RESULTS AND DISCUSSION

Type 2 Diabetes Mellitus among old age population is most common health problem of developing country like India. Diabetes Mellitus has become the global problem of 20th Century.

Due to technological advancement and improved medical facilities, life expectancy of Indian population has increased. Therefore, they are at more risk for developing Non-Communicable Diseases in later life which can affect their quality of life. Diabetes is one of the most common NCD among old age population which can results into short term and long term complication if untreated. Diet, Physical activity, hypoglycemic drugs and use of functional foods plays important role for the management of Type 2 Diabetes Mellitus. In order to prevent and treat chronic diseases like type 2 diabetes mellitus, functional meals must have biologically active components linked to physiological health advantages. Regular consumption of functional foods may be linked to improved anti-oxidant, anti-inflammatory, insulin sensitivity, and anti-cholesterol activities, all of which are essential for managing and preventing T2DM. Biological and behavioral models should be taken into account, and nutrition education should be integrated into lifestyle diabetes preventive studies as part of a personalized strategy to preventing and controlling T2DM. In such a strategy, functional food may offer extra advantages.

The present study was carried out with the objective to assess the effect of pumpkin seed supplementation on Glycemic and Lipemic parameters of on old age population of Urban Vadodara.

The Results and Discussion chapter is divided into 3 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 Glycemic index and Satiety index of pumpkin seed

incorporated recipes

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

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

Analysis of raw pumpkin seeds was carried out to know its proximate composition, micronutrient content, phytochemicals present, antioxidant activity and fatty acid composition. Analysis was done by Indian Institute of Food Processing Technology – IIFPT, Thanjavur [NABL Accredited Laboratory as per ISO/IEC 17025:2017] recognized by FSSAI.

Section 4.1.1. Nutrient profiling of pumpkin seeds

Pumpkin seeds were analyzed for its ash, moisture, protein, carbohydrates, energy, crude fibre and fat content by using standard AOAC methods. Results of nutrient profiling revealed that 100gm of pumpkin seeds were loaded with 552 kcals and 3.47gm of dietary fibre. Amount of Carbohydrates, proteins and fats were reported 8.89gm, 35.94gm and 41.42gm respectively per 100gm of pumpkin seeds which can be considered as a good source of protein reported in table 4.1.1.

It is a well-known fact that presence of few trace elements like zinc, iron, potassium and sodium plays important role in maintenance of normoglycemia by activation of beta cells of the pancreas. 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 seeds. Being rich in magnesium and zinc, pumpkin seeds can be used for the hypertensive patients and magnesium acts as a vasoconstrictor and can be beneficial for the patients suffering from high blood pressure and cardiovascular diseases. Vitamin C was reported as 20mg/100gm of samples whereas very negliable amount of riboflavin, vitamin D and K was reported.

Table 4.1.1.1 Nutrient profile of pumpkin seeds

Analysed parameter	Result (Per 100gm of sample)
Protein	35.94gm
Fat	41.4gm
Carbohydrates	8.89gm
Crude fibre	3.47gm
Energy	552 (Kcal)
Vitamin C	19.70mg
Vitamin K	0.062mg
Vitamin D	0.0085mg
Riboflavin	0.167mg
Niacin	8.552mg
Thiamine	0.506mg
Sodium	8.843mg
Potassium	831mg
Calcium	7.782mg
Zinc	8.162mg
Iron	19.86mg
Magnesium	678.69mg
Selenium	0.051mg

Attempt was made to calculate % RDA met from 10gm of pumpkin seeds and 15gm of pumpkin seeds for various nutrients. From the table 4.1.1.2, it can have stated that 1/4th of RDA for magnesium can be met from 15gm pumpkin seeds whereas 17.5% requirement of selenium and 15.6% of iron requirements can be met via 15gm consumption of pumpkin seeds on a daily basis.

Table 4.1.1.2 % RDA met from 10gm & 15gm of pumpkin seeds

Name of the Nutrient	Result (Per 100gm of sample)	RDA (ICMR,2020)	% RDA met from 10gm of pumpkin seeds	% RDA met from 15gm of pumpkin seeds
Selenium	0.051mg	0.04mg	12.5%	17.5%
Zinc	8.162mg	17mg	9.9%	14.9%
Iron	19.86mg	19mg	10.42%	15.68%
Calcium	7.782mg	1000mg	0.08%	0.12%
Sodium	8.843mg	2000mg	0.04%	0.07%
Potassium	831mg	3500mg	2.37%	3.56%
Magnesium	678.69mg	385mg	17.6%	26.4%
Vitamin C	19.70mg	80mg	2.46%	3.68%
Thiamine	0.506mg	1.4mg	3.57%	5%
Riboflavin	0.167mg	2mg	0.5%	1%
Niacin	8.552mg	14mg	6.07%	9.14%

Section 4.1.2. Antioxidant activity of pumpkin seeds

Oxidative stress plays important role in pathogenesis of diabetes. Hyperglycaemia promotes increased production of free radicals from glucose via auto oxidation process. Supplementation of antioxidants along with medicinal plants scavenges the effects of free radicals and neutralizes them. Thus, antioxidants are used to treat diabetes and its complications. Antioxidant potential Ferric Reducing Antioxidant Potential (FRAP) of pumpkin seed is presented in below table 4.1.2.

Table 4.1.2. Antioxidant Activity of Raw Pumpkin Seeds by FRAP

Parameter	Result
Antioxidant Activity by FRAP	22.84 mM of ferric equivalents per gram of the sample

For the present study, above table shows the trend for ferric ion reducing activities of pumpkin seeds. The presence of antioxidants among pumpkin seeds indicate ability of seeds to scavenge free radicals may due to the presence of various nutrients and polyphenols. Results shows good oxidative stress reducing potency of pumpkin seeds.

Section 4.1.3. Fatty acid composition of pumpkin seeds

Fatty acids plays important role in diabetes management by influencing translocation of glucose receptors and insulin receptors. Therefore, it has been suggested that fatty acids are important for the treatment of insulin resistance and type 2 diabetes mellitus.

Various Fatty acids found in analysis of pumpkin seed sample are summarized in below table 4.1.3.

Table 4.1.3. Fatty acid Compounds identified in the Pumpkin Seeds

Sr. No.	Name of the compound	Peak area (%)
1	Octanoic acid methyl ester	0.73
2	Nonanedioic acid, dimethylester	0.16
3	17-Octadecynoic acid	0.20
4	Methyl tetradecanoate	0.11
5	Hexadecanoic acid, methylester	13.06
6	9,12-Octadecadienoic acid(Z,Z)-, methyl ester	36.07
7	9-Octadecenoic acid, methylester,	36.23
8	Methyl stearate	6.73
9	7,10,13-Eicosatrienoic acid,methyl ester	0.50
10	Linoleic acid ethyl ester	0.47
11	6,9,12,15-Docosatetraenoic acid, methyl ester	0.38
12	Docosanoic acid, methyl ester	0.46
13	Oleic acid, eicosyl ester	4.88

Table indicates fatty acid compounds identified from pumpkin seeds. Several studies shown that supplementation of linoleic acid plays important role in reduction of LDL cholesterol and total cholesterol. Some evidences are also there to support its role in improvement of insulin resistance and blood pressure. Octanoic acid is a medium chain fatty acid which have anti-inflammatory effects. Few fatty acids acts as a precursor of prostaglandin, results into constriction of smooth vessels and ultimately lowering of blood pressure. According to

above table 4.1.3, 9-Octadecenoic acid, methylester and 9,12-Octadecadienoic acid(Z,Z)-, methyl ester were found to be highest as compared to other fatty acids reported in pumpkin seeds.

Therefore, it can be stated that pumpkin seeds are important for the management of Non-communicable diseases due to its fatty acid composition.

Section 4.1.4. Phytochemical screening of pumpkin seeds

Phytochemicals are having positive impact on human health and provide significant health benefits for consumers and due to that phytochemicals are of great interest and have significant antioxidant potential. Regular eating of fruits, vegetables, and whole grains may lower the incidence of a number of diseases associated with oxidative damage, according to epidemiological research and animal studies (Cieslik et al., 2006; Scalbert et al., 2005; Kris-Etherton et al., 2002). The seeds of pumpkin constitute excellent providers of micro and macronutrients like fiber, amino acids, MUFA, PUFA, tocopherol, and carotenoids. In functional foods and medicinal products, pumpkin seed may be used as an ingredient of choice due to the availability of different bioactive phytochemical components that have shown health-promising effects. All of these elements have an essential role in the body's normal functioning and can thus be used as functional therapeutic agents to treat a variety of disorders (Batool M et al, 2022).

The ethanolic extract of pumpkin seeds tested for the presence of various phytochemicals. Below table 4.1.4. summarize the presence of various phytochemicals present in pumpkin seeds.

Table 4.1.4. Phytochemicals present in seed extract

Phytochemicals tested	Result
Squalene	Present
Tocopherol	Present
Stigmasterol	Present
Flavonoids	Present
Phenols	Present

Highlights of Phase I

- *Pumpkin seeds were found to be rich in protein (35.94gm) and fat (41.42gm).*
- *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 seeds.*
- *Pumpkin seeds reported presence of linoleic acids and other fatty acids, 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.*
- *A rich nutrient profile and the presence of various fatty acids and phytochemicals in pumpkin seeds may be value in management of diabetes and other non-communicable diseases.*

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 pulav based on various cooking methods. Pumpkin seeds were incorporated at dosage of 2g,5g and 10g followed by sensory evaluation by semi trained panel members.

Section 4.2a.1. Development and Standardization of Pumpkin seed incorporated recipes

Eight eqi-carbohydrates, Indian breakfast recipes were standardized by adding pumpkin seeds with 2gm, 5gm and 10gm. A control recipe was also made to keep it as standard recipe (without pumpkin seeds incorporation) to evaluate other recipes in comparison to that.

Total eight recipes were developed and standardized and categorized according to the method of preparation.

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

Section 4.2a.2. Sensory Evaluation of the recipes

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 20 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.

The results were prepared and analysed by using ANOVA test to see the differences between recipes and also to see differences among the attributes of each recipes. Following tables shows the **mean composite scores** of various pumpkin seed incorporated traditional recipes.

Methi Muthiya

Table 4.2a.2.1. Mean scores for the sensory attributes of the Methi Muthiya (Mean±SD)

Methi Muthiya					
	Sample 1 (2g)	**Sample 2 (5g)**	**Sample 3 (10g)**	**Sample 4 (Control)**	**F value**
Taste	17.5±1.8	17.2±1.5	17.4±2	17.7±1.6	0.19^{NS}
Texture	17.2±3.5	17±1.9	17.5±2.1	18.1±1.3	0.80^{NS}
Colour and Appearance	18.5±1.8	17.8±1.9	17.7±2.2	17.8±1.7	0.78^{NS}
Absence of defect	18.8±2	18.1±1.4	18.5±1.2	17.6±1.6	1.96^{NS}
Overall acceptability	18±1.7	17.7±0.9	18±1.7	17.7±1.5	0.27^{NS}
Total	88±14	86.6±9.5	86.4±10	89.1±3.8	0.32^{NS}

*Significant from the baseline value at $p<0.05$, ** at $p<0.01$, *** at $p<0.001$, NS- Non- significant

Out of all developed recipes of Methi muthiya, Sample 4 that is Methi Muthiya without pumpkin seed incorporation was the most acceptable followed by Sample 1, Sample 2 and Sample 3. There was no significant difference between Taste, Texture, Colour, Absence of defect and Overall acceptability.

Palak Dhokla

Table 4.2a.2.2. Mean scores for the sensory attributes of the Palak Dhokla (Mean±SD)

Palak Dhokla					
	Sample 1 (2g)	**Sample 2 (5g)**	**Sample 3 (10g)**	**Sample 4 (Control)**	**F value**
Taste	16.66±1.8	17.6±1.4	17.4±2	17.8±1.7	1.66 ^{NS}
Texture	16.8±2.5	17.2±2.4	17.5±2.1	17±1.5	0.43 ^{NS}
Colour and Appearance	17.9±1.6	18.2±1.6	17.7±2.2	17.7±1.6	0.38 ^{NS}
Absence of defect	18±1.5	17.7±1.3	17.4±4.1	17±1.5	0.59 ^{NS}
Overall acceptability	18.3±1.5	17.7±0.9	18.3±1.5	17.4±1.8	2.81 *
Total	87.7±6.6	88.7±4.7	88.72±8.4	87.1±3.6	0.25 ^{NS}

*Significant from the baseline value at p<0.05, ** at p<0.01, *** at p<0.001, NS- Non- significant

Pumpkin seeds were incorporated in Palak Dhokla at level of 2g, 5g and 10g. Sample 4 was developed without any pumpkin seed incorporation. There was a significant difference found in terms of overall acceptability between all four samples. Sample 2 and sample 3 were accepted more as compared to sample 1 and control. Sample 2 was accepted more in terms of colour and appearance whereas sample 3 was accepted more in terms of texture and overall acceptability. Thus, with the minimum difference, Sample 3 can be considered the most preferred by semi trained panel members.

Roasted Chevda

Table 4.2a.2.3. Mean scores for the sensory attributes of the Roasted Chevda (Mean±SD)

Roasted Chevda					
	Sample 1 (2g)	**Sample 2 (5g)**	**Sample 3 (10g)**	**Sample 4 (Control)**	**F value**
Taste	17.7±2.2	17.7±2.7	18.8±1.5	17.5±1.7	1.42 ^{NS}
Texture	18.1±2	18.2±1.9	18.1±2.1	17.9±1.7	0.06 ^{NS}
Colour and Appearance	18.6±1.8	18.3±2	18.4±2.2	17.3±1.6	1.60 ^{NS}
Absence of defect	17.8±2.6	18.1±2.7	17.9±2.5	18.2±1.3	0.09*
Overall acceptability	17.6±2.2	18.4±1.4	19±0.9	16.9±1.7	5.81**
Total	88.5±13.3	89.3±13.8	90.8±12.3	88.1±3.9	0.21 ^{NS}

*Significant from the baseline value at p<0.05, ** at p<0.01, *** at p<0.001, NS- Non- significant

Roasted poha chevda was developed by adding pumpkin seeds at 3 different dosage. No significant difference was found for taste, texture, colour and appearance. Significant difference was found for absence of defect between samples. Overall, sample 3 having 10gm of pumpkin seeds was more acceptable as compared to other samples. As per the comments given by panel members, majority of them liked sample 3 most due to its crunchy and nutty flavour and taste of roasted pumpkin seeds.

Vegetable Thalipith

Table 4.2a.2.4. Mean scores for the sensory attributes of the Vegetable Thalipith (Mean±SD)

Vegetable Thalipith					
	Sample 1 (2g)	**Sample 2 (5g)**	**Sample 3 (10g)**	**Sample 4 (Control)**	**F value**
Taste	18.5±1.2	18.7±1	18.6±1.2	17.8±2	1.62 ^{NS}
Texture	18.1±0.8	18.5±1.3	18.2±1.4	16.7±1.3	7.04***
Colour and Appearance	18.7±1.2	18.8±0.9	18.4±1.2	17.4±1.7	4.7**
Absence of defect	19.2±0.8	19.1±0.7	18.5±1.2	17.3±1.7	9.5 ^{NS}
Overall acceptability	18.8±0.8	19.3±0.8	18.5±0.9	17.5±1.9	6.73***
Total	93.5±2.4	94.6±2.6	92.4±3.7	87±3.5	22.02 ^{NS}

*Significant from the baseline value at p<0.05, ** at p<0.01, *** at p<0.001, NS- Non- significant

Among all 4 developed vegetable thalipith variations, Sample 2 was found most acceptable among other samples. Significant difference found between samples for texture, colour, appearance and overall acceptability. There was no significant difference found for taste, absence of defect and total score. Overall, sample 2 was most acceptable as per mean total score followed by sample 1, sample 3 with minimal difference and sample 4 with maximum difference.

Vegetable Pulao

Table 4.2a.2.5. Mean scores for the sensory attributes of the Vegetable Pulao (Mean±SD)

Vegetable Pulao					
	Sample 1 (2g)	**Sample 2 (5g)**	**Sample 3 (10g)**	**Sample 4 (Control)**	**F value**
Taste	17.8±1.2	17.3±1.9	18.1±1.8	17±1.6	1.67 ^{NS}
Texture	18.1±1.8	17.2±1.9	16.8±1.9	18.3±1.3	2.84*
Colour and Appearance	18.6±1.7	17.8±1.8	18.5±1.4	16.7±1.3	5.14**
Absence of defect	19.2±0.9	18.9±0.8	18.6±1	17.5±1.5	8.33 ^{NS}
Overall acceptability	18.6±1	18.6±0.6	18.3±1.2	17.3±1.4	5.12**
Total	92.4±4.5	90.5±5.1	90.4±4.8	88.1±3.5	2.86*

*Significant from the baseline value at p<0.05, ** at p<0.01, *** at p<0.001, NS- Non- significant

In case of vegetable pulao, Sample 1 having 2gm of pumpkin seed incorporation was accepted more by semi-trained panel members amongst four samples. Significant difference was found for texture, colour, appearance and overall acceptability. Sample 4 developed without pumpkin seeds incorporation was least accepted by panel members which indicates that presence of pumpkin seeds in a product having effect on acceptance of the product.

