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Bioactive Components of *Vigna mungo*

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ABSTRACT

Bioactive compound is secondary plant metabolites eliciting pharmacological or toxicological effects in man and animals. Legumes are valuable source of proteins and nutrients for the majority of the world population. *Vigna mungo* is one of the important legume crop extensively cultivated in India and other parts of the world. Pulses and legumes have been gaining interest because they are excellent source of bioactive compounds. Objective of this present review is to compile all relevant information published regarding bioactive components from the *Vigna mungo.* Various bioactive components reported in *Vigna mungo* were found and it includes flavonoids, isoflavonoids, phytoestrogens, phenolic acids, enzymes, fibres, starches, trypsin inhibitors, phytic acid, lectins, saponins, tocopherols, fatty acids and proteins. This review clearly demonstrates that *Vigna mungo* is rich in bioactive components and these components are located in various organs of the plant.

Keywords: Bioactive components, *Vigna mungo*, Black gram, Legumes

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1. INTRODUCTION:

A bioactive compound is a compound that has an effect on a living organism, tissue or cell. Nutrients are the compounds required for growth, survival and reproduction of an organism while bioactive compounds are not essential since the body can function properly without them. Bioactive compounds can have an influence on health. Definition of bioactive compound is secondary plant metabolites eliciting pharmacological or toxicological effects in man and animals. Bioactive compounds are present in both plants as well as animals. These are classified according to different criteria like pharmacological or toxicological effects or chemical nature. Based on their chemical nature these are classified as glycosides, tannins, flavonoids, proanthocyanidins, terpenoids, resins, lignans, alkaloids, coumarins etc. [1]

Legumes are very important group of plant food stuffs, particularly in the developing world. Legume seeds are valuable sources of proteins and nutrients for the majority of the world population. Legumes are also providing carbohydrates, several water soluble vitamins, and minerals, to human nutrition other than proteins. [2] Examples of legumes are *Vigna radiata* (Mung bean), *Vigna angularis* (adzuki bean), *Vigna unguiculata* cowpea (rice bean), *Vigna mungo* (black gram), *Cajanus cajan* (pigeon pea) etc. [3]

Recently, pulses and legumes have been gaining interest because they are excellent source of bioactive compounds. Some of them are phytates, amylase inhibitors, compound saponins, phenolic compounds, trypsin inhibitors etc. These bioactive compounds are used in functional foods and other applications. These bioactive compounds showing activities like anticancer, management of diabetes, hypolipidemic effect, inhibition of platelet aggregation, antioxidant effects, possible protection against heart diseases, anti-inflammatory responses, both estrogenic and antiestrogenic effects, reduce the obesity risk etc. [4]

Vigna mungo is one of the legume crop extensively cultivated in India. It is called as black gram in English, Masha in Sanskrit. The seeds of black gram are sweet, laxative, aphrodisiac, tonic, appetizer, diuretic, galactagogue and styptic. Seeds are useful in piles, asthma, scabies,

leucoderma, gonorrhoea, pains, epistaxis, paralysis, rheumatism and affections of the nervous system, liver and cough. Pure black gram cake known as idli is used as a night diet for diabetics. It is medicinally used both internally and externally, internally used in gastric catarrh, dysentery, diarrhea, cystitis, paralysis, piles, rheumatism and affections of nervous system, in the form of decoction and externally as poultice, also in gastritis, dysentery and rheumatism. Black gram seeds consist of moisture, proteins, fats, fibers, carbohydrates and minerals. Allantoin, glutathione, plant growth regulators and lignin precursors are present in the seed and seedlings. [5]

Black gram is very important part of Indian food. It is used in the form of cooked dhal, idli, hopper, papad and waries. This review is focuses on the systematic study of bioactive compounds reported in various parts of *Vigna mungo* plant (like leaves, roots, stem, pods, etc.)

