Diabetes Care in Greco-Arab Medicine*

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In Ebers Papyrus, we find probably the earliest descriptions of various diseases identified with some degree of certainty. In one of its sections, mention of sentence, "to regulate the too excessive urine", may refer to diabetes or cystitis. Adherence of Islamic tradition in pathological teaching is well demonstrated in case of diabetes and al-Majusi has given acceptable reasons for diabetes in *al-Malaki* in the Greco-Arabic or Unani terms with diagnostic signs, and this presentation coincides with Galen's explanations, although brief and scanty. Abd ai-Latif ai-Baghdadi discusses that diabetes consists in polyuria for which he has given four reasons rather comprehensively. It is interesting that Abd al-Latif has quoted *al-Hawi,* wherein Razi has discussed the disease and the herbals effective in its treatment. He mentions that when diabetes becomes chronic, the patient loses weight and becomes emaciated, dribbling of urine occurs in such patients with incontinence and there may occur paralysis in course of the disease. Razi has advised diabetics to use vegetables and avoid the diuretics.

Hakim Kabiruddin referring *Sharrhah Asbab* (1271 Hijra) has given the definition, the etiology, the signs and the symptoms of the disease, all applicable in the practice of medicine today, especially in the traditional medicines with Greco-Arab (Unani) roots. Besides the discussion on the disease a number of herbal medicines for the treatment of diabetes are given in the Greco-Arab (Unani) sources, e.g., Qurs Kafoor, Qurs Dhiabitus (diabetes), Kushta Khabath al-Hadid, Kushta Post Baidha Murgh, *Tinospora cordifolia* (gilo-dried), *Gymnema sylvestre* (gur-mar), flowers of *Punica granatum* (anar), acacia, barley decoction etc. These drugs alone or in compound forms are also valuable in diabetes insipidus. There is tremendous scope for research in Greco-Arabic medicines used orally in diabetes, and some work in this direction has been carried out in Pakistan and abroad, and several species have come into light, like *Momordica charantia* (karela) and caraway (kala zera) reported to have significant antidiabetic activity.

Research on these herbal antidiabetic agents can open new vistas, for it would be the Greco-Arab (Unani) or Islamic medicine which will play momentous role in the future development of world health.

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Introduction and History of the Disease

The history of diabetes is the true story of a medical miracle. It has been known as a disease for as long as people have been keeping medical records. The excessive passing of urine and the remedy denoted by "to regulate the too excessive urine" may refer to an obvious sign of diabetes, as the subject of Egyptian Papyrus written around some 3,500 years ago, called the *Papyrus Ebers*[1]. It gives detailed prescriptions for medicines to reduce the urine output. Wells (in *Bones, Bodies and Disease,* 1964) quotes an interesting description of this disease from Aretaeus of Cappadocia (second century A.D.), who said, according to Wells:

> "Diabetes is an astonishing affection ... Being a melting down of the flesh ... into urine ... The patients never stop making water ... The flow is incessant like the opening of an aquaductus ... It is a chronic disease but the patient is short-lived ... And his thirst unquenchable[2].

But the Papyrus of Ebers has been privileged long before for identifying this disease along with various other diseases with some degree of certainty and has referred to diabetes and cystitis. These references, however, suggest that the Egyptians (and later the European writers) did not notice the presence of sugar in the urine of diabetics, whereas the real cause of sweetness of diabetes urine came to be recognized in modern medicine only around 1776.

Diabetes as a distinct disease in clinical medicine was recognized at least 2,000 years ago. Hindu physicians of the pre-Christian era were the first to describe the most important symptoms of this disorder e.g., thirst, sweet urine and weight loss. *Susruta,* a well-known medical classic written around A.D. 100-500, gives a clear description of *Madhu-meha* or *Ikshu-meha* i.e., diabetes. All the symptoms of the disease, viz., thirst, foul breath, voracious appetite and langour, have been recorded in this book. Furthermore, the diabetic conditions were clearly recorded in *Charaka Samhita,* an earlier medical compendium of the ancient Hindus and also in the works of 'Agnivesa' and 'Atreya' as far back as 400 B.C.

> Basically, it was the use of the sense of taste which made possible for the Hindus to diagnose the fundamental characteristics of diabetes mellitus (which they called "honey urine")[3].

Chinese traditional medicine with developed pharmacopoeiae containing as much as eighteen hundred drugs, with sound Chinese philosophy and science, the principles of *Yang* (light, male) and *Yin* (dark, female), the five basic elements (wood, fire, earth, metal, water) associated

with five planets, five directions, five seasons, five colours, five sounds, and five organs in the human body, has a great deal of sound clinical observation incorporated into this system and according to Ackerknecht (1955) diabetes in addition to smallpox, dysentery, and cholera is well described. Amongst the Greeks, it was Aretaeus who gave its name to the disease, diabetes; διαβητηδ ("a passer through"), as he called it[4]. Aretaeus was a talented physician who wrote in a clear and attractive style, and his description of disease resembles that of Hippocrates[5]. He states about diabetes:

> "This disease", fortunately rather rare, consisted in a "liquefaction of the flesh and bones into urine." The kidneys and bladder do not cease emitting urine ... as though the aquaducts were opened wide. "No matter what quantity of fluid the patient drinks, satisfaction never occurs ... he cannot be stopped from drinking or from urinating ... For fluids do not remain in the body, but use the body only as a channel through which they may flow out. Life lasts only for a time but not very long."!

The clinical description like above mentioned reveals the true disciple of Hippocrates, the bedside observer, disdainful of theory and preconceived ideas, and above all eager to be of assistance to the patient.

Greco-Arab Medicine and Diabetes

The adherence of Islamic tradition in pathological teaching is well demonstrated in the case of diabetes. According to al-Majusi[6],

> "Diabetes occurs because of the too great strength of the 'attractive faculty', by which the kidneys attract the watery constituents of the blood, in other words, the urine. Thus the cause lies in a hot dyscrasy of the kidneys which consequently need the water to extinguish and cool the flaming heat (*lahib*) present in them. Thus they attract away the moisture from the liver and the other organs, so that the person experiences a burning thirst. A second possibility for the occurrence of diabetes lies in the weakness of the 'retentive faculty' of the kidneys which cannot retain in themselves the watery constituents reaching them from the liver."
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> "One can diagnose diabetes by the following signs: the patient feels a burning thirst though there is no fever, nor is the body dried out; he produces urine constantly without this burning; the urine is thin, pale, and resembles water, because the water that the patient drinks immediately passes out as urine without it being able to undergo change in the liver."

Al-Majusi's presentation, which coincides with Galen's explanations[7], is extremely brief and scanty, but fortunately there is a monograph on diabetes, a *Consilium* by Abd al-Latif al-Baghdadi[8]. In his views:

> "Diabetes consists in 'polyuria' for which there are four cases: 1) a weakness or paralysis of the sphincter of the bladder; 2) a piercing pain in the urinary passages; 3) a weakness in the 'retentive faculty' of the kidneys; 4) a hot dyscrasy of the kidneys."

The third and fourth points are already mentioned in al-Majusi's book; the first and second rather dispense with logic because these complaints may result in urinary discharge but not necessarily in polyuria. Nevertheless, it must be recognized that 'Abd al-Latif wanted to present diabetes as comprehensively as possible. What he mentioned about are quite heterogenous syndromes, namely, the raised sugar content and the sweet taste of the urine, were known neither to him, nor to al-Majusi, and according to Manfred Ullmann[9], nor to Ibn Sina.