Vegetable Poha

Table 4.2a.2.6. Mean scores for the sensory attributes of the Vegetable Poha (Mean±SD)

Vegetable Poha					
	Sample 1 (2g)	**Sample 2 (5g)**	**Sample 3 (10g)**	**Sample 4 (Control)**	**F value**
Taste	17.6±1.7	16.9±1.6	17.5±1.9	17.2±1.5	0.67 ^{NS}
Texture	17.9±1.9	17.3±1.7	17.5±1.7	16.6±1.8	1.95 ^{NS}
Colour and Appearance	17.1±1.9	18±1.6	17.4±1.7	17.1±1.3	1.31 ^{NS}
Absence of defect	17.7±1.7	17.2±1.5	18.2±1.5	17.5±1.4	1.47 ^{NS}
Overall acceptability	17.7±1.7	17.5±1.5	17.2±1.6	18.1±1.8	1.50 ^{NS}
Total	87.7±3.4	87.1±2.8	88±4.6	86.7±4	0.46 ^{NS}

*Significant from the baseline value at p<0.05, ** at p<0.01, *** at p<0.001, NS- Non- significant

Vegetable poha was incorporated with 2g, 5g and 10g of pumpkin seeds. Among them, Sample 3 having 10gm of pumpkin seed incorporation was acceptable more followed by other samples. There was no significant difference found between samples for various sensory attributes. Sample 1 was more acceptable in terms of taste and texture. Sample 3 was more acceptable in terms of absence of defect and overall acceptable score.

Vegetable Cutlet

Table 4.2a.2.7. Mean scores for the sensory attributes of the Vegetable Cutlet (Mean±SD)

Vegetable Cutlet					
	Sample 1 (2g)	**Sample 2 (5g)**	**Sample 3 (10g)**	**Sample 4 (Control)**	**F value**
Taste	18.4±0.8	18.1±1.6	19.1±1.1	17.4±1.7	4.94**
Texture	17.5±1.5	18±1.6	18±1.8	17.4±1.7	0.58 NS
Colour and Appearance	18.5±1.6	18.4±1.3	18.8±1.1	17.1±1.8	4.60**
Absence of defect	19.3±0.8	19±0.8	19.1±0.8	18.1±1.8	4.29**
Overall acceptability	18.8±0.7	19.1±0.7	18.7±0.9	17.4±1.9	7.49***
Total	92.7±3.3	92.72±3.9	93.9±3.4	87.5±4.1	11.11 NS

*Significant from the baseline value at p<0.05, ** at p<0.01, *** at p<0.001, NS- Non- significant

Vegetable cutlets were developed by incorporating various levels of pumpkin seeds and out of that sample 3 was found most acceptable in terms of mean total score as per composite scoring test. Significant difference found between taste, colour, appearance, absence of defect and overall acceptability. No significant difference was found for texture and total score. Sample 3 was more acceptable in terms of taste, texture, colour and appearance. Sample 4 with no incorporation was most accepted among all 4 samples.

Vegetable Upma

Table 4.2a.2.8. Mean scores for the sensory attributes of the Vegetable Upma (Mean±SD)

Vegetable Upma					
	Sample 1 (2g)	**Sample 2 (5g)**	**Sample 3 (10g)**	**Sample 4 (Control)**	**F value**
Taste	17.5±1.5	17±1.7	15.8±1.7	17.6±1.7	4.22**
Texture	17.2±1.9	17.6±1.5	15±1.2	17.5±1.9	10.11 NS
Colour and Appearance	18±2.2	18±1.7	16.5±1.3	17±1.7	3.16*
Absence of defect	17.4±1.7	17.6±1.3	16.5±1.1	17±1.9	1.85 NS
Overall acceptability	17.7±1.9	16.8±1.5	16.3±1.1	17.6±1.8	3.16*
Total	87.9±4.7	87.1±4.2	80.3±3.4	86.7±3.5	14.53 NS

*Significant from the baseline value at p<0.05, ** at p<0.01, *** at p<0.001, NS- Non- significant

Sample 1 having 2 gm of pumpkin seed incorporation was accepted more followed by sample 2, sample 4 and sample 3 as per the mean scores of various attributes. Significant difference found for taste, colour and appearance, overall acceptability. No significant difference found for texture, absence of defect and total score. Sample 1 was more acceptable in terms of colour and appearance, overall acceptability and total score. Trend in scores indicates that panel members didn't accept the presence of pumpkin seeds for vegetable upma.

Table 4.2a.2.9. Ranking in between the level of incorporation in the developed recipes based on the mean total scores

Recipe	**Methi muthiya**	**Palak dhokla**	**Roasted chevda**	**Vegetable Thalipith**	**Vegetable pulao**	**Vegetable Poha**	**Vegetable cutlet**	**Vegetable upma**
1st rank	Sample 4	Sample 3	Sample 3	Sample 2	Sample 1	Sample 3	Sample 3	Sample 1
2nd rank	Sample 3	Sample 2	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 2
3rd rank	Sample 2	Sample 1	Sample 1	Sample 3	Sample 3	Sample 2	Sample 1	Sample 4
4th rank	Sample 1	Sample 4	Sample 4	Sample 4	Sample 4	Sample 4	Sample 4	Sample 3

Attempt was made to know the overall ranking in between the level of incorporation of pumpkin seeds in different developed recipes. From the table 4.2a.2.9, can be observed that Sample 3 (4 out of 8 recipes) having 10gm of pumpkin seeds preferred most by the semi trained panel members. As next option (Rank 2) 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. Thus, the available trend indicate that as the amount of pumpkin seeds in recipes reduces, acceptance also reduces. Therefore, it is fair to conclude that presence of pumpkin seeds in the products was making them more acceptable for most of all the recipes.

Table 4.2a.2.10. Percentage of the recipes according to Hedonic rating scale (N,%)

Preference	Sample 1 (2g)	Sample 2 (5g)	Sample 3 (10g)	Sample 4 (Control)
Methi Muthiya				
Like	20(100%)	20(100%)	20(100%)	20(100%)
Palak Dhokla				
Like	20(100%)	20(100%)	20(100%)	20(100%)
Roasted Chevda				
Like	20(100%)	20(100%)	20(100%)	20(100%)
Vegetable Thalipith				
Like	20(100%)	20(100%)	20(100%)	20(100%)
Vegetable Pulao				
Like	20(100%)	20(100%)	20(100%)	20(100%)
Vegetable Cutlet				
Like	20(100%)	20(100%)	20(100%)	20(100%)
Vegetable Upma				
Like	20(100%)	20(100%)	20(100%)	20(100%)
Vegetable Poha				
Like	20(100%)	20(100%)	20(100%)	20(100%)

Hedonic rating scale (9 point score) 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. All 8 traditional pumpkin seed incorporated recipes were well accepted by semi trained panel members. None of the panellist rated any of the recipes

as neither like nor dislike or dislike category.

Table 4.2a.2.11. Mean scores of the recipes according to Hedonic rating scale (Mean±SD)

Mean scores of of the recipes according to Hedonic rating scale (Mean±SD)				
	Sample 1 (2g)	**Sample 2 (5g)**	**Sample 3 (10g)**	**Sample 4 (Control)**
Methi Muthiya	7.2±1.2	7.5±0.4	8.1±0.3	8.8±0.4
Palak Dhokla	7.9±1.2	8±0.9	8.7±0.5	7.5±0.9
Roasted Chevda	7.9±1	8.1±0.6	8.6±0.6	7.8±1.5
Vegetable Thalipith	8.2±0.6	9.1±0.8	7.7±1.6	6.8±2
Vegetable Pulao	8.8±0.4	8.2±0.7	7.7±1.2	7±1.6
Vegetable Cutlet	7.8±0.9	8.2±0.8	8.6±0.6	7.3±1.3
Vegetable Upma	8.7±0.5	8.3±0.6	7.8±1.3	6.8±2.1
Vegetable Poha	7.6±1.8	8.4±0.3	8.8±0.5	6.7±1.5

From above table, 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. Therefore, the data depicts good acceptance of pumpkin seeds in recipes.

Maximum composite mean score (94.6±2.6) was received by Vegetable thalipith with 5gm of pumpkin seed incorporation. As per the comments received by semi trained panel members analyzed, it was noted that nutty and crunchy flavour of pumpkin seeds during roasting thalipith, aroma of ingredients, golden colour and optimum texture were major factors behind its maximum acceptability. Therefore, it can be stated that pumpkin seed incorporation in thalipith was highly acceptable as per composite scoring and hedonic rating scale.

Highlights of Phase IIA

- *As per the available data, Pumpkin seeds can be effectively incorporated in Indian recipes for the prevention and management of Diabetes mellitus due to its hypoglycemic properties.*
- ***Out of 8 recipes, vegetable thalipith (sample 2) was highly acceptable and Vegetable upma (sample 3) was least preferred by semi trained panel members.***
- ***As per hedonic rating scale also, vegetable thalipith (sample 2) was highly acceptable and vegetable poha (sample 4) 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.***
- ***Recipes having no incorporation of pumpkin seeds got least score of overall acceptability as compared to recipes containing pumpkin seeds.***
- ***Thus, trend indicates that as the amount of pumpkin seeds in recipes increases, the acceptance of the recipe also increases. Therefore, it is fair to conclude that presence of pumpkin seeds in the products was making them more acceptable for most of all the recipes***

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

The rate of glucose entry into the circulation, the amount absorbed, the rate of glucose disappearance from the circulation due to tissue uptake, and hepatic control of glucose release all play a role in the normal physiological phenomenon known as the glycaemic response (GR), which occurs after eating. Glycaemic Index (GI) is how food affects blood sugar levels after eating. All foods affect blood glucose levels differently after eating. When a person takes a certain amount of a food that contains a set amount of carbohydrates, the GI provides information about the GR that might be anticipated. (Usually 50 g). According to this system, GR is the rise in blood glucose levels that occurs after eating and is measured as the incremental area-under-the-blood-glucose-curve (iAUC) during a two-hour period.

The Satiety Index gauges how full and satiated you are after consuming various cuisines. The index was developed to assist people in making better eating decisions that may aid in appetite control and weight management. It evaluates a meal's level of fullness and satisfaction by comparing it with a reference food. (Usually white bread or glucose). Thus, to assess glycaemic index and satiety index of most accepted recipes (10gm pumpkin seed incorporated) at phase 2a present phase was conducted.

Ten healthy subjects were enrolled for assessment of Glycaemic index and Satiety index after taking consent from them. Eight eqi-carbohydrate and most preferred (10g pumpkin seed incorporated) standardized recipes were tested for its Glycaemic and Satiety index. Subjects were enrolled from the Faculty of Family and Community sciences. For enrolment of subjects as per inclusion criteria, data regarding anthropometric measurements, baseline information and family history of disease was collected. Standard methods of anthropometric measurements and pre tested questionnaire was used to collect data. There are various biological factors such as age and gender, nutritional factors like food habits, previous meal diet, metabolic factors such as medical history of family and physiological factors can influence glycaemic responses of the subjects. So it was tried to keep these factors in mind while enrolling subjects.

Section 4.2b.1. Baseline information of the enrolled Subjects

The mean age of the enrolled subject was 21.2 years. Out of 10 subjects, 8 were females. Majority (90%) of the subjects were Hindu and one subject was Jain (10%). Most of the subjects were unmarried. Half of the subjects completed higher secondary schooling while 40% subjects were graduates and 60% of the subjects were from nuclear family.

Table 4.2b.1. Baseline information of the enrolled Subjects (N, %)

Parameter	Subjects
Age in years (Mean±SD)	21.2±2.8
Gender	
Male	2 (20)
Female	8 (80)
Religion	
Hindu	9 (90)
Jain	1 (10)
Marital Status	
Married	1 (10)
Unmarried	9 (90)
Educational level	
Higher Secondary	5 (50)
Graduate	4 (40)
Post-graduate	1 (10)
Type of family	
Joint	4 (40)
Nuclear	6 (60)

Section 4.2b.2. Anthropometric profile of the enrolled subjects

The anthropometric measurements of enrolled subjects are present in the table 4.2b.2. The mean weight and height of the enrolled subjects were 55.3kg and 163.5cm with an average BMI of 20.7 kg/m2 which indicates that all subjects were in a normal category of nutritional status as per Asia pacific classification of Body Mass Index. Average waist hip ratio reported was 0.76.

Table 4.2b.2. Anthropometric profile of the enrolled subjects (Mean±SD)

Variable	Mean±SD
Weight (kg)	55.3±5.1
Height (cm)	163.5±6.2
BMI (kg/m^2)	20.7±2.1
Waist Circumference (cm)	71.8±4.2
Waist Hip Ratio (WHR)	0.76±0.3

Section 4.2b.3. Glycaemic Index of the pumpkin seed incorporated recipes

Glycemic index of pumpkin seed incorporated recipes was calculated by plotting an incremental area under curve of test recipes and standard recipe. Formula used to calculate GI was incremental area under curve of test food /incremental area under curve of reference food into 100.

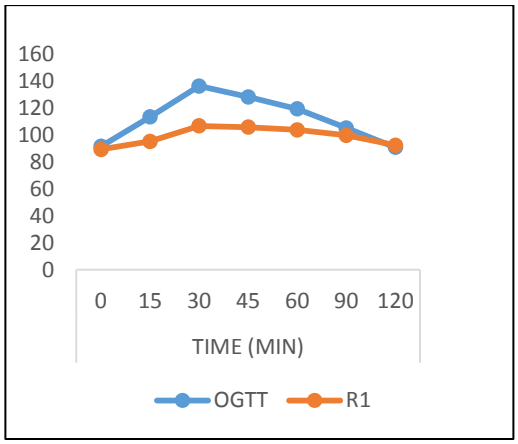
Methi muthiya and Vegetable upma found to be have lowest glycemic index after incorporating 10 gm of pumpkin seeds i.e. (45±10.2) and (47.75±9.2) respectively.

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

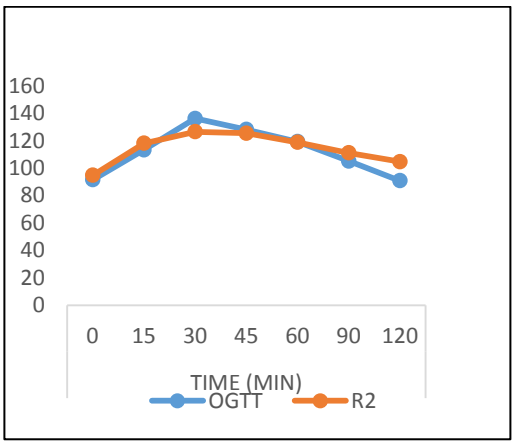
Table 4.2b.3. Glycaemic Index of the pumpkin seed incorporated recipes

Name of the Recipe	Glycemic Index (Mean±SD)
Methi muthiya	45±10.2
Palak Dhokla	63.25±8.8
Roasted Chevda	65.5±7.2
Vegetable Thalipith	64.5±12.2
Vegetable Pulao	64.53±9.9
Vegetable Poha	64.25±10.4
Vegetable Cutlet	59±10.3
Vegetable Upma	47.75±9.2

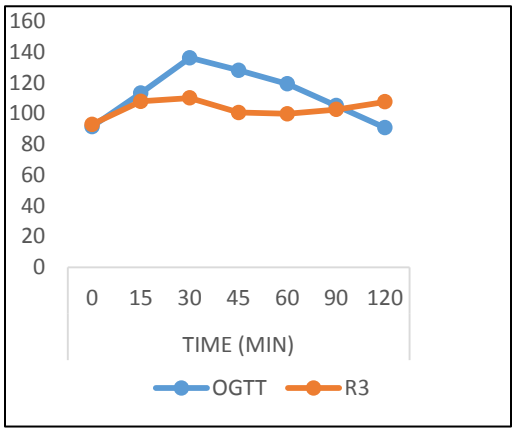
Figure 4.2b.3. Blood glucose response of various recipes compared with Glucose



