The gums are formed in various kinds of plants. They are found mainly in many phanerogamic plants. The true gums are formed as a result of the disintegration of internal tissues, for the most part from the decomposition of cellulose. The gums are insoluble in alcohol but soluble in water, readily swell up in it, and form a viscous mass. They are colloidal in nature. They contain a large amount of sugar and are closely allied to the pectins. They exude naturally from the stems, or in response to wounding. The commercial gums are the dried exudations of the plants. Gums are commonly found in the plants of dry regions. *Acacia* species yields the best gum-arabic of commerce. The gums are utilized as adhesives and are also used in printing and finishing textiles as a sizing for paper, in the paint and candy industries, and as drugs.

The plant gum slowly exudes as a viscous liquid, collected in a drop and hardens. After three to eight weeks these drops are collected. They are bleached by the sun, and the impurities are removed before marketing. The gum is used in the textiles, mucilage, paste, polish and confectionery industries, and as a glaze in painting. In medicine it is used as an emulsifying agent and as a demulcent.
Gum from higher plants shows changes in physical properties and chemical nature depending upon the eco-climatic conditions where plant is growing. Among the physical properties colour of gum varies from colourless-milky white-yellow to dark black colour. Even the viscosity, density, and hardness is found variable as the amount of moisture content varies from 10-16%. The smell and taste is one of the unique characters of gum which help in identification of plant source. Gums are colloidal in nature either dissolve, swell in water but completely insoluble in alcohol and ether. They are non-crystalline in nature and contain large amount of sugar. Chemically speaking plant gum is polysaccharide in nature.

Vegetable gums have a wide and varied use in home and industry. Gums are also used as food by aboriginal in India, West Asia and African countries. In Australia wattle gum is a well known food of aboriginal tribes. Today most of the gum is however used in industry as ingredient of pastes, polishes, syrups, cosmetics and confectionary. They are extensively used as clarifying agent in sugar, wine and beverage industry, as sizing material in paper and textile industry. World's major producers of gums are North America, Australia, India and certain South American countries.

Gums from various trees are regularly collected for local use in India and other parts of Asia. Many of these gums are not normally exported and are articles of internal trade only, being used mainly for edible purpose but also industrially in some instances, e.g. calico printing or dyeing. The production and collection of gum is mainly associated with dry or relatively
dry climates as has already been pointed out. Doubtless it is for this reason that India figures prominently among Asiatic countries as gum producer. Over much of the country an arid climate prevails, in contrast to a good deal of the Asiatic tropics where high humidity and more or less continuous rainfall without a distinct dry season.

Mumbai is the important gum centre of India both from the point of view of export trade to other countries and of internal Indian trade. According to Caius and Radha (1939) gums are received at Mumbai from more or less all parts of India, but particularly from Cawnpore, the Central Provinces—Jabalpure, Nagpur, Amrawati, Rajputana, Punjab, Sindh, Cutch, Kathiawar, East and West Khandesh, Gujarat and the Western Ghats. The wholesale dealers in gums reside in that part of Mumbai known to the general public as 'Danabunda', an unmapped locality situated within the Mandvi area. There the trade is quietly but efficiently carried out by Gujaratis, Jain Banias, Kutchis, and a few Mohammedans; all of them remarkable for the courtesy of their manners and their readiness to oblige. There too, in Samuel Street, is the seat of the “Bombay Gum Merchants Association”.

Most of the local dealers, generally grocers, buy their stock according to need from the wholesale merchants at Danabunder. A few deal directly with firms in Gujarat, Kathiawar, Cawnpore, East Khandesh and Thana Districts; or with collectors in villages of the Deccan and the Western Ghats. Others again procure their goods from the Gonds, Bhils,
Katkaris or other hillmen, who visit the city occasionally and whose occupation is to collect gums from the trees of the forests. As a rule, the men behind the counter give the goods for what they are. They all readily admit that no article is the genuine 'gum bavul' or 'acacia gum'; but a mixture of this with such other gums as kher, bel, lemon, neem, gonda, etc. Nevertheless, the 'bavul gond', owing to its colour and size and the presence of numerous fissures, is always recognizable and, should necessity arise, could be picked out from the mixture and supplied to the customer.

The uses to which the gum is put are indeed, so very, numerous and variable, that the merchant has to keep a large number of assorted grades to be able to satisfy the needs.

The gum is used by mill-owners in the finishing of cloth and paper. It is also employed in the match industry and in the preparation of water colours, inks, varnishes, and paints, and in calico printing. Mixed with lime, mortar and cement it finds its way into house building operations. As an adhesive, gum arabic is used in preparation of wigs, paper kites, clay toys; and there is a very heavy demand for it at the time of the Ganpati festival. A fairly large amount is also needed for the manufacture of the various cosmetics more abundantly required on festive occasions (Caius and Radha, 1939).

The best graded gums are suitable for pharmaceutical applications. A number of gums have been found quite effective in the treatment of asthma,
diarrhoea and other gastrointestinal disorders. The gum is used as an adhesive for pills and tablets and as a suspension of insoluble powders.

Among the reagents sometimes used in the examination of gums and which may be of assistance in identifying a gum when the number of possible botanical sources is known and restricted within reasonable limits. Caius and Radha (1939) have drawn up a key for the identification of the various Indian gums found in the shops and markets of Mumbai (Bombay). And is largely baked on the use of these reagents. In recent years substantial advances have been made in knowledge of the chemistry of the gums, particularly those that are important in Industry. Good accounts or of this work have been given by Norman (1937) and by Mantell (1947). However, much remains to be done in the chemical field, particularly with regard to the less common gums. As the different gums and different classes of gums markedly in their chemical properties and in chemical composition they are best considered separately.

**Gum Arabic**

As with other gums commercial gum Arabic may be derived from various geographical sources and possibly from more than one botanical source or species of *Acacia*. The gum Arabic 'molecule' in structural complexity which considered to stand between hemicellulose and the simple sugar (Mantell, 1947). Gum Arabic is essentially a mixture of calcium, magnesium and potassium salts of Arabic acid (Hirst, 1942).
The composition or chemical structure of gums tragacanth does not appear. The gum arabic and gum tragacanth is of carbohydrates nature and has acidic components which are largely present as calcium, magnesium and potassium salts.

