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Cholesterol & its Ayurvedic Complement – Depicting its role in Pathogenesis as well as Management of Diabetes

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ABSTRACT

Role of cholesterol in the pathogenesis of diabetes is the emergent area of research with full of potential; it not only open a vast area of therapeutic interventions but also can change the prevailing treatment modality. Ayurveda, the Indian system of medicine materialize the concept of lipocenteric approach for the management of diabetes even thousands of years back. According to Ayurveda, the natural properties of lipid are deranged that causes diabetes. It may prove beneficial to quest the search of herbal remedies that can harmonize the lipid balance and uproot the pathogenesis. In the presenting review article, role of cholesterol in the pathogenesis of diabetes is discussed along with detailed description of Ayurvedic concepts regarding pathogenesis and a brief description of herbal management.

Key words: *Lipids, Prameha, Kapha, Herbs, Rasayana.*

INTRODUCTION

Global burden due to diabetes rising steeply affecting >422 million individuals worldwide.[1] Its alarming prevalence has dreaded impact on health sector due to poor quality of life caused by long term complications and associated medical cost. The most disgusting fact related to diabetes is that despite of tremendous effort made by researchers there is still no ray of relief is evident in the near future. More than 90% of all cases accounts for type 2 diabetes and is characterized by insulin resistance as well as pancreatic B cell dysfunction (to what extent B cell are involved in the pathogenesis is disputable).[2] Alteration in pancreatic B cell function causes impaired insulin secretory response to the glucose and this characterized transition from the pre-diabetic to the diabetic state.[3] Recent researches have shown that hyperlipidemia plays decisive role in the pathogenesis of B cell dysfunction.[4] Association of dyslipidemia with diabetes is already well established and role of elevated free fatty acids (FFAs) is well defined and studied extensively[5] but now one more link is added in this pathogenesis. This new linkage is hunting the role of cholesterol in glucose- stimulated insulin secretion from pancreatic B cell. Cholesterol has assigned many important functions in cellular domain. One of its major functions is regulation of signal transduction through membrane microdomain and gene expression through cholesterol- activated transcription factors.[6] Intracellular cholesterol regulates glucose metabolism and gene expression in adipocytes.[7] Disturb metabolism of cholesterol (involving synthesis, storage or excretion) could result in disruption of any one pathway of glucose stimulated insulin secretion to partial or complete loss of secretory functions of pancreatic B cell. Cholesterol is a very important bimolecule with diverse functions ranging from membrane trafficking and signal transduction to its role in embryogenesis.[8] With the advancement in science our insight for this miraculous biomolecule also enhances lifting the veil from its physiological and pathological functions. Cholesterol

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is present in tissues and in plasma either as free cholesterol or as a storage form, combined with a long chain fatty acid as cholesteryl ester. Cholesterol is required to build as well as to maintain cell membrane; it imparts membrane fluidity and mobility.[9] Within the cell membrane it also helps in intracellular transport, cell signaling and nerve conduction.[10] It form lipid rafts along with sphingolipids for cellular signaling.[11] Its de novo synthesis is a complex process and tightly regulated by hormones, HMG Co-A reductase and gene transcription.[12] Uptake of cholesterol is measured by sterol - sensing protein. Binding of cholesterol to sterol sensing protein initiates degradation of HMG-Co A reductase.[13] The most important step in its metabolism is its transport in plasma. In plasma, both forms are transported in lipoproteins. Plasma low-density lipoprotein (LDL) is the vehicle for uptake of cholesterol and cholesteryl ester into many tissues. Free cholesterol is removed from tissues by plasma high - density lipoprotein (HDL) and transported to the liver, where it is eliminated from the body either unchanged or after conversion to bile acids in the process known as reverse cholesterol transport. Membrane fluidity as well as curvature is strongly modulated by the amount of cholesterol present in the membrane and therefore membrane microdomains of B cell can enhance cell signaling by depleting or overloading cholesterol and modulate glucose stimulated insulin secretion (GSIS).[14] Cholesterol alteration also affects glucose metabolism involving glucokinase.[15] Research studies have shown that excess cellular cholesterol is directly linked to reduced glucose sensitive insulin secretion and also that normal secretion can be restored by cholesterol depletion.[16] Elevated serum cholesterol causes increased cholesterol in pancreatic B cells that directly and significantly modulate the insulin secretion independent of FFA levels. Thus, it is now postulated that cellular cholesterol will be a potential target for therapeutic intervention aimed to preserve or improve pancreatic B cell functioning through modulating GSIS. Fryris et.al. postulated that cholesterol is a key determinant of beta cell membrane organization and cell survival.[17] They suggest that different lipoprotein classes have varying effect on beta cell function and survival. Further they concluded that cholersterol can cause B cell loss if allowed to accumulate in cell in an unregulated manner and therefore it is utmost important to maintain beta cell cholesterol homeostasis. *C. Langhi* and *B. Carjou* in their article also stated that dysregulation of plasma lipoproteins with increased TG content in pancreatic B cell leads to lipotoxicity and subsequently cell death.[18] They also emphasize the role of cholesterol modulators like ATP binding cassette transporter A1 and LDL receptor.