This is a little surprising for, in support of his view, 'Abd al-Latif quotes, inter alia, longer passages from the *Kitab al-Hawi* of al-Razi, and precisely in this work there are two passages where the examination of urine in respect of taste is discussed. One of the passages comes from a writing by Rufus, and reads:

> "When examining urine, one must be careful to note the amount, whether little or great, its colour, its taste, its smell, its consistency, that is, whether thick or thin[10]."

The other passage included in 'Abd al-Latif's work comes from an anonymous writer's book, *Kitab ad-Dala'il,* an ancient work on diagnosis:

> "In the case of urine, three things must be examined: its colour, its consistency and its sediment. In addition, its smell, its temperature when a finger is placed in it, and its pungency of taste should be tested."

That the testing of urine by the tongue was not unknown to the Arabs is also seen from a poem in which Ibn al-Munajjim mocks the Jewish doctor Hibat Allah ibn Jumay:

> "He cannot determine the urine of a sick man in the glass, not even when he rolls it on the tongue[11]."

One may ask whether this method, which is not pleasant for the doctor, was in fact practised. But the truth is that no Arab mentions the sweet taste of a diabetic's urine. In their knowledge of diabetes it is suggested, therefore, that the Arabs have not left the Greeks behind. But when we come through the everlasting medical text like *Qanun* of Ibn Sina, the observations and the treatment methods narrated by the King of the physicians promise a perfect position of the Arabs for the understanding of this disease, the renowned supremacy unchallenged and as well the indigenous treatment methods by means of simple and compound herbal medicaments. It is stated in the translation of the second volume of *Qanun:*

> Dhiabitus (or diabetes) is the disease in which there's caused urination just following drinking water. Relation of this disease towards watery substances and towards organs of urinary system is similar to those things eaten and get out of the body as wastes (as in *dhalq-ul-m'eda wa-ama* are related to the intestine). The disease is called as *dhia-isqumis* and *qaramis* in Greek, and as *dawwara, dawlab* and *dhalq-al-kulliyya* (Diabetes mellitus) in Arabic.
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> Some people say that the disease is caused at once because this condition is natural and is not caused by intention. In diabetes mellitus along with sensitivity, intention is also involved and the diseases of gall bladder and intestine are slowly caused. A patient of diabetes is always thirsty and drinks large quantities of water but the thirst is not quenchable. He urinates frequently. Cause of the disease is malfunction of the kidneys or the ducts become open which are present in it. Sometimes this disorder is caused to the coldness imposed on the whole body or on the liver or kidneys. Sometimes this is due to extremely cold water intake or due to coldness internally which causes contraction of the kidney. Continuation in urination thus proceeds in this way: the kidney tries to draw more and more liquefied matter (moistness) from the liver and liver tries to draw it from the above existed organs, in this way a continuous process of drawing water and urination is carried out.
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> And when the liver is lacking in moistness and liquefied matter, and it tries to draw water from the above existing organs which if also do not contain any water, then dryness and thirst is caused[12].

According to Ibn Sina, the disease may result in tuberculosis and emaciation, is due to the reason that most of the body fluids get expelled out and this does not let the body remain moist and dryness

causes emaciation and tuberculosis. Recommendation of treatment according to Ibn Sina is as follows:

> "Often diabetes is due to the natural heat (*hararat-e-nari*), for this its treatment is done by providing coldness. Cold tempered vegetables and fruits and juices are administered which cause satisfaction to thirst. The patient is also suggested to sit in cold water. Inhaling of camphor and water lily (flower's smell) is also suggested because their smell is said to be cold ... water extract (after roasting) obtained from white gourd (*kaddu*) along with ispaghul and water extracts of pomegranate (*anar*), mulberry (*toot*), prunes and fresh flower extract of rose is also useful. In compound preparations, *qurs gulnar* is useful when administered with the mucilage of ispaghul in cold water or with water extract of white gourd[13]."

Ibn Sina writes that making the physiological system soft is beneficial for the patients who usually suffer from constipation. It is necessary to avoid such natural drugs and fruits which can cause constipation.

Causes of the Disease according to Greco-Arab Medicine

Greco-Arab medicine with its sound philosophy and operational experience of centuries, explains two causes of diabetes[14].

a) (i) **Internal causes of diabetes:** Heredity has long been recognized as an important aetiological factor and is considered to be transmitted as genetic (recessive) character. The theory is generally not accepted (with reference to *British Pharmacopoeia of Medical Practice,* Edn. II) and it seems probable that the mode of transmission is more complex.

(ii) **Obesity:** (Physiological disorder): Has been regarded as predisposing to the development of diabetes, but it now seems more probable that the increase in weight which often precedes the onset of diabetes is due to an excess of the same.

(iii) Diabetes mellitus occurs at all ages, but is rare below the age of 5 years and very rare below 2 years. The maximum incidence occurs in women between the ages of 45 and 55 years; outside these limits the sexes are equally affected. The Jews are particularly susceptible, but it is noteworthy that the incidence in Jewish children appears to be no higher than in children of other races.

(b) **External causes:** Sometimes the disease is slowly caused by severe

coldness in winter season and on becoming wet in rain. Sometimes by drinking cold water in condition of the body being hot after performing the exercise. Eating sweet dishes and nutrients containing carbohydrates and sugar extensively, emotions, traumatic defects in brain, liver, kidneys or intestine, in people doing mental work at large. Disorders in the nervous system, seasonal fevers and following the fevers due to various infections, and sometimes the disease may be caused in patients having syphilis or gout (or attacks thereof).

Modern medicine, when we compare it to Greco-Arab also discusses heredity and obesity as the important predisposing causes of diabetes. It states that although the inflammatory and degenerative lesions of the pancreas resulting from pancreatitis, carcinoma, arteriosclerosis and hemochromatosis account for small number of cases, symptoms can vary widely, and a large number of patients with hyperglycaemia manifest no symptoms whatsoever. Weakness, weight loss, increased thirst and urination, diabetic neuritis, failure of vision, impotence, itching of the skin, and furunculosis are all common manifestations of this disease. The subject of aetiology today has gained more interest when we come across viruses that are proposed to cause diabetes. The evidence linking diabetes in general with viruses comes from animal studies. For instance, some cattle develop diabetes-like symptoms when infected with the **Foot and Mouth Disease Virus.** Investigators have discovered a variant of the encephalomyocarditis virus that produces diabetes in mice. The virus multiplies almost exclusively in the cells of the islets of Langerhans, and as a result of its action the infected mice produce reduced amounts of insulin, develop sugar in the blood and urine and show marked increase of thirst and appetite. It is stated at several places in texts that in diabetes that is caused in later life, there's much **Less Evidence** of a viral cause, and much **Clearer Indication** of a genetic role. The evidence that the inherited predisposition to diabetes may consist of a defect in the human body's immunity system, may place this disorder among the so-called auto-immune diseases in which the immunity system is directed against some of the body's own cells – in this case the islet cells of the pancreas. In turn, this also suggests that diabetes may be a type of **Slow Virus Disease,** many others of which seem to involve auto-immunity[15].

