Introduction

Over the past several decades there is dramatic shift in stages of the way the entire globe eats, drinks and moves that have clashed with our biology to create major shifts in boy composition (Popkin 2012). The main drivers to changes in dietary patterns are urbanization, increased income, capital flow and market liberalization (Food and Nutrition Organization, 2004).

Non-communicable diseases (NCDs), also known as chronic diseases, tend to be of long duration and are the result of a combination of genetic, physiological, environmental and behaviours factors. The main types of NCDs are cardiovascular diseases (like heart attacks and stroke), cancers, chronic respiratory diseases (such as chronic obstructive pulmonary disease and asthma) and diabetes.

Global health is being influenced by three trends: population ageing, rapid unplanned urbanization and globalization which results in unhealthy environment and behaviors. As a result, the growing prevalence of NCD's and their risk factors has become a global issue affecting both low-middle income countries (Global Status Report on NCDs, 2014).

These diseases are driven by forces that include rapid unplanned urbanization, globalization of unhealthy lifestyles and population ageing. Unhealthy diets and a lack of physical activity may show up in people as raised blood pressure, increased blood glucose, elevated blood lipids and obesity. These are called metabolic risk factors that can lead to cardiovascular disease, the leading NCD in terms of premature deaths.

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.

Type 2 diabetes mellitus is a chronic, non -communicable disease characterized by insulin resistance, destructed insulin secretion, and hyperglycaemia. It is the most prevalent metabolic condition and one of the major health problems worldwide.

Several data has shown that diabetes is responsible for 9% global mortality rate per your among total diabetic population in the world. Globally more than 180 million people are suffering from diabetes which also increases the risk of cardiovascular complication. India has witnessed a rapid epidemiological transition in last 20 years. There is also improvement in Indian economy in terms of per capita income which had a great impact on lifestyle of Indian population and as a result diabetes has become a main public health problem. Therefore, prevention and lifestyle modifications are important to control the diabetes mellitus.

In India, the elderly population is 10 crores forming 10% of total population and it is estimated to reach up to 15 crores by the year 2020 and it is projected to rise to 12.4% of the population by the year 2026. From the morbidity point of view, almost 50% of the Indian elderly have

chronic diseases and 5% suffer from the immobility. A major contributor of burden of illnesses is prevalence of non-communicable disease.

Diabetes mellitus is a growing problem worldwide because of long life expectancy and life style modifications. Diabetes mellitus complications and comorbidities are more frequent in elders compare to young group. There are some of the causes which are responsible for developing diabetes among elderly such as genetic back-ground, long life expectancy lead to decrease insulin secretion and some environmental factors.

Coronary Heart Disease (CHD) is expected to be the single most important cause of death in India occurs in those aged 35-64 years.

Raised cholesterol increases the risk of heart diseases and stroke. Globally, a one third of ischemic heart diseases are attributable to high cholesterol. Overall raised cholesterol is estimated to cause 2.6 million deaths and 29.7 million disability adjusted life years (WHO Factsheet, 2018)

There are many different options to control diabetes during old age such as dietary modifications, physical activity, drugs, medicines, insulin and life style modifications. One of the pharmacological ways to control blood sugar level is use of botanical products or functional foods which can be tried.

The rising awareness of customers for the potential health benefits of food for disease prevention and health enhancement is increasing functional food and Nutraceuticals market. Functional foods are medicinal food provide certain health benefits beyond daily minimum requirements. There is some biologically active compound present in food functional foods which could improve health and reduce risk of diseases. Increasing demands for functional foods are also helping the producers to diversify their agriculture which is promoting research and innovations especially in the developing countries.

However, the industry has witnessed a rapid growth in the dietary supplements market due to increasing awareness among people to protect themselves against chronic diseases.

Among many food crops, vegetables are important part of the diet and provides bunch of nutrients specially carbohydrates, vitamins, minerals and fibre. By integrated action of oxygen scavenger such as calcium, fibre, Beta carotene which is present in vegetables reduces risk of cancer, heart diseases and premature ageing. Among all of these pumpkin is one of the most important vegetable crops nowadays because of its nutritional and medicinal values (Abd EI-Aziz, 2011).

