

Scientific literature evaluation of *Abelmoschus esculentus* in diabetes, obesity, dyslipidaemia, cancer, fertility, erythrocytopenia, pregnancy and cardiovascular diseases: A mechanistic overview

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ABSTRACT: - '*Abelmoschus esculentus*' is a flowering plant belonging to family 'malvaceae', the plant is highly useful in various diseases like obesity, diabetes, dyslipidaemia, cancers, anaemia, pregnancy, and cardiovascular diseases. The plant is come under the category of nutraceuticals having both medicinal as well as nutritional properties. We have discussed each chemical constituent present in the plant with relation to disease. Polyphenols, flavonoids, and vitamins serve the major purpose of chemical constituents present in the plant. Each part of the plant is equally important and potent but majorly the fruit is highly useful in every household and for the purpose of treatment of diseases.

Keywords: - *Abelmoschus esculentus*, diseases, diabetes, obesity, dyslipidaemia, cancer, cardiovascular diseases, fertility, pregnancy, anaemia, mechanism, nutraceuticals

I. INTRODUCTION

Abelmoschus esculentus popularly known as okra, lady finger, ochro, bamyah, gumbo or bhindi is a flowering vegetable plant belonging to family Malvaceae, contains numerous of chemical constituents in it. The plant is native to sub-continent of Asia, Africa, west Africa, Ethiopian, middle eastern cuisine, Indian cuisine, and some parts of unites states. The leaves, seeds, pods, stem, bark, whole fruit, and roots are highly pharmacologically active and having optimum

potency and efficacy for certain diseases. The seeds of okra are used to produce oil and now a days roasted seeds are used as an alternative of non-caffeinated beverages. In some parts of African countries, the raw stem of the okra is used as a remedy for tooth ache and anti-microbial for mouth germs. The flower, fruit, seed, and leaf are highly known for its antioxidant activity. The plant is highly rich in fibres, minerals, vitamins, fat, protein, carbohydrate, and energy exerting high attention for nutrition purpose. In spite of these characteristics the raw okra consists of gum or resin like viscous liquid, highly rich in alkaloid. The plant is getting enough mature between 60-180 days, at this stage the plant occupied all nutritional values in it those are responsible for various medicinal properties. (Table 1) [1] The plant is used in various diseases like gestational diabetes, oxidation, fatigue, obesity, dyslipidaemia, microbial infection, ulcerogenic, cancer, skin infections, in addition to the capacity to bind LDL cholesterol and bile acids, putting off pollutants from the liver. In spite of these the plant is also noted as an anti-ageing agent. [2]

However, okra plays an important role in meal with full nutritional as well as medicinal properties. That's why okra paying a more attention on hunger index. Chemical constituents present in okra constitute a crucial role in innovation, research, and development sector. [3]

Table 1 showing the total raw *Abelmoschus esculentus* nutritional values per 100g [4]

Nutritional value	Quantity per 100g
Energy	33kcal
Carbohydrates	7.46g

Sugar	1.48g
Dietary fibre	1.33g
Fat	0.13g
Protein	1.9g
Vitamin A	36ug
Vitamin B1	0.2mg
Vitamin B2	0.06mg
Vitamin B3	1mg
Vitamin B9	60ug
Vitamin C	23mg
Vitamin E	0.27mg
Vitamin K	31.3ug
Calcium	82mg
Iron	0.62mg
Magnesium	57mg
Phosphorous	61mg
Potassium	299mg
Zinc	0.58mg
Water	89.6g

Polyphenols present in plant playing an important role to maintain the fitness and mental health of the peoples. ^[5] Vegetable mucilage's had been studied because of their medicinal uses in human beings and animals. The polysaccharides from those mucilage's display a few important roles, which includes immunomodulated and anti-inflammatory. ^[6] Okra mucilage is likewise utilized in conventional therapy to deal with gastric irritations. Some of its chemical constituents helpful to treat helicobacter pylori infection from adhering to belly fat/ tissue. Extract of immature okra fruit used to treat gastric mucosal infection spread by cell membrane proteins. Besides these dietary activities, okra has an additional pharmacological activity like anti-hyperlipidaemic, anti-fungal, antioxidant, anti-inflammatory and anti-cancer. ^[7] Mucilage of okra has a very good cholesterol lowering activity and activity to excrete out pollutants from the body. In these activities,

okra chemical molecules in liver bind with the cholesterol or bile acid molecules and form a complex bond and leads to excrete out from the body by the help of detoxifying technique. It has lengthily been used as a blood expander or as a plasma alternative medically. Okra seeds have additionally been validated a wealthy supply of protein and oil. ^[8]

