sup>	

\*\* P < 0.01; Significant at 1 %level. <sup>NS</sup> Not Significant.

**Table 8.** Changes in the body mass index.

BMI classification*	Obesity grade	Hyperlipidemics	
		Before	After
< 18.5	Underweight	-	-
18.5 to 22.9	Normal	14	20
23.0 to 24.9	At risk of obesity	26	20
25.0 to 29.9	Obese I	31	31
$\geq$ 30.0	Obese II	4	4
Total		75	75

\* WHO (1999).

the hyperlipidemics.

### Clinical symptoms experienced by the hyperlipidemics

The clinical symptoms observed among hyperlipidemics like polyphagia, polydypsia, headache, nocturia, weight gain, fatigue, giddiness, shivering, breathlessness, palpitation, hypertension, inability to work were found to disappear after a three months period of supplementation with cinnamon. Among the adults supplemented with garlic the symptoms like polyuria, polyphagia, polydypsia, insomnia, oedema, headache, nocturia, weight loss, weight gain, fatigue, giddiness, shivering, breathlessness, palpitation, hypertension and asthma showed a minor change after supplementation. It was seen that all the fifteen adults did not suffer any clinical symptoms after consumption of capsules of cinnamon, whereas only very few adults moved to such a stage in garlic supplementation group. No change or improvement was observed in control group.

### Effect of supplementation of spices on the nutritional status

#### Body weight

The changes in mean body weight of the hyperlipidemics

before and after supplementation are given in Table 7.

The mean body weights of the hyperlipidemic adults before supplementation with cinnamon, garlic and control groups were 71.73, 71.6 and 76.07 kg, respectively. After a period of three months of spice capsule supplementation it was observed that there was a weight reduction of 1.86 kg in cinnamon in supplemented groups. This was followed by garlic supplemented group with a mean difference of 0.57 kg. The reduction in weight in cinnamon supplemented group was statistically significant at one %level. When compared between the groups and control it was observed that the weight reduction or increase was not significant which shows that cinnamon helps in reducing the body weight over a period of three months.

#### Body mass index

Body mass index was calculated using height and weight of the selected adults and is given in Table 8. It is evident that none of the adults included for the study were of underweight category as per BMI less than 18.5. Out of 75 adults only 14 were in the normal weight category initially but after the supplementation of spices the number of normal weight adults increased to 20 revealing the effect of supplementation. In the present study, majority was obese and only a few were of normal weight range indicating the need to control and maintain the



**Table 9.** Changes in the waist hip ratio.

WHR*	Grade	Hyperlipidemics	
		Before	After
≤ 0.95	Normal	45	56
≥ 0.95	Obese	30	19
Total		75	75

\* Brahman et al., 2005.

**Table 10.** Changes in the blood pressure.

Blood pressure	Hyperlipidemics	
	Before	After
Normal	21	37
Above or below normal	54	38
Total	75	75

Normal: 120 / 80 mm Hg.

**Table 11.** Changes in the mean blood haemoglobin values.

Group	Blood Haemoglobin (mg/dl) Mean ± SD			't' value	
	Initial (I)	Final (F)	Difference	I Vs F	Between groups
Cinnamon (HA)	13.86 ± 0.91	14.05 ± 0.64	+0.19 ± 0.76	0.98 <sup>NS</sup>	HA Vs HE 1.23 <sup>NS</sup>
Garlic (HC)	13.85 ± 1	14.32 ± 0.7	+0.47 ± 0.55	2.68*	HC Vs HE 3.23**
Controll (HE)	13.87 ± 1.18	13.79 ± 1.27	-0.08 ± 0.32	0.79 <sup>NS</sup>	

Normal values: Males 13.5 to 16.5 g / dl (Ashwood et al., 1994)  
 \* P < 0.05; Significant at 5 %level, \*\* P < 0.01; Significant at 1 %level.

disease condition so as to reduce the risk of cardiovascular complications. After supplementation, there was a shift in the BMI, that is, among the 26 at risk of obesity adults, six moved to the normal group and those in the obese I and II category remained in the same group. 31 adults of obese I category and 4 adults of obese II category remained the same even after supplementation. Results show that cinnamon has a role to play with the BMI in shifting them to a better category.

### Waist hip ratio

Table 9 gives the changes in the Waist Hip Ratio of the hyperlipidemics. Before supplementation among the hyperlipidemic adults 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.

### Blood pressure

Table 10 depicts the changes in the blood pressure among the hyperlipidemics before and after the supplementation period of three months with the capsules of spice powders. It is evident from the table that among 54 hyperlipidemic adults whose blood pressure was either above or below normal 16 moved to the normal blood pressure category after supplementation of spices for a period of three months.

