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Review Article

A CRITICAL REVIEW ON NUTRACEUTICALS IN *MADHUMEHA* (DIABETES)

Bandari Srinivasulu[1*], Goli Penchala Prasad[2], Ala Narayana[3]

[*1]Lecturer, Dept. of Rasashastra, Kunwar Shekhar Vijendra Ayurved Medical College & Research Centre, Gangoh, Saharanpur, U.P., India.

[2]Research officer (Ayu.) Scientist-3, National Ayurveda Research Institute for Vector Borne Diseases, Vijayawada, A.P., India.

[3]Director, National Institute of Indian Medical Heritage, Survey No.314, Revenue Board Colony, Gaddiannaram, Hyderabad, Andhra Pradesh, India.

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ABSTRACT

Diabetes mellitus is a well-known clinical syndrome since antiquity. *Ayurveda* mainly focuses on the role of diet in *Prameha* and *Madhumeha*, which is akin to Diabetes. Nutraceuticals are food or food products that provide health and medical benefits, including the prevention and treatment of disease. Traditional Indian diets are functional and used both as food and medicine. Although in recent scientific studies these diets are evaluated for rich source of dietary fiber (whole grains and vegetables), antioxidants and other active principles suitable for diabetes. Primarily, they have been selected and used based on fundamental principles of *Ayurveda*, such as their *Rasa*, *Guna*, *Virya*, *Vipaka*, *Prabhava,* and so on. Reviewing the characteristic properties along with important antidiabetic properties of conventional system of medicine, accentuates the role of these diets in Diabetes. The correlation further emphasizes the way to include or to evaluate more Nutraceuticals for the benefit of Diabetic population.

Diabetes is a complex disease with multiple variations. Nutraceuticals too have variant properties and belong to various dietetic groups, such as *Kodrava* (grain variety: *Paspolum scrobiculatum* Linn.), *Adhaki* (red gram: *Cajamus indicus* Spreng.), *Yava* (Barley: *Hordeum vulgare* Linn.), *Mudga* (green gram: *Phaseolus radiatus* Linn.), *Kuluttha* (horse gram: *Dolichos biflorus* Linn.), *Amalaki* (Indian goose berry: *Emblica officinalis* Gaertn.), *Meti* (fenugreek: *Trigonella foenum-graecum* Linn.), *Karavellaka* (bitter gourd: *Momordica charantia* Linn.), *Jambu* (java plum: *Syzygium cumini* (Linn.) Skeels.), *Navapatola* (young: *Tricosanthes dioica* Roxb.), *Matsyakshi* (*Alternanthera sessiles* Linn.) R. Br. etc.

KEY WORDS: Cereals, Pulses, Prameha, Madhumeha, Diabetes, Nutraceuticals.

INTRODUCTION

Madhumeha can be taken as Diabetes mellitus of modern science. In some contexts the word *Prameha* has also been used as synonym to *Madhumeha* and vice versa. According to the Diabetes Atlas 2006 published by the International Diabetes Federation, the number of people with diabetes in India was 40.9 million (which was 32 million in 2000) is expected to rise to 69.9 million by 2025 unless urgent preventive steps are taken.[1] As per WHO statistics in India, Diabetic population is increasing rapidly. Research in India suggests that, though earlier Indians were least prone to Diabetes, now they are more prone than any other population in the world. Studies in India proved that average life expectancy in Diabetics is just 8 years. Indians are getting diabetes on an average around 10 years earlier and in migrated Indians these incidences are 4 times higher. The main reasons are improvement in living conditions, increasingly following western dietary habits, which are unsuited to our environment.[2] This alarming condition can also be seen in many developing countries. This stresses the role of diet in etiology, prevention, and treatment of Diabetes.

The concept of nutraceuticals (A nutrient or food believed to have health-promoting or disease-preventing properties) was followed in Ancient classics, religiously. It is quoted that food sustains the life of living beings. Complexion, clarity, good voice, longevity, geniuses, happiness, satisfaction, nourishment, strength, and intellect are said to be conditioned by food.[3] Direct relation of food with diseases is well explained by the concept of *Pathyahara* (wholesome diets) and *Apathyahara* (unwholesome diets). Based on dose, season, method of preparation, habitat, combination, and so on, the diets that are wholesome to the body/channels of the body (*srotas*), which are also pleasing to the mind are considered *Pathyahara* and opposite to those are *Apathyahara.*[3] These *Pathyahara* are specially indicated in certain diseases as nutraceuticals to promote health or cure diseases. Diabetes being a *Yapyavyadhi* (maintainable disease), these *Pathyahara* also help in maintaining the normalcy and in preventing complications.

