



Yoga Prevents and Reverses Type 2 Diabetes

Wazir C Vasudeva 

Former Professor of Chemistry, University of Khartoum, Sudan

Correspondence

Wazir C. Vasudeva

3808N Prospect Avenue, Shorewood,
Wisconsin 53211, USA
Tel 414-964-1863; 781- 738-0765

Abstract

Yoga presents a holistic strategy for managing type 2 diabetes mellitus and its associated complications through lifestyle modifications. This approach encompasses various practices, including asanas (postures), pranayama (breathing exercises), meditation, and adherence to a sattvic diet, all coupled with mental discipline. Research indicates that yoga can significantly mitigate the risks of complications in adults with type 2 diabetes by enhancing physical fitness, activating vital organs such as the pancreas, and improving stress management. Given that stress and a sedentary lifestyle are key contributors to the onset of type 2 diabetes, the incorporation of yoga has been shown to effectively regulate blood sugar levels and promote overall well-being. This communication aims to underscore the importance of yoga as a beneficial intervention for individuals coping with the challenges of type 2 diabetes.

Introduction

The foods we eat are broken down into glucose by our body. Glucose is a form of carbohydrate or sugar. Glucose travels through our blood to our cells. Cells use glucose for energy. To get inside our cells, glucose needs the help of insulin. In people with diabetes, there is a problem with the insulin. Sometimes there is no insulin. Other times insulin is present, but the levels are not adequate and the body has trouble using it. When insulin is not able to do its job, glucose cannot get into the cells. Instead, glucose collects in the blood. The amount of glucose in our blood is called as blood glucose level. It is usually measured and reported as milligrams per deciliter (mg/dl) or as mmol/ liter. Too much glucose in the blood is called hyperglycemia or high blood glucose. Too little glucose in the blood is called hypoglycemia or low blood glucose. Blood glucose levels that are too high or too low may make us feel ill and harm our body. Symptoms of diabetes include, increased hunger, thirst, frequent urination, weakness, weight loss, and muscle wasting. Type 2 diabetes may present few or no symptoms.

Acute life threatening complications of diabetes include, ketoacidosis, hyperosmolar syndrome and hypoglycemia. Chronic complications of high blood sugar can affect the heart and blood vessels, nerves, eyes and kidneys. Diabetes is a food created disorder and we can always overcome diabetes with the right kind of food.

There are 2 main types of diabetes: type 1 (insulin dependent) and type 2 (non-insulin dependent). About 10% of people who have diabetes have type 1, a condition in which the pancreas does not produce any insulin and is commonly diagnosed in childhood. In type 1,

the beta cells of the pancreas are damaged and therefore cannot produce insulin. With type 1

diabetes, insulin injections are essential. Type 2 diabetes (T2DM) is strongly linked to heredity and lifestyle factors such as obesity, lack of exercise and poor eating habits. Symptoms of type 2 diabetes include fatigue, frequent urination, thirst, blurred vision, reduced healing of the skin and gums, itching, increased urinary infections, and numbness in the feet and legs [1]. If someone has two or more of these signs or symptoms, he or she should call their doctor to confirm if they have type 2 diabetes. Fatigue in T2DM is caused by the body's cells not getting enough glucose to fuel activity. Frequent urination and thirst are linked as elevated blood sugar levels lead to increased urination to compensate, and this leads to dehydration.

Symptoms of diabetes include blurred vision caused by the swelling and shrinking of the lenses of our eyes as blood glucose levels rise and fall. The eyes are unable to adjust quickly enough to the more rapid changes and results in blurred vision. Delayed healing, itching and increased urinary infections are due to the improper function of the white blood cells which protect the body against infection. This is due to the high glucose environment of the blood of a person with T2DM. The numbness seen in the feet of those with T2DM is due to neuropathy.

Section 1

Risk Factors for Type 2 Diabetes

The chances of developing type 2 diabetes depends on a combination of risk factors. Although we can not change risk factors related to family history, age, race, or ethnicity, we can still avoid a few risk factors by maintaining

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healthy weights and being physically active. One can develop T2DM at any age, even during childhood. People are more likely to develop T2DM if they are overweight or obese, over the age of 35, have poor eating and exercise habits, daily stress, and/or have a family history of diabetes [2].

What is Obesity?

Overweight and obesity are defined as abnormal or excessive fat accumulation that prevents a risk to health. A body mass index (BMI) over 25 is considered overweight, and over 30 is obese [3]. Obesity occurs when an individual has too much body fat, which can impair health. Obesity is generally caused by eating excessive amounts of calories that exceed the body's intake requirements. Often a lack of exercise and consuming high amounts of fats and sugars will result in surplus caloric energy being stored in the body in the form of fat [4]. Body mass index (BMI) is a measure that uses your height and weight to work out if your weight is healthy [5]. The formula to calculate BMI is kg/m^2 where kg is a person's weight in kilograms and m is their height in meters which is squared.

Health Risk of Obesity[3]

Extra body weight increases the risk of disease and premature death. Carrying too much weight, causes great strain on our heart and other organs, as well as on weight-bearing joints, thus putting us to a greater risk of developing a range of medical conditions, including cardiovascular disease, such as high blood pressure, respiratory disease, osteoarthritis, gallstones and certain cancer.

Obesity also increases the risk of complications during surgical procedures, creating extra complications during surgery or operations.

Obesity makes it more difficult to engage in regular exercise, increasing health risk and lack of fitness. Even a 10 percent decrease in weight can reduce the risk and improve overall health.

What are lipids?

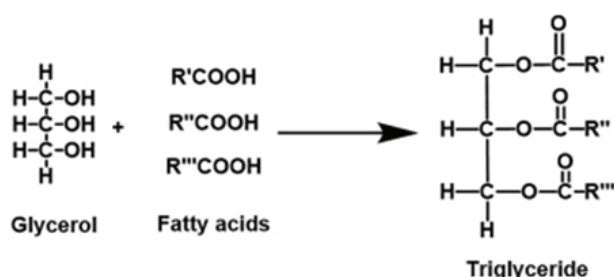
Lipids are biomolecules that include fats, oils, waxes, steroids, cholesterol and fat soluble vitamins. They are soluble in non-polar (organic) solvent but not in water. The lipid content of a cell can be extracted by using organic solvents such as either chloroform or benzene.

Section 2

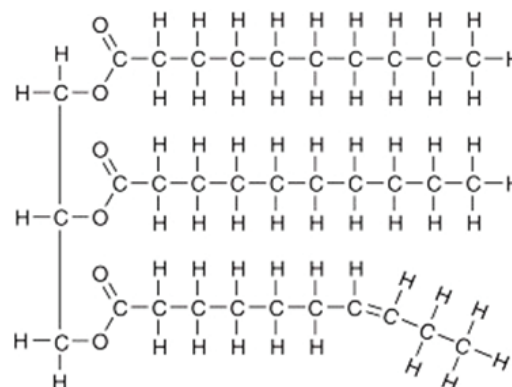
What are fats?

Fats are an essential part of obesity. Chemically, fats are a type of lipid consisting of triesters of glycerol and fatty acid tails known as triglycerides. They are mostly soluble in organic solvents and largely insoluble in water. Fats are solid at room temperature. The chemical structure of a triglyceride is shown below:

Triglycerides formed by the reaction of glycerol and fatty acids [6].



The formula of Triacylglycerol is given below:[7]



What are fatty acids?

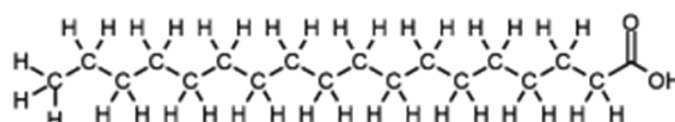
Fatty acids are long chains of carbon atoms attached to carboxylic acid groups. If the carbon atoms of a fatty acid chain have no double bonds and are saturated with hydrogen atoms it is called a saturated fatty acid. If it has one carbon-carbon double bond it is called a mono-unsaturated fatty acid >C=C< . If it has 2 or more double bonds it is called a poly-unsaturated fatty acid. Most animal fats are saturated and solid at room temperature while vegetable fats are unsaturated and liquid at room temperature. Most naturally occurring fatty acids have an unbranched chain of an even number of carbon atoms, which ranges from 4 to 28 [8]. Most vegetable oils are polyunsaturated and are liquid at room temperature. Olive oil is monounsaturated.