In India pumpkin is commonly known as kaddu, kadhu, sitaphal, kashiphal and belongs to the family Cucurbitaceae and the genus cucurbita. It consists of about 118 genera and 825 species according to last taxonomy of Jeffrey.

Seeds of pumpkin are also known as Pepitas and are small, flat, green, having the taste likes nut flavor and mostly are covered by a white husk, however, some varieties may produce seeds without husk.

In addition to high levels of Zinc, Phosphorus, potassium, Selenium, Manganese and Copper the seeds of the pumpkin are also contained Magnesium and iron. It also has high amount of fatty acids content like politic, stearic, oleic and linoleic acids (Nakic SN, 2006).

However, pumpkin seeds are discarded as agricultural waste; Pumpkin seeds are an excellent natural source of essential vitamins and minerals, healthy oils and fibre. Boiled, baked, or even raw, pumpkin seeds are packed full of vitamins, minerals and amino acids. Pumpkin has gained extensive attention in current times due to good nutritional composition of pumpkin seeds and its health benefits.

Researchers have so far focused particularly on fatty acids, phytoestrogens and tocopherol in pumpkin seed oil because of several health benefits such as antioxidant, anti-inflammation, antidiabetic, anticancer, anti-cardiovascular, anti-hyperlipidemia and estrogenic like effect.

Pumpkin seeds having high nutritional and health values and also have pharmacological activities such as antidiabetic,antifungal,antibacterial,anti-inflamation and antioxidant effects which increase considerable attention (Nkosi et al.,2006).

The high unsaturated fatty acids composition of pumpkin seed oil also makes well suited for improving nutritional benefits of foods (Revathy et al., 2013).

Pumpkin seeds are widely considered to have hypoglycaemic properties. Cucurbita maxima seed extract produces significant antidiabetic effect in controlling blood glucose levels. The presence of phenols, flavonoids or saponins in the seed explain its role as potential antidiabetic agents (Sharma et al. 2013).

Several animal models and a limited number of human studies have revealed that polyphenols decrease hyperglycaemia and improve acute insulin secretion and insulin sensitivity. The possible mechanisms include decrease in glucose absorption in the intestine, inhibition of carbohydrates digestion, stimulation of insulin secretion, modulation of glucose release from the liver, activation of insulin receptors and glucose uptake in insulin-sensitive tissues, modulation of intracellular signalling pathways, and gene expression (Aryaeian et al. 2017)

There are many studies which have been carried out on pumpkin seed oil but there are no studies available on pumpkin seeds specifically on humans.

Pumpkin seed oil is expensive than pumpkin seeds. Pumpkin seeds are easy to consume than pumpkin seed oil. Processing of pumpkin seeds at home scale level is also very easy. If people are sensitize regarding health benefits, prevalence of specific disease like diabetes and cardiovascular can be reduced to some extent and quality of life of old age population can be improved.

With increased public awareness in the field of agriculture, pumpkin seeds have the chance to capture a new and emerging market share in the food snack industry. Pumpkin seeds have potential to be developed as novel food and it can be added to various products which can reduce the wastage of the pumpkin seed.

There are numerous other examples around the world in which people are consuming pumpkin seeds as traditional medicine. Even though there is sizable quantum of information is available with regards to beneficial effect of pumpkin seeds, still there is an ample scope to expose unknown properties of these seeds especially on human trials. The utilization of such underutilized agricultural product will help to maximize available resources.

Rationale

- The constituents of pumpkin seeds have several health medicinal properties which lead to opening up new avenues in the use of natural products for therapeutic purpose.
- Pumpkin seeds are generally discarded as waste but they can play important role in food by nutritional aspect. They can be consumed regularly without causing any side effects on human health.
- There is Dearth of information on dosage in human studies.
- Pumpkin seeds have potential to be developed as novel food and it can be added to various products which can reduce the wastage of the pumpkin seed.
- Even though there is sizable quantum of information available with regards to beneficial effect of pumpkin seeds, still there is an ample scope to expose unknown properties of these seeds especially on human trials. The usage of such underutilized agricultural product will help to maximize available resources.
- Sensitization regarding health benefits of pumpkin seeds among old age population will help to reduce diabetes to some extent and will help to improve quality of life.
- Therefore, present study was planned specifically on old age (Above 60 years) population of urban Vadodara.