Role of diet in diabetes-susceptible persons

Death immediately comes in the form of *Prameha* (Diabetes) to those who are less enthusiastic, over -corpulent, over-unctuous, and gluttons.[4]

Role of diet in the prevention of diabetes

The persons who take the diet and do the activities, which are beneficial to all *Dhatus*, will never suffer from Diabetes (*Prameha*).[4]

It can be presumed that, Diabetes is mainly caused by heavy food, which increases *Kapha*, *Medas*, and others. But also emphasized that, excessive starvation or intake of dry substances will also cause another variety of *Prameha* (Diabetes). Thus it recommends wholesome diet suitable to all *Dhatus* (tissues of the body).

As the birds are attracted by their nests on the tree, in the same way the person who eats more, unhygienic, and lazy are attracted (prone to) by diabetes.[4]

Vata, *Pitta*, and *Kapha dosha* are 3 morbid factors and among these 3, *Kapha* having liquidity in excess is the main *Dosha* (*bahudravah shleshmah doshavisheshah*). *Medas* (adipose tissue), *Rakta* (blood), *Shukra (semen)*, *Ambu (body fluid)*, *Vasa (muscle fat)*, *Lasika (lymph)*, *Majja (bone marrow)*, *Rasa (plasma)*, *Ojus (vital substance in the body*, *responsible for body immunity)*, *Mamsa (muscular tissue)* are considered as vitiated tissue elements *(Dushya) and Mutravaha and Medovaha srotas (channels) are the basic seat or location of the disease.*[4-6]

The dietary causes of Diabetes

Prameha originate to human beings after taking *Havisha,* a special rich food made from milk, sugar, and rice offered in *Yajna* (oblation/sacrifice) of *Dakshaprajapati* (a deity of Hindu mythology).[4] This indicates that taking heavy foods similar to *Havisha* can cause Diabetes.

The etiology of Diabetes, many diets were mentioned, namely, excessive use of curds, flesh of animals of domestic, aquatic and marshy places, use of milk and milk preparations, new water (water of rivers and tanks during rains and floods), new grains, puddings made of jaggery/sugar, and using more similar factors, which increase *Kapha Dosha* (these factors may be considered as heavy diets/fatty foods, which increase body weight, cholesterol, and cause obesity, etc).[5]

Many researches proved that Diabetes is increasing day by day due to change of dietary habits. In India and other developing countries, it is specifically considered due to excessive intake of fats and heavy items. Now researches support the slogan of "No oils, No fats, No food fads" for the prevention of Diabetes.[2] Recent studies suggest that milk protein have the strongest Diabetogenic effect. If cow or buffalo milk is introduced before the age of 2–3 months is specifically associated with the presence of antibodies to bovine serum albumin and increase the risk of insulin-dependent diabetes mellitus. Researchers measured the levels of anti-BSA (bovine serum albumin) and anti-ABBOS (specific part of the albumin protein) antibodies in the serum of these children. Antibodies that react to the ABBOS also react with a beta cell surface protein that may represent a target for autoimmune attack and ultimately causing insulin-dependent diabetes mellitus.[51]

In some cases bovine serum albumin may cross-react with a protein (P.69), which can be induced on pancreatic islet beta-cell membrane by the inflammatory mediator interferon-gamma. This study also supports the etiologic concepts that, excessive usage of milk and milk products may cause Diabetes.

The above dietary causes, the foods and drinks that increase *Medas* (adipose tissue) and *Mutra* (urine), and diets that are sweet, sour, salty, fatty, not easily digestible, slimy, cold, and drinks,

such as beer and molasses are also considered as the causative factors.[3,7] Latest research revealed that to prevent Diabetes one should avoid foods that cause rise in blood sugar levels. It has also been proved that people who store fats primarily in their bellies with high blood triglycerides and low levels of good cholesterol (high-density lipoprotein) should eat diet that restricts bakery products, fruit juices, and sugar added foods to prevent Diabetes[50].

Excessive intake of *Ruksha ahara* (dry foods), *Laghu ahara* (light food), excessive use of pungent, bitter, cool items, excessive fasting, etc, increases *Vata* (a type of body humor) and causes *Madhumeha* (Diabetes).[4] WHO identified one particular type of Diabetes as Malnutrition-Related Diabetes Mellitus, which is common in India. Most of lean and thin young adults between 15 and 35 years age are affected with Diabetes, which is often reported in Kerala and Orissa states. This type can be correlated to *Krsha Pramehi*. Thus suggests wholesome diet that is beneficial to all *Dhatus* (body tissues).