In tragacanth gum consist of a soluble portion called tragacanthin and an insoluble portion called bassorin. The chemistry of other commercially importance gums such as Karya gum, locust gum, white silk cotton gum, Bengal kino gum, wood apple gum, cherry gum, Indian Gatty gum have received the attention of number of different workers in recent years.

For many years gum Arabic from the Sudan and to a less extent from Senegal has been available in fair quantity and a good quality. It has been marketed in European and other markets as relatively low price. The vegetable gums are a group of plants product resembling carbohydrates and widely distributed in vegetables kingdom. They are characterized by the ability to dissolve in water forming viscid solutions.

The economically exuded gum may be soft semi viscous but on drying it forms crystal. The dry gums are of different colour depending upon type of plant producing the gum. Most popularly the plant belonging to the family Fabaceae, Meliaceae, Anacardiaceae, Burseraceae, Combretaceae, Celastraceae, Sterculiaceae etc. are known to produce the gum on large scale.
Medicinal uses of gum

The best grades of gum are used in medicine. The gum used for constipation, liverticular disease and as laxative. Also used to cosmetic aids through gum which is form powder. Paste, ring disk, a sheet board advantageous only the other adhesive plasters and cements specially immediately after post surgical care of skin/sensitive skin or in soothing to skin less likely to produce softness, darkness support microbial growth.

The major use of gum is as a bulk laxative in view of its ability to form a mucilaginous gel on contact with water. The gum is neither digested nor absorbed by the body. The gum has also been used in a limited way as a wet end additive in paper manufacture in conjunction with starches. It is used extensively in various totally unrelated industries because of the properties of such as water absorbing / moisture absorbing gel and film forming. Adhesiveness abilities it is highly resistance to hydrolysis by mild acids and degradation by most of the micro organism.

Howes (2006) reported that gum Arabic is used as demulcent and as a colloid. It is also used in cough syrups and intravenous injection. It is also used in maintaing the blood pressure. Powder Acacia is also used for mulstetifusion, fuixed and volatine. Ramesh and Gowthami (1980) observed that the gum karaya is used for constipation, liver disease and as laxative. It is also used to Abdsmoti aids through gum which is form powder, pest, ring, duse. Adhesive plasters and cement specially emergially
after pest surgical core of skin soothing to skin. It is also used in dentine adhesive, medical adhesne desk for the treatment of stomatities.

Gum of *Butea monosperma* is used as antimicrobial and antifungal drug in folk medicine. Gum is useful as and astringent, use in diarrohea, Hemogrhoids, Heepopalsy, leprosy and skin diseases (Vaidyaratnam, 1995 and Kirtakar and Basu, 1975).Gum Arabic is used as an emulsifier and stablilizer in pharmaceuticals industries (Osman et al., 1993a, 1993b).

**Physico-chemical properties of gums**

Physico-chemical properties of gum have very importance in determine their uses and their commercial value. Colour and viscosity are probably are two important factor in assessing the quality of gum while good solubility is also important. Some gum are incline to be vegelatinous when dissolve accuora solution. Buyers and users of gum always attach great significant to the colour. Good viscosity is important for several purposes.

The physical properties of gum are most important to determine the quality of gum depends on the physical property. The market value of commercial gum is fix. The botanical origin of the gum site of collection season of collection is purity and transparency is mainly consider as important factor in the commercial gum. The physical property of gum also where is in different species of the same plant. However edaphic factor and the climatic condition affect mainly on the physio-chemical properties of
gum. Hence while study details of the physical property these factors are taken into consideration.

Another consideration is the treatment is carried by gum collectors and in the gum industry such as washing, drying, sundrying etc. colour and form when the gum is collected it is found in the viscous state or in solid crystal for the colour of gum is form transparent water colour to its different shade like yellow, amber and orange to dark brown. Dark colour depends on the colour of gum are classified into different grades even certain gum possess a pink red or greenish colour. Mequite gum occur form *Prosopis juliflora* is with distinct red colour (Wiesher, 1927). Colour is mainly due to the presence of impurities of some content or it may be due to exposer of gum to different intensity of sunlight.

The age of the gum and the tree also responsible for colour of gum. Tannic acid is the one of the important acid of the gum it is used commercially for calico printing is also main content for different shade of gum. Colour of gum is of great importance in commercial valuation of gums a story from the preference being always shown for those that are light in colour.

Blunt (1926) reported some interesting observation regarding different factor influence the colour of gum arabic. He further states that the best gum is practically colourless, and is usually collected off geneina or garden gum, where the trees are growing on old cultivations. Then there are also the pale rose pink, darker pink, and yellowish. The hard gum is of the
pink variety, whereas, the yellowish gum is very friable. To fix a hard and fast rule as to the reason for the differences in colour is very difficult; the pinkish colour is derived to some extent from the pink under surface of the bark, which probably also contains different quantities of tanning material.

'It is without doubt that old trees give off a dark gum. After extensive observations made by the author, it appears that the old wood will give off a pinkish coloured gum, whereas the new wood, i.e. the branches, give off a colourless or very light pink gum. To a certain extent therefore the variability in colour is due to the age of the part of the tree that is tapped.

The collection gum is a common practise in the tribal area thought it is regards paretic but maximum gum collection in done in summer season.

The tribal people of gum collectors collect the gum in natural state and fix categories on the basis of its shape and forms usually the gum form are in irregular globular or drop or pear shape.

Some gums however, are characteristically stalactitic in shape and after collection and the inevitable fracturing that occurs, have the appearance of irregular rod-shaped fragments, a good example being cashew gum (Anacardium occidental). The tragacanth gums exhibit very characteristic shapes and may be leaf or thread-like in appearance according to the method of collecting or tapping. The surface of most gums when fresh is perfectly smooth, but this may soon become rough or covered with minute cracks or striations due to weathering. This gives an opaque effect, well exemplified in some grades of gum arabic, i.e. "ripened" gum. The
fissures or striations are frequently restricted to the surface, but in some gums they are deep seated and may assist in causing the tear to break up into smaller fragments in the course of handling, transportation, etc.

