Summary and Conclusion

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Variety is the spice of life and enjoying a variety of herbs and spices may help us live a healthier life as well. With the rise of allopathic medicines, much of the folk wisdom fell out of favour and spices were replaced with prescription drugs. Herbs and spices have been used to treat various diseases and ailments for thousands of years. Today the pendulum is swinging back and researchers are confirming what herbalists have found 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 effects of free radicals against the body. The greatest advantage of using herbal remedies over commercial drugs is the reduced side effects, since the concentration of active ingredients is much lower.

Cinnamon (*Cinnamomum zeylanicum*) a bushy evergreen tree of the Laurel family with its strong aroma, sweetness and good taste has been reported to have remarkable pharmacological effects in the treatment of type 2 diabetes. Cloves are the rich, brown, dried unopened flower buds of the clove tree *Syzygium aromaticum*. The compound responsible for the cloves aroma is eugenol and it comprises about 72 to 90 per cent. Cloves are used to kill the pain of toothache and act as an anti-inflammatory against rheumatic diseases and have anti-coagulant effects. Garlic is the dried root of *Allium sativum*, claimed to help prevent heart disease including atherosclerosis, high cholesterol, high blood pressure and cancer. Turmeric (*Curcuma longa*) a rhizomatous plant is long known for its anti-inflammatory properties proving beneficial in the treatment of many different health conditions from cancer to Alzheimer's disease.

Diabetes Mellitus and Cardio Vascular Disease share several important characteristics. The occurrence of both conditions increases with age, both are associated with an adverse lipid profile, obesity and a sedentary life style and

the risk of both can be reduced by lifestyle modifications of common risk factors. Diabetes is a potent, independent risk factor for cardiovascular diseases which are a group of disorders of the heart and blood vessels and are the number one cause of death globally than from any other disease. It has been projected that by 2020, chronic diseases will account for almost three quarters of all deaths worldwide and that 71 per cent of deaths due to ischemic heart disease, 75 per cent of deaths due to stroke and 70 per cent due to diabetes will occur in developing countries.

Many researches are underway using herbal supplements to prevent or potentially alleviate hyperlipidemia and diabetes mellitus. The botanicals available in our country have been proven to be safe and effective, through several hundred to thousand years of use. Ayurvedic physicians have treated diabetes and hyperlipidemia for thousands of years using a combination of regulated lifestyle and herbal formulations. Many actions associated with herbal supplements may help prevent or potentially alleviate hyperlipidemia and diabetes mellitus. There are limited research works available on the use of spices for hyperlipidemia and diabetes mellitus though they are used as home remedies. With this background the study entitle **"Effect of Selected Spices on Hyperlipidemic and Diabetic Adults"** was undertaken with the following objectives:

- To analyse the nutritive value and active principles of the selected spices namely, cinnamon, cloves, garlic and turmeric.
- To prepare the spice capsules.
- To supplement the diets of selected hyperlipidemics and adults with hyperlipidemia and diabetes mellitus with the spice capsules for a period of three months and
- To evaluate the effect of spice capsules on hyperlipidemics and adults with hyperlipidemia and diabetes mellitus using various parameters.

Five hundred adults in the age group of 40 to 60 years residing in Coimbatore with hyperlipidemia and diabetes were identified for the survey.

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 75 mild to moderate hyperlipidemic adult men working in Lakshmi Machine Works Private Limited, Periyanaickenpalayam and 75 men who reported hyperlipidemia with symptoms of diabetes mellitus from Bharat Sanchar Nigam Limited, Bharathi Park Road, Coimbatore were selected for the supplementation study.

Details regarding the socio-economic characteristics including age, sex, occupation, educational status, family type, monthly income and family background were gathered through interview method using a pre-tested questionnaire. Questions were also included to get information on their lifestyle pattern like yoga, exercise, alcohol consumption, chewing habits, smoking, dietary pattern, food intake pattern, foods included and avoided, health status like general health, history of the present condition, diabetic / hyperlipidemic trait in the family, duration and treatment of the condition, physiological symptoms experienced and diseases if any. Consumption of spices and awareness of the spices used for supplementation also formed part of the questionnaire. Five hundred adults including the selected adults for supplementation and control were interviewed. Food consumption pattern of the selected hyperlipidemic and diabetic adults was assessed using a three day recall method.