2. BIOACTIVE COMPONENTS OF THE PLANT

2.1 Flavonoids:

Three kinds of anthocyanin were found in the black seed-coats and the purple-red hypocotyls of Vigna plants these are delphidin 3-glucoside, delphinidin 3-p-coumaroyl glucoside and cyanidin 3- glucoside. Leucocyanidin and leucodelphinidin are present in the seed coats of plant, with the former as the predominant component. Two glycoflavones vitexin and isovitexin were detected in all of the seed-coats, and they were present in the tissues nearly in the ratio of 1:1. Three flavonol glycosides Robinin, Kaempferol 3-rutinoside and Kaempferol 7-rhamnoside were found in the leaves of black gram. [6] Proanthocyanidin, delphinidin and cyanidin are present in the seeds. Kaempferol appears to be the most prevalent flavonoid in the *Vigna mungo.* [7]

Mature leaves of black gram are able to form quercetin glycosides although seedling leaves do not able to form them. Hypocotyl and stem tissues of black gram form all three quercetin glycosides, thus their flavonol composition is quite different from that of young leaves. [8]

Milled fractions of black gram shows distribution of *C*-glycosyl flavones and higher concentrations of *C*-glycosyl flavones are present in husk fractions. These compounds were identified as vitexin and isovitexin. *C*-glycosyl flavones from black gram husk exhibited anticancer activity and protected DNA and erythrocytes from oxidative damage. [9] Reported flavonoids from black gram are summarised in **Table no 1**

Table 1: Reported flavonoids from black gram

Part	Examples of flavonoids	Reference
Seed coat and hypocotyl	Delphidin 3-glucoside, delphinidin 3-p-coumaroyl glucoside and cyanidin 3- glucoside.	[6]
Seed coat	Leucocyanidin and leucodelphinidin	
Seed coat	Glycoflavones	
	Vitexin and isovitexin	
Leaves	Flavonol glycosides	
	Robinin, Kaempferol 3-rutinoside and Kaempferol 7-rhamnoside	
Seeds	Proanthocyanidin, delphinidin and cyanidin	
Leaves	Quercetin glycosides	[8]
Husk	*C*-glycosyl flavones	[9]
	Vitexin and isovitexin	
Flowers	Kaempferol 3-rutinoside	[11]

Adesanya et al identified 16 isoflavonoids from *Phaseolus mungo* (*Vigna mungo*) by their UV, MS and PMR characteristics. Five compounds from these genistein, 2'-hydroxygenistein, kievitone, dalbergioidin and demethylvestitol are reported to be present in Leguminosae as a phytoalexins. Five compounds are known to occurring only in the genus Phaseolus. These were identified in *Vigna mungo* as the isoflavone-2'-hydroxydaidzein, the isoflavanones cyclokievitone, 5-deoxykievitone, 2'-hydroxydihydrodaidzein and the coumestan aureol. Isoflavanone isoferreirin and the pterocarpan glycinol were two *P. mungo* isoflavonoids. Three novel natural isoflavanones which were characterized as 4'-0-methylkievitone, cyclokievitone hydrate and 5-deoxykievitone hydrate along with reported kievitone. [10]

Hypocotyl or epicotyl tissue of the black gram seeds shows presence of phytoalexins which are dalbergioidin, kievitone, phaseollidin and one unidentified substance. These phytoalexins was studied for their antifungal activity. Their antifungal activities were confirmed by bioassay and fungal toxicity tests. Kievitone was found more fungitoxic than dalbergioidin or phaseollin in its effect on mycelial growth, while there was little difference between the three compounds as inhibitors of spore germination. Surveying of flowers and stems for presence of flavonol glycosides showed black gram flowers dominates Kaempferol 3-rutinoside than the stems. [11]

Sharma et al isolated isoflavones from blackgram. Blackgram shows presence of daidzein and p-coumaric acid in small concentration. Isolated isoflavones were supplemented to rats having hypercholesterolemia inducing diet. Daidzein did not produce antilipidemic activity. P-coumaric acid created a substantial reduction in serum cholesterol levels. [12] Reported flavonoids from black gram are summarised in **Table no 2**