Contraindicated diet (*Apathya*)

Alcohols such as *Sauviraka*, Sh*ukta*, *Maireya*, and *Sura*, milk, oil, ghee, sugarcane juice or sugar, jaggery, alkaline, curd, grain cakes, sour substances, sour drinks, sweet drinks, and meats of domestic, aquatic, and swamp animals are contraindicated. [8, 9]

Researches proved that simple carbohydrates are broken down easily and increases blood glucose levels fast. Hence simple sugars such as table sugar, honey, candy, jam, cakes and pastries, and so on, are contraindicated and complex carbohydrates such as cereals, vegetables, and bread, are recommended as at least to 50% of Diabetic diet.

Recommended diet (*Pathya*)

Old cereals such as *Shali* rice and *Ṣashtika* rice, *barley*, *wheat*, *Shyamaka* (*Echinochoa frumentacea* Linn.), *Kodrava* (Kodo millet: *Paspalum scrobiculatum* Linn.) and wild *Kodrava* (wild Kodo millet), preparations of bengal gram, pigeon pea, horse gram, and green gram; vegetables of bitter and astringent groups cooked with oil of danti (*Baliospermum montanum* Muell.), *ingudi* (*Balanites aegyptiaca* Linn.), *sarshapa* (mustard) and *Atasi* (*Linum usitatissimum* Linn.)*;* anti-diuretic and fatless meat of wild animals are *pathya* (beneficial) for *prameha* patients*.* Among spices *Marica* (pepper) and *Zingiber officinale* Roscoe. and in salts *Saindava lavana* (rock salt) is considered beneficial.[8,9]

Various nutraceuticals and their role in Diabetes

Cereals

Rice: Rice is known as the grain of life, and is synonymous of food for Asians. Although rice is rich in carbohydrates. The medicinal value of various types of rice, such as *Ṣashtika shali*, *Rakta shali*, and parched rice have been documented in *Caraka Samhita* (c. 700 BC) and *Sushruta Samhita* (c. 400 BC), in the treatment of various ailments. The famous *Nivara* rice of Kerala is widely used in the practice as a body enriching item, to exclude toxins and to delay premature aging. Colored rice (black and red) are rich in minerals (iron and zinc) and polyphenols and have antioxidant properties. Traditional varieties such as *Basmati* have a low glycemic index and are useful in weight-reducing diets. Being habituated to rice, which is rich in carbohydrates, among diabetics use of old rice is preferred than new rice. In comparison, old rice has low caloric value and absorbs more water on boiling and forms more quantity and gives a feel of fullness. *Ṣashtika shali* is summer rice maturing in 60 days. It is low caloric rice useful to diabetics.

Rakta shali and *Ṣashtika shali* pacifies the vitiated *Tridosha*, and thus useful in Diabetics. One year or more old rice are considered *Laghu* (light) and beneficial in Diabetes in comparison with new rice. [10]

Wheat: Wheat is also a highly consumable variety of food in India. It is recommends inclusion of wheat in Diabetic diet,[10] is more preferable in the form of whole wheat atta, which contains 2% of fiber.

Yava (Barley *Hordeum vulgare* L.)

Yava (Barley), which is high in fiber content (4 g in 100 g) among all relative grains, is highly recommended in Diabetic diet in different forms. *Ruksha* (dry) and *Kaphashamak* (pacifies vitiated *Kapha*) properties of *Yava* support its role on Diabetes. Use of the mixture of whole atta of barley and wheat is considered *Kaphashamak* and is recommended for diabetics.[10] Many recent researches also proved its efficacy in diabetes. In a study conducted on 18 healthy volunteers and 14 patients having non–insulin-dependent diabetes mellitus (NIDDM), use of barley, in NIDDM subjects with a low glycemic index (68.7 in

healthy and 53.4 in NIDDM subjects) and a high insulinemic index (105.2), was proved to mobilize insulin in NIDDM. Hence, found especially suitable cereal for diabetes mellitus. [11]

In another study on adult diabetic rats with a diet containing barley had a modulating effect on the symptoms of diabetes. It was presumed that the beneficial effect of barley might be by its very high content of chromium (5.69 µg/g).[12]

