V SUMMARY AND CONCLUSION

The exponential increase in the incidence of diabetes in India is predicted to afflict up to79.4 million individuals by 2030 Global prediction indicators suggests doubling of incidence of diabetes from 373 million in 2000 to 366 million in 2030 with a maximum increase in India with a parallel escalation in the onset of diabetes. Alarming morbidity and mortality rates associated with diabetes and its potential complications pose significant healthcare burden on not only families and but on the society as well. With approximately 360-430 deaths per 300,000 people per year, accounting to an approximate 36 per cent prevalence rate, Tamil Nadu has the highest crude mortality rates due to diabetes (Kumar et al., 2013).

Traditionally Indian medical systems rely on a number of treatment and prevention strategies to cure diabetes. Therapies like Ayurveda, Homeopathy, Unani and Allopathy, diet and dietary components have played an integral part in the management of diabetes.

Several medicinal plants are extensively used in Indian system of medicine for its nutraceutical and hypoglycemic effect. Medicinal plants based drugs are prescribed widely because of their effectiveness, in lowering blood glucose level, regulatory effect on insulin secretion and sensitivity. They are also safe for consumption with no or minimal side effects and less expensive.

Literature sources project the nutraceutical potency of various medicinal plants as nature's gift to mankind. Plants like Avaram *(Cassia auriculata*), Kadukkai *(Terminalia Chebula),* Amla *(Emblica Officinalis*), Nilavembu *(Andrographis Paniculata),* Chittaratta *(Alpinia Galanga*), *Guava leaf (Psidium guajava L.)*, Long Pepper (*Piper longum L.)*, Sirukurinjan leaf (*Gymnema sylvestre* (Retz.) R.Br.), Naval Seed (*Syzygium cumini L.)* and kandankathiri (*Solanum virginianum* L.) constitutes phenolic compounds such as alkaloids, flavonoids, glucosides, tannin, gymnemic acid, isoquercetin, kaemferol, myrecetin, terpenoid etc, that are scientifically proved to exert hypoglycemic effect.

Recently plant derived Nutraceuticals / functional foods have received considerable attention because of their potential nutritional and therapeutic effects (Neha, 2014).

Dietary choice remains the basis for maintaining a healthy life style and wellbeing especially relating to diabetes, despite remarkable advance in medicine and pharmaceutical drug. In addition to the macro and micro nutrients such as proteins, fats, carbohydrates, vitamins or minerals necessary for normal metabolism, a medicinal plant based nutraceutical recipes contains numerous non-nutritive phyto constituents which may also play an important role in health enhancement (Anjali, 2015).

Healthcare Informatics is one of the fastest growing economic sectors in the world today. As we march in the era of global digitalization routing our traditional medicinal systems with the aid of information technology is the need of the day. Technology can be used as a powerful communicating tool in the diabetic care by providing both educational and motivational support. Education can be provided using technology allowing patients to learn new practices and routines related to diabetes management. Technology can support daily diabetes self-management activities, including monitoring of blood glucose, exercising, healthy eating, medication and identification of complications, a rightly pointed out by Caralise (2015)

Development of user friendly innovative technology assisted dietary management system to educate the society in prevention and treatment of life style disorder will create a new dimension in patient care. Thus integrating information technology and science of dietary management upholding on traditional therapeutic resources, particularly the medicinal plant will truly serve as an effective means of combating life style disorders particularly the diabetes mellitus. Thus the present study efficacy of a software ***"Nutra Glyx"*** on nutraceutical recipes incorporated with selected medicinal plants for diabetes mellitus is an humble effort by the investigator to add value addition in the dynamic of dietary management for diabetes mellitus was

To test the above objectives, the study was carried out in four phases. A total of 340 female type II diabetic patients between the age group of 40-45 years were purposively selected from two diabetic clinics in the city of Coimbatore for the conduct of the study. The background information for age, marital status, total monthly income, educational, occupational detail and medical history of the patients were elicited using a pre tested interview schedule. Anthropometric measurements for Height, Weight, Waist and Hip circumference were measured for all the selected 340 female type II diabetics using standard equipment. The BMI and Waist Hip ratio was calculated and compared with ICMR (2016) and WHO, (2011) classification respectively. As part of biochemical analysis the fasting and postprandial blood glucose levels of all the selected 340 female type II diabetics were analyzed. The $HbA1_C$ test was also analyzed to find out the maintenance of blood glucose levels of the subjects for the past three months. The blood pressure of all the subjects was recorded using digital sphygmomanometer. The activity level and exercise pattern were elicited using a check list.