Okra additionally performs an essential function inside the remedy of kidney illnesses because of diabetes and in addition to the remedy of skin and mucous membrane infections. ^[9] LDL-C receptors that are observed at the faecal of the liver at which chemical constituents from okra plant will bind and remove the fatty acid from liver which further work against dyslipidaemia. ^[10] Polyphenols reduce the synthesis of lipoprotein from liver cells, ensuring a general lipoprotein lowering activity. Okra is a good source of vitamin c and enhance immunity associated disorders by boosting

immunity. Flavonoids presents in okra can be utilized in the treatment of CVD, diabetes, stroke, cancers, and hyperlipidaemia. ^[11] Apart from all these diseases, okra has been proved by scientifically to be used as anti-obesity agent and beneficial in other metabolic disorders. Carbohydrate rich okra is One of the most important mucilaginous meals for gastric irritation. ^[12]

Okra is the most abundant source of chemical constituents those are responsible to control diabetes. Peoples from ancient time uses raw okra water to treat diabetes in infants and older people. The mechanism via which okra controls diabetes is the slowdown of glucose from the intestinal tract that is executed through mucilaginous fibre found in okra. Linoleic acid, a chief polyunsaturated fatty acid is discovered abundantly in okra seed oil having anti-diabetic activity. Okra is extensively utilized by a maximum of people in diabetes mellitus due to its insulin-resistance decreasing activity. Okra as an anti-diabetic increase the glucose uptake via cells which further decreases lipid peroxidation, improves insulin sensitivity and pancreatic cells together, and acts as an alpha-glucosidase inhibitor. Myricetin compound that's found in okra will increase the absorption of sugar withinside the muscle mass which further decrease the elevated blood glucose level. Okra polysaccharides components are answerable for controlling improved blood glucose absorption from the small intestine. ^[13]

Okra includes a good quantity of amino acid tyrosine and lysine. Okra seed protein has an amino acid composition just like soybean protein, but the protein efficacy and amino acid availability are even higher. Okra seeds are rich in vitamin A, C B, and minerals which include

calcium and iron which makes them beneficial in leukorrhea, renal colic, and apathy. For this reason, normal consumption of okra seeds and fruit will offer a good with enough energy and antioxidants which might assist raise the immune system and helpful in treating diseases. Okra is extensively utilized in lung infection and sore throat, extensively utilized for treating exhaustion and depression to a few extents. In a limited quantity the okra can be used to treat bronchial allergies or asthma. ^[14]

Therapeutic potential of *Abelmoschus esculentus* in cancer: -Scientists have confirmed that okra having a major role to stop the apoptotic growth of cell in-vitro as well as in-vivo. The presence of flavonoid compounds withinside the okra has an ability to treat breast cancer's (MCF-7), hepatocellular carcinoma (HepG2), VEGF and cervical carcinoma (HeLa) and had a good cytotoxic effect. ^[15]

Abelmoschus esculentus act at VEGF (vascular endothelium growth factor) also known as vascular permeability factor receptor site VEGFR-A and B which further inhibit the signal protein that is produced by cancerous cells and by inhibiting this process it further stimulates the apoptosis on endothelial cells and inhibit cell migration. ^[16]

Platelet derived growth factor is a growth factor which regulate the cell growth and division, in this *Abelmoschus esculentus* will bind with the PDGF receptor site (cell surface tyrosine kinase receptor) and inhibit the signalling process. By this inhibition *Abelmoschus esculentus* inhibit the proliferation and fibroblast process of cancerous cells. The PDGF responsible for blood cell formation so by inhibiting this protein it further inhibits the blood cancer. (Figure 1) ^[17]

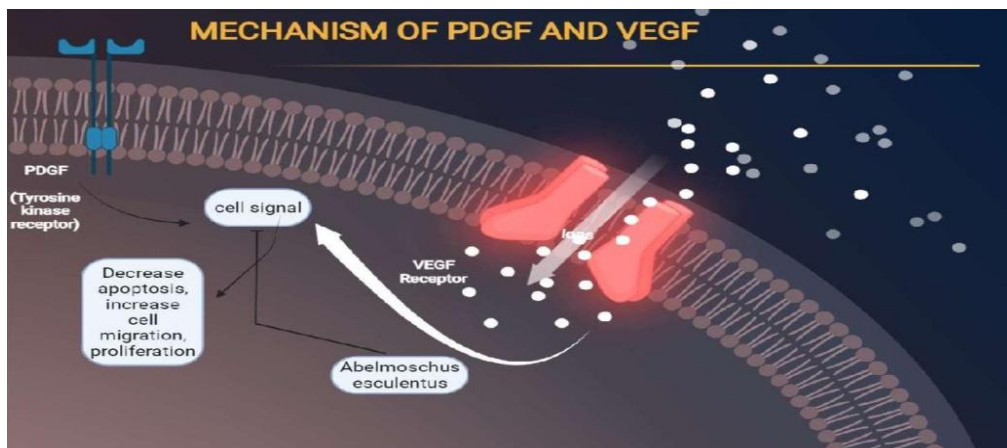


Figure 1 showing the mechanism of Abelmoschus esculentus on PDGF and VEGF receptors.

