CONSERVATION, MANAGEMENT AND UTILISATION OF PLANT GUMS, RESINS AND ESSENTIAL OILS.

Proceedings of a regional conference for Africa held in Nairobi, Kenya

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AIDGUM gtz

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edited by
J. O. Mugah, B. N. Chikamai, S. S. Mbiru and E. Casadei

Foreword

The Regional Conference for Africa on Conservation, Management and Utilisation of Plant Gums and Resins, hosted by Kenya Forestry Research Institute (KEFRI), was held in Nairobi, Kenya from 6 to 10 October 1997.

Coordinated by KEFRI, a number of international and bilateral agencies, namely: Association for International Development of Natural Gums (Aidgum), FAO, Promotion of Sustainable Forestry Management - (GTZ/KEFRI/FD) and Third World Academy of Sciences (TWAS) collaborated by providing funds, sponsoring participants and/or by direct attendance.

The outcome of the Conference was substantial, with clear recommendations for action. We have pleasure in sharing it with all interested persons and institutions. We take this opportunity to acknowledge with thanks the contribution of all those who attended the Conference and their active participation in the discussions, which made this meeting a remarkable success. We thank all those who collaborated with, and supported the efforts of KEFRI in organising this Conference. We are grateful to all the members of the secretariat for their devoted service. Finally, we fully appreciate the contribution of J.O. Mugah, B.N. Chikamai, S. S. Mbiru, E. Casadei for reviewing and editing the Conference report.

No doubt, the perspectives on conservation, management and utilisation of plant gums and resins as they emerged from the discussions at the Conference and the light they threw on how to address aspects of production and quality control and the need for linkages will help national and international agencies in designing and implementing viable programmes. FAO is committed to pursue the outcome of the Conference and to support the implementation of its recommendations, in collaboration with partner agencies and countries.

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QUALITY AND REGULATORY ASPECTS

NETWORKS AND LINKAGES

PART I: BACKGROUND TO THE CONFERENCE AND RECOMMENDATIONS.

1.1 Overview

The role and value of plant gums and resins in Africa cannot be over-emphasised. The resources are found in hot and dry regions, where they are valuable in various ways. In countries bordering the Sahara, the plants have proved useful as windbreaks and shelter belts against desert encroachment and hence desertification. Their canopies intercept rain drops while the root systems are effective in reducing soil erosion, thereby stabilising soils. Species in the genus *Acacia* improve soils due to their ability to fix nitrogen. The foliage and pods are valuable dry season fodder while the stem has wide application in fencing, wood energy and construction. The environmental benefits of these plant resources in the region are therefore significant.

However, the most valued commodities in economic terms are the gums and resins. The most important of these are gum arabic, myrrh and frankincense. Gum arabic is a product of *Acacia senegal, A. seyal* and closely related species. Virtually all the gum arabic of commerce comes from Africa with Sudan accounting for up to 80% of the world production followed by Chad and Nigeria. About 12 other countries in the Sahel, stretching from Senegal/Mauritania in West Africa to Somalia in the Horn of Africa and southwards to Tanzania are also producers. Gum arabic has wide application in the food and pharmaceutical industries and in miscellaneous technical applications. In the food industry (foods and drinks), it is used as a thickening, stabilising, emulsifying and suspending agent. In the pharmaceutical industry, it is used as a binding agent in tablets and as a suspending and emulsifying agent in creams and lotions. Some of the technical applications are in the printing and textile industries where advantage is taken of its film-forming and sizing properties respectively.

Myrrh is produced by species in the genus *Commiphora*. The main source of true myrrh is *C. myrrah* found in Somalia, Ethiopia and Kenya. Myrrh, like resin is also produced by *Commiphora habessinica*, *C. confusa*, *C. africana* and *C. incisa*. Additionally, *Commiphora holtiziana* and *C. pseudopaoli* produce resins commercially referred to as opoponax , which are used as tick repellent. Frankincense on the other hand is produced by species in the genus *Boswellia*. The main source of frankincense from Africa is *B. papyrifera* found in Ethiopia, Sudan and Somalia. *Boswellia neglecta* from East and the Horn of Africa also produce commercial incense. The main uses of myrrh and frankincense are as sources of fragrances and pharmaceuticals.

1.2 The need for a regional conference

Over the years, and particularly in the recent past, there has been a decline in the use of the above-mentioned natural products in favour of synthetics. The latter are preferred because of their consistent quality and generally lower prices. The natural products are characterised by unreliability of supply accompanied by unpredictable prices and variable quality. Nevertheless, gums and resins remain the products of choice if these constraints are addressed. Gum arabic, for example, has functional properties which synthetics cannot match. Additionally, growing health consciousness among consumers is favouring increased use of natural products.

Africa has enormous resources with the potential of producing these natural commodities on a sustainable basis. If properly developed, the resources will provide reliable supply and stabilise the market prices. What is required is a co-ordinated strategy on conservation and development of these resources. This would be in line with the Rio Convention on Biodiversity and Agenda 21. It was the recognition of the opportunities and challenges facing most of the producing African countries that led to the organisation of this conference. The main objectives of the conference were:

- To bring together various stake-holders in plant gums and resins including producers, consumers, representatives from the food industry, relevant international agencies, organisations and leading experts

- To exchange knowledge and experience concerning conservation, management and utilisation of the above-mentioned resources and products

- To liaise with international regulatory authorities with a view to identifying specification requirements

- To develop project ideas that would improve the production and quality of gums and resins at rural and market levels in order to improve food security and standards of living at community level

1.3 Outcome/Recommendations of the Conference

The Conference had two main sessions focusing on plant gums and resins. A workshop was held for each session to discuss pertinent issues and develop recommendations. Major issues on plant gums centred on gum arabic, the main product of commerce in Africa. Similarly, issues on resins focused on myrrh and frankincense. The outcome of the Conference is thus based on the three commodities with the last two being grouped under resins and is presented in the form of draft proposals with details of working groups under each session given as annexes.

1.3.1 Gum Arabic

Gum arabic-producing countries are facing problems in relation to commercialisation and ensuring added value to the product in relation to international markets. Most of the countries of the Africa region feel isolated and cannot readily access the technology, quality control and market opportunities available. These countries need further regional cooperation to exchange information, training, research and development opportunities.

Objective

To create a sub-regional network to enable countries to develop their system of sustainable production, marketing and improvement of their products to international standards. The network should promote the relationship between the primary producer, the processor and the end-user.

Inputs

- Identification of contact point(s) at national level represented by an appropriate institution which is active in this sector
- Definition of the coordination mechanism by which the network should operate and requesting of support from appropriate international organisations to enable the network to operate effectively
- Drawing together:
    - ⇒ English-speaking countries of the region wishing to develop their gum resources
    - ⇒ French-speaking countries of the region wishing to develop their gum resources
- Co-ordinating efforts in the collection, processing, documentation and dissemination of information

Activities

1. Set up the network initially by Kenya, as a follow-up to the Regional Conference

2. Organise workshop to set out the protocol for operation and seek support from various donors (such as FAO, National Aid/Development Agencies, AIDGUM/AIPG, and the Private Sector to pursue the objectives defined).

3. Pursue priority objectives, namely:
    - Improvement of production and distribution of gum arabic
    - Establishment of a buffer stock of gum in producer countries sufficient for 2-3 years
    - Introduction of appropriate technology for identification, collection, storage and quality control
    - Development of research in gum modification and improvement
    - Initiation of appropriate training
    - Establishment of a marketing and application information system

4. Establish Information Systems
    - Prepare a basic manual which sets out the various primary functions performed by farmers and extension workers in gum arabic production and primary quality control
    - Establish a regular newsletter

- Organise workshops and seminars to create awareness on product development
- Undertake resource surveys and create databases on national and regional resources detailing types, distribution and stock density

Expected Outputs
- Improved quality and pool of production of gum with a buffer stock that gives assurance to consumers
- Conformity with international standards
- Improved exchange of information among gum arabic-producing countries
- Simplified channel of commercialised gum, i.e., from producer to end-user in terms of information exchange and related issues
- Classification of gum on the basis of application to enhance marketability

Time Frame
- Two years to establish network

Annexes to the draft proposal based on the outcome of working groups

Annex 1 A Basic Training Manual

Objective

To prepare a basic manual which sets out in an illustrative manner the various primary functions performed by farmers and extension workers in gum arabic production and primary quality control.

Inputs

- Elaboration of first draft manual, circulation and piloting in the field
- Preparation of manual in final forms and publication, in the appropriate languages

Annex 2 Education and Training Programme

Objective

To provide education and training for the person involved in the chain of gum arabic production from planting, collecting, sorting, cleaning, storing, processing, quality control and end-use marketing.

Inputs

- Collection and preparation of training resources

- Identification of the various levels at which training is required

- Organisation of a Training of Trainers workshop to ensure maximum multiplier effect
- Facilitation of exchange of training experts among countries of the region
- Encouragement of the introduction of gum chemistry and technology into the formal and higher education curriculum
- Identification of institutions in individual countries which can collaborate in training programmes

Annex 3 Quality Control

Objective

Develop national quality control systems for gum arabic from production (primary quality control) to end-product (certification of product).

Inputs

- Training in field testing and basic laboratory methods
- Establishment of a Standards and Reference Laboratory in individual countries
- Preparation of guidelines for inspection and sampling of product
- Development of practical chemometric systems for species identification and characterisation
- Facilitation of co-operation within the Region to achieve international standards

Annex 4 Resource Survey

Objective

To establish the production of gum arabic in the region, and identify the future market production opportunities by surveying the plant gum resources (resource map).

Inputs

- Carrying out the survey based on existing forestry records
- Facilitating a wider survey, using new technologies, such as satellite images and aero-photographic exploration
- Establishment of a data base for types, distribution and stock density

1.3.2 Resins: Myrrh and Frankincense

Resins, just like gum arabic, are available in several African countries, and potential to utilise them as commodities of commerce exists. However, their utilisation is hampered by a number of factors relating to production, quality control and marketing. For instance, the resource type, their quantities and distribution are not clearly known.

Objectives

1. To identify ways of improving the production, marketing and quality of resins

2. To establish national/regional bodies which will co-ordinate resource surveys, production, marketing and quality control of resins

Inputs

- Establishing contact points in each country (at national level) by identifying an institution which is active on the different aspects of interest

- Collecting information at national and sub-regional level regarding resins and ensuring its dissemination to interested parties

- Defining co-ordination mechanisms which will assist in promoting the production and marketing of resins

Activities

1. Establish regional network centres

2. Establish information systems:-
   ⇒ to prepare a simple manual for rural communities
   ⇒ to establish a regular newsletter
   ⇒ to undertake resource surveys
   ⇒ to create databases

3. Organise workshop(s) to set out the protocol for operation and seek financial support that will focus on research and development in:-
   a) production
      - Improve production methods in terms of extraction, handling of the product, cleaning, sorting and grading of the product, storage, packaging and pricing
      - Conduct research on land tenure and property rights linked to the production of resins
      - Issue on sustainability should be explored

b) marketing

- Conduct research on marketing in terms of where the product goes, in what form and for what use
- Determine the potential of the resin product
- Search for new markets
- Secure the base and research on consumer acceptance

c) quality control

- Identify simple methods which can be used to characterise resins in producer countries
- Set up standards between producers and users and establish regulations on quality and purity

Outputs

1. Formation of Regional Network Centres

2. Improved exchange of information among resin-producing countries through the formation of a database, establishment of a newsletter for the scientific community and production of a simple manual for the rural communities

3. Improvement and development of the resin industries, from the local communities to the end user, through conformity with international standards

Time Frame

Approximately 2-3 years to establish network

Conference Papers

The Conference comprised essentially three main thematic areas namely

- Conservation and management of the resources
- Quality and regulatory aspects
- Linkages and networks

PART II: CONFERENCE PAPERS

MANAGEMENT AND ORGANISATION OF GUM ARABIC INDUSTRY IN SUDAN

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Introduction

Sudan is the acknowledged world leader in gum arabic production. It contributes between 70 and 90% of the total world production. In 1995 alone it produced 51,564 tonnes comprising 45,564 tonnes of gum hashab (i.e., from *A. senegal*) and 6,000 tonnes from gum talha (i.e., from *A. seyal*). This was in excess of the average world demand of 40,000 tonnes. Not only does it produce far more gum than any other country but its gum is of the best quality and thus sets the standards by which gums from other sources are judged. This success is as a result of two main factors: ideal environmental conditions suitable for the growth of *A. senegal* and a long history of sound production practices. This paper outlines aspects of management and organisation of the gum arabic industry in the country.

Management of the Gum Arabic Resources

Gum arabic from Sudan is a product of *A. senegal* and *A. seyal*. There is only one variety of *A. senegal* in Sudan, i.e., var. *senegal* which is the source of hashab. In the case of *Acacia seyal*, both varieties, i.e., var. *seyal* and *fistula* are found in the country with var. *seyal* being the main source of talha. Production of gum arabic is concentrated in the gum belt between latitudes 10° and 14° North spanning 12 states with an estimated area of 520,000 km^2.

Management of the *Acacia senegal* for gum production falls into either of two systems: hashab owner or hashab renter. Hashab owners are either small- or large-holder farmers. The former make up the majority of gum producers across the gum belt. They own small holding "gum orchards" which are part of the *A. senegal* rotation system and practise gum production in one of three ways:

- Tap gum by themselves; this is the most dominant form of production
- Hire labour to carry out the production operations
- Share-crop production with the gum workers

Large-holder farmers include traditional hashab owners, sheiks, well-to-do families and mechanised scheme owners. They depend on hiring labour and on share-cropping for production.

Collection of gum is carried out by daily payment or share-cropping of the produce. The latter is more prevalent in the dry areas and Darfur region. It is an arrangement where two thirds of the produce goes to the owner and one third to the collector of the gum. Sometimes a 50:50 sharing arrangement is undertaken. This applies when the hashab plantations are remotely located or the owner is not providing food or water to the workers.

The hashab renter system includes those renting forest administration plantations and property owners. The two prominent groups of the first category are the resident local entrepreneurs and financially capable migrants from Kordofan known as "Kardafa". There are also the individual camel owners who associate themselves with a handful of workers. All three groups rent hashab plantations, support the organisation of the labour groups (whom they usually draw from their places of origin) and act as guarantors to the improved labourers at the village shops. A form of liability is demanded by local shops to extend the credit support. The local entrepreneur, when not a merchant, and the migrant organises from Kordofan are often figures known to the shop-owners, whilst the camel owner would be given credit against the value of the camel.

Organisation of the Industry

a) Overview

One of the greatest strengths of the present Sudanese gum arabic industry is the consistency it offers end-users in terms of both quality and price at the point of export. This is due, in large measure, to the fact that production of gum arabic is actively controlled from beginning to end by a single body, the Gum Arabic Company (GAC).

The GAC's activities begin at the start of each gum collection season, usually around September/October, when it announces the export price (FOB Port Sudan) to be set for the coming year. The level at which it is to be set is decided as a result of market intelligence gained through a network of overseas agents and other sources, which enables estimates to be made of likely demand for gum arabic, and the anticipated availability of gum from the resource. Likely production levels can be predicted quite accurately from such factors as rainfall (which is not only necessary for the trees but important for the farmer/collector and his family) and market prices for the farmer's other crops (which will affect his willingness to collect gum).

Using the export price (in US$) and the appropriate exchange rate as a starting point, the total estimated costs (at Port Sudan) of cleaning, handling and preparing the gum for export are deducted to give a Port Sudan procurement price. From this are deducted the costs of up-country cleaning, handling and transport to Port Sudan to arrive at the basic floor price which is set for the gum auctions at origin. Costs at Port Sudan include those incurred as a result of cleaning, quality control, storage, weight losses, fumigation, transport and loading, export duty, insurance and other financial charges, and GAC profits. Those incurred before arrival at Port Sudan include various fees and commissions, cleaning, packing, handling and transport costs, the cost represented by gum weight loss en route to Port Sudan, and merchants' profits.

At the up-country markets the collectors or small village traders to whom they have sold gum, bring sacks of gum for auction and sell to the highest bidder. The bidders are other, larger traders who, if successful, clean and sort the gum and then sell it on to the GAC. The GAC, in turn, re-clean and grade the gum at their warehouses in Port Sudan and prepare it for export. If the bidding at auction does not reach the guaranteed floor price (set by the GAC at the start of the season), then the GAC intervenes to buy the gum themselves.

b) Production Methods

Hashab is collected from *A. senegal* by tapping while talha is from natural exudation. Tapping begins when the trees are just starting to shed their leaves, usually about the end of October or the beginning of November although the exact timing depends on the rains. Older methods of tapping involved making small incisions into the tree with an axe. To avoid the damage that this could do to the tree, methods were developed which use a specially designed tool, a 'sunki'. Through promotion by the extension services the method has largely replaced the older ones. The sunki has a metal head fixed to a long wooden handle. The pointed end of the head is pushed tangentially into the stem or branch so as to penetrate just below the bark, and then pulled up so as to strip a small length of bark longitudinally from the wood. Damage to the wood should be minimal. Several branches are treated in a similar manner at one tapping and in the course of a day one person can tap about 100 trees. In subsequent years, other branches or the reverse side of the previously treated branch are tapped.

For trees, which have been planted from seed, tapping starts at age 4-5 years; for those planted as seedlings, tapping can start in the third year.

After this superficial injury, ears of gum form over the exposed surfaces and are left to dry and harden. After 5 weeks the first collections of gum are made, with further collections from the same trees at approximately 15-day intervals until the end of February, making five or six collections in total. The land tenure system and respect for local tradition generally ensures that the people who carry out the tapping also reap the rewards of collecting the gum. However, after the bulk of the gum has been harvested, the odd tears of gum, which continue to be produced by the tree, can be collected by any other person. Trees in wadis or elsewhere, where the leaves had not been shed earlier, may be tapped and subsequently harvested at a later date than the others.

As far as possible, the tears are picked by hand from the stems and branches where they have formed, and not by knocking to the ground where they can pick up dirt. They are placed in an open basket by the collector, the use of plastic sacks is discouraged since they have been found to increase the risk of moisture retention and mould formation.

At present, little cleaning or sorting is undertaken by the producer (collector) of the gum. Since he is paid at the auction according to the weight of gum rather than on quality criteria (within limits, since his gum would not be accepted for auction if it were grossly contaminated), there is no great incentive for him to spend time cleaning and sorting it.
Some degree of cleaning and sorting may be undertaken by small village traders to whom the producer sells him gum, but it is usually undertaken by the large traders after it has been sold at auction and prior to them selling it to the GAC. If the GAC intervenes to buy the gum at auction because it has not reached the floor price, then the company undertakes the cleaning and sorting at its own warehouses in the regional centres in the gum belt.

Cleaning and sorting is done by hand, usually by women, who sort it on the ground into piles of whole tears and smaller pieces, separating any excessively dark gum and removing pieces of bark and other foreign matter. Gum sorted in this way by the trader is sold on to the GAC and bagged and transported to its warehouses at Port Sudan as 'Selected' and 'Cleaned' gum, distinct from 'Natural' gum. Unlike some other countries, separation of mixtures of gum from different botanical sources (such as *A. senegal* and *A. seyal*) is not necessary because it is kept quite separate during its collection.

On arrival at the GAC dept at Port Sudan, every consignment of gum hashab is re-cleaned, sorted and graded in preparation for export. Until 1991 this operation was carried out manually. Since then, it has been mechanised using a system of conveyor belts and shaking and sieving machines. The traders' bags of cleaned gum are upturned onto an inclined moving belt, which takes the gum up to the shakers and sieves; a person is present at the start of the belt to remove any lumps that are very large. After separation of the dust and under-sized pieces by sieving, the remaining lumps of gum pass on a belt between lines of women who give them a final inspection - any remaining foreign mater (such as stones) or dark coloured pieces are removed by hand. At the end of the conveyor belt the gum is bagged and weighed ready for export or it is transferred to the kibbling machine for further processing.

The outputs from the cleaning and sorting operations are graded and sold according to the following main designations; export prices for 1994/95 are also indicated (per tonne, FOB Port Sudan):

Hand Picked Selected (HPS)	US$4850
Cleaned	US$4200
Siftings	na
Dust	US$2760
Red	na

HPS gum is in the form of clean, whole tears (but not the very largest) which have been carefully selected and which fetch a premium price. Cleaned gum is the gum which is bagged at the end of the conveyor belt, and may comprise whole or broken lumps. Siftings are the smaller pieces of sieved gum, and dust is the fine material which passes through he finest sieve. Red gum is the dark gum removed by hand from the other lumps. Exported gum is packaged in new 50-kg jute bags.

c) Monitoring and Quality Control

The intrinsically high quality of Sudanese gum arabic (hashab), combined with an efficient, long-established system of collection and post-harvest handling, means that the problems of quality control are not as great in Sudan as they are for some other countries. A well-organised extension service ensures that the people who tap the trees and collect the gum do it in the correct manner (for example, no mixing of gum from different botanical sources, picking the gum from the tree rather than off the ground, placing it in baskets rather than closed bags) and these aspects play an important part in determining the quality of the gum which arrives at the market for auction. Traders who purchase the gum (or the GAC) will also do so only if it matches their own visual criteria for cleanliness and this, too, instils in the producer a sense of quality consciousness (although not, perhaps, as great as if there were a financial incentive to produce high quality gum). In turn, the traders who clean and sort the gum before selling it on to the GAC know that they will be penalised if, during the re-cleaning, the gum is found to be below the expected quality.

During the course of the last few years a more rigorous system for quality control and certification has been put in place at the GAC's cleaning and processing facility at Port Sudan. A purpose-built laboratory was established in early 1992 and equipped with new equipment. The laboratory is small, but clean and air-conditioned and has a well-stocked chemical store.

All gum is sampled when it arrives at Port Sudan, in a proper, statistical manner, each of 21 bags out of every 400 are emptied and sub-sampled by quartering; the combined sub-samples are further sampled to give a representative 1-kg sample. Half of this sample is ground to a powder to provide the material for analysis; i.e. loss on drying and optical rotation. The latter parameter is sufficient to identify any gum talha in a mixture with gum hashab. The bags of up-country gum are each labelled with a number which identifies the trader, so any problem brought to light by the quality control measures can be discussed and resolved with the trader concerned.

During mechanical cleaning a sample of gum is taken every hour for analysis (optical rotation and acid-insoluble matter). Finally, during bagging a sample is taken for analysis: loss on drying, optical rotation, acid-insoluble matter and total ash are determined and the details are recorded on a Certificate of Analysis. This is presented with each batch of kibbled, HPS or cleaned gum that is exported. A sample of each export batch (identical to the sample analysed for certification) is kept for reference for one season.

Table 1: Summary of gum arabic data for five French-speaking West African countries, showing botanical source, production, imports into the EC, and main European markets

Country	Main botanical Source	Annual production	Annual imports to EC and main European Markets	
Chad	*A. senegal*	3,500	EC	3,500
	A. seyal	1,500	France	2,800
			UK	600
Mali	*A. senegal*	500	EC	140
	A. seyal		France	45
Mauritania	*A. senegal*	400	EC	180
Niger	*A. senegal*	300	EC	150
	A. seyal		France	115
Burkina Faso	*A. senegal*	200-300		
	A seyal			
Senegal	*A. senegal*	700	EC	450
			France	300
			UK	130

Table 2: Export of gum arabic from FSWA countries (in tonnes)

	1991	1992	1993	1994	1995	1996*
Chad	2188	2450	3696	4662	7021	7315
R.C.A.	74	78	33	119	126	639
Senegal	262	261	459	362	662	213
Mauritania	32	48	55	166	258	256
Cameroon	95	647	841	1031	161	560
Niger	27	155	228	240	110	242
Mali	112	31	77	249	295	229
R.C.I.	0	0	26	50	15	20
TOTAL FSWAC	2790	3670	5415	6879	8648	9474
TOTAL World	37089	31764	27348	41789	38568	32590
%/World	7.52	11.55	19.8	16.46	22.42	29.07

* Some data are missing

Production of gum arabic in Niger is far below the 1980s level when it was among the five top producing countries in the world. It produces both *A. senegal* and *A. seyal* gum. A significant amount of gum arabic - a mixture of hard and flaky gums comes from Burkina Faso. One significant development in Niger is the production of a specialised product under the trade name 'clean sifted Niger gum'. The product is a mixture of 60% flaky gum and 40% hard gum destined to satisfy the demand of a limited number of importers in the industrialised countries. Burkina Faso has been excluded from the wide marketing circuit of gum arabic. It has contributed though in a discontinuous and indirect ways (with border countries such as Mali and Niger acting as go betweens) to supplying the world market.

Markets

The European Community (EC) is the main regional market for gum arabic from FSWACs (Table 3). France is the leading importer within the EC which in 1996 accounted for 54% of the total imports from FSWACs. UK is the second largest importer though in 1996 the total amount imported fell below the 6-year annual average. Imports into Germany have shown a general increase over the last 4 years. Belgium-Lux and Italy are other emerging markets in the EC.

Outside the EC, USA is the single most important trading partner. In 1996 alone, it accounted for 33% of the total imports from FSWACs. Chad is the main supplier of gum arabic to USA. It appears that this increase is the result of two main factors namely the TCP project by FAO which raised the awareness of the potential and value of gum arabic in Chad. This was followed by improvements in the production and quality of locally produced gum arabic. At about the same time a workshop was held by USAID in 1994 in N'Djanena which offered USA with opportunities of a ready source of good quality gum arabic. In addition to USA, small quantities of gum arabic have been exported to South Korea, Sweden, India and Pakistan though in a sporadic manner.

Table 3: Countries importing raw gum arabic from the FSWAC; figures are in tonnes

	1991	1992	1993	1994	1995	1996	6-year annual average
France	1739	2107	3505	4741	4483	5431	3668
U.S.A.	0	18	60	341	1415	2425	710
Germany	37	49	827	432	1139	705	532
U.K.	1008	1476	894	1103	1396	880	1126
Belgium-Lux	0	0	0	39	49	66	26
Italy	0	0	3	0	0	38	-

RECENT ADVANCES ON CLASSIFICATION AND STATUS OF THE MAIN GUM- RESIN PRODUCING SPECIES IN THE FAMILY BURSERACEAE

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Abstract

Burseraceae is a family of 17 genera with some 560 species, which are widespread in the tropics especially in Africa, Malaysia and South America. These are trees or shrubs characterised by aromatic resins from the bark used even in Biblical times for frankincense, myrrh and perfumes. The main resin-producing species are found in the genera *Boswellia* and *Commiphora* which are common in the hot drylands. Despite early recognition, classification and nomenclature of members of the two genera, and particularly those of *Commiphora* have remained unstable. They have been described by botanists as taxonomically difficult, frustrating or confusing. This is largely because of the nature of the plants themselves, appearing leafless and in a drought-dormant condition for much of the year. This has led to the practice of describing species from inadequate and often sterile material. As a result, some species have been described by different botanists under different names. Also, sterile plants from other genera have been described as species of either *Boswellia* or *Commiphora*. For example, six plants described by Engler (the chief worker on the genus *Commiphora*) as new species of *Commiphora* belonged in fact to other genera and in other families. Several plants within the two genera therefore have been known, simultaneously or successively, by two or more different names. This instability of plant names is a real disadvantage as all information about plants and their products is communicated by name. Recent taxonomic revisions of the family Burseraceae have resulted in the union of two or more species previously considered distinct, splitting what was considered previously to be one species into two or more species or outright rejection of wrong names brought about by mis-identification. Most names of the members of the family Burseraceae are therefore marred by numerous synonyms, subspecies, varieties, long descriptions and additional notes. The aim of this paper is to survey the recent advances on classification and look at the status of the main resin-producing species in the family Burseraceae with particular reference to the region of Tropical East Africa.

Introduction

Production of gum resins from members of the family Burseraceae is of economic importance in some tropical countries. Although substantial quantities especially of frankincense and myrrh from the genera *Boswellia* and *Commiphora* are harvested annually for sale, little is known about the status of the main gum resin-producing species within the family. Recent classifications place the family Burseraceae Kunth in the Order Sapindales Bentham and Hooker. This is a natural group consisting of 15 families characterised by their woody habit, compound or cleft leaves, two whorls of stamens, a well-developed nectary-disk and a syncarpous ovary with a limited number (1-2) of ovules in each locule (Cronquest, 1981).