### Effect of supplementation on the biochemical profile of hyperlipidemics

#### Blood haemoglobin levels

Table 11 gives the changes in the blood haemoglobin

**Table 12.** Changes in the mean total cholesterol levels.

Group	Total cholesterol (mg / dl) Mean $\pm$ SD			't' value	
	Initial (I)	Final (F)	Difference	I Vs F	Between groups
Cinnamon (HA)	253.53 $\pm$ 25.55	184.87 $\pm$ 14.44	-68.67 $\pm$ 26.07	10.19**	HA Vs HE 10.50**
Garlic (HC)	245.8 $\pm$ 20.6	209.2 $\pm$ 13.15	-36.6 $\pm$ 18.23	6.39**	HC Vs HE 8.37**
Controll (HE)	249.47 $\pm$ 19.1	256.47 $\pm$ 20.44	+7.00 $\pm$ 6.88	3.24**	

Desirable: <200 mg / dl, Borderline high: 200 to 239 mg / dl, High risk: > 239 mg / dl (NCEP, 2001).

\*\* P < 0.01; Significant at 1 %level.

values of the hyperlipidemics before and after spice supplementation. The initial blood haemoglobin values of the hyperlipidemics of the groups supplemented with cinnamon, garlic and control group were found to be in the normal range of 13.5 to 16.5 g/dl suggested by Ashwood et al. (1994). None of the selected adults were found to suffer from anaemia. A gradual increase in the blood haemoglobin levels was observed among garlic (14.32 mg/dl) supplemented group over the three months period which was found to be significant at 5% level. There was slight increase in haemoglobin levels among the other groups but not at a significant level. A comparison of supplemented groups with control group revealed a high significant (1%) change in haemoglobin levels among garlic supplemented group and no significant change among the other group. This clearly indicate that over a period of three months of time garlic supplementation was effective in raising the blood haemoglobin levels with a minimum increase among cinnamon supplementation.

### **Total cholesterol**

Table 12 present the total cholesterol levels of the hyperlipidemics. The mean total cholesterol levels of the hyperlipidemics before spice supplementation was 253.53 mg/dl in cinnamon group, 245.8 mg/dl in garlic group, and 249.47 mg/dl in control group which were much higher than the normal desirable range of < 200 mg/dl (NCEP, 2001). It is observed that the total cholesterol level in the cinnamon group came down to 184.87 mg/dl with a mean difference of 68.67 mg/dl over a period of three months followed by garlic group with 36.6 mg/dl. The total cholesterol levels came down to the normal range in cinnamon supplemented group which was found to be significant at one % level (P<0.01). The differences in the levels of control group were negligible. Comparison of the mean total cholesterol levels between the control and supplemented groups showed that the spices were more effective in reducing the total

cholesterol level during the supplementation period of three months. Cinnamon plays a pivotal role in reducing the total cholesterol level on hyperlipidemics.

### **Triglyceride levels**

Table 13 depicts the mean triglyceride levels of the hyperlipidemics. Initially the serum triglyceride levels of the hyperlipidemics, among cinnamon, garlic, and control groups were found to be in the borderline high category of 150 to 199 mg/dl as per NCEP (2001). After three months of supplementation with spices the triglycerides reached a level of 147 mg/dl in cinnamon group and 138.67 in garlic group which were well within the desirable level of <150 mg/dl with a minimum change in the control group. A remarkable reduction by 47.73 mg/dl was evident among the garlic supplemented group and cinnamon supplemented groups which were significant at 5 per cent level. When compared between groups with control the cinnamon and garlic supplemented groups were significant at one per cent level. These results revealed that the triglyceride levels were brought well within the desirable range among both cinnamon and garlic supplemented groups. A comparison of the final triglyceride levels with initial values indicated a reduction ranging from 43.33 mg/dl to 47.73 mg/dl among cinnamon and garlic groups which were found to be statistically significant at one per cent level. The results clearly state the triglyceride level of the hyperlipidemics show a significant reduction on supplementation of cinnamon.

### **HDL cholesterol levels**

The mean HDL cholesterol levels of the hyperlipidemics before and after supplementation are presented in Table 14. The initial HDL cholesterol level was found to be in the desirable range among all the groups of hyperlipidemics. However, HDL cholesterol level in the cinnamon

**Table 13.** Changes in the mean triglyceride levels.

Group	Triglyceride (mg / dl) Mean $\pm$ SD			't' value	
	Initial (I)	Final (F)	Difference	I Vs F	Between Groups
Cinnamon (HA)	190.33 $\pm$ 24.81	147.00 $\pm$ 17.34	-43.33 $\pm$ 13.3	12.61**	HA Vs HE 10.42**
Garlic (HC)	186.4 $\pm$ 15.58	138.67 $\pm$ 17.85	-47.73 $\pm$ 19.6	7.74**	HC Vs HE 8.45**
Control I (HE)	195.4 $\pm$ 31.57	195.73 $\pm$ 28.22	+0.33 $\pm$ 8.3	0.13 <sup>NS</sup>	

Normal : < 150 mg / dl; Borderline high: 150 to 199 mg / dl, High: 200 to 499 mg / dl; Very high: > 499 mg / dl (NCEP, 2001).