Flavonoids, vitamin A, beta-carotene, and lutein present in okra have an ability to inhibit molecular proliferation and migration of cancerous cells and act as an antioxidant agent.^[18] in a study, pectinat a molecular level showing an inhibitory response on cancerous cells, it works by increase the apoptosis cycle of cells by 23 times.^[19]

Lectin and pectin isolated from abelmoschus esculentus induce significant cell growth inhibition in skin fibroblast- CCD

1059skcells and MCF-7- breast cancer.^[20] MCF-7 cells when treated with abelmoschus esculentus increase the expression of caspase-3, 9 and p21 genes. In other side beta carotene and vitamin E increase the expression of pro-apoptotic caspase- and 9 and further increase the apoptosis and prevent cancerous cells.(Figure 2)^[21] In addition, with these effects, the extract also increases the Bax/Bcl-2 ratio in MCF-7 cells.^[22]

Mechanism of *Abelmoschus esculentus* constituents (Pectin, Lectine, Beta-carotene and Vitamin E) in cancer

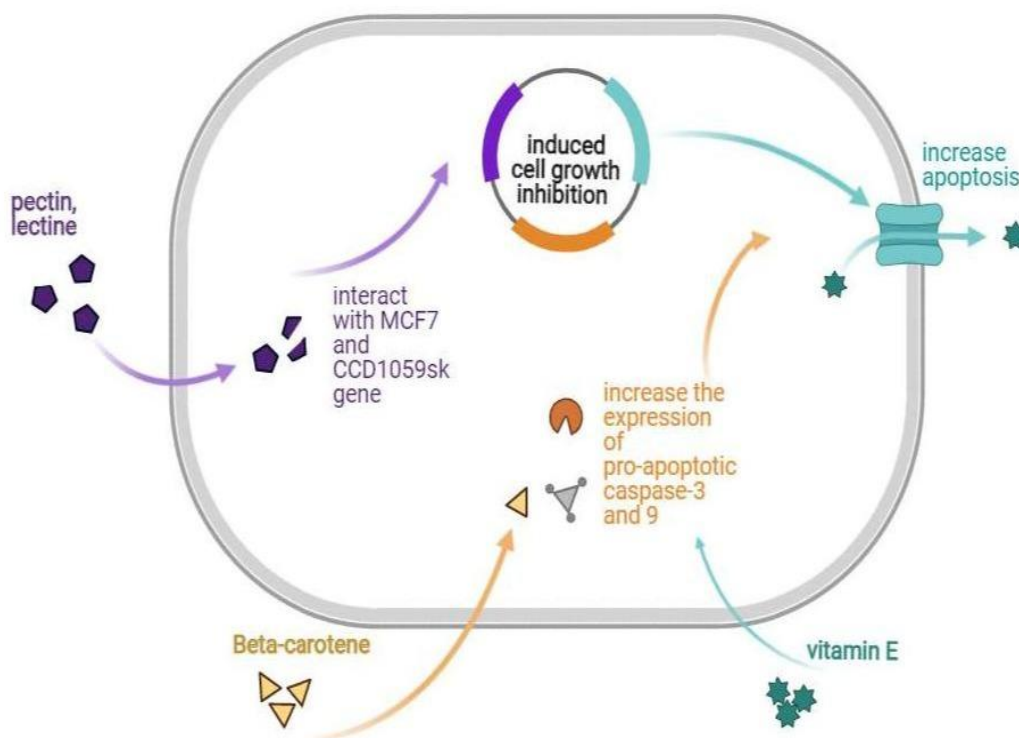


Figure 2 showing the mechanism of *Abelmoschus esculentus* constituents' pectin, lectin, beta carotene and vitamin E in cancer

Therapeutic potential of *Abelmoschus esculentus* in diabetes mellitus: -*Abelmoschus esculentus* is a well-known antidiabetic fruit, used by most of the people in all over the world. Majorly *Abelmoschus esculentus* is highly active in gestational diabetes and used by most of the peoples because the chemical constituents of okra do not cross placental barrier. The raw okra water is mainly consumed in pregnant woman associated diabetes or gestational diabetes.^[23] The fruit is highly potent and decrease the elevated blood sugar level with very optimum range of fruit. The mechanism of plant as an antidiabetic involved the multiple pathways one of the most important

pathways is it increase the insulin secretion from the pancreatic betacells, which further decrease the elevated blood glucose level. Another mechanism involved, increase the sensitivity of insulin sensitized cells by excessive generation of ATP and furthermore increase the influx of calcium inside the cells. The plant is also responsible for decrease the absorption of carbohydrate in the intestine and do not allow cells to generate glucose at high range. Sometimes it also works by desensitizing the glucose-6-phosphate enzyme. Zhao et al. stated that rhamnogalacturonan is the main chemical from okra fruit which is responsible for antidiabetic activity. (Figure 3)^[24]