Fatty Acids can be classified as :

a) **Fully saturated fatty acids:** Saturated Fatty acids are fats with no double bonds between the carbon atoms, in their fatty acid chains. They are solids at room temperature and can be found in both animal and plant sources.

Example: Stearic Acid (no double bonds, M.P. 70°C)

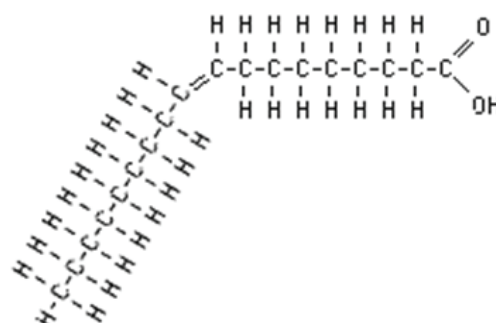
○ Structure - $\text{CH}_3(\text{CH}_2)_{16}\text{COOH}$



b) **Monounsaturated fatty acids:** Monounsaturated Fatty acids are a type of fat that contains a single double bond in their fatty acid chain, with the remaining carbon atoms being single bonded. They are usually liquid at room temperature and solid when chilled.

Example: Oleic acid (one double bond, M.P. 13°C)

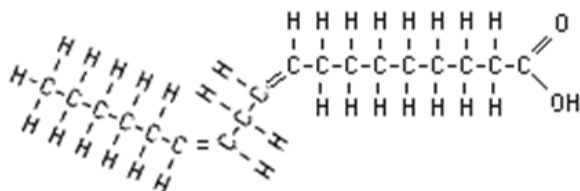
○ Structure - $\text{CH}_3(\text{CH}_2)_7\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$



c) **Polyunsaturated fatty acids:** Polyunsaturated Fatty acids are fat molecules which contain more than one double bond in their fatty acid chain. They reduce the risk of heart diseases.

Example: Linoleic acid (two double bonds, M.P. -5C)

Structure - $\text{CH}_3(\text{CH}_2)_4\text{CH}=\text{CHCH}_2\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$



Essential fatty acids

Essential fatty acids are a type of polyunsaturated fatty acid. There are two categories; Omega - 3 and Omega - 6. These make compounds called eicosanoids, which are important hormones that control the immune system, nervous system and other hormones. Omega - 3 fatty acids promote heart health, while Omega - 6 fatty acids promote immune system, inflammation response, and blood pressure. Fatty acids are essential for the normal functioning of all systems in the body. People must get essential fatty acids from food sources as they are not made by the body, and because the two omega acids can produce opposite effects, it's important to balance them in the diet [9]. Polyunsaturated fats include Omega- 3 fatty acids and Omega- 6 fatty acids. Polyunsaturated fats are found in plant based oils like soybean, corn, and safflower oils and they are found in abundance in walnuts, flax seeds, and fish like salmon, mackerel, herring tuna, and trout.

Examples of Omega - 3 fatty acids [10]:

- Fish and other sea foods like salmon, mackerel, tuna, and sardines
- Nuts and seeds such as flaxseeds, chia seeds, and walnuts
- Plant oils such as flaxseed oil, soybean oil, and canola oil
- Fortified foods such as certain brands of eggs, yogurt, juices, milk, and soy beverages

Examples of Omega - 6 fatty acids [10]:

- Canola oil
- Soybean oil
- Corn oil
- Sunflower oil
- Chia seeds
- Walnuts
- Hazel nuts
- Almonds
- Brazil nuts

Benefits of essential fatty acids

- Formation of healthy cell membrane
- Proper development and function of the brain
- Hormone production
- Regulation of blood pressure, liver function, immune and inflammatory response
- Regulation of blood clot formation (Omega- 6 assists

clotting, Omega- 3 reduces clotting)

- Support healthy skin and hair
- Some research has shown potential effects on reducing depression and protecting against Alzheimers [10]. More work is still needed to establish this connection fully.

Our body needs a certain amount of fat in our diets to stay healthy; Fats provide the required energy in the form of calories. Fat in the diet allows our body to absorb fat soluble vitamins A, D, and E. Every cell in our body needs fat to build a healthy protective membrane. Fat also provides the material that our body uses to produce chemicals that control blood, our blood pressure and prevent blood clots. Eating the wrong kind of fat can trigger health hazards. Some fats are better for our bodies than others.

Sometimes back the feeling of fat was–

“The less fat you eat, the better it is for health.”

However the feeling has changed now–

“Better fats, better health”

Good fats are believed to be an essential part of a healthy diet.

Cis and Trans fatty acids [11]

Unsaturated fatty acids are mainly of 2 types, cis and trans forms. They are geometric isomers. Cis fatty acids are most commonly found in nature and are healthier for human consumption while trans fats can have deleterious effects on human health such as increased risk for cardiovascular disease. Trans fats are rare in nature and are mostly formed by industrial hydrogenation of vegetable oils. They are normally solids at room temperature and increase the risk for clogging the arteries. Trans Fats are considered the worst type of dietary fats. Cis binding refers to the binding of 2 hydrogen atoms to the same side of a carbon double bond, while trans binding refers to the binding of 2 hydrogen atoms on opposite sides of the carbon double bond. The structural differences between cis and trans binding is shown below:

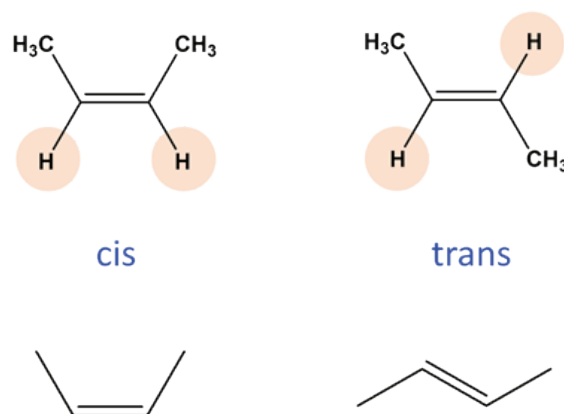


Figure 1. Cis and trans binding [11]

Cis and trans fatty acids are geometric isomers. Cis fatty acids have hydrogen bonds on the same side of two carbon atoms that are double bonded together. Trans fatty acids have the same number of atoms and the same double carbon bond location, but the hydrogens are found on opposite sides of the carbon atoms [12].

Choice of Fats

Fats are an essential part of a healthy diet [13], providing energy, helping the body absorb vitamins, and supporting cell function. Fats also help people feel full, protect organs, and keep the body warm. Fats are a great source of energy with twice the calories of carbohydrates or protein. One gram of fat contains 9 calories, while one gram of carbohydrates or protein contains 4 calories. Fats also help the body absorb fat soluble vitamins A, D, and E. Fats are also building blocks of hormones and essential fatty acids which the body cannot produce on its own.

There are four types of dietary fats:

Trans Fats: Trans fats, or trans fatty acids (TFA) are found in nature and are made artificially. Trans fats are made by adding hydrogen to vegetable oil, making it solid at room temperature. This process is called hydrogenation.

The following foods contain trans fats:

- Margarine
- Vegetable shortening
- Vanaspati ghee
- Fried foods
- Baked goods such as crackers, biscuits, and pies
- Microwave popcorn
- Frozen pizza
- Dairy and non-dairy coffee creamers

Trans fats are considered to be the worst type of fat to eat. It raises bad cholesterol. Trans fats are so unhealthy that their use was banned by the US Food and Agriculture Administration (FDA). The use of trans fats can lead to very serious diseases like congestive heart disease, stroke, atherosclerosis, high cholesterol, and high blood pressure. Studies show that trans fats can significantly increase the risk of congestive heart disease and even small amount of trans fat can elevate the risk of bad cholesterol (LDL) and reduce the HDL and cause vascular inflammation.

Saturated Fats: Saturated fats are solid at room temperature and contain hydrogen molecules with single bonds between carbon molecules. They are found in meat and dairy products, such as butter, coconut oil, and cheese, and can raise cholesterol levels.

According to Dr. Cyrus Khambatta, *“Diets high in saturated fats are effective short-term treatments to lose weight and normalize blood glucose, but they significantly increase your level of insulin resistance which in turn increase your risk of many chronic diseases and premature death in the long term.”* [14]

Examples of foods with saturated fats [15]:

- Beef
- Lamb
- Pork
- Poultry, especially with skin
- Beef fat
- Lard and cream
- Ghee
- Butter
- Cheese
- Ice cream

- Coconut
- Palm oil
- Some baked and fried foods

Unsaturated fats: Unsaturated fats are fats that contain one or more double- a triple bonds between the molecules. They are normally liquids at room temperature and can be found in solid foods and oils.