Anthropometric measurements such as height, weight, Body Mass Index, waist circumference, hip circumference, Waist Hip Ratio, Blood Pressure were recorded for the adults selected for the supplementation study (75 hyperlipidemic; 75 hyperlipidemic and diabetic adults). All the selected adults were screened and examined by a physician for the presence of clinical symptoms before and after the supplementation period. The selected adults were subjected to biochemical tests relevant to their physiological status. The various biochemical tests done for the hyperlipidemic adults included blood haemoglobin, lipid profile, total cholesterol, triglycerides, HDL, LDL and VLDL

cholesterol. The other parameters for diabetic adults included fasting blood sugar, post prandial blood sugar and glycosylated haemoglobin. All these biochemical parameters were done before and after the supplementation period of three months with the help of trained laboratory technicians.

After an extensive appraisal of literature pertaining to spices, cinnamon, cloves, garlic and turmeric were selected for the present study. The spices namely cinnamon, cloves, garlic and turmeric were procured and cleaned to remove any impurities. Spices were washed and allowed to dry under shade to remove the excess water. The cleaned spices were then spread in trays and dried in a cabinet drier at 40^{O} C for one hour. The trays were then removed and allowed to cool. The above process (i.e. heating at 40^{O} C for one hour and cooling) is repeated until the moisture content came to less than 10 per cent. The dried spices were then pulverized, sieved and then stored in air tight containers. Many of the adults of the present study preferred the spices in the form of capsules and so the investigator prepared the spices in the form of capsules with the help of a capsule manufacturing company. Each capsule was filled with approximately 490 to 500 mg of spice powders. The adults were asked to consume four capsules (two after breakfast and two after dinner) amounting to two grams per day for a period of three months. The nutrients present in the selected spices namely cinnamon, cloves, garlic and turmeric were analysed using the standard procedures given by NIN (1983).

The selected 75 hyperlipidemic and 75 adults with hyperlipidemia and diabetes mellitus were divided into five groups consisting of 15 adults in each group. Sixty adults (four groups of 15 adults in each group) constituted the experimental group who were given each two grams of cinnamon, cloves, garlic and turmeric in the form of four capsules daily for a period of three months. The remaining 15 adults constituted the control group. To the hyperlipidemic control group, two grams of powdered sugar and to the 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 effect of supplementation on the

selected adults was evaluated using the anthropometric measurements, clinical assessment and biochemical assessment before and after a period of three months of supplementation. Feedback was obtained from all the selected adults of the supplementation.

The **salient findings** of the research study are summarized as follows

PHASE I

- A majority of 30.4 per cent were in the age group of 40 to 45 years, whereas only 18 per cent of the males were in the age group of 56 to 60 years.
- All the adults were literates. About 70 per cent of the adults have completed either graduation or professional degree.
- About 70 per cent of the adults are either employed in private or government sector or engaged in business. Only 23 per cent of adults were home makers and 8 per cent were retired adults.
- Forty seven per cent of the families are joint and 53 per cent of them are nuclear type. Eighty three per cent had 3 to 5 members in the families whereas remaining 17 per cent had above five members in the families.
- Prevalence of the metabolic disorder i.e. hyperlipidemia and diabetes mellitus was high in high income group (66 per cent) compared to the low and middle income groups.
- Yoga was practised by 45 per cent of the adults either daily, weekly once or twice and 54 per cent of the adults did not practice yoga.
- Thirty five per cent of the adults did exercises regularly from half an hour to one hour and 65 per cent of adults did not do any exercise. All the adults who exercised either went for walking or jogging.
- Almost 75 per cent of the adults had the habit of cigarette smoking. Among them 30 per cent discontinued smoking after the onset of the

disease. Forty three per cent of the adults developed the habit of smoking in the past ten years. Also, about 47 per cent of the adults used less than 5 cigars per day. Only 25 per cent of the adults did not have the habit of smoking.

