SUMMARY AND CONCLUSION

Diabetes is one of the non-communicable diseases. It is one of the largest global health emergencies of 21st century. According to WHO "Developing countries will become old before they become rich while industrialized countries became rich while they were growing old." It has been estimated that one in three death will be occur due to prevalence of non-communicable disease and one of the cause will diabetes.

The market for functional foods and nutraceuticals is growing as consumers become more aware of the possible health benefits of food for illness prevention and health enhancement. Functional foods are medical foods that offer additional health benefits to those required on a daily basis. Functional foods contain a physiologically active component that may help with health and illness prevention. Growing consumer demand for functional foods is also assisting farmers in diversifying their agricultural practices, which encourages research and innovation, particularly in poorer nations. One such functional food is pumpkin seed, which needs to be explored for its functional properties in the prevention and management of diabetes. So the present study entitled "Impact Evaluation of Pumpkin Seeds on Glycaemic and Lipemic Responses of Type 2 Diabetic Old Age Population of Urban Vadodara" was planned with the following major objectives:

- To carry out nutrient profiling of pumpkin seeds
- To develop 8 eqi carbohydrates pumpkin seed incorporated recipes at different dosage.
- To conduct sensory evaluation of the developed recipes
- To assess glycaemic index and satiety index of pumpkin seed incorporated recipes
- To evaluate impact of pumpkin seed supplementation on glycaemic and lipemic parameters of type 2 diabetic old age population of urban Vadodara

The study was carried out in three phases:

PHASE I: Nutrient profiling of Pumpkin seeds (Cucurbita maxima)

PHASE II (A): Sensory evaluation of Pumpkin seed incorporated recipes

PHASE II (B): Assessment of Glycaemic index and Satiety index of pumpkin seed incorporated recipes

PHASE III: Impact evaluation of pumpkin seeds on type 2 diabetic subjects of Urban Vadodara

PHASE I: NUTRIENT PROFILING OF PUMPKIN SEEDS (CUCURBITA MAXIMA)

To determine the proximate composition, micronutrient content, phytochemical presence, antioxidant activity, and fatty acid composition of pumpkin seeds, analysis was done. The NABL-accredited and FSSAI-recognized Indian Institute of Food Processing Technology, Thanjavur, conducted the analysis. 750g of pumpkin seeds in total were sent for analysis. Proximate analysis method used for the determination of moisture content, water activity, ash, and crude protein, and crude fat, crude fibre as per AOAC Standards. Antioxidant profile analysed by FRAP method. Phytochemical analysis carried out by standard procedure.

Salient features of phase I

- According to the results of nutrient profiling, 100g of pumpkin seeds included 3.47g of dietary fibre and 552 kcals. A 100g serving of pumpkin seeds has 8.89 grams of carbohydrates, 35.94 grams of proteins, and 41.42 grams of fat, making it a strong source of protein.

- Pumpkin seeds contain the highest concentrations of zinc (8.6 mg/100 g) and magnesium (678 mg/100 g), respectively, among all the minerals found in pumpkin seeds.

- According to the findings, 15gm of pumpkin seeds can provide 1/4th of the RDA for magnesium, 17.5% of the selenium need, and 15.6% of the iron requirement, respectively.

- Antioxidants (22.84 mM of ferric equivalents per gram of the sample) found in pumpkin seeds suggested that the seeds' capacity to scavenge free radicals may be a result of the presence of numerous nutrients and polyphenols.

- Various Fatty acids found in analysis of pumpkin seed sample such as Octanoic acid, Nonanedioic acid, Hexadecanoic acid, Octadecenoic acid, Linoleic acid, Docosanoic acid and Oleic acid.

- The presence of phytochemicals such as squalene, tocopherol and stigmasterol was reported in pumpkin seeds.

Conclusions

Due to the presence of various fatty acids, phytosterols, and minerals, pumpkin seeds are intriguing vegetable seeds with significant nutritional value, according to the results of this phase of the study. Pumpkin seed ethanolic extract revealed the presence of phytochemicals that may have affected antioxidant activity against the DPPH free radical. The results of current study may aid in determining whether pumpkin seeds have a marketable potential for use in nutraceuticals and food formulations, particularly for the treatment of diabetes, dyslipidaemia and its associated comorbidities.

PHASE II (A): SENSORY EVALUATION OF PUMPKIN SEED INCORPORATED RECIPES

Eight eqicarbohydrate recipes were developed and standardized such as Methi muthiya, Palak dhokla, Vegetable cutlet, Thalipith, Roasted poha chevda, Vegetable poha, Vegetable upma and Vegetable pulao based on various cooking methods. Pumpkin seeds were incorporated at dosage of 2g,5g and 10g followed by sensory evaluation by 20 semi trained panel members. Organoleptic evaluation of pumpkin seed incorporated

recipe carried out by semi trained panel members (n=20) from the Department of Foods and Nutrition, Faculty of Family and Community Sciences, The Maharaja Sayajirao University of Vadodara on 9 point hedonic scale for appearance, colour, aroma, taste, texture and overall acceptability.