Complement of Cholesterol in Ayurveda

Kapha is known by a number of synonyms. Of these, *Shleshma, Bala, Ojas, Mala* and *Papma* are important. The former three refer to its normal states of functioning, while latter two to abnormal states. *Kapha* is the product of water. The synonym, *Shelshma,* which is used as frequently as the term *Kapha* is derived from the root '*Shlish Alingane'* meaning *Shlish* is to embrace, to cohere or to keep together. Charaka considers that *Kapha,* in its normal states of functioning represent a potential source of strength and resistance to disease and decay i.e. *Bala* and *Ojas.* These terms refer to that power or force which resists the factors of decay and disease. *Bala* may be *Sahaja* (innate, natural or inherited), *Kalaja* (seasonal) and *Yuktikrita* (acquired). Sushruta has used the term *Bala* to signify *Ojas* and stated that "*Bala* is the power (of the body) sufficient to resist disease".

Relation between *Kapha* (cholesterol) and *Meda* (adipose tissues)

It has been stated that , among seven *Dhatus* (the seven kinds of primary tissue - elements), *Rasa* (lymphoid plasma), *Mamsa* (muscle tissues), *Medas* (adipose tissues), *Majja* (marrow tissues) and *Sukra* (the male reproductive element) are seats of *Kapha*. It has also been stated that the *Ojas,* a synonym of *Kapha*, is an essential factor of all *Dhatus* (tissues) of the body.

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Table 1: Showing correlation between Lipids and *Kapha* on the basis of their physical properties and biological functions

Lipids		***Kapha***	
Physical characteristic	**Biological functions**	**Physical characteristic**	**Biological functions**
Lipids are group of natural occurring molecules that include fat, waxes, sterols etc., and *lipid* is frequently used as a synonym for fats. Lipid molecules with long carbon chains have high molecular weight like cholesterol have molar mass 386.65 g/mol, fat have 228.98 g/mol and fatty acids like oleic acid have molar mass 282.46 g/mol, etc. Lipids are oily to the touch; they are soft greasy/ slippery or viscous substance.	Storage of energy. Synthesis of cell membranes. Maintaning fluidity and flexibility of the membrane. Regulation of steroid hormone. Act as intracellular signaling molecule. Maintenance of body temperature. Play an important role in pain, fever, inflammation and blood clotting.	*Sneha*, (unctuousness), *Guru* (heavy), *Shita* (cool), *Mrudu* (soft), *Snigdha* (viscous), *Shouklya* (whitishnes), *Madhura* (sweet), *Sara* (firm), *Sthira* (stable, sturdy) and *Pichchila* (slimy), *Sandra* (dense formed, firm or compact).	*Snehana* (the promotion of unctuousness), *Bandhana* (keeping together), *Sthiratwa* (providing stability), *Gaurava* (heaviness), *Vrishatwa* (providing sexual potency), *Ropanam* (promotion of healing and reparative processes), *Puranam* (fulfilment or providing energy), *Bhrimhanam* (promotion of growth, regeneration), *Tarpanam* (providing nutrition), *Sthairyakrita* (confers stability and firmness), *Visarga Karma* (anabolic activity)

Table 2: Relation between types of *Kapha*, Lipids and related diseases

Types of *Kapha*	**Lipids**	**Disease due to vitiation of Kapha/ lipids**
Kledaka	Cholesterol present in bile acids	*Grahani* (Steatorrhea), *Pandu* (spur cell anemia)[3] *Kamala* (obstructive jaundice, intrahepatic cholestasis) etc.
Avalambaka	Neutral lipids including cholesterol, phospholipids, present in heart muscles mitochondria and microsomes.[1] HDL, LDL, VLDL and cholesterol present in blood.	*Hridroga* (Cardiomyopathies, Coronary artery disease,, Myocardial Infarction, etc.) Dyslipidemia,
Slesmaka	Cholesterol and phospholipids present in synovial fluid	*Amavata* (Rheumatoid Arthritis), *Sandhivishlesha* (Osteoarthritis), *Kaphaja Vatarakta* (Psoriatic arthritis)
Tarpaka	glycerophospholipids, sphingolipids, and cholesterol present in	*Dhriti – Smriti bhransa (*memory disorder,

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	CSF and cholesterol, phospholipids, and glycosphingolipids in myelin sheath	Alzheimer's disease, Nuro-degenerative diseases, Smith-Lemli-Opitz syndrome, Niemann- Pick type- C disease).
Bodhaka	fatty acids, cholesterol, monoglycerides, diglycerides and triglycerides present in saliva.	

Fig. 1: Diagrammatic representation showing Bio-constituents of *Kapha* and *Meda Dhatu*.

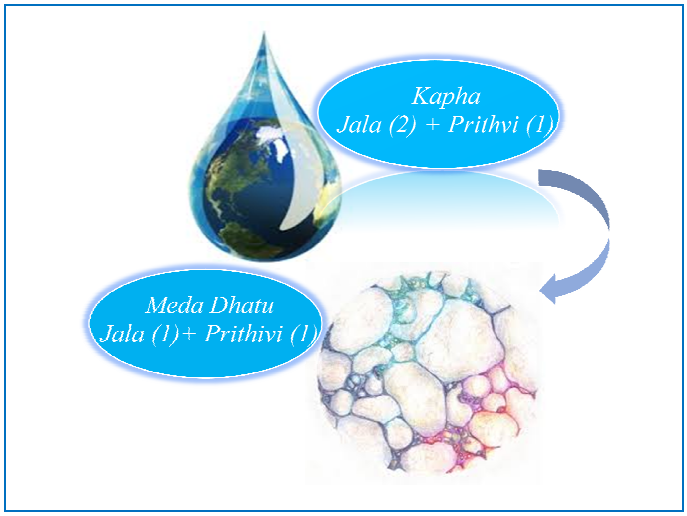


Fig. 2: Biological Functions of Lipids.