- Out of 295 adult males, 110 adults did not use alcohol and others had the habit of consuming it. With regard to the duration of alcohol consumption, 60 per cent consumed for the past 10 years. With regard to the frequency of consumption, 31 per cent of the adults consumed regularly and 34 per cent occasionally. After the onset of the disease condition, about 34 per cent of the adults stopped consuming alcohol.

- Fifty six per cent of the adults did not have the habit of chewing neither tobacco, pan masala nor betel leaves. Forty per cent of the adults had the habit of chewing for the past 11 to 20 years.

- A majority of 61 per cent of the selected adults were non-vegetarians. Remaining 28 and 10 per cent of the adults were vegetarians and ova-vegetarians respectively.

- All the male and female adults consumed three meals a day i.e. breakfast, lunch and dinner with majority consuming either wheat or ragi based food items.

- Fifty three per cent of adults included raw salad along with their diet. All the adults used steaming, roasting and boiling as a method of cooking. About 53 and 61 per cent of adults adopted frying and stewing methods respectively. Bakery items were used by 56 per cent of adults. Majority of the adults used gingelly oil (56 %) and groundnut oil (60 %) for cooking. All the adults used refined oil for cooking various food preparations. Ten per cent of the adults used olive oil for various food preparations.

- Regarding the consumption of beverages majority of adults consumed both tea and coffee either with (17 %) or without sugar (19 %). Twelve

per cent of the adults did not consume any beverage. About 69, 49, 32, 29 and 16 males consumed fruit juices, tender coconut, health drinks, soups and green or black tea respectively. Among females about 83 and 67 of them consumed fruit juices and soups.

- Majority of hyperlipidemic adults consumed green leafy vegetables, vegetables and fruits. Fifty per cent of the adults with hyperlipidemia and diabetes mellitus included more pulses and grams, green leafy vegetables and vegetables. Fifty seven per cent of adults added wheat products and 85 per cent of hyperlipidemic adults avoided coconut and salt in their diet. About 17 per cent of the hyperlipidemic adults did not follow any dietary modifications.

- Out of the 255 adults with hyperlipidemia and diabetes mellitus, majority avoided junk foods, bakery items and snacks (77 %) and sweets (74 %). Coconut (66 %), non-vegetarian (71 %) and deep fried foods (59 %) were avoided by many adults. Nuts and oil seeds were avoided by 67 per cent adults.

- Among the 500 adults, 245 adults had hyperlipidemia and 255 adults had both hyperlipidemia and diabetes mellitus. Twenty six per cent of adults had hyperlipidemia for the past 1 to 5 years and 24 per cent of adults with hyperlipidemia and diabetes mellitus for the past 5 to 10 years.

- Familial tendency of the subjects revealed that heredity is playing a vital role in the precipitation of disease at a younger age. Out of the 255 hyperlipidemic adults with diabetes mellitus, it is found that 179 adults had diagnosed the condition within ten years.

- A total of 8 per cent of the hyperlipidemic adults were taking treatment for a period of 1 to 5 years. In the case of adults with hyperlipidemia and diabetes mellitus, except 7.5 per cent of adults all of them were taking treatment with a majority of 28.6 per cent taking treatment from 1 to 5 years. With regard to the type of treatment a majority of adults undertook allopathic treatment.

- Only 45 per cent adults were aware that spices could help to control or fight against diseased conditions. About 53 males and 50 females were aware that fenugreek mixed with jeera could control diabetes mellitus.

- Nutrient analysis of the spices revealed that the energy content was high in turmeric with 310 Kcal and cinnamon with 190 Kcal per 100 g. The protein content was found to be high in garlic with 11.23 g and a maximum fat content in cloves 1.72 g followed by turmeric with 1.54 g in 100g. Carbohydrate content was highest in turmeric with 44.25 g per cent whereas garlic had only 26.56 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). B complex vitamins like thiamine were maximum in garlic with 0.21 mg, riboflavin in cloves with 0.09 mg and niacin with 0.59 mg in cinnamon. Vitamin A was found to be high in garlic with 106 µg and vitamin C of 36 mg in cloves. The crude fibre was also maximum in cloves with 14.68 g and least 7.38 g per cent in garlic.

- The trace elements like lead, zinc, arsenic and chromium were found to be below detectable limits.