**Taste and smell:**

The true gums are generally scentless or nearly so, in this respect differ markedly from some of the resins and oleo-resins that are so distinctive in smell. They may be tasteless, and are in fact generally devoid of any characteristic taste apart from being blandly mucilaginous, but some are slightly sweet or bitter according to botanical origin. In some gums there is a distinctly bitter after-taste that clings. This is a serious disadvantage in a gum required for edible purposes, such as the manufacture of gum lozenges of pastilles.

**Hardness and density:**

Gums vary in hardness, but attempts to classify them according to hardness, as has been done with minerals, in order to use hardness as a diagnostic character in identifying gums have not proved at all satisfactory (Wiesner 1927). Hardness is obviously governed partly by the amount of moisture present. This generally ranges between 12 and 16%. Density also proves variable in one and the same gum according to the amount of air that may have become incorporated with it when it was formed. Most gums break with a clear glassy fracture when properly dried, and may be readily pulverized, a form in which they are frequently used. Gums of the tragacanth type are not so readily pulverized.
Gums are in the main hygroscopic and will absorb moisture and become soft in a humid atmosphere. This power to hold water or to lose it may have important repercussions in the gum trade. In the Sudan for instance it has been found that on a long camel journey in the dry season gum arabic may lose up-to 5% in weight. In the rainy season, on the other hand, it may gain in weight. According to Blunt this "gaining and losing of weight will always make the trade a gamble" and "gum which has dried in transmission to Europe, and if warehoused in the humid atmosphere of England may not only gain back the weight lost but gain still further in weight.

**Solubility:**

Most gums yield a certain amount of insoluble residue when mixed with water. In general this is greater in amount with the dark coloured gums than with the pale or light coloured and is important in the commercial valuation of a gum sample. The solubility of a gum may be influenced by age and the time it is attached to the tree.

**Viscosity and tenacity:**

Viscosity or the "thickness" of a solution that a gum forms with water is of paramount importance in determining the quality or value of a gum. The higher the viscosity the better the gum. There are various methods of estimating this, but usually some form of standard viscosimeter is used. The tenacity of gums is usually considered along with viscosity; the greater
the tenacity the greater its value; the value of gums for adhesive purposes being dependent upon this character.

**Colloidal nature:**

The viscous solutions of gums in water are colloidal in nature. They exhibit swelling pressures and form gel structures at very low concentrations and over a wide range of concentration. They have low surface tension, do not crystallize and act as protective colloids and stabilizing agents. In effect they prevent the agglomeration and settling of finely divided particles or precipitates. It is this property that renders gums valuable in so many manufacturing processes, notably in the textile, cosmetic, pharmaceutical and food industries (Mantell, 1947).

**Chemical properties**

The gum is naturally or a substrate into metabolism of plants it exudates naturally from the stem or bark in respond to winding during the pursing or utilising injury. Vegetable gums are composed of carbohydrates, hydrogen, oxygen and also include some mineral in it. Minor quantities of ash constitute nitrogen, tannin or ortanic acid. Also reported from the gum. Whether gum in the semi-solid and viscous for or with water gum are closely resemble jelly gelatine and jelly glues.

Robinson (1906) studied detail chemistry of gum and reported that the chemical composition with different stages of the gums. Earlier the chemical composition was studied by different workers and basis on individual chemical compounds. The classification of gum was done.
These were "arabin" (from gum Arabic), "cerasin" (from cherry gum) and "Dassorfh" (from "gum Bassora", a tragacanth-like gum). However, it is now known that the number of gum compounds is very considerable. Consequently, little credence can be placed on the references to "arabin," "cerasin" and "bassorin" that occur so freely in the older literature on gums. It is considered that it is the uncrystallizable properties of gums, rendering their purification difficult and uncertain, that have been the cause of their chemistry being uncertain for so many years.

Until about the end of the last century it was believed that gums were simply carbohydrates, substances similar to sugar, starch and cellulose and the formula C12H22Ou or (C6H10O8) assigned to them. It was later shown however, that gums were not carbohydrates but complex acids built up of a nucleus acid combined with several of the less common sugars. Among the nucleus acids are arabic acid (gum arabic), geddic acid (Gedda gum) and bassoric acid (gum tragacanth and allied gums). Investigations have shown that the properties of the gum of a plant, taken at different seasons, may not always be the same, due to the fact that there may be variation in the proportions of the sugars united to the nucleus acid to form the natural complex gum acid, and in the proportions of the complex acids in the mixture that constitutes the natural gum.

On hydrolysis with dilute mineral acids the gums form various sugars such as the pentoses, arabinose, xylose, tragacanthose and the hexose galactose. Hydrolysis causes them to largely lose their characteristic
tenacity. Not all the gum is converted into sugars but usually about 20% resists treatment. This is the organic acid with which the various sugars were combined. Gums may therefore be considered to consist of gluco-sidal acids of high molecular weight. In most gums the acids are partly combined with calcium, potassium or magnesium in the form of salts; but in some gums they may be present largely in the free state. In gum arabic, each molecule of the glucosidal acid (termed arabic acid), yields on hydrolysis, two molecules of arabinose and four of galactose.

The so-called "artificial gum" or "British gum", which is dextrin produced from starch, differs from gum in being wholly converted into dextrose on hydrolysis. It is also strongly dextro-rotatory, whereas natural gums are invariably slightly laevo-rotatory.

Among the reagents sometimes used in the examination of gums, and which may be of assistance in identifying a gum when the number of possible botanical sources is known and restricted within reasonable limits, are the following:—neutral and basic lead acetate—either will give a precipitate with aqueous solutions of some gums but not others: borax and ferric chloride—both cause gelatinization of some gums but not others. Caius and Radha (1939) have drawn up a key for the identification of the various Indian gums found in the shops and bazaars of Bombay, and this is largely based on the use of these reagents.

Viscosity varies much with different grades of gum arabic and even different consignments of the same grade show wide variation. This is
attributed to such probable factors as earliness or lateness of the season when collected, age of the trees, climatic or edaphic conditions generally and the storage conditions or length of storage.

