CHAPTER – 3

SCIENTIFIC LITERATURE REVIEW

3.0 SCIENTIFIC LITERATURE REVIEW

3.1. PRISONERS' LIFE STRESS AND DISEASES

In 2014, Indian Prison Statistics data, National Crime Records Bureau, gave prisons' total capacity as 356,531, and numbers in prisons as 418,536. Most prisons have limited sunlight and fresh air, are full of bad odors, and suffer poor health services. Bhopal Central Jail is different. Although prisoner numbers exceed the jail capacity, its authorities are much concerned with cleanliness, prisoners' physical and mental health, and their environment. Several studies conclude that stress is high among prison populations. Prisoners are sentenced to rigorous confinement, with fixed routine from morning to evening. Despite rigorous work and not being overweight, they contract illnesses like Diabetes, for which the National Crime Records Bureau kept no records until 2016. In 2014, 5,394 prisoners out of the 418,536 prisoners were mentally ill (NCRB, 2014). Data on psychiatric morbidity in prisoners found prevalence of psychiatric disorders of at 33%: psychotic disorders were 6.7% including 3.4% schizophrenia; 2.5% had bipolar disorder; neurotic disorders, 26.3%; depression in 16.1%; anxiety disorders in 8.5% (generalized anxiety disorder, 6%, and obsessive compulsive disorder (OCD), 2.5%); somatoform disorder in 1.7%. History of drug abuse or dependence prior to imprisonment was found in 58.8%. (Kumar & Daria, 2013)

3.2. CAUSES OF DIABETES:

T2DM is caused by several factors, including insulin resistance; it is a condition where muscle, fat, and liver cells do not respond to insulin effectively, 'insulin resistance'. This may develop to a stage where the body can no longer produce enough insulin to compensate for impaired ability to use it. T2DM symptoms develop gradually and silently, so it can remain undiagnosed for years. *Āyurveda* calls this stage *Prameha.* The role of intermediary

metabolic products in its pathogenesis is very important. Improper utilization of food substances generates *Prameha*.

Classic T2DM, characterized by hyperglycaemia, is a heterogeneous disorder caused by a combination of inherited and acquired factors adversely affecting glucose metabolism. WHO defines its underlying aetiology as defective insulin secretion, with a major contribution from insulin resistance. (WHO, 2014) The WHO report states that, despite normal or even elevated plasma insulin levels, insulin secretion is defective or insufficient to compensate for the insulin resistance, reiterating statements in the American Diabetes Association recommendations of 2005. (American Diabetes Association, 2005) A 1992 study found 75% to 85% of obese individuals are insulin-resistant, but not diabetic. (Bak et al., 1992) Weight reduction in T2DM patients can restore insulin sensitivity, but not reverse β-cell dysfunction (Freidenberg et al., 1988) Hyperglycaemia increases gradually in T2DM, so that it may remain undiagnosed for many years, increasing prevalence and severity of complications.

Micro and macro vascular affects create complications like retinopathy, neuropathy, nephropathy, coronary heart disease (CHD) and stroke. In diabetics, CHD mortality rates are 2-4 times greater than in non-diabetics, and diabetics are twice as likely to suffer from stroke. (Bell, 1994) (Morrish et al., 2001) 80% of diabetics are reported to die from cardiovascular complications, (UKPDS, 1998), implying that any cardiovascular protection additional to therapy to reduce blood glucose levels would be beneficial, even in diabetics not at obvious risk of cardiovascular complications. The United Kingdom Prospective Diabetes Study (UKPDS) is the largest and the longest study on T2DM. Over 5000 newly diagnosed patients recruited from 1977 to 1991 were followed for an average of 10 years to determine whether intensive use of pharmacological therapy to lower blood glucose would result in clinical benefits. Results demonstrated that tight glycaemic control with mean HbA1c level 7.0% and

a 25% reduction in micro vascular end points, the apparent risk reduction of 16% in myocardial infarction was of borderline significance (p = 0.052). (Donahue & Orchard, 1992) Epidemiological analysis of UKPDS data showed a relationship between mean HbA1c value and micro vascular and cardiovascular complications. Every percentage point decrease in HbA1c (eg, from 9% to 8%) yielded a 35% risk reduction in micro vascular, and a 25% risk reduction in cardiovascular, complications without any evidence of a glycaemic threshold above normal glucose levels. (UKPDS,1998).

Recommended blood glucose target levels have dropped over the last decade in line with the above observations (American Diabetes Association, 2005). The latest International Diabetes Federation guidelines (IDF, 2005) recommend achieving HbA1c values less than 6.5%, and suggest that if a lower level can be achieved easily, complications will further reduce. The basis of any T2DM therapy is diet and lifestyle modification to reduce calorie intake to decrease blood glucose levels, and achieve weight loss. Addressing risk factors for CVD requires also controlling lipids and hypertension. If lifestyle modification fails, the physician has several choices of oral anti-diabetic treatment: sulfonylureas like metformin are insulin secretogens addressing β-cell defects and stimulating insulin secretion by closing ATP-sensitive potassium (K_{ATP}) channels in β-cell plasma membranes. A systematic review (Maruthur et al., 2014) analysed 34 articles on diabetes medication pharmacogenetics identifying pharmacogenetic interactions for metformin, sulfonylureas, repaglinide, pioglitazone, rosiglitazone, and acarbose. Several studies reported statistically significant interactions between genetic variants and glycaemic medications. Results require confirmation in future studies to determine whether individual genetic information can help individualize choice of pre-diabetes and diabetes pharmacologic management.