The family Burseraceae consists of 17 genera and about 600 species which are widespread in the tropics but especially well represented in tropical America, Malaysia and north-eastern Africa. The largest genera include *Bursera*, the type genus confined to tropical America with a centre of greatest diversity in Mexico and *Commiphora* which is widely spread in the less humid parts of tropical Africa and Madagascar with fewer species in West Africa, Iran, Pakistan, India, Sri Lanka and Brazil (Gillett, 1991).

Diagnostic features

The family Burseraceae is composed of trees and shrubs with prominent vertical resin ducts in the bark. The leaves, which are compound, are spirally arranged and crowded at twig-tips. The flowers are rather small and are either solitary or inflorescences usually at the twig-ends, regular with parts in threes to fives, bisexual or more often unisexual, the plants often dioecious. The sepals are fused and are either imbricate or valvate, petals free, also valvate or imbricate. The stamens are equal to or double the number of petals and usually in two whorls. The ovary is superior with three to five carpels and two to five locules. The fruit is usually a drupe, sometimes a capsule. Seeds are without endosperm.

Classification and chief genera

Burseraceae can be conveniently divided into three tribes as follows:

Protieae. Drupe with two to five free or adhering but not fused parts: six genera, including Protium and Tetragastris.

Burserae. Drupe with endocarp completely fused, exocarp dehiscing by valves: five genera, including *Boswellia, Bursera* and *Commiphora.*

Canariae. Drupe with completely fused endocarp: six genera, including *Canarium, Dacryodes, Haplolobus* and *Santiria.*

Of the three tribes, Burserae is of economic importance as far as gum resins are concerned. Frankincense comes from *Boswellia,* myrrh from *Commiphora,* while varnish is obtained from *Bursera.*

Burseraceae in tropical East Africa

The most recent work on Burseraceae in East Africa is that of Gillett, (1991) "Flora of Tropical East Africa (FTEA)". Within the flora area, the family is represented by three genera: *Canarium* with 2 species, *Boswellia* with 4, and *Commiphora* with 66. *Canarium schweinfurthii* Engl. which is a tall tree attaining 40 m with a straight cylindrical trunk and compound leaves is found in Uganda and northern Tanzania around Lake Victoria. *Canarium madagascariense* Engl. ,which differs from *C. schweifurthii* in its fewer leaflets seems to be approaching extinction. It has only been collected twice since 1949 in west Usambara, Tanzania (Gillett, 1991). *Boswellia* and *Commiphora*, which produce frankincense and myrrh respectively are well adapted to the hot drylands usually below

2000 m, becoming most numerous in north-eastern Kenya and extending into Somalia and Ethiopia.

Problems associated with identification of Boswellia and Commiphora species

Despite their early recognition, classification and nomenclature of members of the two genera, *Boswellia* and *Commiphora* in tropical East Africa have remained unstable. They have been described by various botanists as taxonomically difficult, frustrating or simply confusing. This is largely because of the nature of the plants themselves, appearing leafless and in drought-dormant condition for much of the year and the difficulty of obtaining complete specimens showing both male and female flowers, leaves, fruits and bark, the useful characters in identifying members of these groups. The flowers and fruits are seldom produced with the leaves and are therefore difficult to identify. The situation is worsened further by the fact that *Commiphora* is a gregarious genus and where one species is found, several others are likely to occur as well (Beenje, 1994). This has led to the practice of describing species from inadequate and often sterile material. As a result some species have been described by different botanists under different names. Also, sterile plants from other genera have been described as species of either *Boswellia* or *Commiphora.* For example, six plants described by Engler (the chief worker on the genus *Commiphora*) as new species of *Commiphora* belonged in fact to other genera and were in other families: two to *Lannea* and two to *Sclerocarya* (Anacardiaceae), one to *Platycelyphium* (Papilionaceae) and one to *Combretum* (Gillett, 1973).

Even today sterile plants of *Lannea* continue to be mistaken for *Commiphora.* In *Lannea,* the bark is tough like string and nearly always some of the hairs are stellate. Such bark does not occur in *Commiphora* and neither do such hairs. Also, sterile specimens of *Boswellia neglecta* S. Moore Rae readily confused with *Lannea alata* Engl. which often occurs together with it and may be distinguished by its narrowly winged leaf-rachis. Several plants within the two genera therefore have been known, simultaneously or successively, by two or more different names. Recent classifications separate the two genera using the fruit as follows:

Boswellia: Fruit a (2)3(4-5) - valved pseudocapsule, releasing 1 - seeded nutlets on dehiscence; calyx-lobes and petals 5, stamens 10; leaves pinnate; true spines absent.

Commiphora: Fruit a dehiscent drupe, splitting into 2(-4) valves disclosing a 1(-2)-seeded stone which is usually surrounded (at least at the base) by a red or orange, fleshy pseudoaril. Calyx-lobes and petals 4, stamens 8 (rarely 4). Leaves simple, 1-3-foliate, or pinnate; spines often present.

The species of Boswellia producing frankincense

The genus *Boswellia* Roxb. ex Colebr. is composed of 20 or so species extending from Ivory Coast to India and south to N.E. Tanzania and N. Madagascar but most numerous in N.E. tropical Africa. These are unarmed shrubs or small to medium-sized trees exuding a watery aromatic substance from the bark which slowly hardens to a resin on exposure. In tropical East Africa, the genus *Boswellia* is represented by four species: *B. papyrifera, B.*

rivae, B. neglecta and B. microphylla. These are easily distinguished by the number, shape and size of their leaflets.

True frankincense is obtained from *B. carteri* Birdw, and some other species growing in northern Somalia, Dhofar and Hadhramaut. In tropical East Africa, the main species producing frankincense is *B. papyrifora,* found in Ethiopia, Sudan and Somalia and *B. neglecta* S. Moore (*B. hilderbrandtii* Engl.) which is abundant in dry bushland of northern Kenya. The latter grows on basement complex or lava and red sandy soils at altitude 200-1300 m with less than 600 mm of annual rainfall.

The species of Commiphora producing myrrh

The genus *Commiphora* Jacq. comprises about 190 species, common in the drylands. These are generally small to medium-sized dioecious trees with outer bark often peeling in papery flakes or scrolls exposing the green or bluish under bark The leaves are compound, spirally arranged and usually clustered at the ends of the short and spiny - tipped shoots.

In East Africa the genus *Commiphora* is represented by about 66 species. This is a taxonomically difficult group and classification of the different groups is made possible by first treating the entire group into 14 sections by use of combined characters and then applying a delimiting key to each section. These sections are as follows: *Rosratae* (1), *Abyssinicae* (13), *Commiphora* (3), *Coriaceae* (1), *Campestres* (7), *Africanae* (7), *Latifoliolatae* (10), *Pedunculatae* (1), *Arillopsidium* (8), *Ugogenses* (1), *Hildebrandtianae* (4), *Hemprichia* (6), *Ciliattae* (1) and *Opobalsameae* (2) species. The different species are distinguished by their resin and colour of the bark as well as details of spines and leaves which are not always available.

Several species of *Commiphora* produce gum resins which are used locally, particularly by the Islamic communities. The chief *Commiphora* gum of economic importance is myrrh, produced by *C. myrrha (C. myrrha* var. *molmol).* This is an important article of commerce in N.E. Kenya which is locally known as Molmol (Somali). Other species producing myrrh but of less value include *C. habessinica (C. madagascariensis), C. schimperi (C. buraensis), C. africana (C. pilosa)* and *C. confusa.* These species are quite abundant in northern Kenya. Gum resins from *C. holtiziana spp. holtziana (C. caerurea)* and *C. pseudopaoli (C. paolii)* are known as opoponax and are used as tick repellent. These are of commercial value especially in the USA where they are used on domestic animals. The same resins are used against snake bite. There are also other species such as *C. incisa(C. candidula), C. campestris* var. *camppestris(C. scheffleri)* which produce gums that are locally chewed.

Conclusion

Over the last few years, it has been increasingly evident that the production of frankincense and myrrh from *Boswellia* and *Commiphora* genera of Burseraceae is gaining in economic importance particularly for some tropical African countries. Although substantial quantities of these products are harvested annually, little is officially known about the status of the trees themselves. Recent classifications such as "An Integrated Systems of Flowering Plants" by Arthur Cronquist (1981) and "The Flora of Tropical East Africa" by Jan Gillett (1991) have greatly contributed to the understanding of the members of the family

Burseraceae. These are natural classifications with high level of productivity and all the groups which they delimit are natural. Useful aromatic resins for instance occur in the tribe Burserae where frankincense and myrrh are restricted to the two genera, *Boswellia* and *Commiphora* respectively. Also, gum resins commercially known as opoponax used as tick repellent occur within Section Hemprichia of *Commiphora*. It is therefore possible to predict with some degree of accuracy which group contains what product by investigating a single species and hence restrict the areas of investigation within the family.

References

Beentje, H.J. 1994. *Kenya Trees, Shrubs and Lianas*. National Museums of Kenya, Nairobi, 722pp.

Cronquest, 1981. *An integrated system of classification of flowering plants* (with a new foreword by Armen Takhtajan). Columbia University Press, New York.

Gillett, J.B. 1991. Flora of Tropical East Africa - Burseraceae. A.A. Balkema, Rotterdam, Brookfield. 94 pp.

Gillett, J.B. 1973. Commiphora Jacq. (Burseraceae) - Englerian species which disappear. Kew Bull. Vol. **28**(1), 25-28.

PLANT GUMS, RESINS AND ESSENTIAL OIL RESOURCES IN AFRICA: POTENTIALS FOR DOMESTICATION

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Introduction

The forests of Africa are full of plants and particularly tree species that people within and around them utilise for various purposes. Gum, resin and essential oil-producing plants form part of these important species (see Fig. 1). Extraction from wild sources still forms over 95% of the total production but deforestation is causing great concern as genepools are becoming smaller and smaller with the imminent threat of severe genetic degradation or extinction in the case of some of these relatively wild species. Genetic resources collection and conservation has commenced in some cases but the full potentials of these products are still to be realised, despite their immense socio-cultural, economic and scientific importance. Leakey and Izac (1996) in considering the domestication and commercialisation of non-timber forest products enumerated some evolutionary steps which extends from raw extractivism of wild products to biotechnology. In the case of gums, resins and essential oils, markets are available, so the development of commercialisation does not feature here although we may need to help market expansion in future. From the wild to the semi-domesticated stages, farmers themselves have exerted some selection pressure based on acquired experiences in the field including markets, local or international. This is indigenous knowledge (IK). Domestication is not a new phenomenon. It is an old process which started very many centuries ago for many plant species. Simon (1996) suggested that it must be seen as a continuum — from 'unmolested or unmodified state' to management of trees in forests (in-situ) to cultivation of semi-domesticated to monocultural plantations of advanced

The definition of Harlan (1975) simplifies it as it says, "to domesticate is to naturalise to human conditions and this involves human-induced changes in the genetics of a plant".

This paper reviews present efforts and identifies needs and potentials for the change in genetics' or genetic improvement of gum, resin and essential oil plants in Africa to facilitate full domestication.

Degradation of native genetic resources

The vegetation of most African forests has been subjected to uncontrolled exploitation (IUFRO, 1989) for many decades. In the drier Sahelian areas where many gum- and tannin- producing species abound, annual fires and droughts have also increased in severity and frequency in the past 2 decades, causing significant changes in local ecologies and vegetations. This has resulted in serious loss of genetic resources and the creation of a poor socio-economy for the rural poor who depend on these trees or their products for survival.

Gums	Resins	Essentail Oils
Acacia senegal	*Allanblackia parviflora*	*Ocimum gratissimum*
A. albida	*Amphimas pterocarpoidas*	*Piper guineensis*
A.dudgeoni	*Berlinia grandiflora*	
A. farnesiana	*Copaifera salikounda*	
A. hockii	*Daniellia thurifera*	
A. polycantha	*Garcinia kola*	
A. nilotica	*Zanthoxylum xanthoxyloides*	
Burkea africana	*Nauclea latifolia*	
Albizia zygia	*Pseudospondias microcarpa*	
Combretum nigricans	*Pterocarpus ernaceus*	
Spondias mombin	*Carapa procera*	
Sterculia setigera	*Ceiba pentandra*	
Stercula tragacantha	*Tetraplaura tetraptera*	
Albizia adianthifolia		
Anogeisus leiocarpus		
Balanites aegyptica		
Cola gigantea		
Dialium guineensis		
Diospyrus mespiliformis		
Entada africana		
Hidegardia barteri		
Piptademiastrum africanum		
Entandofragma spp		

Figure 1. Inventory of Native Gum, Resin and Essential Oil Producing Plants

Apart from deforestation which has resulted in loss of vital germplasm, Africa is not politically stable and many wars which are fought on the continent contribute to loss of genetic resources either in the field or in storage.

Can genetic resources be safely stored in Africa now? Yes, but duplicate copies need to be put away (IPGRI) for security. As deforestation and change in conditions continue, we will continue to lose vital germplasm, resources that are the building blocks for future development. IUFRO (1989) recognised this problem and suggested conservation and research on some multipurpose trees with DANIDA's contribution for seed storage. In Nigeria, this project did not take off, but the document is still available and can be useful. IUFRO (1989) suggested immediate effort on genetic improvement and the development of effective silvo-pastoral management systems for these continually degraded and stressed natural woodlands.

Past Attempts on Genetic Improvement

FAO (1980) proposed a project in Senegal and Sudan, among other countries, for collection of the genetic resources of some tree species including *Acacia nilotica, A. tortilis, Prosopis* spp and the well-known gum-producing tree, *Acacia senegal.* The collection areas in these countries were identified and the taxonomic status of the species and their variants determined. This project commenced a significantly robust and soundly scientific approach to saving the continually degrading genepools of these species. Table 1 shows the state of field plantings of some gum-producing species, particularly *A. senegal,* in many countries in Africa.

In 1988, FAO developed a project plan for many dryland MPTs (see FAO Project GCP/RAF/234/FRA), for Tanzania and many other African countries.

Table 1: Some Records of past general or provenance trials on some gum producing tree species in Africa (Modified after IUFRO, 1989)

Species	Year planted	Location (Country)
Acacia senegal	1973	Nigeria
	—	Mauritania
	—	Niger
	1974	Senegal
	1975	Senegal
	1976	Senegal
	—	Sudan
Parkia biglobosa	1977	Burkina Faso
	1984	Burkina Faso
	1991	Burkina Faso, Nigeria
	1986	Mali

This plan recommended the following steps:

a) Genetic resources collection (*ex-situ* and *in-situ*)
b) Genetic resources conservation
c) Provenance trials, progeny trials and eventual breeding

It also suggested clonal development and selection based on robust clonal trials and then the establishment of clonal seed orchards. The species listed included *Acacia senegal,* obviously because of its importance for the production of gum arabic. Considering that gum arabic was mainly collected from the wild, FAO (1988) reported that in Tanzania only 40 kg of seed was demanded while for *Azadiracta indica,* demand was 600 kg per annum. This shows the low level of planting practiced for most of these MPTs. In *A. senegal,* five provenances were identified (Arusha, Singida, Ilangani, Tabora and Mbinga) in this proposal.

A network of 14 countries (2 regions) was suggested, and it covered Burkina Faso, Cameroon, Chad, Ethiopia, Gambia, Kenya, Mali, Mauritania, Niger, Nigeria, Senegal, Somalia, Sudan and Tanzania. Twelve of these countries were involved in the network suggested by IUFRO (1989) on *Acacia senegal* (see Table 2).

On IUFRO's (1989) request, countries suggested the species in which they were interested but this process was probably wrong. It is thus valuable that a preference survey on gum, resin and tannin including essential-oil bearing trees be carried out in each of the countries.

Table 2: Status of in-country activities in breeding and related research (Modified after IUFRO, 1989)

Country	Biology of tree spp	Clonal and Progeny	Seed Ordered dev.	Veg Prop.	Tissue Culture	Conserve
Burkina Faso	x	x	x	x	—	x
Cameroon	—	x	—	x	—	x
Chad	—	—	—	x	—	x
Ethiopia	—	—	—	—	—	x
Gambia	—	—	—	—	—	x
Kenya	x	x	x	x	x	x
Mali	—	—	—	—	—	x
Mauritania	—	—	—	—	—	x
Niger	—	x	x	x	—	x
Nigeria	x	x	x	x	x	x
Senegal	x	x	x	x	x	x
Somalia	—	—	—	—	—	—
Sudan	—	—	—	—	—	—
Tanzania	x	x	x	x		x

The Process of Genetic Improvement

Many plants produce gums. Various presentations at this meeting have already described gum-producing trees and mentioned the various types which include: Gum karaya (*Sterculia* gum), *S. villosa,* Gum arabic (*Acacia senegal* gum), *A. senegal,* Gum combretum (*Combretum* gum), *Combretum nigicans*; and Gum talha (*Acacia* gum), *A. seyal* and *A. sieberiana.* The situation is the same with resin and essential-oil producing plants (Fig. 1).

Where many plants are involved in the production of useful products, we need to go through various processes in order to get to the priority species and goals of producing improved products (Fig. 2). It is vital that a list of wanted species and traits be generated for each country. This process of species prioritisation is well documented by ICRAF (Jaenike *et al.*, 1996) and can help to identify priority species in each of the countries.

Booth and Wickens (1988) described non-timber uses of selected arid zone trees and shrubs in Africa. They provided a clear account of the uses and the environmental needs of various multipurpose species, including those of *Acacia senegal.* Their account on *A. senegal* has provided the synthesis of information critically needed for developing a viable approach to the genetic improvement and domestication of this species.

Besides, it is important that the criteria for consideration be identified and discussed with farmers, users and in this case by foreign industries that use them and know what product consumers need. In the case of gums, the involvement of the FAO/WHO Expert Committees on Food Additives is vital. The support of the US National Academy of Sciences will also be invaluable so that the desired traits are considered for research, and followed strictly. *Acacia senegal* (the gum arabic producing tree) will be used as an

example here. However, for a multipurpose tree such as *Acacia senegal*, desirable tree criteria may include: fast growth, drought resistance, high gum yield, production of high quality non variable gum, and resistance to pests and diseases.
The process of genetic improvement will continue to follow the pattern described in Fig. 3, where range-wide germplasm collection and conservation will be carried out and inherent variability fully identified and captured. Genetic resources collection will follow the recommendations of FAO (1988), based on prior and adequate eco-geographic survey. Accessions will need to be duplicated at various locations to prevent loss in Africa as a result of constant instability.

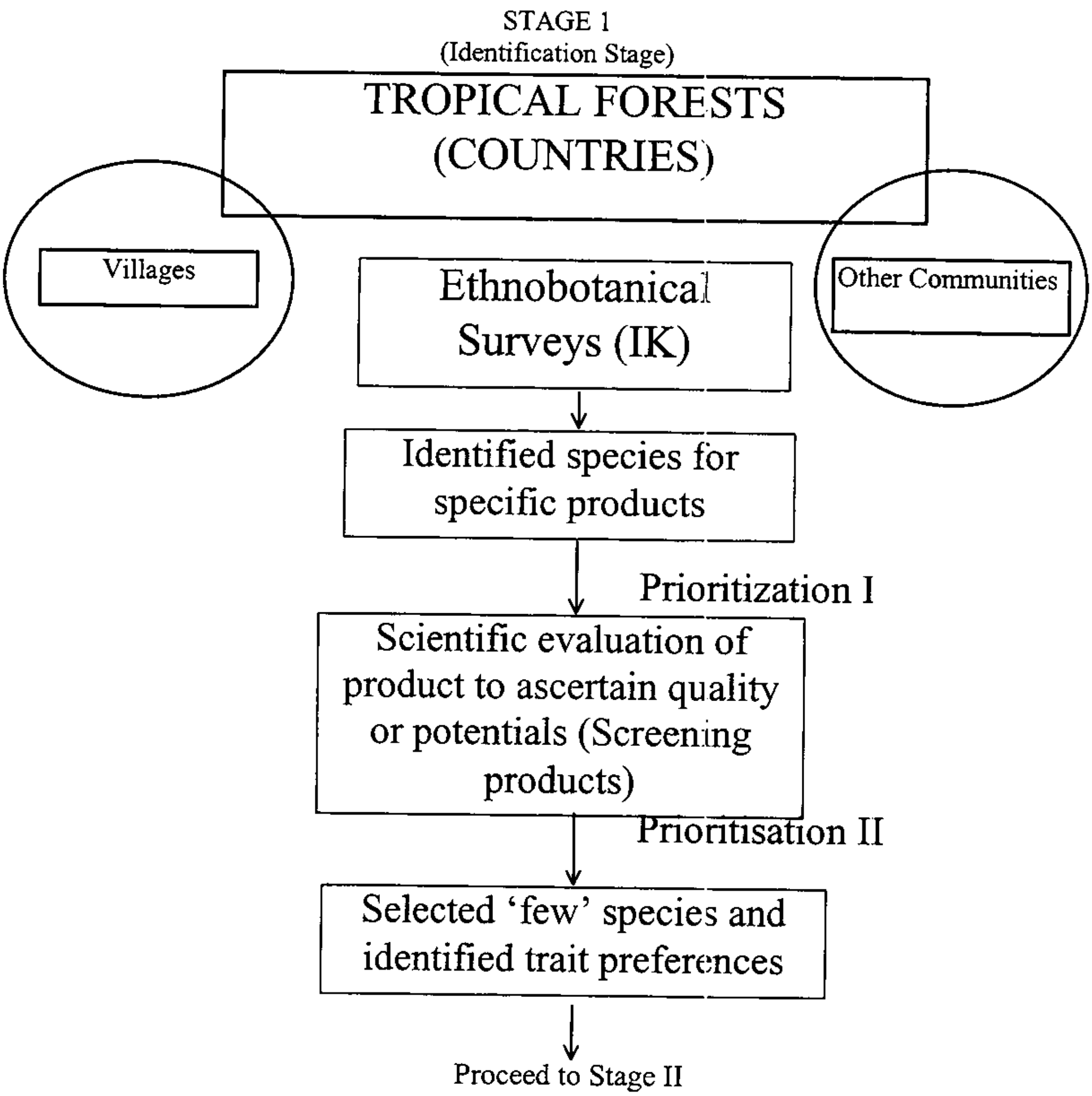


Figure 2: **Processes involved in obtaining priority species and determining goals of producing improved products**

The next phase (Phase III) will include the process for carrying out actual genetic improvement (see Fig. 4). It will need to first review and evaluate the values in the works already carried out in these countries. For example, in Tanzania, where provenances have already been identified and work on them planned and carried out, breeding and selection can proceed. Selection should be carried out at this stage together with all other support activities such as vegetative propagation which can result in early clonal trials. The development of seed orchards to ensure seed supply for commercial planting and the production of high-quality gums or other products as may be the case should also be fully considered. The final phase (Phase IV) will be the integration of the materials produced from the processes described in Figures 2 to 4 into appropriate production systems. In this case, institutions such as ICRAF and National Research Systems, (NARS), including NGOs can proceed to work.

STAGE II
(Genetic Improvement)

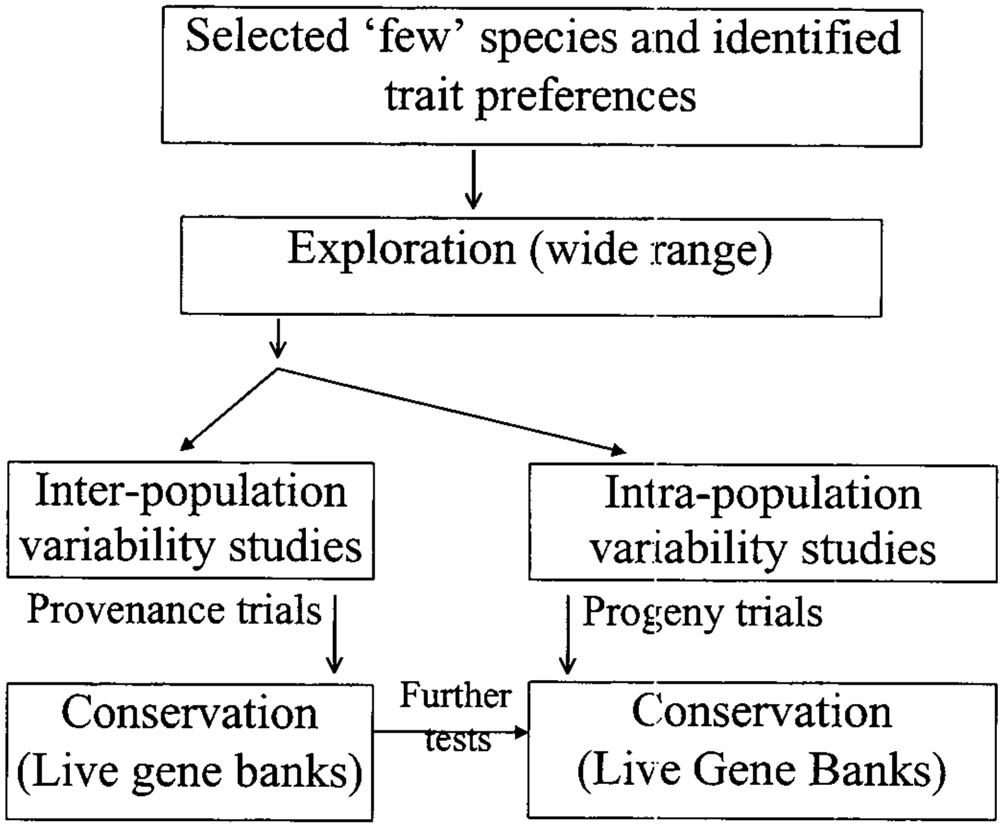
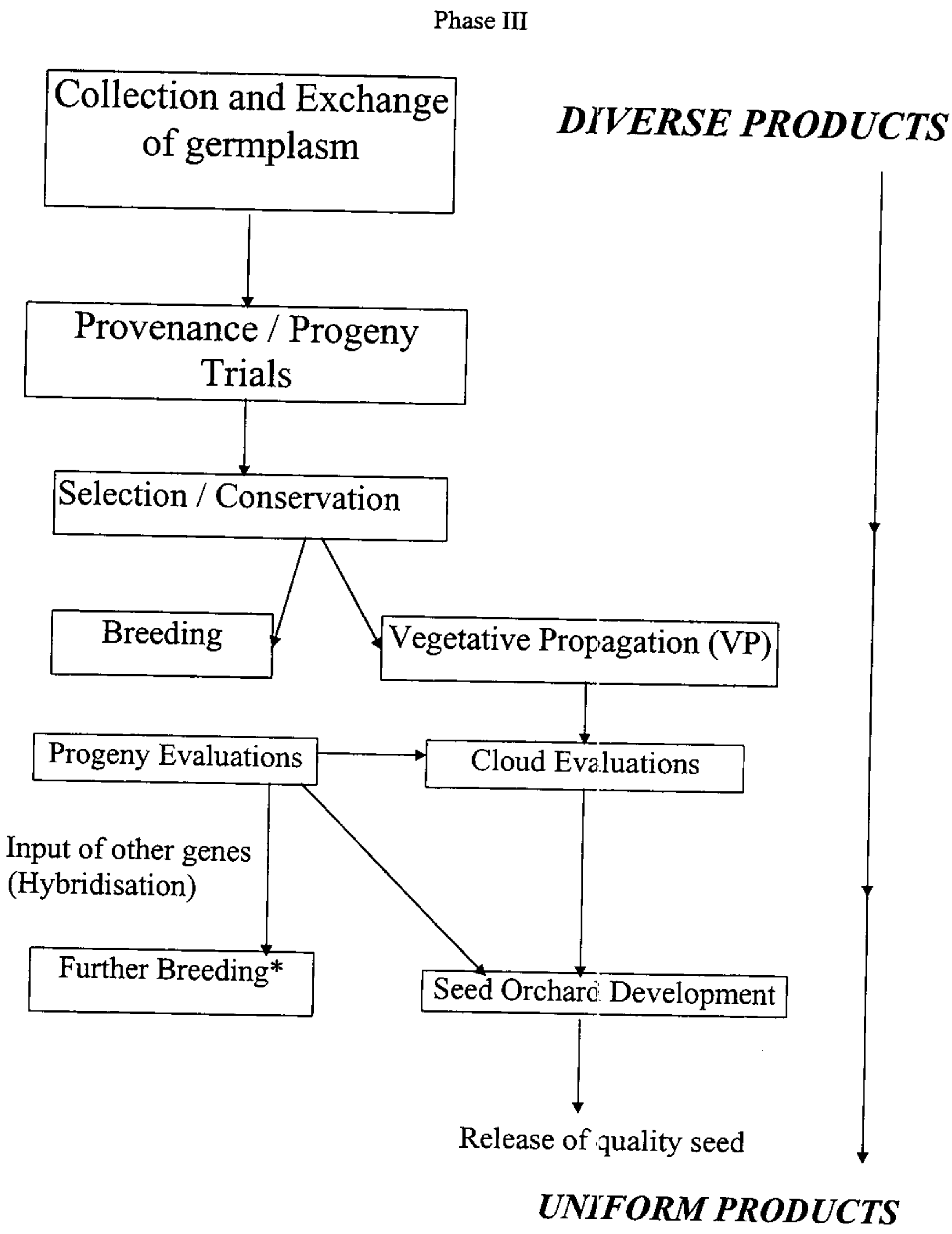


Figure 3. The process of genetic improvement



* Further breeding to solve specific problems (pests, diseases, etc.)