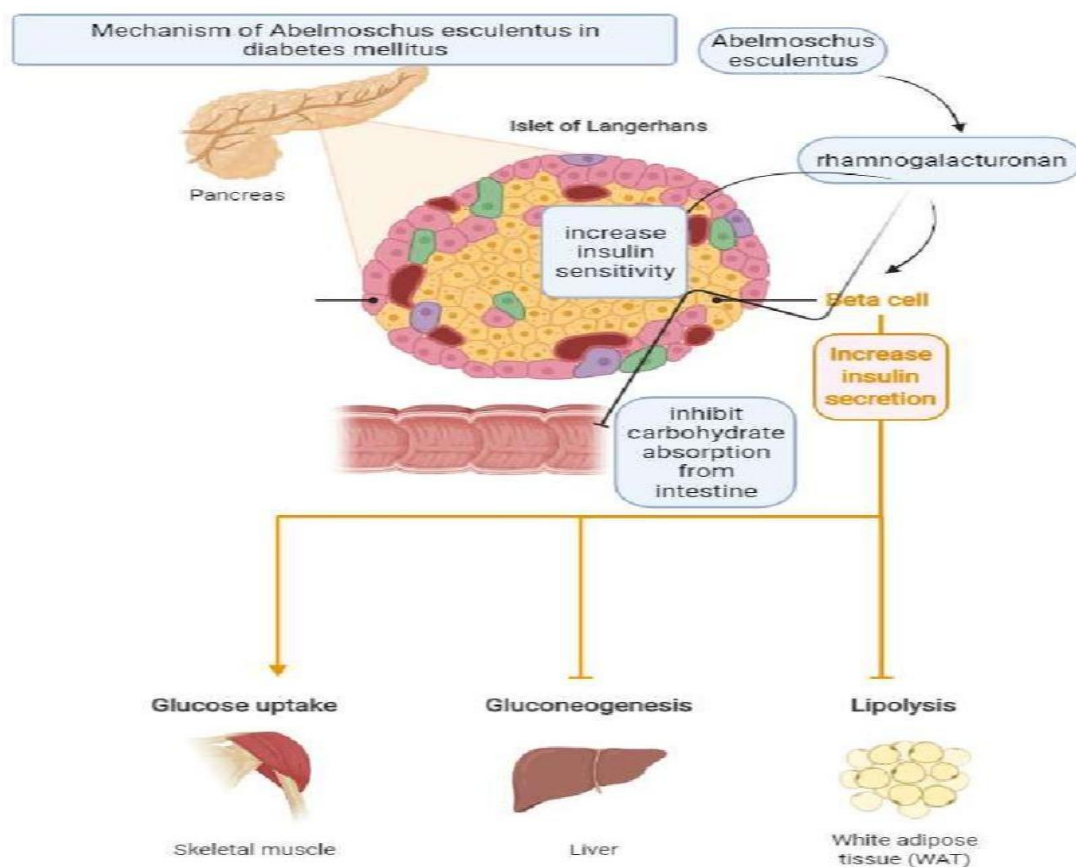


Figure 3 showing the mechanism of *Abelmoschus esculentus* in diabetes mellitus

The chemical constituents of okra work by targeting the enzymes ALP (alkaline phosphatase) and AST (aspartate aminotransferase), dysfunction or abnormality in these enzymes directly indicate the metabolic disorders.^[25]

Therapeutic potential of *Abelmoschus esculentus* in obesity: -obesity is the one of the maximums developing disorders globally affecting from infantsto young to elderly peoples, in diabetes accumulation of immoderate body fats andincreased body mass index varies from equal or

more than 25may be considered as obese. In a literature, researchers found that most of the peoples are taking okra as a remedy for the management of obesity. Other allopathic drugs are also available in market for the management of obesity, but they have more side effects like GIT irritation, floating, abdominal cramps, so to consider these side effects abelmoschus esculentus is a good option to manage obesity with no serious side effects.Besides these effects it also serves good nutrition and vitamin or minerals to the body which retain the body with energy and full nutrition.^[26]

