Editor : N. V. Bringi

NON-TRADITIONAL OILSEEDS AND OILS OF INDIA

Non-Traditional Oilseeds and Oils in India

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Dedicated to the memory of Professor J.G. Kane (1906-1977); former Director of University Department of Chemical Technology, Bombay and Professor of Oil Technology, widely regarded as the father of the Non-Traditional Oilseeds Movement in India

FOREWORD

India is a large country with an extraordinary variety of terrain and climatic conditions. Snow-clad peaks, large forests, river basins, long coastlines, monsoon rainfalls, arid zones and desert all form part of this range, offering conditions for the growth and survival of numerous plants, shrubs and trees. Many of these have been stabilised by natural propagation and growth. Others are cultivated for their economic value for timber, flower and fruit. Yet others are important sources for traditional medicine, fodder and control of pests. Local communities have developed ingenious uses for these through centuries. Many of these are in remote and ordinarily inaccessible areas.

The emergence of new investigative techniques are enabling scientists and technologists to undertake systematic studies of these in the last four decades. The oils and fats contained in seeds have attracted specific attention for a number of years. However, during the last twenty-five years, thanks to the new analytical tools of gas and liquid chromatography as well of different types of spectroscopy, a more thorough knowledge of the composition of these oils and fats is being gained. The fatty acid and glyceride composition as well as the chemical nature of minor constituents are being elucidated. Simultaneously, out of the basic understanding of the chemical and physical nature of the constituents of these oils and fats, technologies have been developed for application for production of soaps, oleochemicals and confectionery fats.

The advances thus made are found in numerous publications and in the unpublished records of research laboratories of industrial organisations. Dr. N.V. Bringi has personally made major contributions in these studies through sustained efforts over twenty years. He has rendered an extraordinary service to science and industry in compiling all the information and in presenting it in a systematic manner. The reviews provide a comprehensive and critical account of the characteristics of each of the oils and fats, the different processes developed for isolation and upgradation and the technologies relevant for application in industry. In addition, information on the known chemical nature of materials other than seeds has been provided. The already established applications as well as potential new applications of various components are listed. The lesser-known oilseeds have also received special attention in a separate chapter.

The entire book reflects the wide knowledge and critical abilities of Dr. Bringi as an author and editor. The potential for further investigations and large-scale application of non-traditional oilseeds and oils is very large. This publication will be a major authoritative source-book for reference for all scientists, technologists, industry managers, entrepreneurs and planners in India and will undoubtedly spur further interest. It will also be a major source of information internationally to all scientists interested in oils and fats and natural products. The researches carried out by Dr. Bringi and his colleagues as well as other investigators have contributed significantly to self-sufficiency, to exports and to economic improvements. The publication will lead to further such contributions in this important area. I am sure it will be widely read and referred to by all those interested in the scientific studies and economic uses of non-traditional oils and fats.

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PREFACE

Historically an exporter of oilseeds and oils, India has in the past two decades slid to a position of a net importer of oils due to a steadily widening gap between supply and demand. The country now imports about 1 to 1.5 million tonnes oil to supplement 3.5 million tonnes of indigenous supply. A Technology Mission on oilseeds has been set up to devise ways and means to increase indigenous production and achieve self-sufficiency in oilseeds. While the major thrust will be to increase productivity of the principal traditional oilseeds like groundnut, rape/mustard which currently contributes 2.5 million tonnes of oil, several other oilseeds and oils, some traditional and some new have been gradually developed and thus offer good scope in augmenting supply. One such source is the tree-borne oilseeds usually referred to as non-traditional or minor oilseeds. These are mainly collected from forest trees.

The late Professor J.G. Kane was a pioneer in not only creating an awareness of the potential of non-traditional oilseeds, but also demonstrating the utility of the oils for edible and industrial uses by carrying out extensive research spanning over two decades in the chemistry and processing of oils.

Most oils are dark, possess disagreeable smell and contain non-lipid constituents with bewildering variety of structural features. These problems are aggravated by the hostile conditions during collection in the forests, storage and subsequent processing. Special processing methods have to be developed depending on the nature of the non-lipid constituents and the end application of the oils. The isolation, characterisation and finding applications of non-lipid constituents of the oil were handled by organic, pharmaceutical, agricultural chemists and entomologists. The chemistry and processing of the oil have been in the domain of oil chemists and technologists. The utilisation of the major by-product, the oil-cake, which in most cases contain anti-nutritional factors were investigated by animal/ poultry nutritionists and toxicologists. Considering the various disciplines involved, it is not surprising that information on the total utilisation of all parts of the seeds is widely scattered. Thus newer advances in processing technology are mainly found in patents, while the chemistry of oil and non-lipid constituents are to be found in journals of oil chemistry and technology and in organic chemistry literature.

