Chapter 1
Introduction
Man is dependent on the plant kingdom from ancient times for so many of his needs including his primary requirements of food, medicinal and industrial raw materials. Systematic scientific evaluation of the useful plants is lacking and hence there is a great deal of uncertainty about the usefulness of many plants. It is a known fact that nature alone knows what is in its store. All this has led to an ever widening search for plants which have potential for human exploitation. Hence research on plants go on in the interests of humanity.

The world of the 1990's shall have to face the challenges posed by the high cost of petrochemicals and availability of enough edible oils for the evergrowing population. Many developing countries now in 1990 strongly feel the urgent need for renewable source of raw materials for the maintenance and growth of their industrial infrastructure. The oils and fats industry, which is about one fifth of the petrochemical industry is bound to play a dominant role in providing edible oils and industrial raw materials. The only valuable source is agriculture with its byproducts from the plant kingdom.
The demand of fats and oils in the present and in future by the third world countries will be largely governed by two factors - (a) food needs (fat and protein) and (b) nonfood industrial needs (fatty acid intermediates).

By the end of the century, the population of the world would increase from 4 billion to 7 billion people. Maintaining the balance between the population and food supply is the problem of major concern particularly to the developing countries. Plants are the energy harvestors and they constitute a primary source of protein, fatty oil, vitamins, carbohydrates and some physiologically and pharmacologically active constituents like alkaloids, glycosides, colouring matters, essential oils, tannins, enzymes, free carboxylic acids, etc. 2-5

India is a major oilseed producing as well as oil consuming country. With increasing population and oil based industries, the country has now become a major importer of oils and oilseeds. The government is trying various methods and giving high priority for the cultivation of oilseeds. Indian forest flora and fauna is rich in having a number of underexploited tropical
oil-bearing plants with promising economic values. It has been estimated that minor oilseeds would yield 5 lakh tonnes of vegetable oils and 40 lakh tonnes of oilseed cakes. Thus, phytochemical screening of wild oil yielding seeds is an essential step to exploit our minor oilseed potential. With a view to explore by chemical screening the wild oilseed potential of "Madhya Pradesh", some of the components of oilseed and oil-derived products like oil incorporated alkyd resins and azo alkyd dyes studied by the author are briefly reviewed below:

**FIXED OILS**

Oils and fats play an important role in agricultural and industrial economics of a country. They are not only one of the most expensive basic nutrients in our diet but is also used as valuable industrial raw materials for the production of soap, paints, varnishes, toiletries, hair oils, plastics, candles, pharmaceutical bases and lubricants. In India, the annual production of edible oils and fats from various sources of oil-bearing materials is inadequate to satisfy the demand. And to meet the gap in between the demand and supply, India relies on massive
import. The amount of import increased from 8.21 Lakh tonnes in 1978-79 to 13.68 lakh tonnes in 1985. For this, the country has to spend valuable foreign exchange.

It has been planned to achieve the targeted production of 45.5 lakh tonnes by 1990 and 66 lakh tonnes of oils by the turn of the century. But simultaneously, the population will increase and it is expected that in 2000 AD 125-200 lakh tonnes of oils will be required to meet the market demand. Thus the gap between the demand and production of oils is expected to be present in the near future as well.

Several approaches have been proposed to augment oil supply. They include (i) more production of cultivated oil seeds; (ii) increasing the contribution of land and marine animals towards oil pool; (iii) biotechnological approaches; (iv) technological improvements (improvement of storage of oil seeds, improvement of expeller or solvent extraction systems, improvement of refining or processing methods, etc); and (v) maximum exploitation of unconventional minor oilseeds. It is obvious that all these approaches should be considered together.
Oils and fats obtained from unconventional and non-traditional sources are used for human consumption in limited areas where they are grown and are known as minor oils.

In view of the oil famine it is necessary to extract every drop of oil from every available source. It is obvious that the role of minor oils of tree origin for augmenting edible oils supplies is negligible today. But if properly exploited, these oils can bridge the gap between supply and demand to a great extent. Besides, there is obvious need for further investigations to utilise the less exploited oilseeds and to search for newer ones.

Fixed oils are triglycerides of saturated and unsaturated fatty acids containing minor proportion of sterols, vitamins, pigments, hydrocarbons and other substances soluble in them. They have an important role in plant metabolism. Fixed oils are good source of energy.

The portion of natural fats and fixed oils which is not saponified by alkali is called as unsaponifiable matter\textsuperscript{18,19}, which contains mainly hydrocarbons, sterols, carotenoids and fat soluble
vitamins. Among all these constituents sterols are most important owing to their miscellaneous therapeutic applications.\textsuperscript{20-24} Detailed reviews on steroids have been described by Louis Fieser and Marry Fieser\textsuperscript{26}, Robinson\textsuperscript{27} and Bergmann.\textsuperscript{28}