Unsaturated fats are divided into two categories:

- Monounsaturated fats contain one double bond in their structure.
- Polyunsaturated fats contain two or more double bonds.

Examples of monounsaturated fats:

- Olive, peanut, and canola oil
- Avocados
- Nuts such as almonds, hazelnuts, and pecans
- Seeds such as pumpkins and sesame seeds

Examples of Polyunsaturated fats:

Polyunsaturated fats include Omega- 3 fatty acids and Omega- 6 fatty acids. Polyunsaturated fats are found in plant based oil like soybean, corn and safflower oils and they are found in abundance in walnuts, flaxseeds, and fish like salmon, mackerel, herring, tuna, and trout.

Section 3

Eating in the way of the Yoga Lifestyle-Yogic Diet

According to yogic tradition [16], a lacto-vegetarian diet free from fish, eggs, and meat with limited intake of dairy products is recommended. A well balanced vegetarian diet has proven to be extraordinarily healthy and cures many diseases. The food, according to yogic scriptures has been divided into three categories based on their qualities (gunas). Foods are sattvic, rajasic, tamasic, or a combination of these three gunas. These qualities are present in everything but in different amounts, making one quality dominant.

Sattvic Diet

The word Sattvic originates from sattva, which signifies purity and goodness. Sattvic food supports clarity and calmness of the mind, fostering spiritual growth. The Sattvic diet comprises fresh fruits, green leafy vegetables, nuts, seeds, legumes, whole grains, plant-based oils, natural sweeteners, mild spices, and herbs. These foods are light and freshly prepared, avoiding leftovers and waste. The Bhagavad Gita describes Sattvic food as “promoting life, virtue, strength, health, happiness, and satisfaction.” Sattvic foods are also abundant in prana, the life force.

Yoga discourages “denatured” foods such as white flour, white bread, refined cereals, canned fruits, vegetables, or drinks, and saturated fats like hydrogenated oils. Reheating cooked food is avoided as it diminishes nutritional value.

Cooking is seen as an act of transferring emotions into food. Therefore, it is recommended to prepare meals with love and goodwill, allowing prana to flow into the food, nourishing those who consume it.

Rajasic Diet:[16]

Foods which are very hot, bitter, sour, dry, or salty are rajasic. Such foods destroy the mind-body equilibrium and feed the body at the expense of the mind. Rajasic foods are mostly spicy

and stimulants. They include foods like coffee, tea, garlic, onion, meat, fish, and chocolate and many processed foods. Eating any food in a hurry is also considered as rajasic. Eating too much rajasic foods will over stimulate the body and make the mind restless and uncomfortable. Bhagwat Gita describes rajasic food as “excessively pungent, sour, salty, hot, harsh, astringent and burnt” leading to pain, misery and sickness. This type of food makes us agitated and overstimulated.

Tamasic Foods: [16]

A tamasic diet neither helps the mind nor the body. It withdraws prana or energy from the body and becomes negative. We lose our power of reasoning and a sense of inertia sets into the body. The body's resistance to diseases is destroyed and the mind is filled with dark emotions such as anger and greed. This type of food includes alcohol, meat, tobacco, onions, garlic, and fermented foods such as vinegar and stale over ripe foods. Overeating is also considered Tamasic. This type of food makes us tired and sluggish.

The yogic diet is based on three principles

- i) Non-violence
- ii) Moderation
- iii) Attitude of mind or emotions

Non-Violence (Ahimsa): The practice of consuming meat, particularly from innocent or defenseless animals, is viewed as an act of cruelty and violence in yoga. Yoga advocates for a diet based on fruits, vegetables, and nuts, as they are considered more harmonious and nourishing than the flesh of slaughtered animals. The quality of protein found in meat is believed to be lower, carrying negative energy or "prana." As a result, those who eat meat are thought to absorb lower-quality protein, which can be detrimental to their well-being. Eating red and processed meat increase the risk of:

- Cancer: red and processed meat can increase the risk of colorectal cancer. Cooking meat at high temperatures can create substances that alter DNA and increase cancer risk
- Heart disease: Red meat contains saturated fats, which can increase the risk of heart disease and stroke
- Diabetes: eating meat can increase the risk of diabetes
- Other diseases: eating meat can increase the risk of pneumonia, diverticular disease, colon polyps, gastro-esophageal reflux disease, gastritis, duodenitis. And gallbladder disease.
- Fatigue: digesting a meat-heavy meal can make you feel tired, sluggish, foggy, or sleepy
- Alzheimer's: a western diet heavy in animal proteins can increase the odds of developing Alzheimer's disease

Processed meats include those such as sausages, bacon, ham, deli meats like salami, canned meats such as corned beef, sliced luncheon meats, pates, and more.

Animal protein also contains high levels of uric acid, which the liver struggles to process. While some of it is excreted, the remainder can accumulate in the joints, leading to stiffness and conditions like gout and arthritis. On the other hand, plant-based foods such as nuts, dairy, legumes, especially soybeans and their derivatives like tofu and soy milk, provide better, higher-quality proteins. Steak only has 5.4 grams of protein per 100 calories and broccoli has 11.2 grams, almost twice as much. [17] Studies have shown that vegetarians tend to have a reduced risk of heart disease, stroke, kidney disorders, and

cancer, and their immune systems are generally stronger. A vegetarian diet is also considered healthier because it avoids harmful additives commonly found in meat, such as pesticides, artificial hormones, preservatives, and colorants, which are often linked to free radicals. Furthermore, it is believed that the fear and stress experienced by animals before being killed can be transferred to those who consume their meat, which may increase tension in the body and mind, raising cortisol levels and contributing to higher blood pressure.

The world health organization's cancer agency [18], named the International Agency for Research on Cancer (IARC), has classified the consumption of red meat as “probably carcinogenic” to humans and that it increases one's risk of colon and rectal cancer by 18%. Many studies [19] have shown that vegetarians are about 40% less likely to develop cancer than meat eaters. Eating foods rich in red meat, chicken, fish, and eggs, leads to heart disease, cancer, obesity, and even impotence. Well planned vegan diets provide us with all the nutrients that are required by our bodies except saturated fats, cholesterol, and contaminants found in animal flesh [20]. Meat contains [21] animal protein, saturated fats and in some cases, carcinogenic compounds such as heterocyclic amines (HCA) and polycyclic aromatic hydrocarbons (PAH) formed during the processing or cooking of meat. HCAs are formed as meat is cooked at high temperatures and PAHs are formed during the burning of organic substances, which increases the cancer risk. The other dangers of eating meat are that it is acidic and loaded with toxins. Meat eaters feel that the only way to get enough protein and other nutrients is to eat meat but most of the doctors and health experts side with vegetarians.

According to William J Mayo, founder of the Mayo Clinic [22], in an address before the American College of Surgeons,

“Meat eating has increased 400 percent in the last 100 years. Cancer of the stomach forms nearly one-third of all cancers of the human body. If flesh foods are not fully broken up, decomposition results and active poisons are thrown into an organ not intended for their reception. Protein poisoning is hyperacidity in the body.”

According to Mayo clinic; Healthy Lifestyle, Nutrition and healthy eating, research shows that people who eat red meat are at higher risk of death from heart disease, stroke, or diabetes. Processed meats also make the risk of death from these diseases go up [43].

According to NHS [23](www.nhs.uk/):

- Eating too much processed meat and red meat probably increases your risk of bowel (colorectal) cancer
- Processed meat can also be high in salt and eating too much salt can increase your risk of high blood pressure
- Red meat includes beef, lamb, mutton, pork, veal, venison, and goat.
- Processed meat is any meat that has been preserved by smoking, curing, salting, or adding preservatives.

Research indicates that the long term consumption of increasing amounts of red meat and particularly of processed meat is associated with an increased risk of total mortality, cardiovascular disease, colorectal cancer and type 2 diabetes in both men and women.