\*\* P < 0.01; Significant at 1 %level.

**Table 14.** Changes in the mean hdl cholesterol levels.

Groups	HDL Cholesterol (mg / dl) Mean $\pm$ SD			't' value	
	Initial (I)	Final (F)	Difference	I Vs F	Between groups
Cinnamon (HA)	40.53 $\pm$ 2.93	43.31 $\pm$ 1.83	+2.77 $\pm$ 2.96	3.62**	HA Vs HE 2.56*
Garlic (HC)	39.91 $\pm$ 4.6	40.74 $\pm$ 4.26	+0.83 $\pm$ 2.29	1.15 <sup>NS</sup>	HC Vs HE 0.55 <sup>NS</sup>
Controll (HE)	39.97 $\pm$ 3.69	40.37 $\pm$ 3.06	0.4 $\pm$ 1.8	0.71 <sup>NS</sup>	

Low: < 40 mg / dl; High: > 60 mg / dl (NCEP, 2001)

\* P < 0.05; Significant at 5 %level \*\* P < 0.01; Significant at 1 %level

<sup>NS</sup> Not Significant.

supplemented groups showed a gradual increase from the initial values after three months of supplementation. The differences between initial and final were found to be significant for cinnamon at one %level (P<0.01). No significant change was observed in the initial and final values among garlic and control group. This difference in the spice supplemented group probably indicates the effect of cinnamon in increasing the HDL cholesterol levels and maintaining a lower risk for lipid profile among hyperlipidemics. Cinnamon supplemented hyperlipidemics showed a gradual increase in HDL cholesterol levels when compared to those supplemented with garlic which is a positive effect.

### LDL cholesterol levels

The changes in the LDL cholesterol levels of the hyperlipidemics before and after spice supplementation are presented in Table 15. The LDL cholesterol levels of hyperlipidemic adults before supplementation of cinnamon and garlic were 174.93 mg/dl and 168.61 mg/dl, respectively and found to be in the higher range of 160 to 189 mg/dl (NCEP, 2001). It showed a reduction of 62.77 and 27.88 mg/dl among the cinnamon and garlic

supplemented groups respectively after three months of supplementation. These values were found to be in the near optimal range of 100 to 129 mg/dl (NCEP, 2001) in cinnamon supplemented group. Though the LDL cholesterol levels decreased in garlic supplemented group they were still in the borderline high risk category of 130 to 159 mg/dl. There was a significant increase in the LDL cholesterol level in the control group at 5% level. The changes in the LDL cholesterol levels of the two groups with the control group was also found to be significant at 1% level (P<0.01) with a higher reduction in the cinnamon group. The significant reduction indicates that cinnamons potentiality in lowering LDL cholesterol with that of garlic.

### VLDL cholesterol levels

Table 16 gives the VLDL cholesterol levels of the hyperlipidemics before and after supplementation of spices. The initial serum VLDL cholesterol levels in the experimental groups of cinnamon, garlic and control groups of hyperlipidemics were 38.07, 37.28 and 39.08 mg/dl, respectively and their values were in the higher range of normal values of 5 to 40 mg/dl as per NCEP

**Table 15.** Changes in the mean ldl cholesterol levels.

Groups	LDL Cholesterol (mg / dl) Mean $\pm$ SD			't' value	
	Initial (I)	Final (F)	Difference	I Vs F	Between groups
Cinnamon (HA)	174.93 $\pm$ 27.22	112.16 $\pm$ 16.06	-62.77 $\pm$ 27.39	8.87**	HA Vs HE 9.07**
Garlic (HC)	168.61 $\pm$ 22.36	140.73 $\pm$ 14.3	-27.88 $\pm$ 17.74	5.00**	HC Vs HE 6.58**
Controll (HE)	170.42 $\pm$ 16.11	176.95 $\pm$ 17.01	+6.53 $\pm$ 8.24	2.52*	

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 (NCEP, 2001)

\*\* P < 0.01; Significant at 1 %level.

**Table 16.** Changes in the mean vldl cholesterol levels.

Group	VLDL Cholesterol (mg / dl) Mean $\pm$ SD			't' value	
	Initial (I)	Final (F)	Difference	I Vs F	Between groups
Cinnamon (HA)	38.07 $\pm$ 4.96	29.4 $\pm$ 3.47	-8.66 $\pm$ 2.66	12.61**	HA Vs HE 10.42**
Garlic (HC)	37.28 $\pm$ 3.12	27.73 $\pm$ 3.57	-9.55 $\pm$ 3.92	7.74**	HC Vs HE 8.46**
Controll (HE)	39.08 $\pm$ 6.31	39.15 $\pm$ 5.64	+0.07 $\pm$ 1.66	0.13 <sup>NS</sup>	

Normal value: 5 to 40 mg / dl (NCEP, 2001)

\* P < 0.05; Significant at 5 %level, \*\* P < 0.01; Significant at 1 %level.