- A maximum quantity of active principles was present in turmeric i.e. curcumin (0.21 mg %), cinnamaldehyde (36 mg %) and allicin (9.32 mg %) compared to the other three spices.

- It was found out that the cost of one capsule of cinnamon was Re. 0.52, cloves was Re. 0.96, garlic was Re. 1.63 and turmeric was Re. 0.38 and was inexpensive when compared with the allopathic drugs.

- It was observed that the consumption of cereals, pulses, roots and tubers, fleshy foods and fats and oils was more than the recommended allowance among the hyperlipidemic adults. Mean food intake was deficit in the consumption of greens, vegetables, fruits and milk products.

Almost a similar trend was observed in the adults with hyperlipidemia and diabetes mellitus.

- The mean nutrient intake of hyperlipidemic adults was deficit in beta carotene and vitamin C when compared with RDA with respect to all nutrients. In case of adults with hyperlipidemia and diabetes mellitus the same trend was seen except riboflavin.

PHASE II

- Supplementation of cinnamon and cloves helped to reduce the clinical symptoms seen among the hyperlipidemics and adults with hyperlipidemia and diabetes mellitus for the experimental group and in the case of garlic, turmeric supplemented groups a minimal change was seen. No change was observed in the control group after three months.

- The cinnamon and cloves supplemented hyperlipidemic adults showed a significant weight reduction by 1.86 kg and 1 kg respectively and the adults supplemented with cloves and turmeric with hyperlipidemia and diabetes mellitus showed a significant weight reduction by 3.8 kg and 2.6 kg respectively compared to other groups.

- It is sad to observe that only 20 and 12 hyperlipidemic and adults with hyperlipidemia and diabetes mellitus had normal BMI, whereas others fell under at risk categories.

Hyperlipidemic adult group

- The blood haemoglobin levels of the hyperlipidemic adults increased significantly in cloves and garlic supplemented groups with 0.66 mg/dl and 0.47 mg/dl respectively. No significant change was observed in cinnamon supplemented group. The haemoglobin levels of the adults decreased in turmeric supplemented and control groups.

- The total cholesterol of the hyperlipidemic adults showed a significant change in cinnamon supplemented group (68.67 mg/dl) followed by cloves, garlic and turmeric groups after a period of three months of supplementation.

- A maximum reduction of triglyceride levels among the hyperlipidemic adults was observed in the garlic supplemented group with 47.73 mg/dl followed by cloves with 44.67 mg/dl, cinnamon with 43.33 mg/dl which was significant at one per cent level and an increase in turmeric supplemented group.

- In case of HDL cholesterol, an increase of 3.83 mg/dl was observed in groups supplemented with cloves followed by cinnamon supplemented group with 2.77 mg/dl and turmeric group with 2.74 mg/dl which were significant at one per cent level and garlic with only 0.83 mg/dl.

- As far as LDL cholesterol is concerned, 62.77 mg/dl reduction, being the maximum was observed in the group supplemented with cinnamon which was statistically significant ($P<0.01$). This was followed by cloves, garlic and turmeric with 46.36 mg/dl, 27.88 mg/dl and 15.34 mg/dl respectively.

- Among the hyperlipidemic adults supplemented with the spices a maximum reduction of 9.55 mg/dl in VLDL cholesterol was observed in adults who were supplemented with garlic followed by 8.93 mg/dl reduction in cloves supplemented group and 8.66 mg/dl by cinnamon group which were significant at one per cent level. An increase in VLDL cholesterol by 2.07 mg/dl was found in turmeric supplemented group.

Adults with hyperlipidemia and diabetes mellitus group

- The blood haemoglobin levels of the adults with hyperlipidemia and diabetes mellitus significantly increased in garlic supplemented group with a mean difference of 0.26 mg/dl and in cinnamon supplemented group with 0.17 mg/dl . No significant change was observed in cloves, turmeric supplemented and control groups.

- It is observed among the adults with hyperlipidemia and diabetes mellitus, that, the total cholesterol levels had a maximum reduction in cinnamon supplemented group with a mean difference of 53.73 mg/dl, followed by cloves with 52.8 mg/dl, turmeric with 34.2 mg/dl and garlic

with 31.13 mg/dl. All the groups supplemented were significant at one per cent level after a period of three months.