Vegetarian Foods: Vegetarians have less weight problems, lower blood pressure and less overall health problems than meat eaters. In fact, plant sources can provide all the proteins we need

as long as we eat a variety of grains, nuts, seeds, and legumes every day. Vegetarian diet is normally much lower in cholesterol and saturated fats and rich in complex carbohydrates, fiber, vitamins and minerals. Yoga favors a lacto-vegetarian diet, which is a diet based on vegetables, milk and dairy products. Yoga recommends a diet of Satvic or pure foods and strongly warns against rajasic or tamasic foods which contain meat, alcohol, and other impure foods. Sattvic foods are milk, milk products, fruits, vegetables and grains. Most yogis are lacto-vegetarians because they link purity of diet with spiritual development. According to yoga, the subtle part of the food creates the energy for thinking processes. Yogis believe that people's food preferences affect their level of mental purity and these preferences alter as they develop spiritually [24]. Eating, drinking and sleeping habits should be normal, as Lord Krishna has described in Bhagavad Gita that our food should be sattvic (high quality of purity) and the mind should be full of sattvic gunas (qualities).

Moderation: Moderation means we should eat only what we need and no more. We should chew each mouthful slowly and will accustom us to take only as much food as we need. Our food should have only a balanced place in our diet. A diet containing a wide variety of wholesome foods always provides a balanced supply of nutrients.

The yoga Pradipika, an ancient handbook on yoga , says "moderate diet means pleasant, sweet food leaving free one fourth of the stomach."

Alice Christensen

According to Shiva Samhita, one should avoid acids, astringents, pungents, salt, mustard, bitters, foods roasted in oil and overeating. This text also suggests that smaller and more frequent meals are beneficial.

Attitude of Mind: When we cook our emotions are transferred to the food. Therefore food should always be prepared with love, allowing prana to pass through the food and nourish the people we are feeding. We should always be peaceful while eating. We should be silent if we eat alone. If we are sitting with friends or family, we should avoid arguments and emotional issues and unnecessary discussions.

Foods injurious to and beneficial to a Yogi according to the Hatha Yoga Pradipika

"Bitter, sour , saltish, green vegetables, fermented, oily, mixed with til (sesame) seed, rapeseed, intoxicating liquors, fish, meat, curds, chhaasa (buttermilk), pulses, plums, oil-cake, asafoetida, garlic, onion, etc., should not be eaten. Food heated again, dry, having too much salt, sour, minor grains, and vegetables that cause burning sensation, should not be eaten." [25]

Characteristics of Yogic or Sattvic Diet

"The food we eat and the surroundings we inhabit must be conducive to stress-free living. If we increase our intake of fruit and vegetables, and nourish our senses with calming scents, sounds, and sights, we will be on the way to a healthier lifestyle."

B.K.S. Iyengar

The Path to Holistic Health

Sattvic diet is food that gives life, strength, energy, courage, and self-determination. This diet gives us a proper mix of carbs, proteins, fats, etc., and is recommended in yoga as the most appropriate diet. Sattvic foods are light in nature, easy to digest, cooling, refreshing, and pleasant to mind.

Whole Grains

The grains which can be eaten on the yogic diet include brown rice, quinoa, oats, spelt, rye, miller, barley, organic rice, and whole wheat. The foods made from these grains are high in fibre and other nutrients and can reduce the risk of cancer. [26]. Whole grains are considered very important in yogic diet and can provide sustained energy and promote steady blood sugar levels. The high fiber content in whole grains can also support digestive health. Other benefits of whole grains include:

- Reducing the risk of heart disease and stroke
- Reducing the risk of obesity and type 2 diabetes
- Supporting healthy digestion
- Reducing chronic inflammation
- Reducing risk of cancer

Beans and Legumes

Beans are the cheapest and best source of fiber [27]. They are low calorie and full of proteins. Beans are also known to lower cholesterol, contain anti-cancerous agents and relieve constipation. Split mung beans, yellow split peas, organic tofu, bean sprouts, lentils, and aduki beans are considered sattvic and used under legumes. It is said that one should eat more foods rich in vegetable protein and less or no with animal protein as high animal protein diets develop kidney or heart problems. Beans are a source of - low fat protein, fibre, vitamin B, iron, foliate, potassium, magnesium, phytonutrients. Research has demonstrated that regular consumption of beans can

1. Lower cholesterol
2. Combat heart disease
3. Reduce cancer risk
4. Stabilize blood sugar
5. Reduce Obesity
6. Relieve Constipation
7. Reduce Hypertension Risk
8. Lower Risk of Type 2 Diabetes

Nuts Seeds and Oils

Nuts are 10-20% protein, high in mono- and polyunsaturated fats, and a good source of dietary fiber and certain vitamins and minerals. Nuts are cholesterol free like other plant foods- but because all nuts are high in fat , and often salted, they should be eaten in moderation [27]. Nuts are cholesterol free. Nuts are the best way to get good fat in our diet. Walnuts are a good source for Omega- 3 fatty acids and have been proven to lower cholesterol. Walnuts are rich in vitamin E. Almonds, featuring monounsaturated fat, protein, and fiber, can also lower cholesterol levels. Nuts and seeds (walnuts, almonds, cashews, hemp seeds, chia seeds, flaxseeds) contain significant sources of unsaturated fats. They have a high nutrient density and are rich in protective phytochemical compounds including lignans, sterols, antioxidants, fiber, polyphenols, minerals, and bioflavonoids [27]. These nuts and seeds are highly rich in essential fatty acids. Fresh nuts and seeds that have not been overly roasted and salted are good additions to the sattvic diet. The following are the major ingredients of sattvic diet:

Good choices of nuts are:

- Almonds
- Pine nuts
- Walnuts

- Sesame seeds
- Flax seeds
- Pumpkin seeds

Sweeteners

Raw honey and raw sugar (not refined) are used in yogic diets as sweeteners

Herbs and Spices

Sattvic spices are the mild spices including basil, cardamom, cinnamon, coriander, cumin, fennel, fenugreek, fresh ginger and turmeric. Rajasic spices like black pepper, red pepper, and garlic are not only excluded, but are sometimes used in small amounts because of their utility. Other herbs used include ashwagandha, bacopa, calamus, gotu kola, ginkgo, tolui, and rose. Some people use them for their stress.

Healing Power of some Herbs & Spices [27]

- **Garlic** - Regular consumption of garlic in the diet lowers the blood pressure and decreases platelet aggregation. Studies have also shown that garlic reduces LDL or Low Density Fatty Acid (Bad Cholesterol) and increases High Density Fatty Acids or HDL (good cholesterol) in the blood. Several studies suggest that garlic consumption is also associated with lower risk of colorectal and gastric cancer. Furthermore, garlic has potent antibiotic properties against various harmful bacterias.
- **Tea** - Regular tea consumption is very useful and is associated with lower blood pressure and skin cancer, decreases aging of skin and cataract prevention.
- **Ginseng** - This ancient herb has been used to treat heart problems for centuries. Ginseng may lower cholesterol and triglyceride levels. This means a lower risk of clogged arteries and heart disease.
- **Ginger** - Ginger helps the body digest fat and may prevent blood clots. It has been found that ginger lowers cholesterol and inhibits LDL oxidation. Contains antioxidants and may help with nausea, vomiting, digestion, inflammation, arthritis, and pain.
- **Aloe vera** - Alovera has excellent, soothing, healing and moisturising properties. It also helps to remove, dead skin cells
- **Ginkgo** - Ginkgo is taken to boost memory and for better blood circulation. Ginkgo rids the toxins that harden the arteries.
- **Fenugreek** - It contains a lot of fiber and helps lower the bad cholesterol, triglycerides and high blood sugar.
- **Turmeric** - Has antioxidant and anti-inflammatory powers. It also lowers cholesterol and blocks LDL oxidation.
- **Neem** - Neem supports a healthy immune system by cleansing toxins, supports healthy blood-sugar levels by purifying blood supply, also reduces unwanted heat and toxins in the GI-tract. Neem also helps grow healthy lustrous hair, supports healthy teeth & gums,
- **Tulsi** - Tulsi is antimicrobial, anti-diabetic, adaptogen and calming. Tulsi promotes healthy weight management thanks to its effect in the adipose tissue layer
- **Ashwagandha** - Has dual capacity to energize and calm throughout the day and promote restful sleep at night. Promotes healthy reproductive system, healthy back

and joints, healthy muscles, thyroid health, healthy functioning of the adrenals.

- **Green tea** - Contains antioxidants called catechins, which may reduce the risk of some cancers and cardiovascular disease. It may also help with weight loss, cognitive function, and blood sugar control.
- **Flax seeds** - High in fiber, omega- 3 fatty acids, and may help lower cholesterol and blood pressure. They also contain lignans, which are similar to the hormone estrogen.
- **Chia seeds** - High in fiber, omega- 3 fatty acids, and antioxidants. They may help with heart health, digestion, and weight management.
- **Honey** - May have antidepressant, anticonvulsant, and anti- anxiety benefits. Topical use of medical- grade honey may also promote wound healing.