***Kodrava* (*Paspolum scrobiculatum* Linn.)**

This was considered as poor men diet in ancient times in India and mainly used by tribes and people with less water sources. It is having *Laghu* (light), *Ruksha* (dry), *Vatavardhak* (increases *Vata*), *Kaphapitta shamak* (pacifies vitiated *Kapha* and *Pitta*). The wild variety of *Kodrava* is considered hotter in potency. Based on its properties it is mainly indicated in *Prameha* (Diabetes), *Medoroga* (obesity), *Vatavardhak* and is more suitable in obese diabetics. Immature and new *Kodrava* are considered poisonous while matured and old *Kodrava* are only indicated as diet.[10] Research proved its antidiabetic property at experimental levels. Aqueous and ethanolic extracts (250 and 500 mg/kg body weight) administered orally to male Alloxan monohydrate-induced diabetic Wistar albino rats showed reduction of fasting blood glucose levels within 60 min of administration. The extracts produced a dose-dependent fall in fasting blood glucose (FBG). After 15 days of treatment with extracts the maximum reduction in FBG (35.14%) was observed in diabetic rats treated with ethanolic extract 500 mg/kg dose. A significant increase in serum insulin level was also observed in the treated rats. Serum lipid levels were reversed towards normal and a control in the loss of body weight was observed in treated rats as compared with diabetic control. The extract treatment also showed a significant increase in the liver glycogen and a significant decrease in glycated hemoglobin levels, suggesting *Paspalum scrobiculatum* significant antidiabetic activity.[13]

***Nartaka* (Finger millet*: Eleusine coracana* L. Gaerth.)**

Finger millet is extensively cultivated and consumed in India. It is one of the Indian staple foods used as whole grain powder in different Indian food preparations. Although *Nartaka* was not mentioned in *Samhitas,* later in *Shaligrama nighantu mentioned* as a light, *Tridoshahara* (pacifying nature of vitiated 3 body humors), and as a blood purifier.[14] These properties are suitable to use in all types of *Prameha*, including *Madhumeha*. Its seed coat is a rich source of dietary fiber (3.7gm%) and phenolic compounds and calcium (344 mg/100gm), iron (6%), and thiamin, riboflavin, and niacin. Since this cereal is having high dietary fiber it reduces the requirement of insulin to the cell in the process of carbohydrate metabolism. The effect of feeding a diet containing 20% finger millet seed coat matter (SCM) was examined in streptozotocin (STZ)-induced diabetic rats. Diabetic rats maintained on the millet SCM diet (diabetic experimental (DE) group) for 6 weeks exhibited a lesser degree of fasting hyperglycemia and partial reversal of abnormalities in serum albumin, urea, and creatinine compared with the diabetic control (DC) group. Total study supports hypoglycemic, hypocholesterolemic, nephroprotective, and anticataractogenic properties of finger millet, suggesting its utility as a functional ingredient in diets for diabetics. In another study, consumption of finger millet–based diets resulted in significantly lowering plasma glucose levels due to the higher fiber content of finger millet compared with rice and wheat. The lower glycemic response of whole finger millet–based diets has been attributed to the presence of anti-nutritional factors in whole finger millet flour, which are known to reduce starch digestibility and absorption.[15]

Pulses

***Adhaki* (red gram: *Cajanus cajan* (Linn.) Millsp.)**

Adhaki is not directly indicated in Diabetes. *Bhavaprakasha nighantu* mentioned as *Pittakapharaktashamaka* (pacifying nature of vitiated *pitta*, *kapha*, and blood),[16] considered as antiobese, *Vatajanana* (increases *Vata*) property it is more suitable in obese diabetics.[10] Traditionally red gram is used in Indian subcontinent as the main pulse for preparation of soups. Using this as full grain is recommended to diabetics. It contains 1.5% fiber and in research and also proved useful in diabetics. In a study conducted at AIIMS pharmacology department proved hypoglycemic and antihyperglycemic activity.[17]

***Kuluttha* (horse gram: *Dolichos biflorus* Linn.)**

Kuluttha a prescribed diet for diabetics and used as one of the ingredients of *Dhanvantari*

ghrta and is used in Diabetic boils and abscess.[8] It is considered *Kaphavatashamak* (pacifies vitiated *Kapha* and *Vata*), hot in potency and acts as *Pittavardhak* (increases *Pitta*). Based on these properties it is mainly indicated in *Kapha* and *Vata* varieties of *Prameha* (Diabetes) and *Medoroga* (obesity).[10] It will be helpful in Diabetic nephropathy in various studies and its hypolipidemic effect also supports its indication in diabetes. In high-fat diet–fed rats, methanolic extract of *D. biflorus* was proved to possess hypolipidemic activity.[18]