The study suggested that a common, multi-factorial form of Type 2 diabetes results from interaction between environmental risk factors and genotype. Saltiel and Kahn suggest that T2DM is characterized by insulin resistance in peripheral tissues like muscle, fat and liver, coupled with effects of aging, obesity and reduced exercise and deregulated insulin secretion by pancreatic β-cells. (Saltiel & Kahn, 2001) In T2DM, the pancreatic β-cells become progressively less able to secrete enough insulin to maintain normal carbohydrate and lipid homeostasis. (Bell & Polonsky, 2001)

Risk factors identified for T2DM include family history, gestational T2DM, age, sex, obesity, central obesity, low physical activity, smoking, diet, ethnicity, elevated blood pressure, dyslipidaemia, stress, and various drug treatments.

Pradhan et al. found in their study, the main physiological abnormalities to be insulin resistance and impaired insulin secretion, with underlying causes of defects remaining unknown. It pointed to evidence suggesting that inflammation may play a role in T2DM pathogenesis, linking it with coexisting conditions thought to originate the same way. Substantial evidence including cross-sectional data point to IL-6 and C-Reactive Protein, two physiological markers of subclinical systemic inflammation, being associated with insulin resistance, hyperglycaemia, and T2DM. (Pradhan et al., 2001)

TABLE 3.1 CLINICAL STUDIES OF BREAKFAST MODIFICATION AND OTHER INTERVENTIONS

Citation	No. of Patients / Design	Summary	Critical analysis
Journal of the American College of Nutrition S Pal et al, 2008	A randomised, crossover design for16 women and 5 men	Altering the glycaemic index of one meal/day (breakfast meal only) for 21 days in obese individuals shows a favourable effect on fasting serum glucose, low density lipoproteins, high density lipoproteins, insulin and triglycerides.	Results of this study show beneficial changes in fasting glucose and satiety by modifying the glycaemic index of a single meal per day, suggesting such modifications could potentially be a useful public health recommendation.
The American journal, EB Tsihlias et al 2000	A randomized crossover intervention using control and test meals was conducted over a 3-week-period. Forty-five Type 2 DM subjects	Two different breakfast meals were administered during the intervention: (A) a high glycemic load breakfast meal consisting of farina (kJ 1833; carbohydrate (CHO) 78 g and psylium soluble fiber 0 g), (B) a low-glycemic load breakfast meal consisting of a fiber-loop cereal. A standardized lunch was provided approximately 4 h after breakfast.	Ingesting a low-glycemic load meal containing psyllium soluble fiber at breakfast significantly improves the breakfast postprandial glycemic, insulinemic and FFA responses in adults with Type 2 DM.
The American journal of clinical nutrition, BM Popkin, et.al, - 2010	Nationally representative cross-sectional study of US data sets from 1977 to 1978, 1994 to 1998, and 2003 to 2006 in 28,404 children (2–18 y of age) and 36,846 adults.	US children and adults are consuming foods more frequently throughout the day than they did 30 y ago.	The change in eating pattern may be the cause of illness. Further study needed to be done.
Ghrelin levels before and after reduction of overweight due to a low-fat high-carbohydrate diet in obese children and adolescents. *International journal of obesity*, Reinehr, T., Roth, C. L., et.al, (2005).	37 obese children (median age 10 y).	Analyzed fasting serum ghrelin levels, weighed dietary record and, as biochemical markers of clinically relevant reduction of overweight, leptin, adiponectin and insulin levels and insulin resistance measured by	Obese children, low-fat high-carbohydrate diet-induced weight loss does not change ghrelin secretion, but significantly decreases leptin levels, increases adiponectin levels and improves insulin resistance determined by

		homeostasis model assessment (HOMA)	significantly decreased insulin resistance indices as well as lowered serum insulin. levels.
Weight management using a meal replacement strategy: meta and pooling analysis from six studies. *International journal of obesity*, *27*(5), 537-549. Heymsfield, S. B., et, al (2003).	Randomized, controlled PMR interventions of at least 3 months duration, with subjects 18 y of age or older and a BMI ≥25 kg/m^2	A PMR plan was defined as a program that prescribes a low calorie (>800 ≤ 1600 kcal/day) diet whereby one or two meals are replaced by commercially available, energy-reduced product(s) that are vitamin and mineral fortified, and includes at least one meal of regular foods.	The study produces effectively produce significant sustainable weight loss and improve weight-related risk factors of disease.

