

Luffa aegyptiaca and Diabetes: A Review

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Abstract

Luffa aegyptiaca (sponge gourd) is a tropical plant widely used in traditional medicine across Africa and Asia for the management of metabolic disorders, including diabetes mellitus. This review critically examines the ethnobotanical uses, phytochemical composition, and pharmacological evidence supporting the antidiabetic potential of *L. aegyptiaca*. Available studies indicate that different parts of the plant—particularly the fruits, leaves, and seeds—contain bioactive compounds such as flavonoids, phenolics, saponins, alkaloids, and triterpenoids, which are known to exert hypoglycemic and antioxidant effects. Experimental models suggest that *L. aegyptiaca* extracts may improve glycemic control through multiple mechanisms, including enhancement of insulin secretion and sensitivity, inhibition of carbohydrate-digesting enzymes, modulation of oxidative stress, and protection of pancreatic β -cells. The review also discusses safety profiles, toxicological data, and current limitations in the literature, highlighting the need for standardized extracts, well-designed clinical trials, and mechanistic studies. Overall, *L. aegyptiaca* shows promise as a complementary therapeutic agent in diabetes management, but further research is required to validate its efficacy and ensure its safe integration into evidence-based practice.

Keywords: *Luffa aegyptiaca*, sponge gourd, diabetes, glycemic control, antioxidant, phytochemical composition.

1. Introduction

Manufacturing Diabetes Mellitus (DM) is a metabolic disorder characterized by the presence of chronic hyperglycemia accompanied by greater or lesser impairment in the metabolism of carbohydrates, lipids and proteins. DM is probably one of the oldest diseases known to man. It was first reported in Egyptian manuscript about 3000 years ago (Baynes, 2015).

Diabetes mellitus (DM) is a group of diseases characterized by high levels of blood glucose resulting from defects in insulin production, insulin action, or both. Several pathogenic processes are involved in the development of diabetes. These range from autoimmune destruction of the β -cells of the pancreas with consequent insulin deficiency to abnormalities that result in resistance to insulin action. The effects of diabetes mellitus include long-term damage, dysfunction and failure of various organs. In its most severe forms, ketoacidosis or a non-ketotic hyperosmolar state may develop and lead to stupor, coma and, in absence of effective treatment, death. Often symptoms are not severe, or may be absent, and consequently hyperglycemia sufficient to cause pathological and functional changes may be present for a long time before the diagnosis is made. People with diabetes are at increased risk of cardiovascular, peripheral vascular and cerebrovascular disease (Kuldeep & Dinesh, 2018).

2. Classification of Diabetes

Diabetes mellitus is mainly classified into many types; however, the most common types are type 1 and type 2 DM. Type 1 DM (T1DM) is typically associated with failure in insulin production resulting from the destruction of pancreatic β -cells by T-cell-mediated autoimmunity. On the other hand, type 2 DM (T2DM) is characterised by insulin resistance and reduction of insulin production (Tan et al., 2019).

2.1. Type 1 Diabetes

Type 1 diabetes, also known as insulin dependent diabetes mellitus (IDDM), is caused by lack of insulin secretion by beta cells of the pancreas. Although type 1 diabetes affects all age groups, the majority of individuals are diagnosed either at around the age of 4 to 5 years, or in their teens and early adulthood. Normally, hyperglycemia leads to reduced glucagons secretion, however, in patients with IDDM, glucagons secretion is not suppressed by hyperglycemia. The resultant inappropriately elevated glucagons levels exacerbate the metabolic defects due to insulin deficiency. The most pronounced example of this metabolic disruption is that patients with IDDM rapidly develop diabetic ketoacidosis in the absence of insulin administration (Ozougwu et al., 2013).

2.2. Type 2 Diabetes

Type 2 DM is characterized by insulin insensitivity as a result of insulin resistance, declining insulin production, and eventual pancreatic beta-cell failure. This leads to a decrease in glucose transport into the liver, muscle cells, and fat cells. There is an increase in the breakdown of fat with hyperglycemia. The involvement of impaired alpha-cell function has recently been recognized in the pathophysiology of type 2 DM. As a result of this dysfunction, glucagon and hepatic glucose levels that rise during fasting are not suppressed with a meal. Given inadequate levels of insulin and increased insulin resistance, hyperglycemia results (Olokoba et al., 2012).