Therefore, there is a compelling need to collate the information and focus on the more recent significant developments. The book has attempted to do so devoting one chapter for each oilseed.

Amongst a large number of trees identified for commercial seed collection and extraction, the potential availability of the 'Big Five' comprising sal, *mowrah*, *neem*, *karanja* and *kusum* is around 1.4 million tonnes of oil. The oil production is, however, 5 per cent of the potential, but the great opportunity has propelled intensive R & D work, which is summarised in this book. Other oilseeds with reasonable potential, but of less economic importance compared to the above oilseeds are in various stages of exploitation and development. Some of the more important ones are also included in the book.

Readers will notice the underlying theme of the first four chapters on sal, *mowrah*, mango kernel, *kokum*, *dhupa*, and *phulwara*. These represent fats with high symmetrical triglyceride content useful as ingredients in cocoa-butter formulation. Steadily an export market has been developed for sal, mango kernel and *kokum* and to a small extent *mowrah*. *Dhupa* and *phulwara* have still to be developed commercially. These crops are largely unknown to the sophisticated CBS manufacturers, and it is hoped the comprehensive treatment of all aspects of the crop and the products presented in this book would enable them to have an authentic information of the current status and future potential.

The following three chapters on *neem*, *karanja* and *kusum* outline the chemistry and processing of oils for industrial use, mainly for soaps. The minor constituents and their usage are described in detail. *Neem* has evoked international interest as it contains a number of tetra nortriterpenes, some of which exhibiting exceptionally powerful antifeedant and pesticidal activity.

The penultimate chapter deals with *pisa* and *pilu*, which contain predominantly lauric/myristic acids useful for soaps, detergents and oleochemicals.

We have chosen eleven oilseeds for treatment in the last chapter on lesser known oilseeds. Reliable surveys indicate that these offer good opportunities for economical seed collection and oil recovery.

I have drawn heavily on R & D work carried out at Hindustan Lever Research Centre, Bombay. This book gave me an opportunity to include a large amount of unpublished results of our team's investigation and I am deeply indebted to Dr. K.K.G. Menon for permission to include unpublished results and for his constant encouragement.

The late Dr. S.M. Patel, the founder member of the Kane Memorial Trust and its first secretary was the prime mover of this book. It was at his persuasion that I accepted this task. His commitment to the activities of the Trust was total and I take this opportunity to pay homage to his memory.

I thank the members of the Board of Trustees of Kane Memorial Trust for the support and the contributors to this volume for their cooperation. I had the good fortune of working with a team of highly skilled and committed colleagues whose names appear in the references. I would like to particularly mention the valuable contributions of Mr. U.V. Pathare and Mr. V.S. Bhat. Fred Padley has been very kind in sharing his knowledge and experience on confectionery fats.

Thanks are due to the Khadi & Village Industries Commission for permission to include sketches, and Mr. S.G. Raman and Mr. G. Balasubramanian for producing a neat manuscript and assistance.

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1

SAL (*SHOREA ROBUSTA*) SEED FAT

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SAL

Sal Tree—*Shorea robusta* Gaertn. f.

The sal tree is the most famous of all the species of *Shorea* (Dipterocarpaceae) found in India.[1] It is a semi-deciduous, gregarious tree, usually very large with a height of 18-30 m and girth of about 1.8-2.1 m. It is found in still larger versions as also in a stunted form.

The total area of sal forests in India is estimated at 111,500 sq km. The forests occur in two principal regions in India, the Central Indian belt and the belt at the foot of the Himalaya, the former accounting for 90 per cent of the total area under sal forest. The statewise distribution is:[2]

	Sq km
Madhya Pradesh	37,700
Bihar	33,500
Orissa	28,750
Uttar Pradesh	5,800
West Bengal	5,250
Assam	2,700

The most characteristic feature of this tree is its adaptability to varied climates and locations. The rainfall in sal forests is anything between 90 and 200 cm/year. The summer temperature is hot to very hot while in winter it varies from near freezing to a moderately warm climate. In many areas of sal forests, sal forms only 20-50 per cent of the crop.