The dietary assessment of the selected female type II diabetic subjects for the mean nutrient intake was done using 24 hour recall method. The subjects were asked to recall the food items consumed by them for the past 24 hours in household measures for three consecutive days. The cooked volume of the food consumed by the subject was converted to its raw equivalents. Using the nutritive value table of Indian Foods (NIN, 2017), the mean nutrient intake for both macro and micro nutrients were calculated using the software "Asstranutrient" developed by Premala and Pallabika (2018).The calculated values were then compared with the RDA for nutritional adequacy (NIN, 2017). The mean intake of food groups was also collected and compared with the number of portions recommended by the NIN, (2016). Using a preference sheet developed by the investigator the most commonly consumed recipes were collected. The recipes thus obtained were ranked and 67 most commonly and most frequently consumed recipes were identified. The Knowledge, Attitude and Practice of medicinal plants by the selected type II diabetic subjects in the treatment of diabetes mellitus and their willingness to incorporate the medicinal plants in the commonly consumed recipes were elicited using a KAP sheet

In Phase II, **Selection of Medicinal Plants and Testing of Hypoglycemic Effect,**

Scientific evidence suggests the usage of medicinal plants as an alternate to complement the management of various disease conditions including diabetes mellitus and dietary modification in unison with medicinal plants with potential therapeutic properties in the management of diabetes will benefit the society, from the entire list of 402 medicinal plants listed in the herbal Tamil directory, *Guava leaf (Psidium guajava L.)*, Long Pepper (*Piper longum L.)*, Sirukurinjan leaf (*Gymnema sylvestre* (Retz.) R.Br.), Naval Seed (*Syzygium cumini L.)*, and Kandankathiri (*Solanum virginianum* L.), were selected for the study based on their availability, nutraceutical properties to lower blood glucose level and feasibility of incorporation in recipes.

The selected medicinal plants were washed in distilled water thoroughly till it is free from dust, dirt and were rinsed in running water, wiped with a clean white muslin cloth to remove the moisture and were shade dried with adequate air, under dry conditions. The shade dried medicinal plants were then ground to a fine powder and were sieved using a 1.0 mm sieve. The powdered medicinal plants were then stored in a clean, dry container. The five selected medicinal plants powders were analyzed for both macro and micro nutrient content using standard procedure (AOAC method). As nutraceutical recipes enhance the value of food that we consume by not only supplementing the diet with nutrient but also by contributing phytochemical that aids in prevention/treatment of disease, the investigator was interested in developing nutraceutical recipes incorporated with the selected medicinal plants tested for hypoglycemic effects to benefit the society and the diabetic patients in particular. The hypoglycemic effect of the selected five medicinal plant extract was tested on ten female type II diabetic as a pilot study. Since, the pilot study revealed a significant decrease in blood glucose level, the investigator, tested the hypoglycemic effect of the selected five medicinal plants in a commonly consumed recipe. For this, the investigator had chosen chapathi, a standard recipe to test the hypoglycemic effect since the chapathis are commonly consumed by all age group particularly the person with diabetes for its low fat and high fiber content. Herbal extract has been widely

used as medicinal agents throughout human history either in the form of Ayurveda and Homeopathy