Figure 4: A regional Research Approach (West and East/South) for *A. senegal*

The improved materials produced will have to be integrated into a viable production system. Wiersum (1996) suggested the consideration of tree morphology. He suggested that this will need to be manipulated as it is a major component of the plant's ability to produce in its immediate environment. Wiersum (1996) was referring to the integration of these trees in agroforestry systems and for this, his assertions are viable.
This phase (Fig. 5) as suggested in the present paper will, however, consider in addition to agroforestry system, the intensive monoculture production systems which have so far been practiced in Africa with *Acacia senegal*, in its present small trial plantings.

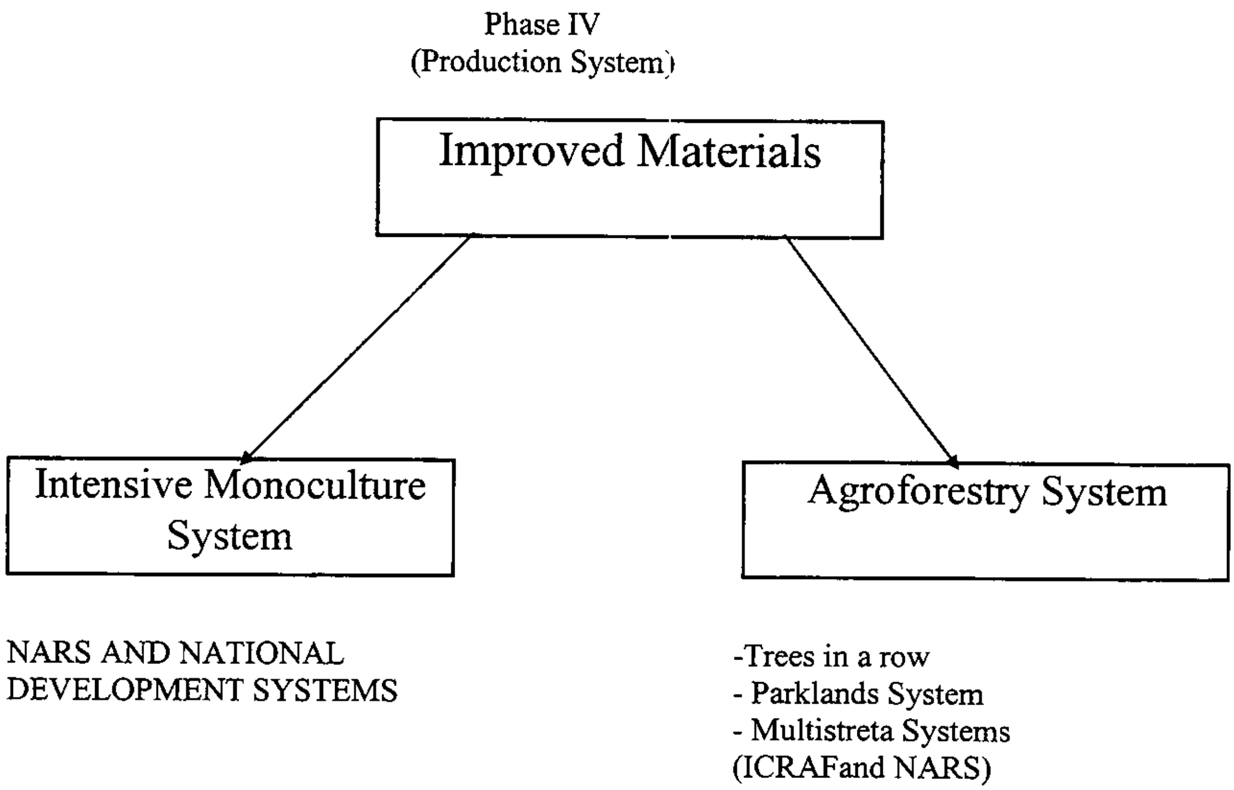


Figure 5: Integration of improved materials into a viable production system

It is common to consider seed orchards mainly as reliable sources of seed for afforestation, such orchards are also established to make genetic management of forests possible. Good "seed production areas" can as well be useful if careful selection of individuals with desirable heritable traits is made from parent trees or stands in the forest.

Through mass selection, genes can accumulate if reselections are confined to stands generated by such selections in the previous generation but this process can be saddled with various problems. Therefore, a strict program for seed orchard development in order to ensure the continued supply of quality seed for development is suggested (Ladipo *et. al.* 1993).

Strategy

Recent regional efforts on some Multi-purpose tree species such as *Parkia biglobosa* (EEC) and *Milicea excelsa* (ITTO) show that it is possible and productive to take a regional rather than a national approach to research on genetic improvement and domestication. Using *Acacia senegal* as an example, a 14 country collaboration (Table 2) is recommended. For ease of research management, a West and East/South Africa approach for research collaboration is suggested but full exchange of germplasm between both zones (East/West) is required and exchange of expertise between the groups (sub-regions) will also be encouraged. It is important to consider this, because in the past, lack of sufficient research collaboration caused major deficiencies in research approach. Particularly, there has never been sufficient exchange or interaction between researchers or experts within the continent or within regions. This has caused a lot of duplication and waste of funds, which could have been better used to further research.

With the efforts of the FAO, and IPGRI and other international agencies or organisations, these problems can be solved as they will act as "links-men" and the proper potentials inherent in these vital non-wood forest resources adequately realised.

Needs

Training is needed in order to allow proper research development. On this issue, the need to identify the key areas of research requiring immediate training or support is thus vital. Although this paper has dealt with *Acacia senegal* , as an example, the process for domestication suggested above can be applied to other species such as those producing resins or essential oils.

References

Abbiw, D. K., 1990. Useful plants of Ghana : West African uses of wild and cultivated plants. Intermediate Technology Publications and The Royal Botanic Gardens, Kew.

Booth, F. E. M. and Wickens G. E., 1988. Non-timber uses of selected arid zone trees and shrubs in Africa. FAO Conservation Guide No. 19. Food and Agriculture Organization of the United Nations, Rome. pp. 176.

Brenan, J. P. M., 1983. Economic plants. Biologist,30(2), 75–79.

FAO, 1988. Evaluatioln and development of genetic resources of dryland Multipurpose Woody Species. Project of the Govt. of Tanzania. GCP/RAF/234/FRA. pp61.

Harding, D., 1982. Conservation of genetic Resources Biologist 29 (5), 268 – 269.

Harlan, J. R., 1975. Crops and Man. American Society of Agronomy/Crop Science. Society of America, Madison, Winsconsin.

ICRAF, 1994. Annual Report. International Centre for Research in Agroforestry (ICRAF) Nairobi, Kenya.

IUFRO, 1988. Tree Improvement and Silvo-pastoral Management in Sahelian and North Sudanian Africa; Problems, Needs and Research Proposals. Compiled by C. Cossalter, D. E. Iyamabo, S. L. Krugman and O. Fugali. (Ed. D. E. Iyamabo). International Union of Forestry Research Organizations. pp 196.

IUFRO, 1989. Tree Improvement and Silvo-pastoral Management in Sahelian and North Sudanian Africa. Problems, Needs and Research Proposals (Ed. D. E. Iyamabo). pp 196.

Jaenicke, H., Franzel, S. and Boland, D. J., 1996. Towards a method to set priorities among species for tree improvement research: a case study from West Africa. Journal of Tropical Forest Science, 490–506.

Ladipo, D. O., Esegu, F. and E. A. Oduwaiye, 1993. The production of quality tree seed: In Proceedings of an International Workshop on Seed Procurement and Legal Regulations for forest reproductive material in tropical and subtropical countries. Ed. H. Wolf pp 555.

Lanly, J. P., 1988. In Non-timber uses of selected arid zone trees and shrubs in Africa. F.E. M. Booth and G. E. Wickens. Food and Agriculture Organization of the United Nations, Rome (FAO Conservation Guide) pp 176.

Leakey, R.R.B. and A.M.N. Izac, 1996. In Domestication and Commercialisation of non-timber forest products in Agro-forestry Systems. FAO, Rome, 1-6.

Seif El Din and Manar Zarroug, 1996. In Domestication and Commercialization of non-timber Forest Products in agroforestry systems FAO Rome, 176–182.

Simmons, A. J., 1996. In Domestication and Commercialisation of non-timber forest products in Agro-forestry Systems. FAO, Rome, 8-22.

Wiersum K.F., 1996. Domestication of valuable tree species in agroforestry systems: evolutionary stages from gathering to breeding. In Domestication and Commercialization of non-timber forest products in agroforestry system. FAO, Rome,147–159.

INDIGENOUS KNOWLEDGE AND ITS APPLICATION IN RESOLVING CONSERVATION AND UTILISATION PROBLEMS

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Local Knowledge Ignored

Arid and Semi-Arid Lands occupy extensive areas of Africa, up to 80% in the IGAD countries and between 30 and 90% in other African countries. Our knowledge base for such lands is woefully lacking. Emphasis has been placed on technological fixes to what are, more often than not, social issues (Barrow, 1996). Land conversion and excision to seemingly more productive land uses, such as irrigation and dryland agriculture is preferred to improving natural resource management. Change has been externally imposed, thereby ignoring the wealth of local knowledge and management experience which exists across the drylands of Africa. By ignoring that knowledge base, through external interventions, education systems which favor others, are being marginalised from their better lands. This perpetuates a neo-colonial and paternalistic perspective derived from agrarian and industrial-based "modern" society, and is probably the single most important contributing factor to the demise of the ASALs, their perpetual famine dependency.

To understand the ASALs we must understand how people survive and thrive, why they do what they do, and what mechanisms both technical and social they have put in place to make use of the limited resource base they have at their disposal - a resource base limited by the unforgiving climate. This is a wide subject, encompassing an understanding of pastoralism, dryland natural resource management and conservation (Ellis and Swift, 1988). For this presentation focus is going to be placed on how and why people inhabiting the drylands of Africa conserve, use and manage trees, with a particular emphasis on the topic of this conference.

Risk and Resilience Central to Dryland Natural Resource Management

Pastoralism is based on risk spreading and resilience - two interdependent factors vital to sustainable management of natural resources in such harsh environments, yet two factors which are misunderstood and misrepresented. For successful dryland natural resource management, risk spreading, mobility and resilience need to include some or all of the following attributes:

- wet, dry season grazing areas, and dry season forage reserves
- keeping of multi species of livestock including grazers (sheep, cattle, donkeys) and browsers (goats, camels)
- access rights, group or individual, to areas of land, rich resources e.g. trees
- water rights (and salt)

- practising low input opportunistic crop production
- making use of and storing wild fruits and foods and other natural products such as gums and resins, especially those of trees
- ability to sell stock and buy grain (and vice versa)
- dividing herds into smaller units
- social structure that enables sharing and lending of livestock
- linkages with other types of resource user to make best use of that resource for instance manuring of agricultural land, and use of crop residues.

Role of Woody Species, Timber and Non-Timber Forest Products

All detailed studies of uses and perceptions of trees by rural people, especially those in the drylands, show that there is an extensive ethnobotanical knowledge, with a keen appreciation of species' properties (Weber and Hoskins,1983; Leach and Mearns, 1988; Rochleau *et al.*, 1988; Chambers, *et al.*, 1989; Barrow, 1996). Trees are used for a wide variety of purposes, and nowhere more so than in the drylands where woody vegetation survives better, and produces more in the drier times. This detailed and extensive knowledge about individual tree species and their management is reflected in their people's life styles, and the extent of their dependence on trees. There is ample evidence across the drylands of Africa that many different tree species in different systems have been deliberately managed by the local people.

Some tree species are more important than others since they can survive and produce well even through the long dry seasons when they are particularly important, including drought times. Indeed, the woody vegetation may constitute the most valuable resource that such arid and semi-arid lands areas have and within such areas riverine forest and other rich patch areas of vegetation may be the most important (Ecosystems, 1985; Barrow, 1987; Forestry Department Turkana District, 1989; Barrow 1990; Gerden and Mtallo, 1990; Barrow, 1996). This knowledge reflects the life styles and the extent of their dependence on the woody vegetation including

- dry timber for woodfuel and charcoal
- building timber for houses, fencing and thatching
- food for livestock particularly in the dry season
- wild fruits and foods for people
- use of gums and resins for food, medicinal and cultural uses as well as for trade
- veterinary medicines for a variety of livestock diseases
- human medicines for a variety of diseases
- making of household utensils
- amenity for shade to act as a meeting place
- variety of cultural values, water purification, and ceremonial purposes
- access and ownership rights to trees

Dryland natural resource management strategies have evolved so as to make optimal use of a wide range of opportunities which mitigate risk and improve resilience. A range of livestock species, a wide array of food species available at different times of the year and the use of natural products for trade among other factors, contribute to this. Yet many of these production strategies are not recognised, not valued, and there are continued attempts to substitute them.

Dryland Natural Resource Management To Have Local Level "Value"

For dryland natural resource management to be important and develop, it has to have value, economic value at a local and national level. However, this value has to be balanced with risk and resilience. Livestock have an obvious and important value. However, the value of other natural products may be locally, but usually are not nationally, understood. To regain some of its viability, the gross pastoral product has to be better recognised, improved economic options need to be in place for the production and marketing of pastoral products and national governments must facilitate the enabling environment pastoralism so badly needs. Not to do so, will perpetuate the expropriation of the most productive drylands, denigration of pastoralism as a land use, and continued famine and aid dependency in the vast drought-prone lands of Africa.

Gums and Resins in Dryland Natural Resource Management:

The role of gums and resins is one component of a number of non-timber forest products, which if integrated and balanced with other opportunities for dryland management, can contribute to the economic well-being and long-term viability of such areas. There are well documented examples of the use of gums and resins in Africa, some of which are being presented in these proceedings (Hammer, 1982; Eckholm *et al.*, 1984; Seif el Din, 1987a; Seif el Din, 1987b). The trick is not to ignore local knowledge, but to understand it so as to be able to assist in adapting and improving it; not to ignore local land-use systems but to strengthen and support their integrity; not to bypass local social structures, but understand and provide synergy for them; and not to substitute or expropriate, but to enable local ownership.

If this workshop is to have impact on dryland natural resource management, it is going have to

- understand the wider issues of dryland natural resource management, where gums and resins are one component;
- assist with improved, but based on existing, production techniques;
- recognise and foster local ownership of land and resources (ownership may be single, but more likely based on a group; it is mostly *de facto*, but can be *de jure*);
- create viable and functional marketing networks for gums and resins; and
- demonstrate that gums and resins can make a contribution to land use and national economies that is worth the investment.

If we cannot start to improve dryland natural resource management, by acknowledging and valuing the wide range of economic options including those from livestock, produce from wild plants and trees, limited cropping, conservation, and tourism; by ensuring that an enabling policy environment is in place; and by building on the potential and opportunities found in the local knowledge base, then the plight of the drylands can only worsen - a plight not of existing land users' making, but externally, and maybe unwittingly, driven by national governments and donors.

References:

Barrow, E. G. C., 1987. Report of results and findings from a survey on 'Ekwar' carried out from November 1986 to July 1987. Lodwar, Forestry Department, Turkana district: 20.

Barrow, E. G. C., 1990. "Usufruct rights to trees: The role of 'Ekwar' in dryland Central Turkana, Kenya." *Human Ecology* **18**(2): 163-176.

Barrow, E. G. C., 1996. *The Drylands of Africa: Local Participation in Tree Management.* Initiatives Publishers, Nairobi, Kenya.

Chambers, R., A. Pacey, et al., Eds., 1989. *Farmer First: Farmer Innovation and Agricultural Research.* London, Intermediate Technology Publications.

Eckholm, E. and G. Foley, 1984. *Fuelwood: the energy crisis that won't go away.* London, Earthscan.

Ecosystems, L., 1985. Turkana District Resources survey 1982-1984. Nairobi, Report for Republic of Kenya, Ministry of Energy and Regional Development, Turkana Rehabilitation Project: 261.

Ellis, J. E. and D. M. Swift, 1988. "Stability of African pastoral ecosystems: alternative paradigms and implications for development." *J. Range Management* **41**(6): 450-459.

Forestry Department Turkana district, 1989. Draft forestry policy and guidelines for Turkana district. Based on the recommendations from district, divisional and location seminars on forestry and woody management for chiefs, leaders, elders, women and extension agents. Lodwar, Forestry Department, Turkana District.

Gerden, C. A. and S. Mtallo, 1990. Traditional Forest reserves in Babati District, Tanzania. A study in human ecology. Uppsala, Sweden, Forestry Trees and People and Swedish University of Agricultural Sciences - International Rural Development Centre Working Paper 128: 50.

Hammer, T., 1982. Reforestaton and community development in the Sudan. Bergen, Norway, Christen Michelsen Institute. DERAP Publication No. 150.

Leach, G. and R. Mearns, 1988. *Beyond the woodfuel Crisis. People, Land and Trees in Africa.* London, Earthscan.

Rochleau, D.and F. Weber, 1988. *Agroforestry in Dryland Africa.* Nairobi, ICRAF Science and Practise of Agroforestry.

Seif el Din, A. G., 1987. Gum Hashab and land Tenure in Western Sudan. *Proceeding of International Workshop on Tenure Issues in Agroforestry*. J. B. Raintree. Nairobi, ICRAF and Land Tenure Centre.

Seif el Din, A. G., 1987. The natural regeneration of *Acacia senegal* (L) wild. Khartoum, University of Khartoum.

Weber, F. and M. Hoskins, 1983. *Agroforestry in the Sahel. A concept paper based on the Niamey Agroforestry Seminar, 23 May to 9 June 1983*. Virginia, Department of Sociology, Blacksburg, Virginia Polytechnic Institute and State University.

INDIGENOUS KNOWLEDGE AND UTILISATION POTENTIALS OF SELECTED GUM, RESIN AND OIL PLANT SPECIES OF TANZANIA

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Abstract

This paper discusses indigenous knowledge and utilisation potentials of selected plants of Tanzania, producing gums, resins and oils. The selected gum-producing plant species include *Acacia senegal, A. seyal, A. spirocarpa* and *A. tortilis* whose 60% of the produce is used in the food industry. The resin plants are *Pinus elliottii, P. patula* and *P. caribaea* whereas selected oil plants include *Allanblackia stuhlmanii, A. ulugurensis, Adansonia digitata, Eucalyptus spp.* and *Jatropha curcas*. Studies on uses of such products in other African countries are mentioned and discussed in this paper for comparison and reflection of the potential uses of Tanzania's forested land.

Introduction

Tanzania (mainland) has an area covering 88.6 million hectares; almost 50% of this area is covered by forests and woodlands (MLNRT, 1989). Only 0.3% of the forested area is covered by plantation forests, with the rest being natural forests. The distribution of the vegetation cover is: Woodlands (42,891,000 ha), Mangrove forests (80,000 ha); and Forests other than mangroves (1,400,000 ha) to give a total of 44,371,000 ha.

Many of the Tanzanian indigenous and exotic tree and shrub species found in these forest types are potential producers of gums, resins and oils. These forest resources contribute to the livelihood of mankind by providing Non-Wood Forest Products (NWFPs) of various sorts including gums, resins and oils. The pharmaceutical, fragrance, food, agricultural, epoxy resin and coating uses are constantly searching for such natural products from plants. Developing countries should use their forest resources to raise their GDP. In Peru, for example, NWFPs yield 90% of the use potential (Statz, 1997).

Humankind has always depended on plant products by utilising indigenous knowledge on forest resources use. Lewington (1990) documented that the inhalation and fumigation of the body with smoke from the burning of fragrant plant materials is one of the oldest uses of plants by humans. Another major use of plants is medicinal. Kasparek (1997) added that at least 35,000 plant species are used worldwide for medicinal purposes.

Because of their number, versatility, end use variation, dissimilarities of the producer base and resource richness, NWFPs represent one of the most challenging product groups from a marketing point of view (Lintu, 1995). For example, out of 3,000 essential oils known, approximately 300 have a commercial importance (Lintu, 1995).

Many authors have documented African indigenous knowledge on the utilisation of plant gums, resins and oils. In South Africa, for example, the Zulu use *Sclerocarya birrea* oil in preservation of meat and massaging the skin as a cosmetic (Taylor *et al.*, 1995). Maliehe (1995) reported that the oil of *Ximenia americana* is used as a cosmetic as well as for softening leather. According to FAO (1983), the kernel of *X. americana* yields 40 - 50% oil and the shell yields 5.9% fat. Lewington (1990) and Axtell and Fairman (1992) documented that the yellow oil obtained from *Balanites aegyptiaca* seeds in Sudan and Chad is used as a type of soap and is also edible.

Concerning plant gums, the uses vary between places. In Cameroon, for example the gum of *Canarium schweinfurthii* is used medicinally to dress wounds and as a cure of round worm and colic ophthalmia (Songwe, 1994) but in Geita Tanzania the use of this gum is in rituals only, in petty gold mines (Makonda, 1997).

Mwamba (1995) in his report for Zambia's resin-, gum- and glue-yielding plants, indicated that while *Acacia polyacantha* can yield gum used for dyeing and tanning, *Albizia adianthifolia* yields sassa gum which is used for cosmetics and book binding while *Piliostigma thonningii* yields gum which is used for caulking boats.

Some of the traditional uses of these products have been copied by industrial manufacturers. The resins from *Commiphora myrrha* and *C. abyssinica,* for instance, are used in some cosmetics and perfumes as well as pharmaceuticals in Sudan (Lewington, 1990). The same author added that gum karaya exuded from *Sterculia sp.* is an important dental fixative in the west. This product, together with gum arabic, is among the six important Indian gums (Soni, 1995).

Chemical analyses may promote some of the forest products. Mushove (1995) gave an example of the oil extract of *Tegetes minuta* (Mexican marigold), an obnoxious weed to have anti-nematode qualities and is used in organic agriculture. Zimbabwe is reported by this author to be the largest exporter of *T. minuta* oil in Africa.

The objectives of this paper are:

- To provide information on the indigenous knowledge on gums, resins and oils of selected plant species of Tanzania
- To provide information on the indigenous knowledge of the same products in other African countries
- To provide information on the potentials of the products to the economic development of the people and the nation at large
- To provide information on areas needing research and economic investments.

Selected gum, resin and oil plant species of Tanzania

Gum plants

Acacia spp

Gum arabic is the most important gum in Tanzania. The product is tapped from acacia trees in unmanaged natural forests mainly in Shinyanga, Dodoma, Singida and Tabora Regions. Practically, gum arabic is obtained from Acacia woodland species but species of importance include *Acacia senegal* (true gum arabic) and *A. seyal*. The gum is only collected from a few species and active tapping is still more limited.
Contrarily, in Sudan, where almost 90% of the world market supply of gum arabic comes from (Awouda, 1976), acacias are grown as part of an agrosilvipastoral system and these produce 70% of Sudan's gum arabic (Jamal and Huntsinger, 1993). The figures for Sudan's exported gum arabic were at 56,000 tons in 1966 (Pollath, 1972). The annual production of gum arabic has been reported by Tanzania Bureau of Statistics (1994) to stand at 1,000 tonnes out of which 50% is exported. The export was at a peak in 1990 when 740 tonnes were exported. Constraints to expanding the market in Tanzania include an unstable world market prices of the product and failure to meet quality requirements for export trade. However, Anderson (1993) reported that gum arabic and gum karaya meeting international specifications have commercial demand at competitive prices. Moreover, information about the resource and present collection practices to be able to assess the potential for gum collection is inadequate.
Statz (1997) reported that 55 - 60% of gum arabic is used in the food industry. Traditionally, gum arabic is an important food for pastoralists and hunters.

Resin plants

Resins of potential development include turpentine and rosin which is obtained by tapping pine trees. Tanzania has 80,000 ha of industrial softwood plantations which form sources of resins. The species grown are *Pinus elliotti* and *P. caribaea*. The major potential sources of supply are within Sao Hill in Iringa, Buhindi and Rubya in Mwanza, Rondo in Lindi, Matogoro in Ruvuma, Ruvu in Coast region, Rubare in Kagera and Ukaguru in Morogoro.

These sources have not yet been tapped and the potential economic value is not yet recognised. Makupa (1995) reported that all commodities which are partial derivatives of turpentine and rosin consumed by various industries in Tanzania are imported and most of them could be substituted if the existing sources in Tanzania were exploited. The greatest single use of rosin in Tanzania is for sizing in paper production (Makupa, 1995). Other uses of oleo-resin are in the paint and varnish industry as a solvent and thinning agent, in the manufacture of adhesives, printing inks, rubber products, greases and lubricants.

Oil plants

Potential oil plants in Tanzania include *Allanblackia stuhlmanii, A. ulugurensis, Adansonia digitata, Eucalyptus globulus, E. maidenii* and *E. regnans* and *Jatropha curcas*.

Allanblackia spp.

Allanblackia stuhlmanii and *A. ulugurensis* are found growing naturally in montane forests of the East Usambaras and Uluguru. Nuts of these species yield an edible fat used locally for cooking, lighting and as a liniment.

Mugasha (1980) observed that a good *A. stuhlmanii* tree can produce up to 300 fruits in one fruiting season. According to Glendon (1946 cited by FAO 1983), sun-dried nuts of *A. stuhlmanii* contain 51% fat. In Kenya, the nuts are used in the manufacture of the famous cooking fat "Kimbo".

Adansonia digitata

Tanzania has vast areas with baobab (*Adansonia digitata*) growing in natural habitats in such regions as Dodoma, Iringa, Singida and Shinyanga. The tree is well known throughout the country for its fruits which are traded for making juice that has a similar taste to that of *Tamarindus indica* fruits. The adansonia fruits and juice are locally known as "ubuyu".

In Dodoma the seeds of baobab are used locally as a source of cooking oil. These seeds contain 37% edible oil (FAO, 1988a; 1988b) which could be extracted easily using modern technologies. To-date, no efforts have been made by the government authorities concerned to utilise these resources.

Eucalyptus spp.

Tanzania has several plantations of *Eucalyptus* species. Large plantations are found in Arusha, Mbeya and Iringa. Essential oils that can be extracted from eucalyptus include cineole, citronellal, phellandrene and piperitone which find uses in pharmaceutical and perfumery compounds.

The blue gum trees (*Eucalyptus globulus* and *E. maidenii*) produce cineole from leaves; the cineole is used for treating nose and throat disorders. The local uses of eucalyptus oil in Geita District has been reported by Makonda (1997) where eucalyptus leaves are smoked to repel mosquitoes and as a cure for yellow fever. Kiwalabye (1995) reported that in Uganda, *Eucalyptus citriodora* leaves were used in the treatment of cough.

Extraction of eucalyptus oils from plantations would improve profitability of primary forest activities and provide employment to the local people. However, as for resins, the actual production of eucalyptus oils in the country has not yet been developed. The trees are only used for poles, posts and pulp.