At present for the clear understanding of the aetiological consequences in cases of diabetes caused by viruses, Professor Keith Taylor of the London Hospital Medical College says that certain blood proteins called the islet cell antibodies, may be produced in response to a breakdown of the islets. He explains:

"The antibodies can themselves interact with and destroy the islets.

So the virus causes the cells to break down, producing the antibodies that continue the destructive processes."

And it is known already that the foot and mouth disease virus known to have caused diabetes among cattle in southern Italy, the pancreas of these animals on examination showed the destroyed islets of Langerhans[16].

Treatment of uncomplicated diabetes is usually an individualized problem and, depending on the severity of the symptoms, may involve diet control alone, diet and use of orally active anti-diabetic agents, or diet and one or more injections per day of insulin. Insulin is regarded as replacement therapy only and does not cure or prevent the pathological condition. Its use, however, often prevents the causes of diabetic death related to arteriosclerosis, hypertension, nephritis, superficial ulcers and infections, gangrene of the extremities, and gall-stones.

Insulin is prepared from extracts of beef and swine pituitaries commercially. All the oral antidiabetic drugs are prepared synthetically. Sulfonylureas, which are derivatives of Sulfanilamide, stimulate the pancreas to produce insulin and affect hepatic enzymes so that glycogen deposition is increased. Moreover, the diguanidines increase glucose utilization by the tissues and tissue glycolysis and decrease hepatic glucose output without glycogen storage.

Treatment of Diabetes by Herbal Remedies

There are many hypoglycaemic plants known through the folklore, but their introduction into modern therapy awaits the discovery of an animal test system that closely parallels the pathological course of diabetes in humans. Such potential oral hypoglycaemic agents as the cyclopropanoid amino acids and hypoglycins A and B derived from the unripe fruit of the West Indian tree *Blighia sapida* are too toxic for use as insulin substitutes. Moreover, their action differs from that of insulin in that they appear to act as anti-metabolites capable of blocking the pathway of oxidation of fatty acids. This depletion of liver glycogen subsequently induces hypoglycaemia. Other folklore remedies, such as tea made from Queen Anne's lace (*Daucus carota*) or from periwinkle *Catharanthus* (Vinca) *roseus* which have allegedly been used successfully to maintain low blood sugar levels in humans, have no effect on diabetes artificially induced in animals. However, tea obtained from *Catharanthus roseus* has been used in South Africa, Nepal, Australia, South Vietnam, and the Philippines, and the proprietary products Covinca® and Vinculin® are still marketed as oral insulin substitutes in some of these countries. Although hypoglycaemic activity cannot be established from crude extracts, two

purified alkaloids, vindolinine dihydrochloride and leurosine sulphate, have a high degree of hypoglycaemic activity. Follow-up studies are warranted for those alkaloids from *C. roseus* and also those from *Tecoma stans,* which could serve as models for new prototypes of hypoglycaemic agents. The latter alkaloids 'tecomine' and 'tecostanine' were isolated from leaves of various species of Tecoma and used by Mexican natives for the control of diabetes. According to Walter H. Lewis more than 200 plant species could be added to a folklore list of insulin substitutes including many common plants such as immature bean pods, olive leaves, wheat, celery, blackberry leaves and the leaves and roots of banana[17].

Greco-Arab Medicine in Treatment of Diabetes

Greco-Arab medicine in contrast to the above mentioned does not seem to provide an alternative to insulin treatment but from its vast array of herbal products (and preparations) gives a number of compound and simple crude drugs to treat the disease in its own way. The Greco-Arab pharmacopoeia contains such polypharmaceuticals which have the cherished simples as their ingredients and each of which amongst them today have proved effective as hypoglycaemic agent. Greco-Arab medicine has its specificity in control of diabetes. Not only Razi and Ibn Sina have emphasised the treatment of the disease by diet but also the latter Islamic medical authors have counted diet as the most important curative measure, and drugs as of secondary importance. They have forbidden the use of sweet dishes and syrups, advised not to use foods containing greater quantity of carbohydrates like rice, to avoid extensive use of pulses, beef, honey and wine. They have considered it better for patients not to suffer from constipation and have mentioned administration of compound tablets (the *Habb-e-Papita)* to resolve it. Amongst the polypharmaceuticals *Sufuf Sandal Dhiabitusi, Sufuf Chaal Golar Wala, Habb-e-Afyun, Kushta Zamarrud, Sufuf Dhiabitus* and *Sufuf-e-Degar* have been proposed (a). Ibn Sina has proposed *Qurs-e-Gulnar* along with some other preparations, (b)[18]. Following the principles of treatment set up by the ancient Greco-Arab physicians we come across the fact that diabetics have been treated orally with plant extracts based on Unani method of treatment. Here we come through the principles put up by the great physician of his age al-Razi, who says that when diabetes becomes chronic, the patient loses weight and becomes emaciated, dribbling of urine occurs in such patients with incontinence and there may occur paralysis in course of the disease. He has advised diabetics to use vegetables and to avoid those herbals which have diuretic effect.

(a) & (b): Details regarding these formulae are given in Appendix A.

Ibn Sina has given a number of polypharmaceuticals and simple herbs and their extracts for use in the treatment of diabetes. Among these, gum arabic (*samagh arabi*), *Sterculia urens* (*katira*), *Rosa damascena* (*gul-e-surkh*) and pomegranate flowers (*gulnar*) are of some value in diabetes individually as well as in compound form.

Besides the resourceful discussion on the disease, various drugs for the treatment are given in the Greco-Arab (Unani) sources, e.g., *Qurs Kafoor, Kushta Khabath al-Hadid, Kushta Post Baidha Murgh* as recommended in the reference of *Sharrah Asbab* (1271 Hijra) by Hakim Kabiruddin[19]. It is stated in this medical text that along with other herbal remedies, *Tinospora cordifolia* (gilo-dried), *Gymnema sylvestre* (*gur-mar*), flowers of *Punica granatum* (*anar*), *Acacia arabica,* barley decoction etc., alone or in compound forms are valuable in diabetes insipidus. Representing such an ancient art of treatment, *Hamdard Pharmacopoeia of Eastern Medicine* (ed. Hakim Mohammed Said, 1969), is unique in its separate listing of herbal antidiabetic agents, recommended by the early Greco-Arab medical men. The list includes eighteen herbs and three mineral and animal products[20]. The herbs named in the Pharmacopoeia include those cherished by folk medicine all along the centuries and most of their antidiabetic effects are confirmed by modern analytical techniques and by scientific procedures e.g., *Aconitum napellus* (*bachnag*), *Aegle marmelos* (*burgbael*), *Allium cepa* (*piyaz*), *A. sativum* (*lehsun*), *Bombax malabaricum* (*senbal*), *Canscora decussata* (*sankhaoli*), *Citrus aurantium* (*santra*), *Coccinia indica* (*kanduri-kibel*), *Eugenia jambolana* (*jamun*), *Euphorbia pilulifera* (*dudhi*), *Gossypium herbaecum* seeds (*binola*), *Grewia asiatica* (*falsa*), *Lodoicea sechellarum* (*narayal-daryai*), *Momordica charantia* (*karela*), *Onosma echioides* (*rattanjot*), *Pterocarpus marsupium* (*bejasar*), *Strychnos nux-vomica* (*kuchla*) and *Tinospora cordifolia* (*gilo*). Out of these, six are those which are recommended as valuable in diabetes and therefore are recommended for further research by the Indian researchers R.R. Chaudhry and S.B. Vohora (1970)[21].