Objectives

Broad objectives:

- To assess nutritional and health status of old age people by using invasive and non-invasive techniques.
- To study effect of pumpkin seeds on glycaemic and lipemic properties of type 2 diabetic old age population of urban Vadodara.

Specific objectives:

- To develop 8 eqi carbohydrate pumpkin seed incorporated recipes at different dosage.

- To carry out sensory evaluation of the developed recipes.

- To determine glycaemic index of pumpkin seed incorporated recipes.

- To determine the satiety index of the developed recipes by using prospective consumption rating scale

- To study the proximate composition of pumpkin seeds.

- To carry out phytochemical analysis of pumpkin seeds.

- To study the antioxidant profile of the pumpkin seeds.

- To assess health and nutritional status of enrolled subjects by using various non-invasive methods such as dietary intake, lifestyle factors, quality of life, physical activity pattern and mental health.

- To assess the current prevailing practices adopted by geriatric population in managing the condition.

- To assess the blood pressure and blood glucose levels of the enrolled old age subjects.

- To assess pre-nutritional status and health condition by using various invasive and non-invasive techniques.

- To supplement pumpkin seeds for 90 days.

- To collect post data after intervention on same parameters

Review of literature

This chapter will focus on the available literature under following heads-

- Non-communicable diseases
- Diabetes
- Types of diabetes
- Pathophysiology of Diabetes
- Risk Factors
- Management of Diabetes
- Glycaemic Index and Glycaemic Load
- Health problems of geriatric population
- Diabetes among geriatric population
- Mental health of diabetic population
- Functional foods
- Role of functional foods in diabetes
- Various seeds in management of diabetes
- Pumpkin and Pumpkin seeds
- Nutritional Composition of Pumpkin seeds
- Health benefits of Pumpkin seeds

Methodology

Description of Study Population

The study would be conducted in urban Vadodara city of Gujarat state. The Vadodara city is divided into 4 zones. Samples collected from each zone from diabetic various places. Old age Subjects above 60 years were contacted and those who were willing and eligible (as per the inclusion and exclusion criteria) enrolled in the study. Subjects selected purposively for the supplementation of the pumpkin seeds. Data on baseline information, anthropometry, blood pressure, morbidity profile, latest blood glucose level, physical activity, food intake, quality of life, mental health , kidney function test, liver function test, lipid profile collected before intervention and post data collected on same parameters after supplementation of 90 days.

Inclusion criteria:

- Subjects above 60 years of age of urban Vadodara
- Subjects who are willing to participate
- Subjects whose FBS levels are between 125-250mg/dl.
- Subjects who are on hypoglycaemic drugs or medications.

Exclusion criteria:

- Subjects suffering from any chronic illness.
- Subjects above 80 years of age.
- Subjects whose FBS levels are more than 250mg/dl. (Further referred to doctors) and whose HbA1c is more than 9%.
- Subjects taking other functional foods to control diabetes.

Sample Size Calculation

For the sample size calculation glycated haemoglobin was taken as the primary outcome. About 1% reduction (15mg/dl) in HbA1C level was anticipated. The standard deviation for HbA1c was taken of old age population of urban Vadodara from past departmental study. Power was set as 80% at a two-sided alpha of 0.05. the sample size of 21 in each phase was computed by using above details. By adding 20% attrition, sample size has finally arrived to 23 (Hulley,2007).

ES= 0.91

Thus we got sample size of 23 subjects for each group. We enrolled 30 subjects in each group for the intervention

Tools and Techniques to be used:
Phase 1:

- 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.

Phase 2a:

Procurement of pumpkin seeds:

For the study pumpkin seeds procured from local market by confirming with botanist.