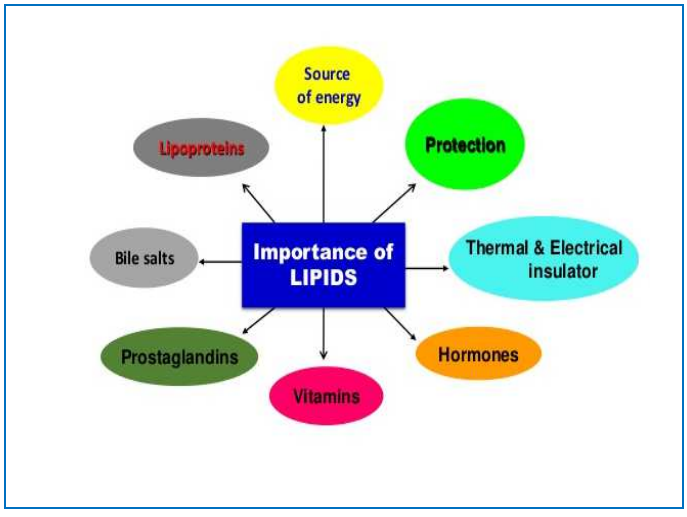


Fig. 3: Role of *Kapha* in Metabolism of Lipids.

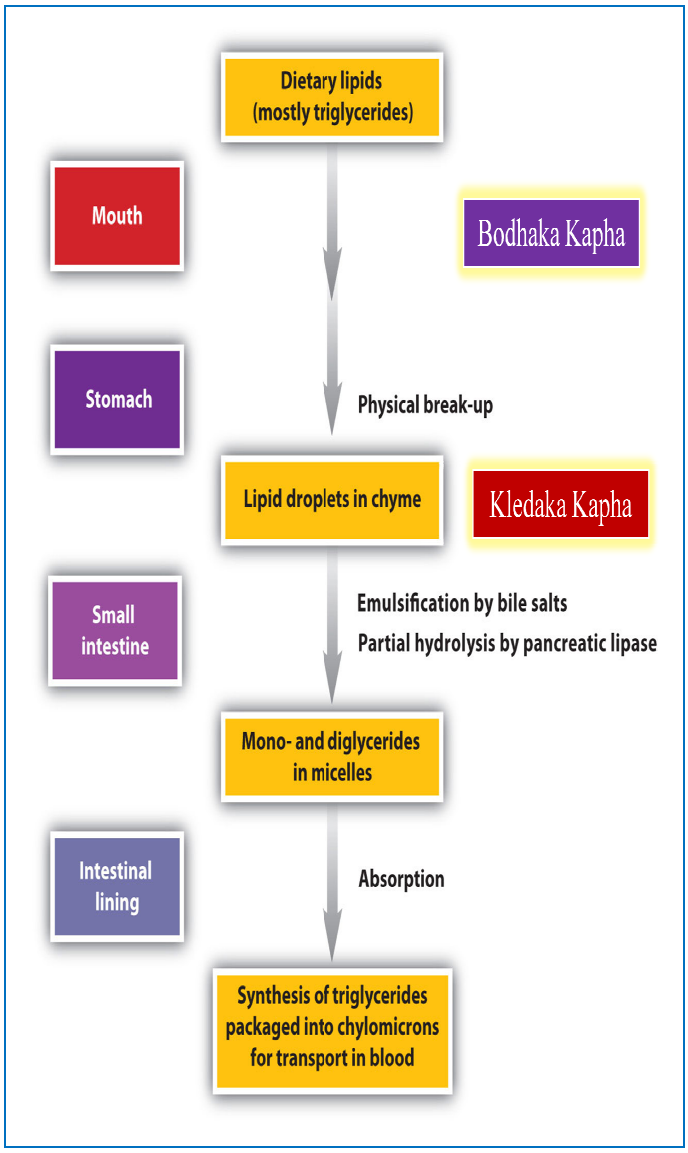
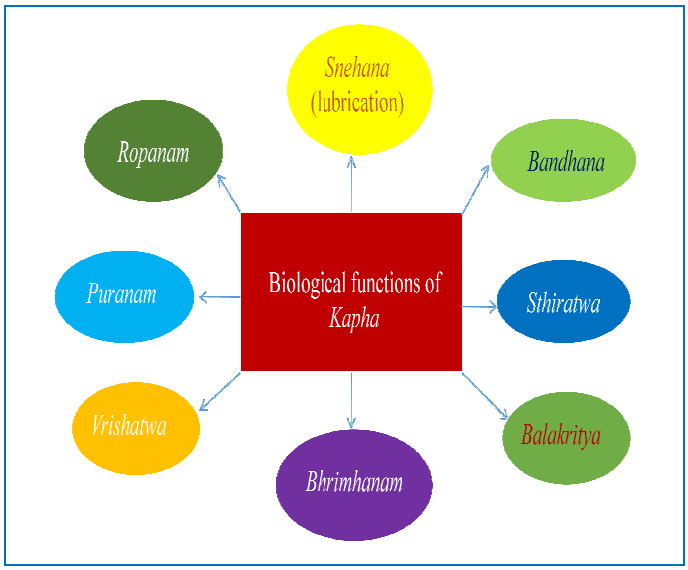


Fig. 4: Biological functions of *Kapha*.