- Maximum reduction in triglycerides among the adults with hyperlipidemia and diabetes mellitus was observed in cinnamon and cloves supplemented groups with 36.2 mg/dl and 32.8 mg/dl followed by garlic and turmeric with a mean difference of 14.53 mg/dl and 11.93 mg/dl respectively and were statistically significant.

- Cinnamon supplemented group showed a maximum increase in the HDL cholesterol with a mean difference of 7.13 mg/dl whereas cloves supplemented group showed a reduction only by 4.26 mg/dl and garlic and turmeric group with 2.16 mg/dl and 1/3 mg/dl respectively. All the groups supplemented with spices were statistically significant at one per cent level.

- A maximum decrease in LDL cholesterol in the adults supplemented with cinnamon, cloves, turmeric and garlic was in the range of 53.62 mg/dl to 30.39 mg/dl after a three months period of supplementation and are statistically significant at one per cent level.

- A maximum reduction in VLDL cholesterol was observed in groups supplemented with cinnamon with 7.24 mg/dl followed by cloves, garlic and turmeric with a mean difference of 6.56 mg/dl, 2.91 mg/dl and 2.39 mg/dl respectively which were statistically significant at one per cent level.

- Fasting blood sugar levels showed a maximum reduction of 47.07 mg/dl ($P<0.01$) in cinnamon supplemented group followed by groups supplemented with cloves with 39.73 mg/dl, garlic 27.07 mg/dl and turmeric 16.07 mg/dl. All the groups were statistically significant at one per cent level.

- The post prandial blood sugar showed a mean difference of 56 mg/dl in cinnamon supplemented group. This was followed by cloves group with 42.47 mg/dl, garlic group with 35.13 mg/dl and turmeric group

with 21.8 mg/dl after a supplementation of three months and was statistically significant at one per cent level.

- Glycosylated haemoglobin showed a maximum mean difference of 1.95 per cent/100ml in cinnamon supplemented group followed by cloves supplemented group of 0.85 per cent/100 ml, garlic group with 0.21 per cent/100 ml and turmeric group with 0.2 per cent/100 ml. and was significant at one per cent level.

- Adults supplemented with cinnamon and cloves reported that they were very active and brisk throughout the study period. They were able to work round the clock without any tiredness. Garlic and turmeric group adults expressed that they did not come across any infections like cold, cough, asthma, wheezing and fever during the three months. All the adults said that they had no headache, giddiness, fatigue, stomach upsets like indigestion and diarrhoea.

The results of supplementation with spices to hyperlipidemic adults and adults with hyperlipidemia and diabetes mellitus indicated the probable role of spices in the management of hyperlipidemia and diabetes mellitus and the associated symptoms. Among the hyperlipidemic adults a positive trend in the control of lipid profile was evident in cinnamon and cloves supplemented groups and longer periods of dietary supplementation of spices could help to maintain the lipid levels. The improved lipid profile might provide them protection against probable degenerative diseases of the age.

As far as the adults with hyperlipidemia and diabetes mellitus, results clearly indicated the positive role of spices in maintaining the lipid profile and in the control of blood sugar 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 and Das, 2000). This positive impact on adults with hyperlipidemia and diabetes mellitus 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 and diabetes mellitus.

Thus, this study though limited in number of sample and period of supplementation beyond doubt proves the presumable beneficial impact of spices in the management of both hyperlipidemia and diabetes mellitus. Being a dietary source, it is needless to further emphasize the miraculous effect of spices in daily dietaries. If spices in the form of dietary supplement can become the daily adjunct of dietaries the benefit it can give to humans suffering from degenerative disease with or without the ageing process is commendable. Let us popularize the use of spices as a source of food nutrients in our Indian dietaries.

RECOMMENDATIONS

The **recommendations** that emerge for further studies are

- Studies on spices which help in the management of other degenerative disease conditions.
- Longitudinal studies on larger samples of hyperlipidemics and diabetes mellitus.
- Studies using the selected four spices with different proportions and combinations.
- Elaborate studies using other spices in the management of various disease conditions.
- Awareness creation among the public regarding the significance of spices which are available at our door steps.