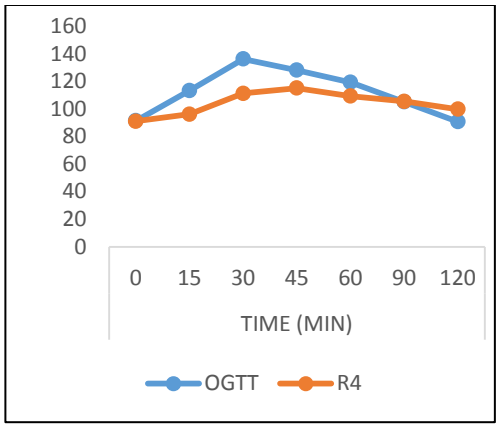
R1: Methi muthiya



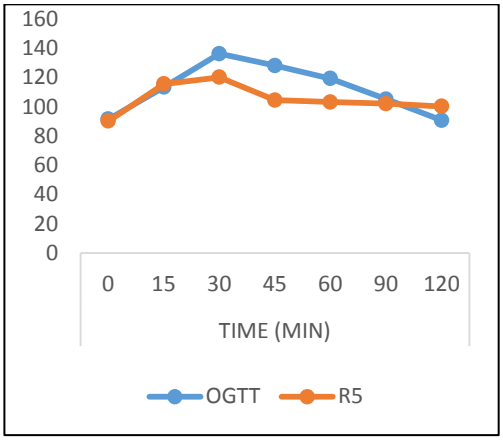
R2: Palak Dhokla



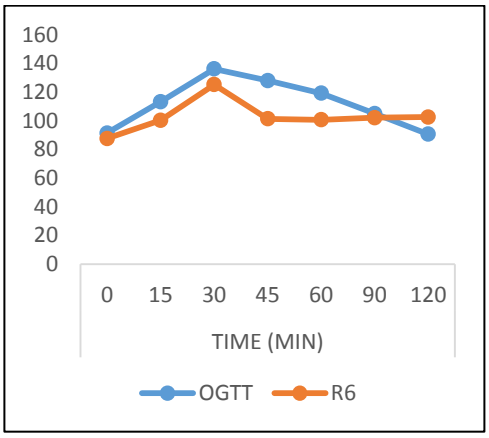
R3: Roasted Chevda



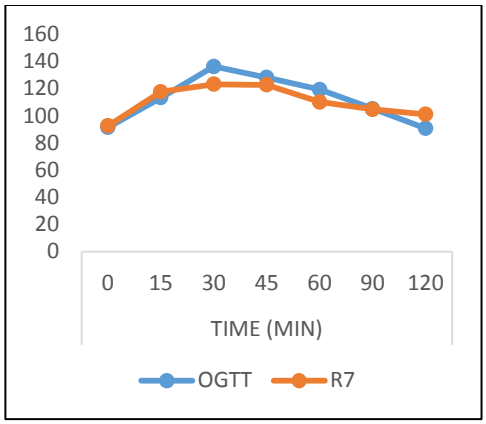
R4: Vegetable Thalipith



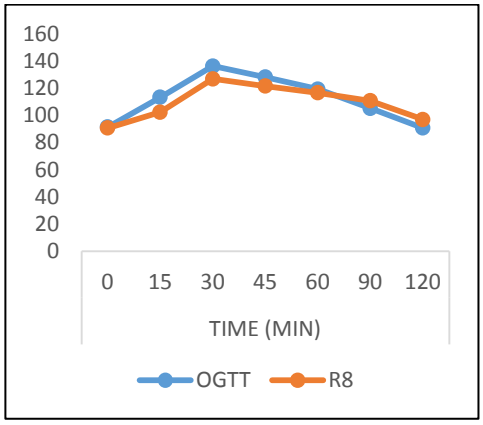
R5: Vegetable Pulao



R6: Vegetable Poha



R7: Vegetable Cutlet



R8: Vegetable Upma

Section 4.2b.4. Prospective Consumption rating score for pumpkin seed incorporated recipes

Apart from glycemic index, other parameters of satiety index were also evaluated by using prospective consumption rating score and visual analog scale in which required time for consumption and other sensory specific attributed were evaluated and presented in below table 4.2b.4. One standard serving (10gm pumpkin seed incorporated) of each recipe was taken into consideration.

Required time for the consumption

The subjects were asked to finish one serving of food within 15 minutes of time. Time required by subjects to consume each recipe was noted. Results revealed that one serving of

Vegetable tikki required maximum time (13.2±3.1 minutes) for its consumption whereas roasted chevda took least time (9.6±2.7minutes) for its consumption. Therefore, it is inferred that shallow fried food took more time against roasted food item.

Sensory specific satiety

The subjects were asked to answer some questions related to prospective consumption after completion of test recipe intake. The responses were analysed to determine satiety index score. Subjects recorded their answers on Visual Analogue Scale (VAS) with two extremes at both the ends. Scores were ranged from 0 to 10.

Serving size sufficiency

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

Desire to eat same food again

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. This means that panellist would like to consume vegetable thalipith again after completing one serving in case of hunger.

Satisfaction after the consumption of food

Vegetable Thalipith (8.7±2.1) was found to be most satisfying food among subjects and vegetable upma (7±1.6)was found to be least satisfying food.

Desire to eat something else

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. This means that panellist require something else after consuming chevda

as it was not satiating but they would not like to have chevda again to satisfy their hunger whereas vegetable thalipith provided utmost satiety to them.

Table 4.2b.4. Prospective Consumption rating score for recipes with pumpkin seeds incorporation

Recipe	Methi Muthiya	Palak Dhokla	Roasted Chevda	Vegetable Thalipith	Vegetable Pulao	Vegetable Poha	Vegetable Cutlet	Vegetable Upma
Time taken (in minutes)	11.3±3	9.8±2.2	9.6±2.7	12.3±3.3	10.5±2.6	11.1±1.9	13.2±3.1	10.1±2.9
Serving size sufficiency	8.3±2.8	7.8±1.1	6.8±3.3	8.8±1.3	8.1±1.5	7.5±2	7.8±2.5	6.9±2.7
Desire to eat this food	3.8±2.5	4.4±2.3	2.8±1.1	5.1±1.2	2.2±1.5	4.8±3.3	3.7±2	4.2±2.5
Satisfaction after eating the food	8.2±2.2	7.6±2.1	7.1±1.1	8.7±2.1	8.3±1.8	7.8±1.3	7.3±2.5	7±1.6
Desire to eat something else	2.8±1.5	3.8±1.3	4.4±1.8	2.4±1.1	2.6±1.9	3.5±2.7	3.9±1	3.8±2.2

Comparing the sensory evaluation scores as well as other aspects of Satiety index, vegetable thalipith was found to be most liked, satisfying and desirous recipe may due to its composition, ingredients, shallow frying cooking method, nutty taste of pumpkin seeds and its appearance.

Highlights of Phase IIB

- *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.***
- ***The most satiating recipe was thalipith and least satiating was vegetable upma.***
- ***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***

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

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.

Section 4.3.1. Baseline information of subjects

For the present study, total 90 stable Type 2 Diabetic old age subjects were enrolled as per defined inclusion and exclusion criteria. Subjects were distributed randomly into 3 groups for the intervention phase. Group 1 and Group 2 received 10gm and 15gm pumpkin seeds respectively for the period of 3 months and Control group with no intervention. Background information of the subjects were collected by using pre-tested questionnaire which included basic information like age, gender, level of education, type of family, marital status and occupation.

Table 4.3.1. gives the information about baseline history of enrolled subjects which shows that there is an equal number of males and females enrolled in the study. Out of 90 subjects, 82.2% were hindu followed by muslim, jain and sikh. Almost, 70% subjects were married and majority of them were graduates. Out of 90; 42 subjects were retired and 29 females were homemakers and remaining subjects were into business or service. More than half subjects were belonging to nuclear family, 25.6% subjects belonged to Joint family.

Table 4.3.1. Type 2 elderly diabetic subjects showing baseline information (N,%)

Variable	Group 1 (10gm supplementation)		Group 2 (15gm supplementation)		Control Group (No supplementation)		Total	
	N	%	N	%	N	%	N	%
Age (Mean+SD)								
Age (In years)	65.9±4.45		66.1±3.93		68±3.83		66.7±4.1	
Gender								
Male	14	46.7	15	50.0	16	53.3	45	50.0
Female	16	53.3	15	50.0	14	46.7	45	50.0
Religion								
Hindu	27	90.0	29	96.7	27	90.0	83	92.2
Muslim	1	3.3	0	0.0	3	10.0	4	4.4
Jain	2	6.7	0	0.0	0	0.0	2	2.2
Sikh	0	0.0	1	3.3	0	0.0	1	1.1
Marital status								
Married	23	76.7	19	63.4	21	70	63	70
Widow	6	20.0	9	30.0	8	26.7	23	25.6
Single	1	3.3	1	3.3	0	0.0	2	2.2
Divorced	0	0.0	1	3.3	1	3.3	2	2.2
Education								
SSC	3	10.0	5	16.7	7	23.3	15	16.7
HSC	9	30.0	10	33.3	10	33.3	29	32.2
Graduate	13	43.3	14	46.7	10	33.3	37	41.1
Post- Graduate	5	16.7	1	3.3	3	10.0	9	10.0
Occupation								
Housewife	11	36.7	8	26.7	10	33.3	29	32.2
Retired	13	43.3	17	56.7	12	40.0	42	46.7
Service	2	6.7	2	6.7	0	0.0	4	4.4
Business	4	13.3	3	10.0	8	26.7	15	16.7
Type of family								
Nuclear	22	73.3	22	73.3	23	76.7	67	74.4
Joint	8	26.7	8	26.7	7	23.3	23	25.6

Section 4.3.2. Anthropometric and Biophysical measurements of the type 2 elderly 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/m2 belonging to overweight category as per Asia pacific cut-offs of Body Mass Index. Mean SBP was 131 mmHg and DBP was 82 mmHg.

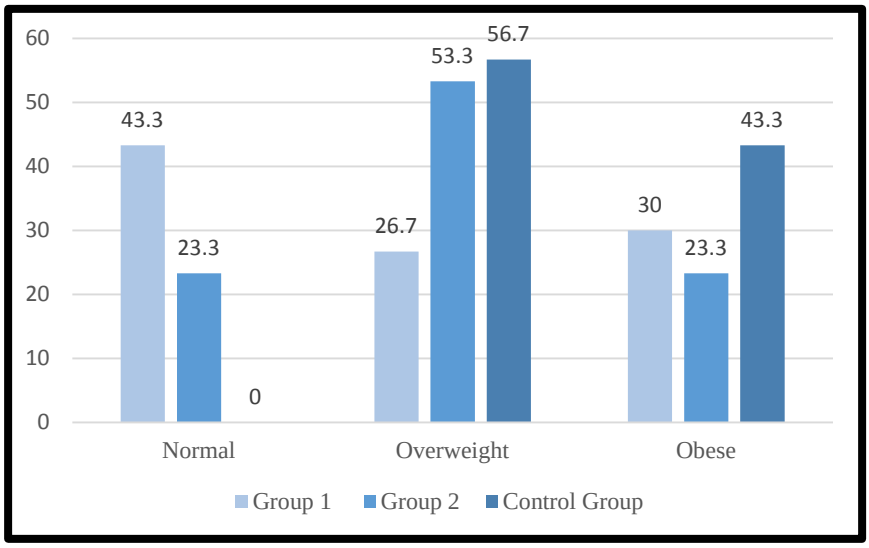
Table 4.3.2. Anthropometric and Biophysical measurements of the type 2 elderly diabetic subjects (Mean±SD)

Variable	Group 1 (10gm supplementation)	Group 2 (15gm supplementation)	Control Group (No supplementation)	F Value
Age (Years)	65.9±4.45	66.1±3.93	68±3.83	0.87^{NS}
Height (cm)	163.7±8.69	164.6±10.4	165.5±9.7	1.09^{NS}
Weight (kg)	65.7±10	66.7±10.26	68.2±9.61	0.90^{NS}
BMI (kg/m²)	24.5±2.97	24.5±2.14	24.8±1.07	0.01^{NS}
Pulse rate	82±8	84±8	84±5	0.61^{NS}
Systolic Blood Pressure (mmHg)	131.3±8.34	130.5±8.45	131.1±7.77	0.12^{NS}
Diastolic Blood Pressure (mmHg)	84±4.89	82.5±5.83	79.6±4.13	9.84^{***}

*Significant from the baseline value at p<0.05, ** at p<0.01, *** at p<0.001, NS- Non- significant

Section 4.3.3. Prevalence of obesity among the type 2 elderly diabetic subjects Figure 4.3.3. depicts prevalence of overweight and obesity of enrolled subjects of all 3 groups. As per graphical representation, 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.

Figure 4.3.3. Prevalence of obesity among the type 2 elderly diabetic subjects



Section 4.3.4. Physical activity pattern of the type 2 elderly diabetic subjects

A chronic endocrine illness, diabetes mellitus requires a specific course of therapy. Diabetes has a number of problems, and if they are not properly treated, they could become life-threatening. Exercise is a key factor in reducing T2DM, according to numerous studies. Exercise can restore issues linked with diabetes, such as cardiovascular disease, which is one of the major consequences, as well as glycemic control and insulin sensitivity (Thent et al, 2013).

As per obtained data, majority of the subjects were not meeting the minimum requirement of physical activity recommended by World Health Organization (WHO). As per data reported by subjects, only 26.7% subjects from group 1 and 20% subjects from group 2 were doing >600 MET mins per week as per WHO guidelines.

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.

Table 4.3.4. Physical Activity levels of the type 2 elderly diabetic subjects

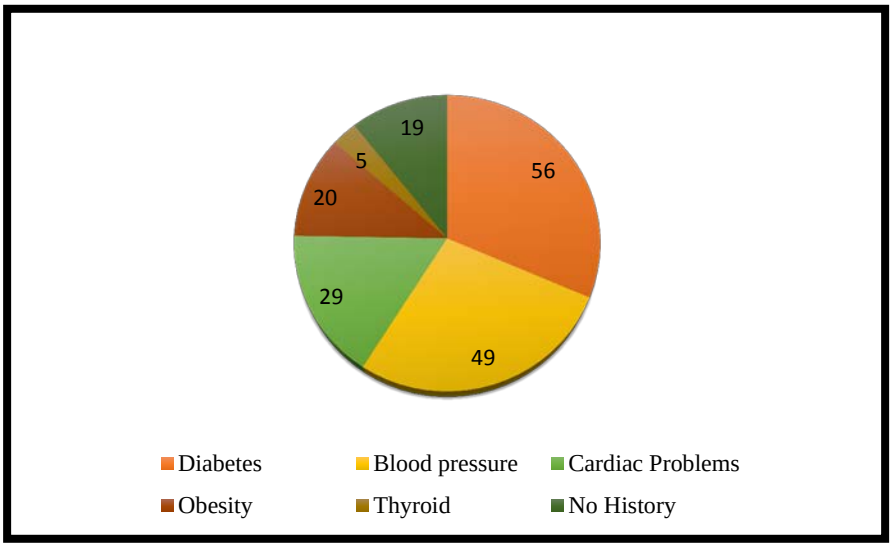
Physical activity level (MET mins.)	Group 1 (10gm supplementation)	Group 2 (15gm supplementation)	Control Group (No supplementation)
<600 MET mins per week	22 (73.3%)	24 (80%)	26 (86.7%)
>600 MET mins per week	8 (26.7%)	6 (20%)	4 (13.3%)

Section 4.3.5. Family history of the type 2 elderly diabetic subjects

Figure 4.3.5. reveled information about family history of the enrolled subjects. Out of 90 subjects 56 subjects were having family history of Diabetes mellitus followed by Hypertension, Cardiac problem, Obesity and Thyroid. 29 subjects did not report any medical family history. This data shows the strong association between family history of Diabetes and occurrence of Diabetes Mellitus.

One similar kind of study conducted by Samaan et al (2015) reported that individuals with family history of Diabetes Mellitus are at more risk for developing Diabetes in future compare to normal population by 30% to 80%.

Figure 4.3.5. Number of type 2 elderly diabetic subjects showing family history of medical conditions



Section 4.3.6. Dietary profile of the type 2 elderly diabetic subjects

General dietary information was collected by using questionnaire which included information about type of meal pattern, number of meals consumed in a day, water intake and frequency of eating out, data on sugar, salt and oil consumption, tea-coffee consumption, types of foods avoided to control diabetes, etc. Information regarding frequency for various food was also gathered by using questionnaire.

According to the table 4.3.6., 65.6% subjects were following vegetarian eating pattern followed by non-vegetarian and lacto-ovo vegetarian. In group 2, 30% subjects were non-vegetarian. Almost everyone were consuming lunch and dinner on a daily basis. Only 6.7% subjects were consuming mid-morning snacks. Around 40% subjects used to consume 4 meal pattern in group 1 and control group. In group 2 majority of the subjects were consuming 3 meals per day. Only 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 and 32.2% subjects were consuming outside food occasionally of which less number of subjects belonged to group 2.

Table 4.3.6. Dietary profile of the type 2 elderly diabetic subjects

	Group 1 (10gm supplementation)		Group 2 (15gm supplementation)		Control Group (No supplementation)		Total	
	N	%	N	%	N	%	N	%
Type of Meal Pattern								
Vegetarian	21	70.0	15	50.0	23	76.7	59	65.6
Non-Vegetarian	4	13.3	9	30.0	3	10.0	16	17.8
Lacto-ovo Vegetarian	5	16.7	6	20.0	4	13.3	15	16.7
Types of meals taken daily								
Breakfast	26	86.7	25	83.3	25	83.3	76	84.4
Mid-morning snack	3	10.0	3	10.0	0	0.0	6	6.7
Lunch	30	100.0	30	100.0	29	96.7	89	98.9
Evening Snacks	10	33.3	7	23.3	8	26.7	25	27.8
Dinner	30	100.0	28	93.3	29	96.7	87	96.7
Bedtime milk	8	26.7	6	20.0	4	13.3	18	20.0
Number of meals taken daily								
1 meal	0	0.0	0	0.0	1	3.3	1	1.1
2 meals	3	10.0	3	10.0	5	16.7	11	12.2
3 meals	11	36.7	16	53.3	12	40.0	39	43.3
4 meals	13	43.3	10	33.3	12	40.0	35	38.9
5 meals	2	6.7	1	3.3	0	0.0	3	3.3
6 meals	1	3.3	0	0.0	0	0.0	1	1.1
Daily water intake								
less than 6 glass	1	3.3	6	20.0	4	13.3	11	12.2
6-8 glasses	15	50.0	17	56.7	12	40.0	44	48.9
more than 8 glasses	14	46.7	7	23.3	14	46.7	35	38.9
Frequency of eating out								
Daily	0	0.0	0	0.0	0	0.0	0	0.0

3-4 times in a week	1	3.3	0	0.0	1	3.3	2	2.2
Once in a week	4	13.3	4	13.3	3	10.0	11	12.2
Once in a 15 days	5	16.7	5	16.7	5	16.7	15	16.7
Once in a month	9	30.0	13	43.3	8	26.7	30	33.3
Occasionally	11	36.7	7	23.3	11	36.7	29	32.2
Never	0	0.0	1	3.3	2	6.7	3	3.3

Section 4.3.7. Sugar, Salt and Oil Consumption Pattern of the type 2 elderly 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 whereas 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. Above data on consumption of Salt, Sugar and Oil can consider very high for Diabetic Patients.