An attempt to review the relevant literature brings on the screen bulk of information in indigenous drugs scattered in fragments with many individuals and in age-old books and manuscripts which are sometimes out of print and not easily available. However, as far as the Indian indigenous anti-diabetic drugs are concerned, a few books like Nadkarni's *Materia Medica* and Chopra's *Indigenous Drugs of India*[22]*,* and some reviews of Mukerjee[23] have given some comprehensive lists of such drugs which are used or claimed to be useful in diabetes. In these lists, quite a number of drugs are common and in recent years many of these have been investigated by various workers on scientific lines – both

under experimental and clinical conditions. Chaudhry and Vohora (1970)[24] have carried out a review of systemic work conducted in the last four decades on the drugs proposed by ancient physicians and according to traditional systems having antidiabetic activities. They state that though an antidiabetic agent tries to make normal all aspects of metabolic disturbances in the diabetic patient, the glucose level being of primary importance, is used as an index of evaluating these agents. According to them, *Momordica charantia, Gymnema sylvestre, Pterocarpus marsupium, Tinospora cordifolia, Eugenia jambolana* and *Coccinia indica* along with some other inorganic and compound preparations are the most important herbal anti-diabetics, that should be given priority to be tested on scientific lines.

Since ancient times, diabetics have been treated orally with plant extracts based on Greco-Arab medicine. Inspite of the fact that isolated research workers studied and confirmed the favourable effect of the extracts of certain plants keeping in view the affiliation of Greco-Arab medicine, modern medicine has introduced insulin and various synthetic products. Possibly the relative success obtained after 1855 with sulfonylureas and a few years later with biguinides, since then, the problem of the pathogenesis of diabetes and the possibility of its oral treatment has found new interest. Thousands of compounds have been synthesized at random and synthesis followed by long and costly pharmacological and finally clinical research. The necessity to recognize the specific biochemical disorders provoking diabetes and the wish to be able to choose, in the light of this knowledge, agents controlling particular biochemical phases becomes more and more important. Also, only some diabetics require insulin therapy.

Literature and the results of the use of reputed herbal hypoglycaemic agents appear to be of sufficient interest to justify further investigation either from oral phytotherapeutic point of view or else because they may help us to understand more about the pathogenesis of diabetes and the contribution of traditional medicine to combat the disease and also the potential of individual crude herbal drug[25].

For a comparative study, an arbitrary subdivision of the known botanical hypoglycaemic agents in 3 groups can be done for practical reasons and to guide the research in this particular field:

Group I: Plants with confirmed hypoglycaemic action and identified active constituents.
Group II: Plants with more or less confirmed hypoglycaemic action (but with as yet unknown active constituents).
Group III: Plants of which both the hypoglycaemic action and active constituents need confirmation.

In the following pages, the discussion is limited to the biochemical observations and analytical achievements regarding some more popular antidiabetic herbal agents.*

GROUP I
Plants with Confirmed Hypoglycaemic Action

1. *Allium cepa* L. (Onion); *A. Sativum* L. (Garlic)

In 1923 Collip noticed that a depancreatized dog could be kept alive for 66 days on 3 injections of crude onion extract. Later a number of research workers confirmed that onion and its extracts have a distinct, slowly developing hypoglycaemic action and that the effect is also shown after per-oral administration. In 1962, purification was done by extraction, with light petroleum ether, producing a fraction with an oral hypoglycaemic action equivalent to 62% of that of a standard dose (0.5 gram) of tolbutamide. An ethyl-ether extract of the evaporation residue of the petroleum extract had an action equivalent to 76.6% of that of the tolbutamide standard. Later, Augusti and co-workers (1974-1976) isolated from the fresh onion by steam distillation and solvent extraction, two active disulphides, 0.01% of 'Allyl Propyl Disulphide' (APDS) and 'Allicin' (Diallyl Disulphide Oxide).

Garlic was equally tested for its hypoglycaemic action and the evaporation residue (0.5 gram) of the total ethyl-ether extract (at 34-36°) of 50 gram dried garlic powder found to have in fasting male albino rabbits an activity equivalent to 58.8% of that of tolbutamide standard.

2. *Bughia sapida* Koenig (Akee Apple)

A tree indigenous in West Africa, Sri Lanka, Venezuela and Jamaica. It could be traced down to the ingestion of unripe akees and in particular to two constituents of these (according to B. Oliver Bever and G.R. Zahnd) namely hypoglycin 'A' and 'B'[26]. These substances have strong hypoglycaemic and emetic action in mice, rabbits, guinea-pigs, cats, dogs and also in humans.

3. *Catharanthus roseus* G. Don (Syn. *Lochnera rosea, Vinca rosea* L., Madagascar Periwinkle)

In the folk medicine of several countries such as the Philippines,

*Some details regarding their parts used, hypoglycaemic chemical constituents and particular action of the principle(s) is discussed in Appendix 'B'.

Jamaica, South Africa, India and Australia, an infusion of the leaves is given to diabetics. Investigations on this plant for its hypoglycaemic activity costed great number of experimental rats for they had lost their resistance through a strong reduction of their lymphocytes. This stood at the beginning of the research undertaken on the treatment of leukaemia by 'Catharanthus alkaloids'. Research on the hypoglycaemic effect was not abandoned however, and the different Catharanthus alkaloids were administered in doses of 100 mg/kg to rats previously fasted for 18 hours. Out of leurosine sulphate, lochnerine, tetrahydroalstonine, vindoline Hcl etc., so far only the hypoglycaemic and diuretic actions of catharanthine had been reported.

4. *Ficus bengalensis* L., (Banyan), *F. religiosa* L., (Sacred Fig.), *F. racemosa* L., (F. Glomerata)

In Indian folk medicine, bark infusions of these trees are, amongst other indications, considered to be antidiabetic. A fall of the blood sugar level of alloxan-diabetic rabbits due to oral administration of *Ficus religiosa* and oral and i.v. administration of *F. bengalensis* extract was also registered, although Vohora found only a negligible effect when administering *F. bengalensis* extract intravenously in normal fasting rabbits. A phytosterolin isolated from *F. religiosa* root-bark given orally to fasting rabbits produced maximum fall of the blood sugar level, equivalent to 81% of the tolbutamide standard.

5. *Galega officinalis* L. (Syn. G. Persica Pers.) (Goat's Rue)

This perennial plant of Southern Europe and Western Asia and its seeds are used in folk medicine as an infusion against diabetes and also favour lactation. A number of research workers have confirmed the hypoglycaemic action of this plant. Galegine is an isoamylene – guanidine obtained from seeds of *G. officinalis.*

6. *Momordica charantia* L. (Bitter Gourd, African Cucumber)

It is used in many regions of the world especially in warm countries as a folk medicine antidiabetic remedy. A hypoglycaemic principle could be isolated and was called 'charantin' by Indian research workers. In fasting rabbits, oral administration of 50 mg/kg charantin reduced the blood sugar by 42% in 4 hours. An alkaloid named 'momordicine', and a glycoside were isolated from the fruits by Rivera in 1941 and 1942.