**CARBOHYDRATES:**

Carbohydrates are the polyhydroxy aldehydes or ketones or substances, which may be hydrolysed by dilute acid to these compounds. This classification does not include compounds such as hexitols (hexahydroxy hexanes) and cyclitols (hexahydroxy cyclohexanes), which are nevertheless conveniently studied alongside the carbohydrates. As products of natural origin, carbohydrates are among the most abundant, being widely distributed in both the plant and animal kingdoms. They fulfil a variety of functions, ranging from stores of potential energy in animals and to sources of energy and as supporting tissues in plants. Hence they are considered as a store house of energy for human beings. Carbohydrates are responsible for transportation of various organic constituents of plants by combining with them. L-Ascorbic acid (vitamine C) is related to the simple sugars and other carbohydrates have unique biological activity. Sugar
phosphates are physiologically important intermediates in the transformation of sugars to various classes of compounds.\textsuperscript{29-31}

Carbohydrates found in the plants as glycosides and gums or in free form which may have protective function in wound healing or being toxic to parasites.\textsuperscript{32,33} Human beings and the animals fulfil their requirements of carbohydrates directly from the plants. Carbohydrates have important contributions in the daily needs like food, fuel, drugs, etc. and on commercial side to whole industries like plastics, paints, lacquers, explosives, papers, textiles, etc. The sugars can be assayed by standard methods\textsuperscript{34-36} and reviewed by many workers\textsuperscript{37-44}. These are classified as (a) sugars and (b) non sugars. Sugars are mostly made up of mono- and disaccharides where as non-sugars are the polysaccharides.}

**MONOSACCHARIDES**

Monosaccharides are simple straight chain polyhydroxy aldehydes or ketones and are found as free sugars or linked with glycosides in plants.
DISACCHARIDES:

Disaccharides on hydrolysis give two moles of similar or dissimilar monosaccharides.

POLYSACCHARIDES:

Polysaccharides are linear or branched chain macromolecules composed of similar or dissimilar monosaccharide units and have the properties typical of high polymers. They are consumed in tremendous volume by a number of industries and have been the subject of research by many scientists in different fields. The polysaccharides may be classified as homopolysaccharides and heteropolysaccharides. On hydrolysis, the homopolysaccharide units yield one kind of monosaccharide units where as heteropolysaccharides yield more than one kind of monosaccharide units.

PROTEINS AND AMINO-ACIDS:

As the name of the protein indicates (Greek, Protos = the first) they have been considered for many years, the primary component of living matter. They are nitrogenous substances which occur in protoplasm of all animal and plant cells. Their composition varies with source-carbon 46-55%, hydrogen
6-9%, oxygen 12-30%, nitrogen 10-32%, sulphur 0.2-0.3% and other elements may also be present, e.g. phosphorus (nucleoproteins), iron (haemoglobin). The basic principle of the chemical structure of proteins is quite simple. They consist of long chains of amino acids linked to each other by peptide bonds. Hence on acid or alkaline or enzyme hydrolysis protein yields a mixture of amino acids. The number of amino acids so far obtained from proteins appear to be about twenty-five, all of which except two are α-amino acids. The two exceptions are proline and hydroxyproline, which are imino acids.

The proteins have a particular significance in biology in that they constitute one of the indispensable components of living matter. Whenever the phenomenon of growth and reproduction are seen, proteins and nucleic acids are primarily involved. In animal and plant cells multiplication is initiated by the nucleus, in which proteins and nucleic acids are closely associated. We must not forget however, that growth and reproduction, like all processes which involve primarily the formation or degradation of proteins and nucleic acids, depend on the presence of certain enzymes and that all these enzymes are proteins. Accordingly, nucleic acids cannot be
formed in the absence of enzyme proteins. The presence of both proteins and nucleic acids is required for growth and multiplication.

Amino acids are classed as essential and non-essential from dietary point of view.\textsuperscript{46,47} Biological value of proteins may be considered to depend upon amino acid composition because ingested protein is hydrolysed to its constituent amino acids within the alimentary canal and these amino acids are absorbed by the body. Proteins which contain sufficient essential amino acids are mainly used in foods and also in industries like paints, plastics, gelatin in photographic films and adhesives. These are assayed and reviewed by number of workers.\textsuperscript{49-55}

**THERMAL POLYMERIZATION :**

The semidrying and drying oil products are generally useful in the preparation of paints, varnishes, adhesives, etc. The value of oils in these preparations lies in their ability to form dry films when exposed to air at normal room temperature and also at backing temperature.\textsuperscript{56} Several methods are known to reduce the drying time by physical or chemical changes in the oil. One of the well known method is
polymerization by heat, also called as thermal polymerization. Polymerizations are inter\textsuperscript{57} and intramolecular\textsuperscript{58-63} condensation or dimerization and/or trimerization which are functionally capable of proceeding indefinitely and thus may theoretically lead to molecules of unlimited size in which intramolecular dimerization is responsible for increasing molecular weight where as, inter molecular dimerization increase only the chain length. Many workers\textsuperscript{64-68} pointed out that the formation of a polymer which was largely carbon-to-carbon linked dimers. Heat-bodied oil is obtained by heating the refined oil to a predetermined temperature.\textsuperscript{69-71} Requirement of temperature range for thermal polymerization was generally depend on the physical as well as chemical characteristics of the oil.