Table 4.3.7. Sugar, Salt and Oil Consumption Pattern of the type 2 elderly diabetic subjects

	Group 1 (10gm supplementation)		Group 2 (15gm supplementation)		Control Group (No supplementation)		Total	
	N	%	N	%	N	%	N	%
Quantity of sugar purchased in a month								
Less than 5 kg	10	33.3	4	13.3	11	36.7	25	27.8
5-7 kg	10	33.3	16	53.3	12	40.0	38	42.2
More than 7 kg	10	33.3	10	33.3	7	23.3	27	30.0

Quantity of salt purchased in a month								
Less than 1 kg	10	33.3	5	16.7	9	30.0	24	26.7
1 kg	10	33.3	13	43.3	14	46.7	37	41.1
More than 1 kg	10	33.3	12	40.0	7	23.3	29	32.2
Quantity of Cooking oil used in a month								
Less than 5 litre	13	43.3	9	30.0	11	36.7	33	36.7
5-6 litres	11	36.7	21	70.0	13	43.3	45	50.0
More than 6 litres	6	20.0	0	0.0	6	20.0	12	13.3
Change of Cooking oil								
Yes	10	33.3	9	30.0	8	26.7	27	30.0
No	20	66.7	21	70.0	22	73.3	63	70.0
Ways using oil which remains after deep frying								
Use it to prepare dal and sabji	14	46.7	11	36.7	15	50.0	40	44.4
Discard it	8	26.7	3	10.0	4	13.3	15	16.7
Reuse for frying	8	26.7	16	53.3	11	36.7	35	38.8

Section 4.3.8. Tea and Coffee Consumption of the type 2 elderly 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 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 against a 23.3% subjects (nearly similar in each group) used to have in tea/coffee daily.

Table 4.3.8. Tea and Coffee Consumption of the type 2 elderly diabetic subjects

	Group 1 (10gm supplementation)		Group 2 (15gm supplementation)		Control Group (No supplementation)		Total	
	N	%	N	%	N	%	N	%
Number of tea coffee cups in a day								
1 cup	5	16.7	7	23.3	7	23.3	19	21.1
2 cups	16	53.3	12	40.0	17	56.7	45	50.0
3 cups	6	20.0	3	10.0	3	10.0	12	13.3
More than 3 cups	3	10.0	8	26.7	3	10.0	14	15.6
Frequency of Use of Sugar in a tea/coffee								
Daily	8	26.7	6	20.0	7	23.3	21	23.3
Weekly	4	13.3	4	13.3	5	16.7	13	14.4
Never	18	60.0	20	66.7	18	60.0	56	62.2

Section 4.3.9. Foods avoided by type 2 elderly diabetic Subjects to prevent Diabetes

According to the data collected, 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.

Table 4.3.9. Foods avoided by type 2 elderly diabetic Subjects to prevent Diabetes

	Group 1 (10gm supplementation)		Group 2 (15gm supplementation)		Control Group (No supplementation)		Total	
Foods avoided to prevent diabetes								
	N	%	N	%	N	%	N	%
None	14	46.7	9	30.0	10	33.3	33	36.7
Rice	7	23.3	11	36.7	9	30.0	27	30.0
Potato	10	33.3	14	46.7	7	23.3	31	34.4
Sugar	6	20.0	2	6.7	3	10.0	11	12.2
Jaggery	14	46.7	8	26.7	15	50.0	37	41.1
Total	30	100.0	30	100.0	30	100.0	90	100.0
Number of foods avoided to prevent diabetes								
1	20	66.7	22	73.3	22	73.3	64	71.1
2	4	13.3	5	16.7	4	13.3	13	14.4
3	2	6.7	1	3.3	2	6.7	5	5.6
4	3	10.0	1	3.3	2	6.7	6	6.7
5	1	3.3	1	3.3	0	0.0	2	2.2
Total	30	100.0	30	100.0	30	100.0	90	100.0

Section 4.3.10. Food frequency checklist

Food frequency checklist was developed by adding various healthy and unhealthy food items to know consumption pattern of elderly type 2 diabetic subjects. Overall, majority of the subjects (>45 subjects) shown frequent consumption of fruits, vegetables, milk, buttermilk and curd which could be considered good for the health while majority of the subjects were also consuming biscuits, soft drinks and namkeen showing negligence over the good health.

Table 4.3.10. Food frequency checklist

Variable	Group 1 (10gm supplementation)		Group 2 (15gm supplementation)		Control Group (No supplementation)		Total	
Fruits								
Daily	4	13.3	4	13.3	5	16.7	13	14.4
2-3 times a week	18	60.0	20	66.7	18	60.0	56	62.2
Weekly	8	26.7	6	20.0	7	23.3	21	23.3
Vegetables								
Daily	22	73.3	24	80.0	23	76.7	69	76.7
2-3 times a week	8	26.7	6	20.0	7	23.3	21	23.3
Green Leafy vegetables								
2-3 times a week	4	13.3	4	13.3	5	16.7	13	14.4
Weekly	18	60.0	20	66.7	18	60.0	56	62.2
Monthly	8	26.7	6	20.0	7	23.3	21	23.3
Milk								
Daily	30	100.0	30	100.0	30	100.0	90	100.0
Curd								
Daily	4	13.3	4	13.3	5	16.7	13	14.4
2-3 times a week	18	60.0	20	66.7	18	60.0	56	62.2
Weekly	8	26.7	6	20.0	7	23.3	21	23.3
Buttermilk								
2-3 times a week	18	60.0	20	66.7	18	60.0	56	62.2
Weekly	12	40.0	10	33.3	12	40.0	34	37.8
Fried foods								
Weekly	26	86.7	26	86.7	25	83.3	77	85.6
Monthly	4	13.3	4	13.3	5	16.7	13	14.4
Biscuits								
Daily	18	60.0	20	66.7	18	60.0	56	62.2
Monthly	12	40.0	10	33.3	12	40.0	34	37.8
Rusk								
2-3 times a week	8	26.7	6	20.0	7	23.3	21	23.3
Monthly	4	13.3	4	13.3	5	16.7	13	14.4
Never	18	60.0	20	66.7	18	60.0	56	62.2
Khari								
Monthly	22	73.3	24	80.0	23	76.7	69	76.7
Never	8	26.7	6	20.0	7	23.3	21	23.3
Soft drinks								
Monthly	18	60.0	20	66.7	18	60.0	56	62.2
Never	12	40.0	10	33.3	12	40.0	34	37.8
Ice cream								
Monthly	30	100.0	30	100.0	30	100.0	90	100.0

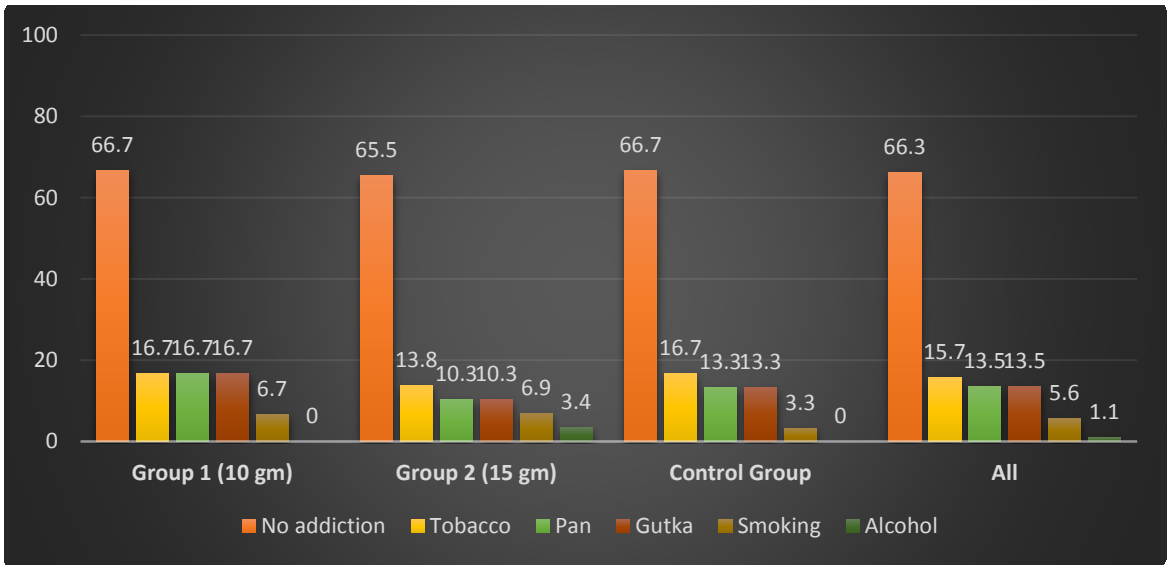
Namkeen								
2-3 times a week	26	86.7	26	86.7	25	83.3	77	85.6
Weekly	4	13.3	4	13.3	5	16.7	13	14.4

Section 4.3.11. Pattern of substance use by elderly type 2 diabetic subjects

Data on substance use pattern was collected to notice and study the addiction pattern of the enrolled type 2 diabetic subjects.

Figure 4.3.11. depicts information about the substance use pattern of enrolled Diabetic Subjects. Out of total enrolled subjects, 66.3% of subjects were not using any substance irrespective to groups. 15.7% subjects were addicted to tobacco followed by pan and gutka (13.5%), smoking (5.6%). Only 1.1% subjects were reported to have alcohol consumption in group 2.

Figure 4.3.11. Percentage of substance use by elderly type 2 diabetic subjects



Section 4.3.13. Current medical problems among elderly type 2 diabetic subjects

Apart from diabetes mellitus, 51 out of 90 subjects were suffering from hypertension. 21.1% subjects also had g high cholesterol problem. 15.6% subjects with thyroid problem followed by kidney stone (11.1%), osteoporosis (5.6%) and cancer (1.1%).

More than 50% of the subjects also reported 2 medical problems including Diabetes. Only 16.7% of subjects were without any medical problem other than Diabetes while 27.8% subjects reported 2 medical problems other than Diabetes. By comparing medical problems of subjects between groups, group 1 subjects reported high prevalence of high blood pressure and high cholesterol whereas group 2 subjects reported more of osteoporosis and kidney stone cases.

Table 4.3.13.1 Current medical problems of the subjects

	Group 1 (10gm supplementation)		Group 2 (15gm supplementation)		Control Group (No supplementation)		Total	
	N	%	N	%	N	%	N	%
Diabetes	30	100.0	30	100.0	30	100.0	90	100.0
High Blood Pressure	21	70.0	12	40.0	18	60.0	51	56.7
Thyroid	6	20.0	4	13.3	4	13.3	14	15.6
High cholesterol	7	23.3	6	20.0	6	20.0	19	21.1
Kidney Stone	2	6.7	6	20.0	2	6.7	10	11.1
Cancer	0	0.0	1	3.3	0	0.0	1	1.1
Osteoporosis	0	0.0	4	13.3	1	3.3	5	5.6

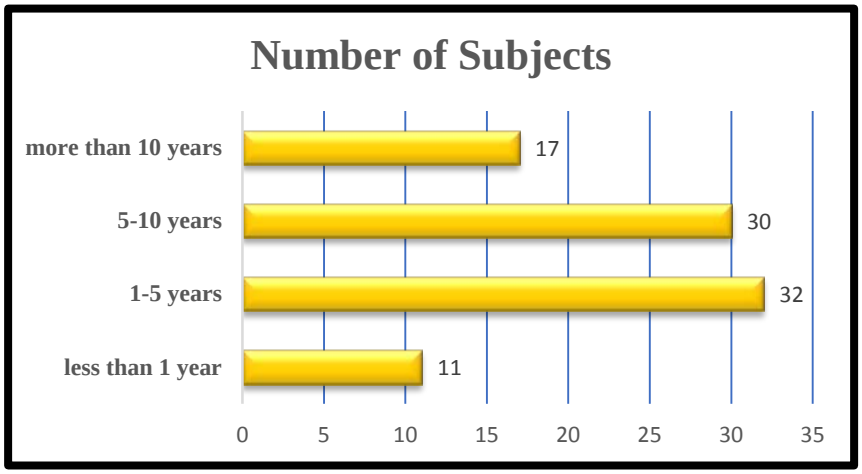
Table 4.3.13.2 Number of total current medical problems

	Group 1 (10gm supplementation)		Group 2 (15gm supplementation)		Control Group (No supplementation)		Total	
	N	%	N	%	N	%	N	%
1 Medical Problem	3	10.0	6	20.0	6	20.0	15	16.7
2 Medical Problems	18	60.0	15	50.0	17	56.7	50	55.6
3 Medical Problems	9	30.0	9	30.0	7	23.3	25	27.8
Total	30	100.0	30	100.0	30	100.0	90	100.0

Section 4.3.14. Duration of Diabetes Mellitus

Figure 4.3.14. indicates Duration of Diabetes of enrolled subjects. Out of 90 subjects, 32 subjects reported to have diabetes since last 1-5 years. 30 subjects were suffering from diabetes between 5-10 years while 17 subjects had diabetes from more than 10 years.

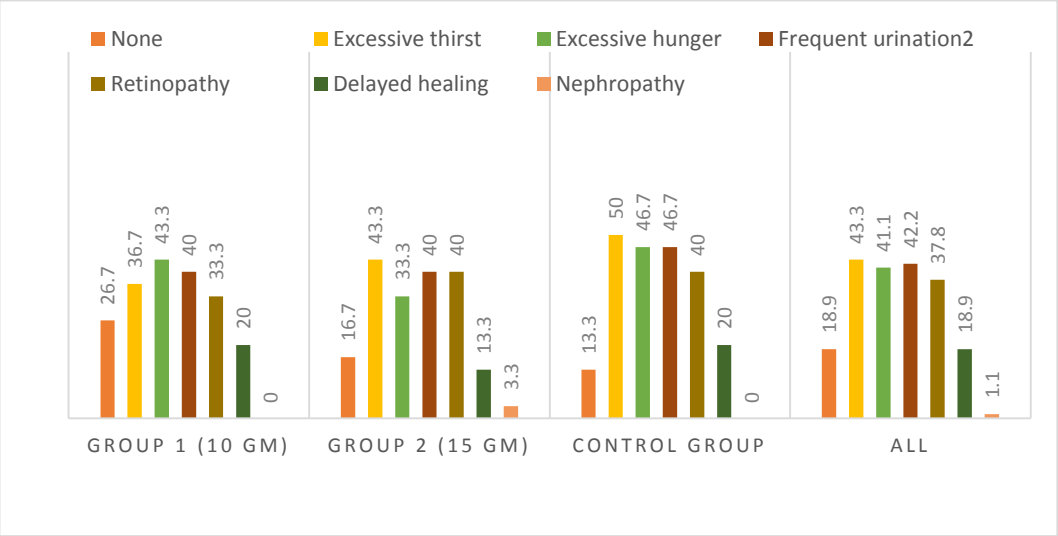
Figure 4.3.14. Duration of Diabetes Mellitus



Section 4.3.15. Symptoms reported by elderly type 2 diabetic subjects

There are various symptoms of Diabetes such as excessive thirst, excessive hunger, frequent urination, Retinopathy and delayed wound healing due to various metabolic changes in the body. Attempt was made to analyse various symptoms of diabetes faced by enrolled 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). severity of symptoms can be dependent on duration of diabetes mellitus.

Figure 4.3.15. Symptoms reported by elderly type 2 diabetic subjects



Section 4.3.16. Type of treatments adopted by elderly type 2 diabetic subjects to manage Diabetes

There are various pharmacological and non-pharmacological treatments available to control and manage Diabetes Mellitus. Above table indicated various treatments adopted by old age type 2 diabetic subjects to control Diabetes Mellitus. 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. The difference in the adopted treatment was kept constant during the intervention.

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.