***Mudga* (green gram: *Vigna radiata* Linn./*Phaseolus radiatus* Linn.)**

Mudga is commonly used in the Indian subcontinent. It produces least flatulence in comparison to other pulses. *Mudga* is considered *Laghu* (light), *Ruksha* (dry), *Kaphapittashamak* (pacifies vitiated *Kapha* and *Pitta*). Hence, whole pulse and as *Mudgamalaka* (a combination of green gram and Indian gooseberry (*Emblica officinalis* Gaertn.) is indicated in *Prameha* (Diabetes).[10] Whole pulse is rich in diet fiber (4.1 g), B-complex, Proteins and vitamin C. The soup of this pulse is advised as congenial in many of the disease conditions, including Diabetes. This pulse is having Glycemic index less than 55%.

Oils

The recommended oils for diabetics are *Nikumba* (*danti: Baliospermum montanum* Muell.), *ingudi* (*Balanites aegyptiaca* Linn.), *sarshapa* (mustard), and *Atasi* (*Linum usitatissimum* Linn.). These oils are pungent in nature and low quantities of these oils are sufficient in cooking to give desired taste and flavor. Among them *Nikumba*, *Ingudi*, and *Atasi* (*Linum usitatisimum* Linn.) oils are not commercially used, and moreover these are not available elsewhere.

Atasi oil is *Vatashamak* (pacifies vitiated *Vata*), vitiates *Kapha*, and considered hot in potency and mainly indicated in *Vataja* type of *Prameha*, including *Madhumeha*.[10] *Atasi* (*Linum usitatisimum* Linn.) oil is well known for its rich sources of the essential fatty acid alpha-linolenic acid, which is a biologic precursor to omega-3 fatty acids, such as eicosapentaenoic acid. Although omega-3 fatty acids have been associated with improved cardiovascular outcomes, evidence from human trials is yet to be decided regarding the efficacy of flaxseed products for coronary artery disease or hyperlipidemia. Further research on these oils is needed to use these oils and to fix particular doses for diabetics or for common use.[19]

Recent research proved that there has been an alarming increase in the prevalence of diabetes and heart diseases in Indians. Earlier traditional cooking fats were condemned to be atherogenic and replaced with refined vegetable oils presuming as "heart-friendly oils" because of their polyunsaturated fatty acid (PUFA) content. Unfortunately this has not been able to curtail the increasing incidences of Diabetes and Heart diseases. The current data on dietary fats indicate that it is not just the presence of PUFA but the type of PUFA that is important. A high PUFA n-6 content and high n-6/n-3 ratio in dietary fats are considered more being atherogenic and diabetogenic. The newer "heart-friendly" oils, such as sunflower or safflower oils possess this undesirable PUFA content and there are numerous research data now available to indicate that the sole use or excess intake of these newer vegetable oils are actually detrimental to health and switching to a combination of different types of fats, including the traditional cooking fats, such as ghee, coconut oil, sesame oil, and mustard oil, would actually reduce the risk of dyslipidemias, AHD, and type-2 DM.[20]

Vegetables

Among vegetables *Navapatola* (young *Tricosanthus dioica* Roxb.), *Tanduliyaka* (Choulayee-*Amaranthus spinosus* Linn.), *Vastukam* (Bathuva-(Hindi) *Chakravarti kura* (Telugu)/*Chenopodium album* Linn., *Matsyaksh*i (*Ponnaganti kura* (Telugu) (*Alternanthera sessiles* (Linn.) R.Br.) all bitter vegetables (*Tikta sakam*), such as *Methica* (*Methi*: leaves of fenugreek (*Trigonella foenum-graecum* Linn.), *Karavellaka* (bitter gourd: *Momordica charantia* Linn.), and others are recommended.

Navapatola is *Laghu*, *Dipan* (appetizer), *Pacan* (digestive) and pacifies the vitiated *Tridosha.* Hence, it is wholesome in diabetics.[10] On experimental studies on rats aqueous extract of *Tricosanthus dioica* Roxb. was proved for its antihyperglycemic action.[21] In another study antioxidant potential of aqueous extract of *Tricosanthus dioica* Roxb. fruits on diabetes-induced oxidative stress of diabetic rats was proved most effective.[22]

Tanduliyaka is *Laghu*, *Ruksha* (dry), *Kaphapittashamak* (pacifies vitiated *Kapha* and *Pitta*) and *Vishaghna* (antipoisonous).[10] Methanolic extract of the stem of *A. spinosus* Linn.

showed significant antidiabetic, antihyperlipidemic effects on STZ-induced diabetic rats.[23]

Vastukam is *Laghu*, *Dipan* (appetizer), *Pacan* (digestive) and pacifies the vitiated *Tridosha.*[10] In India the leaves and young shoots of *Chenopodium album* Linn. are used in dishes, such as Sarson Da Saag, soups, curries, and in *Paratha* (stuffed breads), These are popular in Punjab. It contains 4% fiber, calcium, iron, potassium, magnesium, phosphorus, and many other minerals and vitamin A. Traditionally used as in normal diet and also for diabetics.