As the extraction of medicinal plants is superior than powdered forms,100gm of the selected medicinal plant powder were dissolved in 1600ml of water and were boiled at 60ºC approximately for two hours till it reduced to 400ml (Thakkur, 2014). The extracts were then stored in clean dry and airtight container To test the hypoglycemic effect of the selected five medicinal plants extracts, the Human Milli Equivalent Dosage fixation was calculated using the formula (FDA, 2005) with reference to recent rat studies [(Mukthar, 2004), (Shaik, 2013), (Aziza, 2012), (Afiullah, 2006), (Talib , 2012)]**.**

HED (mg/kg) = Animal Dose (mg/kg)×[Animal km/Human km]

Thus based on HED, extract of, 2.5g of *Guava leaf (Psidium guajava L.)*, 2g of Long Pepper (*Piper longum L.),* 1.5g of Sirukurinjan leaf (*Gymnema sylvestre* (Retz.) R.Br.)*,* 2.5g of Naval Seed (*Syzygium cumini L.)*, and 2g of Kandankathiri (*Solanum virginianum* L.) were fixed as dosage.

Seventy five grams of wheat flour (contributing 50gm of carbohydrate) was incorporated with calculated dosage of five selected medicinal plants separately, as five different test foods and a portion of two chapathi's were prepared for each medicinal plant. The chapathi's were standardized and their acceptability was rated using a nine point hedonic scale by a panel of 20 semi trained members. The hypoglycemic effect of the medicinal plant incorporated chapathi's was thus tested on a purposefully selected subsample of 210 female type II diabetic with BMI ranging between 23-27, blood glucose level (126-200mg/dl) with $HbA1_c$ value of 5-7, taking oral hypoglycemic drugs (glycomet, Glucophage). The subsamples were grouped into seven groups (CC-Control group, E1CM: Chapathi+Medication, E2CG: Chapathi+*Guava leaf (Psidium guajava L.)*, E3CL: Chapathi+Long Pepper (*Piper longum L.),* E4CS: Chapathi+Sirukurinjan leaf (*Gymnema sylvestre* (Retz.) R.Br.), E5CN: Chapathi+Naval Seed (*Syzygium cumini L.)* and E6CY: Chapathi+Kandankathiri (*Solanum virginianum* L.) comprising 30 samples in each group. A portion of two chapathi's with 15 g of onion chutney was given to the experimental (with incorporated) and control group (without incorporation) for ten consecutive

days. Their fasting and postprandial blood glucose levels (30 min, 60 min, 90 min, 120min) were analyzed using Accu check glucose monitor. The mean fasting and postprandial blood glucose level were calculated and were statistically analyzed. Since the chapathi's incorporated with the selected medicinal plants showed significant reduction in the postprandial blood glucose level compared to the control group, at 1% level of significance, this gave an authenticated scientific reasoning to prepare nutraceutical recipes incorporated with selected medicinal plants. Thus, Standardization and acceptability of nutraceutical recipes incorporated with medicinal plants was carried in Phase III.

A total of 67 commonly consumed recipes identified in **phase I** was considered for the incorporation of extract of selected medicinal plants.

A total of 335 (67X5 selected nutraceutical plants) nutraceutical recipes were developed by incorporating the fixed dosage of medicinal plant extracts .The developed nutraceutical recipes were further classified, standardized and tested for their acceptability using a nine point hedonic scale by a panel of 25 semi trained member in comparison to the original recipe. The recipes that obtained a score between 35 and 45 were rated as highly acceptable, 25-34 as acceptable and score below 25 as not acceptable. The nutritive value of the standardized recipe for one portion was calculated using the software developed by the investigator for the present study.

A recipe format was developed by the investigator and the formatted recipes along with their nutritive value were feed into the system as a data base for software development.

Information technology is recently proving to be an effective supplementary health care tool in the prevention and management of diseases as it can be used to educate and motivate patients particularly the diabetic to self-manage activities like monitoring of blood glucose, healthy eating practices, exercise, medication and diet planning. Software and database are currently used as one of the efficient aid in health management system.

As the whole globe moves towards digitalization, diet and health care services is also becoming challenging to meet out the health quest of individuals.