3. Causes of Diabetes

Type 1 Diabetes Mellitus is mainly linked to the genetic predisposition of an individual, in reality, it involves a complex interplay of genetic, immune and environmental factors that destruct the pancreatic b-cell function. Type 1 Diabetes Mellitus can also be triggered by environmental factors such as viral infections, low levels of vitamin D and lower exposure to ultraviolet rays. The major contributors of Type 2 Diabetes Mellitus are diet (Consumption of food high in carbohydrates but low fibre, sugary beverages) and lifestyle (sedentary lifestyle) even though family history plays a role in an individual developing Type 2 Diabetes Mellitus. This is true because less glucose in the blood is taken up by the body to be utilised for energy production due to low level of physical activity. Hence, obesity is often linked to the increasing incidence of diabetes (Tan et al., 2019).

The following are the symptoms of diabetes:

- i. Excessive thirst
- ii. Frequent urination and dehydration
- iii. Excessive hunger
- iv. Unexplained weight loss
- v. Blurred vision, nearsightedness or other vision problems
- vi. Frequent infections, including skin infections, thrush, gingivitis, urinary tract infections and yeast infections
- vii. Slow healing of sores
- viii. Skin problems (itchy skin)
- ix. Drowsiness
- x. Trembling
- xi. Irritability (Samreen, 2009).

4. Treatment/Management of Diabetes

Insulin therapy should endeavor to imitate nature, which is remarkably successful both in reducing postprandial hyperglycemia and preventing hypoglycemia between meals. The site of administration of insulin injection is very important for better and safe action of insulin and can be given by intramuscular or intravenous route (Deshmukh & Jain, 2015). Different preparations of insulin are available such as human insulin, beef insulin, pork insulin. Insulin therapy is not free from complications and unfavourable effects. The most significant unfavourable effects are weight gain and hypoglycemia when inappropriate dose of insulin is taken and when there is an imbalance between meals and insulin injection (Deshmukh & Jain, 2015). Weight gain after commencement of insulin therapy for uncontrolled diabetes is an unavoidable consequence and is the result of increased truncal fat and muscle bulk. This is also due to reduced energy losses through glycosuria. Sulphonyl ureas such as glibenclamide, glipizide and biguanides such as metformin, phenformin are oral hypoglycemic drugs. Sulfonylureas cause hypoglycemia by stimulating insulin release from pancreatic β -cells. Biguanides such as metformin is not hypoglycemic; it is an antihyperglycemic drug. It does not cause insulin release from the pancreas and does not cause hypoglycemia, even in large doses (Deshmukh & Jain, 2015). Other management regimens include:

- i. Regular monitoring of blood sugar,
- ii. Adopting a healthy diet,
- iii. Keeping up a routine of exercise (Naga, 2016).

5. Role of Insulin in Diabetes

Insulin is a regular hormone produced by beta cells of Islets of Langerhans in pancreas. It oversees the movement of glucose and levels of glucose. Insulin authorizes cells to harness glucose for energy. It plays an imperative part in carbohydrate metabolism. When blood sugar rises, insulin acts to motivate certain cells of the body to take in glucose, primarily liver and fat cells (Soumya & Srilatha, 2011). The vital physiological function of insulin is promoting the synthesis of carbohydrates, proteins, lipids, and nucleic acids. The effects of insulin on carbohydrate metabolism includes instigation of glucose transport across muscle and adipocyte cell membranes, management of hepatic glycogen synthesis, and restriction of glycogenolysis and gluconeogenesis. The aftermath of these actions is a drop in blood glucose concentration (Piero et al., 2014).

5.1. Insulin Resistance

Insulin Resistance (IR) is a condition whereby defects in the behaviour of insulin are such that normal levels of insulin do not operate as the indicator for glucose uptake. Pancreas atones for the decreased insulin reaction by increasing the insulin production which results in hyperinsulinemia to retain euglycemia. This activity persists until the reserve capacity is amazed by metabolic demand and insulin production is no longer enough, leading to an increase in the blood glucose concentration and glucose intolerance and the development of type 2 diabetes (Ghorbani et al., 2014).