Product development and Sensory evaluation

- 8 equal carbohydrate Indian recipes were developed by incorporating pumpkin seeds at different dosage such as 2g, 5g, and 10g.
- 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.
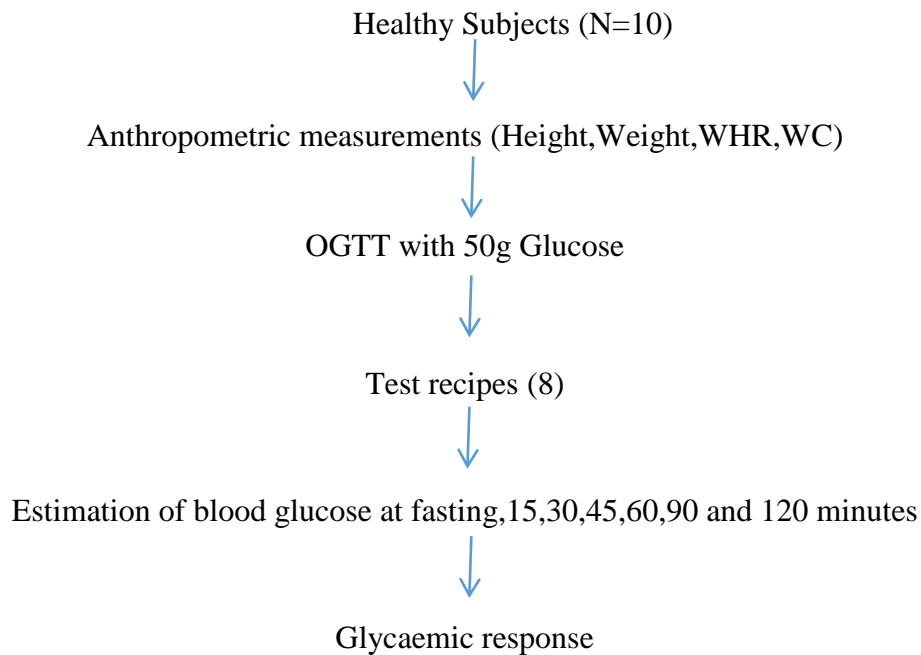
Phase 2b:

Evaluation of Glycaemic Index

- Subjects were selected from the Department of Foods and Nutrition, Faculty of Family and Community Sciences, The Maharaja Sayajirao University of Vadodara who were healthy and whose age was between 20-40 years. Weight, Height, initial fasting blood glucose assessed before the experiment.
- 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.

Experimental plan for determining Glycaemic Index

Healthy Subjects (N=10)

↓

Anthropometric measurements (Height,Weight,WHR,WC)

↓

OGTT with 50g Glucose

↓

Test recipes (8)

↓

Estimation of blood glucose at fasting,15,30,45,60,90 and 120 minutes

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Glycaemic response

Satiety Index

- Subjects were asked to evaluate their satiety using a visual analogue scale.
- During each 2 hour test session, the subjects were asked to consume the entire portion of food at a comfortable pace, within 10 minutes of time. Subjects were free to drink water during entire test time.
- The time taken for eating that specific portion by subjects was recorded. 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.
- Prospective consumption was assessed with questions like 'how much more would you like to eat?'(Nothing at all to a large amount); 'do you like eating something else?' (Nothing at all to large amount), etc.

Phase 3:

      a) **Socio economic status:** Kuppuswamy's Socioeconomic Status Scale-Updating for 2010

      Cut offs to be used:

      Social Class Total Scale Class

               I) 26 - 29 Upper

               II) 16 - 25 Upper Middle

               III) 11 - 15 Lower Middle

      b) **Weight:** Bathroom scale

      c) **Height:** Flexible measuring tape

      d) **BMI:** BMI Calculator, (Asia Pacific Classification 2004 for adults)

      The BMI limit for Indians is:

- Less than 18.4 – Underweight
- 18.5 - 22.9 - Normal
- 23 - 24.9 - Overweight
- More than 25 – Obese

e) Dietary profile: 24 hours Recall Method for 3 consecutive normal days and Food Frequency checklist.

Intervention:

- In phase 3, 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 was collected on various invasive and non-invasive parameters

Invasive:

Fasting blood glucose

HbA1C

Hemoglobin levels

Kidney function test

Liver function test

Lipid profile (Total cholesterol, HDL cholesterol, LDL cholesterol, VLDL cholesterol, Triglycerides)

HsCRP levels

Non-invasive:

Blood pressure: Digital instrument

Physical activity: GPAQ Analysis

Quality of life: WHOQOL Questionnaire, diabetes distress scale

Mental health: MMSE scoring method

Results and Discussion

Phase 1: Nutrient profiling of Pumpkin seeds (Cucurbita maxima)

The present phase of study was carried out with the objective to study proximate composition, fatty acid profile, micronutrient composition, phytochemical analysis and antioxidant screening of pumpkin seeds.