7. *Tecoma stans* Juss. (Syn. Tecoma Molle)

Ornamental tree with drooping clusters of yellow funnel-shaped flowers at the end of the branches, found in many subtropical regions

(Egypt, Central America, Mexico, South America). The leaves of different species of Tecoma have long been used by natives in Mexico as oral antidiabetic remedy. Biological assays showed that, when given intravenously, two alkaloids namely 'tecomine' and 'tecostanine' which had been isolated from the leaves, had a strong hypoglycaemic action comparable to that of tolbutamide. Other alkaloids of this group tecostanine and tecostidine and a quinone similar to lapachol were also isolated from this plant (after 1963).

8. *Trigonella foenum-graecum* L. (Fenugreek)

Grown in many parts of Asia, Europe and Africa, the plant was already used in native medicine by the ancient Egyptians and Greeks. The hypoglycaemic effect of Fenugreek and of its alkaloid 'trigonelline' as described at first in 1948, was re-examined in Israel in the nineteen-sixties. In 1974, the Israeli research workers found that coumarin and nicotinic acid seemed to be the main hypoglycaemic constituents of all compounds isolated from the active fractions of the seeds. 'Trigone Ilene' in comparison exerted a less pronounced but longer persisting activity.

According to Dr. R.D. Sharma of the National Institute of Nutrition, Hyderabad, India, fenugreek seeds, a common condiment used in Indian homes can control diabetes. He stated that the daily administration of 25 grams of fenugreek seeds for 21 days significantly lowered urine and blood sugar levels in diabetes. He has also stated that the hypoglycaemic effect of Fenugreek seems to be due to its gum fibre as well the debitterised seeds are rich in protein and lysine, and can replace pulses in the diets of diabetics[27].

GROUP II
Plants with More or Less Confirmed Hypoglycaemic Action (But Unconfirmed Active Constituents)

1. *Arctium majus* Bernh. (Syn. A. Lappa L., Lappa Major Gaertn; *L. officinalis* All.) (Burdock, Bachelor's Buttons)

Roots and leaves of plants not yet flowered have diuretic, hypoglycaemic and antifurunculous properties. Main components include 'tridecadien' tetrayne, 'tridecene', a sesquiterpene lactone, 'arctiopicrin', inulin, a glycoside named 'arctiin' which produces glucose and a lactone named 'arctigenin' on hydrolysis. Whether any of these compounds are responsible for the hypoglycaemic action is not known.

2. *Argyreia cuneata* (Ker.) Aschers (Syn. *Rivea cuneata*)

In Deccan (India), the leaves are reported to be used locally in the treatment of diabetes and it has been confirmed that a milk extract of the leaves given by mouth for 3-5 days causes considerable remission of the characteristic diabetic symptoms. Work on the chemistry of the plant has been done by many workers[28].

3. *Coccinia grandis* L., (Syn. *C. indica* W. & A., *C. cordifolia* Cogn., *Cephalandra indica* Naud. (Scarlet – Fruited Gourd)

Abundant in India, Pakistan, Tropical Africa and Arabia. The juice of the leaves, stems and tuberous roots are used locally in the treatment of diabetes[29]. The hypoglycaemic action reported for the alcohol extract 58.9% and for the aqueous extract 29.9% of that of tolbutamide standard. Activity of Coccinia has also been attributed to a water-soluble and dialyzable alkaloidal principle[30].

4. *Hordeum vulgare* L., (= *H. sativum* Pers.) (Barley)

A hypoglycaemic principle had been reported in germinating seeds of barley. The hypoglycaemic effect is preceded by an hyperglycaemic action. The radicles contain sugars and the alkaloid hordenine. The clinical effects of barley extract found satisfactory. In normal human subjects a reduction of 17% of blood sugar level was produced by the hypoglycaemic fraction and the extract sufficiently counteracted the hyperglycaemia induced by ingestion of 60 gram glucose. "Labbe' called the hypoglycaemic principle of barley as 'insulinoid' is supposed as free from vitamins after purification and, therefore, the hypoglycaemic fraction could not be confirmed and also does not appear to be further investigated.

5. *Musa sapientum* L. (Syn. *M. paradisiaca* L. Var. Sapientum Kunze.) (Banana)

In evaluating the hypoglycaemic effects of extracts or products of 56 Indian plants of diverse families reputed to be antidiabetic, Jain and Sharma[31] found that banana flowers were second in order of proficiency (*Allium cepa* being first). Out of 3 varieties of banana, the fresh juice of 'Ney Poovan' recorded as most effective hypoglycaemic agent. The third fraction of non-saponifiable portion was found to exert the strongest hypoglycaemic effect[32]. Leucodelphinidin and leucocyanidin are found in flowers and the ripe and unripe fruits contain 60% of glucides as reported by Hood, A.M. and E.J.L. Lowburry[33] and Sinha *et al.*[34].

6. *Syzglum cumini* (L.) Skeels. (Syn. *S. jambolanum* D.C., *Eugenia Jambolana* Lam. L. (Jambul)

The plant is widespread in Indian sub-continent. The hypoglycaemic action is not mentioned officially. Sepaha *et al.,* using 95% alcohol extracts of dried seeds in 18 hours fasting albino rabbits weighing 2 kg and having a blood sugar level of 100-125 mg/100 ml observed an oral hypoglycaemic action comparable to that of tolbutamide[35]. They called the principle "antimellin". Recently a French laboratory put a hypoglycaemic drug based on *Syzgium jambolanum* on market. The product is said to have a strong hypoglycaemic action and can be used either orally or subcutaneously in doses of 1-2.5 or 0.1-0.3 g/day respectively. The galli and ellagi-tannins have been reported in all parts of the plant. The seeds also contain an essential oil. The principal pigments of the flowers and fruits are cyanidin rhamno-glucosides[36]. An alkaloid 'jambosine' was isolated from *S. jambos,* however, none of these have been pin- pointed as yet as the active most hypoglycaemic agent.

GROUP III
Plants of which Both Hypoglycaemic Action and Active Constituents Need Confirmation

The majority of plants treated in this group are used in diabetes in the folk medicine of certain countries, without mention of which symptoms of different aspects of diabetes they act upon. However, the action of a number of these plants has been examined scientifically (see Appendix B, Group III).

Conclusion

From the above mentioned study (scanty as far as the subject is concerned) we can conclude that hyperglycaemic patients can be treated by a variety of natural herbs and their products intervening at different sites of glucose metabolism and the success of the treatment may well depend on particular abnormalities of a given diabetic syndrome. The subject however needs more and more attention. Although early diagnosis, the discovery of insulin, and strict dietary management have brought us a long way toward conquering diabetes, there is much work yet to be done. There are many secondary complications that continue to be a problem for diabetics. Blindness associated with diabetes results from degeneration of the retina, the nerve centre of the eye, which is caused by the formation of abnormal blood vessels that gradually destroy vision.

Degeneration also takes place in nerve tissues and in the kidneys. Heart damage from coronary artery disease occurs in a large number of diabetic patients and most of them have some problems with blood circulation to the limbs, especially the legs and feet[37]. Traditional and modern medical researchers in past and at present have always made diabetes a top priority, the examples from the past, as the literature reveals are indicative of this interest and we are also hopeful that these complications will soon be a thing of past.