5.2. Complications of Diabetes

Diabetes is allied with microvascular complexities such as nephropathy, retinopathy, and neuropathy, and macrovascular complexities such as atherosclerosis and stroke. These complications appear in the late stages of diabetes and are incurable. Diabetic acidosis is a life-threatening disorder triggered by the lack of insulin and it is reckoned as an acute complication. Late-stage complications do not normally develop for 10 to 15 years with Type 1 diabetes. adolescence. Other complications of diabetes may include: Skin Complications such as infections, sores, and itching; and diabetic osteopathy. It is now ingrained that humans with type 1 or type 2 diabetes have an increased risk of fracture. Diabetes and osteoporosis are both frequent endocrine disorders (Soumya & Srilatha, 2011).

6. Uses of Medicinal Plants in the Management of Diabetes

Medicinal plants are an essential part of our natural assets. They serve as meaningful curative agents as well as priceless raw materials for manufacturing numerous traditional and modern medicines. The use of plants as medicine dates back to the beginning of civilization. Our ancestors were driven by their sufferings from chronic and acute illnesses, physical discomfort, wounds and injuries to use any natural substance to find a cure so they could be relieved. Since time immemorial, plants possessing medicinal properties are of great importance throughout the world in treating and preventing human diseases. Traditional medicine has stayed as the most available and easily obtainable source of treatment in the primary health care system of resource poor communities (Hosseinzadeh et al., 2015). Some writings indicate that therapeutic use of plants is as old as 4000 - 5000 B.C. and that the Chinese first made use of the natural herbal preparations as medicines. In India, still, ancient sources about the use of plants as medicine appear in Rig-Veda, which is said to be written between 1600 - 3500 B.C. Much more later, the properties and therapeutic uses of medicinal plants were studied in detail and written down observationally by the ancient physicians (an indigenous network of medicine) which are a basic foundation of ancient medical science in India. Medicinal plant is a valuable component of indigenous medical networks in all over the world. The study of a region's plants and their practical uses through the traditional knowledge of a local culture and people, provides abundant materials for natural drug research and development. "Orthodox" use of herbal medicines indicates a meaningful historical use, and this is undoubtedly true for many products that are available as "traditional herbal medicines". Traditional practitioners and their arsenal of medicinal herbs are relied on by a considerable proportion of the population in many developing nations to address health care needs. Regardless of the fact that modern medicine coexists alongside such ancient practices, herbal remedies have remained popular for historical and cultural reasons (Hosseinzadeh et al., 2015).

7. *Luffa aegyptiaca*

The plant, *Luffa aegyptiaca* (sponge gourd) is from the Cucurbitaceae family. It is widely circulated in tropics and subtropics. In Nigeria, *Luffa aegyptiaca* is grown in most parts of the country as weed; and it have been revealed to possess both medicinal and nutritional capability (Mhya & Mankilik, 2014). It is an annual climbing herbaceous species that can be 15m long. The *Luffa* genus comprises of seven (7) species among which *Luffa aegyptiaca* and *Luffa acutangula* are primarily grown for its fibre production. The young fruits and leaves can be cooked as vegetable (fruits can be used in India to make curry) or eaten fresh or dried. More so, when the fruit matures it becomes fibrous; the fibre is used as sponge for washing and scrubbing utensils as well as the human body. But due to the presence of hydroxyl groups from cellulose and lignin, natural fibre exhibits highly hydrophilic properties. This makes fibre-matrix adhesion very difficult because most structural polymers are hydrophobic in nature which results in an unexpected failure of the composite material in service. Therefore, in order to maximize natural fibre reinforced composite performance, fibre surface modification as well as a chemical additive to polymer matrix is required to improve the performance (Ichetaonye et al., 2015).

The *Luffa* gourd (*Luffa aegyptiaca*) is a fast growing annual vine which grows ubiquitously and matures within four months. The *Luffa* plant is a cucurbit, a group of plants including gourds, pumpkins and cucumbers; all belonging to the Cucurbitaceae family. The *Luffa* has many names, some of the common names are: 'smooth loofah, loofah, loofah sponge, sponge gourd, vegetable sponge, dishrag gourd and Chinese okra'. The species of *Luffa* are *Luffa cylindrica* and *Luffa aegyptiaca*. It is called 'soso' in Hausa, 'kankan' in Yoruba and 'asisa' in Ibo in Nigeria. Loofah is a common vine that produces pretty yellow flowers and strange looking fruits that are edible (in southern USA and China) and used as back scrubbers or sponges when fully matured. Probably native to Africa, loofahs grow like weeds, requiring a little sunny spot and something to climb on, usually seen growing on back fences or walls, the immature fruits (3-6 inches in length) can be fried whole or sliced, or they can be grated for use in soups and omelets (Abayeh et al, 2013).