Temperature affects the viscosity of gum arabic solutions as well as the density. The addition of salts also reduces the viscosity. If, in dissolving gum arabic, the whole of the water is used the outset a higher viscosity is said to be obtained than when part of the water is added later (Mantell, 1947).

The composition or chemical structure of gum tragacanth does not appear to have been altogether satisfactorily ascertained. Mantell (1947) states that "Like gum arabic, gum tragacanth is of carbohydrate nature and has acidic components which are largely present as calcium, magnesium and potassium salt.

Its ability to swell in water to form a gel of high water content (or conversely of low gum content) and the ability of these gels to give unique viscosity, emulsion stabilizing and demulcent behaviour account in large measure for its extensive use.

The viscosity of tragacanth has been studied by a number of workers and the results summarised by Mantell (1947). The demulcent action of the gum is related to its high viscosity and other colloidal properties. Tragacanth is normally acid in reaction. It is reputed that neutralization results in decreased viscosity, and that viscosity is at a maximum at about
pH 8, dropping sharply at either side. The addition of certain salts, notably sodium chloride, also reduces viscosity.

Kumarsing et al., (2010) found there is absence of Alkaloids glycosides and tannins in mango tree gum while Gyedu-Akofo et al., (2008) reported that in cashew tree gum there is presence of protein sugar and the phenols in higher concentration as compared to young trees. Gum arabic in natural source of complex mixture of hydrophilic carbohydrate hydrophobic protein components (FAO, 1990).

Commercial uses of gum:

The gum is using many form gum arabic is used in Sudan from last several years, it is also exported in different countries. It has been market of European, country depending upon the botanical sources, climatic condition the edaphic factor.

The physico-chemical properties gum changes on the basis of that different commercial grade are separated and are exported in different country.

Colour and viscosity are probably the two most important factors in accessing the value of a gum, but good solubility is also important. Some gums are inclined to be very gelatinous when dissolved in water. This is objected to, especially for large scale confectionery purposes, for it hinders proper purification and renders them difficult to pour.

Buyers and users of gum, except for a few specialized purposes, always attach great significance to colour. The paler the gum the higher its
value is likely to be, assuming there are no other objections to it and the sample is reasonably clean. Good viscosity is important for so many of the purposes for which gum is used and often it is necessary to use the gum in strong solution.

The grading of gum may either be carried out in the country of origin or in the country to which it is exported. With gum arabic the gum may be sun-bleached before export. Cleaning and sifting, to remove particles of bark and sand or earth, may also be carried out as a preliminary to grading. Grading is usually done for colour and size of tear or fragment and may involve, more or less, the individual handling of each piece. The number of grades employed varies with different countries and may even run into dozens. The better grades show uniformity in size of fragment and are pale in colour with an absence of dust or powder. Gum dust is marketed separately.

**Gum Trade:**

For many years now the normal annual export of gum arabic from the Anglo-Egyptian Sudan has exceeded 20,000 tons and as far back as 1879 it was in excess of 7,000 tons. Actually, Sudan gum arabic has been an article of commerce for some two thousand years. Originally it was sent to Arabian ports and then to Europe, hence the name "gum arabic". In the middle ages it often went first to Turkish ports and so acquired the name "Turkey gum" that was once commonly used for it in the trade. It is
believed (Blunt) that a certain amount of the Sudan gum also found its way to Bombay to be re-exported as "East India gum."

Gradually the gum came to be exported direct to European and American markets. This took place at first from the Red Sea ports, during the Mahdia however, the trade was badly disrupted and practically ceased. This resulted in a great shortage of gum arabic and caused users to look elsewhere for supplies. The French developed the Senegal gum trade as a result and Indian gums were at a premium, but unfortunately their mixed and consequently inferior nature was against them.

After the Mahdia and with the completion of the railway to Khartoum, Sudan gum was exported mainly through Egypt. However, with the construction of the railway between the Nile and the Red Sea in 1906, Sudan gum gradually came to be exported almost entirely from Port Sudan and not through Egypt. The extension of the railway resulted in a sharp increase in the exports of gum from Port Sudan. It also reduced the importance of Khartoum and Omdurman as centres in the gum trade became the all important centre.

Improved rail and export facilities have not been the only reasons for the steady increase and the healthy growth of the Sudan gum trade. The improved marketing conditions and regularized auction markets inaugurated and run by the Government with such success, have done much to improve and extend the trade. For with the present marketing system the Arabs are assured of fair play and of getting good and fair value for their
gum. The fixed royalty rate, which assists merchants to fix prices in making contracts, is another contributory cause.

Sudan gum arabic is now exported direct to numerous consuming countries. For the five years preceding the second world war the average export (in long tons) was as follows:

<table>
<thead>
<tr>
<th>Country</th>
<th>Export (in long tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>United Kingdom</td>
<td>5155</td>
</tr>
<tr>
<td>Canada</td>
<td>206</td>
</tr>
<tr>
<td>United States</td>
<td>3750</td>
</tr>
<tr>
<td>Egypt</td>
<td>201</td>
</tr>
<tr>
<td>France</td>
<td>2499</td>
</tr>
<tr>
<td>Denmark</td>
<td>185</td>
</tr>
<tr>
<td>Germany</td>
<td>2400</td>
</tr>
<tr>
<td>Brazil</td>
<td>126</td>
</tr>
<tr>
<td>Belgium</td>
<td>1506</td>
</tr>
<tr>
<td>Br. India</td>
<td>123</td>
</tr>
<tr>
<td>France</td>
<td>2499</td>
</tr>
<tr>
<td>Argentina</td>
<td>1029</td>
</tr>
<tr>
<td>Japan</td>
<td>9911</td>
</tr>
<tr>
<td>Poland (Danzig)</td>
<td>92</td>
</tr>
<tr>
<td>Netherlands</td>
<td>817</td>
</tr>
<tr>
<td>Roumania</td>
<td>87</td>
</tr>
<tr>
<td>Australia</td>
<td>590</td>
</tr>
<tr>
<td>Greece</td>
<td>77</td>
</tr>
<tr>
<td>Sweden</td>
<td>480</td>
</tr>
<tr>
<td>Norway</td>
<td>70</td>
</tr>
<tr>
<td>Spain</td>
<td>290</td>
</tr>
<tr>
<td>New Zealand</td>
<td>64</td>
</tr>
<tr>
<td>China</td>
<td>224</td>
</tr>
<tr>
<td>Other Countries</td>
<td>456</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>21689</strong></td>
</tr>
</tbody>
</table>

With some of the major importing countries a certain proportion of the total import may be re-exported and not consumed locally. For example, about 20% of the total quantity imported by the United Kingdom has been re-exported in some years, exports going to the U.S.A., Germany, Poland, Holland, Belgium, France, Italy, Brazil and Japan.