After confirming with the botanist, seeds were sent to NABL Accredited food analysis lab to analyse pumpkin seeds for various components.

As per results, 100gm of pumpkin seeds are loaded with 552 kcals and 3.47gm of dietary fibre. Amount of Carbohydrates, proteins and fats are reported 8.89gm, 35.94gm and 41.42gm respectively per 100gm of pumpkin seeds which can be considered as a good source of protein.

Out of all the minerals, pumpkin seeds are rich in magnesium that is 678mg/100gm and 8.6mg/100gm of zinc was reported which is highest as compared to other minerals in a pumpkin seed.

Pumpkin seeds reported presence of linoleic acids and other fatty acids such as octatonic acid, oleic acid, hexadecenoic acid; important for the management of non-communicable diseases. Pumpkin seeds are also rich in antioxidants which could be due to the presence of polyphenols.

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

Phase 2a: Sensory evaluation of Pumpkin seed incorporated recipes

Standardization and selection of recipes

- Eight eqi-carbohydrates, Indian recipes were standardized by adding pumpkin seeds with 2gm (Sample 1), 5gm (Sample 2) and 10gm (Sample 3).

- A control recipe (Sample 4) was also developed to keep it as standard recipe (without pumpkin seeds incorporation) to evaluate other recipes in comparison to that. The eight recipes were prepared by using different cooking methods.

  Steamed: Methi muthiya and Palak dhokla
  Shallow-fried: Vegetable tikki and Thalipith
  Roasted: Chevda and Vegetable Poha
  Boiled: Vegetable Upma and Vegetable Pulav

- 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.

- Total 30 Semi-trained panel members were selected to carry out sensory evaluation of pumpkin seed incorporated recipes.

- To assess overall acceptability for each level of pumpkin seed incorporation in breakfast recipes, panellists were asked to rate different attributes of each recipes such as aroma, taste, texture, appearance and absence of defect.

- They were also asked to rank each recipes ranging from dislike extremely to like extremely by using 9 point hedonic rating scale

Composite scoring of recipes

- Out of 8 recipes, vegetable thalipith (sample 2) was highly acceptable and Vegetable upma (sample 3) was least preferred by semi trained panel members.

- The highest acceptability and degree of liking was observed for recipes incorporated with 10gm of pumpkin seeds.

- Attempt was made to know the overall ranking in between the level of incorporation in different developed recipes. From obtained results, it can be stated that Sample 3 (4 out of 8 recipes) having 10gm of pumpkin seeds preferred most by the semi trained panel members.

- Sample 2 having 5gm of pumpkin seed incorporation was also preferred by the panel members for 5 recipes. Sample 4 having no pumpkin seeds incorporation was least preferred by panel members for 6 out of 8 recipes

Hedonic rating scale

- Hedonic rating test was used to measure the acceptability of pumpkin seeds incorporated recipes for the different variations. It is a nine scale rating scale ranging from like extremely to dislike extremely. The obtained results were analysed with data received from semi trained panel members.

- From obtained results, it can be concluded that all the 8 pumpkin seeds incorporated recipes were liked (ranged from like extremely to like slightly) by the semi trained panel members. None of the recipes showed score ≤ 5 indicated the good acceptance of pumpkin seed incorporated recipes.

Phase 2b: Assessment of Glycaemic index and Satiety index of pumpkin seed incorporated recipes

- The present phase of study was carried out to assess glycaemic index and satiety index of pumpkin seed incorporated 8 recipes developed in previous phase (phase 2a).

- For the assessment of glycaemic index and satiety index of pumpkin seed incorporated 8 recipes, 10 healthy subjects were enrolled in the study.

Baseline information of enrolled subjects

- Mean age of the enrolled subject was 21.2 years and 80% of them were Hindu.

- Most (90%) of them were unmarried. 40% were graduates and 6 out of 10 were belonging to nuclear family.

- Mean weight of the enrolled subjects was 55.3 ± 5.1kg and BMI was 20.7 ± 2.1kg/m^2.