7.1. Recent Work on *Luffa aegyptiaca* and Diabetes

The Alcohol and Aqueous extract of *Luffa aegyptiaca* was studied for antidiabetic activity in alloxan induced rats via oral administration of extract 100mg/kg body weight for 15 days. The resulting effect was likened with oral dose of 4.5mg/kg Glibenclamide. The alcohol and aqueous extract of *Luffa aegyptiaca* leaves significantly decreased the blood glucose of hyperglycemic rats. Phytochemical study carried out showed the presence of flavonoids. Therefore, it is safe to conclude that *Luffa aegyptiaca* leaf extract has significant antidiabetic activity, which lowered the fasting blood glucose level in alloxan induced rats. From the study, it is indicated that the feasible system by which the plant extract reduced the blood glucose level may be by boosting the potency of insulin effect either by an increase in pancreatic secretion of insulin from beta cells of islets of Langerhans (Sangeeta et al., 2011).

7.2. Phytochemistry of *Luffa aegyptiaca*

Phytochemical screening carried out by Mhya et al., (2014) showed the presence of moderate flavonoids (++) , saponins (++) , tannins (++) , while mild cardiac glycoside (+) was obtained. Saponins have anti-inflammatory effects, hemolytic activity, and cholesterol binding properties. Glycosides are known to cause a reduction in blood pressure and tannins show antioxidant, antimicrobial and antiviral effects (Ndam et al., 2014), flavonoids are known to be responsible for the antimicrobial properties (Mhya et al., 2014).

7.3. Alloxan

Alloxan is an organic molecule that is a urea derivative, a carcinogen and glucose equivalent that is cytotoxic. It is chemically known as 5,5-dihydroxypyrimidine-2,4,6-trione. It is one of the regular diabetogenic agents which is often used to check the antidiabetic effect of both pure compounds and plant extracts in diabetic studies. Alloxan has been used successfully to induce diabetes in a variety of animals such as rabbits, rats, mice, monkey, cats and dogs. It can be administered in single or multiple doses either through intraperitoneal, intravenous and subcutaneous routes. However, single intraperitoneal administration happens to be the favoured administration mode. Alloxan makes use of two pathological effects: Selective impediment of glucose-stimulated insulin production and induced generation of reactive oxygen species (ROS) which encourages selective necrosis of beta cells of the pancreas. Both processes produce a pathophysiological state of insulin-dependent diabetes or type 1-like diabetes mellitus. The major reason why alloxan is able to move across the plasma membrane into the cytosol of the beta cells is due to its structural similarity with glucose (Ighodaro et al., 2017).

7.4. Liver

The liver is the largest solid organ of the human body, its weight is approximately 1500 grams, and it is located in the upper right corner of the abdomen (Plaats, 2005). The liver is one of the most vital organs which functions as an intermediate for the metabolism of nutrients and the elimination of waste metabolites. The major function of the liver is to control the movement and safety of substances absorbed from the digestive system before circulation of these substances to the Systemic Circulatory system. If there happens to be a total loss of liver function, it could lead to the death of an individual within minutes showing the utmost importance of the liver (Ozougwu, 2017).

7.5. Liver markers

7.5.1. Aspartate transaminase (AST)

A greater concentration of AST is found in the heart in comparison with other tissues of the body such as the liver, skeletal muscle and kidney. Aspartate transaminase catalyses transamination reaction. AST exist two different isoenzyme forms which are genetically different, the mitochondrial and cytoplasmic form. Normal serum AST is 0 to 35U/L. Elevated mitochondrial AST can be observed in extensive tissue necrosis during myocardial infarction as well as in chronic liver diseases like liver tissue degeneration and necrosis (Gowda et al., 2009).

7.5.2. Alanine transaminase (ALT)

Alanine transaminase is found in the kidney, heart, muscle, and a greater concentration in the liver in comparison with other tissues of the body. ALT is purely cytoplasmic and it catalyses the transamination reaction. Normal serum ALT level is 7-56 U/ L. Any type of liver cell injury can cause an increase in ALT levels. Marked elevations of ALT levels greater than 500 U/L are mostly seen in persons with diseases that mainly affect hepatocytes such as viral hepatitis, ischemic liver injury (shock liver) and toxin-induced liver damage (Gowda et al., 2009).