Thermal polymerization produce essentially the addition type of polymer by the formation of crosslinkages between the unsaturated section of the fatty acid radicals.\textsuperscript{72-75} If thermal polymerization is continued long enough, it will result in an insoluble and infusible gel product. The figs. 1 (a,b,c) and 2 shows the diene-diene, diene-triene, triene-triene and conjugated-nonconjugated double bond addition systems:
The occurrence of thermal polymerization has been indicated from the decrease in iodine value and increase in density, refractive index, viscosity and number average molecular weight.
ALKYD RESINS:

The term "ALKYD" was coined by KIENLE in 1927 to describe the tough resinous products formed by reacting polybasic organic acids with polyhydric alcohols. The word "Alkyd" is a combination of two letters "AL" from alcohol and last three letters "CID" from acid, namely, al+kyd (Cid). It is indicated as a generic term to embrace all types, including fatty acid, resin acid and fatty oil modification.

In recent years "ALKYD RESINS" have been used in paint industries in greater volume than any other class of resins, as alkyds are adopted to the production of every type of organic coatings. The alkyd resins are hard, insoluble, infusible and translucent. The incorporation of drying oil in alkyds help in easy drying (hardening) of the paints on the applied surface.

To produce tough and flexible polymers for protective coatings, the resin is oil-modified. Oil-modification is a means of controlling the functionality of polyhydroxy alcohol by tying up, hydroxyls with a monobasic group and making it incapable of further esterification. The degree of
esterification and polymerization can be varied by varying the amount of oil and products be obtained with continuous gradation of properties. In addition to limiting the degree of crosslinking, the presence of long and relatively flexible fatty acid chains has a plasticizing effect. A portion of resin may be represented in fig. 3.

Fig. 3: Hypothetical Portion of Resin

An approximate classification is shown in table-1.

Table - 1: Classification of Alkyds:

<table>
<thead>
<tr>
<th>Alkyd Resin</th>
<th>% Phthalic anhydride</th>
<th>% Fatty acids/oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Oil Length</td>
<td>40 - 50</td>
<td>30 - 40</td>
</tr>
<tr>
<td>Medium Oil Length</td>
<td>30 - 40</td>
<td>40 - 50</td>
</tr>
<tr>
<td>Long Oil Length</td>
<td>20 - 30</td>
<td>Over 50</td>
</tr>
</tbody>
</table>
Solubility of the oil modified resins varies with oil length. Greater compatibility with petroleum thinners and therefore, reduced cost results from greater proportion of oil or fatty acid. The long oil length resins are generally used for exterior applications, whereas medium and short oil length resins are used principally for interior applications.

AZO ALKYD DYES:

Dyes may be defined as intensely coloured substances which, when applied to a substrate, impart colour to this substrate by a process which, at least temporarily, destroys any crystal structure of the coloured substances. The dyes are retained in the substrate by adsorption, solution and mechanical retention or by ionic or chemical covalent bonds. The colour of a dye is due to electronic transitions between various molecular orbitals of the molecule, the probability of these transitions determining the intensity of the colour. The energy difference between the orbitals determines whether the "colour" falls in the visible range of the electromagnetic spectrum. 

Englishman "William Henry Perkin",
discovered the first dye in 1856 and just after two years, "Peter Griess", synthesised first azo dye and elucidated the constitution of the diazo compound in 1858. Now a days azo dyes form the largest and most versatile class of all dyes. They are a well defined group of compounds characterized by the presence of one or more (-N=N-) azo groups.  

Azo dye chemistry involves two basic reactions, diazotization and coupling. The dyes are readily classified into two ways, either by chemical constitution or by technological use. In the colour index nearly 3600 constitutions are listed, more than 2250 colouring matters of different constitution being currently marketed and of these more than half are of the azo class chemically. Azo colouring matters are not only the largest chemical class by number, but also by value and weight manufactured.

Practically all manufacturers append letters to the names of their dyes to indicate the tone of the hue, thus B is blue, G-yellow, (the German "gelb") or green, R-red, Y-yellow. Numericals indicate successively yellower or greener shades. Occasionally suffixed letters indicate other properties such as
solubility, lightfastness or brightness.\textsuperscript{85}

Chemically the azo class is subdivided according to the number of azo groups present into mono-, dis-, tris-, tetrakis- and higher, i.e., polyazo, substances with more than three azo groups are generally lumped together as polyazo dyes. Further subdivision is achieved, first according to whether the compounds are water soluble or not and secondly, according to the types of component used.

The water insoluble dyes may be applied as disperse dyes. Disperse azo dyes are coloured organic compounds which are only very slightly soluble in water and therefore dyeing is carried out with an aqueous dispersion. Recent investigations have shown that the dyes are absorbed by the fibre from solution.\textsuperscript{86} Originally technical disperse dyes were introduced for the dyeing of cellulose acetate, but today they are also used for polyester, polyamides and other synthetic fibres as well as plastics. Such applications have been discussed recently.\textsuperscript{87}

\textbf{MODERN METHODS OF ANALYSIS :}

The enormous development in the field of
phytochemistry and polymer chemistry is the outcome of the advancement made in the physical methods like chromatography (column, paper, thin layer and gas-liquid) viscometry, vapor pressure osmometry along with modern spectroscopic techniques of ultraviolet, infrared, nuclear magnetic resonance and mass spectrometry. Some of the above techniques used in this study are briefly reviewed below.