APPENDIX A

Preparational	**Quantity (g)**
HAB PAPEETA	
Carica papaya	150
Piper nigrum	30
Zingiber officinalis	150
Lake salt (*namak sambhar*)	75
Ammonium chloride	20
Doses: Two pills after meals, or as directed by the physician.	
SUFUF SANDAL DHIABITUSI	
Santalum album	3
Sterculia urens	10
Lactuca scariola	10
Portulaca oleracea	10
Armenian bole	18
Punica granatum flowers	18
Rhus coriara	18
Quercus	18
Carbohydrates	10
Gum acacia	10
Doses: 6 g powder (with *chach*).	
SUFUF CHAAL GOLARWALA	
Wild Fig tree bark (*Ficus carica*)	12
Armenian bole	6
Pomegranate seeds (*Punica granatum*)	6
Pomegranate flowers	6
Mangifera indica	6
Emblica officinalis	6
Coriandrum sativum	6
Lactuca scariola	3
Papaver somniferum	3
Doses: 6 g powder with water twice a day.	
HAB-E-AFYUN	
Eugenia jambolana	12
Papaver somniferum (latex)	1
Doses: Two tablets. *Bis Die* (morning and evening).	

Preparational	**Quantity (g)**
KUSHTA ZAMARRUD	
Emerald (*Zamarrud*)	100
Rosa damascena (*Arq-gulab*)	750 ml.
Cow-dung cakes (*uplay* for heating)	30 kg.
Doses: 30 mg. or one tablet with 5 g of *Jawarish Zar'uni Ambari.*	
SUFUF DHIABITUS	
Bambusa spinosa	12
Elettaria cardamomum	12
Mercury	25
Tin	12
Agate	12
Doses: 1 gram daily, increase 125 mg. day by day up to 3 grams.	
SUFUF-E-DEEGAR	
Tinospora cordifolia	25
Glycyrrhiza glabra	25
Sterculia urens	25
Nymphaea lotus	25
Onosma bracteatum	25
Rosa damascena	25
Armenian bole	25
Papaver somniferum	25
Eugenia jambolana seeds	25
Pomegranate flowers	25
Tin (calcined)	25
Gum arabic	25
Coral (calcined)	25
Triturated Pearls (calcined)	25
Doses: Two tablets twice a day with water (morning and evening).	
QURS GULNAR	
Acacia arabica	7.5
Rosa damascena	10.25
Sterculea urens	1.875
Pomegranate flowers	15.0
Gum arabic	3.75
Doses: Tablets prepared, to be administered with Ispaghul (in water) and cold water.	

Preparational	**Quantity (g)**
QURS KAFUR	
Santalum album	10
Bambusa arundinacea	15
Lactuca scariola	5
Glycyrrhiza glabra	15
Cochlospermum religiosum	10
Rosa damascena	15
Acacia arabica	30
Cucumis sativus	25
Lagenaria siceraria	25
Wheat starch	10
White sugar	100
Camphor	6
Liquid Paraffin	3 ml.
Soap stone	8
Magnesium carbonate	2
Doses: 4 tablets with 125 ml of Aqua *Onosma bracteatum* (*Arq Gaozoban*).	
KUSHTA BAIZA MURGH	
Eggs	250
Common salt	500
Water	1 L
Cow-dung cakes (*Uplay* for heating)	20 kg.
Lemon juice	250 ml.
Doses: 125 mg. or 2 tablets with 5 g. of *Jawarish Mastagi* or *Majun Supari Pak* (10 g) followed by 250 ml. of milk.	
KUSHTA KHUBS-UL-HADID	
Iron oxide	250
Vinegar	500 ml.
Blumea balsamifera	250
Emblica officinalis	250
Terminalia belerica	250
Terminalia chebula	250
Aloe barbadensis	250
Cow-dung cakes (*Uplay* for heating)	30 kg.

APPENDIX B

SOME POPULAR HERBAL DRUGS WITH REPUTED ANTIDIABETIC ACTIVITY

Group I
Plants with Confirmed Hypoglycaemic Action and Identified Active Constituents

Plant species Family	Part used	Hypoglycaemic chemical constituents	Particulars on action of principle
1	2	3	4
Allium cepa L. Onion (Liliaceae)	bulbs	Allyl-propyl disulphide (APDS), allicin (diallyl disulphide-oxide), methyl alliin in fresh juice (latter also bacteriostatic). Also in bulbs: flavonglycosides: kaempferol, quercitin and phloroglucin derivatives.	APDS produced in doses of 125 mg/ 50 kg in fasting humans significant fall of bloodsugar and rise of serum-insulin levels, no change in free fatty acids. APDS is believed to remove insulin-inactivating compounds by competing with insulin for the SH groups, thus having an insulin-sparing effect. The activity of petrol-ether and ethyl ether extracts of dried sliced onion were equivalent to 62 and 76% respectively of a tolbutamide standard. Inactive in depancreatized rabbits.

Contd.....

1	2	3	4
Allium sativum L. garlic (Liliaceae)	dried heads	organic sulphur compounds	Action of ethyl ether extract of dried *A. sativum* heads in 58% of tolbutamide standard.
Blighia sapida Koenig Akee apple (Sapindaceae)	fruit aril and seeds	Hypoglycin A=α amino-2-methylene-L-cyclo propylpropionic acid	Hypoglycaemic in most animals; acts also in depancreatized and adrenalectomized rats. The hypoglycins block oxidation of long chain fatty acids leading to loss of energy production for the organism, which reacts by increasing oxidation of glucose. Hypoglycin B produces congenital malformations.
	seeds only	hypoglycin B=γ-glutamyl-hypoglycin A	
Catharanthus roseus G. Don = *Lochnera rosea* (L.) Reichb = *Vinca rosea* L. Madagascar periwinkle (Apocynaceae)	leaves	Hypoglycaemic alkaloids catnaranthine (HCl) – 1 lochnerine – 2 tetrahydroalstonine – 3 leurosine sulphate – 4 vindoline (HCl) – 5 vindolinine (2 HCl) – 6 anthocyan ins in lvs.	The action of 4, 5 and 6 is stronger than that of tolbutamide at equivalent doses. 1-3 had a less pronounced action. The hypoglycaemic effect starts slowly and is relatively long lasting.

Contd.....

1	2	3	4
Ficus religiosa L. *Ficus bengalensis* L. Banyan *F. racemosa* L. *F. glome rata* Roxb. (Moraceae)	stem bark	β-sitosterol-D-glucoside bengalenoside = flavonoid-glycoside. `	Per-oral hypoglycaemic effect in fasting rabbits and in alloxan-diabetic and pituitary-diabetic rats comparable to that of tolbutamide. The pure principle produces in toxic doses stimulation of the CNS and reversion of depresssion induced by reserpine. Average LD_{50} in mice is 62 mg/kg intraperitoneally and a dose of 10 mg/kg is fatal in rabbits (death produced by convulsions) Bengalenoside is half as potent as tolbutamide.
Galega officinalis L. Goat's rue (Papilionaceae)	seeds	Galegine = isoamyleneguanidine	Acts like biguanides in blocking the oxidising enzymes of the Krebs cycle (succinic dehydrogenase and cytochrome oxidase). This leads to reinforcement of anaerobic glycolysis and reduced gluconeo-genesis, thus causing increased transfer of glucose from blood to tissues. Moderate effect and disagreeable taste

Contd.....