Table 4.3.16. Type of treatments adopted by elderly type 2 diabetic subjects to manage Diabetes

	Group 1 (10gm supplementation)		Group 2 (15gm supplementation)		Control Group (No supplementation)		Total	
	N	%	N	%	N	%	N	%
Types of treatment taken for diabetes								
Allopath Medicines	30	100.0	30	100.0	30	100.0	90	100
Ayurveda	4	13.3	2	6.7	3	10.0	9	10.0
Regular Exercise	14	46.7	11	36.7	10	33.3	35	38.9
Diet modification	15	50.0	11	36.7	14	46.7	40	44.4
Insulin (Occasional use)	2	6.7	1	3.3	1	3.3	4	4.4
Homeopathy	0	0.0	2	6.7	3	10.0	5	5.6
Taking medications regularly								
Yes	28	93.3	24	80.0	29	96.7	81	90.0
No	0	0.0	0	0.0	1	3.3	1	1.1
Maybe	2	6.7	6	20.0	0	0.0	8	8.9
Taking any type of diet/nutrient supplements								
Yes	9	30.0	9	30.0	7	23.3	25	27.8
No	21	70.0	21	70.0	23	76.7	65	72.2

Section 4.3.17. Frequency of Medical Check- up among elderly type 2 diabetic Subjects

Regular medical check-up is required to control the metabolic disorders especially Diabetes. 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. Only 1 out of 90 subject reported frequency of once in a month.

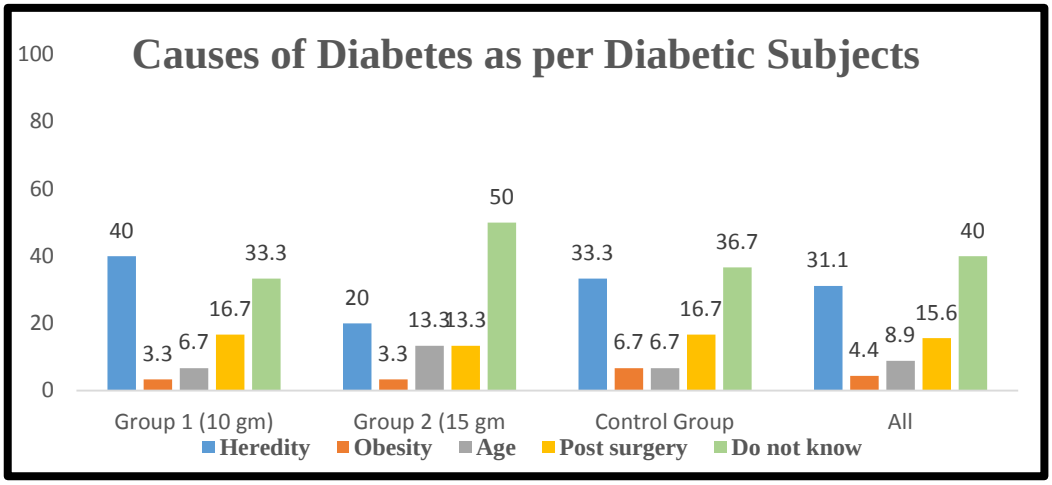
Table 4.3.17. Frequency of Medical Check- up among elderly type 2 diabetic Subjects

Variable	Group 1 (10gm supplementation)		Group 2 (15gm supplementation)		Control Group (No supplementation)		Total	
Frequency of medical check up								
Once in a 3 months	12	40.0	6	20.0	12	40.0	30	33.3
Once in a month	1	3.3	0	0.0	0	0.0	1	1.1
Yearly	7	23.3	9	30.0	6	20.0	22	24.4
Whenever required	10	33.3	13	43.3	11	36.7	34	37.8
Never	0	0.0	2	6.7	1	3.3	3	3.3

Section 4.3.18. Causes of Diabetes as per elderly type 2 diabetic Subjects

There are various causes of Type 2 Diabetes mellitus. Sometime it can be idiopathic also. 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.

Figure 4.3.18. Causes of Diabetes as per elderly type 2 diabetic Subjects



Highlights of Phase III (Baseline information)

- *Majority of the subjects were Hindu (92.2%) followed by Muslim(4.4%), Jain(2.2%) and Sikh(1.1%). 70% Subjects were married and majority (41.1%) of them were graduates.*
- ***Out of 90 subjects, 42 were retired and 29 females were homemakers. More than half subjects (74.4%) were belonging to Nuclear family. 25.6% subjects were belong to Joint family.***
- ***Mean SBP was 131mm/Hg and DBP was 82mm/Hg. In case of physical activity pattern, Majority of the subjects reported less than 600 MET mins per week***
- ***Out of 90 subjects, 56 subjects were having family history of Diabetes mellitus.***
- ***59 out of 90 subjects were following vegetarian eating pattern. Out of 90, 39 subjects were taking 3 meals and 35 subjects were taking 4 meals in a day. Most of the subjects were consuming outside food once 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. Most of the subjects were not changing their cooking oil periodically***
- ***15.6% of the subjects were consuming more than 3 cups of tea- coffee in a day. 66.3% of subjects were not having any addiction.***
- ***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).***
- ***Majority of the subjects were avoiding one food to prevent diabetes. Majority of the subjects were also consuming Biscuits, Soft drinks and Namkeen regularly.***
- ***Apart from allopathic medicines, 10% subjects were on Ayurveda and 5.6% were on Homeopathic medicines***

Impact evaluation of Pumpkin Seeds on various parameters

There are several health benefits of pumpkin seed consumption. Several studies and researches shown that pumpkin seeds possess hypoglycaemic and hypolipimic properties due to its unique nutrient composition and fatty acid profile. There is a dearth of data regarding dosage of pumpkin seeds to get above health benefits therefore present study was planned.

The supplementation of pumpkin seeds in group 1 (10gm), group 2 (15gm) was given for the period of 3 months. Control group subjects were not given any supplementation. Post intervention data was collected on the various parameters before and after intervention which are described below.

Section 4.3.19. Effect of Pumpkin seeds on Anthropometry and Biophysical parameters

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

Table 4.3.19. Effect of Pumpkin seeds on Anthropometry and Biophysical parameters

	Effect of Pumpkin seeds on Anthropometry and Biophysical parameters					
	Group 1 (10gm supplementation)		Group 2 (15gm supplementation)		Control Group (No supplementation)	
	Mean	SD	Mean	SD	Mean	SD
Weight (kg) Before	65.7	10	66.7	10.26	68.2	9.61
Weight (kg) After	64.4	9.05	67.4	9.99	68.5	9.58
t-test value	**0.514^{NS}**		**0.280^{NS}**		**0.110^{NS}**	
BMI ($kg/m^{2)}$) Before	24.5	2.97	24.5	2.14	24.8	1.07
BMI ($kg/m^{2)}$)	24.1	3.22	24.8	2.20	24.9	1.06

After						
t-test value	**0.500^{NS}**		**0.523^{NS}**		**0.388^{NS}**	
Pulse rate Before	82.5	8.42	84.4	8.87	84.5	5.81
Pulse rate After	82.5	8.42	84.4	8.87	86.4	5.68
t-test value	**0.323^{NS}**		**0.626^{NS}**		**0.379^{NS}**	

*Significant from the baseline value at p<0.05, ** at p<0.01, *** at p<0.001, NS- Non- significant

Section 4.3.20. Effect of pumpkin seed supplementation on mean nutrient intake of elderly type 2 diabetic subjects

Nutrient intake of enrolled subjects were calculated by using 24 hour dietary recall method and further calculated via Dietcal Software before and after intervention of pumpkin seeds.

Above table showed significant calorie consumption before and after intervention for group 1 and group 2. 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.

Table 4.3.20. Effect of pumpkin seed supplementation on mean nutrient intake of elderly type 2 diabetic subjects

	Effect of pumpkin seed supplementation on mean nutrient intake of elderly type 2 diabetic subjects					
	Group 1 (10gm supplementation)		**Group 2 (15gm supplementation)**		**Control Group (No supplementation)**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Energy (Kcal) Before	1693	169	1687	143	1633	142
Energy (Kcal) After	1729	141	1607	107	1632	124

t-test value	**0.900***		**2.437***		**0.036^{NS}**	
Protein (g) Before	36.3	4.21	37.0	2.20	37.0	3.93
Protein (g) After	39.2	2.51	38.7	2.12	38.8	2.82
t-test value	**3.316****		**2.985^{NS}**		**2.139^{NS}**	
Fat (g) Before	62.4	8.88	60.3	3.38	60.4	7.47
Fat (g) After	57.3	1.67	65.2	3.43	61.0	5.21
t-test value	**3.048*****		**5.496^{NS}**		**0.353^{NS}**	
Iron (mg) Before	14.7	1.32	14.7	1.56	13.1	1.71
Iron (mg) After	15.2	1.10	17.1	2.07	14.2	1.59
t-test value	**1.700^{NS}**		**5.069****		**2.659^{NS}**	
Calcium (mg) Before	368	42	411	35	384	36
Calcium (mg) After	386	24	430	40	391	34
t-test value	**2.120****		**1.943^{NS}**		**0.780^{NS}**	
CHO (g) Before	163	6	163	8	161	8
CHO (g) After	165	6	171	6	164	8
t-test value	**1.317^{NS}**		**4.088^{NS}**		**1.497^{NS}**	
Dietary fibre (g) Before	20.2	3.54	19.4	1.04	17.5	2.01
Dietary fibre (g) After	18.0	2.12	20.4	2.22	17.6	2.63
t-test value	**2.966*****		**2.307*****		**0.110***	

*Significant from the baseline value at p<0.05, ** at p<0.01, *** at p<0.001, NS- Non- significant

Section 4.3.21. Impact of pumpkin seed supplementation on the quality of life of elderly type 2 diabetic subjects

Quality of life among old age type 2 diabetic patient is extremely important and one of the area of concern. There is a more importance for quality of life and it is going to increase if the patient is having a good glycaemic control. Thus, Quality of life of diabetic patient is important for the prevention of aggravation of other metabolic disorders.

According to WHO, quality of life is defined as “Individual’s perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns”. Responses were collected in form of poor to extreme good quality of life.

Quality of life for the diabetic patients was assessed by WHOQOL-BREF questionnaires consists of 26 items. Out of 26, 2 items are related to QOL and overall health while 24 questions are segregated into 4 different domains such as physical, psychological, social and environmental.

For the group 1, mix trend range from moderate to very much good quality of life was observed for all 4 domains (Physical health, psychological, social relationship, environment). According to the data collected, subjects were having moderate quality of life for physical health domain, very much good quality of life for the psychological and social relationship domain. For environment domain, there were mix responses from moderate to very much good quality of life were reported. 53.3% subjects from group 1 were very much satisfied with their capacity of doing work and 60% subjects were satisfied from themselves which indicates self-confidence and self-esteem. 80% subjects were very much satisfied for the access of various health facilities while 46.7% subjects reported very much good support from their friends. 23.3% of the subjects reported that they often have negative feelings such as blue mood, despair, anxiety and depression.

Group 2 subjects reported very much and extremely good quality of life for all 4 domains. 43.3% subjects were extremely satisfied with the medical treatments available to them while 60% of subjects were satisfied with themselves. 70% subjects were very much satisfied with the opportunities for leisure activities. 46.7% of the subjects were very much satisfied with their personal relationships. Overall, they were more satisfied in terms of environmental and social relationship domain.

Only 9% subjects from control group reported that physical pain is not preventing them to perform day to day activities which indicates more attention towards physical health of the subjects. Majority of the subjects were very much satisfied for the social relationship and psychological domain. 70% of subjects were very much satisfied with their capacity to work.

Overall, the trend followed moderate to very much on scale point responses. However, among 10gm of intervention group, majority of the subjects reported good quality of life followed by very good, neither good nor poor and poor quality of life. Similar trend was observed among group 2 subjects as well. Maximum subjects from control group reported very good quality of life. Overall, 35 out of 90 subjects reported good quality of life.

63.3% subjects from group 1, 70% from group 2 and 66.7% subjects from control group were satisfied with their health followed by very much satisfied and dissatisfied. Overall, 6.7% subjects reported dissatisfaction towards health which may due to increased blood glucose levels or complications of the diabetes.

Table 4.3.21.1. Overall Quality of life of elderly with type 2 diabetes

Likert Scale	Overall quality of life	Group 1		Group 2		Group 3	
		Before	After	Before	After	Before	After
How would you rate your quality of life?							
1	Very Poor	0	0	0	0	0	0
2	Poor	6.7	6.6	10	6.7	3.3	3.4
3	Neither Poor nor good	20	6.6	20	10	30	26.6
4	Good	46.7	53.3	46.7	53.3	23.3	26.6
5	Very Good	26.7	33.3	23.3	30	43.3	46.4

Table 4.3.21.2. Satisfaction with health among elderly with type 2 diabetes

Likert Scale	General Health	Group 1		Group 2		Group 3	
		Before	After	Before	After	Before	After
How Satisfied are you with your Health?							
1	Very Dissatisfied	0	0	0	0	0	0
2	Dissatisfied	6.7	3.3	10	3.3	3.3	3.3
3	Neither Dissatisfied nor Satisfied	0	0	0	0	0	0
4	Satisfied	63.3	66.7	70	73.4	66.7	66.7
5	Very Satisfied	30	30	20	23.3	30	30

Section 4.3.22. Impact of pumpkin seed supplementation on diabetes distress score of elderly type 2 diabetes

Diabetes distress (DD) refers to the unique, often hidden emotional burdens and worries that are part of the spectrum of patient experience when managing a severe, demanding chronic disease like diabetes. High levels of DD are common (prevalence, 18–35%; 18-month incidence, 38–48%) and persistent over time, and they are distinct from clinical depression in their linkages with glycemic control and disease management. High levels of DD have been significantly associated with poor glycemic control, poor self-care, low diabetes self-efficacy, and poor quality-of-life, even after controlling for clinical depression.(Diabetes care, 2012).

It has 4 domains,

1. Emotional burden
2. Physician related distress
3. Regimen related distress
4. Interpersonal distress

In terms of emotional burden (questions related to their mood like feeling angry, scared,

depressed when they think of diabetes) , 63.3% subjects from group 1 and 56.7% subjects from group 2 were falling in normal category and 40%, 43.3% were moderately distress before an intervention. Majority of the subjects from all groups were falling in a normal category in terms of physician related distress (questions related to their doctor, whether they give clear directions to them about the disease etc). Not a single patient had distress regarding regimen (whether they follow their diabetes routine, checking of the blood sugars etc) for all 3 groups. 23.3% subjects of group 1 and 26.7% subjects from group 2 reported moderate interpersonal distress (questions related to their friends and family that whether they are supporting or not). 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 reduced 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.

Similar kind of study was conducted by Roupa et al (2019) depicted that patients suffering from diabetes mellitus were burdened with various sociological and behavioural factors contributing to the occurrence of anxiety and depression related symptoms. Persons who lived alone were more vulnerable and face greater risks than persons who lived with others. Family plays an important role in terms of protective manner, offering a better social involvement, practical and emotional support, but also a sense of responsibility against other members. The high BMI favors the occurrence of anxiety and depression symptoms. Therefore, high BMI puts patient at more risk.

As per the data generated in present study, physical inactivity, Poor dietary habits, abnormal lipid profile, pre-hypertension, poor health related Quality of life does matches with cohort data showing factors responsible of the disease.

Improvement on status with Diabetes disease can be done by intervening or modifiable risk factors like physical activity, proper diet, use of functional food therapy etc, especially when subjects were progressing towards post-geriatric age where poor physical and mental health are indicators of vulnerability towards metabolic syndrome.

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 with improvement in 13% and 6% subjects belonging to group 1 and group 2 respectively.

Overall stress was reduced by 3% among group 1 and 6.6% among group 2 subjects. There were no change in terms of emotional burden observed and slight shift was observed in case of physician related and interpersonal distress aspects.

Table 4.3.22. Impact of pumpkin seed supplementation on diabetes distress score of elderly type 2 diabetic subjects

Parameters	Group 1 N(%)		Group 2 N(%)		Group 3 N(%)	
	Before	After	Before	After	Before	After
TOTAL DDS						
Normal	18(60)	22 (73.3)	14(46.7)	16(53.3)	14(46.7)	16(53.3)
Moderately distress	12(40)	8 (26.7)	16(53.3)	14(46.7)	16(53.3)	14(46.7)
EMOTIONAL BURDEN						
Normal	19(63.3)	19(63.3)	17(56.7)	17(56.7)	11(36.7)	12(40)
Moderately distress	11(36.7)	11(36.7)	13(43.3)	13(43.3)	19(63.3)	18(60)
PHYSICIAN RELATED DISTRESS						
Normal	25(83.3)	26(86.7)	23(76.7)	23(76.7)	22 (73.3)	23(76.7)
Moderately distress	5(16.7)	4(13.3)	7(23.3)	7(23.3)	8 (26.7)	7(23.3)
REGIMEN RELATED STRESS						
Normal	30(100)	30(100)	30(100)	30(100)	30(100)	30(100)
Moderately distress	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
INTERPERSONAL DISTRESS						
Normal	23(76.7)	25(83.3)	22 (73.3)	26(86.7)	26(86.7)	26(86.7)
Moderately distress	7(23.3)	5(16.7)	8 (26.7)	4(13.3)	4(13.3)	4(13.3)

Section 4.3.23 MMSE Score of elderly type 2 diabetic subjects

MMSE is a standard questionnaire, used to assess orientation, registration, attention, calculation, memory , language and visuospatial abilities of the enrolled diabetic subjects (Folstein et al, 1975).

