1. INTRODUCTION

Mankind and its very existence revolve around a single criterion “Good Health" WHO defines health as complete wellbeing of physical, mental, social and emotional quotient and not just the mere absence of disease. As the globe witnesses a sea change in the environment, food culture, lifestyle and economic reform, survival of mankind becomes a complex process.

Pre-mature deaths and increase in the average life span of human beings with no or minimum morbidity remains as a major challenge to mankind.

Addressing the health challenges is crucial to any nation as it has a direct impact on the economy and developmental activities. In short health and well-being of a citizen decides the economic power of a nation.

Countries in the transitional stage of development like India are merely burdened by multidimensional factors such as poverty and prosperity, life style modification, westernization, dietary transition and environmental population. As a result, escalation in the incidence of communicable and non-communicable diseases such as obesity, cardiovascular diseases, cancer renal and diabetes mellitus is witnessed every year. In fact, the prevalence of these diseases has reached an alarming proportion over the last few decades.

World Health Organization (WHO report, 2017) claims that around 40 million people are killed by non-communicable diseases globally with an alarming incidence observed in the younger population, especially young urban men and women.

A lifestyle with lack of physical activity often referred to an as sedentary lifestyle, is one of the leading causes of preventable mortality worldwide including India. Such type of physiologically-stressed lifestyle results in increased levels of risk for diseases, like hypertension (high blood pressure), dyslipidemia (abnormal amount of lipids mainly cholesterol or fats in the blood), diabetes (high blood glucose), respiratory diseases, and obesity (abnormal or excessive body fat accumulation) (Boutayeb *et al.,* 2013).

Diabetes is one of the most crucial health concerns of any nation across the globe and with more than 62 million Indians diagnosed for diabetics, the prevalence of diabetes is predicted to double globally from 171 million in 2000 to 366 million in 2030 with a maximum increase in India. India leads the world with the largest number of diabetic subjects earning the dubious distinction. It is predicted that by 2030 diabetes mellitus may afflict up to 79.4 million individuals in India. This equates to approximately three new cases every ten seconds or almost ten million per year. International diabetes federation also estimates that as many as 183 million people are unaware that they have diabetes (International Diabetes Federation, 2017).

A study conducted by INDIAB (2016), supported by the Indian Council of Medical Research indicated a prevalence of about 42 lakhs individuals with diabetes and 30 lakhs people with pre-diabetes. According to the study report, Coimbatore alone houses 2.8 lakh of diabetic individual and 3.2 lakh of pre-diabetic subjects.

According to the National Family Health Survey (NFHS-3), 15% of women in India are either obese or overweight. Obese diabetic patients have 13.5 % more chances of developing diabetic complications compared to non –obese diabetic patients.

Since diabetes mellitus pre-disposes to multiple degenerative complications, treatment and management of the disease also warrant multiple dimensions. Diabetes mellitus is thus treated world-wide through the different set of therapeutic practices starting from Ayurveda, Siddha, Homeopathy, Unani and Naturopathy to Nutraceutical.

As the whole globe walk through the era of digitalization, indigenous systems of medicine with the use of the meter medicinal plant is slowly proving to be a replacement for pharmacological drugs/medicine. Medicinal plants are cheaper, accessible and readily available and are safe due to fewer side effects compared to the pharmacological drugs. The golden fact is that the use of medicinal plants in treatment is independent of any age group and sex.

Since time immemorial, in search of rescue for their disease, people looked for drugs in nature. The traditional use of medicinal plants has led to the discovery of new potent botanical agents in the treatment of several diseases. Around 7000 natural compounds are currently used in modern medicine; most of these had been used for centuries by traditional healers. In spite of the development of pharmacological agents for the treatment of chronic diseases, the use of medicinal plants continues to flourish.

Medicinal plants are thus the boon to the mankind from mother earth for they possess millions of healing solutions to a disease. Therefore, the use of herbal medicines is still continued in modern society for the prevention, wellbeing and treatment of diabetes. Medicinal use of herbal medicine in the treatment and prevention of diseases including diabetes has a long history compared to conventional medicine. The therapeutic benefits of indigenous medicinal plants in the treatment and management of diabetes mellitus can be traced back to bygone times of India, the traditional medical system such as Ayurveda, Siddha and Unani.

Even today, in spite of a mammoth growth in the pharmacological industries, concoction and churanas of the herbal mixture, dissolved plant concentrates (or) extracts of bioactive components, isolation of phytochemical, alkaloids and phenolic compounds finds its pace in primary healthcare and at household level for treating various disease conditions. Since ages, the medicinal plants are highly used as a natural source of medication to restore and maintain good health and wellness due to the presence of the therapeutic/ healing compound that is chemically and biological active (Shakya, 2016).

As righty claimed by Oladej and Agbelusi (2018) two third of word population rely on medicinal plants for ailments such as diabetes mellitus, cardiovascular diseases, hypertension and obesity due to their hypoglycemic, anti-inflammatory and hypolipidemic properties.