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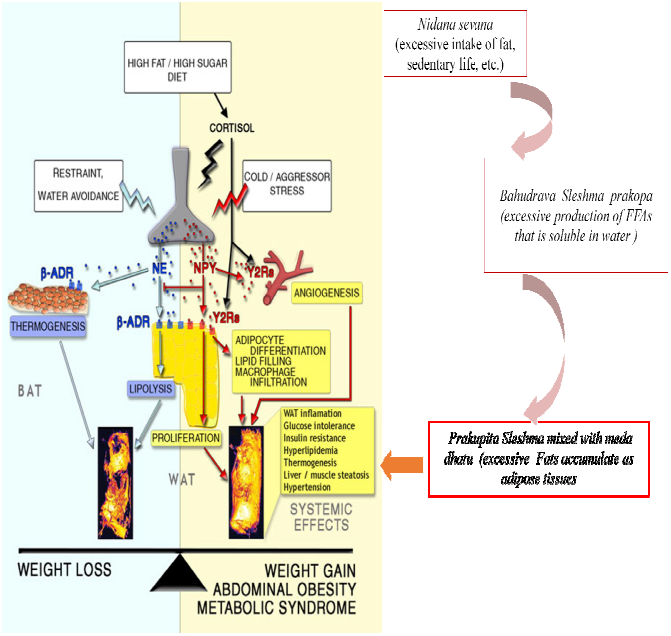

Vitiated *Kapha* causing *Prameha* (Diabetes Mellitus)

Charaka Samhita has firmly established the relationship between obesity and *Prameha*. The role of *Meda* (fat/ adipose tissue) is of great importance in the pathogenesis of *Prameha*. Its role is not only as *Dushya* (disturbed functioning of the *Dhatus*), but something more than that. According to Charaka Samhita, *Bahudrava Shlema* (*Kapha* that contains too much liquid) joins and affects *Meda*, causing it to become *Abadha* (unobstructed or fluid) in nature.[19] This form of *Meda* has been described as acting on *Mamsa* (muscle tissue), thereby increasing the volume of body fluid. This has been described as *Sharira- Kleda* (body fluid) in Ayurveda. Thus, excess water in the blood causes increased diuresis. This route of pathogenesis for *Prameha* is closely related to obesity.

The role of *Meda* (fat/adipose tissues) is of great importance in the pathogenesis of *Prameha*. Its role is not as *Dushya* (disturbed functioning of the *Dhatus*), but something more than that. According to Charaka Samhita, *Bahudrava Shleshma* (*Kapha* that contains too much liquid) joins and affects *Meda*, causing it to become *Abaddha* (unobstructed or fluid) in Ayurveda. This has been described as *Sharira- Kleda* (body of fluid) in Ayurveda. Thus, excess water in the blood causes increased diuresis. It is very important to elaborate the term *Bahudrava Slesma*. *Sleshma/ Kapha* is one among the three basic humor regulating all physiological and psychological process in the living organism. At its normal state it cause binding of body tissues i.e. maintain the tissues integrity, represent the normal cell mediated immunity etc. *Bahudrava* means that *Kapha* loses its natural properties and get vitiated, it is worthful to mention here that this derangement may be acquired or congenital, Whatever may be the cause this vitiated *Kapha* is unable to perform its normal functions. Describing the physical properties of *Kapha* it is mentioned that it is unctuous in touch and look like *Ghrta* (ghee). Thus it can be said that *Kapha* in body represents lipid components of the body and vitiated *Kapha* can be correlated with dyslipidemia. Role of dyslipidemia and metabolic abnormalities in the pathogenesis of diabetes is very obvious and well elaborated in modern medicine. Among the metabolic abnormalities that commonly accompany diabetes are disturbances in the production and clearance of plasma lipoproteins. Moreover, development of dyslipidemia may be a harbinger of future diabetes. A characteristic pattern, termed diabetic dyslipidemia, consists of low high density lipoprotein (HDL), increased triglycerides, and postprandial lipemia. This pattern is most frequently seen in type 2 diabetes and may be a treatable risk factor for subsequent cardiovascular disease.

Management of *Kaphaja* disorders

Use of Herbs

Acharya Charaka mentioned a group of ten drugs that should be used for scraping the excessive fat known as *Lekhaniya drugs.* All these ten drugs are found to have hypolipidemic effects *Musta* (*Cyperus rotandus* Linn.), *Kustha* (*Saussurea lappa* C.B.Clarke), *Haridra* (*Curcuma longa* Linn.), *Daruharidra* (*Berberis aristata* D.C.), *Vaca* (*Acorus calamus* Linn.), *Ativisa* (*Aconitum heterophyllum* Wall.), *Katurohani* (*Picrorhiza kurroa* Royle ex Benth.), *Citraka* (*Plumbago zeylanica* Linn.), *Cirabilva* (*Pongamia pinnata* Merr.) and *Hemavati* (*Iris versicolor*) are ten drugs given by Acharya Caraka to reduce body fats. Charaka Samhita has been claimed to be effective in *Medoroga* (lipid disorder).