Glycaemic responses of pumpkin seed incorporated recipes

- Methi muthiya and vegetable upma found to be have lowest glycemic index after incorporating 5gm of pumpkin seeds i.e. (45 ± 10.2) and (47.75 ± 9.2) respectively.

- Out of total 8 recipes, Roasted poha chevda obtained highest glycemic response (65.5 ± 7.2) as compared to other recipes.

Satiety index of pumpkin seed incorporated recipes

- Time required by subjects to consume each recipe was noted. Results revealed that Vegetable tikki required maximum time $(13.2\pm3.1$ minutes$)$ for its consumption whereas roasted chevda took least time $(9.6\pm2.7$minutes$)$ for its consumption.

- Recipes were also analysed for its sufficiency in terms of serving size and results indicated that Thalipith (8.8 ± 1.3) ranked highest for its serving size and chevda (6.8 ± 3.3) was least.

- Among various pumpkin seed incorporated recipes, Vegetable Thalipith (5.1 ± 1.2) received maximum score for desire to eat the same food again while Vegetable Pulao (2.2 ± 1.5) got least score.

- Vegetable Thalipith (8.7 ± 2.1) was found to be most satisfying food among subjects and vegetable upma $(7\pm1.6)$was found to be least satisfying food

- The desire to eat something else apart from test recipe was highest after the consumption of chevda (4.4 ± 1.8) and desire to eat something else was lowest after consumption of Vegetable Thalipith (2.4 ± 1.1) which is also indicating that it was most satiating food among other test recipes.

- Out of 8 recipes for comparison of GI with the standard recipes (without seeds), 3 previously studied recipes were taken into consideration.

Phase 3: Impact evaluation of pumpkin seeds on type 2 diabetic subjects of Urban Vadodara

The present phase of study was carried out to assess impact of pumpkin seed supplementation on type 2 diabetic old age subjects (age more than 60 years) of urban Vadodara. Supplementation was carried out for 90 days.

In this phase, 90 subjects were enrolled in the study as per inclusion and exclusion criteria and they were divided into three groups for the supplementation purpose. Group 1 received 10gm of supplementation, group 2 received 15gm of supplementation and group 3 was treated as control group (no intervention).

Baseline information of enrolled subjects:

- An equal number of males and females enrolled in the study.
- Out of 90 subjects, 92.2% were Hindu followed by Muslim, Jain and Sikh. 70% Subjects were married and majority of them were graduates
- As far as occupation is concerned, out of 90 42 subjects were retired and 29 females were housewives. More than half subjects were belonging to Nuclear family. 25.6% subjects were belonging to Joint family.

Anthropometric and Biophysical Profile of the Type 2 Diabetic Subjects

- Mean age (in years) of group 1, group 2 and group 3 subject was 65.9±4.45, 66.1±3.93 and 68±3.83 respectively.
- Mean height of enrolled subjects was 164.6±9.59 cm and weight was 66.86±9.95 kg.
- Mean body mass index was 24.6±2.06 kg/m^2 belonging to overweight category as per Asia pacific cutoffs of Body Mass Index.
- Mean SBP was 131 mmHg and DBP was 82 mmHg

Physical Activity pattern of type 2 diabetes mellitus subjects

- Overall out of 90 subjects, only 18 subjects were reported to perform having physical activity >600 MET mins per week.
- Majority of subjects were not meeting the WHO recommendations given for physical activity. Subjects of group 1 were more physically active than other 2 groups.

Prevalence of Obesity among Type 2 Diabetic subjects

- 30% subjects were obese and 26.7% subjects were overweight in group 1.
- In group 2, more than half of the subjects (53.3%) were overweight whereas 23.3% subjects were Obese and Normal
- For control group, 56.7% subjects were overweight and 43.3% subjects were Obese

Family History of Type 2 Diabetic subjects

- Out of 90 subjects 56 subjects were having family history of Diabetes mellitus followed by Hypertension, Cardiac problem, Obesity and Thyroid.
- 29 subjects were not reported any medical family History. This data shows the strong association between Family history of Diabetes and occurrence of Diabetes Mellitus.

Dietary habits of Type 2 Diabetic subjects

- 59 out of 90 subjects were following vegetarian eating pattern followed by non-vegetarian and lacto-ovo vegetarian.