1	2	3	4
Momordica charantia L. Balsam pear African cucumber, Bitter gourd (Cucurbitaceae)	seeds	Charantin (momordicin) = phytosterolin or sterolglycoside = β-sitosterol + βD glucoside + 5-25 stigmadien 3 β-olglucoside	50 mg/kg doses reduce glycaemia by 42% in rabbits. Possesses pancreatic and extrapancreatic action and is more active than tolbutamide. Slight antispasmodic and anticholinergic effect controls but does not heal diabetic patients
Tecoma stans Juss. (Bignoniaceae)	leaves	Alkaloids: tecomine and tecostanine	Seems rather non-toxic, does not act in total absence of active β-cells of the pancreas
Trigonella foenum-graecum L. (Papilionaceae)	seeds	Alkaloid: trigonelline (N-methylnicotine acid) coumarin, nicotinic acid	The alkaloid counteracts the hyperglycaemic effect of cortisone given two hours beforehand or simultaneously. Variable effect in alloxan-diabetic rats and in diabetic patients. Nicotinic acid had a stronger hypoglycaemic action of short duration whilst the effect of trigonellin lasted in diabetic rats for 24 hrs.

Group II
Plants with More or Less Confirmed Hypoglycaemic Action
But with as Yet Unknown Active Constituents

Plant species Family	Part used	Known chemical constituents	Action of extract (or evaporation residue)
1	2	3	4
Arctium majus Bernh. *A. lappa* L. *Lappa major* Gaertn. *L. officinalis* All. Greater burdock (Compositae)	roots, leaves of plants without flowers (vegetative stage)	Bitter principle 'arctiopicrin' = sesquiterpenic lactone with antibiotic properties, 40-60% inulin, polyines and polyenes, In seeds glycoside: arctiin.	Pronounced and long-lasting oral hypoglycaemic effect in rats, repeatedly quoted as hypoglycaemic between 1930 and 1967. Has also anti-furunculous properties and acts on staphylococci infections.
Argyreia cuneata (Kerr) Choisy *Rivea cuneata* Wight (Convolvulaceae)	leaves	In leaves: heterosides of flavonoids In related *A. kurzei* Boer, phenolic heterosides derived from caffeic acid. In *A. nervosa* ergot alkaloids.	Clinical observations in India with an extract of the leaves in milk. Reduction of normal fasting blood sugar levels in rabbits by juice ≤15 mg

Contd.....

1	2	3	4
Coccinia grandis L. *C. indica* W. & A. *C. folia* (L.) Cogn. *Cephalandra indica* Naud. (Cucurbitaceae)	tuberous roots	Hypoglycaemic fraction in alcoholic and aqueous extracts of roots. Known constituents of root: caffeic acid, quercetin, kaempherol, β-sitosterol	Hypoglycaemic effect of alcohol extract in rabbits = 58.9% that of tolbutamide. Effect in alloxan diabetic rabbits is comparable to that of tolbutamide.
Gymnema sylvestre (Willd.) R. Br.	leaves	'Gymnemic acid' consists of at least 9 glycosides of narrowly related constitution	Reduces glycosuria and destroys the sense of sweetness and bitterness. Found in Tropical and South Africa, Australia and India.
Hordeum vulgare L. = *H. sativum* Pers. Barley (Gramineae)	germinating seeds (radicle)	Hypoglycaemic principle has to be freed from hyperglycaemic fraction (sugars and hordenine) and vit. B. Known constituents: Alkaloids: hordenine, gramine, enzymes: amylase, vitamins of group B, glucides, proteids, lipids.	Hypoglycaemic, reduces blood in fasting rabbits .by 37.9% and in diabetic patients by 25%. Produces strong reduction in elimination of acetone and oxybutyric acid and improves general condition. Is also diuretic and emollient.

Contd.....

1	2	3	4
Musa paradisiaca L. var. *sapientum* (L.) Kuntze = *Musa sapientum* L. Banana (Musaceae)	juice of flowers	Liquid extract of flowers, mainly 3rd fraction of non-saponifiable portion is hypoglycaemic. In bracts anthocyanidins, in fruits hydroxytryptamine, glucides	Hypoglycaemic in tests on fasting rabbits (reduction of 15-24 mg%).
Nymphaea lotus L. Lotus (Nymphaeacae)	roots	Alkaloids in *N. alba, N. lutea* and *N. lotus:* nymphaeine and cardiac glycoside: nymphalin in flowers	Reduces in doses of 10 mg/kg normal fasting blood sugar in rabbits by 14-15 mg%
Ocimum sanctum L. (Labiatae)	whole plant	Hypoglycaemic fraction in aqueous decoction of dried plant. Known constituents: Essential oil with estragol and methylchavicol	Hypoglycaemic action different from that of galegine

Contd.....

1	2	3	4
Syzygium cumini (L.) Skeels (syn: *S. jambolanum* D.C. = *Eugenia jambolana* Lam. = *E. cumini* Merr.) Jambul, Java plum (Myrtaceae)	seeds	Hypoglycaemic principle: 'antimellin' (glycoside). Known const. in seeds: phytosterin, jambosine (alkaloid), jambolan, essential oil, galli- and ellagi-tannins. In flowers and fruits: cyanidine-2-rhamnoglucoside	In cats and rabbits the alcoholic extract has oral hypoglycaemic action comparable to tolbutamide. In alloxan-diabetic rats the purified principle abolishes hyperglycaemia and glycosuria within seven days
Tinospora cordifolia (Willd.) *Miers=Cocculus cordifolius* D. = *Tinospora palminervis Miers=Menispermum cordifolium* Willd. Gulancha (Menispermaceae)	plant	Known constituents: alkaloids of the berberine group with isoquinoline base; bitter heterosides (picroretin, tinosporide, cordifolin) and glycosides (giloin, gilonin)	Hypoglycaemic also in alloxan-induced diabetes, is equally antipyretic. No effect on normal fasting rabbits.

Group III
Plants of which Both the Hypoglycaemic Action and Active Constituents Need Confirmation

Plant species Family	Part used	Known chemical constituents constituents	Uses Country
1	2	3	4
Acacia arabica (Lam.) Willd. = *A. nilotica* (L.) Willd. & Del. and other *A. spp.* (Mimosaceae)	gum, bark, seeds	Alkaloids of phenylethylamine tryptamine and B-carboline classes in many spp. of genus. In gum polysacharride.	Diabetes (India)
Actinodaphne hookeri Meissn. (Lauraceae)	leaves	Alkaloid: actinodaphnine=2-hydroxy-3-methoxynor-aporphine. In related *A. nitida* alkaloid: boldine and laurolitsine	Diabetes (India)
Adiantum caudatum L. *A. formosum* R. Br (Polypodiaceae)	plant (scales)	Triterpenoids in allied species	Diabetes (Peru, India)
Anacardium occidentale L. (Anacardiaceae)	leaves	Phenolic acids and flavonoids (quercetin and kaempferol hetero-monosides)	normalises glycaemia

Contd.....