Table 2: Isoflavonoids Reported in Black Gram

Part	Examples of Isoflavonoids	Reference
Seeds	isoflavone-2'-hydroxydaidzein, cyclokievitone, 5-deoxykievitone, 2'-hydroxydihydrodaidzein and the coumestan aureol, isoferreirin, pterocarpan glycinol, 4'-0-methylkievitone, cyclokievitone hydrate and 5-deoxykievitone hydrate, kievitone.	[10]
Seeds	daidzein and p-coumaric acid	[12]

A novel enzyme, UDP-D-galactose: flavonol 3-*O*-galactosyltransferase was detected and purified from *Vigna mungo* seedlings. This enzyme was responsible for the catalysing the transfer of D-galactose from UDP-D-galactose to the 3 position of 5, 7, 4′-trihydroxyflavonol (Kaempferol). This enzyme was separated from UDP-D-glucose: flavonol 3-*O*-glucosyltransferase [13]

2.2 Phytoestrogens:

There is presence of estrogen compounds in plants that induce estrus in immature animals or interfere with normal reproductive processes. These compounds are called phytoestrogens. The lignans secoisolariciresinol (SECO) and matairesinol (MAT) are examples of phytoestrogens and known for their estrogenic, antiestrogenic, anticarcinogenic, antiviral, antifungal, and antioxidant activities. Mazur et al have applied an isotope dilution gas chromatography–mass spectrometry in the selected monitoring mode (ID/GC/MS/SIM) method for the identification and quantitative determination of these two lignans (SECO and MAT). They reported for the first time the presence of the lignans SECO and MAT in *Vigna mungo*. [14]

2.3 Phenolic Acids:

Girish et al. studied phenolic acids, which were separated using HPLC system coupled to a diode array detector at room temperature. A solvent system consisting of water: methanol: acetic acid (83:15:2) was used as mobile phase at a flow rate of 1 mL/min. All fractions showed the presence of ferulic acid in higher concentration, followed by genistic acid. Gallic acid and protocatechuic acids were present in all fractions. Similar phenolic acids were found to be present in the seed coat, aleurone layer enriched in seed coat and plumule fractions of black gram except for the absence of vanillic acid. Phenolic acids like syringic and caffeic acids were lacking in plumule fraction. Important reported phenolic acids in black gram seeds and its milled floor are gallic acid, protocatechuic acid, genistic acid, vanillic acid, syringic acid, caffeic acid, and ferulic acid. [15]

Girish TK et al study shows that polyphenols are present in aqueous extract of the black gram husk. With the help of RP-HPLC they identified phenolic acid in the extract as gallic, protocatechuic, gentisic and ferulic acids The extract exhibited antioxidant properties, inhibited a-glucosidase activity. It also protected DNA and erythrocyte from oxidative impairment. [16] **Table No 3** shows details of reported phenolic acids.

Table 3: Phenolic Acids Reported in Black Gram

Part	Examples of Isoflavonoids	Reference
Seed coat, aleurone layer, plumule fraction	Gallic acid and protocatechic acids,	[15]
Seeds and its milled floor	Gallic acid, protocatechic acid, genistic acid, vanillic acid, syringic acid, caffeic acid and ferulic acid	

2.4 Enzymes:

Black gram husk, which is a major waste by-product from milling industry, was found to be a rich source for a peroxidase enzyme. Peroxidase from aleurone layer rich husk fraction was purified using two steps, ion-exchange chromatography followed by gel filtration. Alija et al extracted Peroxidase from the aleurone layer husk rich fraction by grinding method using sodium phosphate buffer. This extract was subjected to DEAE-Sephacel chromatography. Peroxidase has wide substrate specificity and these characteristics make useful in several industrial, analytical and biomedical applications. They are also used in the treatment of wastewater containing phenolic compounds and aromatic amines as labeling enzyme in immunochemistry and characterization of disease status in experimental pathology, as a reagent for organic synthesis and biotransformation as well as in coupled enzyme assays, chemiluminescent assays and immunoassays. Black gram which is a major waste by-product from milling industry husk will be a potential source for a peroxidase enzyme. Oxidation of a variety of substrates using H2O2 is catalyzed by peroxidase enzyme. [17]