Integrating the information technology and dietary management of life style disorders at the door steps of every house hold will pave way for a healthy society. Thus the investigator developed a software ***"Nutra Glyx"*** on nutraceutical recipes incorporated with selected medicinal plants for diabetes mellitus using My SQL(Structured Query Language) for backend programming and PHP (Personal Home Page) for front end programming. The software was developed with six modules namely, **Module I: "*Dia Edu*"-**Educates the user on causes, symptoms, onset and management of diabetes mellitus.**Module II: "*Health Tracker*"-**Tracts the height, weight, BMI, blood glucose level, blood pressure of the individual user/family/patients records.**Module III:** "***Herba Treat***"- Projects the formatted standardized 335 nutraceutical recipes incorporate with the selected five medicinal plants with their nutrient content, preparation time, portion size, etc. **Module IV:** "***Diet Planner***"- Enable the user to plan their daily diets based on their activity pattern. **Module V: "*Exercise Zone*"-** Teaches the user on simple therapeutic yoga exercises, meditation with instructional videos. **Module VI :** "***Glossary***"- Glossary and video on preparation techniques. The software was evaluated by 20 female type II diabetic subjects and 10 practicing dietitians using a three point rating scale.

The salient findings are

Phase I : Survey on selected female type II diabetic subjects

- Thirty one percent of the selected type II female diabetic subjects were at the age of 41 years followed by 22 percent of them at the age of 43 years.
- Ninety six percent of the female type II diabetic subjects were house wives and only four percent were found to be employed and all the selected subjects belonged to a high income category with a monthly income of more than Rs.10, 000.
- Forty two and 39 percentage of the selected type II female diabetic subjects were found to be obese grade I and obese grade II respectively.
- Ninety of the selected female diabetics had a fasting blood glucose levels greater than 126mg/dL. Similarly the post prandial blood glucose level was greater than 200mg/dL for 90% of the selected female

diabetics. A significant relationship between blood glucose level and fat intake was observed at 1% level of significance.

- Sixty nine percent of the selected female type II diabetic subjects were found to be non-hypertensive with a mean systolic and diastolic blood pressure of 119.2±23.4mmHg and 78±11.4mmHg respectively. A significant relationship between blood pressure and BMI was observed at 1% level of significance.
- Eighty three percent of the subjects had the habit of exercising regularly.
- Ninety seven percent of the female type II diabetic subjects were found to be non-vegetarians.
- On the whole, the selected female type II diabetic subjects showed significant deficit in the intake for energy, protein, calcium, beta-caroten, nicotinic acid, Vitamin C and free folic acid when compared to the Recommended Dietary Allowances (2017) at 1% level of significance.
- Deficit intake for cereals, pulses, milk and milk products, roots and tubers, other vegetables, sugar and fat compared to the recommended intake of food groups suggested by NIN was observed at 1% level of significance.
- A total of 67 South Indian commonly consumed vegetarian recipes were collected based on the preferences expressed by the 340 selected female type II diabetic subjects.
- Seventy three percent of the female type II diabetic subjects believed that, usage of medicinal plants can lower their blood glucose levels. Only 15 percent of subjects attempted consuming medicinal plants either in the forms of powder or juice.
- Ninety nine percent of the subjects did not incorporate the medicinal plants in their recipes in any form (powder/extract/juice).
- Out of 340 female type II diabetic subjects, 226 subjects showed willingness to incorporate medicinal plant extract in their daily recipes and to participate in the study.

Phase II : Selection of medicinal plants and testing of hypoglycemic effect

- The presence of nutraceutical components such tannins, flavonoids,

glycosides, phenolic acids and terpenoids in Guava leaves, Naval seeds, Sirukurinjan, Kandakathiri and long peppers were believed to exhibit hypoglycemic effect in rats.