- Almost everyone were consuming lunch and dinner on a daily basis. Only 6.7% subjects were consuming Mid-morning snacks.

- 20% of subjects reported bed time milk consumption.

- Out of 90, 39 subjects were taking 3 meals and 35 subjects were taking 4 meals in a day and out of that maximum combination was Breakfast, Lunch, Evening snacks and Dinner. Only 1 subject was consuming more than 5 meals in a day.

- 48.9% subjects were consuming 6-8 glasses of water in a day. Most of the subjects were consuming outside food once in a month.

Sugar, Salt and Oil consumption of Type 2 Diabetic subjects

- According to the data collected on Salt, Sugar and Oil consumption, only 27.8% subjects were using sugar less than 5kg in a month. 30% of the subjects reported sugar consumption more than 7kg in a month.

- Majority of the subjects were purchasing 1 kg salt in a month.

- Half (50%) of the subjects were using 5-6 litres of cooking oil in a month. Most of the subjects were not changing their cooking oil periodically as they were not aware about the purpose behind it

- 44.4% of the subjects were using oil to prepare dal sabji which remains after deep frying. 16.7% of the subjects were discarding the cooking oil after used for deep frying.

Tea and Coffee consumption of Type 2 Diabetic subjects

- Half of the subjects were consuming 2 cup of tea/coffee in a day.

- 15.6% of the subjects were consuming more than 3 cups of tea- coffee in a day which can be considered very high caffeine intake.

- 62.2% subjects were reported that they are not consuming sugar in a coffee and tea.

Foods avoided by Diabetic Subjects to prevent Diabetes

- Subjects were avoiding rice (30%), potatoes (34.4%), sugar (12.2%) and jaggery (41.1%) to control Diabetes.

- 33 out of 90 subjects were not restricting any food to control Diabetes.

- Majority of the subjects were avoiding one food to prevent diabetes.

- 13 subjects were avoiding more than 2 food items to prevent diabetes.

Food frequency of various food among Type 2 Diabetic Subjects

- Overall, majority of the subjects (>45 subjects) shown frequent consumption of Fruits, Vegetables, Milk, Buttermilk and curd.

- Majority of the subjects were also consuming Biscuits, Soft drinks and Namkeen frequently which is not good for their health.

Substance usage pattern of Type 2 Diabetic Subjects

- Out of total enrolled subjects, 66.3% of subjects were not having any addiction.

- 15.7% subjects were addicted to tobacco followed by pan and gutka (13.5%), Smoking (5.6%). Only 1.1% subjects were reported alcohol consumption.

Current medical Problems of Type 2 Diabetic Subjects

- Apart from diabetes mellitus, 51 out of 90 subjects were suffering from hypertension.

- 21.1% subjects were also having High cholesterol problem. 15.6% subjects were having thyroid problem followed by kidney stone (11.1%) and osteoporosis (5.6%)

Duration of Diabetes

- Out of 90 subjects, 32 subjects were having diabetes duration of 1-5 years

- 30 subjects were suffering from diabetes between 5-10 years while 17 subjects were having diabetes from more than 10 years.

Symptoms reported by type 2 diabetic subjects

- 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).

Type of treatments adopted by Diabetic Subjects to manage Diabetes

- 100% subjects were using allopathic medicines to control diabetes. Apart from allopathic medicines, 10% subjects were on Ayurveda and 5.6% were on Homeopathic medicines. 4 out of 90 subjects reported occasional use of insulin to control blood glucose levels. Non-pharmacological therapies such as Dietary modifications and Regular exercise were adopted by 44.4% and 38.9% respectively.

- Out of total subjects, almost everyone was consuming medications on a daily basis. 27.8% subjects reported use of Nutrient supplements such as Calcium, Vitamin B12, Vitamin D and Vitamin C as recommended by their physicians.

Frequency of Medical check-up

- Out of total, 33.3% subjects were going for a medical check-up once in every 3 months while 37.8% whenever required and 24.4% subjects reported once in a year.

Causes of diabetes as per diabetic subjects

- Subjects were also asked about the cause behind the occurrence of diabetes but 40% subjects were not aware about the cause behind it while 31.1% subjects reported heredity as a reason behind occurrence of Diabetes.