Jatropha curcas

Jatropha curcas is widely planted in Tanzania as hedges. It is also planted in graveyards for demarcation. The seeds of this plant contain 35% non-edible oil (Henning, 1997). In Geita

District, Tanzania, the oil is used for lighting and the sap from leaves and twigs is used for cleaning tongues particularly in children (Makonda, 1997).

Henning (1997) reported that in Mali, *Jatropha* oil is used as fuel in pre-combustion chamber engines and in manufacturing soap. This technology could also be imported into Tanzania, which does not produce mineral oil. The *Jatropha* oil would form a substitute for diesel, to save some foreign exchange and also provide raw material for manufacture of soap and boost the local economy.

Conclusion and Recommendations

The forests of Tanzania are a great reservoir of gum, resin and oil plants which have been neglected. Important information about these products is lacking and so the products are greatly under-valued and under-utilised.

These products are of social and economic importance; they provide employment and income opportunities and are potential foreign exchange earners.

To maximise benefits from these resources, the following actions are recommended:

- More research on promising gum, resin and oil plant species to establish information concerning quantities, quality, potential uses and possibility of domestication
- Development of appropriate harvesting methods and tools and timing of operations, processing and grading. These will help to minimise injuries to the plants concerned and improve quality and quantity of the products
- Development of programmes geared towards enabling the rural communities to help themselves using the plant resources available or which can be made available

References

Anderson, D.M.W., 1993. Some Factors influencing the Demand for Gum Arabic (Acacia senegal (L.) Willd.) and other Water Soluble Tree Exudates. *Forest Ecology and Management 58(1-2): 1 - 18.*

Axtell B.L. and R.M. Fairman, 1992. Minor Oil Crops. FAO - Agricultural Services Bulletin No. 94, 241pp.

FAO, 1983. Food and Fruit-bearing Forest Species I: Examples from Eastern Africa. FAO Forestry Paper 44/1 Rome.

FAO, 1988a. Traditional Food Plants. FAO Food and Nutrition paper 42, Rome.

FAO, 1988b. Non-Timber Uses of Selected Arid Zone Trees and Shrubs in Africa, FAO Conservation Guide 19, Rome.

Henning, R.K., 1997. More energy- more food. *Gate 2: 33 - 37.*

Kasparek, M., 1997. Medicine for the billions. *Gate 2: 23 - 26.*

Kiwalabye, V., 1995. The Diversity of Medicinal Plants in Uganda. Paper presented to the 2nd Roundtable Discussion on Non-Wood/Timber Forest Products: 21-23 Nov. 1995 Pretoria, South Africa.

Lewington, A., 1990. *Plants for People.* Natural History Museum, London.

Lintu, L.,1995. Marketing NWFPs in Developing Countries. Trading and Marketing of Forest Products, *Unasylva 183(46): 37 - 41.*

Makonda, F.B.S., 1997. The Role of Non-Wood Forest Products to the Livelihood of Rural Communities of Geita District, Mwanza Tanzania. MSc. thesis SUA Morogoro.

Makupa, E.O.K.,1995. Factors Affecting Gum Oleoresin Yielding Potential and Quality in *Pinus elliottii* and *Pinus patula* at Sao Hill Forest Plantation, Tanzania MSc. thesis, SUA Morogoro.

Maliehe, T.M., 1995. Non-Wood Forest Products in South Africa. A pilot Country Study prepared for the Commonwealth Science Council.

Ministry of Lands, Natural Resources and Tourism, 1989. Tanzania Forestry Action Plan 1990/91 - 2007/08, Dar es Salaam

Mugasha, A.C., 1980. The Silviculture of Tanzania Indigenous Tree Species Vol. I. *Allanblackia stuhlmanii.* Tanzania Silvicultural Research Note No. 37, 7pp.

Mushove, P., 1995. A review of the Socio-economic Potential of Non-Wood/Timber Forest Products in Zimbabwe.

Mwamba, C.K., 1995. Zambia's Perspective Toward Non-Wood/Timber Forest Products. Paper presented to the 2nd Roundtable Discussion on Non-Wood/Timber Forest Products: 21-23 Nov. 1995 Pretoria, South Africa.

Nkana, Z.G. and S. Iddi, 1991. Utilisation of Baobab (*Adansonia digitata*) in Kondoa district, Central Tanzania. Record No. 50, SUA Morogoro.

Statz, J., 1997. Non-Timber Forest Products: A key to Sustainable Tropical Forest Management. *Gate 2:4 - 11.*

Songwe, N.C., 1994. Extractivism and Potentialities of Multiple Use Forest Resources in Cameroon with Special Reference to Non Timber Forest Products. Paper presented at the workshop on Extractivism and Potentialities of Multiple Use Forest Reserves in Africa: 8-13 May 1994, Naro Moro Kenya.

Soni, P.L., 1995. Some Commercially Important Indian Gum Exudates. *Indian Forester 121(8): 754 - 759.*

Tanzania Bureau of Statistics, 1994. Statistical Figures on Agricultural and Forestry Crops. PMO - Dar es Salaam.

Taylor, F.W., K.J. Butterworth and S. Mateke, 1995 The Importance of Indigenous Fruit Trees in Semi-Arid Areas of Southern and Eastern African. Veld Products Research, Gaborone Botswana.

SOME EXPERIENCE ON ADAPTIVE RESEARCH INPUT ON NATURAL RESOURCE USE: THE CASE OF GUMS AND RESINS IN MUKOGODO RANGELANDS, LAIKIPIA DISTRICT, KENYA

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Background

Mukogodo Division on the Northern edge of the Laikipia Plateau comprises slightly over 1000 sq. km. with an altitudinal range of 1600 - 2000 m A.S.L. Annual rainfall varies between 400 and 600 mm per annum (Berger, 1989). As a result of the varying topography and climatic characteristics, the division supports a wide range of physiognomically different vegetation types (Taiti, 1982). The main economic activity is semi-sedentary pastoralism. Currently, the wood component is dominated by the genera *Acacia, Euclea* and *Acokanthera* - while the grass layer is predominantly *Themeda, Cynodon, Eragrostis* and *Pennisetums*. These are interspersed with a tree/shrub layer of *Dodenea, Solanum*, and *Ipomoea* among others. Admittedly, the ecosystem is fairly complex with no comprehensively described aggregate of fauna and flora. The balance of the wildlife, livestock, vegetation production systems and man's activities is equally complex in a drastically changed ecosystem.

Over time, the human interphases have greatly interfered with the natural course of species succession and differentiation to an extent of negatively shifting the balancing forces within the different production systems in the ecosystem. Briefly, these interphases can be broadly grouped in three time frames. Prior to the 19th century, the Mukogodo Maasai characterised by the different groups i.e. Iloshon, Mukogodo, Ilngwesi, Ilmumonyot, Ildigiri and Illeuwaso coexisted with the vegetation as hunters and gatherers (Herren, 1993), with defined grazing corridors.

Early this century, the European settlers designated the hitherto "productive" rangeland, for beef ranching, locking out the Dorobo "reserves". This process was followed by the new-post independent government "one million-acre scheme project" that opened up the subdivision of the formerly private ranches to small scale farmers in Laikipia. The process has continuously introduced major conflicts in sustainable natural resource use including gums and resins.

An earlier inventory of Mukogodo Forest based on panchromatic photographs 1:25,000, (Blacket, 1994), described estimates of the forested area and standing volumes. This report was inadequate on information on other flora and fauna notwithstanding the rich indigenous knowledge by the locals as later confirmed by other studies (Gachathi and Kariuki, 1996). The usefulness of the forest for dry season grazing and ecotourism biodeversity among other uses was conspicuously omitted.

The fact that gums and resins have been commercially extracted in neighbouring Isiolo District especially since the involvement of SALTLICK, has generated considerable interest in the assessment of the potential for resource availability in Mukogodo by different development practitioners. The importance of Non Wood Forest Products (NWFPs) to sustainable resource use had not been addressed sufficiently. Consequently, various attempts have been made to understand the vegetation trends and more recently the gums and resins resource availability. An earlier attempt by the Kenya Ministry of Culture and Social Services jointly with Laikipia Research Programme (1993) was inadequate in quantifying the amount of resource available within Mukogodo Division.

Subsequent studies by the ASAL - Applied Research Unit jointly with Kenya Forestry Research Institute, World View (K) and the local community participatorily used a holistic approach in attempting to understand the critical links between the flora and the different Non-Wood Forest Products in Mukogodo ecosystem including gums and resins.

Methodology

A review of the vegetation resources within Mukogodo rangelands was carried out based on the work of Taiti (1982). From this review, the main vegetation types were identified. A participatory reconnaissance survey was undertaken in 1995 (Muchiri and Kariuki, 1996). The survey employed various participatory tools including: transect walks/drives, interactive group/individual discussions, observations, and demonstrations on various preparation methods.

A formal survey was also carried out where the area was clustered into five clusters and eight sub-clusters according to group ranches. The snowball method (Blalock, 1981) was used to lead to key informants. Nineteen key respondents (3 females and 15 males) were interviewed and plants of focus by each respondent identified. Samples of unidentified plants were pressed and later verified at the National Museum herbarium. Further data verification was carried out by a taxonomist during a follow-up study on NWFPs (Gachathi and Kariuki, 1997), where 11 informants classified by the community were involved (Appendix I).

In focusing on gums and resin resources, references were made to the work done by the Department of Social Services (1993) where information on principal production areas was obtained. This was followed by belt transect surveys with the assistance of local people. Within a given area, sampling was based on the belt transect approach (Chikamai and Mbiru, 1995) where 0.4 ha., square plots were established at every sampling point. Data was collected on density by diameter class of the main gum-and resin-producing species, density of associated species, terrain and soil conditions.

Results and Discussion

Reconnaissance Survey

Indigenous knowledge among the Mukogodo Maasai on natural vegetation was found to be enormous. However, there seem to be gaps in knowledge levels between generations. The reason perhaps is due to diminishing inter-generation interactions as younger generations ascribe to changing lifestyles. The male respondents portrayed a generalised knowledge base with the exception of isolated experts on ethnomedicine while female gender was specific on plants with attributes on food values and sickness in children.

The Mukogodo Maasai have through generations depended on natural flora principally or supplementarily to subsidise either directly or indirectly their livelihood. Flora utility was found to have both material and non materials attributes (Table 1a). A total of 78 plant species with multiple uses were sampled.

Table 1a: Ranked use groups of Mukogodo flora by the Mukogodo Maasai

User group	* Frequency	Comments
1. Ethnomedicine Human	52	One spp. applied to between 1 & 4 ailments
2. Construction	18	Focus on Manyattas, cattle bomas and dead fencing
3. Fodder	17	Differentiated to wet, dry and all season fodder, forage
4. Food	16	Mainly fruits, soup, tea additives, chewing gum
5. Fuelwood	7	Preference on high density, less smoky/ashy spp.
6. Crafts	7	Focus on quivers, bows, arrows, bee hives rungus
7. Condiments	7	Perfumes, necklaces, beadwork
8. Bee forage	6	Prolific flowering spp. for white/black and yellow honey
9. Ethnovet	5	Very narrow spp. on focus??
10. Toothbrush	4	Spp. with medicinal attributes for oral health
11. Preservatives	4	Food and milk products
12. Insecticide	2	Repellents e.g. houseflies/cockroaches
13. Ceremonial	2	Rituals e.g. circumcision

* Frequency refers to different uses under the 13 classified groups

Source: Field data collection, Mukogodo, (1995).

It is clearly evident that the Mukogodo Maasai appreciate the gum/resin-producing plant species. However, the main use of these products is chewing gum (User Group 4) and fastening arrow heads on arrow shafts (User Group 6). The point of interest is, however, the other priority uses that the same plant species fulfil which gives a pointer to potential conflicts in resource management. A summary of plant species of gums/resins potential is presented in Table 1b.

Table 1b: Plants of potential for gums and gum resins exploitation

Plant species	*Frequency (user groups)	Utilisation by community	Potential
Acacia senegal (ALDERKESI)	5	Gum from the stem eaten as chewing gum, medicinal, bee forage, fencing	Production of gum arabic
Boswellia neglecta (SILALEI)	4	Resinous aromatic gum used as chewing gum, gum used on arrow shafts, medicinal, fencing.	Production of resins which are processed into resinoids
Commiphora africana (LOISHIMI)	4	Fragrant gum, chewing, gum used as arrow heads on arrow shafts for play by new initiates, circumcision, live hedge.	Production of copins.

* Frequency refers to different uses under the 13 classified user group

Source: Field data 1996-97

Table 1c: Priority plant species in use (frequency) and uses (use groups) in Mukogodo

Plant name	* Frequency	** Use groups
1. *Olea africana* (Lorien)	5	5
2. *Acacia senegal* (ALDERKESI)	5	4
3. *Croton megarocarpus* (Merigwet)	5	4
4. *Senecio stuhlmanii*	4	4
5. *Acacia nilotica*	4	4
6. *Carrisa endulis*	4	4
7. *Boswellia neglecta* (SILALEI)	4	4
8. *Croton dichogamus*	4	3
9. *Cordia sinensis*	4	2
10. *Aloe kendogensis*	4	2
11. *Zanthoxylum chalebeum*	4	2
13. *Clerodendrum myricoides*	4	1

* Frequency refers to different uses under the 13 classified user groups

Source: Field data collection, Mukogodo, (1995).

An analysis of how the Mukogodo Maasai exploit their vegetation resources shows a consciousness on sustainability. The traditional uses revealed a detailed and delicate network of interaction between the society and the environment. The emphasis on non-extractive uses and particularly on Non Wood Forest Products (NWFP) attest to inbuilt community conservation of natural vegetation. Ten out of 13 user groups are non-extractive in nature (Appendix I). Careful selection on harvesting was shown, among the extractive user groups, fuelwood, construction and crafts. For instance, the exploitation of *Psyda arabica* for arrow making was mainly from selected branches and twigs while the bush/shrub was left standing.

3.2 Resource Inventory (Ground Truthing)

The main species of importance in gums and resins production represented in Mukogodo Division are *Acacia senegal* and *Commiphora* species. Generally, the main stands where these species are found are on the outlying fringes of Mukogodo Forest, particularly along the lower glades facing Isiolo District.

Acacia senegal was confirmed to occur in four different clusters towards the more arid northern part of the division bordering Isiolo. Significant densities were found in Sek-Louwai, Ewaso, Tura (Upper and Lower) and Leshesh areas though in the later case, the occurrence is fairly patchy. A characteristic feature of these clusters is rugged terrain with ridges interspersed with Luggas (dry river valleys) and sandy to stony/rocky soils. The dominant vegetation is *Acacia/Commiphora* bushland.

An analysis of stocking density revealed that the area around Tura has the highest density (overall mean density of 192 sph) and Sek-Louwai the lowest (145 sph). However, there was greater disparity in the density within Tura, probably resulting from the patchy nature of the resource as observed from the value of C.V. The resource was confined mostly on the slopes of ridges and low hills (Table 2a) and in Ewaso (Table 2b and 2c). This implies that there is probably better distribution of the resource in the latter areas and hence overall higher representation. An assessment of the quantity of resource revealed higher representation in the juvenile age class which indicates normal stand dynamics.

Table 2a: Density (sph) of *Acacia senegal* in Tura (upper and lower), Mukogodo Division

Terrain: Ridges and low hills
Soils: Sandy to murram

Site	Density by diameter class <5 cm	5 - 10 cm	> 10 cm
1	170	180	160
2	220	130	70
3	140	230	41
4	110	115	60
5	340	250	100
6	360	380	220
Mean	**225**	**214**	**109**

Mean density = 182 std dev. = 98 C.V. = 54%

Table 2b: Density (sph) of *Acacia senegal* in Ewaso, Mukogodo Division

Terrain: Plains and low hills
Soils: Sandy

Site	Density by diameter class		
	< 5 cm	5 - 10 cm	> 10 cm
1	170	124	116
2	230	140	127
3	240	160	134
Mean	**213**	**141**	**126**

Mean density = 160 std. dev. = 43 C.V. = 27%

Table 2c: Density (sph) of *Acacia senegal* in Sek Louwai, Mukogodo Division

Terrain: Ridges
Soils: Sandy to stony

Site	Density by diameter class		
	< 5 cm	5 - 10 cm	> 10 cm
1	150	200	160
2	130	140	120
3	140	140	110
4	220	120	140
Mean	**160**	**150**	**133**

Mean density = 148 std. dev. = 31 C.V. = 21%

When examining the potential of the area for gum arabic production, one indicator is the abundance of the resource. However, lack of relevant secondary data, i.e., spot images and aerial photographs limited the team's ability to produce resource maps. As a result, it was not possible to quantify with certainty the amount of resource available. However, observations made during the sampling combined with data analysis revealed that on the overall, the areas of Sek-Louwai and Ewaso have expansive resources which extend into neighbouring Isiolo District. The latter is known for gum production and offers opportunities for ready market of gum arabic. Although the area around Tura recorded high densities, the resource is generally patchy in distribution with relatively low overall amount.

The second and perhaps major factor relates to conditions for gum production. Gum arabic and gum resins are produced when the trees are under stress. In particular, they are produced under conditions of high temperatures (> 30° C) over a prolonged period. The areas of Ewaso and Sek Louwai are on relatively lower altitude and lee-ward side which experience relatively higher temperatures. Reports of gum production have been reported within the two areas. However, Tura is relatively higher in altitude and generally cooler. These conditions are not favourable for gum production and indeed local people reported little gum production.

Among the resin-producing species, only *Commiphora africana* was recorded in reasonable quantities. Others include *Commiphora schimperi, Acacia seyal* and *Boswellia* species. The principal region was the area around Sek-Louwai. A mean stocking density of 24 sph was recorded but with a generally higher disparity between sampling points. Compared with *Acacia senegal,* it had higher representation in the mature diameter class (Table 3). In terms of resin production, the species is known to produce copious amounts. There is documented information which attributes the use of resin as plaster for abdominal spasms and against fever. However, not much commercial application has been established for the resin in the country.

Table 3: Density (sph) of *Commiphora africana* in (Sek-Louwai), Mukogodo Division

Terrain: Ridges
Soils: Sandy to stony

Site	Density by diameter class		
	< 5 cm	5 - 10 cm	> 10 cm
1	25	15	40
2	53	8	60
3	10	15	25
4	13	3	15
Mean	**25.25**	**10.25**	**35**
Mean density = 24	**std. dev. = 17**	**C.V. = 70%**	

The way forward

From the foregoing discussion, it is apparent that gums and resins contribute significantly to the livelihood of the pastoral Maasai in Mukogodo Division. Nevertheless, quantities for viable and sustainable commercial exploitation are limited. This shortcoming therefore, poses new scenarios for the future exploitation.

First, exploitation of gums and resins should not just be seen as an end in itself but a means to an end. The gums and resins will therefore, provide opportunities for adding value to the crucial process of range improvement and rehabilitation where the main out put is livestock production. As a tier technology to prioritised user groups, stakeholders should use gums and resins initiative as an entry point to promoting viable projects in the rangelands.

Secondly, mechanisms for cross fertilisation and dialogue between the local expert systems (based on ITK) and external practitioners unfold in the gums and resins initiatives. The interface between the two knowledge paradigms has the potential to harmonise conflicting goals and expectations of key stakeholders.

Thirdly, an understanding of why the neighbouring Isiolo District has an upper edge in exploitation and commercialisation of gums and resins as compared to Mukogodo Maasai requires ground truthing. Are their inherent skills and values embedded among the Borans and Samburu linked to exploitation of gums and resins which the Mukogodo Maasai lack?

Fourthly, attempts to exploit the limited gums and resins resources are also hampered by Socio-cultural dynamics among and between neighbouring communities (i.e. the Maasai visa -a-viz. Samburu and Borans). This therefore calls for affirmative action from the law enforcement agents to settle livestock ownership and pasture management-related conflicts. Once conflicts are resolved, an enabling environment for exploitation and marketing of gums and resins is likely to prevail.

Fifthly, local collectors and dealers in gums and resins are "voiceless" given the non existence of a formal institution to stabilise the market forces. It is therefore imperative that such an institution/organisation is put in place. The initiatives by ITFSP with GTZ (i.e,. formation of Gum Arabic and Resins Association - GARA), which among others is to look into the welfare of stakeholders, is welcome.

References

Blacket, H.L. 1994. Kenya Indigenous Forest Conservation Programme. Forest Inventory Report No. 15, Mukogodo.

Berger, P. 1989. Rainfall and Agroclimatology of the Laikipia plateau, Kenya. Geographica Bernesia, Berne,

Blalock, H.M. 1981. Social statistics. Singapore: McGraw - Hill, Second edition.

Chikamai, B.N. and Mbiru, S. 1997. Assessment of gum arabic and gum resin resources in Mukogodo Division, Laikipia district.

Gachathi, F.N. and Kariuki, A.M. 1997. Useful Non-Wood Forest products of Mukogodo forest and adjacent rangelands. (Unpublished).

Herren, U. 1993. "Socio-economic strategies of Pastoral Maasai Households in Mukogodo, Kenya". PhD Thesis. Department of Ethnobotany, University of Berne.

Muchiri, B. and Kariuki, A.M. 1996. A survey of Indigenous food plants of Socio-economic importance in Mukogodo rangelands, Laikipia. (Unpublished).

Republic of Kenya, Min. of Culture and Social Services and LRP. 1982. The vegetation of Laikipia District, Kenya. Laikipia Mount Kenya Papers B-2.

Taiti, S. W. 1992. The vegetation of Laikipia District, Kenya

APPENDIX I

List of plants and their uses from the Mukogodo Maasai perspective

Plant name **Botanical /(Maasai)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
1. *Dodonea viscosa* (Ilgilai)	x				x	x			x				
2. *Solanu incanum* (Ntulelei)	x					x							
3. *Synadenum grantii* (Olkorbobit)	x							x					
4. *Cassia dydrimobotria* (senetoi)	x												
5. *Euclea divinorum* (Olkingei)	x				x	x		x					
6. *Melhania verutina* (Epupoi)	x												
7. *Withania somnifera* (Leisayet)	x												
8. *Olea hoschtetteri* (Lorondo)	x	x		x				x					
9. *Acacia nilotica* (Olkiroriti)	x	x		x				x					
10. *Carrisa enduris* (Lamuriaki)	x	x					x	x					
11. *Olea africana* (Lorien)	x					x	x		x				x
12. *Psyda arabica* (Olombai)	x								x	x			
13. *Ipomoea hildebrantii* (Lokitengi)	x						x				x		
14. *Euphorbia graciliramea* Ikangu)	x												
15. *Croton dichogamus* (Olkirndingai)	x				x	x	x						
16. (Olkonyil)	x												
17.*Clerodendrum myricoides* (Olmakutukutu)	xx xx												
18. (Iltipirikwa)	xx												
19. *Grewia bicolar* (Ill)			x										
20. *Jasminum* sp. (Ilmaneen)	x												
21. *Euphorbia* sp. ( )	x												
22. *Combretum molle* (Olmomoi)	xx												
23. *Maerua triphylla* (Olamarak)	xx x												
24. (Ololoi)	xx						x			x			
25. *Acacia nubica* (Ildepe)	xx											x	
26.*Pyragmanthera discallensis* (Ilmeidim kooa)	x .						x						
27. *Ramnus staddos* (Olkolakola)	x						x						
28. *Sansavellia sp* (Oldupai)	xx												
29. *Pappe capensi* (Oldonganaiyoi)	x												
30.*Euphorbia heterochroma* (Engeletlit)	x						x	x					

31. (Olmenangi)	xx			x									
32. *Aloe kendogensis* (Suguroi)	xx x						x						
33. *Lantana* sp (makirkirienie)	xx												
34. *Berlena aegyptium* (sucha)	x			x									
35. (Sukurtut)i	xx												
36. *Acacia lahai* (Oltepesi)	x						x						
37. *Zanthozyllum challybeam* (Oloisuki)	xx		xx										
38. *Draceana ellenbeckiana* (Ndokindongit)	x								x				
39. *Aerua persika* (Ilturilan)	xx				x								
40. *Croton megalocarpus* (Merigwet)	xx		x		x			x					
41. *Plumbago zylanica* (Ngeriatus)	x												
42. *Ximenia americana* (Olomai)	x							x					
43. *Cordia sinensis* (Silapani)	xx x							x					
44. *Warbugia ugandensis* (Sokonoi)	x												
45. *Strychnos henningsii* (ilpirikwa)	x			x								x	
46. (Oloilei)	x												
47. *Acacia mellifera* (Olminishoi)	x		x	x	x								
48. *Albezia zizermaunia* (Mugutan)		x											
49. (Sumeita)	xx												
50. (Olparamunyo)	xx												
51. *Ozoroa insignus* (lukunonoi)	xx												
52. *Piliostigma thoningii* (Bukoi)		x											
53. *Boswellia hildebraulii* (Silalei)	x			x				x					
54. *Turraea mombasana* (Njeni-engasho)							x						
55. (Loikordodai)							x	x					
56. *Senecio stuhmanni* (Leleshua)								x	x			x	x
57. *Acacia etbaica* (Njakwai)				x				x					
58. *Acacia sp.* (Echurai)				x				x					
59. *Podocarpus gracilior* (Olpiripiri)								x					
60. *Acacia seyal* (Olerai)	x		x		x								
61. (Olaraiti)				x				x			x		
62. *Rhoicissus tridentateo* (Elkinyeal)							x						

63. *Acacia shimperi* (Murigoi)			x					x					
64. *Lannea triphylll* (Olampirori)									x				
65. (Kurpule)									x				
66. *Gloriosa superba* (Saikutari)												x	
67. (Olmenjo)				x									
68. *Eurphorbia kibwenzis* (Olpopongi)				x	x				x				
69. (Lokoilie)				x									
70. *Eurphorbia tirucalli* (Olpurshuruti)			x	x									
71. (Ngobiuta)i				x									
72. *Pittosporum lanatum* (Ingilenyai)				x									
73. *Lychium shansii* (Ngokii)							x						
74. *Cissus rotundifolia* (Ngunee)							x						
75. *Cucumis dispassence* (Naigordodoi)							x				x	x	
76. *Ficus sycamorus* (Oreteti)							x			x			
FREQUENCIES	**52**	**5**	**7**	**17**	**6**	4	**16**	**18**	**7**	**4**	**2**	**7**	**2**

EXPERIENCES IN BENZOIN RESIN PRODUCTION IN SUMATRA, INDONESIA

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Introduction

Data presented here are the preliminary results of research on benzoin in North Sumatra by two projects dealing with non-timber forest products in Indonesia[1]. It was decided to study benzoin among other products, because of its interesting management, and because very little data was available on present exploitation. This product has been used, exploited and traded for several centuries, but historical information is sparse. Colonial foresters led some work at the beginning of this century, but little interest has been shown in non-timber forest products from that period until very recently. Exploratory fieldwork was initiated in October of 1996 and new members of the team will start their research at the beginning of 1998. So this paper will raise questions rather than provide answers.

Benzoin is the resin of various species of *Styrax* trees *(Styracaceae)*. One group of species, as described below, is distributed throughout Sumatra and Peninsular Malaysia, and may be in Java and Bali. As will be observed later, its production is over 1000 tonnes/ year. Another group of species is found in continental South-East Asia. The main resin producing species is *Styrax tonkinensis* (Pierre) Craib ex Hartwiss (Pinyopusarerk, 1994) while *Styrax benzoin* Craib. is a minor one (Burkill, 1966). Benzoin resin from *S. tonkinensis* is commercially known as 'Siam benzoin', as it was traded through the kingdom of Siam (present Thailand). Chinese historical data suggest that it was first exploited and traded from North Sumatra, in the 8th-9th centuries. From about the 12th century, it also came from continental South-East Asia, where its names seem to be derived from Indonesian languages (Yamada, 1954-55; Wheatley, 1959). In Sumatra, it is called *kemenyan* in Malay and *haminjon* in Batak (the Malays inhabit the coasts and the Eastern part of Sumatra, the Batak the highlands of North Sumatra). The

[1] CIFOR project 8, directed by Manuel Ruiz Pérez, on "Global trends in non-timber forest products" and European Union project, directed by Geneviève Michon, on "Alternative strategies for the development of forest resoures: extractivism, agroforestry or plantations?". EU project involves French, Spanish and Norwegian, Indonesian and Filipino research institutions and NGOs. CIFOR and EU projects are interacting and overlapping, and some scientists, such as Esther Katz, are members of both.