TABLE3.2 CLINICAL STUDIES OF HERBAL JUICES TREATMENTS AND SPROUTS AS INTERVENTIONS

Citation	No. of Patients / Design	Summary	Critical analysis
A Review of the Hypo glycaemic Effects of Five Commonly Used Herbal Food Supplements	The first trial recruited 120 diabetic patients without complication or symptomatically normal. The second trial had 53 participants including 43 patients with type 2 diabetes and 10 healthy volunteers. The third trial was a randomized and controlled study with 49 diabetic patients. The most recent clinical study recruited 13 uremic diabetic patients and 15 healthy volunteers.	There is strong scientific evidence (Level B1) to support that composite supplements containing emblica officinalis is effective in lowering blood glucose levels in diabetic patients. However, there was not enough evidence of other 4 herbs to supports the hypoglycemic activity of emblica officinalis alone.	Food supplements have increasingly become attractive alternatives to prevent or treat hyperglycemia, especially for subjects with mild hyperglycemia.
Kothari, S., Jain, A. K., Mehta, S. C., & Tonpay, S. D. (2008). Effect of fresh Triticum aestivum grass juice on lipid profile of normal rats. *Indian journal of pharmacology*, *40*(5), 235.	old Wistar rats divided into three groups of six rats each and received following treatments for 21 days, control (CG) that received normal saline, second group (T5) was given GJ at a dose of 5 ml/kg body weight and the third group (T 10) animals were given same juice at the dose of 10 ml/kg body weight.	Dietary wheat bran has been known to modulate hypolipidemic effect of fish oils in rats. Present work was aimed to conduct preliminary phytochemical analysis and to study hypolipidemic activity of oral fresh *T. aestivum* GJ in normal rats.	Results clearly show that oral fresh GJ of *Triticum aestivum* has hypolipidemic properties. Though the physiological mechanism of this activity cannot be concluded from the present study and need further investigations, yet the positive presence of phytochemicals such as saponins, tannins, and sterols in GJ seem to cause these changes. Such changes are already recorded for these compounds.
Panda A K, Comprehensive Ayurvedic Care in Type-2 Diabetes, Journal of Homeopathy & Ayurvedic Medicine, January 02, 2014	-	Studies reveal that single herb and exercise can control PPBS up to 200 mg/dl. Comprehensive care in Ayurveda can control PPBS above 400 mg/dl. It takes one month to three months to reach the absolute control of PPBS. Intensive lifestyle intervention can be more effective along with the Ayurveda drug/formulations.	There is widespread use of herbal dietary supplements that are believed to benefit type 2 diabetes mellitus, few have been proven to do so in properly designed randomized trials; their efficacy for intermediate-term glucose control remains unclear.

TABLE3.3 CLINICAL STUDIES OF IAYT AND OTHER YOGA INTERVENTIONS

Citation	No. of Patients / Design	Summary	Critical analysis
S Kumari**,** Effect of SMET yoga module on emotional dynamics of managers**,** 2013	The study was performed on one hundred & seventy healthy male managers aged between 25 to 50 years (mean 27.4 ± 6.5 yrs). Normal healthy, mid to top-line managers were included in the study while female managers, low level of managers and those who are not able to perform Yoga postures were excluded.	This RCT study has clearly showed that 30 minutes of SMET practice produced highly significant improvements in Emotional Intelligence and Emotional Competence (as also on all its sub-scales) of managers compared to the control group, which used walking as the equivalent 30 minute intervention.	Between groups results showed highly significant increase in Emotional Intelligence in SMET group compared to Controls. Results indicated that the SMET intervention significantly increased the level of Emotional Intelligence.
K. B. Meenakshy Electrodermal assessment of SMET program for business executives, 2014	5 day stress management programme (SMET) for managers as measured by AcuGraph3. Forty five volunteers (both female & male), employees from a large Indian corporation, aged between 30 and 50 years were selected for the study. A single group, pre-post assessment was applied and the subjects were assessed on day 1 (pre) and day 5 (post) of the intervention.	The 5 days SMET intervention increased overall pranic energy in the main acupuncture meridian channels. The results begin to explain why yoga practice is clinically effective.	Low energy levels indicate strain, and suggest susceptibility to disease. It is well known that pressurized work environments make employees disease prone and this data corroborate that meditative stretching combined with guided relaxation induces deeper muscular relaxation
Pandya A.K., Pandya K.D. et al, Effect Of Alternative Therapy On Cardiorespiratory And Sensory Parameters Of Chronic Type 2 Diabetes Mellitus Patients, NJIRM. 2012, 3(3): 20-23	Fifty-two known chronic type 2 diabetic patients were managed through yogic exercises and diet therapy for 150 days. Physiological parameters were studied in all subjects	DBS, positive breath holding time, pain threshold and tactile discrimination showed changes within 15 to 30 days of regime. Reduction in body weight and respiratory rate. The rise was observed in 40 mm of mercury endurance test and positive breath holding time.	Improved physiological parameters indicates, yogic exercise, meditation and diet control regularly can manage type 2 diabetes in a natural way avoiding the side effects of oral hypoglycaemic medications. Patients should continue the therapy to control the disease life time for better health without oral medication.

3.3. PRE-DIABETES OR *PRAMEHA ĀYURVEDA* LITRATURE

Āyurveda discusses *Prameha* as a precursor to *Madhumeha*, diabetes, saying that it occurs due to deposition of *Āmavāta* **(***Yoga Ratnākara*, 1998, p93), sedentary lifestyle (Suśruta Saṁhitā, Sū. Ch. 45, v472-481, 2005) and stress. *Yoga Ratnākara* states that eating before the end of the first *Prahara* (quarter of the daylight hours) increases *Āma* which *Āyurveda* texts also call *Doša dušti*.

All *Āyurveda* texts insist that *Āma* important in disease development including *Prameha*. Absence of physical activity leads to decreased vital energy and promotes disease. *Caraka Samhitā* stresses that, to prevent deposition of *Āma*, one should avoid eating food before digestion of the previous meal is complete. Improperly digested food due to *mandāgni* generates allergic reactions in the intestine. *Āma* is a causal factor in initiating pathogenesis of diseases like *Prameha*, rheumatoid arthritis (*Āmavata*), bronchial asthma, ulcerative colitis, psoriasis, and liver disorders, an immunologically active complex of pathologies**.**

3.4. *PRAMEHA* – A METABOLIC DISORDER RELATED TO MENTAL STRESS

Obesity, metabolic syndrome, and diabetes mellitus are common metabolic disorders. In *Prameha* pathogenesis, the role of intermediary metabolic products is very important, because it is generated through improper metabolism of food substances. In *Āyurveda*, *Āma* refers to toxic intermediary products of digestion and metabolism resulting from incomplete digestion. The relationship between *Prameha* and *Āma* is well documented. If *Jataragni* (digestive power) is weak, *Āma* accumulates, leading to *Prameha* as one possibility. *Charaka Samhitā* states that *Āma* can be due to psychological factors, evidence that *Prameha* can be caused by mental stress (*Caraka Samhitā*: *Vi.Ch.2, v8-9*). The same section says that excessive desire, anger, greed, affection, jealousy, grief, pride, anxiety, or fear, can cause disturbed *agni* (*Viṣamāgni*), anything eaten is not properly metabolized. The process leads

ultimately to production of *Āma*, strongly suggesting a close relationship between stress and *Āma*, factors contributing to *Prameha*, metabolic syndrome, and diabetes mellitus.