7.5.3. Total protein

Total protein also known as Total serum protein is a biochemical test that is used to measure the total amount of protein in serum. The total protein in the serum consists of both albumin and globulin. Albumin are proteins that are made in the liver. Lower than normal albumin and total protein levels is an indication of liver damage or disease. The normal value for albumin is 3.4 to 5.4 g/dL of blood (Himel, 2020).

7.6. Lipid profile

7.6.1. Total cholesterol

Cholesterol is a vital biomolecule located in almost all animal cells. It is a major component of the cell membrane and is also one of the building blocks of stress and sex hormones, and is needed in the body to insulate nerves. It plays an important role in the health status of the human heart. An increase in total cholesterol level above normal is an indicator of the risk of Coronary Heart Disease; and in this situation, excess cholesterol found in the bloodstream forms a thick, hard deposit (plaque) in the artery walls (Dauqan et al., 2011).

7.6.2. High density lipoprotein (HDL)

High density lipoproteins (HDLs) consists of diverse particles with regards to their size and composition. In comparison with other lipoproteins, they possess the largest relative density while being the smallest in size. HDLs play a vital role as carrier in reverse cholesterol transport (RCT) and act as a carrier of cholesterol back to the liver. They also function effectively in homeostasis and lipid metabolism. It is referred to as good cholesterol due to its antioxidants and anti – inflammatory properties along with its role in the removal of cholesterol from the artery (Zhou et al., 2015; Dauqan et al., 2011).

7.6.3. Low density lipoprotein (LDL)

Low Density lipoprotein (LDL) is referred to as bad cholesterol. It deposits cholesterol in tissues, creating plaque which clogs (blocks) coronary arteries. Elevated levels of LDL is a predisposing factor of Coronary Heart Disease (CHD) (Armbruster & Lambert, 1996).

7.7. Renal indices

7.7.1. Urea

Urea is a major product of protein and amino acid catabolism, it is produced by the liver and distributed throughout intracellular and extracellular fluid. The most constantly determined clinical indices for evaluating renal function depends on the concentration of urea in the serum. It is vital in differential diagnosis of acute renal failure and pre renal condition where blood urea nitrogen–creatinine ratio is increased (Gowda et al., 2010).

7.7.2. Creatinine

Creatinine is the end-product of creatine phosphate in muscle, and is normally produced at a fairly constant rate by the body depending on muscle mass. Creatinine is conventionally an indicator of kidney function. Renal failure is

usually suspected when serum creatinine is greater than the upper limit of the "normal" interval. Elevated creatinine values can be seen in muscular dystrophy paralysis, anemia, leukemia and hyperthyroidism. Decreased creatinine values are observed with conditions such as glomerulonephritis, congestive heart failure, acute tubular necrosis, shock, polycystic kidney disease, and dehydration (Gowda et al., 2010).

7.7.3. Bicarbonate

The kidney preserves a steady concentration of serum bicarbonate by reabsorbing the filtered bicarbonate and manufacturing enough bicarbonate to annul the net endogenous acid load. A major decrease in serum bicarbonate levels can be observed when there is a compromise in the functioning of the kidney. This compromise in the normal functioning of the kidney are seen in conditions such as sickle cell nephropathy which could result in Chronic Kidney Disease (CKD) if not properly managed. Other factors that are culprits of low serum bicarbonate levels are: smoking, albuminuria, diet, etc (Kraut & Madias, 2016).

7.8. Hematological indices

The study of Hematological parameters or Hematological indices, is a commonly used laboratory test for the diagnosis of several diseases. It is used for frequent health inspection with preoperative assessment. The values of hematological parameters are determined by a number of factors even in presumably healthy individuals. These factors include age, sex, nutritional, environmental and social factors with cultural backgrounds. Some hematological parameters show extensive variation in different period of life (Sahoo et al., 2015).

7.9. Glucose

Glucose is the major source of energy in the body. Evaluation of glucose levels in humans serve as a diagnostic tool in diabetes mellitus. Elevated concentrations of glucose in the blood may be associated with thyroid dysfunction, pregnancy induced diabetes and liver damage. Normal serum glucose values for fasting ranges from 70-105mg/dl but if the blood glucose level is at or above 126mg/dl in a fasting state, such an individual is considered diabetic (Carlos, 2011).