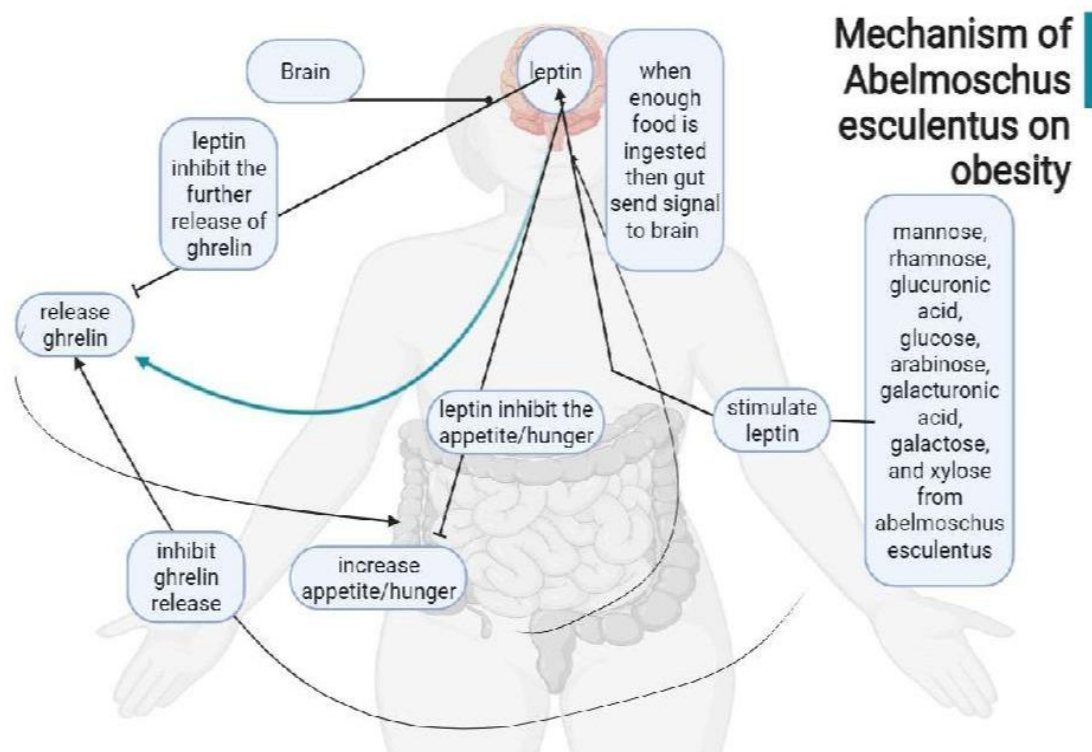


Figure 4 showing the mechanism of Abelmoschus esculentus in obesity

The mechanism of okra as an anti-obesity is not fully described by the scientists but few researchers declare that polysaccharides present in okra like mannose, rhamnose, glucuronic acid, glucose, arabinose, galacturonic acid, galactose, and xylose have a good anti-obesity activity, also serves excessive power and growth in the metabolism, and reduce the absorption of different vitamins from the intestine. These polysaccharides at a molecular level release the leptin and inhibit ghrelin hormone by intermediate action of glucose used by adipose cells. Leptin is a hormone predominantly made through adipose cells and enterocytes inside the small gut that facilitates to adjust energy through inhibiting hunger in response to adipocytes. Leptin acts on molecular receptors present inside the ventromedial nuclei, in addition to different elements of the hypothalamus and dopaminergic neurons of the ventral tegmental area, therefore mediating feeding. In obesity, reduced sensitivity to leptin occurs, which further increase hunger and obesity, but these polysaccharides increase the sensitivity and decrease hunger and obesity. (Figure 4)^[27]

Therapeutic potential of Abelmoschus esculentus in Dyslipidaemia: -Dyslipidaemia is a condition associated with increased lipid level from

its normal level and further leads to many cardiovascular diseases such as hypertension, angina pectoris, myocardial infarction and many more. Females are more prone to this disorder as compared to males due to hormonal imbalance. The other factors like physical inactivity, less exercise, stress, are considered for obesity in both the sexes.^[28] The chemical constituents present in the Abelmoschus esculentus plant like mannose, rhamnose, glucuronic acid, glucose, arabinose, galacturonic acid, galactose, and xylose having anti-dyslipidaemia activity by increasing the metabolism of carbohydrate and elimination of fat from the body. Abelmoschus esculentus also work by decrease the absorption of carbohydrate and fat from intestine. In most of the literature researchers suggest that watery mucilage of raw okra is more potent as compared to other forms. In raw okra chemicals are more active and present in maximum amount as compared to cooked and dried okra.^[29]