In India, those with pre-diabetes, i.e. FBS of 110-125 mg/dl (Gupta et al., 2003), are at increased risk of developing T2DM (FBG ≥100 and <126 mg/dl); 5-10% will develop T2DM within one year, 25% within 5 years (Nathan et al., 2007) Lifestyle interventions including exercise have been effective in offsetting T2DM complications and the progression from pre-diabetes or metabolic syndrome to T2DM (Tuomilehto et al, 2001) (Zanuso et al., 2009).

By modifying muscle fibres and enhancing beta cell functions, exercise can optimize insulin sensitivity and improve glucose intolerance (Richter & Derave, 2001). (Blair, et al. 1996). Thus, exercise may be particularly effective in early disease stages. It has led to reductions of 30% in metabolic syndrome (Katzmarzyk et al., 2003) and 63-65% for pre-diabetes to develop into T2DM. (Laaksonen et al., 2005)

3.5. IMPORTANCE OF MEAL TIME MODIFICATION IN REDUCING *ĀMA*

Yoga Ratnākara (*Yoga Ratnākara*, 1998, p54) and other *Āyurveda* texts insist on the importance of meal time in reducing *Āma*. Modern studies agree. A study found that, for those with T2DM, eating two large meals each day may be more beneficial for weight loss and glucose control than six small meals with the same caloric content (Kahleova, et al, 2014). Most of the studies were on known T2DM patients. The important part of our study is changing traditional breakfast to fresh herbal juices, which may restore health to those with *Prameha*.

3.6. HERBAL PLANTS: A POTENTIAL SOURCE OF TREATMENT

Āyurveda's 'Science of Life' states that the health means balance of *doṣas* and *dhatus*, which translates into metabolic balance. *Āyurveda* developed between 3,500 and 500 BC in India. (Hankey, 2017) *Charaka Samhita* divided *Āyurveda* therapeutics into 8 sections consisting of

180 chapters listing 314 plants (Vikrant, A. Kumar, G. V. 2011), for medicinal use, over five thousand years ago. Even today, *Āyurveda* remains an important medical system. Alkaloids are the primary active ingredients of *Āyurvedic* drugs. Today, pharmacologically active ingredients of many *Āyurvedic* medicines have been identified, and their usefulness as drugs investigated. However, the program has largely failed, apparently because plants and plant medicines contain mixtures of one or more, possibly many, pharmaco-active substances with synergistic modes of action.

With its ecological diversity, the Indian subcontinent is a vast repository of medicinal plants used in traditional medical treatments (Premila, 2006), only a tiny fraction of which are in use today. In India, around 15,000 medicinal plants are estimated to be known, but so far only 7,263 have been recorded including those used by tribes and other traditional communities (http://www.medicinalplants.in/). Medicinal plants listed in AYUSH systems are: *Āyurveda* (1540 species); *Siddha* (1149 species); *Sowa-Rigpa* (250 species); *Unani* (493 species), *Homeopathy* (372 species), *Folk Medicine* (5,376 species).

3.7. FUNCTION OF CONVENTIONAL DIABETES DRUGS:

Glucose, the most important energy source for human body, plays a vital role in maintaining health. Cells' mitochondria metabolize glucose molecules to produce ATP, the fuel that powers most cellular processes. Glucose is delivered to cells by the blood; to ensure its steady supply for cell function, a relatively constant blood level must be maintained. Failure to do so results in hypoglycaemia or hyperglycaemia.

Under normal physiological condition, blood glucose concentration is tightly regulated by various mechanisms. The major source is food. After digestion, glucose is released from sugars and starchy food, absorbed by small intestine from where it enters the blood. The liver acts as a repository of glucose, in its glycogen, taking it up for later release to the blood. The

major means to decrease blood glucose levels is its uptake cells for use as an energy source. An alternative, long-term storage for future use is adipose tissue. Blood glucose concentration reflects the combined effects of food consumption, glucose production, transport into and out of liver and adipose cells and physiologic use.

Hyperglycaemia or elevated blood glucose level is a potentially pathological condition, most commonly associated with pre-diabetes and T2DM, the first being a condition not satisfying diagnostic criteria for diabetes but where blood glucose levels are elevated. All diabetes patients have passed through a non-diabetic hyperglycaemic stage, before it escalates into full-blown diabetes. Studies indicate that both pre-diabetic and diabetic patients have significantly increased risk for CVD and other complications. Incidence of pre-diabetes and diabetes imposes great burden on healthcare worldwide. (Deng, 2012)

Various drug therapies are available for hyperglycaemia. However, such treatments are also associated with adverse responses like hypoglycaemia and weight gain. Most oral drugs like sulfonylureas cause digestive track problems, liver toxicity with thiazolidinedione, and skin rash with insulin injection (Desai & Tandon, 2007). Blood glucose levels are often not well controlled by pharmacological therapies, mainly due to poor compliance and self-care behaviour, and psychological problems with insulin injection. Despite supposedly adequate safety profiles and convenience, they fail to control blood glucose levels in many T2DM patients, though further pharmacological options still may control them.