- 8.9% subjects were considered age as a reason.

Effect of Pumpkin seeds on Anthropometry and Biophysical parameters

- Pumpkin seed supplementation do not have any significant changes on anthropometric parameters.

Effect of pumpkin seed supplementation on mean nutrient intake of Diabetic subjects

- Significant increase in protein consumption was found for group 1. For group 1, overall significant difference was reported for fat, calcium and Dietary fibre. Significant difference reported for iron and dietary fibre among group 2 before and after intervention.

- Overall, mean calorie consumption by diabetic subjects was same before (1633.3±142.5) and after (1632.1±124.9) intervention without any significant difference. Intake of iron, protein and calcium were found to be inadequate probably due to lack of knowledge regarding importance of all the food groups and meal planning.

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Effect of pumpkin seed supplementation on Overall Quality of life of Type 2 Diabetic subjects

- After supplementation period, there was a slight improvement in terms of overall quality of life.
- Similarly, after an intervention period few subjects from dissatisfied score were shifted to satisfied score category which is also indicating slight positive impact on quality of life.

Effect of pumpkin seed supplementation on Diabetes Distress Scale (DDS) of Type 2 Diabetic subjects

- Overall after an intervention period of 90 days, subjects shifted to normal category from 60% to 73.3% in case of group 1 and from 46.7% to 53.3% in case of group 2.
- Overall stress was reducing from 40% to 26.7% for group 1 and 53.3% to 46.7%. there was no change in terms of emotional burden and slight shift was observed in case of physician related and interpersonal distress.

Effect of pumpkin seed supplementation various biochemical parameters of Diabetic   Subjects

- Before enrolment as per pre data collected, mean haemoglobin level was 12g, 12.3g and 12.6g for the group 1, group 2 and control group respectively.
- After intervention, there was no significant rise on the haemoglobin levels with the levels of 12.5g .12.7g and 12.2 g for all 3 groups.
- Significant reduction was found after Pumpkin seed supplementation in Fasting Blood glucose levels and glycated haemoglobin levels for group 1 and group 2.
- Significant reduction was found in Total cholesterol levels among group 1 and group 2 after supplementation.
- Significant reduction in triglycerides levels and significant increase in HDL cholesterol levels were also reported among group 2.
- Mean levels of all kidney and liver indicators were in a normal range for all 3 groups before and after intervention.
- Thus, we can conclude that there are no toxic effects of pumpkin seed consumption on kidney and liver function.
- The mean HsCRP levels were found to be slightly high among all 3 groups which reduced to some extent after having an intervention for the period of 3 months.
- There was no significant association found between consumption of pumpkin seeds and HsCRP levels among Diabetic Subjects.
- Significant reduction in FBS levels found among experimental groups when compared with control group.

Effect of pumpkin seed supplementation on Blood pressure of Diabetic Subjects

- After intervention, 2 subjects from both intervention groups shifted to pre-hypertensive category from hypertensive category which indicates positive impact of pumpkin seed supplementation.
- Similarly for group 2 also, After intervention, 2 subjects from both intervention groups shifted to pre-hypertensive category from hypertensive category which indicates positive impact of pumpkin seed supplementation.

Correlation between BMI and Fasting Blood Sugar levels of subjects

- There was a positive correlation between BMI and Fasting Blood sugar levels among experimental groups means as BMI is increasing, fasting blood sugar levels are also increasing.
- There was a negative correlation between BMI and Fasting Blood sugar levels among control group.

Correlation between BMI and Glycated Haemoglobin

- There was a negative correlation between experimental groups between BMI and Glycated hemoglobin levels indicating that rise in Glycated hemoglobin levels are independent from Body mass index.
- There was a positive correlation among control group between BMI and Glycated hemoglobin levels indicating that rise in Glycated hemoglobin levels are dependent on Body mass index.

Impact of pumpkin seed supplementation on MMSE Scores of Diabetic Subjects

- Pumpkin seed supplementation do not have any noticeable impact on MMSE scores of type 2 diabetic subjects.

Conclusion and Recommendations

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

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

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

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

- 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 have any harmful effects on liver and kidney functioning.

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

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

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