Matsyakshi is light, bitter, and astringent in taste, *Pittakaphasrajit* (pacifies vitiated *Pitta*, *Kapha*, and blood).[16] The whole plant of *Alternanthera sessiles* (Linn.) R.Br. is used as vegetable and also to treat wounds, flatulence, cough, bronchitis, and diabetes. This plant is also reckoned as an important ingredient of several compound preparations. The people of Bihar reportedly use the plant to treat night blindness. A poultice of this herb is reportedly useful to promote the healing of boils. The leaves and stems of this herb are used as galactagogue and febrifuge.

Methika is pungent, *Laghu* (light), *Snigdha* (unctuous) in nature, and hot in potency, best *Vatashamak* and can be indicated in *Vataja Prameha*, including *Madhumeha.*[24] leaves, seeds, are common ingredients of daily Indian diet. It is found to have hypoglycemic, hypocholesterolemic property on pharmacologic screening.[25] Clinical studies carried out on *Methika* (fenugreek) seed powder in the dose of 9 g/day for 3 months, shown significant decrease in blood sugar levels, serum cholesterol, and triglyceride values.[26]

Karavellaka is a regularly used vegetable in India, having bitter and pungent in taste, *Laghu* (light), *Ruksha* (dry), and *Kapha-Pitta shamak* (pacifies vitiated *Kapha* and *Pitta*). Due to its hot potency it maintains the normalcy of *Vata.* All these properties support its antidiabetic effects,[24] found to have antihyperglycemic activity, antihepatotoxic activity and glucose absorption inhibition activity on pharmacologic screening.[25] In a study conducted to observe the protective effect of *M. charantia* extract on the kidneys of STZ-induced diabetic rats, it has shown an antioxidant effect by preventing the oxidative damage involved in the diabetic kidney.[27] In another study alcoholic extract of whole fruit of *M. charantia* Linn. was prepared and studied on the pancreatic islets of alloxan diabetic albino rats. Different doses of alcoholic extract of *M. charantia* were found to decrease the blood sugar level significantly. Extract feeding showed definite improvement in the islets of Langerhans. No toxic effect was observed in the liver. The significant features of the study are the blood glucose once lowered by the treatment with *M. charantia* fruit extract remained static even after discontinuation of drug for 15 days.[28] In another study *M. charantia* Linn. fruit ethanolic extract on experimental findings with respect to the mechanism of action in alloxan diabetic rats suggest that it enhances insulin secretion by the islets of Langerhans, reduces glycogenesis in liver tissue, enhances peripheral glucose utilization, and increases serum protein levels. Furthermore, treatment restores the altered histologic architecture of the islets of Langerhans. Hence, the biochemical, pharmacologic, and histopathologic profiles of *M. charantia* Linn. fruit ethanolic extract clearly indicate its potential antidiabetic activity and other beneficial effects in amelioration of diabetes-associated complications. Furthermore, an evaluation of its antilipidemic activity in old obese rats demonstrated significant lowering of cholesterol and triglyceride levels while elevating HDL-cholesterol levels.[29]

Palandu **(Onion: *Allium cepa* Linn.)**

Palandu is almost used in every Indian diet, having sweet and pungent in taste, heavy, penetrating, and slightly hot in nature and considered best *Vatashamak* (pacifies *Vata*) and *Kaphapittavardhak* (increases *Kapha* and *Pitta*).[24] Although in classics it is not directly indicated in diabetes, its antioxidant, antidiabetic, hypoglycemic, hypocholesterolemic, antiatherogenic, antihyperlipidemic, antihypertensive, and antiarterosclerotic actions were proved on pharmacologic screening.[30] Its hypoglycemic and hypolipidemic actions were proved to associate with antioxidant activity.[31]

Spices

Marica **(pepper*: Piper nigrum* Linn.)**

Black pepper is native to South India and is extensively cultivated in tropical regions of Southern India. The black pepper is extensively used in almost all the regions of the world that it has acquired the name “the King of Spices.” Black pepper is well known and valued since ancient times for both its flavor and its medicinal use. It is pungent, light, penetrating, and hot in potency,