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1. ***Musta* (*Cyperus rotandus* Linn.):** *Nagarmotha* or *Musta* is reported to have significant hypolipidaemic activity.[20] Administration of C. rotundus extract at 250 mg/kg and 500 mg/kg as well as the hypolipidemic drug, simvastatin at 5 mg/kg found to caused a significant (p = 0.05) decrease in serum total cholesterol and LDL cholesterol. Triglyceride was also significantly reduced at 500mg/kg extract and simvastatin at 5mg/kg but the decrease at 250 mg/kg extract was not significant. In this study the level of HDL cholesterol was significantly (p = .05) increased in the treatment groups.[21] *Nagarmotha* is found to increase reabsorption of bile salt and thereby regularize the hepatic liposynthesis it reverse cholesterol transport pathway, in which HDL cholesterol induces an efflux of excess accumulated cellular cholesterol and prevents the generation of an oxidatively modified LDL. C. rotundus is found to reverted the age associated increased level of total cholesterol and LDL cholesterol to the level of young control rats.[22] The beneficial effect of cholesterol lowering activity of C. rotundus could be attributed to β-sitosterol and saponin that are well known for their cardioprotective properties by lowering the cholesterol.[23],[24]

2. ***Kustha* (*Saussurea lappa* C.B.Clarke):** *S. lappa* Clarke of Compositae is known as *Kushta* in Sanskrit. It is a tall, robust, perennial herb distributed in Kashmir. The roots are hot, bitter, sweetish, pungent, and flattering. It is used as an analgesic, digestive, aphrodisiac and diuretic. Some authors have reported that the roots of this plant possess cortisol-lowering effect.[25],[26] Traditionally, aqueous extract of the root of *S. lappa* was used for its anti-anginal effect.[27] The hot water extract of the roots has been traditionally used for the treatment of asthma,[27],[28] inflammations and rheumatism.[29],[30] Ethanolic extract of *S. Lappa* showed significant hypolipidemic activity which may be due to presence of tannins, triterpenes, alkaloids, inulin, essential oil in its root. Treatment with ethanolic extract of *S. Lappa* significantly reduced serum and tissue cholesterol, LDL-C. HDL-C level in both serum and tissue are significantly increased by ethanolic extract of *S. Lappa.*[31] *Saussurea lappa* is one of the antioxidant - rich medicinal plants.

3. ***Haridra* (*Curcuma longa* Linn.):** The metabolite of C. longa – curcumin (0.5%) is found to significantly decrease the cholesterol, LDL, VLDL, triglycerides and phospholipids in Streptozotocin-induced diabetic rats. In a parallel study, wherein diabetic animals were maintained on a high cholesterol diet, the extents of hypercholesterolemia and phospholipidemia were still higher compared to those maintained on control diet. Curcumin exhibited lowering of cholesterol and phospholipid in these animals also. Liver cholesterol, triglyceride and phospholipid contents were elevated under diabetic conditions. Dietary curcumin showed a distinct tendency to counter these changes in lipid fractions of liver. This effect of curcumin was also seen in diabetic animals maintained on high cholesterol diet. Dietary curcumin also showed significant countering of renal cholesterol and triglycerides elevated in diabetic rats. Curcumin enhances liver cholesterol catabolism as evidenced by increase in hepatic cholesterol-7a-hydroxylase activity.[32-37]

4. ***Daruharidra* (*Berberis aristata* D.C.):** According to Ayurvedic pharmacopeia of India, *B. aristata* DC is used in diabetes. Diabetes mellitus is one of the most common chronic diseases and is associated with hyperlipidemia and co-morbidities such as obesity and hypertension. *B. aristata* at the dose of 25 mg/kg revealed a significant reduction in serum cholesterol, triglycerides and LDL-C.[38] The hypolipidemic effects of *B. aristata* may be due to the presence of berberine alkaloid, since berberine act at both endothelium and the underlying vascular smooth muscle to induce relaxation.[39] The strong antihyperglycemic effect of methanolic extract of *B. aristata* DC stem could indirectly be related to beneficial

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action against the abnormal high concentration of serum lipids observed in diabetes rats.[40]

5. ***Vaca* (*Acorus calamus* Linn.):** *A.calamus*. Linn. (Araceae), commonly known as "sweet flag" or "calamus", is a semiaquatic, perennial, aromatic herb with creeping rhizomes. *A. calamus*. Linn. has been used as traditional Indian and Chinese prescriptions for its beneficial effects on memory disorder, learning performance, lipid peroxide content, and anti-aging and anticholinergic activity. Moreover, pharmacological studies have revealed that *Acorus*. rhizome and its constituents, particularly α.- and β.-asarone, possess a wide range of pharmacological activities such as sedative, CNS depressant, behavior modifying, anticonvulsant, acetylcholinesterase inhibitory, memory enhancing, anti-inflammatory, antioxidant, antispasmodic, cardiovascular, hypolipidemic, immuno suppressive, cytoprotective, antidiarrheal, antimicrobial, anthelmintic, insecticidal, adulticidal, diuretic, antioxidant, genotoxic, and mutagenic activities.[41] Administration of the 50% ethanolic extract (100 and 200 mg/kg) as well as saponins (10 mg/kg) isolated from the extract demonstrated significant hypolipidemic activity.[42] Apart from its insulin sensitizing effect, A. calamus extract may have hypoglycemic effects via mechanisms of insulin releasing and alpha-glucosidase inhibition, and thus improves postprandial hyperglycemia and cardiovascular complications.[43]