Salient features of phase II (A)

- Sensory evaluation of pumpkin seed incorporated recipes at different dosage i.e., 2gm, 5gm, 10gm and control was carried out by using Hedonic rating scale and Composite scoring test.

- Out of the eight recipes, vegetable thalipith (sample 2) was well regarded while vegetable upma (sample 3) received the least favourable reviews from the semi-trained panel.

- Recipes such as palak dhokla, roasted chevda, vegetable poha and vegetable cutlet that included 10g of pumpkin seeds had the highest level of acceptability and liking.

- In comparison to dishes that contain pumpkin seeds, recipes without pumpkin seeds received the lowest overall acceptance rating.

- The semi-trained panel members enjoyed 8 recipes with pumpkin seeds incorporation (ranging from like extremely to like slightly). None of the recipes with scores below 5 on hedonic rating scale suggested that pumpkin seeds were well-received in the developed recipes.

Conclusions

Using pumpkin seeds in food products could be a crucial tactic for creating a healthy community. Products with 10 g of pumpkin seed inclusion were well received by semi trained panel members. These items are simple to make at home and are consumable frequently. Selected pumpkin seed incorporated traditional recipes can effective for managing diabetes and its associated comorbidities, and the addition of pumpkin seeds improves their functional characteristic also.

PHASE II (B): ASSESSMENT OF GLYCAEMIC INDEX AND SATIETY INDEX OF PUMPKIN SEED INCORPORATED RECIPES

10 healthy subjects were enrolled for assessment of Glycaemic index and Satiety intake after taken consent from them. Eight eqicarbohydrate and most preferred (10g pumpkin seed incorporated) standardized recipes were tested for its Glycaemic and Satiety index. Subjects were studied on separated days in morning after 10-12 hours of overnight fast. After ingestion of food blood glucose levels were estimated at every 15, 30, 45, 60, 90 and 120 minute initially for test food and then for reference food. Glycaemic index was calculated by under curve of test food over reference food by multiplying 100. Subjects were asked to evaluate their satiety using a visual analogue scale. Immediately after consumption, subjects were also asked to report their desire for prospective consumption using a Visual Analogue Scale (VAS) developed by Holt (1995). It is a measurement scale that tries to measure a characteristic; or attitude that is believed to range across a continuum of values.

Salient features of phase II (B)

- The average age of the students was 21.2 years. Hindus made up the majority of the subjects (80%), followed by Muslims (10%) and Jains (10%). The majority of the subjects were single. 40% of the subjects were graduates, whereas 50% of the subjects had completed their higher secondary education. Sixty percent of the individuals were from nuclear families.

- The average BMI of the enrolled participants was 20.7 kg/m2, indicating that they were all in the normal category for nutritional status according to the Asia-Pacific categorization of Body Mass Index. The subjects' average weight and height were 55.3 kg and 163.5 cm, respectively.

- After adding 5gm of pumpkin seeds, methi muthiya and vegetable upma were discovered to have the lowest glycemic index readings, at 45±10.2 and 47.75±9.2,

respectively.

- In comparison to the other 8 recipes, Roasted Poha Chevda had the greatest glycemic response (65.5±7.2).

- Vegetable upma was the least filling recipe, and thalipith was the most filling.

- Consumption of chevda (4.4±1.8) was followed by the highest want to eat something else, while consumption of vegetable thalipith (2.4±1.1) was followed by the lowest desire to eat something else, showing that it was the most satiating food among the test recipes.

Conclusions

The effect of recipes using pumpkin seeds on blood sugar levels after meals was significant. Pumpkin seeds were discovered to be an efficient way to lower glycemic reactions due to their high nutritional and phytochemical profiles. As a result, pumpkin seeds are recommended as a complementary non-pharmacological therapy for the management of diabetes.

PHASE III: IMPACT EVALUATION OF PUMPKIN SEEDS ON TYPE 2 DIABETIC SUBJECTS OF URBAN VADODARA

In phase 3, 90 subjects were enrolled for the supplementation as per inclusion and exclusion criteria. Subjects were distributed randomly in 3 groups. Group 1 received 10gm pumpkin seed intervention, group 2 received 15gm pumpkin seed intervention and group 3 treated as Control group. Supplementation was carried out for the period of 3 months. Data on baseline information, anthropometry, blood pressure, morbidity profile, blood glucose level, physical activity, food intake, quality of life, mental health, diabetes distress, kidney function test, liver function test, lipid profile were collected before intervention and post data was collected on same parameters after supplementation of 90 days.

Salient features of phase III (Baseline information)

- Equal number of males and females were enrolled in the study. Hinduism made up the majority of the subjects (92.2%), followed by Islam (4.4%), Jainism (2.2%), and Sikhism (1.1%). 70% of the subjects were married, and the majority (41.1%) had graduate degrees.

- Among the 90 participants, 42 were retired and 29 were housewives.