The Indian system of medicine, the Ayurveda, in particular, has used several medicinal plants as potential hypoglycemic agents. According to

WHO (2009), medicinal plants are the ones that possess biological compound which helps in the synthesis of metabolites to bring positive therapeutic change when used in the formulation of drugs.

Each metabolite have phytochemicals such as tannins, flavonoids and alkaloid that are proven for their antimicrobial activities and hence are used in the treatment of communicable diseases. The anti-inflammatory properties of some of the bioactive components such as tannins, glucosides, gymnemic acids, tartaric acids, flavonoids and saponins are used in the management of disease like inflammatory bowel syndrome and any other inflammation in mucosal layer (Ramya, *et al*., 2012). They are thus believed to heal and treat wounds. The hypolipidemic properties of tannins, glucosides, flavonoids, saponins and anthocyanin are helpful in preventing cardiovascular diseases and obesity. Similarly the bioactive/nutraceutical compounds derived from medicinal plants have a prominent role in the metabolism of carbohydrate and hence they are recently explored for their hypoglycemic effect and prevention of diabetes. Bioactive compounds such as tannin, phlobatannins, saponin, flavonoids, steroids, terpenoids, triterpenoids, polyphenol and glycosides are significantly proved for their hypoglycemic effect (John, 2014).

These neutraceuticals help in combating some of the major health problems of the century such as obesity, cardiovascular diseases, cancer, osteoporosis, arthritis, diabetes, cholesterol, etc. Nutraceutical can be defined as a plant food/ any part of the plant/food that has the potential to cure or prevent diseases and promote health and wellbeing in humans. Nutraceutical is superior to dietary supplement as they not only supplement the diet with nutrients but also aid in the prevention and treatment of diseases. In short nutraceutical are conventional foods that are used as a prominent item in a meal or a diet.

As rightly pointed out by Chatterjee et al., (2016), essential nutrients can be considered nutraceutical if they provide benefits beyond their essential role in normal growth or maintenance of the human body. According to Santhi *et al*. (2016), nutraceutical is any purified or isolated food products that have medicinal property. She also claims that ethnomedicine, which refers to the study of traditional medical practice, is an integral part of the culture and the

interpretation of health by indigenous populations in many parts of the world. For example, Indian Ayurveda and traditional Chinese medicine are among the most enduring folk medicines still practiced. These systems try to promote health and improve the quality of life, with therapies based on the use of indigenous drugs of natural origin.

Therefore when a recipe is being cooked or prepared using "scientific intelligence" with or without knowledge of how or why it is being used, the food is called "nutraceutical recipes". Nutraceutical foods/recipes resemble conventional foods in appearance, taste, texture, and quality. The former being consumed as part of the normal diet. However, these foods have demonstrated physiological benefits and can reduce the risk of chronic disease beyond essential nutritional functions, including maintenance of gut health.

Recently medicinal plants derived neutraceuticals / therapeutic foods have gained considerable prominence as they are safe to consume and have curative properties. Since the majority of nutraceuticals are multidimensional in use due to their innumerable therapeutic value, the plant biotechnologist and healthcare professional like dietitian/nutritionist have started to explore this natural resource to enhance the dietary values of fruits, vegetable, cereals, spices and condiments.

It is generally accepted that food can have health-promoting properties that go beyond its traditional nutritional value. Bioactive compounds present in food greatly influence the physiological or cellular activities in the animals or humans when consumed. For example, flavonoids, vitamins, and carotenoids are bioactive compounds found in medicinal plants that act as anti-oxidants, anti-inflammatory, anti-carcinogenic and protective agents against metabolic syndromes such as diabetes and coronary diseases. Recently, much attention has been given to bioactive food components that may be beneficial for the prevention of diabetes.

Scientific studies clearly establishes a significant relationship between the presence of primary and secondary metabolites present in medicinal plants such as tannins, alkaloids, flavanoids, terpenoids and their functional/nutraceutical properties. Food or any component of the food that heals

and restores the normal physiological function of the human organ are called as a nutraceutical. Dietary fibers, antioxidants, phenolic compounds, fatty acid (poly unsaturated) are some of the common nutraceutical products. It is well-accepted fact that since ages besides food, medicinal plants are the major source of nutraceutical product as they are loaded with numerous bioactive compound that has healing power.

Many medicinal plants like Avaram (*Cassia auriculata),* Kadukkai *(Terminalia Chebula), ,* Amla (*Emblica Officinalis*)*, Guava leaf (Psidium guajava L.), syzygium cumini (*Naval seed)*, Andrographis Paniculata (Nilavembu),* Sirukurinjan leaf (*Gymnema Sylvestre* (Retz.) R.Br.)*,* Chittaratta *(Alpinia Galanga*)*,* Kandankathiri (*Solanum virginianum* L.)*,* Long Pepper (*Piper longum L.)* are recently explore for nutraceutical benefit as they are anti-diabetic, anti-inflammatory and anti-oxidative.