Therapeutic potential of Abelmoschus esculentus in male and female fertility: -fertility is the biological process of producing offspring through reproduction and non-reproduction. Fertility is considered as male fertility or female fertility, in which reproduction system plays an important role. Infertility is the disorder considered as reproductive system disease in which the male or

female is incapable of producing offspring. In male, the sperm is immature or defective through which it will not attach, or it will not travel to the eggs of the female ovary. But in female infertility, female eggs are not able to produce offspring, factor can be the inability of the eggs to attach with the sperm or ovum is unable to live. In research conducted by Bello et al suggested that abelmoschus esculentus showing negative impact on male and female fertility.^[30] The methanolic extract of okra showing decrease sperm count, decrease sperm motility and decrease spermatogenesis. So, it is not suitable to eat raw

okra for healthy fertile peoples. The antioxidants present in okra like beta carotene, Lutein and zeaxanthin and vitamins like vitamin A, B,C and K and one of the major constituent folates, all of these constituents are decrease the fertilization process in both male and females.^[31] besides all other chemical constituent's gossypol is the main active constituent involved in anti-fertility activity. In a study researchers claim that gossypol is highly active in male as compared to female and furthermore research need to do on this plant for anti-fertility activity. (Figure 5)^[32]

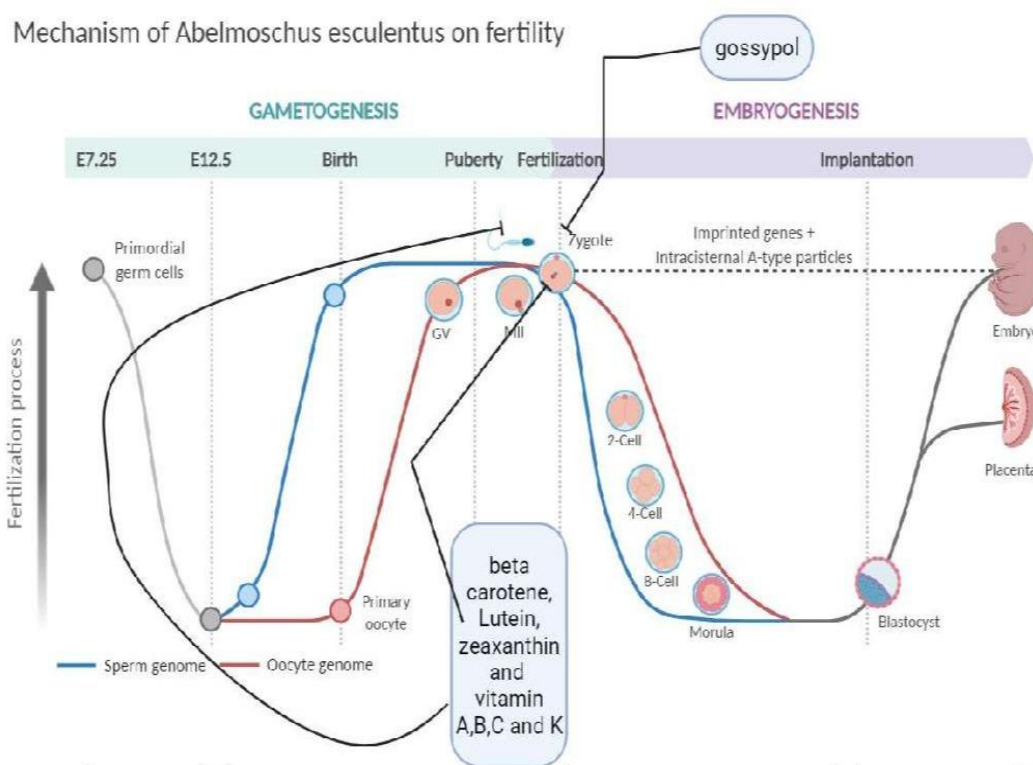


Figure 5 showing the mechanism of *Abelmoschus esculentus* on male and female fertility

Chronic alcoholism has more infertility as compared to others, so by increase the raw okra water mucilage uptake infertility can be increased, so it is totally prohibited the use of okra with alcohol.^[33]

Another study concluded that consumption of okra generally increases the level of testosterone, luteinizing hormone and follicle stimulating hormone. The gossypol a major chemical constituent present in okra seed is responsible for infertility process.^[34]

Therapeutic potential of *Abelmoschus esculentus* in anaemia: -Anaemia or

Erythrocytopenia is a blood disorder characterized by decrease in the production of red blood cells or normally decrease in RBC count. Red blood cells contain oxygen that supply oxygen further to all over the body through blood. In the deficiency of RBC, the oxygen supply in the body reduced which further leads to many other diseases like hypoxia, tissue death, and anaemia^[35]. Every year number of infants or children are suffering from anaemia because of lack of iron and folic acid in their diet. Countries like Africa, Iran, Afghanistan, Syria, and some parts of India are majorly affected countries by anaemia and need more attention. *Abelmoschus*

esculentus is the one of the most suitable sources for the treatment of erythrocytopenia. Okra rich in iron, folic acid, vitamin k which supply these nutrients in the body, and treat iron deficiency

anaemia or simple anaemia. Raw okra contains high amount of iron and folic acid, so it is advisable to eat raw okra instead of boiled to treat anaemia more frequently. (Figure 6) [36]