**CHROMATOGRAPHIC METHODS:**

Chromatography has come to the recognition as a very prominent method for isolation, purification and characterisation of individual constituents, when present even in very small amount in a mixture of compounds. The term chromatography and its principle were first discovered by a Russian Botanist, Michael Tswett (1906). In 1938, Reichstein introduced liquid chromatography and thus extended the applicability of the method to colourless substances also.

**THIN LAYER CHROMATOGRAPHY:**

The technique of thin layer chromatography was first introduced by Izmailov and Shraiber in 1938.
It is also known as surface chromatography and open column chromatography. For this technique, various coating materials like silica gel (acidic), alumina (basic), kieselguhr (neutral) and cellulose powder (neutral) are used as adsorbents according to the nature of separating material. In this technique, slurry of the adsorbent in a suitable solvent is spread uniformly on a glass plate and after drying the plates at room temperature, they are activated at 100-110°C for 30 minutes. Sample in appropriate solvent is applied through a capillary and developed in a solvent. Separated constituents are visualised by spraying with a suitable reagent. This technique has several advantages over other technique because it is simple, faster and the separated compounds can easily be recovered by scraping the adsorbent layer and dissolving it in a suitable solvent, etc.

The extensive applications of TLC have been reviewed\(^{91-98}\) especially for steroids, alkaloids, methyl esters of fatty acids, saponins, flavones, amino acids and other plant products.

**COLUMN CHROMATOGRAPHY\(^{99-104}\):**

This technique was developed by the
American Petroleum Chemist, **D.T.Day** in 1900. In this technique the substance having greater adsorbing power adsorbs first and when the column is eluted, it comes at last. So according to their different adsorbing power, various components present in the sample can easily be separated. Adsorbents used for column chromatography are starch, calcium and magnesium carbonate, activated silicic acid, activated magnesium silicate, activated alumina etc. Size of the column and adsorbent are used according to the sample, to be separated.

**PAPER CHROMATOGRAPHY:**

Paper chromatography is a liquid-liquid partition chromatography on a sheet of filter paper. Separation by paper chromatography has the advantage of possibility of working with microgram quantities, simplicity of material, availability of material, equipment and efficiency in the separation. The $R_f$ value is the most important means of describing and distinguishing the different constituents.¹⁰⁵ A considerable range of "modified" filter papers are available commercially for achieving particular chromatographic separations. There are many forms of
paper chromatography. Some of them which are of much use are:

i) Descending paper chromatography,

ii) Ascending paper chromatography,

iii) Circular paper chromatography,

iv) Two dimensional paper chromatography.

This technique now a days mostly used for the separation of fatty acids$^{106-108}$, carbohydrates$^{109,110}$ and amino acids$^{111,112}$

**GAS LIQUID CHROMATOGRAPHY**:

GLC is a relatively recent development in the general field of chromatographic techniques. The stationary phase for GLC is a liquid of low vapour pressure which is absorbed on a porous inert solid support enclosed in a narrow tube. Most frequently GLC is automatically linked to spectroscopic instruments and the combined GC-MS apparatus has emerged in recent years as one of the most important of all techniques for phytochemical analysis. The earliest attempt of direct combination was made by Holmes and Morrell in 1957. In 1963 McFadden et al.$^{113}$ successfully used
cappillary column connected via a splitter to a mass spectrometer for the analysis of flavones.

GLC is used for the separation of fatty acid methyl esters.\textsuperscript{114,115} Separation of components of essential oil have been reviewed by \textit{kingston}.\textsuperscript{116} It is also employed for the determination of composition of unsaponifiable matters\textsuperscript{117,118}, protein\textsuperscript{119-121}, sugars\textsuperscript{122,123} and other natural products.\textsuperscript{124-125}

\underline{VISCOMETRY}\textsuperscript{126-133}:

Viscosity measurement of dilute solution of polymer samples can yield information about the molecular mass of the polymer. Ubbelhode suspended level type viscometer is helpful for diluting the solution in the viscometer itself and hence this type of viscometer generally used to determine the viscosity of polymer solutions.

\underline{VAPOR PRESSURE OSMOMETRY}\textsuperscript{134-142}:

Vapor pressure osmometry (VPO) is a commonly used method to measure the number average molecular weight ($\bar{M}_n$) of polymers in 100 to 10,000 Dalton range. The case of measurement, sensitivity and
ability to use a wide range temperatures and solvents was made it generally preferable to ebulliometry and cryoscopy for most measurements. One commercially available version of the VPO, that is capable of operating at 130°C is the Hewlett-Packard design. High temperature operation is often needed since no room temperature solvents are known for many polymers such as polyethylene.

Although the exact operating principles for the VPO are not completely understood, the basic principle and operating system are straightforward. A known weight of polymer is dissolved in a solvent and a drop of this solution and a drop of the solvent are suspended from separate thermistors in a closed cell saturated with a solvent vapor. At a constant applied voltage, the difference solution activities of the two drops results in differential mass transfer between them and therefore in the small temperature difference between the thermistors causes the bridge to become unbalanced and the resistance difference $\Delta R$ is measured. The value of $\Delta R$ is measured along with a calibration constant to determine the $M_n$ of the polymer.
ULTRAVIOLET AND VISIBLE SPECTROSCOPY:

It is the earliest physical method available for elucidation of molecular structure. Usually the data obtained from UV spectra are complimentary and may be used in conjunction with other spectral data. It is possible to get useful information about the degree of substitution and the nature of double bonds.