In contrast, herbal food supplements, *Rasāhāra* with sprouted whole grains used in this study have been consumed for centuries. Their safety is well established. Over the past 10 years, experience with incoming pre-diabetic patients at the *Rasāhāra* clinics has found food supplements increasingly popular for hyperglycaemia management.

3.8. MECHANISM OF *RASĀHĀRA* ACCORDING TO MODERN SCIENCE:

In the last decade, preventive medicine has undergone a great advance, especially in developed countries. Research has demonstrated that nutrition plays a crucial role in the prevention of chronic diseases, as most of them relate to diet. Functional foods are now considered not only necessary for life, but also sources of mental and physical well-being. They contribute to prevention of disease by enhancing one or more target functions in the body relevant to wellbeing and health, or reduction of risk of a pathologic process or an NCD like diabetes. (López-Varela et al., 2002) (Roberfroid, 1999).

Rasāhāra satisfies all qualities of functional food; being anti-oxidant. Synthetic and natural food antioxidants are routinely added to foods and medicine to protect them from oxidation, especially those containing oily fats. Synthetic phenolic antioxidants, e.g. butylated hydroxy-toluene (BHT) and butylated hydroxy-anisole (BHA), have been widely used as antioxidants by industry in food, cosmetics, and therapeutics. At high temperatures, BHT and BHA show some carcinogenic properties. Natural antioxidants should be preferred. (Papas, 1999)

Increasing risk of various diseases, has contributed to a global trend toward use of natural substances present in medicinal and dietary plants as therapeutic antioxidants. One study noted that use of natural antioxidants in food is a promising alternative to synthetic ones. They are cheaper and compatible with dietary intake without harmful side-effects. Many naturally occurring antioxidants from plant sources have been identified as free radical or active oxygen scavengers (Brown & Rice-Evan, (1998). Built-in antioxidant activity gives herbal molecules important therapeutic advantages in preventing late complications of T2DM like nephropathy and CVD. (Chopra & Singh, 1994). Synthetic drug molecules have established modes of action, but rarely exhibit antioxidant activity, and high incidence of toxicity from long term treatment is well-documented.

T2DM increases oxidative stress through a number of mechanisms. First, glucose catalyzes lipid peroxidation; evidence suggests that acute glucose load decreases antioxidant defences. (Ceriello et al., 1998) Second, advanced glycation end-products generate free radicals. (Mullarky et al., 1990) meaning that T2DM reduces levels of antioxidants like glutathione, vitamins C & E, and carotenoids. Molecules proposed to act as anti-oxidants *in vivo* include carotenoids like β-carotene, xanthophylls, metallothioein, taurin and its precursors, creatinine, polyamines, retinol, flavonoids, and polyphenols of plant origin (Dhanukar et al.,2000). The four herbs used in this study all have well-established antioxidant activity (details below).

3.9 IMPORTANCE OF THE FOUR HERBS AND GERMINATED FOOD

3.9.1 *Āmalaki* (*Emblica officinalis*)

Emblica officinalis, known as Indian gooseberry or *Āmalaki*, is an edible fruit. The *Āmalaki* tree belongs to the family, *phyllanthaceae*. Indian mythology claims it to be the first tree created in the universe. Its fruit can be eaten raw, or in cooked or pickled form, as a remedy for metabolic conditions like hyperlipidemia and T2DM. It is anti-diabetic, anti-oxidant, immunomodulatory, antipyretic, anti-tumour, analgesic, antitussive, gastroprotective and cyto-protective. It has beneficial roles in cancer, diabetes, liver problems, heart trouble, ulcer, anaemia and other conditions. It may also be helpful in neutralizing snake venom and as an antimicrobial. It makes memory strong, and can cure ophthalmic disorders, it also lowers cholesterol level. (Rao et al., 2005). Two recent patents, largely supported by four clinical trials with diabetic patients, claimed that *Āmalaki* is anti-hyperglycaemic, and can be used to manage the condition. (Deng, 2012)

It has extraordinary medicinal qualities and promotes iron absorption and hence can combat anaemia, prevalent among women and children. It also curs skin problems, hair problems acidity, diabetes, asthma, cholesterol and cholesterol induced atherosclerosis. *Caraka*

emphatically mentions it as a great *rasāyana* to protect people from disease and keep away manifestations of premature ageing. Since *Āmalaki* pacifies all the three *došas*, it has many corrective and curative effects on the human body. It is rightly called *sarvadošahara* - remover of all diseases. The National Medicinal plants board has undertaken a national campaign to promote it throughout the country. Dry *Āmalaki* is wrinkled and of grey-black colour. *Āmalaki* is the only fruit that has all five tastes, though it does not seem salty. Easy to digest (*laghu*), dry (*rukša*) and cold (*cita*) in qualities, it is a very rich source of vitamin C, with 700 mg per 100 gm fresh *Āmalaki* according to lab tests, 20 times higher than oranges. Recent investigation finds *Āmalaki'*s Vitamin C present in a complex form, ascorbates of gallic and ellagic acids, the *emblicanins*, *Āmalaki*'s active ingredients. The fresh fruit (over 80% H_2O) contains proteins, carbohydrates and fibre, besides the minerals, calcium, phosphorus, iron, and vitamins of the B complex and carotene. When dried in shade, *Āmalaki* retains much of its vitamin C.