Mechanism of *Abelmoschus esculentus* in erythrocytopenia

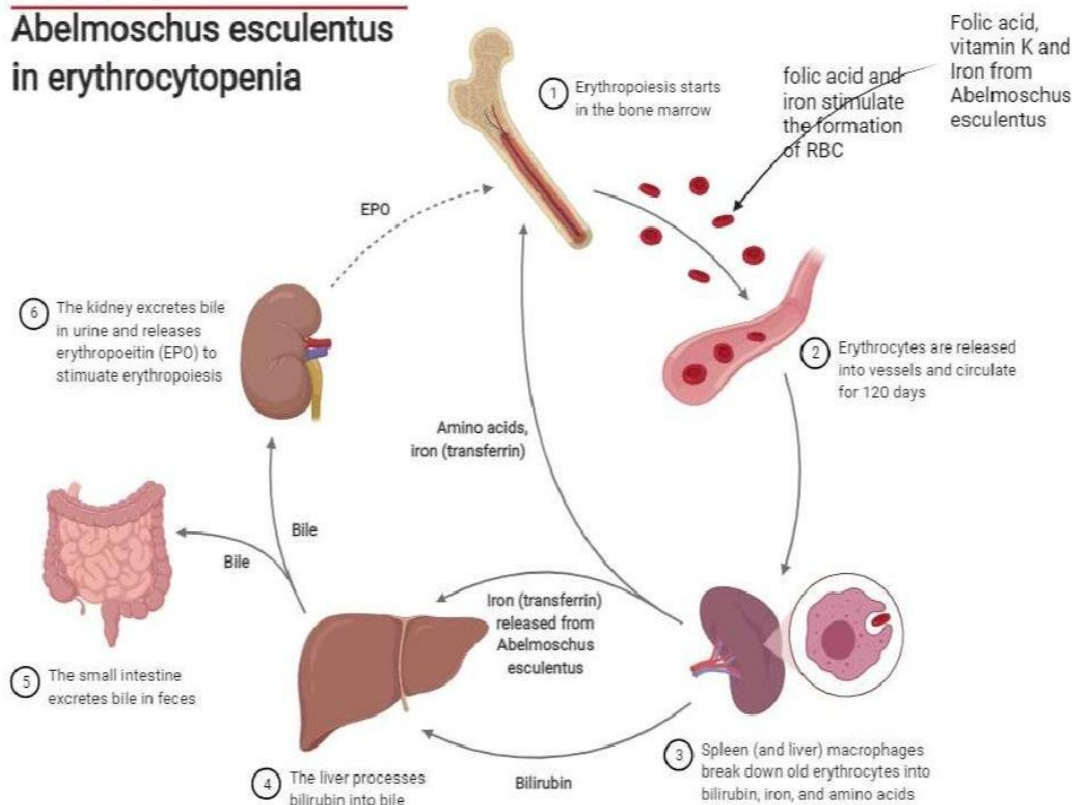


Figure 6 showing the mechanism of *Abelmoschus esculentus* in anaemia or erythrocytopenia

Therapeutic potential of *Abelmoschus esculentus* in cardiovascular diseases: -20 % of world population died because of CVD, and the major cause of development of CVD is dyslipidaemia and cholesterol. If these parameters are treated carefully more than half of the CVD are automatically cured. Cardiovascular diseases like hypertension, angina pectoris, myocardial infarction, arrhythmia all diseases are interconnected with the accumulation of fat or inflammation in the blood vessels. Various treatments are available in the market for the treatment of CVDs, but all have certain side effects and at the end they just treat the symptoms not the disease. But *Abelmoschus esculentus* in a study found that, it decreases the cardiovascular risk more than 50%. [37] It decreases the HDL, LDL, inflammation, and cholesterol at different doses of extract. HDL, LDL,

inflammation, cholesterol these all are the major biomarkers for CVD. In-vivo and in-vitro studies showed that okra upregulate the cholesterol 7 α -hydroxylase (CYP7A1) gene expression and downregulate the expression of sterol regulatory element binding protein 2, 3-hydroxy-3-methylglutaryl-CoA reductase (HMGR), low-density lipoprotein receptor (LDLR) and carnitine palmitoyltransferase-1A (CPT1A). these all genes involved in the pathogenesis of cardiovascular diseases. It was concluded that by upregulating the cholesterol degradation through CYP7A1 and by inhibiting the lipogenesis through SREBP1c and FAS okra acts as an hypolipidemic, which further decrease the CVDs. [38]