The electronic spectra of molecules are found in the wavelength region 1000-8000 Å of electromagnetic spectrum. The visible region corresponds to 4,000 - 8,000 Å and the ultraviolet region is again subdivided into (i) the region between 2,000 - 4,000 Å is known as near ultraviolet region and (ii) below 2,000 Å is known as far or vacuum ultraviolet region.

The U.V. spectroscopy of fatty acids has been reviewed by Pitt and Morton¹⁴³ and Kass¹⁴⁴. UV spectroscopy has also proved to be of great importance for the identification of alkaloids¹⁴⁵, sesquiterpenes¹⁴⁶, coumarins¹⁴⁷, anthocyanins and sterols¹⁴⁸, terpenes¹⁴⁹-¹⁵¹, amino acids, sugars and other compounds like synthetic dyes, cosmetics etc.¹⁵²-¹⁵⁵.
Infrared spectroscopy is one of the advanced analytical techniques which offers the possibility of identification. The technique is based upon the simple fact that a chemical substance shows markable selective absorption in the infrared region. After absorption of IR radiation, the molecules of a chemical substance vibrate at many rates of vibration, giving rise to a close-packed absorption bands called IR absorption spectrum. The ordinary infra-red region extends from 2.5 - 15 μ (4000 - 667 cm⁻¹), the region from 0.8 - 25 μ (12,500 - 4000 cm⁻¹) is called the near infrared and the region from 15 - 200 μ (657 - 50 cm⁻¹) is called the far infrared. This technique is also useful for the identification of functional groups, study of chemical reaction, study of tautomerism and for finding out hydrogen bonding in the molecule.

Now a days many workers use this technique for the structural interpretation of terpenes, sterols, saponins and fatty acids and their derivatives alkaloids, glycosides and all kinds of natural products, paint products and synthetic compounds. Advanced studies have been done in this field and are illustrated by many workers.
Problem Taken And Work Done
Man's dependence and close relationship with the plant products dates from times immemorial has given the world of today innumerable benefits like providing raw materials that go to form a variety of products i.e., cosmetics, flavours, foods, pharmaceuticals and other industrial products. India has a vast store house of plant materials and Madhya Pradesh is one of the state having large area occupied by forests. Medicinal and aromatic plants have been the subject of major interest in the activities of several national and international agencies during the last three decades.

Keeping in view of the importance of plant products, phytochemical investigation of plant products like - fixed oil, proteins and free amino acids, polysaccharides and reducing sugars from the seeds of some non-conventional plants, viz. - Jatropha curcas, Leucaena hawaii K-8, Ougeinia dalbergioids, Pithecell-obium dulce and Salmalia malabarica have been taken up in the present investigation.

Another aim of the proposed work is to polymerize above seed fatty oils thermally to check their utilities for non-edible industrial purposes,
like, in paints, varnishes, adhesives and other related products.

Some of the above oils, viz - *Jatropha curcas*, *Leucaena hawaii K - 8*, *Melia composita* and *Pithecellobium dulce*, were incorporated in alkyds and in substituted 3-nitro and 4-nitro alkyds by copolymerising. Kinetics of alkyd formulations, properties of alkyd film and resistivity of alkyd film against water, acids, alkalies and various organic solvents are taken into consideration and have been worked out.

Besides the above work some oil-modified azo alkyd dyes were prepared from oil modified nitro alkyd resins by reduction, diazotization and coupling with phenolic compounds. The shades of the azo alkyd dyes were checked on nylon, polyester fabrics and wool yarns as disperse dyes. Their exhaustion and fixation studies alongwith fastness properties were also one part of the present investigation.

The application of advanced techniques like, chromatography (column, paper, thin layer and
gas-liquid), U.V., I.R. spectroscopy, Technicon sugar autoanalyzer and V.P.O. have been used to tap the secrets of nature.

From the present study, all the above non-conventional plant seed oils find the mentioned uses. The proposed research work may help in solving the national problem of scarcity of oils.
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Section 1

Chemical Examination Of
Non-Conventional Plant
Seeds
Study of the plant kingdom is more important because of its ancient heritage. The natural products occupy a prominent position in the world. Continuing the investigation and development of plant chemistry is an outcome of the old phrase, Necessity is the mother of investigations. The study of natural products from plant world has been very fascinating. It comprises of a large number of constituents of extraordinary variety and interest. Some of these are alkaloids, steriods, fixed oils, essential oils, proteins and amino acids, carbohydrates, tannins, glycosides and saponins, enzymes, free carboxylic acids etc. All these are distributed in each part of the plant. In this section, main interest is to study the fixed oils, carbohydrates (reducing sugars and polysaccharides) and proteins from seeds of the plants.