3.9.2 *Guḍuci (*Tinospora cordifolia*)

In *Āyurvedic* texts, *Guḍuci* is also called *Amritā* because of its multiple medicinal properties, preventing many NCDs, and enhancing lifespan. One of *Āyurveda*'s most useful herbs acting as a tonic and aphrodisiac, Studies of *T. cordifolia* have investigated immunomodulatory, (Purandare et al., 2007), anti-allergic rhinitis (Badar et al., 2005), anti-ulcer (Sarma et al., 1995), cardioprotective (Rao et al., 2005), chemopreventive (Singh et al., 2006), hepatoprotective (Bishayi et al., 2002), adjuvant therapy in hyperreactive malarious splenomegaly (Singh, 2005), hypolipidaemic (Prince et al., 1998), neuroprotective (Rawal et al., 2005), obstructive jaundice (Rege et al, 1993), oxidative stress (Prince & Menon, 2001), and radioprotective effects (Goel et al., 2002;40). Anti-fertility effects in male rats are reported (Gupta & Sharma, 2003).

Alkaloids, steroids, diterpenoid lactones, and glycosides have been isolated from the various parts of the plant, including root, stem, and whole plant. Starch from its roots or stems can be used against chronic diarrhoea and dysentery. Its fresh juice is diuretic, used in gonorrhoea, and chronic fevers, gout, vomiting, cardiac debility, skin diseases, leprosy, anaemia, cough, asthma, jaundice, seminal weakness, neuropathy and splenopathy. Its medicinal properties are: anti-diabetic, anti-periodic, anti-spasmodic, anti-inflammatory, anti-arthritic, anti-oxidant, anti-allergic, anti-stress, anti-leprotic, anti-malarial, anti-neoplastic, hepatoprotective and immunomodulatory. (Saha et al, 2012). It is of great interest to researchers around the world.

3.9.3 ***Vāsā*** (*Adhatoda vasica Nees*)

Vāsā belongs to the family Acanthaceae. *Vāsā* pacifies *paitik* disorders and blood disorders. Bitter and astringent in taste, *Vāsā* is light in its effect and easily digested. Its leaf, *Vāsaka*, improves voice, increases *vāta* and reduces *kapha*. *Vāsā* cures fever due to aggravated *kapha* and *pitta*; gives relief in internal bleeding; is useful in skin diseases; relieves breathlessness, cough, and vomiting sensations; against certain urinary tract infections, skin diseases, and toxic substances; and can help excessive thirst. Pregnant women should use it with caution, as it can induce abortion.

Carak samhitā recommends its local application in skin diseases, stating that *Vāsā ghrita* is useful in inflammations and fever, burning sensations in the hands and feet in tuberculosis. The *Bhāvaprakāça Nighantu* (*Bhāva prakāça Nighaṇṭū*, 1977) says it can be beneficial for bronchitis. *Vāsā* leaves juice may help malaria; while poultices of them can be used in arthritis, and other types of inflammation.

The reason for including *Vāsā* in this study was its ability to reduce *pitta.* (*Astanga sangraha, Su.Ch.7, p81*), since pre-diabetes is a disease of *pitta* as well as *kapha* aggravation. (*Caraka Saṁhitā Ni. Ch4.v11, 27*).

Particular Studies: *Vāsā* exhibits protective action against oxidative stress, and, in the brain, monoamine modulatory activity, a possible reason for its anti-depressant properties. (Gupta et al., 2014). Another concluded that *Vāsā* is an important herb for malaria, intrinsic haemorrhage, cough and asthma, leprosy, skin diseases and piles, functioning as an expectorant, antidiabetic, anti-inflammatory, abortifacient, antimicrobial, antitussive and anti-cancer, with leaves rich in Pyrroloquinazoline and alkaloids: vasicine, vasicol, adhatonine, vasicinone, vasicinol, and vasicinolone. Of these Vasicine is a bronchodilator, respiratory, and weak cardiac and uterine stimulant (H Sharma, et, al, 2014).

A review (Ahmad et al, 2009) listed a wide range of phytochemical constituents isolated from *Vāsā*, giving it antitussive, antibacterial, abortifacient, anti-inflammatory and antiulcer properties. Other activities like radio-modulation, hypoglycaemic, cardiovascular protective, antitubercular, antiviral, hepatoprotective, antimutagenic and antioxidant were reported. It concluded that *Vāsā* should be used extensively for its therapeutic benefits.

Methanolic extracts from *Vāsā* leaves showed higher inhibitory activity on rat intestinal α-glucosidase than medicinal parts of 40 traditional Chinese herbs. This first report on mammalian α-glucosidase inhibition by *Vāsā* found inhibitory effects on sucrose by two compounds, showing that they could be useful treatment for metabolic disorders. It concluded that *Vāsā* extracts are anti-diabetic agents. (Gao, et. al. 2008).

Vasa leaves' total phenolic content, responsible for antioxidant activity (Maurya & Singh, 2010), has been analyzed, as has anti-inflammatory activity of methanol extracts. (Chakraborty & Brantner, 2001). Many reports emphasize the medicinal value of *Vāsā* and its

usage for treating diseases such as bronchitis, asthma, fever, jaundice, vomiting, leucoderma, tumours and diabetes (Ram et al., 1991). The antitussive effect (Jayant N.D. 1999) and the antioxidant property (Kumar A. et al., 2005) of this plant are established. WHO judges *Vāsā* a medicinal plant with recommended therapeutic uses, being non-toxic, and safe in primary health care for both adults and children (Claeson et al., 2000) Ethanolic extracts from the leaves of *Vāsā* showed hypoglycaemic activity after oral administration in rats and rabbits. (Modak & Rajarama Rao, 1966)

One plant phytosterol, (3β)-stigmast-5-en-3-ol identified in *Vāsā* plants (also known as beta-Sitosterol, beta-Sitosterin, alpha-Phytosterol, and occasionally even cupreol, rhamnol, or quebrachol) may have therapeutic effects countering insulin resistance, and cholesterol lowering effects. (Sujatha et al., 2010)

3.9.4. Wheatgrass (*Triticum aestivum*)

Wheatgrass juice contains chlorophyll, other enzymes, amino acids, vitamins and minerals in high concentrations. The fresh juice has been shown to possess anti-cancer activity, anti-ulcer activity, anti-inflammatory, antioxidant activity, anti-arthritic activity, and blood building activity in Thalassemia. Due to its high content of biologically active compounds, such as bioflavonoids like apigenin, quercetins, and luteoline, minerals and antioxidants like indole compounds and amely-choline, wheat grass is said to help blood flow, digestion, and general detoxification of the body.