As per the data shown in the table, majority of the subjects (73.3%) fall in the normal category as per MMSE Score. Around 30% subjects from group 1, 26.7% from group 2 and 20% subjects from control group were falling in the mild category of cognitive impairment. Out of 90, 3 subjects were falling in moderate category of cognitive impairment that is one from group 1 and 2 from control group. None of the subject was found in the severe category of cognitive impairment.

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

Table 4.3.23 MMSE Score of elderly type 2 diabetic subjects

MMSE Score	Group 1 (10gm supplementation)		Group 2 (15gm supplementation)		Control Group (No supplementation)	
	N (Before)	N (After)	N (Before)	N (After)	N (Before)	N (After)
>26 (Normal)	20	20	22	23	22	23
21-26 (Mild)	9	10	8	7	6	6
11-20 (Moderate)	1	0	0	0	2	1
<10 (Severe)	0	0	0	0	0	0

Section 4.3.24 Impact of pumpkin seed supplementation on the various biochemical parameters

Pumpkin seeds supplemented for the period of 90 days. Group 1 supplemented with 10gm of pumpkin seeds and group 2 supplemented with 15gm of pumpkin seeds while control group didn't receive any intervention.

Before intervention data on few blood parameters were collected such as Haemoglobin,

Blood glucose parameters such as Fasting Blood Sugar (FBS) and Glycosylated Haemoglobin (HbA1C), lipid profile such as Total Cholesterol, LDL cholesterol, VLDL cholesterol and Triglycerides. Kidney function test and liver function test were also conducted to evaluate toxic effects of pumpkin seeds on vital organs. Data was collected on same parameters after the completion of intervention period for 3 months.

Hemoglobin levels

Mean haemoglobin level were 12g, 12.3g and 12.6g for the group 1, group 2 and control group respectively at baseline. After intervention, there was no significant rise n the haemoglobin levels with the levels of 12.5g .12.7g and 12.2 g for all 3 groups respectively.

Table 4.3.24.1 Impact of pumpkin seeds on hemoglobin levels

Parameter	Group 1 (10gm supplementation)		Group 2 (15gm supplementation)		Control Group (No supplementation)	
	Mean	SD	Mean	SD	Mean	SD
Hemoglobin (Before)	12	1.53	12.3	1.25	12.6	1.07
Hemoglobin (After)	12.5	1.33	12.7	1.28	12.2	2.21
t-test value	**1.162^{NS}**		**1.100^{NS}**		**0.781^{NS}**	

*Significant from the baseline value at p<0.05, ** at p<0.01, *** at p<0.001, NS- Non- significant

Blood Glucose Parameters

Before enrolment as per pre data collected, mean FBS levels were 159.5mg/dl and 153mg/dl for group 1 and group 2. An insignificant association was found between group 1, group 2 and control group. Significant association was found between Pumpkin seed supplementation and reduction in Fasting Blood glucose levels (Weighted Mean Difference [WMD], -11.3mg/dl; 95% CI; P=0.06*) for group 1 and (Weighted Mean Difference [WMD], -12.6mg/dl; 95% CI; P=0.07*) for group 2. There was no significant difference found between control group before and after intervention.

Glycosylated haemoglobin indicates average blood glucose control of past 3 months. HbA1C was analyzed for enrolled subjects before and after an intervention. Again, significant relation found between pumpkin seed supplementation and reduction in HbA1C

levels for group 1 (Weighted Mean Difference [WMD], -0.7%; 95% CI; P=0.03*) and group 2 (Weighted Mean Difference [WMD], -0.9%; 95% CI; P=0.07*).

Table 4.3.24.2 Impact of pumpkin seeds on fasting blood glucose and HbA1c levels

Parameter	Group 1 (10gm supplementation)		Group 2 (15gm supplementation)		Control Group (No supplementation)		F test value
	Mean	SD	Mean	SD	Mean	SD	
Fasting Blood Sugar (FBS) (Before)	159.5	34.33	153	18.66	146.7	9.31	3.31^{NS}
Fasting Blood Sugar (FBS) (After)	148.2	30.22	140.4	19.38	148.9	9.14	
t-test value	**0.880***		**1.751***		**0.910^{NS}**		
HbA1c (Before)	7.4	0.48	7.5	0.43	7.3	0.72	5.21^{NS}
HbA1c (After)	6.7	0.43	6.6	0.44	7.2	0.62	
t-test value	**4.842***		**7.980***		**1.454^{NS}**		

*Significant from the baseline value at p<0.05, ** at p<0.01, *** at p<0.001, NS- Non- significant

Figure 4.3.24.1 Overall shifts and reduction in FBS levels among subjects

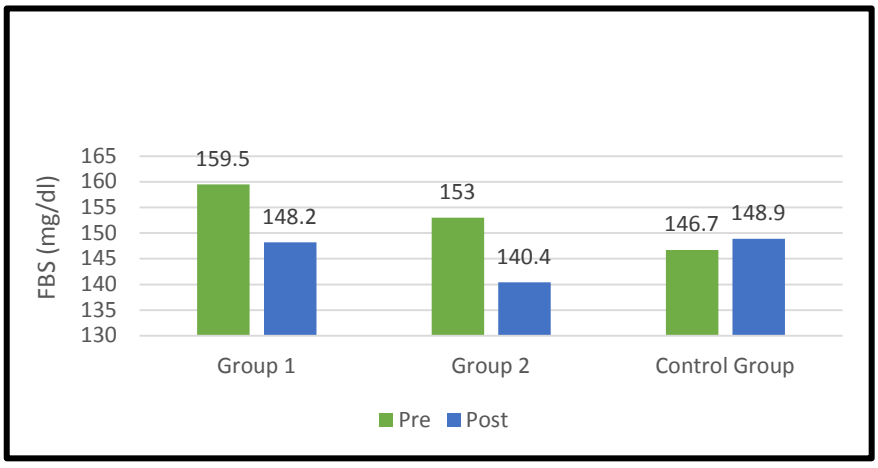
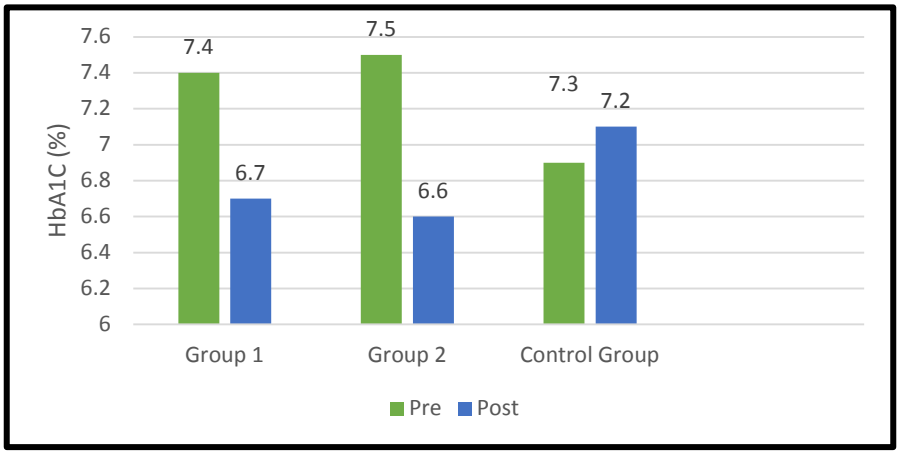


Figure 4.3.24.2 Overall shifts and reduction in HbA1C levels among subjects



Fasting blood sugar (FBS) and glycated haemoglobin (HbA1C) levels among experimental groups all significantly decreased as a result of pumpkin seed administration. There was 7% reduction in Fasting Blood Glucose (FBS) 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 showing the positive impact of pumpkin seed supplementation on both experimental groups.

Lipid profile parameters

Several studies and researches supported antilipmeic properties of pumpkin seeds due its unique composition and fatty acid profile. Therefore to assess the impact, various lipid profile parameters were checked before and after an intervention.

Total cholesterol, Triglycerides, LDL Cholesterol and HDL Cholesterol were measured before and after an intervention. An insignificant association was found between all 3 groups for all the parameters.

Significant association was found between Pumpkin seed intervention and Total cholesterol reduction for group 1 (Weighted Mean Difference [WMD], -13.8mg/dl; 95% CI; P=0.06*) and 2 (Weighted Mean Difference [WMD], -17.3mg/dl; 95% CI; P=0.06*); Pumpkin seed intervention and triglycerides reduction for group 2 (Weighted Mean Difference [WMD], -

8.2 mg/dl; 95% CI; P=0.03*) and Pumpkin seed intervention and increase in HDL cholesterol for group 2 (Weighted Mean Difference [WMD], 3.4mg/dl; 95% CI; P=0.01*).

Reduction in triglycerides levels was noticed among both the group after an intervention. Furthermore, slight reduction was observed among control group as well. There is a significant reduction triglycerides levels in group 2 (Weighted Mean Difference [WMD], -8.2mg/dl; 95% CI; P=0.03*). Group 1 (Weighted Mean Difference [WMD], -9.4mg/dl; 95% CI; P=0.95NS) also reduced triglycerides levels after an intervention period.

Mean LDL Cholesterol level was 138.7±10.7mg/dl and 145.5±12.8 mg/dl for group 1 and group 2 respectively. After an intervention for 90 days it reduced into 133.5±10.mg/dl and 136.9±12.1mg/dl respectively. Control group didn't show any noticeable change in LDL cholesterol levels after an intervention.

HDL cholesterol levels were improved slightly among both the groups. Significant increase was observed in group 2 (Weighted Mean Difference [WMD], 4.5mg/dl; 95% CI; P=0.01*) which is more than group 1 and control group. Thus, we can summarized that 15gm intervention of pumpkin seed is more effective to improve HDL cholesterol as compare to 10gm of intervention.

Table 4.3.24.3 Impact of pumpkin seeds on lipid profile of the subjects

Parameter	Group 1 (10gm supplementation)		Group 2 (15gm supplementation)		Control Group (No supplementation)		F test value
	Mean	SD	Mean	SD	Mean	SD	
TG (Before)	156.8	26.35	164.1	12.31	150	10.3	6.5^{NS}
TG (After)	147.4	25.85	155.9	10.65	147.6	14.22	
t-test value	**0.954^{NS}**		**2.447***		**0.749^{NS}**		
TC (Before)	225.4	19.88	222.3	15.76	202.1	16.69	7.2^{NS}
TC (After)	211.6	16.19	205	13.16	205	15.13	
t-test value	**3.383***		**4.073***		**0.705^{NS}**		
HDL (Before)	37	5.28	32.5	2.94	36.6	4.96	3.8^{NS}
HDL (After)	38.7	4.25	36	3.64	36.3	4.88	
t-test value	**1.374^{NS}**		**4.134***		**1.354^{NS}**		
LDL (Before)	138.7	10.7	145.5	12.81	148.7	9.02	4.4^{NS}
LDL (After)	133.5	10.11	136.9	12.19	147.5	7.03	
t-test value	**1.950^{NS}**		**2.664^{NS}**		**0.607^{NS}**		
VLDL (Before)	30.04	11.3	32.8	10.6	33.5	8.7	6.2^{NS}
VLDL (After)	27.3	9.2	28.6	11.2	32.1	9.1	
t-test value	**0.421^{NS}**		**0.501^{NS}**		**0.621^{NS}**		

*Significant from the baseline value at p<0.05, ** at p<0.01, *** at p<0.001, NS- Non- significant

Figure 4.3.24.3 Overall shifts and reduction in TC levels

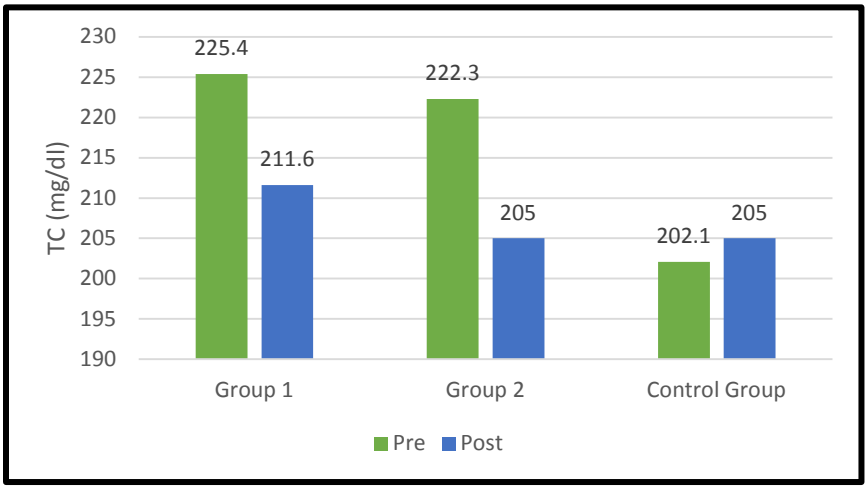
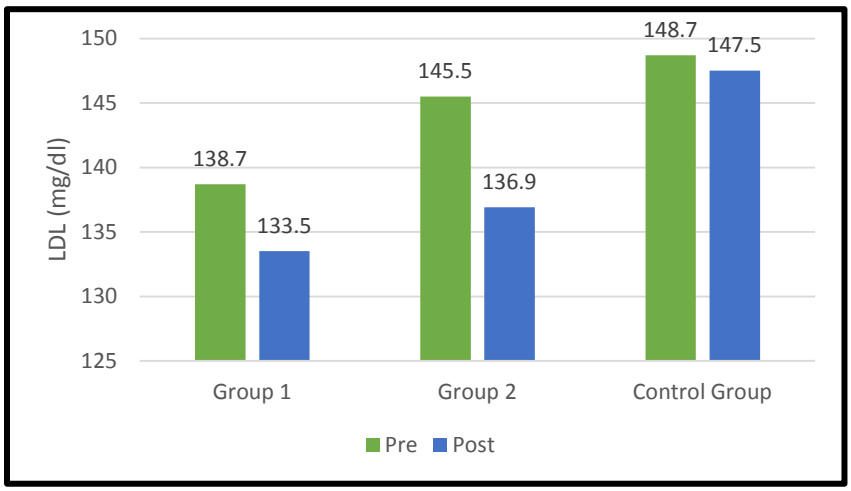


Figure 4.3.24.4 Overall shifts and reduction in LDL levels



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.

Kidney and Liver Function test

Liver and kidney functions were assessed via different group of tests to ensure its optimum function and to analyze toxic effects of an intervention. Thus, before and after three months, data regarding SGPT, SGOT enzymatic activities for liver function and creatinine, urea, BUN and e-GFR for renal function were collected. Mean SGPT levels were increased significantly among group 2 ($P<0.05$) whereas levels increased significantly among control group ($P<0.05$) although there was a slight change. Overall, diabetic subjects were not found to have any significant changes on liver function indicators except for SGPT levels among group 2 and control group.

Kidney function tests were performed through a cluster of tests including serum creatinine, Blood Urea Nitrogen (BUN), Urea and e-GFR on diabetic subjects. Mean levels of all kidney indicators were in a normal range for all 3 groups before and after intervention. Thus, it can be concluded that there was no toxic effects of pumpkin seed consumption on kidney function of the subject belonging to group 1 and group 2.

Table 4.3.24.4 Impact of pumpkin seeds on kidney and liver function parameters

Parameter	Group 1 (10gm supplementation)		Group 2 (15gm supplementation)		Control Group (No supplementation)	
	Mean	SD	Mean	SD	Mean	SD
Creatinine (Before)	0.52	0.3	0.76	0.51	0.66	0.48
Creatinine (After)	0.48	0.3	0.68	0.44	0.62	0.5
t-test value	**1.242^{NS}**		**0.849^{NS}**		**0.693^{NS}**	
Urea (Before)	23.1	9.32	24.5	5.48	23.2	4.89
Urea (After)	22.4	8.6	22.8	5.32	26.2	6.1
t-test value	**0.320^{NS}**		**1.218^{NS}**		**2.100^{NS}**	
(BUN) (Before)	11.7	6.06	15	4.47	15.6	3.69
(BUN) (After)	11.9	6.01	15.5	4.24	17.4	3.32
t-test value	**0.095^{NS}**		**0.427^{NS}**		**2.005^{NS}**	
e- GFR (Before)	95.6	14.16	88.6	9.12	83.8	8.16
e- GFR (After)	99.8	6.89	90.7	8.91	82.2	5.43
t-test value	**1.461***		**0.902^{NS}**		**0.875^{NS}**	
SGPT (Before)	21.6	8.48	24.7	7.53	23.6	3.87
SGPT (After)	21.9	8.56	25.8	5.6	22.9	2.97
t-test value	**0.156^{NS}**		**0.622***		**0.712***	
SGOT (Before)	23.5	7.24	29.7	8.28	31.7	6.67
SGOT (After)	24.2	7.72	28.7	7.53	29.7	5.04
t-test value	**0.364^{NS}**		**0.473^{NS}**		**1.267^{NS}**	

*Significant from the baseline value at p<0.05, ** at p<0.01, *** at p<0.001, NS- Non- significant

Inflammatory markers

Inflammation in diabetic subjects was assessed by measuring HsCRP levels. The mean HsCRP levels were found to be slightly high but in normal range 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. Thus, it proved that supplementation did not cause any adverse effect on health of the subjects belonging to group 1 and group 2.