(2001). At the end of the supplementation period of three months there was a reduction in the VLDL cholesterol levels among the cinnamon and garlic group and no change was observed in the control group. The reduction in the VLDL cholesterol levels in the cinnamon and garlic supplemented groups were found to be significant at 1% level (P<0.01). A comparison of both the groups with the control group revealed a statistically significant difference at one %level. Cinnamons VLDL cholesterol lowering effect has been high when compared with that of garlic bringing out the potentials of cinnamon.

From the foregoing parameters on lipid profile on the hyperlipidemics on supplementation with spices namely cinnamon and garlic it could be clearly seen that the cinnamon supplementation was more effective than the garlic supplementation. Further, long term supplementation studies are required to give conclusive evidence. Comprehensive spicy therapeutic regimen thus offers time tested safe and effective support to conventional therapy in the management of hyperlipidemia.

## Conclusion

Variety is the spice of life and enjoying a variety of herbs

and spices may help us live a healthier life as well. The results of supplementation with cinnamon and garlic to hyperlipidemics indicated the probable role of spices in the management of hyperlipidemia and the associated symptoms. Among the hyperlipidemics a positive trend in the control of lipid profile was evident in cinnamon supplemented group and longer periods of dietary supplementation of spices could help to maintain the lipid levels.

The results clearly indicated the positive role of spices in maintaining the lipid profile and relieved them of painful symptoms in perfect condition thus corroborating the results of some studies on cardiovascular condition from other countries (Jenkins et al., 2000; Das, 2000). This positive impact on adults with hyperlipidemia 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 in the management of hyperlipidemia. Let us popularize the use of spices as a source of food nutrients in our Indian dietaries.

## REFERENCES

Archer AW (1988). Determination of cinnamaldehyde, coumarin and

- cinnamyl alcohol in cinnamon and cassia by high-performance liquid chromatography, *J. Chromatogr.*, 447: 272–276.
- Ashwood ER, Tietz NW, Burtis CA (1994). *Tietz textbook of clinical chemistry*, 2nd edition, Philadelphia, Saunders Co.
- Brahman GNV, Laxmaiah A, Mallikharjuna Rao K and Reddy G (2005). Methodology of assessment of diet and nutritional status of community, *Manual of National Institute of Nutrition*, Hyderabad, pp. 7–9, 13, 16.
- Charles C (1998). *The Scents of Eden: A Narrative of the Spice Trade*, New York: Kodansha International, pp. 234.
- Fareed G, Scolaro M, Jordan W, Sanders N, Chesson C, Slattery M, Long D, Castro C (2007). The use of high dose garlic preparation for the treatment of *Cryptosporidium parvum* diarrhoea, *NLM Gateway*, pp. 643–645.
- ICMR (2004). *Nutrient requirements and RDA for Indian*, ICMR, New Delhi.
- John SJ (1988). Treatment leads on Cryptosporidiosis: preliminary report on opportunistic infection, *AIDS treatment news*, pp. 49.
- Khan A, Safdar M, Ali Khan MM, Khattak KN, Anderson RA (2003). Cinnamon improves glucose and lipids of people with type 2 diabetes. *Diabetes Care.*, 26(12): 3215–3218.
- NCEP (National Cholesterol Education Program) (2001). Cholesterol guidelines. *Current Med. Scene.*, pp. 1–8.
- NIN (1983). Edited by Raghuramulu N, Madhavan Nair K and Kalyana Sundaram S, ICMR.
- Palmer AS, Stewart J, Fyfe L (1998). Antimicrobial properties of plant essential oils and essences against five important food borne pathogens, *Lett. Appl. Microbiol.*, 26: 118–122.
- Sivam GP (2001). Protection against *Helicobacter pylori* and Other Bacterial Infections by Garlic, *J. Nutr.*, 131:1106S–1108S.
- Sovova M, Sova P (2004). Pharmaceutical importance of *Allium sativum* L, Hypolipidemic effects of *in vitro* and *in vivo*, *Ceska Slov Farm*, 53(3): 117–123.
- WHO (1999). *Malnutrition in adolescence and adults: Management of severe malnutrition a manual for physician and other senior health workers*, WHO, Geneva, pp. 37–42.
- World Health Report (2004), World Health Forum, WHO, Geneva, 16(4): 4–6.
- www.herbwisdom.com
- Zak V (2006). *The Magic Teaspoon*, Penguin group, USA.