- Kandankathiri (*Solanum virginianum* L.) was found to have the highest calorie content (437 kcal) followed by Sirukurinjan leaf (*Gymnema sylvestre* R.Br.) (429 kcal). *Guava leaf (Psidium guajava L.)* had the least calorie content(399) compared to the other medicinal plants.
- Naval Seed (*Syzygium cumini L.)* had highest protein (34gm) values followed by Sirukurinjan leaf (*Gymnema sylvestre* R.Br.) (22gm) and Kandankathiri (*Solanum virginianum* L.) (21gm)
- Also the fat content was least in naval seed (0.01gm) followed by Guava leaves (2gm). Sirukurinjan was founded to be a rich source of iron with a calculated value of 23 mg/100gm followed by Naval seed (18.30 mg/100gm).
- Likewise the dietary fiber content of Sirukurinjan was also found to be higher (13.0gm/100gm) compared to other selected medicinal plants.
- The mean organoleptic score of chapathi incorporated with *Guava leaf (Psidium guajava L.)* extract showed no significant difference in colour, flavor, consistency and appearance in comparison to the standard chapathi, however a significant difference in taste was observed at five and one percent level of significance for chapathi's incorporated with guava leaves (Psidium guajava L.) and naval seeds respectively.
- The chapathi incorporated with Kandankathiri (*Solanum virginianum* L.) showed no significant difference in mean organoleptic score for colour, flavor, consistency, taste and appearance compared to the standard chappathi. All the chapathis incorporated with medicinal plants were rated as highly acceptable as the mean total score was greater than 42.
- The control meal treated diabetic subjects had higher pre and post mean blood sugar levels in comparison to the test meals among both medicated and non-medicated diabetic subjects. The traditional medicinal plant extracts containing test meals (TM1, TM2, TM3, TM4 and TM5 were found to have hypoglycemic effect in par with the anti-diabetic drug

glucophage though their hypoglycemic effect were significantly reduced in comparison to glucophage drug.

Phase III: Standardization and acceptability of nutraceutical recipes incorporated with selected medicinal plants.

- The mean organoleptic score of medicinal plant extracts incorporated nutraceutic recipes (breakfast/dinner) showed no significant difference in colour, flavor, consistency and appearance in comparison to the standard chapathi, however a significant difference in taste was observed at five percent level ($p<0.01$) of significance

- The mean organoleptic scores of nutraceutical chutneys incorporated with selected *medicinal plants* showed no significant difference for sensory attributes. All the chutneys were highly accepted by the panel members with the mean score greater than 40.

- The mean organoleptic score of nutraceutical kuzhambu's incorporated with selected *medicinal plants* extract showed no significant difference in colour, flavor, taste, consistency, and appearance. All the nutraceutical kuzhambu obtained score ranging between 40 and 43 and hence were highly acceptable.
- Nutraceutical poriyals and kootu's incorporated with selected *medicinal plant* showed no significant difference in mean organoleptic score for colour, flavor, consistency, taste and appearance compared to the standard recipes. All the nutraceutical recipes were highly acceptable with score ranging between 40 and 43.
- The mean organoleptic score of nutraceutical recipes (lunch) incorporated with selected *medicinal plant* extract showed no significant difference in colour, flavor, consistency and appearance in comparison to the standard recipes. All the nutraceutical recipes for lunch were rated as highly acceptable by the panelist in

comparison to the standard recipes with overall score above 40.

- The mean acceptability score of nutraceutical snacks incorporated with selected medicinal plant extract showed no significant difference in colour, flavor, consistency and appearance in comparison to the standard recipes; however a significant difference in texture was observed at one percent level of significance.

Phase IV: Development and evaluation of a software *"Nutra Glyx"* on nutraceutical recipes incorporated with selected medicinal plants

- The ***"Log In"*** and ***"Registration"*** icon on the tool bar of the software ***"Nutra Glyx"*** enables the user to register and view the software. A click on the ***"Registration"*** button will take the user to the registration window.
- The user needs to fill his/her personal details such as the name, e-mail, mobile number and, user type (Home/Dietary department). Since the software was designed for both home maker/health care professional mainly dietician, the user can choose two option under "The user type". Thus a click on the drop down button "user type" enlists two options namely home and dietary department Thus selection of home connects the user to track all the information of the family member he/she wishes to maintain. Similarly selecting the option a "dietary department" enables the health care professional to track the record of their patient. The "***Log In"*** is also password protected and hence the user's should set a password to secure their data. On completion of registration process, the user gets access to view.
- The home page of ***Nutra Glyx*** has six modules. A click on each module will take the user to the respective module namely **Module I: *"Dia-Edu"***, **Module II:** "***Health Tracker"***, **Module III:** "***Herba Treat"***, **Module IV***: "Diet Planner"*, **Module V:**