Table 4.3.24.5 Impact of pumpkin seeds on inflammatory markers

Parameter	Group 1 (10gm supplementation)		Group 2 (15gm supplementation)		Control Group (No supplementation)	
	Mean	SD	Mean	SD	Mean	SD
Hs CRP (Before)	8.1	4.16	9.4	3.6	6.9	3.07
Hs CRP (After)	7.5	3.91	8.3	2.48	7.1	3.59
t-test value	**0.611** ^{NS}		**1.354** ^{NS}		**0.231** ^{NS}	

*Significant from the baseline value at p<0.05, ** at p<0.01, *** at p<0.001, NS- Non- significant

Section 4.3.25. Impact of pumpkin seed supplementation on Blood pressure of elderly type 2 diabetic subjects

Below table indicates various stages of hypertension found among diabetic subjects before and after intervention. From given table it was noted that prevalence of Pre-hypertension is more among diabetic subjects. 76.7% of the diabetic subjects were suffering from Pre-hypertension among both the intervention group while 80% diabetic subjects were pre-hypertensive from control group. Around 20% of the diabetic subjects from group 1 and group 2 have abnormal diastolic blood pressure. After intervention, 2 subjects from both intervention groups shifted to pre-hypertensive category from hypertensive category which indicates positive impact of pumpkin seed supplementation.

Table 4.3.25. Impact of pumpkin seed supplementation on Blood pressure of elderly type 2 diabetic subjects

Parameter	Group 1 (10gm supplementation)		Group 2 (15gm supplementation)		Control Group (No supplementation)	
	N	%	N	%	N	%
SYSTOLIC						
Before						
Normal (<120)	1	3.30	1	3.30	0	0.00
Pre-hypertensive (120-139)	23	76.70	23	76.70	24	80.00
Hypertensive stage 1(140-159)	6	20.00	6	20.00	6	20.00
After						
Normal (<120)	1	3.30	1	3.30	6	20.00
Pre-hypertensive (120-139)	25	83.30	25	83.30	24	80.00
Hypertensive stage 1(140-159)	4	13.30	4	13.30	0	0.00
DIASTOLIC						
Before						
Normal (<80)	4	13.30	6	20.00	18	60.00
Pre-hypertensive (80-89)	20	66.70	19	63.30	11	36.70
Hypertensive Stage 1 (90-99)	6	20.00	5	16.70	1	3.30
After						
Normal (<80)	3	10.00	4	13.30	21	70.00
Pre-hypertensive (80-89)	24	80.00	24	80.00	8	26.70
Hypertensive Stage 1 (90-99)	3	10.00	2	6.70	1	3.30

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.

Figure 4.3.25.1 Impact of pumpkin seed supplementation on Blood pressure of group 1 elderly type 2 diabetic subjects

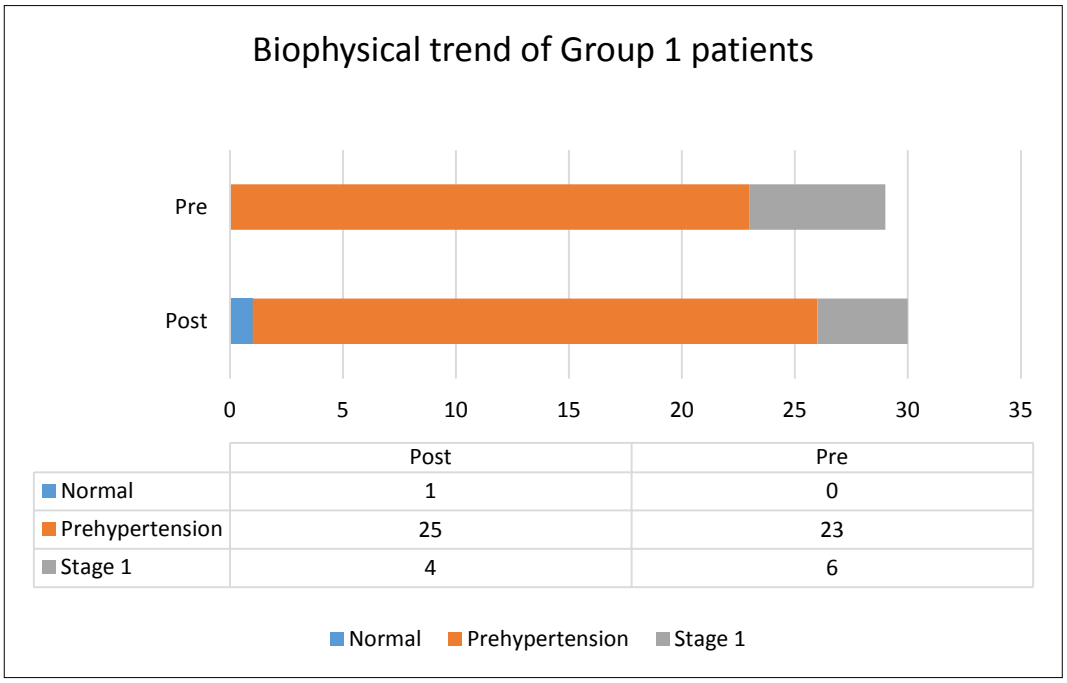
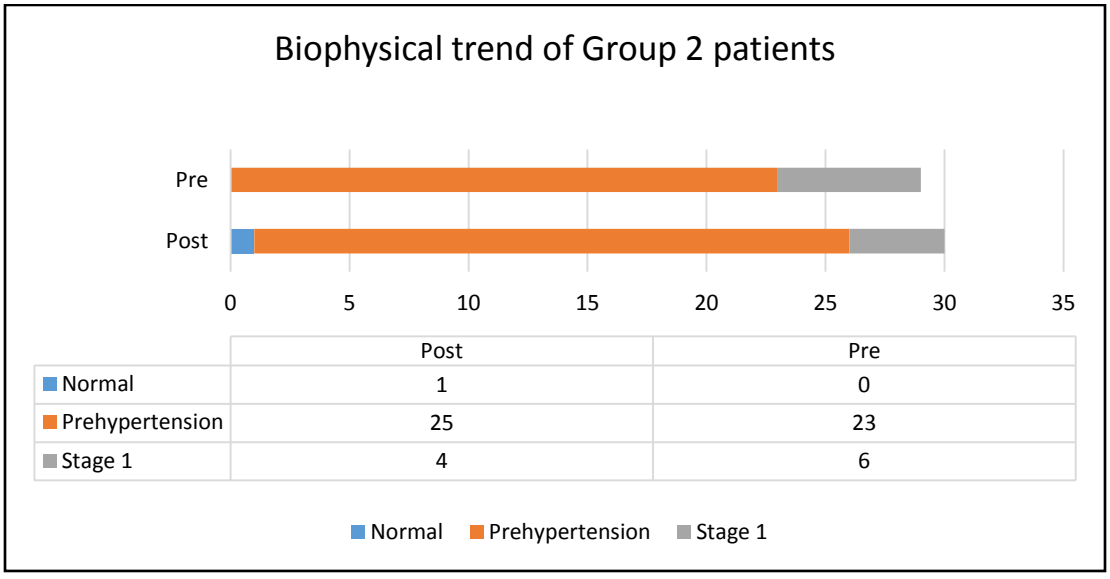


Figure 4.3.25.2 Impact of pumpkin seed supplementation on Blood pressure of group 2 elderly type 2 diabetic subjects

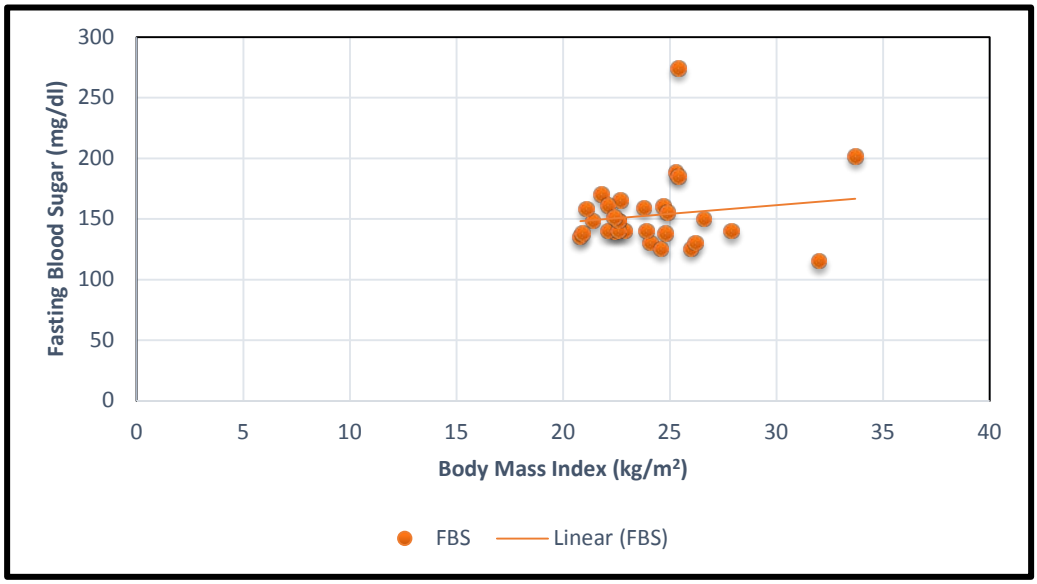


Section 4.3.26. Correlation between BMI and Fasting Blood Sugar levels of subjects on post intervention

Table 4.3.26.1 Correlation between BMI and Fasting Blood Sugar levels of experimental group subjects on post intervention

Body mass index (Mean)	Fasting Blood Sugar (FBS)	Spearman's Correlation coefficient value
24.6 kg/m2	145.2 mg/dl	0.025*

Figure 4.3.26.1 Correlation between BMI and Fasting Blood Sugar levels of experimental group subjects on post intervention

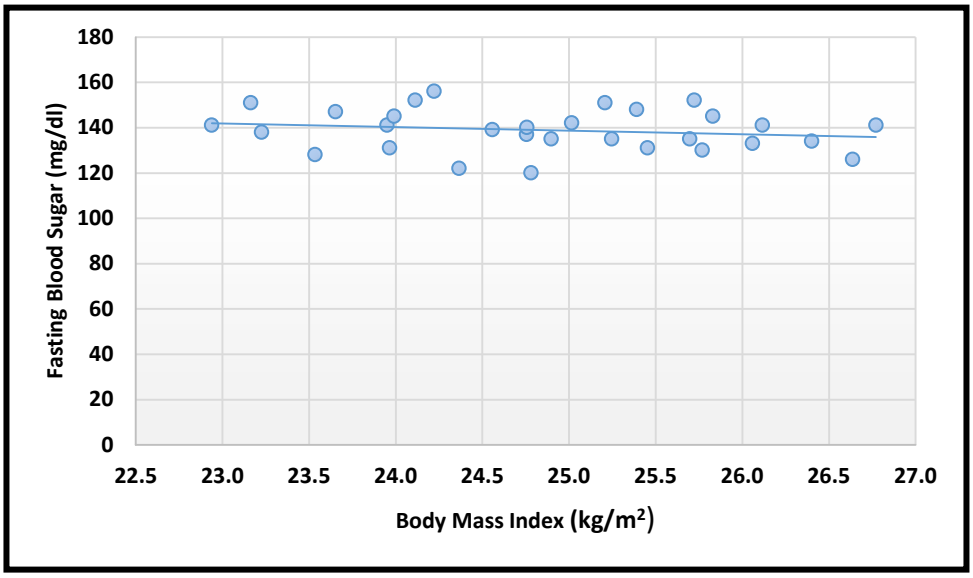


There was a positive correlation between BMI and Fasting Blood sugar levels means as BMI is increasing, fasting blood sugar levels are also increasing. Similar kind of study performed in 2014 also reported positive correlation between BMI and Fasting blood glucose levels with (r=0.402; p=0.014) among 38 elderly subjects (E Sepp et al,2014).

Table 4.3.26.2 Correlation between BMI and Fasting Blood Sugar levels of control group subjects on post intervention

Body mass index (Mean)	Fasting Blood Sugar (FBS)	Spearman's Correlation coefficient value
24.9 kg/m2	138.9 mg/dl	-0.18

Figure 4.3.26.2 Correlation between BMI and Fasting Blood Sugar levels of control group subjects on post intervention



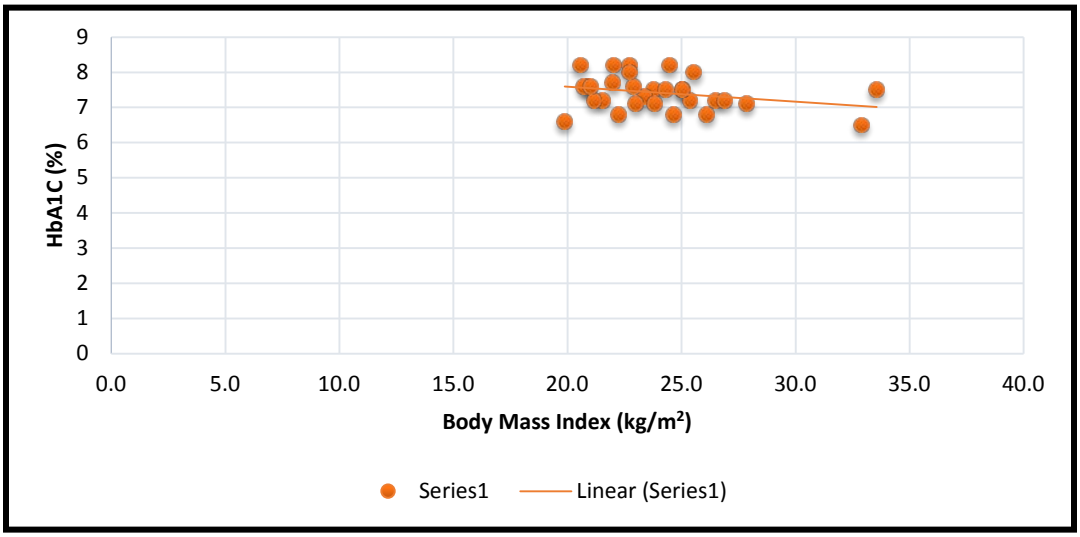
Above figure indicates scattered diagram between two parameters. Surprisingly, there was a no correlation between BMI and Fasting Blood sugar levels among control group which means rise in HbA1C levels are independent from Body mass index.

Section 4.3.27. Correlation between BMI and Glycated Haemoglobin levels of subjects on post intervention

Table 4.3.27.1 Correlation between BMI and Fasting Blood Sugar levels of experimental group subjects on post intervention

Body mass index (Mean)	Glycated Haemoglobin (HbA1C)	Spearman's Correlation coefficient value
24.6 kg/m2	6.9%	0.002*

Figure 4.3.27.1 Correlation between BMI and HbA1C levels of experimental group subjects on post intervention

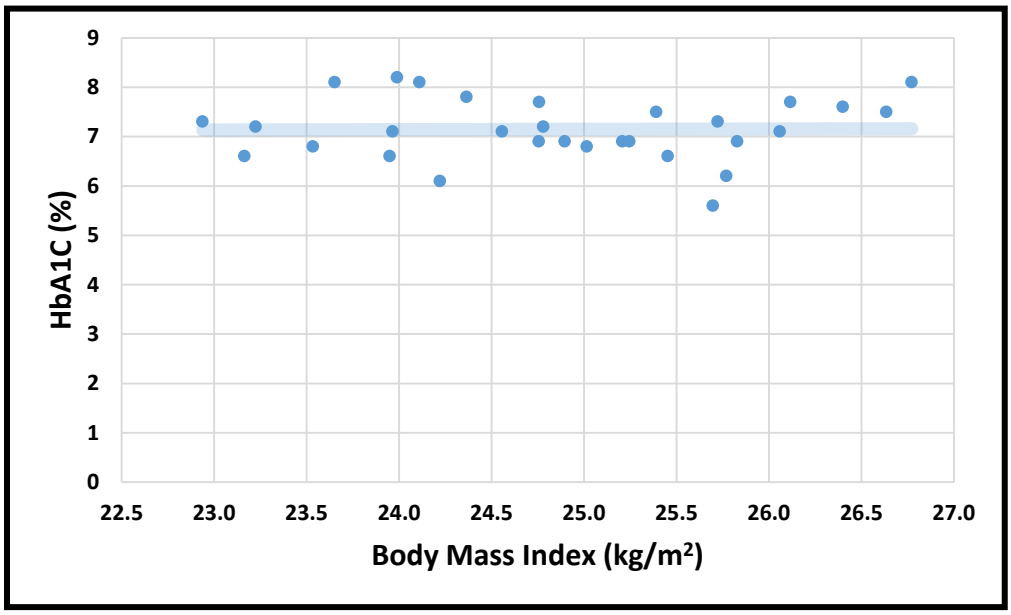


There was a negative correlation between BMI and Glycated hemoglobin levels indicating that rise in Glycated hemoglobin levels are independent from Body mass index while one of the study conducted in 2022 reported positive correlation between BMI and Glycated hemoglobin. In study they found 110 subjects with Type 2 diabetes with abnormal BMI with significant correlated HbA1c levels (Jha S et al,2022).