The black gram had a high amount of catalase. Sprouted black gram seeds show the presence of catalase. It is considered as a principal antioxidant enzyme in black gram seed. [18]

Fungal contamination is one of the most threating pathogens to crop plants that alone contribute to a 25% loss of food crops and stored food grains throughout the world. The consumption of these contaminated crops or food products adversely affects human health causing growth disorders, liver and kidney damage, skin diseases, cancer, and other mutations. Chitin is the main constituent of the cell walls of fungi and it is used as a fungal growth indicator. Fungal invasion detection method includes quantification of chitin content by analytical methods and the enzymatic methods employing chitinases. Chitinase activity assay can be efficiently used as an indicator of fungal growth. A novel chitinase was purified from seeds of black gram. The purified chitinase was tested for its ability to determine the chitin contents of the stored cereals and chitin content was shown successfully. [19] Yamauchi isolated two overlapping genomic clones for cysteine endopeptidase from a *V. mungo* genomic library. A cysteine endopeptidase is responsible for the degradation of storage globulin in cotyledons of germinating seeds of *Vigna mungo*. It is one of the hydrolytic enzymes that act to degrade storage globulin in combination with a serine endopeptidase. [20] In the

Mitsuhashi and Minamikawa study, sulfhydryl-endopeptidase, one of the major enzymes responsible for storage protein degradation was purified from the *Vigna mungo* seedlings. A sulfhydryl-endopeptidase was purified as a 33 kilodalton (kD) mass polypeptide from cotyledons of *Vigna mungo* seedlings. [21]

Acid phosphatase was isolated by using by ion-exchanger column chromatographies from cotyledons of dark-grown *Vigna mungo* seedlings. It was separated into four forms which are different from each other in their properties such as substrate specificity, thermal stability, molecular weight and susceptibility to metal ions and other substances. [22] Acid phosphatase was isolated by using a combination of column chromatography and gel electrophoresis from cotyledons of *Vigna mungo* seedlings is composed of at least six forms (la, Ia2, Ib, Ib2, Ha and lib). They examined the immunological relationships between the multiple forms from cotyledons and the distribution of the enzyme in organs of maturing and germinating seed. [23]

In non-endospermic leguminous seeds such as pea, Vigna and Phaseolus, it is also known that α-amylase activity in the cotyledons increases during the germination with concurrent mobilization of storage starch. Using this affinity chromatography technique, Koshiba and Minamikawa purified the a-amylase which increases in the cotyledons of germinating *Vigna mungo* seeds. They decontaminated the a-amylase from 4-day-old cotyledons by affinity chromatography on epoxy actuated Sepharose 6B replaced with β-cyclodextrin and by column chromatography on Bio-Gel P-200. [24] Summary of enzymes from *Vigna mungo* are reported in **Table No 4**

TABLE 4: Enzymes Reported in Black Gram

Part	Examples of enzymes	Ref
Husk	Peroxidase	[17]
Sprouted seeds	Catalase	[18]
Seeds	Chitinase	[19]
Seeds	Cysteine endopeptidase	[20]
Seedlings	Sulfhydryl-endopeptidase	[21]
Seedlings	Acid phosphatase	[22]
Seedlings	α-amylase	[24]