"Exercise Zone" and **Module VI:** ***"Glossary".***

- The first module ***Dia-Edu*** was set as a home page. The module ***Dia-Edu*** was conceptualized by the investigator to educate the users on the meaning of diabetes, onset of the diseases condition, causes symptoms, types of diabetes and the risk factors for diabetes. Thus ***Dia-Edu*** screen was developed with five Fragment Section(FS), namely, the FS1 ***"Introduction on diabetes"***, FS2 ***"Take a Look"***, FS3 ***"Symptoms"***, FS4 ***"Types of Diabetes"*** and FS5 ***"Know Your Risk"***.
- An introductory note on diabetes is given for the viewers in FS1 ***"Introduction on diabetes"*** to know what diabetes is. A click on the button "***Continue Reading"*** navigates the user to view the entire introductory note for different types of diabetes.
- In the second fragment of *Dia-Edu* : FS2 ***"Take a look"***- a short video was developed by the investigator to educate the viewers on the onset of diabetes. Thus a click on the play button connects the viewer to view the video developed.
- The third fragment section FS3 *"* ***Symptoms"*** of the home page of ***Dia-Edu*** educates the users on the symptoms of diabetes. A click on the button "***Continue reading"*** helps the user to continue their learning on the various symptoms of diabetes.
- The fourth fragment section FS4 ***"The types of diabetes"*** of "**Dia-Edu"** project the definition for various type of diabetes. Two small buttons at the end of the fragment enable the user to slide the screen to view the content on other types of diabetes.
- The fifth fragment section FS5 ***"Know your risk"*** was designed by the investigator to assess the risk of the individual for diabetes.
- Thus a click on each appropriate check box for risk factor listed on the page enable the user to take up the risk assessment. A final click on the "***Review"*** button helps the viewers to assess their level of risk for diabetes. Based on the response, the user's will be assessed as "no risk", "mild risk", "moderate risk" and

"high risk" for diabetes.

Module II ***health tracker*** was designed by the investigator to track the Anthropometric and Bio-chemical parameter of the user.

The ***Sign- in*** *button* at the top enables the user to get access to the tracking modules.

- A click on the ***Sign-In*** button takes the user to the sign- in window. The user should furnish the detail of email and password to gain access. Only the registered user can sign-in and gain access to all the modules of the software. This module was designed with two in-built sub modules namely ***Anthro-tracker*** and ***Bio-Tracker***.
- The "***Anthro-tracker"*** was designed to store and track the anthropometric measurement namely height, weight and BMI for single /multiple user. The "***Anthro-tracker"*** has three text boxes. The user's have to type their name, numerical value of height and weight in respective text box. A click on the *save* button will enable the user to save the entire anthropometric value into a database. Further a click on the "***BMI tracker"*** button takes user to the next screenshot of "***BMI tracker"*** which is structured with three text boxes. The user's will have to enter their name, height and weight to track their BMI.
- A click on the calculate BMI button flashes the BMI value along with their BMI status ***"Search"*** options at the right side of the screen enable the user to track the anthropometric measurement of a particular patient. Also the entire history of the search for a particular user/patient will be automatically displayed. The **EXCEL** and the **PDF** buttons at the left hand side of the screenshot helps the user to export the data in an excel format and store them as a PDF file.
- The module **Bio-tracker** was conceptualized to track the bio chemical parametric of the individual. A click on the button ***"Track"*** on the screen shot of health tracker will navigate the user to the next screen shot of **Bio-tracker.** A click on the ***Result*** button assist the user to find out whether their blood parameter and blood pressure values are

within the normal range or not.The "**Search"** option on the screen shot enables the user to track the bio-chemical values of particular user/patient. It also helps the user to view the entire history of the search on bio chemical parameters for a particular user/patient.