Table 4.3.27.2 Correlation between BMI and HbA1C levels of control group subjects on post intervention

Body mass index (Mean)	Glycated Haemoglobin (HbA1C)	Spearman's Correlation coefficient value
24.9 kg/m2	7.1%	0.01*

Figure 4.3.27.2 Correlation between BMI and Fasting Blood Sugar levels of control group subjects on post intervention



Above figure depicts scattered diagram between two parameters. There was no correlation between BMI and Glycated hemoglobin levels indicating that rise in Glycated hemoglobin levels are dependent on Body mass index.

Highlights of Phase III (Post intervention)

- *Pumpkin seed supplementation did not show any positive impact on anthropometry parameters of enrolled subjects.*
- ***Overall, mean calorie consumption by diabetic subjects was same before (1633.3±142.5)kcal and after (1632.1±124.9)kcal 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.***
- ***After intervention, slight increase was observed in terms of quality of life of enrolled subjects. Few subjects were shifted to very good category after an intervention probably due to improved physical and psychological health domains.***
- ***In case of Diabetes distress also, there was reduction in overall diabetes distress score after an intervention***
- ***Pumpkin seed supplementation resulted in significant reduction in Fasting blood sugar, glycated hemoglobin, Total cholesterol and LDL cholesterol levels among experimental groups.***
- ***Pumpkin seed supplementation did not alter liver and kidney function tests thus causing no toxic effects.***
- ***The finding of entire study supports its hypoglycemic and hypolipemic properties of pumpkin seed supplementation.***
- ***15gm of pumpkin seeds have batter potential to be used as a functional food in management of Diabetes and dyslipidemia.***

DISCUSSION

It is well established fact that diabetes is one the non-communicable disease affects overall quality of life of old age population. Uncontrolled diabetes can result in to various complications and impairments. Older adults are most affected age group as compared to younger ones.

The incidence rate of T2DM has been significantly reduced from 28% to 58% globally thanks to appropriate preventative measures that have mostly concentrated on lifestyle treatments comprising physical activity and diet strategies targeted at pre-diabetes and high-risk populations (Ramachandran A et al., 2006).

In order to prevent and treat chronic diseases like type 2 diabetes mellitus, functional meals must have biologically active components linked to physiological health advantages (T2DM). Regular consumption of functional foods may be linked to improved anti-oxidant, anti-inflammatory, insulin sensitivity, and anti-cholesterol activities, all of which are essential for managing and preventing T2DM (Ahmad Alkhatib et al., 2017).

A bibliographic survey on 11 randomized control trial (RCTs) articles from PubMed and Cochrane Database of Systematic Review was carried out to understand the role of functional foods for managing and controlling diabetes. Review reported positive impact of resveratrol, wheat albumin, ginger, and wine grape pomace on lipemic control, insulin sensitivity, blood pressure, and lipid profiles (Hidetaka H, 2016).

Various researches has been concentrating on the content and composition of fatty acids (FA) and tocopherols in pumpkin seed oil because of its beneficial health effects. Other lipid components, such as sterols, alcohols, and phenol acids, have been studied to a lesser extent, as is the case with other food matrices, in order to identify specific markers characteristic of the plant varieties.

Several studies have demonstrated a link between diabetes mellitus and an increase in free radical production as well as a decrease in antioxidant capability. The levels of antioxidant parameters are reported to be lower in diabetes mellitus patients, hence many research have

advised using phytochemicals with antioxidant and free radical-scavenging properties to increase insulin sensitivity. Several phytoactive substances, including prophenylphenols, lignans, and flavonoids, are also discovered to prevent the consequences of diabetes (Bacanli, M et al., 2019).

Present study reported presence of antioxidant properties in pumpkin seeds by using methanolic extract. According to Saavedra et al (2015), cooked seeds have high amount of total phenolic compounds. Some cooking methods such as roasting and boiling increase the total phenolic and flavonoids content of various seeds and grains. Possible mechanism behind it may due to the breakdown of cell structure during toasting, bound phenols and flavonoids are released. The other is that the maillard reaction takes place and generates a variety of compounds that can combine with the FC reagent to raise the overall phenol content. Cooked pumpkin seeds were found to have superior antioxidant properties than fresh seeds when they were extracted with methanol (0.31-0.32 mol TE/g vs. 0.37-0.47 mol TE/g). (R2 = 0.980, P 0.05), statistical analysis revealed a substantial correlation between antioxidant activity and total phenol content. Therefore, one of the factors contributing to the increased antioxidant capacity of roasted pumpkin seeds is the rise in total phenol content.

Regardless of the extraction solvent used, the seeds of the pumpkin types have superior antioxidant qualities. When used as an extracting substance, 50% ethanol is more effective than 80% methanol. When compared to 80% methanol, the antioxidant activity values found with 50% ethanol are higher. Because the fatty acids under investigation differ significantly in composition, it is feasible to select the ideal pumpkin variety for the application (Nawirska-Olszańska et al, 2013).

Present study findings reported presence of various phytochemicals and antioxidants in pumpkin seeds. One of the study conducted by Ashok et al during 2013 also reported medicinal properties of pumpkin seeds. Phytochemical screening of pumpkin seeds conducted by them revealed presence of carbohydrates, proteins, phenolic and tannins in acetate extraction while presence of carbohydrates, proteins, phenolic, tannins, flavonoids and saponins in alcoholic extraction of pumpkin seeds which could make it useful in the formation of drugs and therapies for treatment if non communicable diseases. While the

phytochemical analysis revealed that both the pumpkin flesh and seed extracts had a variety of phyto-constituents, the physicochemical evaluation demonstrates that the extracts had a good and high purity level. The ethanolic extracts of pumpkin flesh and seeds (dose level 150 mg/kg) demonstrated a significant decrease in blood sugar (Novarianti M et al, 2017).

To promote the increased growth and consumption of those that are highly nutritive, knowledge of the nutritional value of regional foods and ingredients is required. According to the results of present study, 100gm of pumpkin seeds contained 35.9 gm of protein, 678mg of magnesium and 0.05mg of selenium. 100gm of pumpkin seed contained. Study conducted by Venugopal and Arora in 2018 reported 20.7gm of protein, 272gm of magnesium and 0mg of selenium in 100gm of chia seeds. While one of the study published in 2021 conducted by Saad S et al reported 27.5gm of protein and 320mg of magnesium in 100gm of sunflower seeds. Thus, pumpkin seeds are rich in protein, magnesium and selenium when compared to other seeds.

Cucurbita moschata seeds' ethanolic extract revealed the presence of phytochemicals that may have implications for their antioxidant activity against DPPH free radicals. Also, the extract had a proliferative effect on the development of fibroblast cells in a dish. Hence, the pumpkin seed extract may have effects on how quickly wounds heal, as well as potential anti-aging and cosmetic benefits (Agrahari A et al.,2020). Parellal to this studies, research conducted by Ashiq Hussain et al (2022)., stated pumpkin seeds as more powerful as compared to pumpkin powders and peel powders. A significant decrease in blood glucose level (128:33 ± 1:67 mg/dl), TC (88:43 ± 0:66 mg/dl), TG (69:79 ± 0:49 mg/dl), and LDL-C (21:45 ± 0:08 mg/dl) was recorded in rat groups fed with 15 g pumpkin seed powder, at the end of study.

In the present study, it was revealed that methi muthiya (45±10.2) and vegetable upma (47.75±9.2) are having low glycemic responses as compared to other recipes. Methi muthiya, which was prepared by using fenugreek leaves (methi). Methi muthiya also contained fibre rich legumes such as Bengal gram dal and red gram dal. Presence of both dals could also have attributed for its lower glycemic index.

An evaluation of the effectiveness of fenugreek consumption (10g/day) on people with prediabetes was conducted over a three-year period in a randomized controlled study with 66 participants. For three years, T2DM progression was monitored every three months. By the end of the intervention period, it was seen that the fenugreek group's diabetes had significantly decreased when compared to the control group. Comparing participants in the intervention group with controls, there was a 4.2-fold increase in the risk of acquiring diabetes (Gaddam A et al, 2015).

Methi Thepla also contained a lot of fibre. Insoluble fibres were used in the study to examine the impact of food intervention on blood glucose response. A control group or an intervention group was selected for a group of fourteen healthy women. While the subjects in the intervention group were required to eat white bread with little fiber, the control group had to eat low-fiber white bread. It was discovered that fibre enrichment was linked to a significant drop in postprandial blood sugar values, demonstrating its efficacy in regulating blood sugar levels (Weickert MO et al, 2005).

Vegetable upma (47.75±9.2) reported low GI according to the classification of GI given by American Diabetic Association. Addition of vegetable like peas, carrots, coriander, and others—which the American Dietetic Association classifies as low Gl foods—tends to have this impact.

Among all recipes, Roasted poha chevda reported highest glycemic response (65.5±7.2) after its consumption. This might be due to the presence of highest amount of processed form of rice (rice flakes). Pulses and vegetables were not incorporated in chevda so absence of fibre might have contributed for its high glycemic index. In line with this finding, one of the study conducted on impact of various cooking methods on glycemic index reported that Some of the roasted and baked items had significantly higher GI values and areas under the glucose response curve than the boiled or fried foods ($P< 0.05$). Therefore, the findings suggest that items that have been roasted or baked may have a higher GI (Bahado-Singh, P et al, 2006). However, pumpkin seeds are rich in several antioxidants and trace minerals, heat sensitive nutrients can be destroyed during some cooking processes like roasting and boiling.

It is undetermined whether between or within individual variation is liable for the variability of the glycaemic index (GI) in various individuals. Additionally, it is unknown how much of a clinically significant difference in GI exists between various meals for people with diabetes. In this study, glycaemic response variations among subjects for same recipe were observed among glycaemic index of pumpkin seed incorporated recipes. There are various biological factors such as age and gender, nutritional factors like food habits, previous meal diet, metabolic factors such as medical history of family and physiological factors can influence glycaemic responses of the subjects which may responsible for the variations among glycaemic index of pumpkin seed incorporated recipes.

In this study, semi trained panel members accepted incorporation of 10gm of pumpkin seed incorporation for most of the developed Indian traditional recipes. Similar in this line one of the study conducted in 2016 on sensory analysis of poppy seeds incorporated traditional recipes reported that semi trained panel members accepted recipes like potato papad and besan papdi with 5g of poppy seed incorporation most as compared to control and recipes developed by using 10g of poppy seeds (Bala and Dhankhar 2016). In a study conducted by M Angel and B Atchaya (2022), Cookies containing three variations of the Moringa oleifera seed powder, each 5%, 10%, and 15%, were used. Twenty members of the panel were given the standard cookies and three variations; the standard cookies received the greatest acceptance. 1 with 5% of all the variations. Cookies using moringa oleifera seed powder received the highest acceptance rate. According to one of the study conducted on sensory evaluation of chia seed incorporated recipes, All of the chia seed-infused recipes were well received by the panellists and were found to be comparable to the control samples. All degrees (4g, 8g and 12g) of chia seed incorporation were confirmed to be acceptable (Venugopal and Arora, 2018). One of the study carried out by using flax seeds revealed that as per to the composite scoring test, there were no significant discrepancies in either of the attributes for globs up to 20g of roasted flaxseed substitution, indicating that the globs were well-tolerated at all three levels of substitution. Nearly 50% of the panel of semi-trained judges judged globs as being similarly superior for up to a level of 20g flaxseed replacement (Agrawal and Chauhan, 2017). Thus, various study findings conducted on different seed incorporated Indian recipes supported seed incorporation at the level from 2g to 20g.

The results of current study revealed that consuming pumpkin seeds for 90 days was an effective intervention in treating diabetes among old age subjects and also improved their lipemic profiles.

Amongst other studies, Flax seeds were also used to find out their effectiveness to control the blood sugar levels. Brining to use a randomized crossover design, nine glucose intolerant obese people were told to consume 40 g ground flaxseed every day for around 12 weeks (84 days) with a 4-week washout period. The study's results weakly supported the decrease in insulin resistance due to the antioxidant activity of flaxseed (R Yeong et al., 2011).

Researchers looked at how fenugreek affected non-insulin dependent diabetics' random blood sugar or postprandial glucose and insulin levels after the MTT (meal tolerance test) (NIDDM). Fenugreek seed powder (about 15g) was steeped in water before being administered. It was discovered to dramatically lower the corresponding postprandial glucose levels. In NIDDM, it was also discovered that fenugreek decreased plasma insulin levels, but there was no statistically significant difference. 3 hours after the MTT, fenugreek did not appear to have a significant impact on cholesterol levels. Fenugreek has demonstrated that it may be useful in the treatment of NIDDM (Madar Z et al., 1988).

One of the study conducted on sunflower seeds revealed a favorable and stronger effect of seeds in lowering the FBS levels in those with type-2 diabetes while also significantly raising HDL levels (good cholesterol). The daily recommended intake of proteins, vitamins, minerals, and phenolic antioxidants is just half a scoop of sunflower seeds. Furthermore, they reported that Sunflower seeds contain a lot of chlorogenic acid. By decreasing or preventing the liver's ability to break down glycogen, chlorogenic acid aids in blood sugar regulation. Hence, helps individuals with type 2 diabetes maintain adequate control over their blood sugar levels (Cheenam B et al, 2016).

A randomized, single-blind, placebo-controlled study was conducted to evaluate postprandial glycemic effects of pumpkin seeds in which 15 normoglycemic subjects were selected and glycemic index was calculated by feeding 65gm of pumpkin seeds on three consecutive days. Findings of this study reported lower incremental area under glycemic response curves (iAUC) after consuming pumpkin seeds (Cândido FG et al, 2018).

Similarly, in present study also Glycemic index was calculated for 8 pumpkin seed incorporated recipes. Out of 8, 2 recipes namely methi muthiya and vegetable upma found to have low glycemic index (<55) as compared to other developed recipes. Hence, pumpkin seeds can be incorporated in food items to reduce glycemic index of the recipes. In parallel to this finding, Venugopal S and Arora S (2019) reported 44.78% reduction in glycemic index of chia seed incorporated methi muthiya as compared to methi muthiya with no chia seeds incorporation. Overall study findings reveled that chia incorporated recipes had a low GI as compared to the recipes without incorporation of chia seeds.

Diabetes is linked to psychological issues like anxiety and depression and has an effect on psychosocial functioning and day-to-day activities, which lowers quality of life (QoL). Patients with diabetes have lower QoL, which is worsened by complications or the presence of concomitant conditions. In this study, diabetic subjects reported impaired quality of life due to presence of disease and associated comorbidities. Overall, 6.7% subjects reported dissatisfaction towards health which may due to increased blood glucose levels or complications of the diabetes. According to one of the study finding, poor glycemic control was strongly associated with poor quality of life (Srinivas HK et al, 2014). Similarly, study conducted on 50 subjects at Jaipur revealed that half of the subjects were having poor quality of life (Jain A et al, 2017). Poor sleep quality was noted and linked to a low quality of life in a different cross-sectional study involving 300 T2D people from Delhi (Deswal J et al, 2020).

In present study, it was found that total diabetes distress was 48.9% among enrolled subjects. Of total subjects, 47.8% were having moderate distress for emotion, 22.9% reported regimen related distress followed by 21.1% for interpersonal related distress. In line with this finding, a cross sectional study conducted in china reported 90.82% overall DD with average score of 3.01 ± 0.58. Among them, 57.14% had severe diabetes distress, and 33.67% had moderate diabetes distress among type 2 diabetic subjects (Hu Y et al, 2020) while study conducted in Bangladesh reported that, among the study participants, 52.5% had DD (29.7% moderate and 22.8% high DD). The prevalence of emotional burden, physician-related distress, regimen-related distress, and interpersonal distress was 68.7, 28.6, 66, and 37.7%, respectively (Kamrul-Hasan et al,2022). Out of the 185 patients, 65 (35%) had distress based

on DDS self-administered questionnaire. Among the patients with distress, 55% were females and 64% had lower grade of education as per study conducted in Iran among type 2 diabetic subjects (Hamid R et al, 2013). The most efficient clinical approach for assessing the quality of life (QOL) issues of older diabetics is to be aware of and swiftly recognise the psychological suffering that diabetes causes. The results of this study will help decision-makers create and carry out policies that will enhance the quality of life for "elderly people with diabetes."

In the present study, 10g and 15g of pumpkin seed supplementation also shown significant reduction in total cholesterol and triglycerides levels among type 2 diabetic old age subjects. To support this finding in another study, pumpkin and flax seeds mixture was fed to 30 male Wistar rates which resulted into significant reduction in Triglycerides and Total cholesterol levels indicated anti athrogenic hepatoprotective effects of pumpkin seeds probably due to presence of various unsaturated fatty acids (Makni M et al, 2008). Similar to this findings, study conducted on alloxan induced diabetic rats reveled significant reduction in glucose, TG, TC and CRP levels among pumpkin seeds powder supplemented rats as compared to non-fed rats (Asgary S et al, 2011). One of the study conducted by using Pumpkin Seed Oil (PSO) supplementation on 127 participants for the period of 90 days shown significant reduction in LDL and Diastolic blood pressure (DBP) levels and significant increase in HDL cholesterol levels. These findings reveal its hypolipimic and antihypertensive properties.