Seeds obtained from five wild plants, namely Jatropha curcas Linn. (N. O. Euphorbiaceae), Leucaena hawaii K-8 Benth. (N. O. Leguminoseae), Ougeinia dalbergioids Benth (N. O. Papilionaceae), Pithecellobium dulce Benth (N. O. Leguminoseae) and Salmalia malabarica DC (N. O. Bombacaceae) have been taken for the analysis of their constituents of fixed oil, protein and carbohydrates.
A: **Jatropha curcas** Linn. (N. O. Euphorbiaceae)\(^1-6\)

**Jatropha curcas** is commonly known as "Jangali arandi, Safedarand, Bagbherenda", etc. in Hindi. It is an evergreen shrub, indigenous to America. It is cultivated to a certain extent as an oil seed crop in Cape Verde Islands. **Jatropha curcas** is found in India in semiwild conditions. It is propagated easily by seeds or cuttings. The plant is more popular due to its industrial as well as medicinal properties.\(^7-12\) The seeds of **J. curcas** yielded the **curcas oil**, which is a powerful purgative and is also used in the manufacturing of candles, soaps, varnishes, illuminants, lubricants and in wool industry. Medicinally it is used in sciatica, dropsy, paralysis, externally for skin troubles and rheumatism, also considered to be an abortifacient. Latex dries to a bright reddish-brown, brittle substance, resembling shellac and used as a marking ink. Bark and leaves yielded tannin and a dark blue dye useful for dyeing clothes, fishing nets and lines. Juice of the plant is useful in scabies, eczema and ringworm. Leaves are rubefacient and lactagogue.

In the present study the seeds of **J. curcas** were collected from Nagpur District area of Maharashtra.
B: **LEUCAENA HAWAII K-8** Benth (N. O. Leguminoseae)

*Leucaena hawaii K-8* is known as "Subabul or Vilayatibabul" in Hindi and Marathi. It is a genus of trees and shrubs native of tropical America and Pacific Islands. It is widely cultivated in tropical and sub-tropical countries and is naturalised throughout India.

Analysis of seed and leaf of other species of *Leucaena* Viz - *Leucaena glauca* and *Leucaena leucocephala* has been reported in the literature. No work has been reported on *L. hawaii K-8* species. In the present study the seeds were supplied by Pratap Nursery and Seed Stores, Dehradun (U.P.).

C: **OUGEINIA DALBERGI OIDS** Benth (N. O. Leguminoseae - Papilionaceae)

It is also known as *Ougeinia oojeinensis* (Roxb.) and in Hindi it is popular by the names "Sandan, Panjan, Tinsa and Panan". It is a moderate sized deciduous tree, under certain circumstances of gregarious, found chiefly in the intermediate zone of Sub-Himalayan tract from the Sutlej to the Tista, ascending to 5,000' from Punjab to Bhutan and also in Central
India, Orissa, Marwar and Rajputana. It is a popular plant due to its good economical, industrial and medicinal values. The bark is acrid and hot, anthelmintic, astringent to the bowels. Cures Kapha and Vata, dysentery, leucoderma, urinary discharges, ulcer, blood diseases, skin diseases, biliousness, burning sensation etc. Leaves are used as fodder to cattle. The analysis of saponin and pentacyclic triterpene of the plant bark has been reported in the literature. For the present study seeds of O. dalbergioides were supplied by "Pratap Nursery and Seed Stores, Dehradun (U.P.).

D : PITHECELLOBIUM DULCE Benth (N. O. Leguminoseae - Mimosaceae)

It is commonly known as "Vilayati imli or Jangle jalebi" in Hindi. It is a large tree, introduced from Mexico and now cultivated throughout India. It has fast rate of growth. Earlier reports mentioned that the pods are useful for edible purposes. Seeds are eaten raw or in curries. Saline extract of seeds show a homolytic agglutinating reaction with human blood. The fatty oil of seeds was reported to be edible and can be used in soap manufacture. Meal is reported to have high protein content and may be used
as an animal feed. Bark contains tannin, a yellow dye and pectin, causes dermatitis and inflammation of the eyes. It has been reported to be used as an astringent in dysentery and as a febrifuge. Leaves serve as fodder. Wood used for general construction purposes.

Earlier workers\textsuperscript{59-74} have reported the analysis of saponin, tannin, flavones etc. from bark and pod. There is no mention about the analysis of oils, polysaccharides and protein of the seed.

In the present study the seeds of \textbf{P. dulce} collected from "Seminary Hills" area of Nagpur, Maharashtra were used.

\textbf{E: SALMALIA MALABARICA DC (N. O. Bombacaceae)}

\textit{Salmalia malabarica} is commonly known by the names "Semul, Shembal, Rakatsenbal, Kantisenbal, Pangun" in Hindi. It is a very large, deciduous tree with branches in whorls spreading horizontally and the stem with large thorny buttresses. The tree grows throughout the hotter forests of India and Burma. It is a largest and most characteristic tree of eastern Rajputana. Economically and Medicinally it is one of the most important and popular plant in India.\textsuperscript{75-82} The
flower buds are eaten as a pot-herb. Gum contains tannic and gallic acid, used as aphrodisiac, drunk in the milk as a tonic and also used in diarrhoea, dysentery and menorrhagia. The roots and barks are also emetic and styptic. Paste of leaves is useful for glandular swellings. Fruits are stimulants, expectorant and diuretic, used in calculus affections, ulceration of bladder and kidneys. Seeds yield an edible fatty oil used for soap manufacturing and as an illuminant. Floss is useful in stuffing life-belts, mattresses, cushions and pillows, upholstery and quilts. Also used as an insulating material for refrigerators, sound proof covers and walls. It is better than cotton-wool for packing of fragile materials. Wool is useful for making match boxes in match industries.