Organic Dairy [28]

Dairy products are rich in vitamins and minerals, and are sattvic. They are recommended, to strengthen the immunity. However, it is found that dairy products are overloaded with saturated fats, and this makes them quite dangerous for the body. Therefore, dairy products should be taken in moderation. Eating and drinking dairy products provides nutrients beneficial for health and maintenance of the body, such as building and maintaining strong bones. Dairy products contain Calcium, Phosphorus, Vitamin A D and B12 Riboflavin, Protein, Potassium, Zinc, Choline, Magnesium and Selenium.

Calcium and vitamin D are very important for the body at any age. Dairy products provide nutrients to

- Improve bone health in children and adolescents
- Promote bone health and prevent the start of osteoporosis

Dairy products provide nutrients that are difficult to obtain in low dairy or dairy free diets. Dairy free diets cannot provide the required daily amount of calcium intake for bone health. Some people avoid dairy in their diets because of high saturated fat content which may lead to several diseases like lactose intolerance, osteoarthritis, rheumatoid arthritis or cardiovascular disease. This makes the dairy controversial and more work needs to be done in this direction for the people to make their own decision.

Section 4

Organic Fruits and Vegetables

Most organic vegetables are considered sattvic including beets, carrots, celery, cucumbers, leafy greens, sweet potatoes and squash. Pungent vegetables like hot pepper, garlic, onion, mushroom, and potatoes are excluded as they are considered rajasic and tamasic in nature.



Figure 2A. Organic Vegetables

Fruits and vegetables are an important part of a Yogic diet because they contain vitamins, minerals, fiber, antioxidants, and phytochemicals. Fruits and vegetables are rich in vitamins, minerals, fiber, and provide a tremendous variety of tastes and textures. Whenever possible, we should choose fresh fruits and vegetables in season. They taste better, are more nutritious, and cost less. Foods out of season must be stored in good warehouses under refrigeration.



Figure 2B. Organic Fruits

Fruit has the highest water content of any food. All fruit is 80 percent to 90 percent cleansing, life-giving water. In addition, all the vitamins, minerals, carbohydrates, amino acids and fatty-acids that the human body requires for its existence are found in fruit. The life force inherent in fruit is unsurpassed by any other food.

Some benefits of fruits and vegetables include [29]:

- Reduced risk of disease: Fruits and vegetables can help lower the risk of heart disease, stroke, type 2 diabetes, obesity, and some cancers.
- Fruits and vegetables are a good source of fiber.
- Fiber- rich vegetables include artichokes, green peas, broccoli, and cauliflower improve digestion.
- Fruits and vegetables can help lower blood pressure.
- Fruits and vegetables can have a positive effect on blood sugar.
- Improved skin, teeth, and eyes: Healthy eating can help keep your skin, teeth, and eyes healthy.
- Healthy eating of fruits and vegetables can support muscles.
- Boosts immunity: Healthy eating can boost immunity.
- Supports healthy pregnancies and breastfeeding

Some fruits and vegetables are rich in starch, which provides energy. For example, potatoes, sweet potatoes, tapioca, and yams are rich in starch.

Glucaric acid is also found in many fruits and vegetables with the highest concentrations to be found in oranges, apples, grapefruit, and cruciferous vegetables. Beta- glucuronidase has been shown to decrease the rate of elimination of estrogen and carcinogens such as polycyclic [30] aromatic hydrocarbons and nitrosamines by deconjugation. Inhibition of beta- glucuronidase activity with calcium glucarate improves excretion of metabolized estrogen and carcinogens. A current commercial use of a salt form of d- glucaric acid as a dietary supplement claimed to help maintain healthy cholesterol levels and prevent cancer. As a dietary supplement, d- glucaric acid functions as a

precursor to the β - glucaric acid functions as a precursor to the β - glucuronidase inhibitor and d- glucaro-1,4-lactone. Calcium D- glucarate might lower estrogen levels, which might have effects in some people with hormone- dependent cancers. People use calcium D- glucarate for preventing breast cancer, prostate cancer, and colon cancer, and for treating other conditions, but there is no good scientific evidence to support these uses. Beta- glucuronidase has been shown to decrease the rate of elimination of estrogen and carcinogens such as polycyclic aromatic hydrocarbons and nitrosamines by deconjugation. Inhibition of beta- glucuronidase activity with calcium glucarate improves excretion of metabolized estrogen and carcinogens.

According to nutritionists, blueberries, bananas, avocados, and citrus fruits are some of the healthiest fruits. Some of the healthiest vegetables include kale, spinach, and sweet potatoes.

Vitamins and Minerals in Fruit and Vegetables

Fruits and vegetables contain many vitamins and minerals that are good for your health; many of these are antioxidants and may reduce the risk of many diseases [29].

- Vitamin A (beta- carotene)
- Vitamin C
- Vitamin E
- Magnesium
- Zinc
- Phosphorus
- Folic acid

Folic acid may reduce blood levels of homocysteine, a substance that may be a risk factor for coronary heart disease. Research has shown that consuming these nutrients as food, within fruits and vegetables, is more beneficial for health than consuming them as supplements.

- Fruits and vegetables are good for health as they are low in fat, salt and sugar. They are also a good source of dietary fibre. [29] They reduce obesity, lower bad cholesterol, and blood pressure.

Fruits and Vegetables Protect Against Diseases

Research shows that regular use of fruits and vegetables reduce the risk of type 2 diabetes, stroke, heart disease, cancer, stomach problems, throat and high blood pressure.

Colors of Fruits and Vegetables

1. Foods of similar colors generally contain similar protective compounds [29].
2. Red fruits such as tomatoes and watermelon and green vegetables like spinach and kale contain lutein and zeaxanthin which may help protect against age-related eye disease.
3. Blue and purple foods like blueberries and eggplant contain anthocyanins, which may help protect the body from cancer.
4. White vegetables such as cauliflower contain sulforaphane which helps to protect against some cancers

Consumption of Fruits and Vegetables

According to Dr Joel Fuhrmann MD, author of “Eat to Live” [17], we should eat the following every day:

- Large bowls of green salads
- Large serving of steamed greens

- One cup of beans
- At least 1 oz of raw nuts and seeds
- At least 3 fresh fruits
- Some tomatoes, peppers, onions, and garlic

In order to make us more productive and effective during the day, while at the same time, allowing our body to work at the elimination of toxic waste, the following table is suggested for the different meals of the day: [22]

AM	Fresh Fruits and Fruit Juices
AM	Fresh Vegetable Juices and Salads
PM	Raw Nuts and Seeds Organic Dairy (or substitutes like Almond or Soy Milk)
PM	Grains, Bread, Potatoes, Steamed Vegetables
PM	Vegetable Soups, Beans and Legumes

Section 5

Use of Alcohol in Yogic Diet [31,32]

Alcohol use disorder (sometimes called alcoholism) is a common medical condition. In this disorder, people can't stop drinking, even when drinking affects their health, puts their safety at risk, and damages their personal relationships. Yoga strictly forbids use of alcohol in yogic diet.

Drinking alcohol may cause-

DNA Damage

Modern research shows that ethyl alcohol in the body metabolizes into acetaldehyde, a toxic chemical that can damage DNA and prevent our body from repairing it, which can lead to cells growing out of control and forming cancer tumors. The International Agency for Research on Cancer classifies alcoholic beverages as carcinogenic and has linked alcohol consumption to several types of cancer, including head and neck, esophageal, liver, breast and colorectal cancer.

Dehydration

Alcohol is a diuretic, which means it removes fluids from the body. Excessive drinking can lead to dehydration, which can cause many hangover symptoms, such as thirst, dizziness and lightheadedness.

Stomach irritation

Alcohol increases the acidity in the body, which may lead to nausea, vomiting and aching stomach. Heavy drinking can cause painful sores called ulcers or gastritis, which is an irritation of the stomach lining.