2.5 Saponins:

Soyasaponin I have been reported in *Vigna mungo* seeds. Soyasaponin-I is having ability to bind with cholesterol from diet and bile salts from the digestive system hence it becomes good candidate for treatment of hypercholesterolemia. [25] Analysis of black bean shell and the root of black bean sprout, confirmed the saponins of soyasaponin I, soyasaponin II, soyasaponin V, saponin A, saponin B, acetylsoyasaponin A4 and soyasaponin βg. Saponins were also found in the stem and leaves of the black bean sprouts, except soyasaponin βg and acetylsoyasaponin A4, respectively. [26] The study of Jood et al concludes that saponins are present in chickpea and black gram and can contribute substantially to saponin content of human diet. Common methods of domestic processing and cooking, to which these pulses are subjected before they are consumed, decrease the saponin level of the seeds to a varying extent. [27] Summary of reported saponins from *Vigna mungo* are summarised in **Table No 5**

Table 5: Saponins Reported in Black Gram

Part	Examples of Saponins	Reference
Seeds	Soyasaponin I	[25]
Black bean shell, root of black bean sprout, stem, leaves of sprout	soyasaponin I, soyasaponin II, soyasaponin V, saponin A, saponin B, acetylsoyasaponin A4 and soyasaponin βg	[26]

2.6 Carbohydrates:

The hexasaccharide ajugose generally uncommon in legumes was detected in the seeds of *Vigna mungo*. Ajugose structure was established by application of various analytical techniques. [28] The determination of oligosaccharide content of black gram and effects of treatments like soaking, cooking, enzyme treatment etc on the dry seeds and flour was studied by Girigowda et al. Reduction in the raffinose, stachylose, verbascose and ajugose content was seen after soaking for 16 hours and cooking for 60 min. Among the different methods employed, enzyme treatment was found to be the most effective for removing alpha-galactosides in black gram. [29]

2.7 Trypsin Inhibitor:

The trypsin inhibitor fraction was isolated by ammonium sulphate fractionation from black gram. It exerted maximum in vitro inhibition on trypsin. Haemagglutinating activity was lacking in the extract as well as in the trypsin inhibitor fractions. [30] Chita and Sadasivum studied Trypsin inhibitor activity on Black gram seeds. The Trypsin inhibitor activity (TIA) was expressed as TIU/g of sample. Studies showed that the whole grain contained 905 TIU/g while cotyledon was found to contain 99-1% of the total TI activity whereas the husk contained only 0.9%. Studies also showed that TIA increased as the seed matured and the decrease in TIA during the initial period of germination. [31] Cheung et al reported three trypsin-chymotrypsin inhibitors from seeds of the black gram. A 16 kDa trypsin-chymotrypsin inhibitor which showed inhibitory activity towards HIV-1 reverse transcriptase was reported from black gram. [32]

2.8 Phytic Acid:

Reddy and Salunke studied the interactions between protein, phytate, and minerals at pH 2.80, 6.40, and 8.40. Results showed that 1% of phytate was present in black gram cotyledons, of which 88.7% existed in water soluble form. Phyate phosphorus represented for about 89% of total phosphorus in black gram cotyledons. [33] The presence of several antinutritional factors such as phytic acid, polyphenols, enzyme inhibitors, saponins and flatulence factors in these foods hinders their utilisation for human nutrition. Phytic acid lowers the bioavailability of minerals and inhibits proteolytic and amylolytic enzymes. Phytic acid content was found in black gram seeds. Soaking the seeds for 12 h reduced significantly the phytic acid contents and cooking further lowered the phytic acid contents significantly. The decrease in the level of phytic acid of legume seeds during soaking may be attributed to leaching out of this antinutrient into the soaking water under the influence of concentration gradient. Such losses may be

taken as a function of changed permeability of seed coat. [34]