**Antimicrobial activity of gum:**

Marques et al., (1992) found that cashew tree gum inhibited the growth of 10 out of 25 fungal samples including *Aspergillus flavus,*
Review of Literature

Penicillium implicatium, Colletotrichum musae and Verticillium sp. 30 out of 5 bacterial samples. Bacillus subtilis, Serratia marcescens and Staphylococcus aureus. While Torkuato et al., (2004) reported that cassia tree gum has weak antimicrobial activity against yeast (Saccharomyces cerevisiae) but cassia tree gum have no activity against Bacillus cereus, Escherichia coli, S. chaleraesius, Listeria monocytogenes, Staphylococcus marxianus, Lasiodiplodia theobromae, Colletrotichum sp. Gurav et al., (2007) observed that gum of Butea monosperma shows antimicrobial activity against Staphylococcus aureus, Bacillus subtilis, Bacillus cereus, Salmonella typhimurium. Pseudomonas aeruigenosa, Escherichia coli, Conidida abbicans and Saccharomyces cerevisiae. Dharurkar (2007) found that gum of Azadirachta indica, Acacia arabica, Ficus benghalensis, Acacia chundra, Mangifera indica, Moringa oleifera retard the growth of Alternaria alternata, Aspergillus flavus, Curvularia lunata, Fusarium oxysporum and Penicillium notatum.

Recently Ishnava et al., (2010) observed that Commiphora wightii gum shows antibacterial activity against Gram positive Gram negative Bacteria like Bacillus cereus, Bacillus subtilus, Bacillus megaterium, Staphylococcus aurens, Micrococus lutens and Enterococcus faccalis and five Gram negative bacteria Escherichia coli, Klebsiella, Penumoniae, Pseudomonas aeruginasa and Salmonella typhi.
Plant byproducts as antifungal agent:

a) Latex as antifungal agent

Latex as a potential antifungal agent is reported by very a few workers. Amrita (1989) tested the latex of 20 plants species against two ringworm fungi viz. *Microsporum gypseum* and *Trichophyton mentagrophytes*, only the latex of *Croton bonplandianum* exhibited absolute toxicity by inhibiting the growth of both the fungi. The latex of *Argemone mexicana* was found active against *T. mentagrophytes* while that of *Jatropha panduraefolia* against *Microsporum gypseum* only. The fungi toxicity remained stable at high temperature and long storage period.

Kumpoun et al., (2001) recorded the anti-colletotrichum activity of compounds present in the latex of mango fruits. The compound which was responsible for antifungal activity was later-on identified as resorcinol derivatives.

Luciliene et al., (1999) reported the insecticidal and antifungic proteins of the latex from *Manihot glaziovii*. Arg. In their *in vitro* assay of phytopathogenic fungi viz *Colletotrichum gloesporoides*, *Fusarium solani* and *Macrophomina phaseolina*, they recorded significant reduction in growth of these fungi.

Sameer (2008) studied the genotoxic effect of latex of *Calotropis procera* on *Aspergillus terreus* (Thom). In his findings he recorded that the latex of *Calotropis procera* had potent lethal and mutagenic activities. The percentage survival decreased as concentration or time of exposure
increased. In addition to that he also recorded that the DNA and total protein contents of each mutant was significantly lower than wild type of *Aspergillus terreus*.

Kareem et. al., (2008) studied the antimicrobial effect of ethanol, aqueous and chloroform extracts of leaf and latex of *Calotropis procera* on three fungi viz *Aspergillus niger*, *Aspergillus flavus* and *Microsporum boulardii* and on yeast i.e. *Candida albicans* were determined using agar well diffusion and paper disk methods. The results revealed that ethanol was the best extractive solvent for antimicrobial properties of leaf and latex of *C. procera* followed in order by chloroform and aqueous. The growth of four test fungi were inhibited by ethanol and chloroform extracts while the aqueous extract was the least effective on the test fungi. The best antifungal activity was recorded in ethanol extract of *C. procera* latex against *Candida albicans*.

Coopoosamy and Magwa (2007) tested the ethanolic and water extract of latex of *A. excelsa* against the *Aspergillus flavus*, *Aspergillus glaucus*, *Candida albicans*, *Candida tropicalis*, *Trichophyton mentagrophytes* and *Trichophyton rubrum* and recorded strong inhibitory action of the latex of *A. excelsa*.

Sehgal et. al., (2005) studied the inhibitory effect of extracts of latex of *Calotropis procera* against *Candia albicans* and concluded the anticandidial activity of the extracts of DL of *Calotropis procera*, at the
same time they have concluded that such a property could be related to the presence of enzymes and stable cysteine proteases in the latex.

Toki et. al., (2005) purified three Chitinases, designated as gazyumaru (*Ficus microcarpa*) latex chitinase (Glx chi)-A, -B, and -C, from latex of gazyumaru. GLY Chi-A did not exhibit any antifungal activity. At low ionic strength Gly Chi-C exhibited strong antifungal activity to a similar extent as GLX Chi-B. The antifungal activity of GLX Chi-C became weaker with increasing ionic strength, whereas that of GlX Chi-B became slightly stronger. These results suggest that the chitin binding domain of basic class I chitinase binds to the chitin in fungal cell walls by hydrophobic interaction and assists the antifungal action of the chitinase.