Short-term health effects of alcohol

- Dizziness
- Lack of judgment
- Loss of coordination
- Memory loss
- Vomiting
- Accidental injury (to self or others)
- Being in a road accident
- Deliberately harming self or others
- Alcohol poisoning (which can be fatal)
- Fatigue
- Headaches
- Hangover

Long-term health effects of alcohol

Drinking too much alcohol affects concentration, judgment, mood, and memory. Heavy drinking of alcohol can increase our blood-pressure and can lead to heart damage and heart attacks. Drinking 3-4 drinks a day increases your risk of developing liver cancer. Regular heavy drinking of alcohol reduces men's testosterone levels, sperm count and fertility

Section 6

Prevention and Reversal of Type 2 Diabetes by Yoga

Yoga can benefit people with type 2 diabetes in the following ways:

1. Yogic and Sattvic Diet
2. Controlling Stress and Blood Sugar Level
3. Yogic Postures
4. Yogic Breathing

Yogic or Sattvic Diet

The details of this diet are discussed previously (section 3)

Sattvic diet is a pure clean lactovegetarian diet which provides clarity and calmness of mind, fostering spiritual growth.

Eating fragmented and unbalanced food causes many problems, such as obesity, high blood pressure and diabetes. Diabetes is a food created disorder, and the right food choices can rid us of this life shortening disease and its associated medical complications. Learning how the food we eat affects our health and well being gives us the power to become healthy, live longer, and feel better every single day. [33]

According to Yoga the subtle part of the food creates energy for the thinking process. This idea of food for thought makes perfect sense in scientific terms: like all other cells of the body, the neurons in the brain need to absorb specific nutrition in order to function properly. Eating fresh plant food, which has absorbed maximum sunlight is the best source for physical and mental strength and it reduces the stress, which further controls blood sugar and hence diabetes [34].

Yogic diet forbids the use of denatured foods, such as white flour, white bread and refined cereals. It also does not allow the use of flesh food, which has been proved harmful and the cause of many cancers. Yogic diet is prepared, with goodwill and emotions. Yogic diet is a good source of fiber and many vitamins and minerals. Beans and lentils in yogic diet are good sources of proteins. Organic fruits and vegetables are useful aspects of yogic diet. They calm and cleanse the mind, removes the stress and is very helpful to overcome type 2 diabetes.

Controlling Stress and Blood Sugar Levels

Yoga mediation and some yogic postures are extremely useful to combat stress levels. Modern research shows that increased stress levels can raise blood sugar levels. During stressful situations, epinephrine (adrenaline), glucagon, growth hormone, and cortisol play a role in blood sugar levels, stressful situations include infections, serious illness, or significant emotional stress. When stressed, the body prepares itself by ensuring that enough sugar or energy is readily available. Insulin levels fall, glucagon and epinephrine (adrenaline) levels rise and more glucose is released from the liver. At the same time, growth hormone and cortisol levels rise, which causes body tissues (muscle and fat) to be less sensitive to insulin. As a result, more glucose is available in the bloodstream. [35] This high level of glucose in the blood can affect the organs like the heart, blood vessels, kidneys, nervous system, due to chronic

hyperglycemia. This stressful situation can be avoided if yoga meditation is done. Yoga meditation generates a relaxation response which encounters the stress levels in the body. Similarly yogic postures also reduce stress in the body. Yoga practices that incorporate physical poses, concentration, and deep breathing may also help people with type 2 diabetes by:

- Lowering oxidative stress and blood pressure
- Improving pulmonary function
- Reducing stress
- Supporting weight loss
- Enhancing mood, sleep, and quality of life
- Reducing medication use

Yogic Postures

What are asanas? : Asanas, or yoga poses, are physical postures intended to benefit the mind and body. Asanas are said to improve flexibility, strength, and balance. They also help with stress, anxiety, and lower back pain. Some claim that asanas can help with specific conditions like asthma, diabetes, and chronic obstructive pulmonary disease.

- **Asanas:** In ancient times, asanas were used to prepare the body and mind for long periods of meditation with minimal distractions. Hatha yoga practices aim to create harmony between the mind and body by balancing the active and passive aspects of the self. Asanas include sitting, standing, lying, and inverted postures. Asana practice involves focusing the mind's attention completely on the body, allowing the practitioner to move as a unified whole and perceive what the body is communicating. Asanas were claimed to provide both spiritual and physical benefits. More recently, studies have provided evidence that they improve flexibility, strength, and balance; to reduce stress and conditions related to and specifically to alleviate some diseases such as asthma and diabetes.

Figure 5 shows some important postures for Yoga and Meditation.



Section 8

What is stress?

Stress is a feeling of physical and emotional tension. It can come from any event or thought that makes you frustrated, angry or nervous. Stress is your body's way of responding to any kind of demand or threat. When you sense danger whether it is real or imagined, the body's defenses kick into high gear in an automatic process called the stress response [42]. There are 2 main types of stress: acute stress and chronic stress. Acute stress comes and goes in a short time and is felt in times such as doing something exciting/scary that triggers adrenaline. Chronic stress lasts for a longer period of time, such as weeks or months,

and can be caused by things such as financial difficulties, a troubled marriage, or problems at work. If chronic stress is left unmanaged it may cause serious health problems.

- **Stress Management and Meditation:** Our life is full of stress and tension and it is very difficult to remove them from our life and every action in life is stressful. When good work is done without any selfish motive, the stress caused by it is positive and it is not much harmful. The main reasons for negative stress are anger, fear, speed, greed, and unhealthy ambition which are extremely damaging and harmful. Walking, eating, and reading all give stress but differ in their degree. We have unavoidable stress in our life. This stress on the mind builds up mental disturbances such as anger and desire and results in emotional stress. Meditation does not remove stress. Meditation is only possible when one has already achieved a certain "stressless" state. By learning how to relax the brain, one can begin to remove stress. In fact true meditation in the yogic sense can not be done by a person who is under stress. In the process of asanas (yogic postures) the body releases its stress and strain through movement. Similarly while doing pranayama (breath control exercises) the body is fully energized, the nerves are soothed, the brain is calmed, and the hardness and rigidity of the lungs are loosened. There are certain vibrations which can make rhythmic and subtle changes in our asanas and pranayama practice without force or stress. We become one in ourselves and are in a meditative state [40].

Yoga meditation provides an answer to the problems of stress

There has been some strong scientific evidence to show that yoga meditation can act as an effective antidote to stress. Laboratory studies by Dr. Herbert Benson, well known cardiologist and professor at Harvard Medical School and founder of the Benson- Henry Institute for Mind and Body Medicine who worked for over three decades on the health benefits of meditation, have shown that yoga meditation produces what Dr. Benson refers to as the relaxation response. According to Dr Benson, stress evokes fight- or- flight response. It increases energy, metabolism, heart rate, blood pressure, and the rate of breathing. It also triggers the secretion of adrenaline and noradrenaline, but because of a lack of sleep and exercise, the body cannot use these hormones appropriately. unused adrenaline puts us at increased risk for a number of diseases and conditions such as anxiety, depression, insomnia, heart attack, stroke, bowel disorders, and infertility. He further said that there is a response opposite to the stress response known as the relaxation response, a physiological set of changes that counteracts the stress response. One of the best ways to bring forth the relaxation response is with meditation. The relaxation response is a physical state of deep relaxation in which your body releases chemicals that slow down our breathing and heart rate. This brings healthy blood back to important organs, especially the brain.

It decreases breathing rate and oxygen consumption by about 20% and lowers heart rate by approximately 3 beats per minute. It shows a marked decrease in blood pressure and meditators whose levels have been higher than normal. A fall in the levels of blood lactate was observed. Blood lactate is known to be linked with attacks of anxiety. During meditation, Alpha waves of the brain, which are associated with mental relaxation, are produced. This brings relaxation and serenity of mind, and people are better able to cope with their stress.

Relaxation response

The relaxation response is a physical state of deep relaxation in which your body releases chemicals that slow down your breathing and heart rate. This brings healthy blood back to important organs, especially the brain. It decreases breathing rate and oxygen consumption by about 20% and lowers heart rate by approximately 3 beats per minute. It shows a marked decrease in blood pressure and meditators whose levels have been higher than normal. A fall in the levels of blood lactate was observed. Blood lactate is known to be linked with attacks of anxiety. During meditation, Alpha waves of the brain, which are associated with mental relaxation, are produced. This brings relaxation and serenity of mind, and people are better able to cope with their stress.

Yogic Breathing (Pranayama)

Pranayama improves functioning of the digestive system, removes toxins from the body, and improves cardiovascular functioning and circulation, as well as improves functioning of the lungs which can promote longevity. Pranayama activates the flow of energy in the body, which can help the lungs with being more alert and present and may allow us to need less sleep when practiced regularly.