8. Conclusion

The available evidence suggests that *Luffa aegyptiaca* possesses considerable potential as a complementary agent in the management of diabetes mellitus. Its rich phytochemical profile, including flavonoids, phenolics, saponins, and triterpenoids, underpins a range of biological activities relevant to glycemic control, such as antioxidant, anti-inflammatory, and enzyme-inhibitory effects. Preclinical studies indicate that extracts from different parts of the plant may improve glucose homeostasis by enhancing insulin action, protecting pancreatic β -cells, and reducing oxidative stress.

Despite these promising findings, the current body of research remains largely limited to in vitro and animal studies, with a notable scarcity of well-designed human clinical trials. Variability in extraction methods, dosages, and plant part used further complicates direct comparison across studies. Future research should therefore focus on standardization of *L. aegyptiaca* preparations, detailed elucidation of molecular mechanisms, and rigorous clinical evaluation of safety and efficacy. With such advances, *L. aegyptiaca* could be more reliably positioned within evidence-based strategies for diabetes prevention and management.

References

Abayeh, O. M., Garba, I. H., Adamu, H. M. & Abayeh, O. J. (2013). Quality Characteristics of *Luffa aegyptiaca* seed oil. *International Journal of Scientific & Engineering Research*. 4(4): 11-16.

- Armbruster, D. A. & Lambert, P. A. (1996). Direct Assay of LDL Cholesterol Comparing Measurement and Calculation. *Laboratory Medicine*. 27(9):613-617.
- Baynes, H. W. (2015). Classification, Pathophysiology, Diagnosis and Management of Diabetes Mellitus. *Journal of Diabetes and Metabolism*. 6:541.
- Carlos, E. (2011). Blood Glucose Levels. *Undergraduate Journal of Mathematical Modeling: One + Two*. 3(2):12.
- Carlton, (1967). Carlton's histological techniques. Oxford university press, new york. 4:144–149.
- Dauqan, E. M. A., Abdullah, A. & Abdullah, H. S. (2011). Natural Antioxidants, Lipid Profile, Lipid Peroxidation, Antioxidant Enzymes of Different Vegetable Oils. *Advance Journal of Food Science and Technology*. 3(4):308-316.
- Deshmukh, C. D. & Jain, A. (2015). Diabetes Mellitus: A Review. *International Journal of Pure Applied Bioscience*. 3(3): 224-230.
- Ghorbani, Z., Hekmatdoost, A. & Mimiran, P. (2014). Anti-Hyperglycemic and Insulin Sensitizer Effects of Turmeric and Its Principle Constituent Curcumin. *International Journal of Endocrinology and Metabolism*. 12(4).
- Gowda, S., Desai, P. B., Hull, V. V., Math, A. A. K., Vernekar, S. N. & Kulkarni, S. S. (2009). A review on laboratory liver function tests. *The Pan African Medical Journal*. 3:17.
- Gowda, S., Desai, P. B., Kulkarni, S. S., Hull, V. V., Math, A. A. K. & Vernekar, S. N. (2010). Markers of renal function tests. *North American Journal of Medical Sciences*. 2(4):170-173.
- Hassan, B. A. R. (2012). Medicinal Plants (Importance and Uses). *Pharmaceutica Analytica Acta*. 3:10.
- Himel, N. H. (2020). Liver Function tests: Significance of ALT (Alanine aminotransferase) and AST (Aspartate aminotransferase) as markers of Liver injury.
- Hosseinzadeh, S., Jafarikukhdan, A., Hosseini, A. & Armand, R. (2015). The Application of Medicinal Plants in Traditional and Modern Medicine: A Review of *Thymus vulgaris*. *International Journal of Clinical Medicine*. 6:635-642.
- Ichetaonye, S. I., Madufor, I. C., Yibowei, M. E. & Ichetaonye, D. N. (2015). Physico-Mechanical Properties of *Luffa aegyptiaca* Fiber Reinforced Polymer Matrix Composite. *Open Journal of Composite Materials*. 5:110-117.
- Ighodaro, O. M., Adeosun, A. M. & Akinloye, O. A. (2017). Alloxan-induced diabetes, a common model for evaluating the glycemic-control potential of therapeutic compounds and plants extracts in experimental studies. *Medicina*. 53:365–374.
- Kraut, J. A. & Madias, N. E. (2016). Metabolic Acidosis of CKD: An Update. *American Journal of Kidney Disease*. 67(2):307-317.
- Kuldeep, T. & Dinesh, K. (2018). Recent classification of diabetes mellitus. *International Journal of Innovative Science & Technology*. 3(4):52-57.
- Mhya, D. H. & Mankilik, M. (2014). Phytochemical Screening of Aqueous Extract of *Luffa aegyptiaca* (Sponge gourd) Leave Sample from Northern Nigeria: A Short Communication. *International Journal of Pharmaceutical Sciences and Research*. 5(7):344-345.