The sal is a tree of great antiquity in India and is mentioned in great epics like the *Ramayana* and the *Mahabharata*. The tree is best known for its wood, which is the most extensively used of all timbers in north, central and east India. Sal timber is widely used for sleepers in railway tracks. It is also used in enormous quantities as a constructional wood for beam, flooring, railway carriage wagon, carts and several other fabrications. Apart from the mechanical strength for heavy duty applications, the timber is immune to attack by white ants or common fungi. The timber is, however, not considered suitable for sophisticated furniture and woodwork.

The sal tree is a source of an oleoresin known as Sal Dammar obtained by tapping. It is a commercial resin and large quantities are produced and used mainly as an incense. On dry distillation, the resin yields 41-68 per cent of an oil known as Chua oil, which mainly consists of a mixture of 15 per cent, 3, 4 dimethoxy and propyl benzene, 40 per cent oxygenated aromatic compounds and 26 per cent azulenes.[1]

Sal Fruit

The flower buds appear in mid- or late February and they blossom and bear fruit in March/April. In the periods of profuse flowering the whole forest is adorned in a pleasing white colour. The weather during March to May should be conducive to blossoming and bearing of fruit. Storms, hail or strong dry winds cause flowers to wither or drop resulting in a poor crop of fruit.

The flowers, bloom in large bunches, they cover up the trees and are frequented by honey bees. It takes about eight to ten weeks for the fruits to ripen. Sal bears a profusion of fruit—about the size of a pea with five segments of fruiting calyx enveloping it and forming three big wings (2 inches each) and two narrower smaller segments around the fruit. The sal tree begins to fruit after 25 to 30 years. The loppice shoots, however, begin bearing fruit within ten years.

The wings of the fruit are green when immature and turn brown on further maturing and drying. The mature fruit with dry brown wings falls from the tree as such or is assisted by strong breeze towards the end of the hot season (end May or June) or in some places at the commencement of rains (mid-July to late July). In the matured fruit the enclosed nut remains green but gradually turns brown on storage. It browns quickly on artificial drying.

Sal Seed

Description

The typically dry fruit is composed of 23 per cent wing, 30 per cent pod and 47 per cent kernel. The dried wings are very brittle and can be easily pulled off. The dewinged seeds contain an outer thin, brittle seed pod. Slight pressure of the fingers breaks the pod very easily exposing a rather hard ovoid kernel.

In the beginning of the season the kernel is invariably green but turns tan and finally deep brown on storage. The size of the kernel is small, on an average 4 to 4.5 g. Slightly larger or smaller kernels, the latter especially when the seeds are immature, are also seen.

POTENTIAL OF SAL KERNELS

The total potential of sal kernels is about 5.5 million tonnes.[2]

Area of sal forest in India	: 27.5 million acres
Anticipated yield of sal fruit per acre	: 400 kg
Yield of kernels/acre	: 200 kg
Gross potential	: $27.5 \times 10^6 \times 200$ kg$/10^3$
	$=$ 5.5 million tonnes
Equivalent oil (at 13 per cent yield)	: 715,000 tonnes.

Considering the inaccessibility of the dense forest areas and the onset of monsoon, a very optimistic practical limit for collection would not exceed about 25 per cent of the total, about a million tonnes of kernels.

COLLECTION OF SEEDS

The dried mature fruits start falling on the ground from early or mid-May. In the major sal forest areas the southwest monsoon usually breaks by the first week of July and to ensure natural regeneration the forest department suspend collection after mid- or end June. Therefore, only six or at the most eight weeks are available for collection. The absence of infrastructure restricts penetration into the forest for collecting the seeds. The collection is done manually by women and children, whose habitat is in the fringe areas of the forests. Assuming a person can collect enough fruits to get 25 kg kernels a day, 110,000 persons should have been deployed for six weeks for collecting the record output of 150,000 tonnes kernels in 1978. Sal collection, therefore, provides welcome employment, albeit for a short season, to the economically backward community in the forest areas.