- The module III - "**Herba-Treat"** of the software was developed with four sub menu button namely SB1 ***"Nutra delight",*** SB2 ***"Standard recipes"***, SB3 ***"Ready reckoner"*** and SB4 ***"Recipe chain".***
- The sub menu SB1 ***"Nutra Delight"*** is a compilation of 335 nutraceutical recipes incorporated with five different medicinal plants namely *Guava leaf (Psidium guajava L.)*, Long Pepper (*Piper longum L.)*, Sirukurinjan leaf (*Gymnema sylvestre* R.Br.),Naval Seed (*Syzygium cumini L.)*, Kandankathiri (*Solanum virginianum* L.)**.** Thus, A click on the sub menu button takes the user to the next screen shot of SB1 "***Nutra delight".*** This screen shot was constructed with four drop down menu options.
- A click on the ***Option 1 "Choose Medicinal Plant"*** enables the viewer to view a drop down menu with a list of five medicinal plants. A click on each medicinal plants connect the users to the next utility ***Option 2 "Choose Meal".*** A click on the said option enlist a drop down menu for different meal time namely breakfast, lunch, dinner, snacks and gravy/curry/poriyal. Selecting a particular meal connects the user to the ***Option 3 "Choose Recipe".*** A click on the "***Choose Recipe"*** list out the number of recipes under the selected category. Selecting a particular recipes facilitate the user to view the entire recipes with all information such as ingredients, method of preparation, medicinal plant used, preparation time, portion size, number of serving and equipment used. The screen also provides information on the nutritive value of the selected recipes for both micro and macro nutrients.
- To add scientific validation to the nutraceutical recipes, the bio-active/nutraceutical compounds present in selected medicinal plants is also list along with the recipe format.

- Two tertiary button on the screen "***Get nutritive value***" and " ***Get bio active compound***" assist the user to view only the Nutritive value or Bio active compound of the recipe selected for specific medicinal plant.
- The second sub menu SB2 ***"Standard recipes"*** is a recipe data base that navigates the user to view the compilation of 67 commonly consumed recipes collected and standardized by the investigator. This module enables the user to choose recipes without the incorporation of medicinal plants. Thus a click on the sub menu "***Standard recipes"*** connect the users to the next screen shot of ***Standard recipes*** with built in three drop down menu option.
- A click on ***Option a "Choose meal"*** assist the user to view a drop down menu with the list of different meals namely breakfast, lunch, dinner, snacks and gravy/curry/poriyal. Further a click on each meal connects the users to the subsequent button ***Option b "Choose recipes".***
- A click on **"Choose Recipes"** enlists a number of recipes selected under each category of meal. Further a click on the particular recipes take the viewer to the next screen shot that displays the entire information of the recipe such as ingredients, method of preparation, preparation time, cooking time, portion size, number of serving and equipment used, presented in a well-constructed recipe format. This screen shot also displays the nutritive value of the selected standard recipes for both micro and macro nutrient. A button **"compare"** on the screen shot enables the users to view and compare the nutritive value of nutraceutical recipe incorporated with medicinal plant and the corresponding standard recipe selected.
- A default menu ***"Accompaniment"*** facilitates the users to view a set of accompaniments suggested for the main dishes chosen by the user ***"Get nutritive value"*** button assist the users to view only the nutritive value of the selected recipe.
- The third sub menu *SB3* ***"Ready reckoner"*** of "***Herba treat"*** was planned with the objectives to educate the user on various dietary

guidelines.