Kaphavatashamak and indicated in diabetes.[24] Along its stimulant, expectorant, carminative, antipyretic, anthelmintic properties its antioxidant, and antidiabetic properties were also proved.[32] Its pharmacologic inhibition of acyl CoA: diacylglycerol acyltransferase (DGAT, EC 2.3.1.20) has emerged it as a potential therapy for the treatment of obesity and type-2 diabetes.[33] Another study revealed that oxidative stress plays a key role in diabetes, and treatment with *P. nigrum* is useful in controlling not only the glucose and lipid levels but also in strengthening the antioxidants potential.[34]

Lashuna (Garlic: *Allium sativum* Linn.)

Lashuna consists 5 tastes (sweet, salt, bitter, pungent, and astringent) with predominance of pungent, heavy, penetrating, and hot in nature. It pacifies *Kapha*, *Vata*, increases *Pitta*, *Rakta* (blood)[24] and mainly indicated in heart diseases and all painful disorders. Its hypocholesterolemic, hypolipidemic, antioxidant, antiaging, cardioprotective, hypoglycemic, hypotensive, fibrinolytic actions were proved on pharmacologic screening.[35] Most of its beneficial effects, such as antioxidant, antibacterial, and antitumoral involve sulfur-derived amino acids. In a study the acute effects of aqueous extract of garlic on plasma glucose and cholesterol levels in normal rats were re-evaluated. It was confirmed that garlic contained an active fraction, exerting both glucose- and cholesterol-lowering activity.[36] In another experimental study raw and boiled garlic showed improvement in plasma lipid metabolism and plasma antioxidant activity.[37]

Upakuncika (*Nigella sativa* Linn.)

Upakuncika (black cumin) is bitter and pungent in taste; hot, light, and penetrating in nature. It is indicated in diabetes and considered as cardiotonic.[16,38,39] Its hypoglycemic, hypotensive, cardiovascular, antidiabetic, and cardiac depressant actions were proved on pharmacologic screening.[35]

A study was conducted to evaluate the possible protective effects of the volatile oil of *Nigella sativa* seeds on insulin immunoreactivity and ultrastructural changes of pancreatic beta-cells in STZ-induced diabetic rats. A therapeutic protective effect in diabetes by decreasing morphologic changes, preserving pancreatic beta-cell integrity and protecting against oxidative stress was observed.[40]

Ardraka (*Zingiber officinale* Roscoe.)

Ardraka is pungent in taste; hot and heavy in nature, pacifies vitiated *Tridoshas* (3 body humors). It is indicated in diabetes and heart disease and used as rejuvenator and aphrodisiac.[16,38,39,41] Its hypolipidemic, antiatherosclerotic, cardiovascular, antioxidant, antistress, and hypoglycemic actions were proved on pharmacologic screening.[32] In a study over 40 antioxidative compounds from *Zingiber officinale* Roscoe. were found effective against the development of diabetic cataract in rats and can be suggested for the prevention or delay of diabetic complications.[42]

Fruits

Modern research suggests Diabetics to avoid fruits with high simple sugars, such as Banana, Sapota (Cheekoo), Grapes, and Mango, etc., but suggest Orange, Watermelon, Apple, Guava, etc. It was recommended *Amalaki* (*Emblica officinalis* Gaertn.), *Jambu* (*Syzigium cumini* (L.) Skeels.) *Kapittha* (*Feronia elephantum* Correa.), and other fruits.

Indian gooseberry (*Emblica officinalis* Gaertn.)

Amlaki consists 5 tastes (sweet, sour, bitter, pungent, and astringent) with predominance of sour, cool, heavy specially indicated in diabetes and considered best rejuvenator. It pacifies all the 3 *Doshas* (body humors) and maintains health and considered the best drug to delay the aging.[16, 38, 43] It is also indicated in obesity and other hyperlipidemic disorders.[39] Along with turmeric powder its juice is indicated in Diabetes. [8,44] Among the suggested fruits for diabetics *Amlaki* is given prior importance.[8] Its antioxidant, hypolipidemic, and hypoglycemic actions were proved on pharmacologic screening.[45] *Emblica officinalis* Gaertn. and its constituent tannoids are considered to inhibit aldose reductase (AR), which involves in the development of secondary complications of diabetes including cataract. The effect of *E. officinalis* and its enriched tannoids on STZ-induced diabetic cataract in rats were studied and found that both *E. officinalis* and its tannoids did not prevent STZ-induced hyperglycemia as assessed by blood glucose and insulin levels but slit lamp microscope observations indicated that these supplements delayed cataract progression.[46]

Jambu/Java plum (*Syzygium cumini* (L.) Skeels.)