1	2	3	4
Anticharis glandulosa Aschers. (Scrophulariaceae)	plant	—	Diabetes (India)
Artemisia cannariensis Nees (Compositae)	leaves flower buds	Vulgarinesesquiterpenic lactone	Hypoglycaemic
Bauhinia candicans Benth. (Caesalpiniaceae)	leaves	Alkaloids in allied species	Diabetes (Argentina)
Caesalpinia digyna Rottl. (Caesalpiniaceae)	roots	Bonducin (saponin) terpenic glycosides in allied spp.	Diabetes (India)
Casearia esculenta Roxb. (Flacourtiaceae)	root-bark	Resin, tannins, colouring matter, starch.	Diabetes (India)
1. *Cassia auriculata* L. 2. *C. glauca* Lam. 3. *C. fistula* L. 4. *C. sophera* L. (Caesalpiniaceae)	bark, leaves, seeds	Anthraquinones (rhein, chrysophanol), anthracenosides (sennosides A and B) root-bark phlobaphenes, tannins	Diabetes (India)

Contd.....

1	2	3	4
Ceiba pentandra (L.) Gaertn. (syn. *Eriodendron anfractuosum* D.C.) Silk cotton tree (Bombacaceae)	juice, roots, bark	Quercetin and kaempferol glucosides, traces of gossypiol, methylglucuronoxylan. In related *Adansonia digitata:* adansonia-flavonosides	Diabetes (India)
Cephalanthus glabrata (Spreng.) K Schum. (Rubiaceae)	stem-wood	Alkaloid in allied spp.	Diabetes (Argentina)
Cheilanthes pruinate Kaulfuss. 'Cuti-cuti' (Polypodiaceae)	—	Alkaloid cheilanthifoline in *Corydalis* spp.	Diabetes, also used in liver diseases (Peru)
Coptis teeta Wall. (Ranunculaceae)	rhizome	Alkaloids: berberine, coptine.	Slightly hypoglycaemic (China, Far East)
Cymbalaria muralis Gaertn., Mey. & Schreb. (syn. *Linaria cymbalaria* Mill.) Ivy-leaved toadflax (Scrophulariaceae)	plant	Alkaloid: peganine in certain Allied spp.	Diabetes (India)

Contd.....

1	2	3	4
Cynara scolymus L. Globe artichoke (Compositae)	flowerheads, receptacle leaves	Choleretic principle=cynarin, eynaropicrin= cynarogenin=cynarogenin (trihydroxysteroid) + cynarin, taraxasterol, sitosterol, stigmasterol, inulin, luteolin, 7-glucoside	Hypoglycaemic? Mainly choleretic hypocholesterizing
Dermostachys bipinnata Stapf. = *Uniolo bipinnata* = *U. cynusoroides* Beauv. (Gramineae)	plant	—	Hypoglycaemic (Israel)
Eucalyptus globulus Labill. (Myrtaceae)	leaves	Complex phenolic heterosides (calyptoside)	Active in alloxan-diabetic rabbits not in rats
Feronia limonia (L.) Swingle, Wood apple (Rutaceae)	fruit pulp	Essential oil in leaves	Slightly hypoglycaemic (India)
Glycyrrhiza glabra L. Liquorice (Papilionaceae)	roots	Rhamnoliquiritin, liquoric acid (triterpenoid), glycyrrhizic acid etc.	Sweetening agent

Contd.....

1	2	3	4
Helicteris isora L. (Sterculiaceae)	juice of roots	—	In diabetic empyema
Kandelia rheedii W. & A. *K. candel* (L.) Druce (Rhizophoraceae)	bark	(With ginger or long pepper and rose water as a cure)	Diabetes (India)
Kickxia ramosissima (Wall.) Janchen = *Linaria* ramosissima Wall. (Scrophulariaceae)	plant	Alkaloids	'Remedy' in diabetes (India)
Lupinus albus L. White lupin (Papilionaceae)	seeds (decoction)	Alkaloids (lupanine etc.) in *L. luteus,* alk. lupinine = cardiac poison	Increase glucose tolerance (Europe)
Maytenus senegalensis (Lam.) Excell- *Gytnnosporia montana* (Roth) Benth= *G. senegalensis* (Lam.) Loes = *Celastrus senegalensis* Lam. (Celastraceae)	leaves	Hexacosane, hexacosanol, antibetulin, β-sitosterin.	Diabetic

Contd.....

1	2	3	4
Notholaena aurea (Poiret) Desv. *N. nivea* (Polypodiaceae)	leaves	Chalcone (ceropten) in allied Polypodiaceae.	Diabetes (Peru)
Olea europea L. Olive tree (Oleaceae)	leaves	Oleuropeoside-oleuropein (bitter heteroside) verbascoside = orobanchoside (chromogene) luteolin-7-glucoside, olivin-4'-diglucoside (chalcone)	Hypoglycaemic and also hypotensive. Hypoglycaemic effect to be checked
Phyllanthus sellowianus Mull. Arg., *P. niruri* L. (Euphorbiaceae)	leaves	Flavonoids (phyllanthin and hypophyllanthin), astralgin, quercetoside, quercitrin, leuco-delphinidin alkaloids (norse-curinine isomer)	Diabetes (India)
Pithecellobium bigeminum Benth	seeds	Alkaloids, saponin	Diabetes (India)
Pterocarpus marsupium. Roxb. Kino (Papilionaceae)	wood	Kino-tannic acid	Hypoglycaemic in 7% of cases. Aids renal glucose retention

Contd.....

1	2	3	4
Quercus robur L. Oak *Quercus infectoria* Oliv. (Fagaceae)	shell of acorn gall	Flavonoid (quercitroside) in penta-o-galloyl-glucose	Hypoglycaemic in rabbits
Rehmannia glutinosa Liboch (Scrophulariaceae)	plant	Hypoglycaemic principle in alcoholic extract	Sub-cutaneous injection hypoglycaemic in rabbits last 5 hrs. (China)
Rhizophora mucronata Lam. *R. mangle* Roxb. Mangrove (Rhizophoraceae)	bark, roots	Decoction = hypoglycaemic 15-42% catechins and tannins	Diabetes (India)
Rhus typhina L. Sumac, Staghom shrub (Anacardiaceae)	leaves	Tannins, phenolic compounds	Hypoglycaemic (Canada)
Rosa eanina L. Dog rose (Rosaceae)	fruits	Flavonoids, carotinoids 30% glucides, Vitamin C	Diabetes (Italy)

Contd.....

1	2	3	4
Salacia retieulata Wight (Celastraceae)	root-bark	Dulcitol	Diabetes (India)
Salvia officinalis L. Sage (Labiatae)	leaves	Diterpenoid bitter principle = picrosalvin = camosol. Oestrogenic substance (1-2% of dried plant; essential oil (lineol, borneol, thuione)	Also antipyretic. Oil = bactericidal (Southern Europe)
Striga gesneroides (Willd.) Vatke (*S. orobanchioides* Benth.) (Scrophulariaeeae)	plant	—	Diabetes (India)
Tephrosia villosa Pers. (Papilionaceae)	leaves (juice of)	Dimethyloxyacetones tephrosin and deguelin in leaves of allied species. Glucoside oxyritin in *T. purpurea*	Diabetes (India)
Torenia asiatica L. (Scrophulariaceae)	plant	—	Diabetes (Ceylon)

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