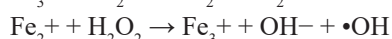
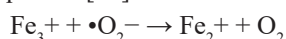
Pranayama complements and improves the physical yoga : kapalbhati helps tone the belly and serves as a nice warm up, while viloma helps to expand the lungs capacity, deepen the breath and focus and steady the mind. Sitali can help cool the mind and body if we are overheating and nadi shodhana can close practice with a balancing and meditative effect.

Many of the pranayama practices soothe the nervous system, release tension and anxiety, calm the body and mind and help to bring emotions into balance and reduce stress which further controls the blood sugar levels and, hence, type 2 diabetes. During kapalbhati, the lung capacity increases up to five times the normal amount which provides more oxygen to the body.

Our digestive system breaks down our food into several nutrients which is converted to glucose that enters into the bloodstream. High levels of glucose in the blood increases the chances of diabetes. Bhastrika and Kapalbhati are rapid cleansing processes, and the oxygen intake within the body during these pranayamas is 1.0% to 18% higher than the normal breathing. This consumed oxygen is partially converted to $\bullet\text{OH}$ free radical by the Haber-Weiss reaction (modified by Fenton) which oxidizes the glucose [36].

Haber Weiss Reaction

The Haber-Weiss reaction is kinetically slow but is catalyzed by dissolved iron ions which are obtained from red blood cells in the body. The reaction can be expressed by the following equation [38]:



D(+)-Glucose – $\bullet\text{OH}$ reaction

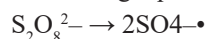
$\bullet\text{OH}$ free radicals are highly reactive oxidizing agents. They are also very short lived (half-life of approximately 10 nanoseconds). Because of its reactivity, it immediately removes electrons from any molecule in its path, turning that molecule into a free radical and so propagating a chain reaction. Hydroxyl radicals can react with all types of macromolecules such as carbohydrates, nucleic acids, lipids, and amino acids. The oxidation of glucose by $\bullet\text{OH}$ free radicals results in two possible

paths:

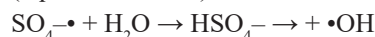
- Oxidation of terminal group
- C-C change

The free radical nature of the reaction

The oxidation of glucose by $\bullet\text{OH}$ radicals were studied in detail [36,37,40]. It is known that peroxydisulfate ion in aqueous solutions decomposes to give two $\text{SO}_4^{\bullet-}$ radicals which instantaneously hydrolyze to form $\bullet\text{OH}$ radicals according to the following equations [41].



(aqueous solution)



The reaction was found to follow first order w.r.t. $\bullet\text{OH}$ and a fractional order of 0.2 w.r.t. glucose, indicating that one molecule of glucose can be oxidized by 5 molecules of oxygen. This can probably be achieved through pranayama. Further, it was found that increasing the surface area of the reaction vessel increases the rate constant of the reaction. The fractional order of the reaction and increases in rate constant with surface area indicate the radical chain nature of the reaction.

The structural formula of D- glucose can be given as follows:

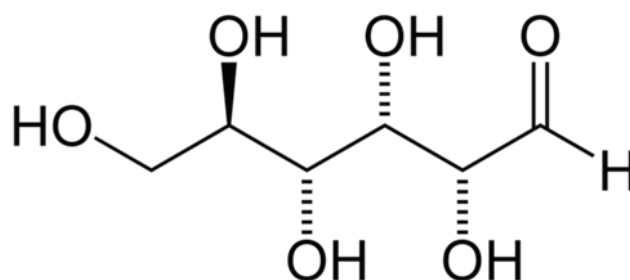
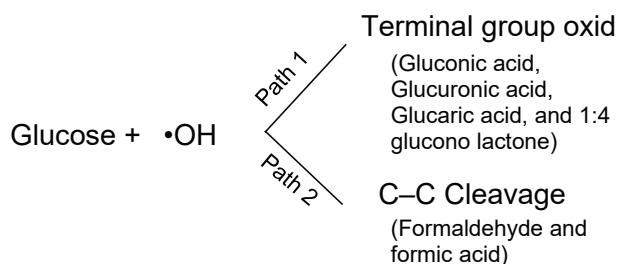


Figure 4. Glucose structure

Analysis of the Reaction Products of Glucose– $\bullet\text{OH}$ Reaction

A study performed by the author and coworkers [36] showed that constant rate coefficients could not be obtained for the reaction. D-Glucose was oxidized in aqueous solution by an equal weight of potassium persulfate for five days at 60°. Distillation of the aqueous solution gave a volatile organic acid, together with volatile non-acidic compounds, one of which was identified as formaldehyde. The non-volatile part of the reaction mixture was acetylated under acidic conditions, and the acetylated product was resolved, by column 3, and by thin-layer chromatography, into four products: penta-O-acetyl-D-glucopyranose (from unchanged D-glucose), tetra-O-acetyl-D-glucopyranuronic acid, penta-O-acetyl-D-gluconic acid, and 2,3,5,6-tetra-O-acetyl-D-glucono-1,4-lactone. The presence of tetra-O-acetyl-D-glucopyranuronic acid in the products arises from the acetylation of D-glucuronic acid. The latter is undoubtedly formed by oxidation of the $-\text{CH}_2\text{OH}$ group in D-glucose. The oxidation of primary alcohols by persulfate is known to proceed by way of an aldehyde, but unless the alcohol is in excess, oxidation proceeds further to the carboxylic acid. The residual products were reconfirmed by mixed melting point method. The acetylated products in the reaction mixture indicate the presence of gluconic acid, glucuronic acid, glucaric acid, and D- Glucono 1:4 Lactone in the reaction mixture.



Benefits of the products of reaction between glucose and OH

Gluconic acid $\text{CH}_2\text{OH} \cdot (\text{CHOH})_4 \cdot \text{COOH}$

It is mild acid neither caustic nor corrosive. It is non-toxic and biodegradable organic acid of great interest. Gluconic acid and its derivatives are used in the formation of pharmaceuticals, cosmetics, and food products as additives or buffer salts. Aqueous solutions of gluconic acid contain glucono delta lactone which chelates metal ions and forms stable complexes. In alkaline solutions, it exhibits strong chelating activity towards calcium, iron, aluminium, copper, and other heavy metals, and removes some undesirable and unwanted metals from the body

Glucuronic acid $\text{CHO}(\text{CHOH})_4\text{COOH}$

It is formed when glucose is oxidized. Its formation takes place in the liver of all animals including humans. The main function of this acid is to combine with drugs, toxins, and hormones and either carry them to different parts of the body or eliminate them. Glucuronic acid also assists in biosynthesis of ascorbic acid in the body. Since glucuronic acid is part of natural detoxification process in the body, it removes harmful toxins and is used in the treatment of prostate cancer.

Glucaric Acid: $\text{COOH} \cdot (\text{CHOH})_4 \cdot \text{COOH}$

Glucaric acid is a sugar acid derived from D-glucose in which both aldehydic carbon atom and the carbon atom bearing the primary hydroxyl group are oxidized to carboxylic acid groups. Calcium D-glucarate is a chemical which is similar to naturally occurring chemical called glucaric acid. Glucaric acid is found in our bodies as well as in fruits and vegetables. Calcium D-glucarate is made by combining glucaric acid with calcium to make supplements that people use for medicine. It enhances the glucuronidation, a process by which the body rids itself of potentially dangerous carcinogens and other harmful chemicals. According to Dr. Thomas Slaga* [Dr Thomas Slaga is the President/CEO and the chair of the center for cancer causation and prevention at the AMC Cancer Research center in Denver, Colorado], "calcium D-glucarate is a substance that aids in glucuronidation, which is one of the body's major detoxification systems for eliminating both foreign chemicals and androgenous chemicals such as steroids and sterols. Glucuronidation is a reaction where a toxin is made water-soluble so that it can be more easily excreted in the urine or bile. Calcium-D glucarate inhibits the detoxification – reversing enzyme Beta-Glucuronidase and it inhibits the 'bad enzyme' in the detoxification process". He further said D-glucarate has been shown to decrease lung, skin, liver, breast, and colon cancers by 60% or more. Calcium-D-Glucarate lowers cholesterol by 12%, LDL by 28%, and triglyceride by 43% in humans. CDG decreases stress on the liver which lowers our need for cholesterol, specifically LDL.