Phytic acid, saponin and polyphenols are present in significant amounts in *Vigna mungo*. Kataria et al considered consequence of domestic treating and culinary methods including soaking, ordinary and pressure cooking of soaked and unsoaked seeds, and sprouting on phytic acid, saponin and polyphenol contents. They are significantly reduced during domestic processing and cooking. Germination of *Vigna mungo* seeds seemed to be the most effective method of reducing the levels of these antinutrients. [35] Rehman and Shah stated that the tannin and phytic acid contents in black grams, chick peas, lentils, red and white kidney bean ranged from 770–1100 mg/ 100 g to 970–1440 mg/100 g, respectively. Their results after cooking suggested that there is reduction in the levels of antinutrients, along with an improvement in protein and starch digestibility. Different thermal heat treatments reduced contents of antinutrient like tannin and phytic acid. [36]

Reddy et al determined phytate phosphorus, calcium, magnesium, zinc and iron in black gram seeds. Phytate phosphorus (P) represents 79% of total Phosphorous in black gram seeds. Phytate P is the primary storage form of phosphate in black gram seeds. It was found that 50% of phytate P had disappeared on the 10th day of germination. [37] Summary of phytic acid from *Vigna mungo* are reported in **Table No 6**

Table 6: Phytic Acid Reported in Black Gram

Part	Examples of Saponins	Reference
Seeds	Phytic acid	[35]
Seeds	Phytate phosphorus	[37]

2.9 Lectins:

Suseelan et al observed two galactose-specific lectins, BGL-I and BGL-II in the black gram seeds. The purified lectins were associated with galactosidase activities. These lectins agglutinate trypsin treated rabbit erythrocytes. The monomeric lectins have both lectin and galactosidase activities indicative of a bifunctional protein. [38] Black gram (*Vigna mungo*) seeds are shown to contain a lectin with certain unusual features as per the study of Singh and Rao. In their studies the lectin agglutinates only trypsinized red cells, and its sugar specificity is complex. They showed that the clot forming ability of the lectin is unusual. [39] Sharma and Salahuddin isolated lectin from *Phaseolus mungo* seeds by using affinity chromatography on a galactosyl Sepharose 6B column which was found to contain 8.3% neutral carbohydrate. Their results suggested that the lectin is a dimer whose overall native conformation is nearly globular. Isolated lectin was galactose/N-acetylgalactosamine-specific, having significantly reduced affinity for N-acetylgalactosamine. These results were from the effect of 10 saccharides on the hemagglutinating activity of lectin against trypsinized rabbit erythrocytes. [40]

2.10 Proteinase inhibitor:

The Prasad et al investigation shows the presence of a serine Proteinase inhibitor in black gram. Proteinase inhibitor was purified by using ammonium sulphate fractionation, followed by ion-exchange, affinity and gel-filtration chromatography. Isolated purified inhibitor was identical with molecular mass in SDS–PAGE and MALDI-TOF mass spectrum. It showed inhibitory activity against both trypsin and chymotrypsin. Chemical modification studies indicated that lysine present in the reactive site of BgPI play a significant role in trypsin inhibition. [41]

Cysteine proteinase inhibitors were purified from black gram and rice beans with 12000 dalton molecular weight. It was purified by using heat treatment, followed by chromatography on a carboxymethyl papain-Sepharose affinity column. It showed concentration dependant papain and cathepsin inhibition. The purified inhibitors were thermostable up to 90C and active in the neutral and alkaline pH ranges. [42]

2.11 Neutral detergent fibre:

Neutral detergent fiber was isolated from the black gram. NDF contains hemicellulose, cellulose, lignin, cutin and silica. Hemicellulose is present in higher concentration and it is considered as most active constituent. Isolated NDF showed hypolipidemic, hypoglycemic and anticolon cancer activity. [43]

2.12 Tocopherol, Fatty acids and Sterols:

Seeds of black gram have acceptable fatty acids, tocopherol and sterol profile. The oil fraction of Indian pulses contained high amounts of tocopherols especially γ- and Δ-tocopherols and unsaturated fatty acids especially linolenic. [44]