Thai, Lao, Khmer and Vietnamese names are close to *kemenyan* (for instance *nhan* in Lao) (Yamada, 1954-55). The word 'benzoin' and its equivalents in other European languages derive from the Arabic *luban jawi*, 'frankincense of Sumatra', as it was brought to Europe through the Arab world[2]. Benzoin is chiefly used for incense, perfume and medicine.

We thought that benzoin in North Sumatra had become a very minor activity, yet we found that it is still produced in fourteen sub-districts distributed over two districts, Dairi and North Tapanuli, where it is either the main source of income, or secondary to commercial agriculture (coffee, pineapple, etc.). Thousands of farmers and small local traders still live from this resource.

Species identification

Although benzoin resin has been known for a very long time, the identification of benzoin resin producing *Styrax* trees in Indonesia is not yet totally accurate. Different species of *Styrax* grow all over the island of Sumatra, at least from Aceh to Jambi (and are also found in Peninsular Malaysia). Most authors describe *Styrax benzoin* as the best resin producing species (Braam, 1917; Heyne, 1927; Hulssen, 1940; Burkill, 1966; Pastorova & Boon, 1994). The second most important species is *Styrax paralleloneurum* Perk. (Hulssen, 1940, Pastorova & Boon, 1994), but Watanabe *et al.* (1996) consider it a better species and believe it to be the same as *S. sumatranum* J.J. Smith (mentioned by Burkill, 1966), which may also be another name for *S. sumatrana* (mentioned as a secondary species by Heyne, 1927). Burkill (1966) also describes *S. subpaniculatum* Jungh. & De Vriese which grows in Palembang area, in the South of Sumatra, and *S. serrulatum* Roxb. The taxonomy of *Styrax* species has been revised since Burkill's work, but unfortunately no ethnobotanical information is provided in this revision (Putz & Ng, 1978). Heyne (1927) collected samples, local names and ethnobotanical information at the beginning of the century, which needs to be compared with present data. Batak peasants distinguish two or three species of benzoin trees, with different qualities of resin, but we have not collected all the species, nor identified them. The names and number of species vary according to the areas. Local names have been given to us in Batak Dairi in Dairi district and in various dialects of Batak Toba in North Tapanuli, which are two different, although closely related, languages

Chemical composition

Some information is available on the resin chemical composition of *Styrax tonkinensis* ('Siam benzoin'), *Styrax benzoin* and *Styrax paralleloneurum*. Siam benzoin is more valued for pharmaceutical preparations and for perfume than Sumatra benzoin. According to data compiled by Burkhill (1966), *Styrax tonkinensis* and *Styrax benzoin* both contain benzo-resinol and traces of three fragrant substances, benzaldehyde vanillin, phenylpropyl cinnamate styrol, and styracin; but *Styrax tonkinensis* contains free benzoic acid, while *Styrax benzoin* contains free acid and holds lower quantities of vanillin and styrol; *Styrax paralleloneurum* yields a benzoin made up principally of cinnamic acid. A recent study was made on samples of different qualities of *Styrax benzoin* and *Styrax*

[2] The first Arab travellers called both Java and Sumatra 'Jawa'.

paralleloneurum collected in North Sumatra (Pastorova & Boon, 1994). From the gas chromatograms, they identified six groups of components in all the samples: free benzoic acid, free cinnamic acid, free alcohols and vanillin, benzoic acid esters, cinnamic acid esters and higher molecular weight compounds. They concluded that quality of both the resins is correlated with the aromatic ester content. *Styrax paralleloneurum* contains primarily cinnamic acid esters and *Styrax benzoin* about equal amounts of cinnamic and benzoic acid esters. Lower grades contain mainly free benzoic and cinnamic acids and an amount of triterpenoids. It is very likely that the collectors and the traders mix the different species of Sumatra benzoin.

Tree management

Data about the natural distribution of *Styrax* trees has also to be compiled and revised. In Sumatra, they can be found in the undergrowth of primary forests (Laumonier, 1991), but are more common in secondary forests (Laumonier, pers. com.), which is also the case in Northern Laos (Vidal, 1960).

In Indonesia, resin production is centered in the highlands of North Sumatra, where its cultivation seems to have originated. Benzoin was also extracted for local uses in Kerinci Seblat National Park (Aumeeruddy, pers. com.), in Jambi (Laumonier, pers. com.) and maybe in other parts of Sumatra and Central Java. According to Dutch forestry literature, it was also traded from Palembang (Heyne, 1927).

Most of the North Sumatra production presently comes from planted trees. They are usually cultivated at elevations from 800 m to about 1500 m. Farmers say that wild benzoin trees can be found in the forests located far away from the villages. We have not been in any of these forests. As this environment has been managed over many centuries, we wonder whether these trees are really "wild". An ecological study will be undertaken at different vegetation gradients and will probably provide answers to these questions.

Most of the farmers we have interviewed so far plant benzoin seeds, or preferably seedlings, inside the forest, usually in a place where there are already benzoin trees. They pick seedlings around the best resin producing trees in their plantation. When the benzoin trees reach about one meter, they progressively eliminate the other species. After eight years, they start tapping the benzoin trees. If they do it properly, they can extract the resin for about sixty years - this means that the farmer, his son and his grandson will live on it. Then they abandon the site and let it grow as a forest. They say that they cannot replace the trees one by one, as it is done in Southern Sumatra, in damar plantations *(Shorea javanica)* (Michon & Bompard, 1987). This plantation method was reported at the beginning of the century by Heyne (1927), but plantations have also been described in abandoned rice fallows (Braam, 1917; Heyne; 1927; Marsden, 1986)[3]. This practice is apparently much less common nowadays. According to farmers in Tapanuli, the trees produce resin only after 20 years, compared to 8 years under forest cover.

[3] In Laos, benzoin trees grow spontaneously in rice fallows (Savathvong *et al.*, 1997)

The history of benzoin cultivation will have to be traced. Plantations were observed by a British traveler as early as 1772 (Marsden, 1986), but we do not know when they were established. No foreign traveller reached the highlands previously, as the Batak fiercely defended their territory. As there was an external trade demand from the 8th century, intensification of the production may have happened several centuries ago, but was probably expanded a few generations ago. In 1917, Braam (*op. cit.*), observed that a lot of planting had occurred in the few preceding years. We do not know either what has been the proportion of cultivated trees to 'wild' trees over the centuries. Marsden *(op. cit.)* saw wild benzoin trees, but it is difficult to know what was really wild, favoured or managed in the forest. We still have to study the difference between wild and cultivated benzoin trees and better understand the method of selecting seedlings. We need to recognise, in any case, that the Batak farmers started planting and selecting the trees at a time when there was no scientific agronomic research and that the indigenous knowledge of benzoin has been built up over centuries.

Presently the benzoin farmers are facing problems of land limitation. Their plantations are getting old and forest spaces have been reduced to the minimum. A big pulp and paper company located in the area is in great need of wood. This company has already cut hundreds of hectares of pines which were planted in colonial times and have been planting eucalyptus trees. In some villages, they have cut benzoin plantations or are planning to do so and replace them with eucalyptus. This is quite a paradox, because in Vietnam, *Styrax tonkinensis* are planted for pulp and paper (Pinyopusarerk, 1994). Young farmers also voluntarily sell their benzoin trees and turn to other activities. Many older farmers' sons have migrated to the cities. These farmers have no reason to set up new plantations, and when they are too old to work, they abandon their plantation or sell it. The price incentive to retain benzoin is very low at the moment. Prices on local Sumatra markets have not increased for several years, which means that in real terms, they have been decreasing. Both farmers and traders are worried about the future[4].

Tapping techniques

During the peak seasons, farmers whose main activity is benzoin exploitation go to their forest plantations for about three to five days per week and return to the village for the weekly market and church. Benzoin exploitation is usually a male occupation. It is hard and risky, as it requires the tapper to climb up the tree to 4-6 meters. The bottom of the tree is tapped or harvested first, and then a rope of sugar palm fiber is tied at about 2 meters above the ground. The tapper stands on a small piece of wood tied to the rope to tap or harvest the second part of the tree. This is repeated at the next 2 meters, and so on if necessary. Only a few women exploit the trees to help their husband or because they are widows, and this does not occur in all the villages. The benzoin tree itself is perceived as a woman and the resin is seen as her tears or her milk. Before going to their plantations, the farmers must be nice to their wives and while tapping, they must not talk in a coarse manner, otherwise the 'lady tree' will not give resin.

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[4] In Laos, farmers located close to roads have turned to other alternatives. Only farmers located in marginal remote areas still tap benzoin trees (Chagnaud, 1996; Savathvong *et al.*, 1997).

Before tapping, the bark has to be cleaned of mosses with a scraper *(guris)*. This way, the resin will not mix with impurities when it flows out, and the sun shines directly on the trunk, warming it. Farmers say that the moss keeps it cool and that the tree produces more resin if it is warm. A type of a knife *(agat panuktuk)* is used to open a small wound of about 2 cm in the bark. The metal goes under the bark and lifts it up, then the farmer pushes it back with the knife handle, shaped like a hammer. This way, more resin will remain under the bark. They make about 10 wounds on each two meters level of the tree, 5 on each side, so about 30 wounds are made on a tree. The tapping starts in May and lasts about until August, depending on the number of trees to tap. Only trees with full foliage can be tapped. The trees, which have lost their leaves or have very young ones (they are called *susang)* have to be tapped later, between January and March, once their foliage has recovered.

The resin flows under the bark and outside. It can be collected after three or four months, from August to about December, for most trees, and from April to June for the *susang*. It is better to collect it in the rainy season, because the weather is cooler and the resin does not melt, but if it gets wet while collecting, it becomes dirty. Collecting should be avoided in the middle of the day in the hot sun, as it is also likely to melt. The farmer uses a small blunt broad bladed knife *(agat)* to pry away the bark to which the resin is stuck. He puts it in a basket carried on his back. A farmer can collect about 5 kg/day, which gives about 3 kg of pure resin. This first flow resin is called *takasan,* the inner white resin is called *mata dalam,* the outer yellowish resin is called *mata luar*.

Two or three months later, the farmer can go back to the same tree and collect the second flow of resin from the wounded bark. He just scrapes it from the tree with the same knife. This resin is called *lecet.* Part of this resin is white, and part a dark brown colour, described as 'black' by local people. As the resin flows on to the tree trunk, some impurities are collected. It dries less easily than the first-flow resin[5].

Then, about three months later, a third flow of resin can be collected. Usually, while farmers collect it, they tap the tree in another part of the trunk. More commonly, they tap on the side opposite to the last wound. This third resin, called *tahir* or *jurur,* is also dark. It looks like the dark parts of the second resin, but some of it can be slightly reddish and more transparent. Data about the average annual resin production per tree vary between 200 g/year /tree and 1 kg/year/tree. It depends on the age of the trees. Watanabe *et al.* (1996) mention a production of 1 kg/year/tree for fully producing trees.

Drying, commercialization, sorting, processing and transportation

Some people sell their harvest directly with the bark, while others prefer to dry it for a week, in a dark cool place, usually an attic, before cleaning the resin from the bark. If the farmers have enough money, they dry the resin a little longer, as it increases the value. Otherwise, they sell it right away to the local village traders. The barks can be sold separately in large quantities for 3 cents/kg. The prices for resin vary from \$2 to \$4

[5] Laos benzoin is only harvested once and only gives white resin (Pinyopusarerk, 1994).

according to quality. The trader sorts the different types of resins according to their colour and size and dries them for a longer time. For instance the second resin is both white and black. He may extract the white pieces and put them with the resin of first quality and gain some profit on it. He sieves the benzoin and separates it into heaps of different sizes, called 'big pieces', 'bean', 'corn', 'rice', 'dust'[6]. If he has enough capital, he keeps the benzoin drying as long as he can. The drier the benzoin, the easier it is for transportation. When enough benzoin has been accumulated, the trader or his wife goes to the nearest trading town to sell it, usually on market day. He or she has to go very early so that the resin does not melt with the sun or heat. They transport it in cardboard boxes or big baskets on the top of buses. On one occasion, we observed a village trader who could not catch an early bus, as they were crowded, and whose benzoin melted on the way. As he arrived into town, all the pieces were stuck together, altering the shape and the colour. The selling price consequently dropped. Maybe means of transportation could be improved in order to preserve the quality of benzoin.
In the market town, the traders again mix the different qualities. They place the smaller size pieces in the bottom of the heap, then bigger ones over it and the biggest ones on top. The trading game consists of the buyer evaluating the quantity of each size and the profit that can be made on the whole heap. The buyers go from one heap to the other, take pieces from the bottom and lift them up to the top; pick a sample to evaluate the proportion of each size; burn a small piece of resin on their cigarette to smell its fragrance; look at its appearance and its shine. They bargain the price with the seller until reaching an agreement or leaving it. Occasionally sellers do not find adequate buyers and return home with their heap, especially if they are based in that same town.

The bigger traders again sort out the different sizes and qualities and dry the benzoin longer. They keep it about four months before they sell it to distant places: Central Java, located at four days drive, and Singapore, reached by boat from Medan harbour within about a day. Drying and stocking the benzoin requires again to hold enough capital to be able to wait for a few months. The longer traders keep Sumatra benzoin, the drier and the more valuable it is. In contrast, Laos benzoin, which seems to dry faster, must be sold as quickly as possible to preserve its fragrance (Fischer, personal communication). It is possible that Sumatra benzoin also loses its scent in the process, but if it does not dry properly, the product loses more of its quality. We wonder whether all the different manipulations of sorting the pieces by sieving, mixing them again and sieving them again do not also alter the quality[7].

Some benzoin is sold pure, but a bigger proportion is processed. Possibly some processing occurs in Sumatra, and some in Singapore, but most of the benzoin is transformed in Central Java. There, it is wrapped in little plastic bags, pressed into blocks or put into cigarettes. In some cases, blocks may be made out of pure benzoin, but more

[6] In Singapore, the traders use three main categories: 'almonds' (for big pieces), 'siftings' (for small pieces), 'dust'.
[7] This question was also raised by Chagnaud (1996).

commonly, benzoin is adulterated with damar resin *(Shorea* spp.*)*, which is cheaper[8]. Some Batak traders also mentioned that it was going into glass and textile industries, and it may also be processed in Indonesia in flavouring, perfume and essential oil industries, but we do not have any information about it yet.

Uses and trade

The present trading channels of benzoin still have to be accurately researched. According to official regional figures, present production in North Sumatra would be of about 5,000 T/ year, of which 1,000 T are exported[9]. We do not know whether it includes only exports from Sumatra or also from Java and if they are reliable. Another official source gives similar figures (800-1,100 T) for benzoin exports from Indonesia to Singapore (about 90%), Malaysia, Taiwan, United Arab Emirates, Kuwait, India, Hong Kong, Pakistan, Japan, Saudi Arabia (Silitonga, 1994, quoted by Coppen, 1995). In 1920, the district of Tapanuli alone was producing 2,000 T/ year (Schnepper, 1923). In 1931, 2,500 T/ year were exported, to Singapore, India, Arabia, Egypt, Algeria, Europe and America (Koppel, 1932). It is very difficult to trace benzoin exports to other countries, as their figures are not large enough to warrant a separate category; they are included in the "gums and resins" category. We have not checked the current figures, but our estimates, based on two field trips, indicate that the North Sumatran production falls within an order of magnitude of thousands of tonnes. If it really is 5,000 T, we wonder how 4,000 T are consumed by the national population of Indonesia, even though there are 200 million inhabitants.

The use of benzoin has a long history in Sumatra, since it was already exported from there in the 8th century. Its oldest uses may be associated with shamanistic rituals. Even today, shamans in the Batak highlands, as well as in all Sumatra and Java, burn benzoin incense when they enter a possession trance in curing rituals. It is widely used in both islands in different types of traditional rituals : protection from bad spirits, rice-reaping ceremonies, rain rituals, offerings to the dead, to the house spirits, etc. Benzoin is also taken as a medicine and smoked in cigarettes, sometimes also used in rituals. The habit of smoking benzoin cigarettes is very much ingrained in Central Java, where rituals involving the use of benzoin incense are more common and frequent than anywhere else in Indonesia. We estimated the sales of a small retailing stand in the central market of a main city in Central Java to be; a minimum figure of 5 T/ year. The enquiry needs to go further to estimate the local consumption in that region. Some small local industries still make benzoin cigarettes, but these cigarettes, whether industrial or home made, are now smoked only by older people of Javanese peasant background. Industrialists expect it to die with the passing of this generation (Tarmidi, 1996). Nevertheless, it is possible that

[8] We saw that benzoin used to be adulterated by frankincense or myrrh. We don't know when it started to be adulterated by damar, but it is mentioned at least in the early fourties (Hulssen, 1940). At that time there were processing factories on the west coast of North Sumatra.

[9] Informasi Pasar Industri Produksi Lokal Jenis Tanaman Kemenyan di Kabupaten Tapanuli Utara, 1993-94, data collected by J. Coppen in April 1997 at North Sumatra Forestry Service.

benzoin is also added as a flavouring to some brands of modern *kretek* clove cigarettes, what would imply large quantities since 140 billions of *kretek* cigarettes were produced in 1993, mainly for the national market (*ibid.*). In a modern fast-changing Indonesia, traditional Javanese rituals involving benzoin, practised since pre-islamic times, are now perceived as backward and are rejected by orthodox Muslims. So this consumption has been declining and is likely to decrease even more. Nevertheless, in the rest of the Muslim world,[10] benzoin is widely used and burnt in homes and mosques, in many religious and life cycle rituals, as well as to chase away bad spirits. In the Maghreb, in particular, its use is very frequent. They always use block benzoin.

As early as the 8th century, benzoin was discovered in Sumatra by Middle-Eastern traders who, as noted earlier, called it 'frankincense of Sumatra' and imported it to be used in a similar way or in association with frankincense and myrrh. Around the 12th century, Arab merchants began shipping frankincense from the Hadhramaut ports (present Yemen) to the Sumatran harbour of Sri Vijaya, from where they were trading it to China. They were also shipping benzoin to India and the Middle-East for adulteration with Indian *gum-gugul* [11] and Arabian frankincense, prior to carrying back to the East for sale in China (Wheatley, 1959). At that time, the Chinese were mainly using it as a means of fixing the aroma of more volatile perfumes, and not yet as a medicine *(ibid.)*. They probably also included it in their incenses, as did neighbouring countries such as Japan and Vietnam.[12] The Christians too were using frankincense and myrrh for religious purposes, which, according to the Bible, were brought by the Three Wise Men to Jesus. They also received benzoin from the Arabs, probably in the Middle-Ages, and added it to the earlier incenses. A study in France showed that the use of incense declined in Catholic churches, but is still very important in oriental churches (Goloubinoff, 1997).[13] It seems to be more widely consumed in countries where there are still big Catholic processions, such as in Spain. Benzoin is still used in Western pharmacopeia, in particular for respiratory ailments, but in small quantities. It is employed as well in the perfume industry, as a fixative for more volatile scents and to give a sweet "oriental" note. The quantities involved in this industry are not very great either (about 1-10 T/ year for small and middle-sized companies). In the pharmacy and perfume industries, Siam benzoin is actually more valued than Sumatra benzoin, but perfumers mix both resins to reduce the costs, since Siam benzoin is more expensive. In Marseille harbour, in 1997,

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[10] It includes at least the Middle and Near-East, the Indian sub-continent and the Northern part of Africa, from the Somali and Swahili coast to Senegal.

The results of archeological excavations presently led by a French-Indonesian team in Barus, a historical harbour of North Sumatra, will provide more accurate data on the history of the benzoin trade. Disperse data on benzoin historical and present uses and trading channels will have also to be gathered.

[11] *Gum-gugul* is probably a *Commiphora.*

[12] Japan in particular has developped an "incense culture". Incense ceremonies, similar to tea ceremonies, are still practised nowadays (Kobayashi, personal communication, 1997).

[13] In the city of Paris, the consumption of incense would not exceed 400 kg/year in the Catholic churches, and 75 kg/year in the Oriental churches. As they are incense mixtures, benzoin is only a part of this amount (Goloubinoff, 1997).

the price of pure Sumatra benzoin was between $6 and $18 according to quality, and Siam benzoin was $27. Curiously, several perfumers we visited did not seem to have access to the highest qualities of Sumatra benzoin almonds.

With new esoteric and 'green' trends, there is a recent development of the use of incense in the Western world, which is actually a return to old traditions. The study in France showed that small quantities are sold, but at high prices. Adulterated benzoin is often sold under the name of 'benzoin' or 'Sumatra benzoin' in small 50 g bags, for prices from $50 to $165/ kg. In two places, 50 g bags of pure benzoin siftings (worth $8 /kg in Marseille) were sold for $215/kg under the name of 'Tibetan incense', 'for deep meditation' (Goloubinoff, 1997). As far as we know, Tibetans make incense out of Himalayan plants, and do not use benzoin. This raises the question of labelling. This 'Tibetan incense' is an example of false labelling. Also, adulterated benzoin should not be sold under the name of 'benzoin'. The consumer should be able to know what he is buying and the origin of the product. Probably very small quantities are sold in each of these shops, but the prices differences are amazing. In contrast, the profits made by the different intermediaries between Sumatra and a European harbour are not very high.
We wonder whether this new trend develop further and if new niche markets can be found for benzoin with an increasing use of natural products such as essential oils, natural flavours and fragrances.

Conclusion

Benzoin production by Batak farmers is based on centuries of indigenous knowledge. Amazingly, benzoin is used for the same purposes (incense, medicine and perfume) all over the world and with an incredible historical continuity. In the same way, present trading channels follow very old trading routes. The uses of benzoin are so much ingrained in cultural and religious habits that we can imagine there will continue to be a demand for it. The Indonesian consumption, which is possibly the highest in the world at the moment, is the most likely to decrease, as using benzoin in rituals is now perceived as backward. If benzoin really is a component of *kretek* cigarettes and if health campaigns occur in the future in the country, this end use could also decrease tremendously. Research is still needed to more accurately define the present marketing channels and the future potential of this product. Benzoin is everywhere, but few people know about it or pay attention to it. Its consumption and trade, which at first sight seemed to belong to the past, are not major enough to be noticed, but are not that minor either.

We recommend that customs offices change their categories, so that import-export figures of 'minor' products such as benzoin can appear separately. For centuries, this product has had no need to be advertised, but it may be time now to advertise it and let consumers know more about it. Its marketing and trade have been operating the same way for centuries. Maybe now, quality standards should be set up. Handling, storing, packaging and transportation of the product could be improved, and maybe also production methods. It would be interesting to label the product properly and make a distinction, as it was already suggested by Dutch chemists in the forties (Hulssen, 1940), between pure benzoin resin, more appropriate for perfume and chemistry purposes, and adulterated benzoin blocks, cheaper but suitable as incense. At the moment, benzoin incense consumers have no idea about what the original product looks like, and they have a right to know. As each producing area in North Sumatra has its characteristics, it would be interesting too to classify and label according to the place of production, as it is done for wine, for instance. Local traders know that the most fragrant resin of the area comes from the sub-district of Parlilitan. Perfumers might want to choose this type of product, even with an added value, if its quality standard was kept high and constant.

References

BRAAM, J. S. Van , 1917. — "Het Boschwezen in Tapanoeli", *Tectona,* X: 209-214.

BURKILL, I. H., 1966 (1935). — *A Dictionary of the Economic Products of the Malay Peninsula,* Government Malaysia and Singapore, Ministry of Agriculture of Malaysia and Singapore, Kuala Lumpur.

CHAGNAUD, F., 1996. — "La valorisation des sous-produits agroforestiers au Laos : une alternative pour le développement durable" in *L'alimentation en forêt tropicale,* C. M. et al. HLADIK (ed.), UNESCO, Paris, 1065-1074.

COPPEN, J. J. W., 1995. — *Gums, resins and latexes of plant origin,* Non-Wood Forest Products, FAO, Rome, 142 pp.

GOLOUBINOFF, M., 1997. — *Commerce et usages du benjoin et du camphre en France,* CIFOR Report.

HEYNE, K, 1927 (1917). — *De Nuttige Planten van Nederlandsch-Indië,* Buitenzorg: Dept van Landbaouw, Nijverheid & Handel in Nederlandsch-Indië.

HULSSEN, C. J. Van , 1940. — "Sumatra-Benzoë", *Pharmaceutisch Tijdschr.,* 1:pp 13.

KOPPEL, C. Van de, 1932. — *De economische beteeknis der Ned. Indische harsen ,* Kolff, Batavia (Jakarta), 13 pp.

LAUMONIER, Y., 1991. — *Végétation de Sumatra: écologie, flore, phytogéographie,* Thèse pour le doctorat d'Etat, Université Paul Sabatier, Toulouse.

MARSDEN, W. , 1986. — *The history of Sumatra,* Singapore, Oxford University Press (Reprint of the 1811 edition, London, Longman *et al.*).

MICHON, G. & J. M. BOMPARD, 1987. — "The damar gardens *(Shorea javanica),* Sumatra", *Proceedings of the third round table conference on Dipterocarps,* Samarinda, UNESCO, pp. 3-17.

PASTOROVA, I. & J.J. BOON, 1994. — *The analytical chemistry of the natural resins from* Styrax benzoin *Dryand and* Styrax paralleloneurum *Park.,* Progress report, F.O.M.-Institute for Atomic and Molecular Physics, Amsterdam.

PUTZ, F. & NG, F. S. P. , 1978 — "Styracaceae", in NG, F. S. P. (ed.), *Tree Flora of Malaya,* London, Kuala Lumpur, Singapore, Longman.

PINYOPUSARERK, K, 1994. — *Styrax tonkinensis: Taxonomy, ecology, silviculture and uses,* ACIAR, Canberra.

SAVATHVONG, S., M. FISCHER & K. PINYOPUSARERK, 1997. — "Fallow Management with *Styrax tonkinensis* for Benzoin Production in Upland Cultivation Systems in Northern Lao PDR", *Indigenous strategies for intensification of shifting cultivation in South East Asia,* ICRAF workshop, Bogor, Indonesia.

SCHNEPPER, W.C.R., 1923. — "Benzoëcultuur en volkswelvaart in Tapanoeli (Sumatra)", *Tectona,* XVI: 264-275.

SILITONGA, T., 1994. — "Indonesia", in *Non-wood forest products in Asia,* FAO Regional Office for Asia and the Pacific, Bangkok, pp. 49-54.

TARMIDI, L. T., 1996. — "Changing structure and competition in the Kretek cigarette industry", *Bulletin of Indonesian Economic Studies,* 32(3): 85-107.

VIDAL, J., 1960. — "Les forêts du Laos", *Bois et Forêts des Tropiques,* 70:5-21.

WATANABE, H., K.-I. ABE, K. KAWAI & P. SIBURIAN, 1996. — "Sustained use highland forest stands for benzoin production from Styrax in North Sumatra, Indonesia", *Wallaceana,* 78: 15-19.

WHEATLEY, P., 1959. — *Geographical Notes on some commodities involved in Sung Maritime Trade,* Journal of the Malayan Branch of the Royal Asiatic Society, Tien Wah Press Ltd., Singapore, 139 pp.

YAMADA, K., 1954-55. — "A study on the introduction of An-hsi-hsiang in China and that of gum benjoin in Europe", *Report Institute World Economics,* 5: 1-24, 7: 1-30.

PRODUCTION, MARKETS AND QUALITY CONTROL OF GUM ARABIC IN AFRICA: FINDINGS AND RECOMMENDATIONS FROM AN FAO PROJECT

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Introduction

With a view to identifying ways in which production, and more particularly quality, can be increased or improved, all aspects of production, marketing and quality control were reviewed in 12 producing African countries, comprising six Anglophone and six Francophone countries in a project formulated by FAO. The Anglophone countries were Ethiopia, Ghana, Kenya, Nigeria, Sudan and Zimbabwe, while the six Francophone countries were Burkina Faso, Mali, Mauritania, Niger, Senegal and Chad. The findings and the recommendations of this project are summarised in the present paper. The report established that a total of 17 species of *Acacia* produce gum which is collected by local communities either for domestic use or export. Out of these, four species produce gum that is marketed as gum arabic; *Acacia. senegal* and *A. seyal* (across the Sahel) and *A. polyacantha* and *A. karoo* (in localized regions). It was further established that whereas the botanical source affects quality of gum arabic, the main factor relates to harvesting and post harvest treatment. Included in this are the method of harvesting, cleaning, sorting and grading practices. Regarding quality control, it was observed that two factors were responsible; lack of a clear definition for gum arabic and inadequate analytical procedures which do not adequately take into account natural product variability. Based on the above considerations, several recommendations were developed as a means of improving production and quality of commercially produced gum arabic.