Its chelating property helps iron overload disorders. Wheatgrass particles contain 70% chlorophyll, chemically similar to haemoglobin. One difference being the central atom of Mg, magnesium, in chlorophyll, while it is Fe, iron, in haemoglobin. This quality makes wheat grass useful in clinical conditions and chronic disorders involving haemoglobin deficiency. Some call it green blood. The similarity between chlorophyll and haemoglobin

can be seen in the structure of their porphyrin heads. (Figures 3.1 and 3.2) (Vaidya & Devasagayam 2007).

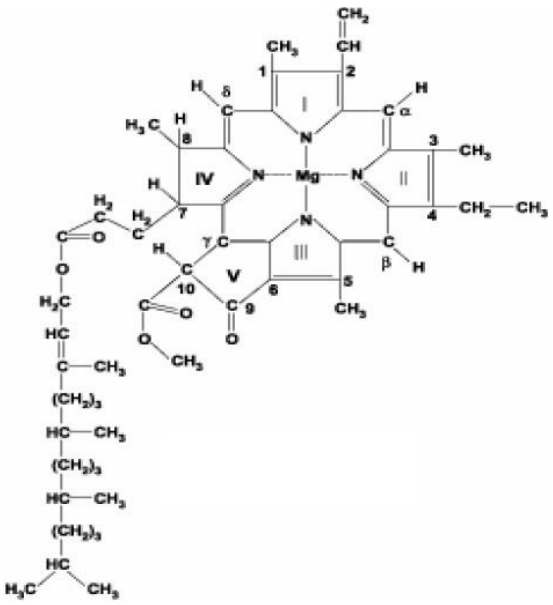

Figure 3.1: Structure of Chlorophyll Molecule

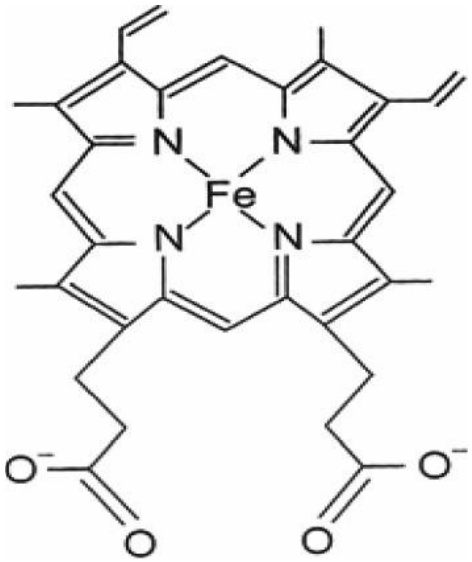

Figure 3.2: Structure of Haemoglobin Molecule

Human diet enriched with young plants, so called “green food”, improves nutrient balance intake in a natural way. ‘Wheatgrass’ refers to young grass of the common wheat plant (*T. aestivum*), India’s most common member of the Poaceae family. The plant has many nutritional values; it is also known to be anti-inflammatory, antioxidant, anti-carcinogenic, immunomodulatory, laxative, astringent, diuretic, antibacterial and anti-aging. It benefits acidity, colitis, kidney malfunction, atherosclerosis and swelling.

Wheatgrass juice helps in building red blood cells and stimulates healthy tissue growth. One hundred grams of the powder is as beneficial as 23 kilos of fresh vegetables. Ideally, it should be taken about an hour before a meal, allowing its full metabolism without interfering with other foods. It may also curb hunger. At least a litre of water should be consumed with the juice to reap maximum nutritional benefits. Its ‘green energy’ is boosted when taken as a supplement in mid-morning or mid-afternoon. (Rana et al, 2011)

3.9.4.1 The Anti-hyperglycaemic Role of Wheatgrass

When used as a health drink wheatgrass has potent antioxidant effects, and has been used in folk medicine to cure T2DM. Experiments on its effects on T2DM concluded that it is a potent anti-hyperglycaemic agent. In male albino Wistar rats, it helps regulate plasma glucose and insulin levels, activity of glucose oxidase enzymes hexokinase and glucose-6-phosphate dehydrogenase, and liver glycogen levels. Glucose oxidative enzymes and levels of insulin and liver glycogen decreased in diabetic rats, but changes reverse with wheatgrass treatment. (Shakya et al., 2016).

Wheatgrass’ anti-diabetic and antioxidant potential has been evaluated *in vivo* comparing wistar strain albino rats with streptozotocin-induced diabetes with normal rats. (Mohan et al., 2013). The diabetes-induced group showed significant increase in FBS, PPBS, HbA1c, liver glycogen and serum marker enzyme levels. All lipids reduced significantly. After treatment

with ethanolic wheat grass extract, significant decreases were observed in levels of lipid peroxides, superoxide dismutase, and glutathione peroxidise; and increase in levels of enzymes, vitamin E, catalase, and glutathione's reduced form.