Giordani et. al., (2001) studied the in-vitro susceptibility of *Candia albicans* to ketoconazole and *Euphorbia characias* latex alone or in combination were tested using the macrobroth dilution method. The utilization of a mixture of latex at several concentrations and ketoconazole indicates a synergistic effect between latex and ketoconazole.

Bandewar (2009) studied latex as antifungal agent. The latex of selected plant like *Ficus benghalensis, Alstonia scholaris, Alstonia macrophylla, Euphorbia splendens, Jatropha curcas, Jatropha gossypifolia, Euphorbia triucalli, Plumeria alba, Calotropis procera, monilkra zapata* against the fungi like *Alternaria alternata, Alternaria solani, Aspergillus*
flavus, Aspergillus niger, Fusarium oxysporum and Trichoderma viride. It shows antifungal properties of maximum selected plant latex.

b) Essential oil as antifungal agent

A large number of essential oils for antifungal activities have been screened against several pathogenic fungi. However, studies regarding their characterization and fungitoxic properties have received little attention. Several workers confined their investigations in vitro fungitoxic studies of the oils and little attention has been paid to find out their in vivo applicability for the control of fungal diseases. Maruzella and Lignori (1959) have screened 51 essential oil against some storage fungi while Haerdtl (1962) reported essential oils of Eucalyptus sp. was fungitoxic to Aspergillus niger. Whereas Dogvgich (1971) exhibited the oil of basil, coriander and fennel to be active against Alternaria tenuis, Aspergillus oryzae and Penicillium chrysogenum. However Banerjee and Nigam (1977) tested the essential oil of rhizome of Curcuma angustifolia to some storage fungi. Simultaneously, Sawhney et al.,(1977) showed essential oils of Cymbopogan citratus, C. martini, C. winteriamus, Ocimum basilicum, O. gratissimum, Mentha arvensis having fungitoxicity against Penicillium notatum while Thind and Dahiya (1977) reported the essential oils of A. indica, Allium sativum possessed strong antifungal activity against Aspergillus fumigatus and Penicillium italicum.

Misra and Dixit (1978) stated that the essential oil of Inula racemosa having antifungal ability against Fusarium moniliforme and Colletotrichum
capsici while, Chaturvedi (1979) exhibited the *Adenocalymna allacea* oil showed broad spectrum of antifungal activity against 13 storage fungi. Whereas, Grover and Rao (1979) have been reported the moderate activity of essential oil of *Psoralea corylifolia* against *Aspergillus flavus*, *A. niger*, *Rhizopus stolonifer*. Similarly, Lahanya and Rao (1979) observed fungitoxic activities of *Cyperus scariosus* and *Ocimum basilicum* oils against *Aspergillus fumigatus*, *A. niger* and *Penicillium italicum* and the oil of *Cyperus scariosus* was found to be most biological activity.

Similarly, Garg and Oswal (1982) collected the oil from *Chloroxylon swietenia* and tested against *Aspergillus oryzae* and *A. terreus*. Singh *et al.*, (1983) showed the efficacy of *Mentha arvensis* var. *Piperascens* oil against 16 storage fungi. Tripathi *et al.*, (1983) found the inhibition action of *Alpinia galangal* oil against 26 storage fungi and oil showed broad antifungal spectrum at 0.4 percent and 0.6 percent concentration. However, Singh and Vays (1984) found that the oil cake of mustard (*Brassica compestris*), *Linum usitatissimum* (Linseed), *Ricinus communis* (Castor) and *A. indica* (Mahua) inhibits the mycelial growth of (betelnine) *Phytophthora parasitica* var. *Piperrina*. Similarly Kola *et al.*, (1984) screened the essential oils of *Zingiber* sp. Lemon grass, Palmarosa and Mentha sp. against *Aspergillus parasiticus*. While, Pathak and Dixit (1984) screened essential oils of *Glossocardia bosvallia* against *Phytophthora prasitica*, *Botryodiplodia theobromae*, *Fusarium solani* and *Rhizopus nodolaorus*. Whereas, Adisa (1985) recommended that mature kernel oil
avoids infection by *R. oryzae*, *Curvularia lunata* and *Phoma sorghina* (soft rot pathogens) and *Fusarium equiseti* (dry rot pathogens). However, Batra and Mehta (1985) isolated essential oil from the seeds of *Argyeria speciosa* and tested against *Geotrichum candidum*, *Alternaria solani*, *Helminthosporium* sp. and *Colletotrichum dematum*. Simultaneously, Maiti et al., (1985) showed the essential oils of *Mentha piperata*, *M. citrate* and *Cymbopagoan pendulus* having antifungal activity against *Helminthosporium oryzae*, *Macrophomina phaseolina*, *Drechslera oryzae* and *D. sorokiana* while, Dixit (1986) suggested that oils of several plants tested against *Aspergillus flavus* and *A. niger* and found *Ocimum gratissimum* oil to be the most effective. Yadav (1986) stated that the inhibition of growth of *Aspergillus flavus* and *A. niger* by the oils of *Lepidagathis hyalina*.

Siddiqui and Garg (1987) isolated oils from *Artabotrys odoratissimus* and tested against 8 storage fungi i.e. *Trichoderma viride*, *C. lunata*, *Rhizopus* sp., and *Chaetomium* species. However, David et al., (1988) screened oils of leaves of *Vitex negundo* against *Trichoderma viride*, *Fusarium* sp., and *Colletotrichum* species while, Naseem and Lanjewar (1989) suggested that seed treatment with neem oil is effective against *Aspergillus niger*. Simultaneously, Farog et al., (1989) screened oils of some species (thyme cumin, clove, caraway, rosemary, sage) against *Aspergillus parasiticus* and found the complete inhibition of fungus and
aflatoxin production by them. Similarly, Onawunmi (1989) showed the oil of lemon grass to be strong fungitoxic against *Aspergillus fumigatus*.