- Naga, S. R. (2016). A Review on Diabetes Treatment Methods. *Research & Reviews in Biosciences*. 11(3):102.
- Ndam, L. M., Mih, A. M., Fongod, A. G. N., Tening, A. S., Tonjock, R. K., Enang, J. E. & Fujii, Y. (2014). Phytochemical screening of the bioactive compounds in twenty (20) Cameroonian medicinal plants. *International Journal of Current Microbiology and Applied Sciences*. 3(12):768-778.
- Olokoba, A. B., Obateru, O. A. & Olokoba, L. B. (2012). Type 2 Diabetes Mellitus: A Review of Current Trends. *Oman Medical Journal*. 27(4):269-273.
- Oyedemi, S. O., Adewusi, E. A., Aiyegoro, O. A. & Akinpelu. D. A. (2011). Antidiabetic and haematological effect of aqueous extract of stem bark of *Azelia Africana* (Smith) on streptozotocin-induced diabetic wistar rats. *Asian Pacific Journal of Tropical Biomedicine*. 1(5):353-358.
- Ozougwu, J. C., Obimba, K. C., Belonwu, C. D. & Unakalamba, C. B. (2013). The pathogenesis and pathophysiology of type 1 and type 2 diabetes mellitus. *Journal of Physiology and Pathophysiology*. 4(4):46-57.
- Ozougwu, J. C. (2017). Physiology of the liver. *International Journal of Research in Pharmacy and Biosciences*. 4(8):13-24.
- Piero, M. N., Nzaro, G. M. & Njagi, J. M. (2014). Diabetes mellitus – a devastating disorder. *Asian Journal of Biomedical and Pharmaceutical Sciences*. 4(40):1-7.
- Plaats, A. V. D. (2005). The Groningen hypothermic liver perfusion system for improved preservation in organ transplantation.
- Sahoo, D., Gosai, H., Harsoda, J. M & Palan, B. M. (2015). A Comparative Hematological Profile Study Among Young Individuals. *Canadian Journal of Basic and Applied Sciences*. 3(6):178-181.
- Samreen, R. (2009). Diabetes mellitus. *Scientific Research and Essays*. 4(5):367-373.
- Sangeeta, C., Saxena, R. C., Chaurasia, I. D. & Rajeev S. (2011). Antidiabetic activity of *Luffa aegyptiaca* (Mill) in alloxan induced diabetic rats. *Journal of Chemical and Pharmaceutical Research*. 3(2):522-525.
- Shukla, R.K., Painuly, D., Shukla, A., Kumar, V., Singh, J., Porval, A. & Vats, S. (2015). Physical evaluation, proximate analysis and antimicrobial activity of *Morus nigra* seeds. *International Journal of Pharmacy and Pharmaceutical Sciences*. 7(1):191-197.
- Soumya, D. & Srilatha, B. (2011). Late Stage Complications of Diabetes and Insulin Resistance. *Journal of Diabetes and Metabolism*. 2(9).
- Tan, S. Y., Wong, J. L. M., Sim, Y. J., Wong, S. S., Elhassan, S. A. M., Tan, S. H., Lim, G. P. L., Tay, N. W. R., Annan, N. C., Bhattamisra, S. K. & Candasamy, M. (2019). Type 1 and 2 diabetes mellitus: A review on current treatment approach and gene therapy as potential intervention. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*. 13:364-372.
- Voet, D. J, Voet, J. G. & Pratt, C. W. (2008). *The Principles of Biochemistry*, 3rd Edition., John Wiley & Sons 111 River Street, Hoboken, pp: 74-219.
- Zhou, L., Li, C., Gao, L. & Wang, A. (2015). High-density lipoprotein synthesis and metabolism (Review). *Molecular Medicine Reports*. 12(3):4015-4021.