Therapeutic potential of *Abelmoschus esculentus* in pregnancy: - pregnant women need more nutrition and minerals as compared to non-

pregnant or males. Most of the pregnant women have low haemoglobin or iron and folate deficiency, so it is advisable to take iron rich and folate rich vegetables regularly. According to CDC, it is necessary intake of 400mcg folic acid and 200mcg of iron regularly for pregnant women. *Abelmoschus esculentus* contains all these nutrients in high amount, evidence suggest that okra is safe in pregnancy and support mental and physical health of the mother and child. Iron and folic acid present in okra will help to increase the haemoglobin in pregnant women and good source for the development of brain of the foetus. [39]

Spina bifida is a genetic abnormality occur at the phase when the foetus growth and development or organs are started to develop. The *Abelmoschus esculentus* contain a vitamin B9 which is helpful for treating spina bifida defect by accelerating the cell regeneration [40].

Folic acid and vitamin C in combination to boost the immune system of the pregnant women which help the foetus and mother to fight against infections. Vitamin C acts as an antioxidant, which further helpful for good sleep, stressless, improve fatigue, skin, and overcome weakness. (Table 2) [41]

Table 2 showing all the chemical constituents present in the *Abelmoschus esculentus* and their pharmacological activity

Chemical constituents present in <i>Abelmoschus esculentus</i>	Pharmacological activity	References
Polyphenols and flavonoids	Antioxidant and anti-fatigue	[42]
Oligomeric catechins and derivatives of flavonoids	Antioxidant	[43]
Derivatives of hydroxycinnamic	Antioxidant, fatigue, treat cardiovascular diseases	[44]
Pectin, lectin, indole-3-carbinol	Anti-cancer	[45][46]
Vitamin k	Prevent Blood clotting	[47]
Folates	Prevent neural tube defects	[48]
Vitamin B6 (Pyridoxin)	Act as Co-enzyme functions in metabolism of amino acids, glycogen, and sphingoid bases	[49]
Thiamine (vitamin B1)	Co-enzyme functions in metabolism of carbohydrates and branched-chain amino acids	[50]
Pantothenic acid	Constituent of co-enzyme A and phosphor pantetheine involved in fatty acid metabolism	[51]
Vitamin C	Protect from free radicals, Reduce episodes of cough and cold, Develop immunity	[52]
Vitamin A	Decrease sebum production on the skin, rejuvenate dead skin cells	[53]
Carotene-beta	Decreased risk of CVD, oral cavity, and lung cancer	[54]
Vitamin E	Antioxidant, CVD, dementia, cancer, nerve disability, skin disease	[55]
Rhamnogalacturonan (polysaccharide)	Antidiabetic,	[56]
Mannose, rhamnose, glucuronic acid, glucose, arabinose, galacturonic acid, galactose, and xylose	Ant obesity	[57]
Tryptophan	Regulating appetite, mood, pain and sleep	
Methionine	Prevent senile greying of hair	[58]
Oleic acid,	Lowers cholesterol and inflammation	[59]
Linoleic acid	Improve CVS, brain function, immunity, skin health and bone strength	[60]
Oxalic acid	Maintain the tone and peristalsis of the bowel	[61]
Oligomeric catechins	Prevent atherosclerosis	[62]

Palmitic acid	Increase apoptosis, cell proliferation	[63]
Antioxidants (Lutein and zeaxanthin, Beta carotene)	Anticancer, ant obesity, antidiabetic, antifertility	[64] [65]
Gossypol	Antifertility	[66]

II. CONCLUSION:

In traditional system of medicine okra is a very important plant to treat various ailments, because of high active chemical constituents present in okra serve the purpose of nutrition as well. The incidence of obesity and dyslipidaemia are decreased due to okra. In future, people will more tend towards plants having more nutritional as well as medicinal properties. In searching all the literature, we have concluded that okra is a powerful plant in the treatment of various diseases/disorders like diabetes, obesity, dyslipidaemia, anaemia, cardiovascular diseases, cancer, oxidation, and pregnancy. But the plant is strictly prohibited in infertility condition, more intake of okra can worsen the condition of infertility in male and female. Now a days peoples prefer okra water in early morning to decrease obesity and diabetes. According to literature we can claim that the watery juice of okra is more powerful to treat obesity, dyslipidaemia and diabetes and it is recommended to drink this juice early morning for furthermore effects like to treat fatigue, cancer, GIT upset and to neutralize acid in the stomach.

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