6. ***Ativisa* (*Aconitum heterophyllum* Wall.):** *Ativisha* (*Aconitum heterophyllum* wall) of family Ranunculaceae is an Ayurvedic herb which is known for its important medical properties. It is a tall herb and its roots are tuberous and paried. Based on morphology and anatomy, several forms of A. heterophyllum are recognized (white, Yellow, Black and Red) amongst which the white variety is the best.[44] Aconitum heterophyllum is an endangered Himalayan plant. The subterranean part of the plant is used for the treatment of diseases like nervous system disorders, fever, diarrhea, obesity, etc. The A. heterophyllum treatment markedly lowered total cholesterol, triglycerides and apolipoprotein B concentrations in blood serum. It also showed positive effects (increase) on serum high-density lipoprotein cholesterol (HDL-c) and apolipoprotein A1 concentrations. On the other hand, A. heterophyllum treatment lowered HMG- Co A activity, which helps to reduce endogenous cholesterol synthesis and also activated lecithin-cholesterol acyltransferase (LCAT), helping increase in HDL-c.[45]

7. ***Katurohani* (*Picrorhiza kurroa Royle* ex Benth.):** Due to high Glycoside content it has potent anti-hyperlipidemic activity. The alcoholic, chloroform and aqueous root extracts of *P. kurroa* Royle ex Benth showed significant antihyperlipidemic activity in Triton wr- 1339 induced albino rats with Atorlip-20 as reference standard.[46] It enhances the bile secretion through liver, improve the reestrification of long chain fatty acids and increase the production of HDL.

8. ***Cirabilva* (*Pongamia pinnata* Merr.):** *Cirabiva* is one among four varieties of *Karanja* - an ancient Ayurvedic herb described in Rigveda and Atharvaveda. It is mainly use to pacify *Kapha-Vata Dosha.* Methanolic extract of flower and pod of P. *pinnata* showed significant hypoglycemic activity in the Streptozotocin induced diabetic rats.[47] Insulin deficiency or insulin resistance is associated with hypercholesterolemia and hypertriglyceridimia.[48] *P. pinnata* pod and flower extract are found to significantly decrease the level of cholesterol, LDL, VLDL, triglycerides and increase the level of HDL. HDL improves the reverse cholesterol transport that further improves the removal of excessive cholesterol from non-hepatic tissues to liver thereby enhancing its excretion in the form of VLDL.

9. ***Citraka* (*Plumbago zeylanica* Linn.):** *P. zeylanica* Linn. extract is found to decrease intestinal cholesterol absorption and lower the activity of

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lipogenic enzymes like HMG CoA reductase in the liver thus also helps in decreasing the cholesterogenesis. Additionally it also reduced the total lipid content in the liver. Moreover, the aqueous extract demonstrated a potential antioxidant capacity in DPPH and TBARS *in vitro* antioxidant assay.[49]

10. ***Hemavati* (*Iris versicolor*):** It is a controversial drug because in Samhita the term *Hemavati* is also used for *Vaca* (*Acorus calamus*), but in this context *Vaca* is already described therefore *Iris versicolor* is taken for *Hemavati*. Very few scientific research studies are available for evaluating hypolipidemic effect of *Iris versicolor*. One such study showed its effect on norepinephrine stimulated fat cells where it increases the concentrations of glycerol and FFA further and increase in FFA can be accounted for the reduction in the process of reesterification. It is known that reesterification occurs concurrently with liberation of FFA during the process of lipolysis, and L. glycerophosphate is required. This result indicates that this has independent lipolytic effect on adipose tissue to mobilize fat. The lipolytic effect on adipose tissue may be directly and/or through catacholamines. There are evidences that central neuron system had ability to specifically control lipid mobilization without affecting glucose homeostasis. As for the neurochemistry is concerned, norepinephrine, released from brain neurons (by the action of drugs) mobilizes FFA in rats by activation of B receptors in the adipocyte plasma membrance.[50]

11. ***Guggulu (Commiphora mukul)*:** The gum resin of the *Commiphora mukul* is found to possess hypolipidemic activity. In an experiment, in-vitro administration of *Commiphora mukul* gum resin extract and medium-chain triglyceride found to significantly reduced low-density lipoprotein cholesterol and increased the high-density lipoprotein/low-density lipoprotein ratio. The combination showed direct inhibition of HMG-CoA reductase activity in a dose-dependent manner and compared very well with the inhibitory effect of statins like Pravastatin and Mevastatin. The adipocyte differentiation was also inhibited. It is found to increased the AMPKα phosphorylation and AMPK kinase activity and inhibited the phosphorylated form of mTOR expression. It also highly upregulated the expression of LXR and PPARα genes and moderately upregulated BABP and SHP genes.[51]

12. ***Sunthi (Zinziber officinalis)*:** It has been found that oral administration of ginger extract showed hypolipidemic effect in *Vanaspati* supplemented rats.[52] Zinziber extract lowers the lipid level by disrupting the cholesterol absorption and also by inhibiting liver lipogenesis.[53],[54] Evidence suggest that ginger contains antioxidant properties which have a hypocholesterolemic effect and anti-atherogenic and these activities might be attributed to the inhibition of LDL oxidation and the suppression on the activity of HMG-CoA (3-hydroxy- 3methyglutaryl co-enzyme A) reductase.[55] This also might occur due to the elevation of hepatic cholesterol 7-alpha-hydroxylase activity, which is a rate-limiting enzyme in the biosynthesis of the bile acids and stimulates the conversion of cholesterol to bile acids leading to the excretion of cholesterol from the body.[56]

Use of Herbo- Mineral Preparation - *Arogyavardhini Vati*, a traditionally used Ayurvedic medicine may be a useful therapy for hypercholesterolemia through reducing oxidative stress (decreasing MDA and increasing GSH) and lipid levels. *Arogyavardhini Vati* significantly decreased serum cholesterol, triglyceride, LDL, and C-reactive protein (CRP) and significantly increased serum HDL in a dose-dependent manner. Decreased MDA and increased GSH levels in liver were observed at all doses of *Arogyavardhini Vati* (50, 100, 200 mg/kg) and fenofibrate - treated groups when compared with Triton-treated group. Atherogenic Index (AI) level was significantly decreased in fenofibrate and *Arogyavardhini Vati* (200 mg/kg) treated rats when compared with normal control.[57]

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***Pancakarma* Procedures:** Purificatory procedures of *Panchakarma* are extremely helpful in maintaining the homeostasis of lipids in blood.