Guava leaf (Psidium guajava L.), is an important food crop and medicinal plant that grows in many countries of tropical and subtropical regions of the world. The leaves of the Guava tree is widely used in folk medicine around the world. The phytochemicals such as tannins alkaloids, steroid, glycosides, flavanoids, saponins and anthracenosides are reported to have the hypoglycemic, hypolipidemic and anti-oxidant effect (John, 2014). Also, other bioactive compounds such as quercetin, catechin, vescalagin, gallic acid, peltatoside, hyperoside, isoquercitrin, and guaijaverin have been credited with regulating blood glucose level (Dia-z-de-cerio, *et al*., 2017).

The tribal folk medicine widely use Long Pepper (*Piper longum L.)* to cure diabetes, excess weight gain and diseases of gastro intestine. The presence of steroids, alkaloids, glucosids, arbutin and saponins present in Long Pepper (*Piper longum L.)* acts as antidiabetic and antilipidemic agents. A study conducted by Nabi (2013), confirms the hypoglycemic effect on *Piper Longum Linn* in the management of diabetes and hepatic diseases. However, the active principles responsible for the hypoglycemic effects need further investigations.

The leaves of Sirukurinjan (*Gymnema Sylvestre R.Br*) is yet another medicinal plant that is recently explored for its blood lowering effects. The presence of gymnemic acid in this leaves is reported to have hypoglycemic

properties. According to evidence-based studies, the molecular structure of gymnemic acid is similar to that of glucose and hence it prevents the uptake of glucose into the cell and their by helps in the maintenance of healthy blood glucose levels.

Naval seed (*Syzygium cumini L.)* a common traditional medicinal plant is explored widely by the scientific community for its hypoglycemic and antibacterial properties. Though the seeds of *Syzygium cumini L.* is used in traditional medicine, their active role in the therapeutic properties demands more analytical studies. Presence of maleic acid, oxalic acid, gallic acid, tannins, cyanidin glycoside, oleanolic acid, flavonoids, essential oils, betulinic acid, friedelin have been reported for antianaemic, gingivitis, antidiarrhoeal, antipyretic, antibacterial, antineoplastic, anti-inflammatory, hypoglycemic, gastroprotective and hypolipidemic properties (Ramya, 2012).

The fruits of Kandankathiri (*Solanum virginianum* L.) is considered as a valuable medicinal product by traditional healers in the treatment of many common diseases in other parts of India. In Ayurveda, medicinal use of Kandankathiri (*Solanum virginianum* L.) is well documented. Phyto constituents present in Kandankathiri (*Solanum virginianum* L.) are used as anti-fertility, anti-inflammatory, anti-allergic agents and anti-diabetic agents (Shashan, 2014). Kandankathiri (*Solanum virginianum* L.) contains alkaloids, phenolics, flavanoids, steroid, saponins and has a wide range of medicinal values (Poongothai *et al*., 2011).

Diet plays a significant role in the maintenance of blood sugar levels in persons who are obese or who have pre-diabetes and diabetes symptoms. Healthy lifestyle and high intake of nutritious food can provide good health throughout the life of humans. A range of interventions both directed at individuals and society with an immediate and long term time horizon are necessary.

As we march towards the digital era**,** digital technology has become an integral part of life, healthcare professionals are now using it to educate and motivate diabetic patients in addition to conventional treatment strategies. Thus programmed digital information tools and software's aid diabetic patients to self-

monitor their blood parameter (blood glucose level) workout pattern, dietary habits and medications to lead a healthy life.

Caralise (2015), opines that enhancement of technological assisted intervention to diabetic patients for self-management can open up new avenues for innovative diabetic management strategies.

Educative information coupled with interactive instructional materials in the form of software's, database and mobile application can create and sustain the interest of the patient. This will, in turn, bring positive change in the behavior of diabetic patient and promote self-management diabetic care in individuals. Also, software/mobile apps also serve as an essential tracking tool for healthcare professionals.

Based on the observation made by Minet (2010) facilitation of self-management behavior for diabetic care strengthens personal competency of individual and build positive hope to monitor and control the disease.

Therefore software solutions and other digital interventional strategies developed by the dietitian/nutritionist and healthcare professional should concentrate more on medical, dietary, health and life style challenges of the diabetic along with disease management. The above approach can bring down diabetes-related complication.

Thus the development of user-friendly innovative technology assisted dietary management system to educate the society in the prevention and treatment of diabetes mellitus will create a new dimension in patient care. Therefore integrating information technology and science of dietary management upholding on traditional therapeutic resources, particularly the nutraceutical properties of 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 a humble effort by the investigator to add value addition in the dynamic of dietary management for diabetes mellitus.

Objectives

The primary objective of this study is to test the efficacy of a software **"*Nutra Glyx*"** on nutraceutical recipes incorporated with the selected medicinal plant for diabetes mellitus.

The secondary objectives

The secondary objectives of the study are to

- Undertake a baseline survey on female type II diabetics
- Select medicinal plants with nutraceutical properties for hypoglycemic effect
- Test the hypoglycemic effect of selected medicinal plants
- Standardize and study the acceptability of nutraceutical recipes incorporated with selected medicinal plants and
- To design and evaluate the efficacy of the software **"*Nutra Glyx*"** on nutraceutical recipes incorporated with selected medicinal plants for diabetes mellitus.