Black gram seeds were found to be rich source of α-linolenic acid and oleic acid. Bulk of the oil consisted of unsaturated fatty acids. There is reduced risk of cholesterol-related heart diseases by consuming oils containing more unsaturated fatty acids. γ-tocopherol contents are in highest quantity while considerable contents of δ-tocopherol followed α-tocopherol were also noted. The extracts indicated good tyrosinase and AGE-inhibition activity. Naturally arising tocopherols are used for oils and fats equilibrium against oxidative degradation, it proposes their usage in pharmaceutical, biomedical, and nutritional products. Substantial amounts of campesterol, avenasterol and stigmasterol were found in oils of seeds [45]

2.13 Minerals:

Seeds of black gram contain considerable amount of essential minerals like Ca, K, Na, Mg, Cu and Zn. Potassium is major mineral from seeds and Zinc is present in lowest quantity. The high content of potassium is useful for patients who use diuretics to manage hypertension and there is unnecessary seepage of potassium from their body fluids. The low content of sodium compared to potassium led to low sodium: potassium ratio, which is favourable from nutritional point of view, as foods with low Na: K ratio are linked with lower frequency of blood hypertension. Mash bean may provide adequate quantity of minerals to meet the mineral requirements of human body. [45]

2.14 Starch:

Starch from black gram was isolated. Amylose content of starch was 26.65%. The raw as well as cooked starch was resistant to hog pancreatic α-amylase hydrolysis in vitro. [46]

2.15 Proteins:

According to Harris and Chrispeels proteins and starch are stored in protein storage vacuoles and starch granules of *Vigna mungo* seed cotyledons, respectively. [47] Mahajan et al studied characterisation of black gram seed storage proteins. They dehulled and defatted black gram flour *Vigna mungo* seeds. It was found to contain 25% protein like globulins (63%), Albumins (12%) and glutelins (21%) and trace amount of prolamins (1%). Glutamic acid was present in higher concentration followed by aspartic acid and lysine. [48] Toyooka identified the localisation of α-amylase in

Vigna mungo cotyledons or embryo axis removed seeds by using immunocytochemical assays. [49]

2.16 Other components:

GC-MS analysis of root nodules of black gram amended with commercial vermicompost shows presence of 3-O-Methyl-d-glucose, n hexadecanoic acid, Propane, 1, phthalic acid, butyl isohexyl ester and ethylbenzene. GC-MS analysis of root nodules of black gram amended with coir waste manure shows n-hexadecanoic acid, 9, 12-octadecadienoic acid, phthalic acid and oleic acid. The phytochemicals observed in this study possess antimicrobial, anti-inflammatory, anticancer properties etc. [50]

Kingsley et al studied antimicrobial activity of methanolic extract of black gram. Bacterial strains and fungal strains were used on Muller Hinton agar medium and potato dextrose agar medium respectively. The methanol extract of blackgram inhibited various bacterial and fungal strains like *Klebsilla* sp., *Bacillus* sp., *Enterococci* sp. and *Pseudomonas aeruginosa*, *Aspergillus niger* and *Candida albicans*. The GC-MS spectrum of methanol extract showed the presence of Heptadecanoic acid, 9-methyl, methyl ester with molecular weight of 297.326 [51]

3. CONCLUSION:

Black gram (*Vigna mungo)* is rich in bioactive components. Reported bioactive components are flavonoids, isoflavonoids, phytoestrogens, phenolic acids, enzymes, saponins, trypsin inhibitors, phytic acid, lectins, neutral detergent fibre, proteinase inhibitors, tocopherols, fatty acids, proteins and minerals. Most of the reported components are from seed part of black gram. Various processes like cooking, soaking, germination have effect on bioactive components. These bioactive components have been reported to produce different activities like anticancer, antioxidant, antimicrobial activity, anti-inflammatory, hypolipidemic, hypoglycemic, estrogenic, antiestrogenic, antiviral and antifungal activity. Reported studies showed the presence of bioactive compounds in other parts of the plant like leaves, pods, roots, stem etc. which are normally considered as a waste product. Hence there is need to isolate and characterize novel bioactive components from other parts of black gram plant.

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