Role of *Vamana*: Expulsion of vitiated *Doshas* through oral route is known as *Vamana*. Procedure of *Vamana* consist of following steps:

- **Step I -** *Deepan - Pachan* (use of carminative and digestive drugs) with *Panchakola Churna* (mixture of *Piper longum, Plumbago zeylanica*, *Zingiber officinale, Piper chaba Hunter* powder in equal amount) powder in the dose of 3gm given twice in day with lukewarm water-orally for 3 days.
- **Step II -** *Snehapan* (oleation therapy) with *Triphala Ghrita* - orally 3-7 days in the increasing order dose to be decided according to the *Koshtha, Prikriti, Satva* and *Agni* of the patients.
- **Step III -** *Vamana Karma* - Paste of *Madanphala Churna* - 5gm, *Vacha Churna* - 3gm, *Saindhav Lavana* - 2gm, *Madhu* - 5gm, Milk - 4 liter- orally - O.D /Madhuyasti Phanta/ nimbadi kwath - 3 liter- orally - O.D

Role of *Lekhaniya Basti:* *Lekhan basti* is mentioned by different Acharyas for *Kaphaja Roga* (diseases due to dyslipidemia, hypercholesterolemia) and *Kaphavrita Vata.* The word *Lekhana* itself indicates its action means - "*Lekhanam Karshanam*". Thus *Lekhan* is nothing but a process of emaciation while Sharangadhara considered *Lekhana* in a wide sense, i.e. *Lekhan* is a process of drying up or desiccation of all excess *Dosha, Dhatu* and *Mala* i.e. "*Deha Vishosanam* ". The drugs of *Lekhan Basti* are described as follow,

1. ***Kwatha Dravya*** (drug used for decoction)- (a) *Triphala*- 30 gm (b) *Nagarmotha*-10gm (c) *Guduchi*- 10gm (d) *Amalthas*- 10 gm (e) *Madanphala* – 10 gm
2. ***Kalka Dravya*** *(*drug used for making paste*): Triphla churna* – 5gm *Yavakshar churna*- 5gm, *Pippali churna* – 5gm, *Madhuyasti churna*- 5 gm + Madhu -25 gm +Sarshap Tail- 50 ml + Gomutra- 150 ml

Note: These quantities are required for preparation of 300 ml of *Lekhaniya Basti.*

***Rasayana* Therapy:** In Charaka Samhita, Acharya Charka descried a cluster of symptoms that appears due to faulty dietary habits, faulty life style and faulty thoughts what we know today as Metabolic Syndrome. *Acharya* says that excessive use of cultivated grains, vegetable, fruits and poultry products without appropriate work out (exercise), sedentary life style, unstable emotions like excessive fear, grief, greed, stress, etc. produces an array of syndrome that should be treated with *Rasayana* only.

The success of *Rasayana* therapy lies mainly in its multi-pronged approach in controlling health, while pacifying the disease. As any other therapy, this also has a set of rules to be adapted for its application. The outcome of *Rasayana* therapy depends upon the degree of adapting and observing these procedures. That includes *Purvakarma* (before procedures), *Pradhanakarma* (main procedure) and *Pashcatakarma* (after procedures).

Purva karma includes the *Samana* and *Sodhana Cikitsa*, to have a purified body (*Suddha Sharira*), in which a suitable *Rasayana Aushadha* can be administered. The administration of a suitable *Rasayana Aushadha* becomes the *Pradhana Karma* in the context of *Rasayana* therapy. During the *Rasayana* treatment and after the completion of the treatment, one has to adhere to the *Acara Rasayan* (moral ethics), which consists of instruction for using diet and life style after *Rasayana* therapy, this is known as *Pashcat Karma*. *Pashcat Karma* consists of *Parihara Kala*, which is twice the duration of *Pradhana Karma*. After the *Parihara Kala*, the individual is allowed to use normal diet.

Rasayana useful for *Kaphaja* Disorders

1. ***Bhallataka* (*Semecarpus anacardium* Linn):** Acharya Charaka says that there is no *Kaphaja* disorder on earth that can't be cured by *Bhallatak*. Acharya Charak describe *Kalpa* use of *Bhallatak* starting with 10 *Bhallatak* fruit, increasing one every day reaching upto 30 and then decreasing gradually to 10 *Bhallatak* thus total of 1000 *Bhallatak* can be used but never be more than this. The doses described by Acharya in

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Samhitas are much more that can be tolerated by human in present time, therefore it is recommended that physician should modify the doses according to the patient strength.