Background

The project on production, markets and quality control of gum arabic was formulated by FAO with two main objectives:

- To acquire information on all aspects of gum arabic production and quality control, and on the basis of recommendations, assist producer countries in their efforts to improve the quality of their products so as to meet international specifications
- To collect samples of gum from authenticated trees and from commercial sources in the countries visited. These samples were analysed in three independent laboratories and the data made available to JECFA for use in drawing up revised specifications for good-grade gum arabic.

The project was implemented by a multi-disciplinary team of experts which comprised a three-man international team and an FAO team member. The latter was assisted by a marketing expert and six national consultants. A total of 12 producing African countries were covered comprising six Anglophone and six Francophone countries. The six Anglophone countries were Ethiopia, Ghana, Kenya, Nigeria, Sudan and Zimbabwe, while the six Francophone countries were Burkina Faso, Mali, Mauritania, Niger, Senegal and Chad. The Anglophone countries were covered by the International team while the Francophone countries were covered by the FAO team member and his group. Gum chemistry was carried out by the mission chemist assisted by the FAO team member and one other expert. The project was carried out between April 1995 and December 1996 and covered two gum production seasons allowing for collection of more samples and other data not collected during the first mission. Findings and recommendations of the project are summarised in the present paper.

Mission Findings

Botanical Sources and Management Aspects

Seventeen species were identified as sources of *Acacia* gum collected by the local communities - either for domestic use or for export (Table 1). *Acacia senegal, A. seyal* and *A. polycantha* have widespread distribution within the gum belt. *Acacia senegal* and *A. seyal* are variable species with the former having about four varieties while the latter has two. Other species have limited regional distribution. For instance, *A. Karoo* is confined to Southern Africa (where it is widely distributed), *A. drepanolobium* and *A. paoli* to Eastern Africa and the Horn of Africa, while *A. late* and *A. dudgeoni* are confined to West Africa. *Acacia gourmaensis, A. macrostachya* and *A. macrothyrsa* have even more restricted distribution in West Africa. Except for Sudan, and to some extent Nigeria, Chad, Mali and Senegal, where initiatives have been undertaken to introduce plantations of *A. senegal*, the bulk of gum arabic and *Acacia* gum is derived from natural stands and by natural exudation. In most of the countries, the extent of distribution is not known very precisely, making it difficult to establish the potential for production and for sound management decisions to be taken. The problem in some countries is compounded by a lack of knowledge about the botanical sources and sound practices of gum production and this can lead to inadvertent mixing of gums.

Production, Quality and Markets

Production levels for gum arabic in the 12 countries are shown in Table 2. There is wide variation in the scale of production with Sudan, Nigeria and Chad accounting for the majority of gum arabic in world trade.

Quality of gum arabic was observed to be influenced by two factors, one of which was botanical origin. Gum from different species (*A. senegal* and *A. seyal*) exhibited characteristics that were intrinsically different. Even within the same species, different varieties produce gum with different characteristics. Recognising these differences in the species and/or varieties is important in producing gum arabic for desired end use. Besides botanical source, quality is also affected by harvest and post-harvest treatment. Tapping for example, gives a more consistent and better formed gum than collection caused by insect borers. Better quality gum is obtained by picking it off the tree rather than letting it fall on the ground. Above all, mixing the gum from different species at collection time or at post-harvest handling stage results in variability and is the prime reason for poor quality.

Characterisation and specification of gum arabic

The average values (physico-chemical, carbohydrate and amino acid composition) for gum from *A.senegal* and *A. seyal* were consistent with published data and typical of each type of gum irrespective of source, i.e., country or locality. However, though related (possessing the same chemical species), the two gums could be distinguished from each other by all the three methods. This supports the idea of producing and marketing the two gums separately if future improvements in quality and quality control are to be attained. It was shown further that *A. late* and *A. polycantha* are closely related to *A. senegal* while *A. karoo* is closely related to *A. seyal.*

Meanwhile, within a given type of gum there was significant sample variation brought about either by differences in varieties, climatic factors or handling aspect. These observed variabilities are worth noting and may require applying more than one analytical method before a decision is made when specifying gum arabic for commerce.

Evaluation of the methods revealed that chemometrics when applied to the analytical data obtained in the investigation is a powerful method of characterising the gum arabic of commerce, by identifying individual species of *Acacia* and those gums which would be adulterants within the terms of the JECFA definition of gum arabic. *Acacia. senegal* and *A. seyal* could be separated into distinct clusters, despite the fact that the two are related (Fig. 1).

Table 1: Source of Acacia gum in 12 African countries covered in the project

Country	Acacias utilised for commercial AG production	Source of bulk AG produced 1	2	Methods of obtaining AG Species	3	4
Burkina Faso	*A. senegal*	**	**	*A. senegal*		**
	A. laeta		**	*A. laeta*		**
	A. seyal		**	*A. seyal*		**
	A. gourmaensis		**	*A. gourmaensis*		**
	A. dudgeoni		**	*A. dudgeoni*		**
	A.raddiana		**	*A.raddiana*		**
Mali	*A. senegal*	**	**	*A. senegal*	**	**
	A. laeta		**	*A. laeta*	**	**
	A. seyal		**	*A. seyal*		**
	A. polyacantha		**	*A. polyacantha*		**
	A. raddiana	**	**	*A. raddiana*		**
Mauritania	*A. senegal*	**	**	*A. senegal*	**	**
	A. laeta		**	*A. laeta*		**
	A. seyal		**	*A. seyal*		**
	A. macrostachya		**	*A. macrostachya*		**
Senegal	*A. senegal*	**	**	*A. senegal*	**	**
	A. ehrenbergiana		**	*A. ehrenbergiana*		**
	A. laeta		**	*A. laeta*	**	**
	A. macrostachya		**	*A. macrostachya*		**
	A. macrothyrsa		**	*A. macrothyrsa*		**
	A. nilitica		**	*A. nilitica*		**
	A. polycanthat		**	*A. polycanthat*		**
	A. sieberana		**	*A. sieberana*		**
	A. tortilis		**	*A. tortilis*		**
Country	**Acacias utilised for commercial**	**Source of bulk AG produced**		**Methods of obtaining AG**		

	AG production	1	2	Species	3	4
Sudan	*A. senegal* var. *senegal*	**	**	*A. senegal* var. *senegal*	**	
	A. seyal var. *seyal*		**	*A. seyal* var. *seyal*		**
Ethiopia	*A. senegal* var. *senegal*	**	**	*A. senegal* var. *senegal*	**	**
	A. senegal var. *kerensis*		**	*A. senegal* var. *kerensis*		**
	A. seyal var. *seyal*		**	*A. seyal* var. *seyal*		**
	A. seyal var. *fistula*		**	*A. seyal* var. *fistula*		**
	A. polyacanthat		**	*A. polyacantha*		**
	A. drepanolobium		**	*A. drepanolobium*		**
Kenya	*A. senegal* var. *kerensis*		**	*A. senegal* var. *kerensis*		**
	A. paoli		**	*A. paoli*		**
Zimbabwe	*A. karroo*		**	*A. karroo*	**	**
Nigeria	*A. senegal* var. *senegal*		**	*A. senegal* var. *senegal*	**	**
	A. seyal var. *seyal*		**	*A. seyal* var. *seyal*		**
	A. nilotica		**	*A. nilotica*		**
Ghana	*A. sieberana*		**	*A. sieberana*		**
	A. polyacantha		**	*A. polyacantha*		**
Chad	*A. senegal* var. *senegal*		**	*A. senegal* var. *senegal*	**	**
	A. laeta		**	*A. laeta*	**	**
	A. seyal		**	*A. seyal*		**
	A. polycantha		**	*A. polycantha*		**
Niger	*A. senegal*	**	**	*A. senegal*	**	**
	A. seyal		**	*A. seyal*		**
	A. raddiana		**	*A. raddiana*		
	A. tortilis		**	*A. tortilis*		**
	A. polyacanthat		**	*A. polyacanthat*		**

1. Plantations 2. Natural Stands 3. Tapping 4. Natural exudation or incidental injury

Table 2: Summary of gum arabic data for 12 African countries (botanical source, production, imports into EC, USA, Japan and main European markets)

Country	Main botanic source	Annual production[a]	Annual imports to EC, USA, Japan[b]		Annual imports to main European markets	
Sudan	*A. senegal var. senegal*	17,100	EC	12,200	France	4,900
	A. seyal	3,900	USA	3,800	UK	2,400
			Japan	1,750	Italy	2,300
					Germany	1,300
Nigeria	*A. senegal var. senegal*	60,000-10,000?	EC	4,500	UK	2,500
	A. seyal		USA	300	Germany	1,300
			Japan	3	France	650
Ethiopia	*A. senegal*	250-300	EC	80	Germany	80
	A. seyal	50-100	USA	-		
			Japan	-		
Kenya	*A. senegal var. kerensis*}	200-500?	EC	40	Italy	25
	A. senegal var. senegal}		USA	30	UK	10
			Japan	2		
Zimbabwe	*A.karroo*	<30	EC	-		
			USA	-		
			Japan	-		
Ghana	*A. polyacantha*	<10	EC	50	UK	50
			USA	-		
			Japan	-		
Burkina Faso	*A. senegal*	200-300				
	A. seyal					
Chad	*A. senegal*	3,500	EC	3,500	France	2,800
	A. seyal	1,500			UK	600
Mali	*A. senegal*	500	EC	140	France	45
	A. seyal					
Mauritania	*A. senegal*	400	EC	180		
Niger	*A. senegal*	300	EC	150	France	115
	A. seyal					
Senegal	*A. senegal*	700	EC	450	France	300
					UK	130

Notes: a Estimates except for Sudan which are 7- year annual averages (1988 - 94)
b Annual averages from trade statistics (EC and Japan 1988-93; USA 1991-94)

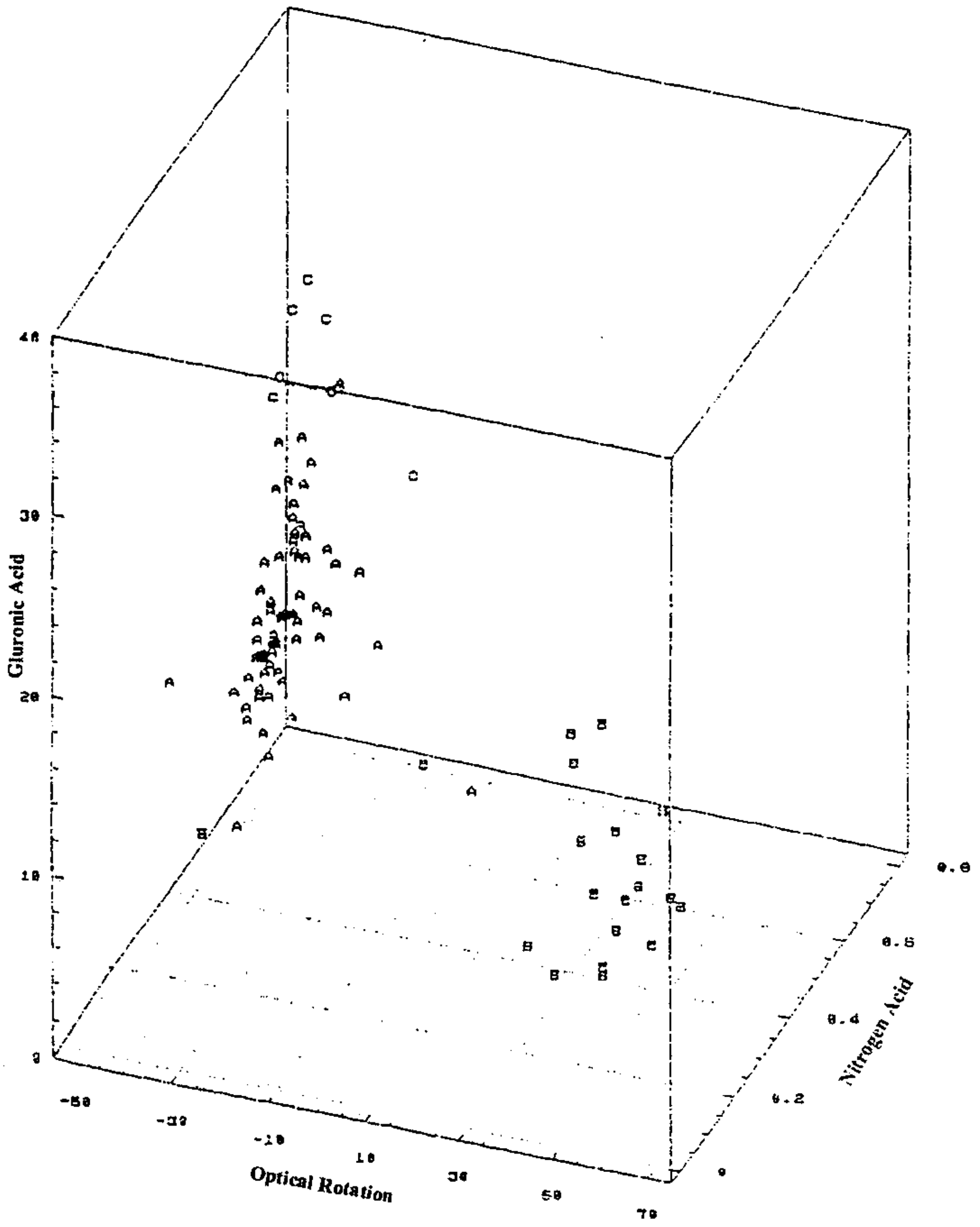

Figure 1: Cluster analysis based on three parameters, N%, specific rotation and uronic acid.

Recommendations

Production, Quality and Markets

Education, training and dissemination of information were identified as key to improving production, its quality and the prospects for developing new or increased markets.

It was therefore recommended that:

- The preparation and publication of a manual or technical profile be commissioned covering all aspects of gum arabic production, from collection from the tree to the point of export of the product: the manual should be available in formal/national languages used by producing countries and distributed to relevant organisations involved in gum arabic production and trade including donor agencies and international organisations.
- A package of training initiatives be developed to promote 'good manufacturing practice' and 'quality consciousness' among producers and traders of gum arabic at all levels with the manual serving as one of the main tools for training.

The first step should be a regional workshop to sensitise both the producer and consumer countries on the initiatives already undertaken by FAO in relation to promoting the importance and value of gum arabic, including regional corporation. This could be followed by carefully structured study tours in Sudan and Chad by extension officers (or similar staff) from the other producing countries. Finally workshops/seminars for representatives from the public and the private sector dealing with gum arabic quality control could also be organised as part of the training initiative.

It was also recommended that:

- Priority be given to undertaking resource surveys in all the countries producing gum arabic and improving the resource base itself.

Characterisation and specification of gum arabic.

- Because gum arabic of commerce is a product of *A. senegal* and *A. seyal,* (the two gums contribute upto 95% of total gum entering the market comprising 70%. *A. senegal* and 15-25%, *A. seyal*) the term gum arabic should be revised to include the two species and "closely related" species. The words 'closely related' should apply to those species established in the study to be chemically closely related to *A. senegal* and *A. seyal* respectively. However, in view of the observed analytical differences between the two main gums, they should be produced and marketed separately so as to minimise variability and improve aspects of quality and quality control.
- The general methods by JECFA need to be updated to take into account newer methods such as Chemometrics in specifying gum arabic of commerce. This is in addition to the current methods (FAO, 1995).

References

FAO (1995). Food and Nutrition, No. 52. Add.3.

THE CHEMICAL CHARACTERISATION OF MYRRH AND FRANKINCENSE AND OPPORTUNITIES FOR COMMERCIAL UTILISATION

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Introduction

Oleo-gum resin is an exudate, essentially mixture of volatile oil, resin and gum, obtained by incision from the plant family Burseraceae. Oleogum-resin obtained from the genus *Boswellia* is olibanum or frankincense while that obtained from genus *Commiphora* is myrrh.

There are about 12 species of the genus *Boswellia* in North, East Africa and Southern Arabia (Howes, 1949). *Boswellia serrate* is an Indian variety, while *Boswellia carterii* and *B. papyrifera* are African varieties.

On the other hand, there are about 160 species of the genus *Commiphora*. All are African with the exception of 12 species which occur from S. Arabia to India. *Commiphora africana* is indigenous to Africa while *C. abyssinica* is found in S. Arabia and E. Africa.

Chemical composition

Oil

It has been reported (Hough *et al.*, 1952; Treas and Evans, 1978; Abdel *et al* ., 1987) that olibanum from *B. carteria* contains 60-70% resin and 3-8% volatile oil. In contrast, myrrh contains 25-40% resin and 7-17% volatile oil. Recently (Karamalla, 1997) ethanol-extracted oil has been found to be 72.1, 72.2, and 95.9% while steam-distilled oil has been found to be 2.8, trace, and 9.6 for *B. papyrifera, C. africana* and *C. abyssinica* oleo gum resins respectively.
Twenty-seven sesquiterpene hydrocarbons have been identified (Yates and Wenninger, 1970) in the oil of *Boswellia* spp obtained by steam distillation.

The volatile oil of myrrh has been shown (Treas and Evans, 1978) to contain terpenes, sesquiterpenes, esters, aldehydes and alcohols while that of olibanum has been found to consist of numerous terpenes and sequiterpenes.
Seven sesquiterpenes hydrocarbons, a furanosesquiterpenoid oil and furanoidiene have been detected (Graveiro *et al.*, 1983) in the volatile oil of *C. quidotti.*
A study (Provan *et al.*, 1987) of the volatile portions of resins from a number of Kenyan species of *Commiphora* has shown that these oils consist mainly of monoterpenoids or sesquiterpenoids.
Two triterpenes have been identified in the resins of *C. incisa* and *C. kua* and their potential chemotaxonomic significance indicated (Provan and Waterman, 1988).

Thirty-three constituents have been identified in the steam distilled oil of *B. carterii*, eleven of which were not detected in the n- hexane extract. The oil contained 62.1% ester, 15.4% alcohol, 9.9% monoterpene hydrocarbons and 7.1% diterpenes (Abdel *et al* ., 1987).

The resins of *C. terbinthina* and *C. cyclophylla* have been shown (Abegaz *et al.*, 1989) to consist primarily of moneterpene hydrocarbons with limonene as a major component. However, the resin of *C. terbinthina* is rich in sesquiterpenes.

The carbohydrate component of Oleo-gum resins

Content

Extraction of gum myrrh with 90% alcohol gave a crude polysaccharide (PS) that ranged in yield from 27 to 61% (Hough *et al.*, 1952, Treas and Evans, 1978; Hirst and Jones, 1981). On the other hand, gum olibanum on similar treatment gave a crude polysaccharide that ranged from 27-35%.

Recently (Karamalla, 1997) the carbohydrate component contents of *B. papyrifera, C. africana* and *C. abyssinica* have been found to be 27.9, 27.3 and 4.1% respectively.

Protein content

It has been reported (Hough *et al.*, 1952,) that the crude PS of myrrh contained 18% protein, and that the purified PS from *B. papyrifera* has only 4-8% protein (Anderson *et al.*, 1965). Recently (Abdel Kariem, 1992) the protein content of the crude PS of *B. papyrifera* has been found to be 3.9%.

The crude acidic PS of gum myrrh has an equivalent weight of 547 (Hough *et al.*, 1952) and that of *B. carterii* has an equivalent weight of 540 (Jones and Nunn, 1955).

Very recently (Karamalla, 1997), 614 and 628 have been reported as values for the equivalent weight of PS from *B. papyrifera* and *C. africana* respectively.

Specific rotation

Specific rotation for frankincense of *B. carterii* and that of gum myrrh have been reported (Jones and Nunn, 1955) to be -8° and +32° respectively. For gum from *B. papyrifera* a value of -4° for the specific rotation has been reported (Abdel Kariem, 1992).

Very recently (Karamalla, 1997) PS from *B. papyrifera* and *C. africana* have been found to have specific rotation of -11° and -26° respectively

Sugar composition

Complete hydrolysis of PS from *B. papyrifera* (Anderson *et al* ., 1965) has afforded uronic acid 19%, D-galactose 60% L-arabonose 10% and L-rhamnose 5% plus a trace of L-fucose. Recently (Abdel Kariem, 1992) PS from *B. papyrifera* has been found to contain D-galactose 35%. L-arabinose 12% uronic acid 20% with traces of L-rhamnose and L-fucose. Very recently (Karamalla, 1997) it has been shown that the sugar composition of PS of *B.papyrifera* is L-arabonose 12.7%, LL-rhamnose 13.7%, L-fucose 13.1%, D-galactose 18.7%, D-glucuronic acid 25.3% and 4-0- methyl-D-glucuronic acid 13.8% white PS from *C. africana* afforded L-arabinose 20.2%, L-rhamnose 19.7%, L-fucose 17.6%, D-galactose 19.6%, and D-glucuronic acid 22.8%.

Heterogeneity of PS

Solvent fractionation yielded a number of PS fractions for myrrh and olibanum that varied in yield, solubility in water and alkali, specific rotation and molar proportions of D-galactose and L-arabinose (Hough *et al.*, 1952). This finding has recently (Karamalla, 1997) been confirmed by acetone fractionation of the polysaccharide from *B. papyrifera*, indicating once more the heretogeneity of plant gums.

Utilisation

Exports of gum olibanum and gum myrrh have been increasing in recent years with a rapid rise in production and earning, indicating expanding utilisation of these oleo-gum resins.
Historically, myrrh has been used by the ancient Egyptians in embalming and as a chewing gum (Hirst and Jones, 1981). Now oleo-gum resins are widely used in perfumes, medicine and as insecticides.

(i) Perfumes

The gum resin of *C. africana* melted with water is used as a perfumed application to the body (Watt and Berger, 1962). Olibanum is used as odourous fragrance which last for a very long time and is an excellent fixative for perfumes for men. Oleo-gum from *B. carterii* and from *B. wightii* is widely used as an incense in religious ceremonies for example (Elamin, 1981). Oil of *B. serrate* is used in the soap and perfumery industry (Karnik and Sharma, 1970).
It has been suggested that the alcohol soluble resins oil of olibanum has much more fixation properties than the volatile oil. However, the reverse is true of myrrh.
Oleo-gum from *B. papyrifera* is used widely as incense in holy places and temples and also to perfume houses (Elamin, 1981).

(ii) Medical uses

Myrrh is a disinfectant and may be used as a local stimulant to the mucous membrane (Howes, 1949). The resin of *B. carterii* is used as a diuretic. It is boiled with sesame oil and taken daily for bilharzia. A decoction made with cinnamon and cardamon is used for the relief of stomach-ache. In India, oleo-gum resin is used as a remedy for rheumatoid and diseases of nervous system, and is an ingredient of certain ointments (Watt and Berger, 1962).

Oleo-gum resin from *C. wightii* is considered as astringent, demulcent, expectorant, carminative aphrodisiac and antiseptic (Elamin, 1981) it has also been used for treating rheumatoid arthritis, heart ailments, neurological disorders, skin infections, and obesity in humans. An extract from the resin of some species of *Burseraceae* has been known to have anti-inflammatory activities.

(iii) Insecticides

Myrrh is used as an insecticide especially as a repellent of termites and as a mosquito repellent when blended as incense sticks (Elamin, 1981).

Essential oil from *B. serrata* is found to affect spermatogenesis in *Dysdercus similis*, thereby acting as an effective insect growth regulator. Constituents of the resin from *C. rostrata* have repellent effects against the maize weevil. The effect of gum resin of *B. papyrifera* and *C. africana* on three insect pests of economic importance, has led to morphological malformation of adults and pupa, reducing the emergence of adults and increasing mortality rate.

References

Abdel Kariem, E. H. 1992. Structural Studies of Some Sudanese Gums. Ph.D. Thesis Faculty of Science University of Khartoum.

Abdel Wahab, S.M.., Aboutable, E.A., El-Zalbeni, S.M.,. Fouad. H.A., De Pooter, H.I., and El- Fallaha B. 1987. *The essential oil of olibanum.* Planta Medica 52, 382-384.

Abegaz B., Dagne, E.,. Bates C. and Waterman, P.G. 1989 Monoterpene -rich resins from two Ethiopian species of *Commiphora. Flavour and Fragrance Journal* 4 (30., 99-101.

Anderson, D.M.W., Cree, G.M., Marshall, J.J. and Rahman, S. 1965. Studies on uronic acid materials Part XI. The carbohydrate component of the oleo-resin from *B. papyrefera. Carbohydrate Research* 1-320-323.

Elamin 1981. *Trees and Shrubs of the Sudan.* Ph.D. Thesis, Faculty of Science, University of Khartoum, Sudan.

Graveiro, A., Corsano, S., Proitti, G. and Strappaghetti G. 1983. Constituents of essential oil of C. guidotti. *Planta Medica,* 48 (2), 97-98.

Hirst E. I. and Jones, J.F.N. 1981. *Chemistry of Plant gums: Research* 4.411.

Hough, L., Jones, J.K.N. and Wadman 1952. Some observation on the constituents of gum myrrh. *J. Chem. Soc.* 795-797.

Howes, T.N 1949. *Vegetable Gums and Resins* pp 199-182, Chronica Botanica Co, Waltham, Mass. USA

Jones, J.K.N. and Nunnn, J.R. 1955. The Structure of Frankincense gum. *J. Am. Chem. Soc.* 77.8745.

Karamalla, K. A. 1997. Unpublished results, Faculty of agriculture, University of Khartoum, Sudan.

Karnik, M.G. and Sharma, O.R. 1970. Further studies on the distribution and utilization of oleo-gum resin of *B. serrata.* Indian Drugs 96 (1) 843-848.

Provan, G.J., Gray, A.I., and Waterman P.G. 1987. Monoterpene -rich resins from some Kenyan Burserceae.

Provan, G.J., and Waterman, P.G. 1988. Major triterpene from the resin of *C. incisa* and *C. kua* and their potential chemotaxonomic significance.

Treas. G.E. and Evans, W.C. 1978. *Volatile oils and resins pharmacognosy* pp. 463-464 B. Tindall, London.

Watt, J., and Breger, M.G. 1962. *The Medicinal and Poisionausss Plants of Southern and Eastern Africa* pp 151-153. Livingstone Ltd. Edinugh and London

Yates, R.L. and Wenninger, J.A. 1970. Constituents of olibanum oil sesquiterpene hydrocarbons. *J. of Association of Official Analytical Chemists,* 53, 941-980.

PRELIMINARY REPORT ON ESSENTIAL OILS FROM FRANKINCENSE, MYRRH AND OTHER PLANTS OF ETHIOPIA

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Introduction

Boswellia and *Commiphora* species (family Burseraceae) are mainly found in the Horn of Africa with a few species in Arabia and India. The major frankincense suppliers of the world today are Ethiopia, Somalia and Kenya. These plants are sources of the culturally and economically important resins known as frankincense and myrrh respectively. The principal frankincense producing species are: *B. papryfera*, *B. neglecta* and *B. rivae* occurring in Ethiopia, *B. sacra* (syn *B. carteri*) and *B. frereana* in Somalia and *B. serrata* in India. The highly aromatic resin producing *B. pirotae* is endemic to central and northern Ethiopia.

Myrrh is a natural oleo-gum-resin composed of 3-8% essential oil, 30-60% water soluble gum and 25-40% alcohol soluble resins. Myrrh has been employed as incense and for embalming since ancient times. It is employed in formulations of perfumes since it blends well with geranium, musk and patchouli. It is known to impart pleasant aromatic flavour to mouthwashes and tooth pastes. Strictly speaking myrrh is the resin obtained from *Commiphora myrrha* (syn *C. molmol*). However, resins from other *Commiphora* species (*C. africana C. habessinica, C. hildebrandtii, C. erythraea, C. kua, C. schimperi* etc) sometimes pass as myrrh or as its adulterants.