- The average DBP was 82mm/Hg, and the SBP was 131mm/Hg. The majority of the individuals reported weekly physical activity levels of less than 600 MET minutes.

- Among the 90 participants, 56 had a family history of diabetes mellitus.

- A vegetarian diet was followed by 59 out of 90 individuals. Out of 90 participants, 39 consumed three meals per day and 35 consumed four. The majority of the subjects occasionally ate meals from other sources.

- 30% of the participants said they consumed more than 7kg of sugar in a month. The majority of the individuals bought 1 kg of salt every month. The majority of the individuals did not frequently change their cooking oil.

- 32 of the 90 participants had diabetes for one to five years.

- 15.6% of the participants reported drinking more than three cups of tea or coffee each day. 66.3% of participants had no history of any substance use.

- Majority of the subjects (43.3%) reported excessive thirst, frequent urination (42.2%), excessive hunger (41.1%) followed by retinopathy (37.8%) and delayed wound healing (18.9).

- In addition to allopathic medications, 10% of subjects took Ayurveda remedies, while 5.6% used homoeopathic ones.

Salient features of phase III (Post intervention)

- Pumpkin seed supplementation did not change subjects' anthropometry measurements such as weight and BMI.

- The insufficient intake of iron, protein, and calcium was discovered to be caused by a lack of information regarding the significance of all food groups and meal preparation.

- Following intervention, a small improvement in the individuals' quality of life was seen. After an intervention, only a small number of participants were moved to the very good group, most likely as a result of better physical and mental health.

- There was a decrease in the overall diabetes distress score following an intervention in the case of diabetic distress as well. Supplementing with pumpkin seeds has no discernible effect on MMSE scores of type 2 diabetic subjects.

- Fasting blood sugar, glycated haemoglobin, total cholesterol, and LDL cholesterol levels among experimental groups all significantly decreased as a result of pumpkin seed administration. 7% reduction in Fasting Blood Glucose (FBS) was observed among group 1 and 8.5% reduction was noted for group 2. HbA1C levels were reduced by 9.4% among group 1 and 12% among group 2.

- For Total cholesterol (TC), 6% reduction among group 1 and 7.7% reduction among group 2 was noted. LDL cholesterol levels were reduced by 3.7% and 6% in group 1 and group 2 respectively.

- Supplementing with pumpkin seeds had no harmful effects because tests on kidney and liver function were unaffected.

- Two participants from each intervention group moved from the hypertension to the pre-hypertensive category after the intervention, indicating a beneficial effect of the supplementation with pumpkin seeds.

- The relationship between BMI and Fasting was favourable. Blood sugar levels imply

that as BMI rises, fasting blood sugar levels rise as well. The growth in glycated haemoglobin levels is independent of body mass index, as shown by the negative connection between BMI and glycated haemoglobin levels.

- The overall study's findings confirm hypoglycemic and hypolipemic properties of pumpkin seeds.

Conclusions

- Consumption of pumpkin seeds can be promoted to control and manage hyperglycemia and dyslipidemia. 10g to 15g of seeds can be safely consumed as an alone or with the combination with foods or recipes. Polyphenols, especially flavonoids found in pumpkin seeds have a promising anti-diabetic impact. Hence, eating pumpkin seeds is advised as a practical preventative measure and management strategy for diabetes, especially type II diabetes among the elderly population.

- According to the results, improvement in glucose and lipid parameters was observed after 90 days supplementation of pumpkin seeds. Hence, authors reject null hypothesis and accept alternative hypothesis.

Major conclusions

- Composition of pumpkin seeds on the basis of its analyzed value shows good nutritional profile that can be recommended for supplementation in required/proper dosage.

- Pumpkin seeds are rich in various vitamins and minerals especially magnesium. Pumpkin seeds contained various good fatty acids that are essential to improve lipid profile.

- Pumpkin seeds have good antioxidant properties. This property can help to control and manage various non-communicable diseases like diabetes.

- Incorporation of 10gm of pumpkin seeds in various recipes was found to be highly

acceptable.

- Use of pumpkin seeds as topping was found to be more desirable as compared to incorporation of seeds during preparation. Roasting process enhances taste and flavor of pumpkin seeds whereas cooking methods such as boiling and steaming are alternating texture of pumpkin seeds.

- Majority of the pumpkin seed incorporated recipes have low to moderate glycemic index. Thus, recipes can be incorporated in meals of diabetic patients.

- Recipes like methi muthiya and vegetable upma reported lowest glycemic index as compared to other recipes may due to presence of fibre due to methi and pulses in methi muthiya and presence of vegetables in upma.

- Hypoglycemic effect of pumpkin seed was observed among type 2 diabetic old age subjects when supplemented for the duration of 90 days.

- Pumpkin seed supplementation did not show any harmful effects on liver and kidney function tests.

- Pumpkin seeds have the potential to be used as a functional food in management of Diabetes mellitus and associated co-morbidities.

- The finding of this research supports the hypoglycemic role of pumpkin seeds.

- The alternative hypothesis and major objectives of the study were achieved successfully.