Days	Doses of *Bhallatak*
1st Day	Starting with 10 *Bhallatak*
2nd Day- 21th Day	Increasing 1 *Bhallatak* daily
21th Day	30 *Bhallatak*
22nd – 41th Day	Decreasing 1 *Bhallatak* daily
41th Day	10 *Bhallatak*
42nd – 48th Day	Increasing 1 *Bhallatak* daily
48th Day	17 *Bhallatak*
49th Day – 54th Day	Decreasing 1 *Bhallatak* daily
54th Day	11 *Bhallatak*
54th and 55th Day	11 *Bhallatak*
Total	**1000 *Bhallatak***

Bhallatak should always be taken with milk to avoid mouth ulcers, gastritis etc. Acharaya Charak described 10 different dietary items of *Bhallatak* for use viz. milk, ghrita, honey, jaggery, etc.

2. ***Shilajita* (*Asphaltum*):** *Shilajita Rasayan* can be used in three ways – *Pravara* (maximum dose), *Madhyam* (moderate dose) and *Avara* (minimum dose). For maximum dose *Shilajita* is used in the dose of 4 *Tola* (= 46gm approx) for seven weeks, for moderate dose 2 *Tola* (=23gm approx) is used for three weeks and for minimum dose 1 *Tola* (=11.5gm approx). *Shilajita* is used for one week. During *Shilajita* use patient should be kept on milk diet.

3. ***Pippali Rasayan* (*Piper longum*):** For *Rasayan* purpose *Pippali* can be use in following methods:

- ***Pippali Vardhmana Kalpa* -** In this method dose of *Pippali* is escalated and then reduced gradually. For 10 days dose of *Pippali* powder is increased as 10 *Pippali* powder daily and then for 10 days its dose is reduced as 10 *Pippali* daily, thus total of 1000 *Pippali* is used keeping patient only on milk diet.
- ***Pippali Naimittika Rasayana* -** In this method, powder of 3 *Pippali* fruits is daily boiled with milk and taken empty stomach **(**method of preparation: Pippali powder + 250 ml of milk and 250ml of water boiled till only milk remains, then should be taken once in a day).
- Powder of 5,7,8 or 10 *Piper longum* fruit can be taken with honey and *Ghrita* for the purpose of *Rasayan*. Piper longum fruit is firstly soaked in *Palasha Kshara* and then dry to make powder. Powder of three Pippali should be taken in morning, before meal and after meal thrice time in a day for the desired effect of *Rasayan*.

Indication for using *Pippali Vardhamana Rasayana*

a) Patients without any major complication (bleeding diathesis, gastritis, malena etc.)

b) Patients with strong body built, strength, and good mental stamina (*Pravara Satva*).

c) Should be used in patients with chronic liver diseases, liver cirrhosis, and other autoimmune liver disorders.

Indication for using *Pippali Naimittika Rasayana*

a) Patients having complicated Cirrhosis (Cirrhosis with PHTN or Oesophageal varices).

b) Those who cannot tolerate Pippali vardhamana kalpa and patients in which *vardhamana kalpa* is contraindicated.

4. ***Triphala*:** *Triphala* means powder of three fruits namely *Haritaki* (*Terminalia chebula*), *Amalaki* (*Emblica Officinalis*) and *Bibhitaki* (*Terminalia Bellerica*). For *Rasayan* purpose powder of one

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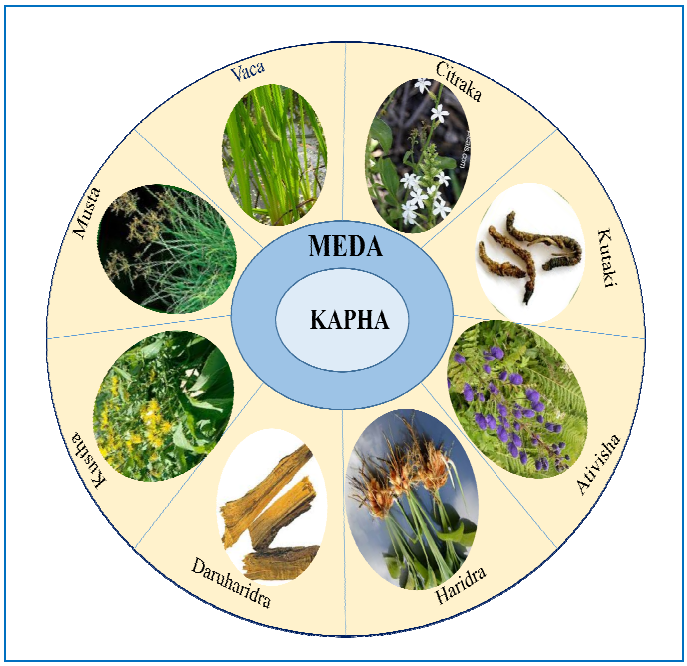
Haritaki fruit should be taken after digestion of food (i.e. morning), powder of two *Bibhitaki* is taken before meal and powder of four *Amalaki* is taken after meal. *Triphala* paste painted around an iron utensil for whole night and then taken in morning with honey and water also work as *Rasayan* and is very useful in *Kaphaja* disorders. Equal amount of *Triphala* powder and *Madhuyasti* powder taken daily can also use for *Rasayan* purpose.

Fig. 5: Diagrammatic representation showing role of *Lekhaniya* drugs on *Meda*



CONCLUSION

Thus it is very clear that cholesterol has a definite role in insulin secretion through pancreatic B cell and hypolipidemic agents may prove beneficial in the management of diabetes. Use of herbs is the safest and cheapest way for scraping the accumulated cholesterol in the most natural manner. Purification therapy (*Panchakarma* therapy) and Rejuvenation therapies are very beneficial for disrupting the vicious cycle of hyperlipidemia and insulin resistance and prevent or minimize the complications.

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