DECORTICATION[2]

The fruits are brought to a convenient central place and spread out to dry in the sun for a couple of days. Clean kernels are

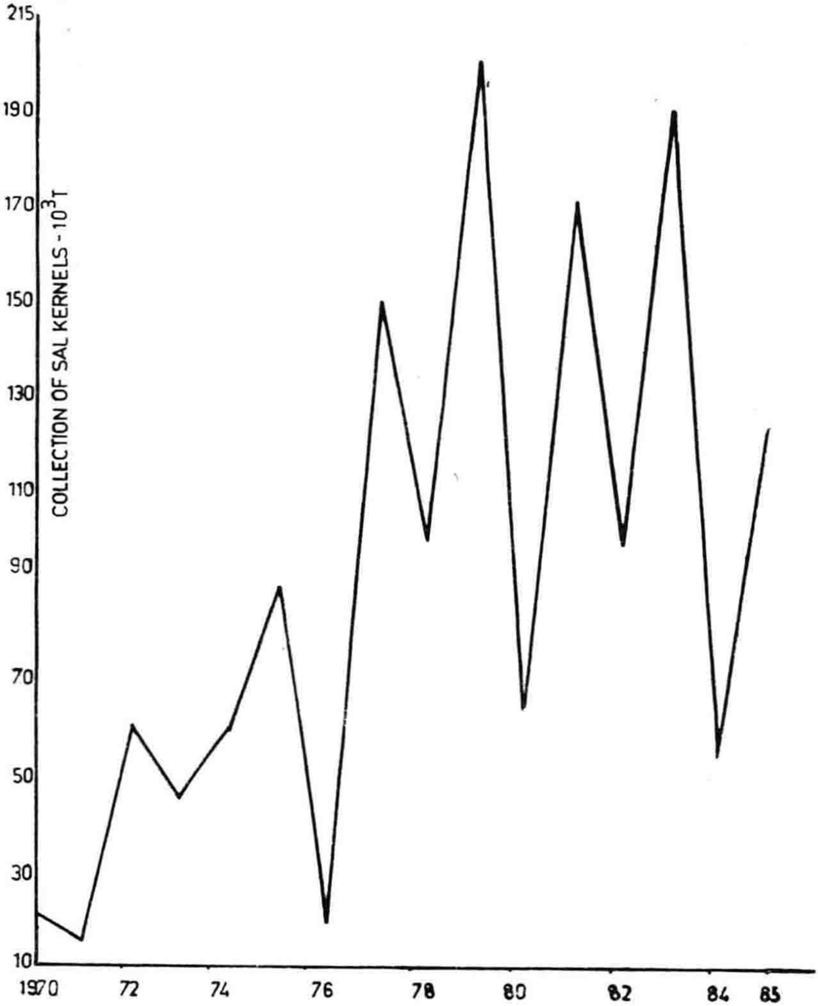
COLLECTION OF SAL KERNELS - 10^3T
215
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Fig. 1

obtained by removal of wings and pods. This operation is carried out manually near the collection centre in the forest. There are two variations in the manual operation. In one case, the dried fruits are spread on a hard surface to a thickness of about 10 cm and beaten with a wooden stick to detach the fragile wings. The dewinged fruits are separated and again placed on a hard surface. A forward and backward motion of a gently pressed wooden plank breaks the brittle shell and the hard, partly broken kernels can be easily separated by winnowing.

Another method of dewinging is to set a controlled fire to a small heap or evenly spread dried fruits. Only the wings are readily combustible. The seeds with pods are then separated and the pods removed manually. The dewinging method has an important bearing on the quality of fat extracted from the kernels. This aspect will be taken up later.

Mechanical decortication is indeed very simple but its relevance to the manual operation in a forest site, and that too for a short duration, is limited. A mechanical decorticator is in various designs. One design is a modified Kalyan type groundnut decorticator, which can be operated manually or by power. Near total decortication can be achieved with yields of 66 per cent kernels and 33 per cent husks. It has a capacity of 1 T/hr when operated manually. The whole dried fruits with wings can be decorticated in a conventional groundnut desheller of 10 T/hr capacity also. In one experiment by adjusting the fluted rollers, capacity in excess of 1 T/hr has been achieved, using dried sal fruits.

A hand operated portable decorticator has also been developed, with a capacity of 50 kg fruits/hr. The efficiency of decortication is reported to be around 97 per cent.

Collection Statistics

The actual collection of kernels in the past 16 years is shown in Fig. 1. The equivalent oil quantity at 13 per cent can be easily calculated from the graph in Fig. 1. In the sal-growing areas, it is widely believed that fruit bearing is irregular but opinions are divided about the pattern. Some believe that the sal tree bears a good crop every alternate year, while others claim a good season is successively followed by a moderate, lean moderate year before the next good harvest. It is, however, clear that lean and