D – Glucono 1-4 Lactone

D – Glucono 1, 4 lactone is one of the metabolites of D – Glucaric acid and has the ability to prevent the activity of glucuronidase and increase the excretion of toxic compounds. It is a conjugate of D – glucono 1, 4 lactone (one of the identified products). According to the National Center for Biotechnology Information – "D – glucaro 1, 4 lactone is a delta in which hydroxy group in position 6 has been oxidized to the corresponding carboxylic acid. It is a conjugate of a glucono 1, 4 lactone." (National Center for Biotechnology Information, National Library of Medicine pubmed. ncbi-nih.gov/compound/D – glucaro – 1, 4 – lactone). Thus D – gluconaro 1, 4 lactone with further reaction with $\bullet\text{OH}$ is converted to D – gluconaro 1, 4 lactone which is a very useful product for liver detoxification. 1, 4 lactone which is a very useful product for liver detoxification.

Volatile Products

The volatile products found in this fraction were identified as formaldehyde and formic acid which are supposed to be formed as a result of C-C cleavage in the glucose molecule. The cleavage path was quantitatively estimated as 5% of the total reaction [36].

A search of the literature shows that the formaldehyde and formic acid both are dangerous compounds. Formaldehyde is used as an industrial fungicide, germicide, and disinfectant and as a preservative in mortuaries. Formaldehyde is an irritant of the eyes and causes sensitization dermatitis. Prolonged exposure to formaldehyde may cause cancer in humans and therefore has been classified as a human carcinogen.

Formaldehyde is dangerous at higher concentrations.

According to the American Cancer Society:

"The main way people are exposed to formaldehyde is by inhaling it. The liquid form can be absorbed through the skin. People can also be exposed to small amounts by eating foods or drinking liquids containing formaldehyde. Enzymes in the body break down formaldehyde into formate (formic acid), which can be further broken down into carbon dioxide. Most inhaled formaldehyde is broken down by the cells lining the mouth, nose, throat, and airways, so that less than a third is absorbed by the blood".

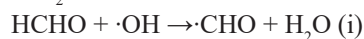
American Chemistry Council writes in its "formaldehyde overview"

"Formaldehyde is found in every living system – from plants to animals – to humans – produced as normal metabolic process. Formaldehyde is a naturally occurring substance made of carbon, hydrogen, and oxygen. Humans produce 1.5 ounces of formaldehyde a day as a normal part of our metabolism. Inhaled formaldehyde is rapidly metabolized and ultimately converted to carbon dioxide and exhaled. Formaldehyde does not accumulate in the body"

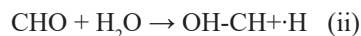
Alternatively, the following mechanism is proposed by the author for the oxidation of formaldehyde to formic acid and formic acid to carbon dioxide and water. This mechanism is based on the following facts:

- Hydroxyl free radicals ($\bullet\text{OH}$) are generated in the body by the Haber Weiss process (modified by Fenton).
- Hydroxyl/free radicals ($\bullet\text{OH}$) are extremely reactive (Half-life 10-9 seconds) and are capable of abstracting hydrogen atoms from C-H in formic acid 45 (or formaldehyde) to generate free radicals.
- These free radicals are hydrolyzed to form corresponding

hydroxy compounds which further decompose to CO_2 and H_2O

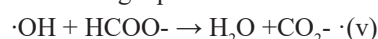


(Formaldehyde)

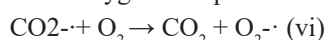


(Formic acid)

The formate radical is further decarboxylated as according to the following equation



The carbon dioxide radical is powerfully reducing and converts oxygen to superoxide.



The presence of $\text{CO}_2\cdot$ in the system was detected by the e.s.r method [44].

Thus, pranayama exercises (breath control) help to reverse diabetes, decrease risk of cancer, detoxify the body, ensure healthy liver function, and lower LDL and total cholesterol levels.

Conclusion

To conclude, it can be said that yoga therapy has a beneficial effect in the patients of type 2 DM in terms of reducing blood sugar and insulin resistance and increasing sensitivity to insulin. Yoga also has positive effects on lipid profiles, management of weight, and blood pressure in type 2 diabetes mellitus. Yoga practices such as cleansing, asanas, pranayama, mudras, meditation and relaxation are known to reduce blood glucose levels.

- **Section 1:** Deals with some important terms used in type 2 diabetes and their explanation.
- **Section 2:** The properties of some fats and essential fatty acids are described. The harmful effects of trans and saturated fats are mentioned.
- **Section 3:** Deals with eating in the way of yoga lifestyle. Foods in yogic diet are placed in three different categories:

Sattvic diet: - The word sattva signifies purity and goodness, sattvic foods (supports clarity and calmness of mind fostering spiritual growth),

Rajasic diet: Foods which are very hot, bitter, sour, dry, and salty are called rajasic; they are mostly spicy and stimulant. They include foods like coffee, tea, garlic, onion, meat, fish, etc. Eating any food in a hurry is considered rajasic.

Tamasic diet: - A tamasic diet neither helps the mind nor the body. With this diet, we lose power of reasoning and sense of inertia sets in the body. This diet includes alcohol, meat, tobacco, onions, garlic, and fermented foods like vinegar.

Yogic diet is based on the principles of non violence, moderation, and attitude of mind. Sattvic yogic diet recommends the use of several herbs and spices which are described. Dairy products are rich in vitamins and minerals and are sattvic and are recommended to strengthen immunity. However, it is found that the dairy products are overloaded with saturated fats, and this

makes them quite dangerous.

- **Section 4:** Fruits and vegetables are an important part of the yogic diet because they include vitamins, minerals, and phytochemicals. Fruits and vegetables are rich in vitamins, minerals, fiber, and provide a tremendous variety of tastes. Fruits and vegetables can help lower the risk of heart disease, stroke, type 2 diabetes, obesity, and some cancers. According to nutritionists, blueberries, bananas, avocados, and citrus fruits are some of the healthiest fruits. Some of the healthiest vegetables include kale, spinach, and sweet potatoes. Fruits and vegetables contain many vitamins and minerals that are good for your health; many of these are antioxidants and may reduce the risk of many diseases. Vitamin A (beta- carotene), vitamin C, vitamin E, magnesium, zinc, phosphorus, folic acid. Research shows that if we regularly eat lots of fruit and vegetables, we will have a lower risk of type 2 diabetes, stroke, heart (cardiovascular) disease, cancer, stomach, throat, and high blood pressure (hypertension).
- **Section 5:** Use of alcohol in yogic diet is strictly forbidden.
- **Section 6:** Yoga can prevent and reverse type 2 diabetes by healthy lifestyle, controlling stress and blood sugar levels, yogic postures, and yogic breathing. Yogic breathing exercises are very important as in some exercises like kapalbhati, the lung capacity is increased to about five times. The part of the oxygen is partially converted to $\cdot\text{OH}$ by Haber- Weiss reaction and reacts with glucose molecule to give some useful products which give the following benefits: Gluconic acid exhibits strong chelating activity towards calcium, iron, aluminum, and removes some unwanted metals from the body. Glucuronic acid the main function of this acid is to combine with drugs, toxins, and hormones and eliminate them from the body. It is also used in the treatment of prostate cancer. Glucaric acid has been shown to decrease lung, skin, liver, breast, and colon cancers by 60% or more, lipid lowering (used for detoxification, calcium D- glucarate lowers), helps with cholesterol by 12%, LDL by 28%, and triglyceride by 43%. Yoga and mindful eating can help manage type 2 diabetes. Yoga is an ancient practice that uses breathing and postures to regulate hormones, improve pancreatic health, and promote insulin production. Yoga practice has been correlated with improved eating habits, such as eating more fruits and vegetables. Mindful eating has shown to improve dietary intake, glycemic control and modest weight loss. Other studies have shown that yoga practice can improve fasting blood glucose, triglyceride, LDL, cholesterol, and blood pressure values for people with prediabetes. People who undergo psychological stress, have an unhealthy eating pattern, or have a sedentary lifestyle are more prone to getting diagnosed with diabetes. Yoga is beneficial for your mind, body, and soul. Here is how yoga can benefit people with diabetes: controlling stress levels, preventing diabetic neuropathy, bringing stability and balance, maintaining normal blood sugar levels. High levels of blood glucose can be lowered by 1- asanas, or yoga poses, are physical postures intended to benefit the mind and body. Asanas are said to improve flexibility, strength, and balance. They also help with stress, anxiety, and lower back pain. Some claim that asanas can help with specific conditions like asthma, diabetes, and chronic obstructive pulmonary disease. 2- stress management and yoga meditation, 3- yogic breathing exercises.

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