In the present study the seeds of S. malabarica were supplied by "Forest Research Institute", Dehradun (U.P.).

All the above seeds were identified from the Department of Botany, Dr.Hari Singh Gour Vishwavidyalaya, Sagar (M.P.).

As the plants have not been chemically investigated so far, the seeds of the above plants have
been taken up for the analysis of fixed oil, carbohydrates, protein and amino acids. This section deals with systematic study of fixed oil (Chapter II), carbohydrates (Chapter-III) and proteins and amino acids (Chapter-IV) obtained from the seeds of above plants.

The proximate analysis of the dried and powdered seeds gave the following percentages of moisture, ash and fibre contents (reported in table-1).

<table>
<thead>
<tr>
<th>S. Analysis No.</th>
<th>J. curcas K-8</th>
<th>L. hawaii</th>
<th>O. dalbergioides</th>
<th>p. dulce</th>
<th>S. malabarica</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Moisture content</td>
<td>05.02%</td>
<td>05.00%</td>
<td>03.80%</td>
<td>03.80%</td>
<td>04.33%</td>
</tr>
<tr>
<td>2. Ash content</td>
<td>02.56%</td>
<td>02.64%</td>
<td>02.73%</td>
<td>02.73%</td>
<td>03.46%</td>
</tr>
<tr>
<td>3. Fibre content</td>
<td>12.00%</td>
<td>07.80%</td>
<td>05.80%</td>
<td>09.63%</td>
<td>06.67%</td>
</tr>
</tbody>
</table>

The ash on analysis showed the presence of the following radicals, reported in table-2.

SUCCESSIVE SOLVENT EXTRACTION -

One hundred grams each of finely powdered dried seeds of **J. curcas**, **L. hawaii K-8**, **O. dalbergioides**, **P. dulce** and **S. malabarica** were successively extracted with different solvents in the order of increasing
<table>
<thead>
<tr>
<th>S. Analysed No. Radicals</th>
<th>J.curcas K-8</th>
<th>L.hawaii</th>
<th>O.daber-gioids</th>
<th>P.dulce</th>
<th>S.malabarica</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Bicarbonate</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>2. Calcium</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>3. Chloride</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
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<tr>
<td>4. Copper</td>
<td>+</td>
<td>-</td>
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<td>+</td>
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<tr>
<td>5. Iron</td>
<td>+</td>
<td>-</td>
<td>+</td>
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<td>+</td>
</tr>
<tr>
<td>6. Magnesium</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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</tr>
<tr>
<td>7. Nitrate</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>8. Phosphate</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>9. Potassium</td>
<td>+</td>
<td>+</td>
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<td>+</td>
<td>+</td>
</tr>
<tr>
<td>10. Sodium</td>
<td>+</td>
<td>-</td>
<td>+</td>
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<tr>
<td>11. Sulphate</td>
<td>+</td>
<td>+</td>
<td>+</td>
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</tr>
</tbody>
</table>

**INDICATIONS**: (+) Presence of radicals tested.  
(-) Absence of radicals tested.

Polarity of the solvent [i.e., Petroleum ether, Benzene, Chloroform, Acetone, Ethanol] and finally the seed powder was extracted with a mixture of water and chloroform by maceration. After removal of the solvents, percentage yields of each extract are tabulated in table-3.
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Solvent</th>
<th>J. curcas K-8</th>
<th>L. hawaii</th>
<th>O. dalbergioides</th>
<th>P. dulce</th>
<th>S. malabarica</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Petroleum ether</td>
<td>Yellowish white (38.00%)</td>
<td>Dark yellow (06.80%)</td>
<td>Greenish yellow (10.00%)</td>
<td>Pale yellow (16.00%)</td>
<td>Yellowish white (19.21%)</td>
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<tr>
<td></td>
<td>(60-80°C)</td>
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<tr>
<td>2.</td>
<td>Benzene</td>
<td>Yellowish white (91.8%)</td>
<td>Yellow (1.2%)</td>
<td>Greenish yellow (0.8%)</td>
<td>Pale yellow (1.4%)</td>
<td>Yellowish white (1.2%)</td>
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<tr>
<td>3.</td>
<td>Chloroform</td>
<td>Yellowish light white (91.6%)</td>
<td>Light yellow (0.9%)</td>
<td>Yellow (0.8%)</td>
<td>Yellow (1.2%)</td>
<td>Yellowish Brown (0.8%)</td>
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<tr>
<td>4.</td>
<td>Acetone</td>
<td>Light yellow (1.3%)</td>
<td>Light yellow (1.9%)</td>
<td>Yellowish Brown (1.3%)</td>
<td>Yellowish Brown (1.6%)</td>
<td>Yellowish Brown (2.0%)</td>
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<tr>
<td>5.</td>
<td>Ethanol</td>
<td>Brownish Black (8.25%)</td>
<td>Brownish Black (6.38%)</td>
<td>Brown (5.0%)</td>
<td>Brown (9.32%)</td>
<td>Brownish Black (5.9%)</td>
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<tr>
<td>6.</td>
<td>Water: chloroform (9:1)</td>
<td>White (7.1%)</td>
<td>Pinkish Brown (5.2%)</td>
<td>Yellowish white (4.8%)</td>
<td>Yellowish Brown (6.8%)</td>
<td>Yellowish white (5.0%)</td>
</tr>
</tbody>
</table>