3.9.4.2 Clinical Uses of Wheatgrass:

A 2009 study suggested that with its ability to improve glucose and lipid levels, wheatgrass can be used to manage T2DM effectively. Conducted on 30 volunteers with wheatgrass added to a meal. Addition of 15 gm of wheatgrass to certain foods improved blood glucose levels, significantly lowering their glycaemic index. Triglycerides also improved. (Kothari S, Jain AK, Mehta SC, 2008). Larger studies confirming these findings were recommended, though a book originating in Australia strongly recommends wheatgrass for T2DM patients (Murray & Lyon, 2006)

3.9.4.3 Proportions of Constituents in Wheatgrass

Instrumental neutron activation analysis has been used to determine element concentrations in 8-day old wheatgrass. Concentrations of the elements K, Na, Ca and Mg increased linearly in the shoots, while concentrations of Zn, Mn and Fe remained constant. (Clark et al., 1987). Its vitamin content makes it an important adjuvant in treatments for allergies and asthma. Enzymes play a vital role in its effect on cancer. Its bioflavonoids, naturally occurring antioxidants, also account for clinical uss like IBS management, and as a general detoxifier. (Padalia et al., 2010)

3.9.5. Germinated Food Sprouts

Because of their exceptional nutritional value, the practice of sprouting cereal grains is now popular in the western world. Sprouts can be grown easily without sophisticated equipment. Good quality untreated seeds with high germination rates are first soaked in water for 12

hours, and then allowed to grow for several days in the open at desirable temperatures. *Āyurveda* says little about sprouted food, except that *Carak samhitā* states that the sprouts are more difficult to digest **(***Carak samhitā, Cikitsā sthāna, chapter 1, v3*).

Raw food has the advantage of being a 'live food' (Wigmore, 1985) meaning that it contains health giving *prana* and vital energy. Scientific studies have investigated advantages of germinated food and the effects of eating it regularly. Sprouted grains have exceptional nutritive value. (Wigmore, 1986) Sprouted grains activate dry matter, increasing enzyme activity, and total protein, bringing changes in amino acid composition, and decreasing starch. It increases in sugars, and there is slight increase in crude fat and crude fibre. Most of the increases in nutrients simply reflect the loss of dry matter, mainly in the form of carbohydrates, due to respiration during sprouting. As total carbohydrates decrease, percentages of other nutrients increase.

In comparison, another study, on β-carotene antioxidant activity in mung bean sprouts, found it highest on day 1 of germination. (Randhir et al., 2004) Regarding cooking, some T2DM-related functionality may be improved. Heat increases fenugreek α-amylase and α-glucosidase inhibitory activity more than in mung beans. (Randhir et al., 2009)

A food is a 'functional food', if it demonstrates beneficial effects on body functions like liver, kidney, or heart, when they lack adequate nutrition. Such foods improve health and well-being reducing risk of disease. Sprouted grains are functional foods, containing higher available amounts of Ca (12%,), Mg (14%,), Cu (25%,) and Zn (45%,) than dry seeds. (Marton et al, 2010) Another study found that sprouting grains for limited periods increases activities of hydrolytic enzymes, improving availability of essential amino acids, sugars, and B-group vitamins, and decreasing dry matter like starch, or non-nutrients. Partial hydrolysis improves digestibility of proteins and starch. (Chavan, Kadam, & Beuchat, 1989).

3.10 MODERN SCIENTIFIC INVESTIGATION OF YOGA'S BENEFITS

The Western world now regards Yoga and its 5,000+ year-old tradition as a holistic approach to health. The US National Institutes of Health, National Centre for Complementary and Integrative Medicine (NCCIH) (https://nccih.nih.gov/health/yoga) recognize it as a form of complementary medicine, quoting the US National Health Interview Survey, 2007, that yoga is among the top 10 complementary and integrative health approaches used by U.S. adults, widely practiced for its benefits to body and mind.

In India, Yoga therapy is increasingly appreciated, and comes under the Ministry of AYUSH. By increasing subtle energy, Yoga engages practitioners in healing processes (Desai and Tandon, 2009) , guiding their journey toward health. Healing comes from within, not from a supposed outside source, giving a greater sense of autonomy. The principle of yoga is that the state of a patient's mind, and its quality, play vital roles in healing, even for physical disorders. Negative states of mind block flows of subtle energy, and delay or even prevent healing; positive mind-sets achieved by Yoga accelerate healing.

Research confirming yoga's beneficial effects on myriad aspects of psychological health has proliferated in recent years. An entire issue of Indian Journal of Psychiatry was devoted to Yoga's benefits for different psychiatric problems, particularly depression. (Satishchandra, 2013) (Khalsa, 2013) (Naveen et al., 2013). Positive therapeutic and neurotropic effects of yoga in depression: A comparative study. Indian journal of psychiatry, 55(7), 400.) A later paper discussed possible mechanisms for Yoga's observed benefits to schizophrenia (Mehta et al, 2016), particularly restoring the brain's connectome, that was related to benefits of Yoga based meditation, *Dhyana*, to schizophrenia in an accompanying article. (Hankey & Shetkar, 2016) Yoga's benefits for psychiatric conditions have also been described in an article in Lancet Psychiatry. (Thirtalli et al., 2016)

Studies suggest how yoga improves symptoms of stress, anxiety, PTSD and depression, among other psychiatric problems (Kuntsevich, Bushell, and Theise, 2010). Woodyard emphasizes promotion of well-being including life satisfaction and happiness is equally important. He also found that yoga practices reduce stress, anxiety, depression, and chronic pain, improve sleep patterns, promote recovery from addiction, and enhance overall well-being and QoL. (Woodyard, C., 2011). Many explanations or pathways for these benefits have been proposed. The deepest depends on complexity biology and its well-established role in brain cortices (Shetkar and Hankey, 2016), where self-organized criticality maintains self-regulation, a known aspect of yoga.