Syzigium cumini (L.) Skeels. is one among the most common medicinal plants used to treat

diabetes. Leaves, fruits, and its barks have been used for hypoglycemic activity. It has a mixed taste of sweet, astringent, sour, cool and light, pacifies *Pitta* and *Kapha* diseases. On excessive use it causes constipation and aggravation of *Vata* (a type of body humor).[16,38,39,41] It is also used to control excessive urination and the fermented tonics (*Asava* and *Arishta*) and Iron tonic (*Ayaskrti*) prepared from *Jambu* are indicated in Diabetics.[8,43,45] *Syzigium cumini* (L.) Skeels. inhibits adenosine deaminase activity and reduces glucose levels in hyperglycemic patients.[47]

Kapittha (*Feronia elephantum* Correa.)

Kapittha is another fruit indicated in Diabetes.[39] Alloxan-induced hyperglycemic male Wistar rats were orally administered the aqueous fruit extract of *F. elephantum* in 500 mg/kg, p.o. for 30 days. Blood glucose was estimated on 31st day by Kit method. The aqueous fruit extract of *F. elephantum* Correa. exhibited significant hypoglycemic effect in hyperglycemic rats.[48]

Fatty animals, such as domestic, aquatic, and marshy lands are contraindicated and recommended forest animals and birds meat, which are relatively fat free.

CONCLUSION

Diabetes under the heading of *Prameha* and *Madhumeha* is an ancient Indian heritage, most scientific and time tested. Traditional Indian diets prescribed to prevent and treat diabetics are functional and used both as food and medicine. They have been selected and used based on fundamental principles, such as their *Rasa*, *Guna*, *Virya*, *Vipaka*, *Prabhava*, and so on. In recent researches they are proved to contain rich amounts of dietary fiber (whole grains and vegetables), antioxidants, and other active principles. Certain diets that are harmful to diabetics are contraindicated. It is time to highlight this ancient Indian wisdom at global level and make the scholars aware about the depth of knowledge and foresight of ancient Indian scholars. Majority of these prescribed ancient diets are beneficial for diabetic population to maintain their health and to reduce complications and are proved in many experimental and clinical studies. Moreover, certain diets have also been proved beneficial to prevent diabetes. Fenugreek, bitter gourd, and so on, diets are well known for their pancreatic protective properties. High fiber cereals, such as finger millet and barley, and pulses, such as green gram and bitter green leafy vegetables, have been found very much useful as nutraceuticals to prevent and maintain diabetes. Especially hypoglycemic, hypocholesterolemic, nephroprotective, and anticataractogenic properties of finger millet are suggesting its utility as a functional ingredient in diets for diabetics.[49] Although certain diets, such as leaves of *Chenopodium album* Linn., grains of *Paspolum scrobiculatum* Linn., oil of *Linum usitatisimum* Linn., oil of *Baliospermum montanum* Muell., oil of *Balanites aegyptiaca* Linn, and others, are indicated in diabetic diet, nowadays they are not popular in usage and further researches in a multidimensional way is needed to confirm the utility of these nutraceuticals. The role of forest animals meat in comparison to domestic animals should also be studied further for the benefit of diabetic population.

By considering all these facts it can be concluded that

1. Many nutraceuticals are prescribed in various classics and majority of those are proved useful by various researches.
2. Due to urbanization and fast food culture certain nutraceuticals are not in familiar usage but even today they are used by the tribes. There is a necessity to highlight and propagate the benefits of these diets in the public domain. Using biotechnology methods steps should be taken to cultivate the endangered nutraceuticals.
3. Certain forest animals/birds were also proven more beneficial as they contain less fat and other beneficial properties. Animal breeding techniques in developing forest animals and birds in commercial levels without altering the qualities and benefits will also help the diabetic population in particular and every nonvegetarian in general.
4. Based on fundamentals and contemporary scientific researches more diets are to be evaluated for the benefit of the common man. There is also a need to popularize the true research outcomes to common man to take preventive steps from becoming young diabetics.

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***Address for correspondence**
Dr.Bandari Srinivasulu
Lecturer
Dept. of Rasashastra, Kunwar Shekhar Vijendra Ayurved Medical College & Research Centre, Gangoh, Saharanpur, U.P., India.
Email: dr.vaasu@rediffmail.com
Ph: +919347000599