Qualitative analysis of various extracts by established methods indicated that the seeds contain fixed oil, colouring matter, sterols, sa ponins, glycosides/carbohydrates, tannins/phenolic compounds, protein, alkaloids and free acids. All the above tests are tabulated in table-4 for J. curcas, L. hawaii K-8, O. dalbergioides, P. dulce and S. malabarica seeds.
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Specific Tests For Plant Constituents</th>
<th>Petroleum Ether</th>
<th>Benzene</th>
<th>Chloroform</th>
<th>Acetone</th>
<th>Ethanol</th>
<th>Water: Chloroform (9:1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A B C D E</td>
<td>A B C D E</td>
<td>A B C D E</td>
<td>A B C D E</td>
<td>A B C D E</td>
<td>A B C D E</td>
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<tr>
<td>1</td>
<td>Fixed Oil</td>
<td>+ + + + +</td>
<td>+ + + + +</td>
<td>- - - - -</td>
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<tr>
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<td>Filter Paper spot test</td>
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<td>2</td>
<td>Steroids</td>
<td>+ + + +</td>
<td>+ + + + +</td>
<td>+ - - - -</td>
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<td>2.</td>
<td>Atimony trichloride test</td>
<td></td>
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<tr>
<td>b) Hess's test</td>
<td>+ + + + +</td>
<td>+ + + + +</td>
<td>A B C D E</td>
<td>A B C D E</td>
<td>A B C D E</td>
<td>A B C D E</td>
<td>A B C D E</td>
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<tr>
<td>c) Liebermann reaction</td>
<td>+ + + + +</td>
<td>+ + + + +</td>
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<tr>
<td>d) Liebermann-Burchard reaction</td>
<td>+ + + + +</td>
<td>+ + + + +</td>
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<tr>
<td>3</td>
<td>Colouring Matters</td>
<td>+ + + + +</td>
<td>+ + + + +</td>
<td>+ - - - -</td>
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<td>3.</td>
<td>Sodium hydroxide test</td>
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<tr>
<td>4</td>
<td>Tannins and/Phenolic compounds</td>
<td>- - - - -</td>
<td>- - - - -</td>
<td>- - - - -</td>
<td>+ + + + +</td>
<td>+ + + + +</td>
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<tr>
<td>4.</td>
<td>Ferric chloride test (alcoholic)</td>
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<td>5</td>
<td>Bromine water test</td>
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<td>- - - - -</td>
<td>+ + + + +</td>
<td>+ + + + +</td>
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<tr>
<td>6</td>
<td>Gelatin solution test</td>
<td>- - - - -</td>
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<td>+ + + + +</td>
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<td>7</td>
<td>Potassium chromate solution test</td>
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<td>- - - - -</td>
<td>+ + + + +</td>
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<td>8</td>
<td>Lead acetate test</td>
<td>- - - - -</td>
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<td>5. Alkaloids-</td>
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<tr>
<td>a) Mayer's reagent</td>
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<td>b) Dragendorff's reagent</td>
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<td>c) Wagner's reagent</td>
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<td>d) Ammonium reineckate solution test</td>
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<td>e) Phosphotungestic acid soluition test</td>
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<td>6. Saponins</td>
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<td>a) Honey comb foam test</td>
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<td>b) Haemolysis test</td>
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<td>7. Carbohydrates/Glycosides</td>
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<tr>
<td>a) Molisch's test</td>
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<td>b) Benedict's solution test</td>
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<td>c) Tollens reagent test</td>
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<td>d) Fehling's solution test</td>
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<td>8. Proteins and Free Amino Acids</td>
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<td>a) Biuret test</td>
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</table>
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<table>
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<th></th>
<th>A</th>
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<tbody>
<tr>
<td>b) Ninhydrin reagent test</td>
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<td>e) Millon's reagent test</td>
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<td>f) Xanthoproteic test</td>
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**9. Free Acids**

a) Sodium bicarbonate test

<table>
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<tr>
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<th>A</th>
<th>B</th>
<th>C</th>
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</tbody>
</table>

**INDICATIONS:**

A  - Extract of *J. curcas* seeds.
B  - Extract of *L. hawaii* K-8 seeds.
C  - Extract of *O. dalbergioides* seeds.
D  - Extract of *P. dulce* seeds.
E  - Extract of *S. malabarica* seeds.
(+ ) - Presence of Constituents tested.
(- ) - Absence of Constituents tested.