Narayana et al., (1980) tested *Cinnamomum zeylanicum* oil against *A. fumigatus*, *A. niger* and *Rhizome* sp. Renu et al., (1980) exhibited that *Cestrum diurnum* oil was found to be inhibitory to the growth of 21 fungi at 0.75 concentration while, Asthana and Singh (1981) showed fungicidal activity of *Ocimum adsecendens* oil at its minimum concentration of 200 ppm. Whereas, Bhargava et al., ((1981) tested *Ocimum canum* oil against 13 storage fungi. Chandra and Dixit (1981) found that *Ageratum conyzoides* oil having fungitoxicity against *Colletotrichum capsici* and *Penicillium italicum*. Rao and Prasad (1981) tested *Artemisia pallens* and *A. vulgaris* oils against 7 storage fungi at 0.2 percent concentration. Kishore et al., (1982) studied the fungitoxic spectrum of the oil of *Chenopodium ambrosioides* against 15 storage fungi.

Similarly, Mishra et al., (1993) used essential oils of *Apium graveolens* and *Cuminum cuminum* against 29 fungi. Similarly Srivastava et al., (1993) screened the *Palmarosa* oil and *Eucalyptus* oils obtained from *Cymbopogan martini* and *Eucalyptus citriodora* against *Aspergillus* sp., *Fusarium* sp., *Curvularia* sp., and *Cladosporia* sp.

fungitoxic activity of oil against pathogens of beetle vine crops and the oil inhibited the growth of *Colletotrichum piperis* and *Sclerotium rolfsii* completely at 500 ppm.

Ndounga and Ouamba (1997) showed the oil of *Ocimum gratissimum* having strong activity against microorganisms and *Ocimum basilicum* having moderate activity.

Saju et al., (1998) extracted oil from dried rhizomes of turmeric and tested against *Colletotrichum gleoesporioides, Saphaocoma cardamoni, Pestalotia palmarum, Rhizoctonia solani, Aspergillus* sp. and *Fusarium* sp., *in vitro*. Similarly, Zollo et al., (1998) studied the effect of oils extracted from *Hoslundia opposite, Hyptis lanceolata, Hyptis suaveolns, Thyme vulgaris, Piper capense, Plectranthus guineense* and *Bixa orellana* against pathogenic fungi while, Bowers et al., (1998) exhibited the effect of aqueous emulsions of 90 % clove oil, neem oil (10%), mustard oil with extract of *Cassia tora*, fungicide and litter.

Sahasrabudhe et al., (2000) studied the antimicrobial activity of castor (*Ricinus communis* L.) mustard (*Brassica compestris* L.), clove (*Eugenia caryophyllus*) and *Eucalyptus* sp. oil against different pathogens. Similarly, Hussain et al., (2001) reported that the two essential oils citral and piperitone rich oil obtained from lemon grass and *Cymbopogon jawarncusa* inhibited the radial growth of *Fusarium solani, Rhizoctonia solani, Curvularia lunata* and *Phoma sorghina* with 0.1 % oil concentration. While, Singh et al., (2001) noticed that the fungitoxicity of
Eucalyptus and garlic oils against Phytophthora infestans, Cyperous menthe and lemon grass oil against Rhizoctonia solani, Penicillium digitatum and Inula racemosa against A. solani, Fusarium oxysporum, R. solani etc. Certainly, Meleo et al., (2001) tested the antifungal activity of monoterpenoid essential oil evaluated for Fusarium oxysporum.

Sonawane (2002) studied the fungitoxicity of essential oil and medicinal concentration oil (0.5 %) against pathogenic fungi. All the oils inhibited the growth of Alternaria alternata, clove oil and lemon grass oil inhibited the growth of Aspergillus flavus whereas Curvularia lunata and Fusarium roseum showed moderate inhibition as like Alternaria alternata, Castor oil inhibited the growth of Helminthosporium tetramera.

Dharurkar (2007) studied the essential oil as antifungal agent. The clove oil, camphor oil, Eucalyptus oil and tulsi oil is proved highly inhibitory to all the mycelium growth and sporulation of five test fungi. However, Alternaria alternata also inhibited by castor oil. Aspergillus flavus and Curvularia lunata inhibited by black pepper and castor oil. Fusarium roseum inhibited by camphor oil and black pepper oil. However other oils do not proved its inhibitory effect on the growth of fungi.

Insecticidal properties of botanicals

Plants are considered as resource of bioactive compounds their may be an alternative source as insect control agents (Wink, 1993). Pest control strategies, especially those that are effective, cheap and environmentally non hazardous are needed. Hence crude plant extract play an important role
in this aspect (Mahadevan, 1982). Mankind has used botanicals to control insect, since ancient times. Plant drive product have received increased attention from scientists and more than 2000 plant species are already known to have insecticide properties (Baladrin, 1985, Rawls, 1986 and Sukamar et al., 1991). However insecticides of plant origin have been extensively used on agricultural pests and to a very limited extent. Against insect vectors of public health importance (Das et al., 2007).

The aqueous and methanol extracts of the leaf and stem bark of *A. boonei* have been found to be bioactive against *Maruca Virata Fabricius* and *Sesamia Calamistis Hampson* (Oigiangbe et al., 2007a 2007b).

Bisht and Kamal (1994), observed that there is strong need to investigate the chemical composition of many plants to determine their ability to be used as fungicides or insecticides. Phytochemicals derived from plants sources can act as larvicide. Insect growth regulators, repellent and ovipositor attractant and have different activities observed by many researchers (Babu and Murugan, 1998 and Venketachalalam and Jebasan, 2001)

Ramos et al., (2006) reported that the toxic effect of latex constituents from *Calotropis procera* (R.Br) upon egg hatching and larvae of *Aedes aegypti* (Linn). In their work they fractionated the crude latex produced by the green parts of the plants and evaluated its toxic effect upon egg hatching and larval development of *Aedes aegypti*. The whole latex was shown to cause 100% mortality of 3rd instars within 5 min. The latex was
fractionated into water soluble dialyzable (DF) and non-dialyzable (NDF) rubber free material. Both fractions were partially effective to prevent egg hatching and most individuals growing under experimental conditions died before reaching 2\textsuperscript{nd} instars or stayed in 1\textsuperscript{st} instars. Besides, the fractions were very toxic to 3\textsuperscript{rd} instars causing 100\% mortality within 24 hours. When both fractions were submitted to heat treatment the toxic effects were diminished considerably suggesting low thermostability of the toxic compounds. While Zalucki and Malcolm (1999) recorded the first instar larvae of the monarch butterfly, Danaus plexippus a milk weed specialist, generally grew faster and survived better on leaves when latex flow was reduced by partial severance of the leaf petiole. The outcome depended on milkweed species and was related to the amount of latex produced. The outcome also may be related to the amount of cardenolide produced by the plants as a potential chemical defence against herbivory.