- The fourth sub menu SB4 ***"Recipes chain"*** was created with the aim to facilitate the user to add new recipes he/she come across in future. Thus this module gives the scope of adding endless number of recipes into the software.
- A click on the *SB4 "**Recipes chain"*** drop down menu and text box. Each utility option helps the users to add the food type (Veg/Non-Veg) and choose meal (breakfast, lunch, dinner, snacks and gravy/curry/poriyal), choose variation (standard recipes, recipes incorporated with medicinal plants). The text box area given on the right hand side of the screen shot assist the user to type the ingredients and method of preparation.
- The ***"Save"*** button on the screen shot adds the typed recipes to the database of the software. A click on the button ***"Calculate nutritive value"*** facilitate the users to view the nutrient content of the recipes added.
- The module IV "***Diet planner "*** was designed to assist the users in the self-management of diet planning (whole days menu) based on their activity level. Thus a click on diet planner on the menu bar takes the user to the next screen shot with a drop down menu that enlist the different age group of individual as given in the RDA (NIN 2017). A click on a particular age group(eg: men adult, women adult, boy 10-12 years, girl 10-12 years, Boy 13-15 years, girl 13-15 years, boy 16-17 years and girl 16-17 years) connects the user to the next drop down menu that enlist the activity level (Sedentary, Moderate and Heavy activity). Selection of particular activity level showcases the caloric requirement of the individual with suggested possible combination of breakfast, lunch and dinner item along with their accompaniment for the whole day
- Thus the module V ***"Exercise zone"*** expedite the users on the right techniques of doing different types of exercise. A click on the ***"Exercise zone"*** displays three utility sub menus namely Yoga, Exercise and Meditation. A click on the sub menu ***"Yoga"*** takes the

user to a video clip on the different yoga postures for diabetic people. Further a click on the sub menu ***"Exercise"*** displays a sub menu options for "**Walking" and "Running".** Selection of a particular exercise connects the user to their respective video clip on the right way of doing the selected exercise. A click on the sub menu ***"Meditation"*** educate the user on simple meditation techniques in the form of a video instruction.

- The last button VI ***"Glossary"*** on the menu bar educates the user on processing of medicinal plants and simple extraction procedure to be followed at home level.

- All the 20 female type II diabetic subjects rated the authentication of bio-tracker , reliability of the software content ,presentation of the software content, efficacy of a software in self-management of diabetes, usefulness of exercise zone and clarity of videos as very effective.
- Nineteen out of 20 female type II diabetic subjects rated Authentication of nutraceutical component given, usefulness of comparison of nutrient content between nutraceutical recipes and standard recipes and ease in using the software as very effective. Further it was also observed that none of the evaluator rated the software as not effective.
- . All the selected practicing dietitians (10) rated the authentication of BMI-tracker, usefulness of nutraceutical recipes, authentication of nutraceutical component given, usefulness of diet planner, adaptability of the software in home/hospital dietaries, duration of the software programmes, reliability of the software content as very effective. Further it was also observed that none of the evaluator rated the software as not effective**.**

Conclusion

To conclude as we face a double burden of communicable and non-communicable diseases with an alarming rate of diabetes mellitus, a therapeutic management system that ensure a safe, cost effective , eco and human friendly strategy intertwining the knowledge source of traditional system of medicine and technology is the need of the hour. Thus the current study "Efficacy of a software ***"Nutra Glyx"*** on nutraceutical recipes incorporated with selected medicinal plants for diabetes mellitus" has tested and proved the hypoglycemic/ nutraceutical properties of selected medicinal plants namely *Guava leaf (Psidium guajava L.)*, Long Pepper (*Piper longum L.)*, Sirukurinjan leaf (*Gymnema sylvestre* (Retz.) R.Br.), Naval Seed (*Syzygium cumini L.)*, and Kandankathiri (*Solanum virginianum* L.) on selected female type II diabetic subjects at 1% level of significance. The analysis of nutrient content of the above selected medicinal plants carried out in the present study throws light on their nutritional benefits. The developed software "**Nutra Glyx"** adds a new dimension in the dietary management and self-care management of diabetes mellitus. The User friendly software can serve as an efficient tool to monitor, track ,plan and recommend healthy diet plans at home and dietary departments by the home makers/ dietitians.