Several thousand tons of frankincense and myrrh are collected annually from wild trees in eastern and north eastern Africa and exported to many parts of the world because of great demand in the international market for their steam distillates and extracts, which are used in the manufacture of perfumes. There is also a large local market for use of these products as incense. However, hardly any effort has been geared towards adding value to these natural products in particular in those countries where the resin-producing trees are found in abundance. Value-added processing should be introduced so that the concerned communities in these countries earn more income from the resins and thereby become more aware of the value of maintaining the sustainable utilisation of the trees.

The starting point for research into these resources is to establish the botanical identity of the resin-producing species. It should be pointed out that much of the chemistry work on frankincense and myrrh in the past was conducted on resins obtained from commerce, thus leading to much confusion in the chemical literature. However, recent advances in the botanic identification of many *Boswellia* and *Commiphora* species is making it possible for chemists to work on resins obtained from properly identified species.

In our laboratory, chemical investigation is in progress on resins obtained from several botanically identified *Boswellia* and *Commiphora* species. Literature reports show that these species are rich in sesquiterpenes. However, much remains to be done, since in Ethiopia alone there are at least 6 *Boswellia* and 50 *Commiphora* species.

There is rich ethnobotanical heritage in communities where the trees are found and it is therefore important to document this knowledge. Cursory interviews of elders in such communities by botanists of the Flora Project of the National Herbarium in Addis Ababa revealed that the gums of *C. kua* and *C. habessinica* are used as soap substitute, that of *C. tubuk* and *C. coronillifolia* as glue and for making ink. The gum of *C. myrrha* when mixed with charcoal also yields ink used for writing texts from the Koran on wooden boards. The resins with medicinal values are those of *C. gowlello* used against swellings on humans and livestocks, *C. incisa* to treat skin disease, *C. ogadensis* against ring worm and *C. myrrha* against stomach ache and to suppress virility of young men. Frankincense derived from *Boswellia neglecta* is smoked to repel snakes and flies.

Preliminary results on frankincense and myrrh

One of the most important sources of frankincense in Ethiopia *is Boswellia papryfera* which occurs widely in the northern parts of the country. The ^{13}C NMR spectrum of the crude steam distillate from resin obtained from an identified *B. papryfera* tree is shown in Fig. 1, which indicates the main component (88%) to be octyl acetate, a result also confirmed by GC-MS analysis (Fig. 2) supported by NIST and Wiley databases.

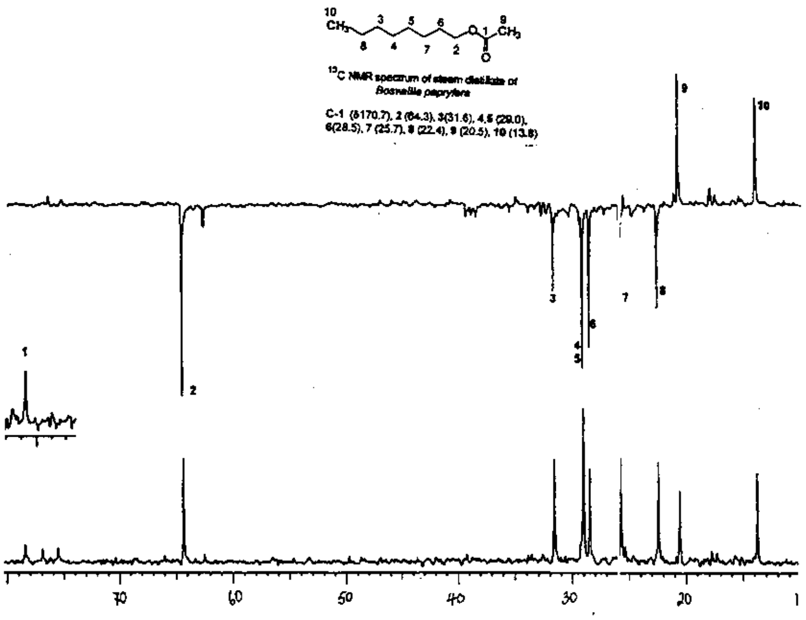


Figure 1: ^{13}C NMR spectrum of crude steam distillate of *B. papryfera* showing that octyl acetate is the principal component

It is interesting to note that Abdel Wahab *et al.* (1987) found octyl acetate to the extent of 60% along with 33 other components in the steam distillate of olibanum purchased from the Drug Market in Cairo and presumed to originate from *B. carterii* growing in Somalia, an assertion that is difficult to substantiate when one is studying resins originating from markets.

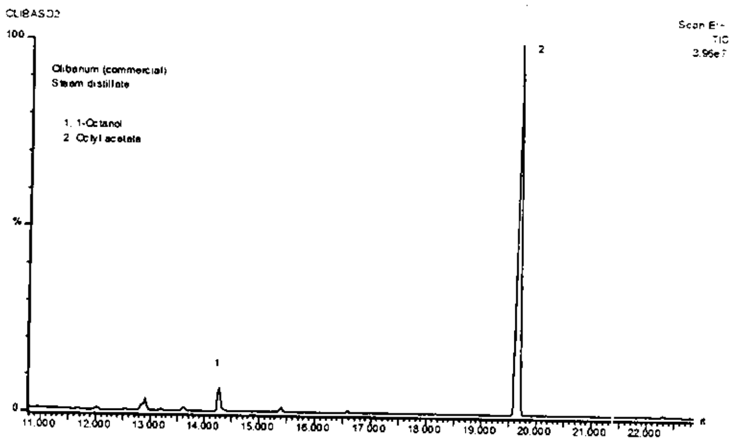
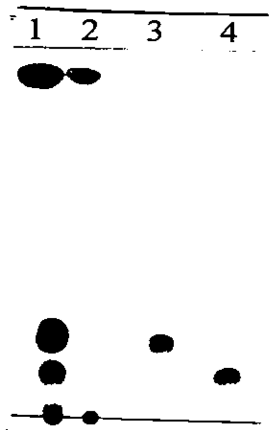
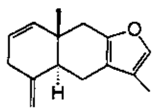


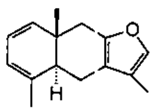
Figure 2: Gas chromatogram of the steam distillate of commercial olibanum in which the major component is octyl acetate.

In the course of our work we have been able to collect resins of myrrh from trees properly identified as *C. myrrha*. This tree is the true source of the well known myrrh of commerce. The constituents of the steam distillate are quite similar to that of the petrol extract. The main components are the known four sesquiterpenes: two of the eudesmane type (**2a** and **2b**) and the other two (**3** and **4**) possessing the germacrane skeleton. Compounds **2a** and **2b**, which have nearly identical R_f on TLC are unstable once removed from the resin. As these compounds decompose quite fast when coming in contact with silica gel both CC and TLC are better performed using aluminum oxide. The fact that components of myrrh are unstable after isolation has not been clearly stated in previous reports on the chemistry of this resin.

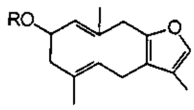




2a = lindestrene



2b = furanoeudesman-1,3-diene



3, R = Me

4, R = Ac

Figure 3: TLC on aluminum oxide (developed by petrol) of:

1 = Petrol extract of myrrh

2 = Ref cpds **2a** and **2b** (spot at origin, decomposition)

3 & 4 = Ref cpds **3** and **4**

These compounds were reported along with several others by Brieskorn and Noble (1980, 1983) who worked on resins obtained from commercial sources originating most likely from *C. myrrha* but not properly botanically substantiated.

Other essential oils under study in our laboratory

We have recently investigated the aerial parts of the rather rare and pleasantly smelling *Artemisia abyssinica* which occur sporadically in farms in central Ethiopia. The plant yields on steam distillation of its aerial parts a light yellow oil whose GC profile is shown in Fig. 4 .

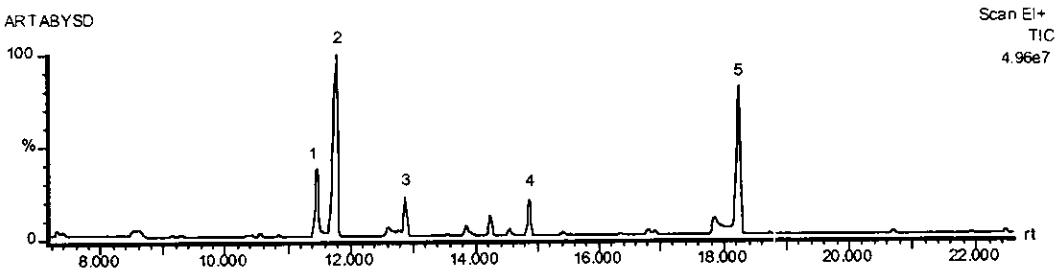
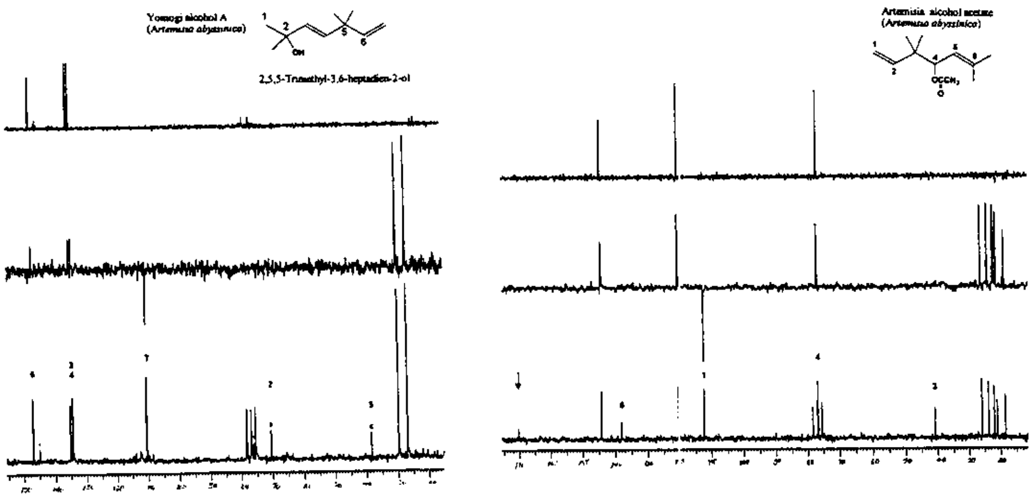


Figure 4: Gas chromatogram of the essential oil of *Artemisia abyssinica* .
(1. Unknown 2. Yomogi alcohol 3. Artemisia alcohol 4. Unknown 5. Artemisia alcohol acetate.)



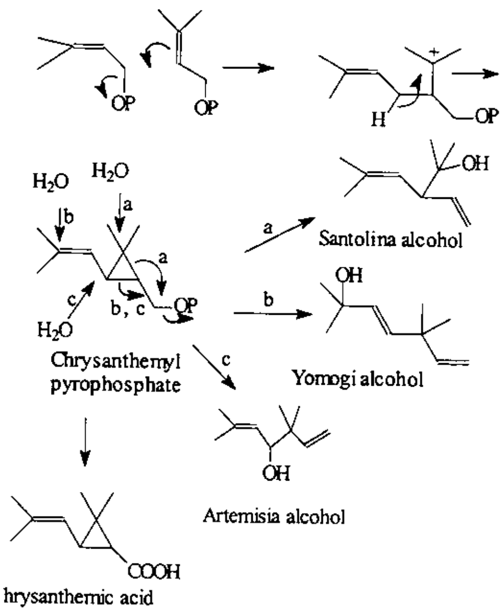
A B

Figure 5: ^{13}C NMR spectrum of A. yomogi alcohol and B. artemisia alcohol acetate.

In both cases the lowest spectrum is due to completely decoupled, the middle CH and CH_3 up and CH_2 down, and the top CH only.

By means of GC-MS and NMR analysis three rare irregular monoterpenes namely yomogi alcohol, artemisia alcohol and artemisia alcohol acetate were readily identified. The ^{13}C NMR spectra including DEPT of two of these monoterpenes separated by means of column chromatography on silica gel are shown in Fig. 5.

The biosynthesis of the irregular monterpenes and chrysanthemic acid is shown in the scheme below, where the key intermediate is chrysanthemyl pyrophosphate (Torssell, 1997). Unlike in the case of the regular monoterpenes, geraniol and nerol are not obligatory intermediates.



In contrast to this, Abegaz and Yohannes (1982) have shown that the essential oil of *Artemisia rehan,* another common aromatic plant of Ethiopia widely used by many people for fragrance purposes, is mainly made up of monoterpenes such as

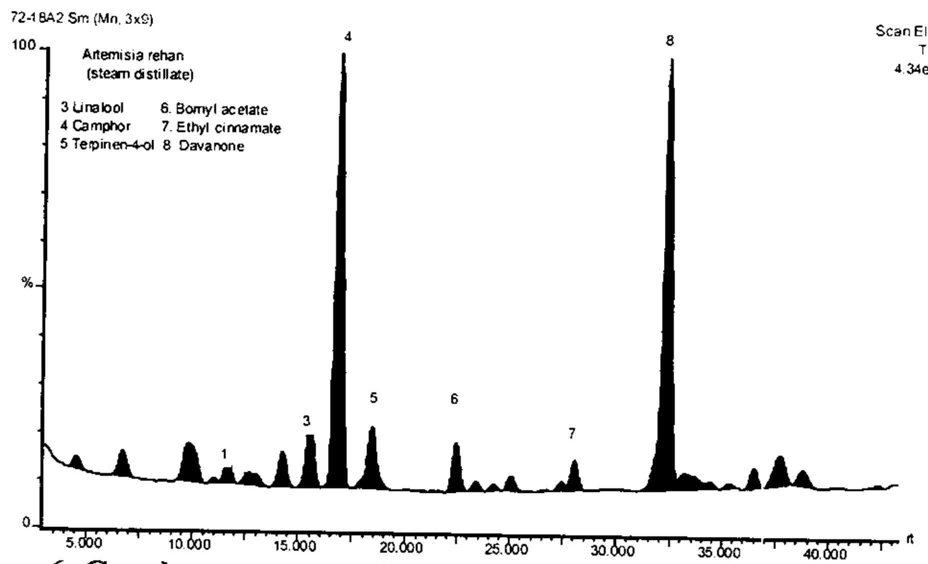


Figure 6: Gas chromatogram of the essential oil of *Artemisia rehan*.

linalool, camphor, terpinen-4-ol and the sesquiterpene davanone. Re-examination of the oil by our group has confirmed the result of the above workers and the gas chromatogram is shown in Fig. 6.

Work is in progress in our laboratory on several essential oil-bearing plants including *Ocimum basilicum* var basilicum, *Ocimum basilicum* var thyrsiflorum and *O. lamifolium*. Attempts are also being made to investigate how to add value to four locally produced essential oils (palmarosa, lemon grass, citriodora and orange peel oils). The results of our studies on *Euclayptus* oils were recently published (Muchori *et al*., 1997; Assefa and Dagne, 1997).

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REFERENCES

Abdel-Wahab, S.M., Aboutabl, E.A., El-Zalabani, S.M., Fouad, H.A., De Pooter, H.L. and El-Fallaha, B. 1987. The Essential Oil of Olibanum. *Planta Med*, **53**, 382-384.

Abegaz, B. and Yohannes, P.G. 1982. Constituents of the Essential Oil of *Artemisia rehan*. *Phytochemistry*, **21,** 1791-1793.

Assefa, A. and Dagne, E. 1997. Essential oils of three *Eucalyptus* species acclimatized in Ethiopia. *Bull. Chem. Soc. Ethiop*., **10**, 47-50.

Brieskorn, C.H. and Noble, P. 1980. Drei Neue Furanogermacrene aus Myrrhe. *Tetrahedron Letters*, **21,**1511-1514.

Brieskorn, C.H. and Noble, P. 1983. Furanosesquiterpenes from the Essential Oil of Myrrh. *Phytochemistry*, **22,** 1207-1211.

Brieskorn, C.H. and Noble, P. 1983. Two Furanoeudesmanes from the Essential Oil of Myrrh. *Phytochemistry*, **22,** 187-189.

Muchori, P., Manguro, L., Chikamai, B., Dagne, E. and Bekele, T. 1997. Essential oils of five *Eucalyptus* species grown in Kenya. *Sinet: Ethiop. J. Sci*., **20**, 139-143.

Torssell, K.B.G. 1997. Natural Products Chemistry, Swedish Pharmaceutical Society, Stockholm, p. 265.

INTERNATIONAL REGULATIONS FOR NATURAL PRODUCTS USED AS FOOD ADDITIVES

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Introduction

Foods moving in international trade are subject to a variety of constraints, including basic food quality and safety laws and regulations. These are officially applied by importing countries to protect consumers, to ensure fair food trading practices and to prevent commercial fraud.

Food control agencies of importing countries generally apply regulations which give them authority over such factors as food safety, hygiene, quality, packaging, labelling, handling and storage. In general, these regulations include precise requirements, which must be met if food products are to be admitted into the importing country. For example, regulations often indicate levels of contaminants (microbiological, agricultural and veterinary, environmental and radioactive) and levels of additives that must not be exceeded. These are often referred to as sanitary requirements. Other regulations, which are commonly referred to as quality requirements, include parameters concerning the essential composition, labelling and description of foods. Food products which do not comply with these requirements, will often result in their rejection or detention.

While the need to protect consumers from health hazards and deception is beyond question, the potential for applying national regulations in an inequitable or discriminatory manner is ever present. The application of such inequitable or discriminatory practices amounts to non-tariff technical barriers, which impede, rather than facilitate, international trade in foods.

Codex Alimentarius Commission

The importance of non-tariff technical barriers to trade in impeding international trade in foods is recognised by the major food exporting and importing nations. The Codex Alimentarius Commission, which is administered by the Joint FAO/WHO Food Standards Programme, was established in part in response to the potential for the application of such non-tariff barriers to trade. The work of the Commission has been specifically recognised under the World Trade Organisation (WTO) Agreements on Sanitary and Phytosanitary Measures and on Technical Barriers to Trade.

In undertaking its work on the establishment of maximum levels for food additives in foods, the Commission relies on the use of independent scientific advice provided by FAO and WHO through the Joint FAO/WHO Expert Committee on Food Additives (JECFA). For almost 40 years, the recommendations of JECFA have formed the essential basis for countries to judge the acceptability and safety of these compounds and have set the parameters for fruitful intergovernmental Codex discussions on additives. Similar advice has been provided on an ad hoc basis by FAO and WHO in the areas of Contaminants (including radionuclides), Food Hygiene, Nutrition, Analytical Methods, Protein Quality Evaluation and Labelling.

The use of food additives is regulated at international level by Codex standards. Only food additives, which have been evaluated by JECFA and found acceptable for use in foods, are included in the Codex General Standard and are permitted for use in foods. Food additives are only included in Codex standard when the substance does not present any risk to the health of the consumer at the levels of use proposed. Acceptable Daily Intake, or equivalent assessment, established for the additives and its probable daily intake from all sources are taken into account before the inclusion of food additives in Codex standards.

Food additives used in accordance with the Codex General standard, should be of appropriate food grade quality and should at all times conform with the applicable Specifications of Identity and Purity recommended by the Codex Alimentarius Commission or, in the absence of such specifications, with appropriate specifications developed by responsible national or international bodies.

Food additives are classified according to their functional class but can be distinguished between natural and synthetic products. The division between natural and synthetic food additives cannot be considered separated by a net mark, because many natural products are produced synthetically and many synthetic products are produced by modifying natural products or using for their production biological systems such as fermentation.

One of the main differences between natural and synthetic food additives consists in the fact that for synthetic products it is quite easy to establish Specifications of Identity and Purity while for natural products it is more elaborate to establish such specifications due to the complex nature of the products and to some differences depending on areas of production, climatic and soil conditions and sources which can influence notably the composition of the product.

Principles for the safety assessment of food additives in food

More than 500 substances have been evaluated and provided with specifications for purity and identity by JECFA. Specifications of food additives are intended to serve as a guide for manufacturers and users of the additives, as well as the basis for new or revised national legislation or regulation of member countries of FAO and WHO.

JECFA has always operated on the principle that testing requirements for all food additives should not be the same. Such factors as expected toxicity, exposure levels, natural occurrence in food, occurrence as normal body constituents, use in traditional foods, and knowledge of effects on man should be taken into account. In relation to carcinogenic hazards, the Committee has stated that "the scope of the test required should depend on a number of factors, such as the nature of the substance, the extent to which it might be present in food and the population consuming it". More generally, the Committee has requested data on, *inter alia,* methods of manufacture, impurities, fate in food, levels of use of food additives in food, and estimates of actual daily intake, and concluded that such information "was important and relevant both for the toxicological evaluation and for the preparation of specifications"

Naturally occurring polysaccharides

The term 'gums' is used to describe a group of naturally occurring polysaccharides which find widespread industrial use because of their ability either to form viscous solutions or gels or to stabilise emulsions and dispersions. A convenient means of classifying gums is according to their source and Table 1 gives details of gums commonly used.

Polysaccharide gums are poly disperse materials containing molecules with a broad range of molecular masses and usually differ to a greater or lesser extent in their carbohydrate structure or make-up depending on their source and method of extraction or manufacture. Such differences in composition commonly leads to variability in properties.

Tree Exudates

Gum exudates differ considerably chemically. Gum arabic (*Acacia senegal*) consists of three water-soluble fractions, namely an arabinogalactan (± 90 %) and two arabinogalactan-protein complexes which differ in their molecular size and in the proportion of the proteinaceous material associated with each. Gum tragacanth consists of a water-swellable fraction called tragacanthic acid (or bassorin) (60 - 70 %) and a water soluble fraction called tragacanthin. Gum Karaya is a heavily acetylated polysaccharide composed of chains of α-D-galacturonic acid and α-L-rhamnose. Gum ghatti has a main chain of alternating 1,4-β-D-glucopyranosyluronic acid and 1,2-αD-manno-pyranose units and contains numerous side-chains and branches consisting of L-arabinose, D-galactose and D-glucuronic acid.

Seaweed Extracts

Seaweed gums constitute the structural component of the plant and are isolated by acid or alkaline extraction followed by precipitation and drying. Agar and carrageenan are both polygalactans. Agar consists of two components, namely agarose (50 - 90 %) and agaropectin. The carrageenans are a group of linear sulphated galactans and three types are available commercially: kappa, iota and lambda.

Microbial Gums

Xanthan and gellan gums are extracellular polysaccharides obtained from the aerobic fermentation of the respective bacteria in batch culture. Xanthan gum consists of a linear 1,4-linked-β-D-glucopyranose main chain with a trisaccharide side-chain on alternate glucose residues. Gellan is a linear molecule with a tetrasaccharide repeating unit consisting of two glucopyranose residues, glucuronic acid and rhamnopyranose.

Table 1: Classification of gums

Source	Gum	ADI	Functional class
Tree exudates			
Acacia	Gum arabic	NS (1997)	TA; S; E
Astragalus	Gum tragacanth	NS (1985)	TA; S; E
Sterculia urens	Gum karaya	NS (1988)	E; S; TA
Anogeissus latifolia	Gum ghatti	NA (1983)	TA; S
Seaweed extracts			
Red seaweed *Rhodophyceae*			
Gelidium/ Gracilaria spp.	Agar	NS (1973)	TA; S
Euchema cottonii, Euchema spinosum, Chondrus crispus and Gigartina sp.	Carrageenan	NS (1984)	TA; GA; S
Brown seaweed *Phyophyceae*			
Laminaria hyperborea, Macrocystis pyrifera and Ascophyllum nodosum	Alginate	NS (1992)	TA; S; GFA; E
Plant extracts			
Peel of various citrus fruits and apple pommace	Pectin	NS (1981)	TA; S; GA
Seed and root gums			
Cyamopsis tetragonoloba	Guar gum	NS (1975)	TA; S
Ceratonia siliqua	Carob bean gum	NS (1981)	TA; S
Cesalpina spinosa	Tara gum	NS (1986)	TA; S
Amorphophallus konjac	Konjac mannan	NS (1993)	GA; TA; E; S
Microbial gums			
Xantomonas campestris	Xanthan gum	NS (1986)	TA; S
Auromonas elodea	Gellan gum	NS (1990)	TA; S; GA

Note: NS - ADI not specified
NA - ADI not allocated - The year refers to the latest evaluation by JECFA
E Emulsifier; **GA** Gelling Agent; **GFA** Gel-Forming Agent; **S** Stabilizer;
TA Thickening Agent

Use in Foods

Whilst our modern life style has led to an increasing demand for convenience foods our growing awareness of the relationship between food and health has increased the requirement for high-fibre, low-fat food products. These factors have resulted in a considerable interest in the use of hydrocolloids, including various gums, modified starches and gelatine, in foods and this is expected to continue in the years ahead.

Gums have a major influence on the structural characteristics, texture and overall appearance of food products, even though they are usually present at concentrations of less than 1%. On food labels they are commonly referred to as 'stabilizers'', 'thickeners' or 'gelling agents', and in fact they may serve a number of functions such as enhancing viscosity, inducing gelation, emulsifying oils, stabilising foams and inhibiting ice or sugar crystallisation.

Dietary Importance

Food gums are purified soluble polysaccharide constituents of plant cells. Purified food gums are used in the food industry to stabilise emulsion and improve the texture of food. They are also used as medicines in the prevention and treatment of diabetes mellitus, obesity and hyperlipidaemia, and in the treatment of constipation.

Food gums cannot be digested in the mammalian small intestine, where they tend to form viscous solutions with dietary water and digestive secretions. Viscous solutions are antimotility agents; they impair the effects of gastrointestinal contractions in delivering food from the stomach into the small intestine, in mixing complex macronutrients with digestive secretions and in making the products of digestion available to the absorptive surface. In effect nutrients remain trapped in the gum matrix. This is thought to result in a marked reduction in the rate of absorption of rapidly absorbed substances, such as glucose and probably also in the degree of absorption of nutrients that are absorbed more slowly, such as fat and certain micronutrients.

Food gums vary in the degree to which they may be broken down by colonic bacteria. Pectin and guar are rapidly metabolised to short-chain fatty acids, yielding large amounts of gases (carbon dioxide, hydrogen and methane). Acetic acid, propionic acid and butyric acid are the major products of polysaccharide fermentation in the colon, and they each make a contribution to the energy economy.

Conclusions

All gums indicated in Table 1 have been evaluated by JECFA, which established for all products, except gum ghatti, ADI 'not specified'.

Gum ghatti was evaluated by the Committee in 1980, 1982 and 1985. It has the typical heteroglycan structure of other gums in food additive use. Notwithstanding this, the Committee considered that data to allow evaluation for food additive use were insufficient. No toxicological monograph was prepared. The existing specifications were maintained as tentative.

ADI not specified is a term applicable to a food substance of very low toxicity which, on the basis of the available data (chemical, biochemical, toxicological, and other), the total dietary intake of the substance arising from its use at the levels necessary to achieve the desired effect and from its acceptable background in food does not, in the opinion of JECFA, represent a hazard to health. For that reason, and for reasons stated in individual JECFA evaluations, establishment of an acceptable daily intake expressed in numerical form is not deemed necessary by JECFA. An additive meeting this criterion must be used within the bounds of Good Manufacturing Practice (GMP). According Codex definition, GMP include:

1. The quantity of the additive added to food shall be limited to the lowest possible level necessary to accomplish its desired effect
2. The quantity of the additive that becomes a component of food as a result of its use in the manufacturing, processing or packaging of a food and which is not intended to accomplish any physical, or other technical effect in the food itself, is reduced to the extent reasonably possible; and,

3. The additive is prepared and handled in the same way as a food ingredient.

At its 22nd Session, the Codex Committee on Food Additives and Contaminants agreed to endorse the use of food additives with non-numerical ADIs for use in foods in general according to GMP and without specific reference to their technological function. It also agreed to Annex a list of food categories or individual foods where the use of these additives was not allowed or was restricted, based on a similar list currently in effect in the European Community. The list of food additives with non-numerical ADIs and the Annex including food categories is attached as Appendix I to this paper.