Jayasuriya et. al., (2000) studied the insecticidal properties of \textit{Euphoria antiquorum} (Euphorbiaceae) latex using the samples collected from 3 different districts of Sri Lanka. They used seven solvents i.e. dichloromethane petroleum ether, acetone, methanol, n-hexane, distilled water and xylene. It was found that the insecticidal components were best extracted by xylene. They also reported that the potters sprayer method was found to be better for insect bioassays than the leaf dip, hand sprayer and microapplicator methods. The xylene-latex extract was tested against six insect species, two predatory coccinellid species and a predatory spider. The
latex extracts was highly toxic to soft body insect spiders. They also recorded the insecticidal activity was independent of seasonal variations.

Pereira et al., (1999) observed the insecticidal and antifungal proteins of the latex from *Manihot glaziovii* Muell. Arg. The latex of *Manihot glaziovii* showed the presence of various enzymatic and inhibitory activities. The latex had an inhibitory effect on development of cocopea weevil (*Callosobruchus maculatus*). Finally they suggested the presence of some of the protein nature compound, involved in plant defence mechanism in this exudation product.

Jayasuriya et al., (2000) isolated radiocide A, from root extract of latex yielding plant of family Euphorbiaceae i.e. *Trigonostemon reidioides*. Later on radiocide A was tested at the Merck facilities and showed potent activity against mosquito larvae in biological assays. It was also shown to be highly effective against fleas, especially *Ctenocephalides felis*. The pest of domesticated animals. Marck claims that radiocide A is one of the most powerful anti-flea compounds discovered to date within their research programme.

Badgjur et al., (2008) reported that the larvicidal properties and phytochemical constituents of *Calotropis procera* (Ait) R.Br, latex. They studied the larvicidal properties against *Anophillus stephensi* by using aqueous solution of latex. They recorded highest activity at the 0.8, 0.9 and 1% concentration of latex. Phyto-chemical analysis of latex revealed
that the larvicidal activity was mainly due to the presence of pheneolic compounds especially alkaloids and cynogenic glycoside.

**Hydrolytic Enzymes**

Biodeterioration has been attributed mainly to the efficiency of seed moulds to produce various types of hydrolytic enzymes like amylase for the degradation of starch (Vidhyasekaran and Govindswamy, 1968), lipase for the degradation of oil (Goodman and Christensen, 1952) and Lalithakumari et al., (1971) protease for the degradation of protein (Sinha and Prasad, 1977) and Chauhan and Magar (1979) reported that cellulolytic and pectolytic for the degradation of cellulose and pectin.

Hydrolytic enzymes such as amylase, cellulase, pectinase, protease and lipase etc. in case of fungi have been studied by many workers. These enzymes are found to be helpful during invasion and colonization by various plant pathogens. The *Alternaria alternata*, *Fusarium solani*, f. sp. *Minus*, *Pleospora infectoria* and *Alternaria solani* were capable of producing pectinase, amylase, cellulase and protease types of enzymes which results into seed biodeterioration.

**Amylase production**

Among various group of fungal pathogens which are reported to be amylolytic in nature are species of *Penicillium* and *Aspergillus* (Le Mense et al., 1947), *Alternaria tenuis*, *Fusarium coeruleum* and *Curvularia lunata* (Tondon, 1949), Some thermophilic fungi (Cooney and Emerson, 1964), Actimonycetes (Emerson 1968), *Aspergillus flavus*, *Aspergillus candidus*,

45
Review of Literature

*Curvularia lunata* and *Curvularia pellescence* (Prasad, 1979). Fashim et al., (1985) found that *Aspergillus flavus* as most efficient amylase producing fungus which was followed by *Alternaria alternata* and *Aspergillus niger*.

Usually cereals are rich in starch and other carbohydrates. Several workers worked on the role of amylase in the hydrolysis of starch due to seed moulds. However amylase production in seed-borne fungi was directly related with reduction in quality of seeds.

Fashim et al., (1985) reported that *Alternaria flavus*, *Alternaria alternata* and *A. niger* found to be most efficient amylase producing fungi, while Khairnar (1987) reported that amylase production in the species of *Alternaria*, *Curvularia* and *Helminthosporium* was stimulatory in the presence of substrate.

Stimulatory effect of starch was noticed in case of *Phoma exigua* (Charya and Reddy, 1983), *Curvularia lunata*, *Alternaria tenuis* and *Aspergillus flavus*.

**Cellulase**

Rai (1977) studied cellulolytic enzymes associated with *Gloeosporium papayae*, causing fruit rot of papaya and found polymethyl galacturonase (PMG), pectin methyltrans-eliminase (PMTE) polygalacturonate-trans-eliminase (PGTE) and Cellulase as of pathogen origin. Some studies conducted in vitro have presented the evidence of cellulolytic enzyme production by *C. musae* (Shillingford and Sinclair,
1980) and *G. papayae* (Rai, 1977), but it is uncertain to what extent these pathogens are capable of degrading tissue.

**Pectinase**

Several workers worked on the production of pectinase in the hydrolysis of carbohydrates due to fungi. However pectinase production in fungi was directly related with reduction in quality. Chandra and Tandon (1963) studied that the appearance of galacturonic acid in diseased tissue has been attributed to the active role of pectic enzymes. Later on Brown (1965) observed that the inactivating principle is not present as such in the natural juice but it develops as a result of oxidation by polyphenol oxidases of phenolic substances present in it. Similarly, Cole (1956) observed considerable depletion of both soluble and insoluble pectin compounds.

He reported pectic enzymes associated with *Gloeosporium papayae*, causing fruit rot of papaya and found polymethyl galacturonase (PMG), pectin methyltrans-eliminase (PMTE) polygalacturonate-trans-eliminase (PGTE) and cellulose as of pathogen origin.