In view of the fact that at present risk analysis was considered to be an integral part of the decision-making process of Codex, the Committee on Food Additives and Contaminants is working on the elaboration of procedures for risk assessment and management and is considering that a screening method should be used to evaluate additives which require further assessment of their exposure, and that an appropriate number of these additives be referred to JECFA for the evaluation of data on probable human exposure.

References

Codex Alimentarius Commission, ALINORM 97/12A, Report of the Twenty-Ninth Session of the Codex Committee on Food Additives and Contaminants, 1997

Codex Alimentarius Commission, ALINORM 97/37, Report of the Twenty-Second Session , 1997

Evaluation of certain food additives and contaminants (Twenty-ninth report of the Joint FAO/WHO Expert Committee on Food Additives), WHO Technical Report Series, No 733, 1986

FAO, Summary of Evaluations Performed by the Joint FAO/WHO Expert Committee on Food Additives (JECFA), ILSI Press, 1996

Gums pp 2267 - 2288. In: Encyclopaedia of Food Science, Food Technology and Nutrition, London (UK). Academic Press. 1993

JECFA, Compendium of Food Additive Specifications, FAO Food and Nutrition Paper 52/1, 1993

APPENDIX I

GENERAL STANDARD FOR FOOD ADDITIVES: DRAFT SCHEDULE OF ADDITIVES PERMITTED FOR USE IN FOOD IN GENERAL, UNLESS OTHERWISE SPECIFIED, IN ACCORDANCE WITH GMP

Line	INS No.	Additive
1	260	Acetic Acid
2	472a	Acetic and Fatty Acid Esters of Glycerol
3	1422	Acetylated Distarch Adipate
4	1414	Acetylated Distarch Phosphate
5	1401	Acid Treated Starch
6	406	Agar
7	400	Alginic Acid
8	1402	Alkaline Treated Starch
9	1100	Alpha-Amylase (*Bacillus megaterium* expressed in *Bacillus subtilis)*
10	1100	Alpha-Amylase (*Bacillus stearothermophilus* expressed in *B. subtilis)*
11	1100	Alpha-Amylase (*Bacillus stearothermophilus)*
12	1100	Alpha-Amylase *(Bacillus subtilis)*
13	1100	Alpha-Amylase (Carbohydrase) *(Bacillus licheniformis)*
14	559	Aluminium Silicate
15	264	Ammonium Acetate
16	403	Ammonium Alginate
17	503(i)	Ammonium Carbonate
18	510	Ammonium Chloride
19	380	Ammonium Citrate
20	368	Ammonium Fumarate
21	503(ii)	Ammonium Hydrogen Carbonate
22	527	Ammonium Hydroxide
23	328	Ammonium Lactate
24	349	Ammonium Malate, D,L-
25	517	Ammonium Sulphate
26	300	Ascorbic Acid
27	162	Beet Red
28	1403	Bleached Starch
29	1101(iii)	Bromelain
30	263	Calcium Acetate
31	404	Calcium Alginate
32	556	Calcium Aluminium Silicate
33	302	Calcium Ascorbate
34	107(i)	Calcium Carbonate
35	509	Calcium Chloride
36	333	Calcium Citrate
37	623	Calcium Glutamate, DI-L-
38	629	Calcium Guanylate, 5'-
39	526	Calcium Hydroxide
40	633	Calcium Inosinate, 5'-
41	327	Calcium Lactate
42	325(ii)	Calcium Malate, D,L-
43	529	Calcium Oxide
44	282	Calcium Propionate
45	634	Calcium Ribonucleotides, 5'-
46	552	Calcium Silicate
47	516	Calcium Sulphate
48	150a	Caramel Colour, Class I
49	290	Carbon Dioxide
50	410	Carob Bean Gum
51	407	Carrageenan
52	140	Chlorophylls
53	1001	Choline Salts
54	330	Citric Acid
55	472c	Citric and Fatty Acid Esters of Glycerol
56	1400	Dextrins, white and yellow, Roasted Starch
57	628	Dipotassium Guanylate, 5'-

Line	INS No.	Additive
58	632	Dipotassium Inosinate, 5'-
59	627	Disodium Guanylate, 5'-
60	631	Disodium Inosinate, 5'-
61	635	Disodium Ribonucleotides, 5'-
62	1412	Distarch Phosphate
63	1405	Enzyme Treated Starch
64	315	Erythorbic Acid
65	462	Ethyl Cellulose
66	467	Ethyl Hydroxyethyl Cellulose
67	297	Fumaric Acid
68	418	Gellan Gum
69	575	Glucono Delta-Lactone
70	1102	Glucose Oxidase (*Aspergillus niger, var.*)
71	620	Glutamic Acid, L-
72	422	Glycerol
73	626	Guanylic Acid, 5'-
74	412	Guar Gum
75	414	Gum Arabic
76	507	Hydrochloric Acid
77	463	Hydroxypropyl Cellulose
78	1442	Hydroxypropyl Distarch Phosphate
79	464	Hydroxypropyl Methyl Cellulose
80	1440	Hydroxypropyl Starch
81	630	Inosinic Acid, 5'-
82	1202	Insoluble Polyvinylpyrrolidone
83	505	Iron Carbonate
84	593	Isomalt
85	416	Karaya Gum
86	[425]	Konjac Flour
87	270	Lactic Acid
88	472b	Lactic and Fatty Acid Esters of Glycerol
89	966	Lactitol
90	322	Lecithin
91	1104	Lipase (Animal Sources)
92	1104	Lipase (*Aspergillus oryzae, var.*)
93	504(i)	Magnesium Carbonate
94	511	Magnesium Chloride
95	625	Magnesium Glutamate, DI-L-
96	504(ii)	Magnesium Hydrogen Carbonate
97	528	Magnesium Hydroxide
98	329	Magnesium Lactate, D,L-
99	530	Magnesium Oxide
100	553(i)	Magnesium Silicate (Synthetic)
101	518	Magnesium Sulphate
102	296	Malic Acid, D,L-
103	965	Maltitol (including Maltitol Syrup)
104	421	Mannitol
105	461	Methyl Cellulose
106	465	Methyl Ethyl Cellulose
107	460(i)	Microcrystalline Cellulose
108	471	Mono- and Diglycerides
109	624	Monoammonium Glutamate, L-
110	622	Monopotassium Glutamate, L-
111	621	Monosodium Glutamate, L-
112	1410	Monostarch Phosphate
113	941	Nitrogen
114	1404	Oxidized Starch
115	1101(ii)	Papain
116	440	Pectins (Amidated and Non-amidated)
117	1413	Phosphated Distarch Phsophate
118	1200	Polydextroses
119	261	Potassium Acetate
120	402	Potassium Alginate

Line	INS No.	Additive
121	303	Potassium Ascorbate
122	501(i)	Potassium Carbonate
123	508	Potassium Chloride
124	332i	Potassium Dihydrogen Citrate
125	501(ii)	Potassium Hydrogen Carbonate
126	351(i)	Potassium Hydrogen Malate, D,L-
127	525	Potassium Hydroxide
128	326	Potassium Lactate (Solution)
129	351(ii)	Potassium Malate, D, L-
130	283	Potassium Propionate
131	560	Potassium Silicate
132	515	Potassium Sulphate
133	460(ii)	Powdered Cellulose
134	944	Propane
135	280	Propionic Acid
136	470	Salts of Fatty Acids (Ammonium, Calciurn, Potassium, Sodium)
137	551	Silicon Dioxide (Amorphous)
138	262(i)	Sodium Acetate
139	401	Sodium Alginate
140	554	Sodium Aluminosilicate
141	301	Sodium Ascorbate
142	500(i)	Sodium Carbonate
143	466	Sodium Carboxymethyl Cellulose
144	331(i)	Sodium Dihydrogen Citrate
145	316	Sodium Erythorbate
146	237	Sodium Fumarate
147	500(ii)	Sodium Hydrogen Carbonate
148	350(i)	Sodium Hydrogen Malate, D, L-
149	524	Sodium Hydroxide
150	325	Sodium Lactate (Solution)
151	350(ii)	Sodium Malate, D,L-
152	281	Sodium Propionate
153	500(iii)	Sodium Sesquicarbonate
154	550(i)	Sodium Silicate
155	514	Sodium Sulphate
156	420	Sorbitol (including Sorbitol Syrup)
157	1420,1421	Starch Acetate
158	1450	Starch Sodium Octenylsuccinate
159	553(iii)	Talc
160	417	Tara Gum
161	472f	Tartaric, Acetic and Fatty Acid Esters of Glycerol (mixed)
162	957	Thaumatin
163	171	Titanium Dioxide
164	413	Tragacanth Gum
165	1518	Triacetin
166	380	Triammonium Citrate
167	332(ii)	Tripotassium Citrate
168	331(iii)	Trisodium Citrate
169	415	Xanthan Gum
170	967	Xylitol

ANNEX TO APPENDIX I

FOOD CATEGORIES OR INDIVIDUAL FOOD ITEMS WHERE THE USE OF FOOD ADDITIVES WITH GOOD MANUFACTURING PRACTICE LIMITATIONS ON USE ARE NOT ALLOWED OR RESTRICTED[14]

Category Number	Food Category
1.1.1	Milk and Buttermilk
1.2	Fermented and Renneted Milk Products (plain) Excluding Drinks
1.4.1	Pasteurized Cream
1.4.2	Sterilize or UHT, sterilized whipping cream, or whipped and reduced fat creams
2.1	Fats and oils, essentially free from water
2.2.1.1	Butter and concentrated butter (Only Butter)
4.1.1	Fresh Fruits
4.1.1.2	Surface treated fruits
4.1.1.3	Peeled or cut fruits
4.2.1	Fresh Vegetables
4.2.1.2	Surface treated vegetables
4.2.1.3	Peeled or cut vegetables
4.2.2.1	Frozen vegetables
6.1	Whole, broken or flaked grains, including rice
6.2	Flours and starches
6.4	Pastas and Noodles (Only Dried Products)
8.1.1	Fresh meat, poultry and game in whole pieces/cuts
8.1.2	Fresh comminuted meat, poultry and game
9.1	Fresh fish and fish products, including mollusks, crustaceans and echinoderms
9.2	Frozen fish and fish products, including mollusks, crustaceans and echinoderms
10.1	Fresh Eggs
10.2.1	Liquid Egg products
10.2.2	Frozen Egg products
11.1	White and semi-white sugar, fructose, glucose, xylose; sugar solutions and syrups; (partially) inverted sugars
11.2	Other sugars and syrups (e.g., brown sugar and maple syrup)
11.3	Honey
12.1	Salt
12.2	Spices, herbs, seasoning (including salt substitutes) and condiments (Only herbs and salt substitutes)
12.8	Yeast
13.1	Infant formulae and follow-on formulae
13.2	Foods for young children (weaning foods)
14.1.1.1	Natural Mineral Waters and Source Waters (Only Natural Mineral Waters)
14.1.5	Coffee, coffee infusions, and other hot cereal beverages, excluding cocoa

[1] It should be noted that Codex has established additional provisions on the use of food additives in certain Codex Commodity Standards and may establish provisions to Schedules 1 and 2 **to this Standard in the future.**

GUM ARABIC - LIFE IN A SATURATED MARKET

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Acacia senegal is an amazing tree. It grows where almost nothing else will survive, provides fodder, enriches the soil with nitrogen and provides gum arabic, an extraordinary harvest which can bring security to the fragile existence of people in the arid lands who depend on livestock or dry-land farming. Gum arabic is a unique and natural product which is very important to the food and pharmaceutical industries but it is much more important as an arid lands resource. It provides real and sustainable benefits to the environment and the people of those regions.

There is a growing range of industrial alternatives to gum arabic. More are possible through fields such as genetic engineering, but gum arabic is still the best. Being a natural product is a selling point which should keep gum arabic at the head of the field for a long time. As an industry we have a collective interest in promoting gum arabic and presenting it in a form which gives little desire or funding to replace it with synthetic or other products.

The pattern which has brought gum arabic usage down from 70,000 tonnes in 1960 to a low of 25,000 tonnes in the early 1990's is now familiar. The domino effect of drought, shortage and high prices leads to reduced demand. Reduced confidence is shown as, each time prices return to former levels, usage fails to recover, users having found alternative products and are unwilling to change back. It is obvious what damage the cyclical trends in the gum arabic market do. User confidence is damaged further by the effect of casual, opportunist collectors in some countries. They compete fiercely when prices are high, often supplying low-quality adulterated gums at a time when users are willing to accept them. Then, when prices reduce, collection ceases leaving the end-user and the pastoralist collector equally disillusioned.

Building Customer Confidence

1. Reliable supply
2. Stable prices
3. Pure unadulterated product
4. Traceability - guarantees of good working practice.

At this point in time there are gum arabic stocks built up throughout the world to last for up to 2 years. It is probable that we will not see a large increase in prices for many years. As a result the user is gaining new confidence in price and supply. There are encouraging signs of recovery in the market. The user is now in a powerful position and can demand the things he/she wants.

Probably the most important of those things is purity. It is so fundamentally important that we present gums which are not adulterated with gums of another type or species. Gum arabic is increasingly used as a technical product. It is often blended with other gums or materials to produce precise ingredients for food and pharmaceuticals. The variability which has sometimes been normal in the past is no longer acceptable. The vast sums of money which go into developing new product lines demand that ingredients must be of a relatively invariable nature. If gum arabic is to be in that category every one right down to the collector must be committed to the supply of a pure and unadulterated product.

Users also want traceability and guarantees that ensure they receive a product which does not expose them to risk. There are increasing problems from micro-biological organisms such as *E. coli* and Salmonella. Residues of chemicals or other things are equally unacceptable. Clean baskets, sacks, transport and storage conditions can go a long way to ensuring reasonable levels of safety. Producers who adopt and can guarantee good working practices will have a more saleable product.

How does a country like Kenya achieve these things? Kenya is a very small producer but has the potential to satisfy rich markets and can increase current levels of production.
There must be some co-operation between all those involved, leading to the development of a standard for Kenya gum. Any certification scheme should be tough enough to deliver consistent standards to build customer confidence and promoted to deliver real benefits for its members.

The aim should be:-

1. To develop standards which guarantee clear, graded and unadulterated gum of each separate type or species; and
2. To enforce a code of practice which ensures;
   - traceability and guarantees of good working practice and
   - that collectors are consistently and fairly treated.

If this can be achieved, it should be possible to see the differences in Kenyan gum not as a disadvantage which incurs a discount on market price but as an advantage which attracts a premium.

The world is of course littered with marketing boards and authorities which have failed to protect their product often through too much bureaucracy and very often through a belief that they can dictate to the market. We are in a world where there is a surplus of most commodities, where the customer is King. The fundamental rule is listen to the customer because he will only buy from people who are committed to improving his business.
I would like to conclude by saying that Sudanese Kordofan has been an incredibly successful product over the years. The way is open for other countries to develop gums from different species and different regions with different qualities. These can complement Kordofan and provide the customer with an increased range of technical products for an increasingly technical world.

As producers we should keep things as simple as possible:

- Pick gum from the right trees
- Keep it separate
- Keep it clean
- Deliver in a sack to the customer.

Anyone who can achieve this I think has a healthy future in gum arabic.

CHEMOTAXONOMIC ASPECTS OF GUM EXUDATES FROM SOME ACACIA SPECIES

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Key Work Index - *Acacia*, chemotaxonomy; gum exudates, properties

Abstract

Although *Acacia drepanolobium* and *A. malacocephala* are regarded as being closely related botanically, analysis of the specimens of their gum exudates confirm that they are indeed two distinct species. The properties of the gum exudate from *A. senegal* var *leiorhachis* differ from that obtained from *A. senegal* var *senegal* (widely accepted as the source of commercial gum arabic) by being much more viscous and having higher proportions of insoluble gel fraction and nitrogen contents. However, the properties of the gum exudates from *A. seyal* var *seyal* and *A. seyal* var *fistula* are quite similar and it is justifiable to retain them as variations of the same species.

Introduction

Morphologically, *A. drepanolobium* and *A. malacocephala* plants are very similar and it is almost impossible to distinguish between them on the basis of herbarium specimens alone. The only difference that can be appreciated in the field is that they flower at different times of the year. Burtt (1942) considered them as two distinct species and made an interesting distinction that *A. malacocephala* flowers in the later dry season, the flowers disappearing in the first rains, whereas *A. drepanolobium* flowers in the rainy season.

The species *A. senegal* is extremely variable. *Acacia senegal* var. *senegal* itself shows a wide range of variation in terms of indumentum, armature, flower size and general habit. *Acacia senegal* var. *leiorhachis* differs from *A. senegal* var *senegal* solely by its glabrous inflorescence axis, a difference considered as a minor variation by (Brenan, 1959). *Acacia senegal* var *kerensis* also seems not to be uniform but its bushy habit is the most distinctive in the field. However, the status of these variants of *A. senegal* is quite uncertain (Brenan, 1959). It is not yet known whether they represent a response to an unusual habitat, exceptions in an otherwise normal population or just distinct local races.

Acacia seyal var *fistula* has a greenish white smooth bark, with 'anti-galls' and grows commonly on black cotton soil on the plains. *Acacia seyal* var. *seyal*, on the other hand, has a reddish bark, without 'anti-galls' and occurs commonly on the hills (Brenan, 1959).
Acacia drepanolobium, A. malacocephala, A. seyal var. *fistula* and *A. seyal* var. *seyal*, belong to Bentham's series (Bentham, 1875) Gummiferae whereas *A. senegal* var. *senegal* and *A. senegal* var *leiorhachis* belong to the series Vulgares.

The use of analytical data to provide chemotaxonomic evidence to distinguish between closely related varieties of species has been suggested by some workers (Anderson and Brenan, 1975; Anderson and Weiping, 1990). This paper presents the physicochemical properties of gum exudates from the above-named species (except *A. senegal* var. *kerensis*) and presumably will contribute in underpinning the identity of the various closely related species.

Results and Discussion

The physicochemical data for the samples are summarised in Table 1. *Acacia* gums are known to be highly soluble in water unlike other tree exudate gums (e.g. gum karaya) which are not completely soluble in water and form highly viscous solutions or suspensions at relatively low concentrations (Anderson and Street, 1983; Gliksman and Sand, 1973). The gum exudate from *A. drepanolobium* is almost completely soluble in water (CWIG, ca. 0.4% w/w) whereas its close relative, *A. malacocephala* possesses a substantial amount of insoluble gel fraction (Table 1). Nitrogen content is considered as one of the very useful parameters in distinguishing gums from different species (Anderson, 1976; Anderson, 1977). In fact, JECFA (JECFA/FAO, 1990) introduced the specification for nitrogen content (0.26-0.39% w/w) in the definition of gum arabic to ensure identity and purity of the gum. However, gums from some closely related species analysed in this work have been found to differ significantly with respect to this parameter. Thus, the nitrogen contents of the gum specimens from *A. malacocephala* found in this work are significantly higher than those of *A. drepanolobium* gum (ca.0.30%) (Table 1). Likewise, the specific optical rotations and acid equivalent weights (AEW's) of the gums from *A. malacocephala* and *A. drepanolobium* are remarkably different. However, the methoxyl contents and the total ash levels of the gum samples from these two species are fairly similar.

In general, the properties of gums from *A. malacocephala* and *A. drepanolobium* are substantially different. Therefore, although *A. malacocephala* and *A. drepanolobium* are regarded as being closely related botanically, the properties of their gum exudates confirm that they are indeed two distinct species. Accordingly, in order to provide an unambiguous identity for the two species, it is recommended that some properties of their gum exudates should be included in their taxonomic description.

Table 1 shows that the AEW's and total ash levels of the gums from *A. senegal* var. *leiorhachis* and *A. senegal* var. *senegal* are similar. However, apart from these two parameters, the overall impression is that these two species produce gums with different properties. For example, there is a notable difference in terms of solubility. The gum from *A. senegal* var *leiorhachis* is far less soluble than that from *A. senegal* var *senegal*. *Acacia* gums with a high proportion of insoluble gel are known to be more viscous than those with a low proportion of insoluble gel(Phillips *et al.*, 1980). Therefore as expected, the viscosity of *A. senegal* var *leiorhachis* gum is significantly higher than that of *A. senegal* var *senegal* at the same concentration Table 1). A similar observation has been reported for gum ghatii(Jefferies *et al.*, 1977). In this work *A. senegal* var *senegal* has been found to have a more negative optical ration (I, -25:II, -26). Since *A. senegal* var *senegal* is the most prevalent variation of Sudanese *A. senegal* (Anderson *et al.*,1983), the value of -35 for optical rotation assigned to Sudanese gum arabic (Anderson *et al.*,1983) is presumably the of *A. senegal* var *senegal* gum. The differences between values obtained in this work and the literature value (-30) (Anderson *et al.*, 1983) might be due to variation between the exuding *A. senegal* trees as reported by Devaluate *et al.* 1993, who recorded a wider range of optical rotation with a minimum of -25 and a maximum of -62. The optical rotation values of *A. senegal* var. *leiorhanchis* gum are comparable to those reported for Sudanese *A. senegal* gum (-30) (Anderson *et al.*,1983) but significantly lower than that of *A. senegal* var *kerensis* gum (-35) (Chikamai and Banks, 1993).

Table 1: Physicochemical properties of gum exudates from some *Acacia* species of the series Vulgares and Gummiferae

Parameter	drepa		mala		sese		sele		seya		sefi	
	I[a]	II	I	II	I	II	I[b]	II	I[a]	II	I	II
Moisture % w/w	10.7	14.4	13.2	13.4	15.0	14.1	13.8	15.3	15.0	14.0	14.2	13.4
Ash % w/w	2.0	1.6	3.0	2.3	4.5	3.8	4.2	5.2	3.0	3.5	3.2	2.6
Acid insoluble matter % w/w	0.20	0.35	1.88	0.73	0.88	0.60	0.30	0.21	0.30	0.78	0.65	0.60
CWIG % w/w	0.30	0.43	5.88	3.43	1.57	1.83	8.90	15.67	0.20	0.70	2.70	0.35
HWIG % W/W	0.30	0.40	3.92	2.96	0.96	1.23	2.10	4.03	0.10	1.06	1.70	0.30
Ca (g/100g)[c]	0.66	0.53	0.68	0.59	0.72	0.43	0.75	0.74	1.01	1.06	1.78	0.77
Mg (g/100g)[c]	0.09	0.05	0.08	0.05	0.29	0.02	0.17	0.15	0.15	0.09	0.08	0.08
Na (g/100g)[c]	0.08	0.03	0.13	0.03	0.01	0.01	0.02	0.02	0.01	0.02	0.01	0.04
K (g/100g)[c]	0.19	0.10	0.28	0.11	0.98	0.09	1.09	1.35	0.20	0.20	0.18	0.17
Methoxyl % w/w	0.81	1.02	1.12	1.10	0.17	0.26	0.30	0.27	1.22	1.29	1.21	1.43
Nitrogen % w/w	0.30	0.32	1.67	0.84	0.33	0.28	0.44	0.48	0.13	0.07	0.21	0.18
Hence, Protein (N x 6.25)	1.88	1.94	10.44	5.25	2.06	1.75	2.75	3.00	0.81	0.44	1.31	1.12
[α]D In H_2O, deg	+101	+104	+70	+86	-25	-26	-50	-55	+54	+53	+54	+56
Viscosity (centipose)												
100 gl^{-1}	4.0	2.9	4.73	5.33	4.61	2.90	33.69	79.22	8.98	6.00	7.32	5.70
150 gl^{-1}	9.5	5.8	11.06	11.04	9.44	6.14	64.18	181.8	18.83	13.87	19.25	15.39
Optical density	0.18	0.06	0.14	0.10	0.06	0.06	0.19	0.07	0.09	0.08	0.12	0.27
Tannin %w/w	0.33	0.40	0.42	0.48	0.28	0.52	0.37	0.44	0.31	0.59	0.29	0.51
Acid Equivalent Weight	2263[d]	2607	1615	1940	1575	1922	1583d	1703	1424[d]	1423	1284	1812

KEY: drepa= *A. drepanolobium*, mala = *A. malacocephala*, sese = *A. senegal* var *senegal*, sele = *A. senegal* var *leiorhachis*, seya = *A. seyal* var *seyal*, sefi = *A. seyal* var *fistula*. [a] Some of the data are from ref.(Mhinzi and Mosha, 1995). [b] Data from ref. (Mhinzi and Mrosso, 1995) except Na. K

and AEW. [c]Corrected for moisture content. [d]Data from ref. (Mhinzi and Mosha, 1993).

The cationic compositions (Table 1) of *A. senegal* var *senegal* and *A. senegal* var *leiorhachis* gums are quite similar; Metal ion content in plant material is thought to be a function of the composition of the soil on which the plants grow (Anderson and Wieping, 1990; Anderson and Morrison, 1989; Anderson and Weiping, 1990). Thus, their levels are not very useful as chemotaxonomic markers in identifying different *Acacia* species. The nitrogen contents and specific rotation values of *A. senegal* var *leiorhachis* gum found in this work are similar to those found in *A. senegal* var *kerensis* gum (Chikamai and Banks, 1993) reflecting a close relationship between the two varieties of *A. senegal. Acacia senegal* var *senegal* gum has been found in this work to have a slightly lower level of nitrogen.

The existence of the *Acacia senegal* complex is well known. The notable differences observed in this study between the properties of the gums from *A. senegal* var. *senegal* and *A. senegal* var *leiorhachis* amplifies the need to incorporate selected analytical data as chemotaxonomic evidence in distinguishing some closely related *Acacia* species.

Another pair of gum specimens we have compared chemotaxonomically, in this work, are those from *A. seyal* var. *fistula* and *A. seyal* var *seyal*. The former can readily be distinguished from the latter as it possesses a greenish white smooth bark, with 'anti-galls'. *Acacia seyal* var *seyal*, on the other hand has a reddish bark, without 'anti-galls'. Table 1 shows that these two varieties produce gums which have similar properties. Thus, the values of specific optical rotation, methoxyl content, total ash and viscosities of the gums from these variants of *A. seyal* are quite similar. It is concluded, therefore, that in general the properties of *A. seyal* var *seyal* and *A. seyal* var *fistula* gums are similar and it is justifiable to retain these two species as variations of the same species.

Experimental

Origin of samples - The gum samples were collected by the authors from central Tanzania in the following locations:

1. *A. drepanolobium*	I	78 km from Dodoma on the Dodoma to Singida road.
	II	12 km north west of Dodoma Town.
2. *A. malacocephala*	I	15.4 km West of Singida town along the Singida-Mlandara road.
	II	As above
3. *A. senegal* var. *senegal*	I	63 km from Dodoma on the Dodoma to Morogoro road
	II	As above
4. *A. senegal* var *leiorhachis*	I	37 km from Morogoro on the Morogoro to Dodoma road.
	II	As above
5. *A. seyal* var *seyal*	I	162 km from Morogoro on the Morogoro to Dodoma road
	II	As above
6. *A. seyal* var *fistula*	I	91 km West of Singida. Mlandara village.
	II	22 km from Dodoma on the Dodoma to Kwamtoro road.

Botanical vouchers for each of the species were also collected and deposited in the Herbarium, Botany Department, University of Dar-es-salaam. Confirmation of the species was obtained from the Royal Botanic Gardens (Kew, UK).

The detailed experimental methods for all the parameters have been described previously (Mhinzi and Mrosso, 1995).

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References

Anderson, D.M.W. 1976 in Iranex S.A. (Editor), Gums and Hydrosoluble Natural Vegetable Colloids, 4th Int. Symp., Paris, p. 105.

Anderson, D.M.W.; *Kew Bulletin,* **32**(3), 529 (1977).

Anderson, D.M.W. and Brenan, J.P.M. (1975) *Boissiera* **24**, 307

Anderson, D.M.W. and Morrison, S.A. (1989). *Food Hydrocoll.,* **3**(1), 57.

Anderson, D.M.W., Morrison, N.A., Weiping , W. (1983) . *Food addit. Contam.*, **7**, 303.

Anderson, D.M.W. and Street C.A. (1983). *Talanta* **30** (11),887.

Anderson, D.M.W. and Weiping, W. (1990) *Food Hydrocoll.,* **3**(6), 475.

Anderson, D.M.W. and Weiping, W. (1990). *Biochem. Sys. and Ecol.* **18**(6), 413.

Bentham, G. (1875) *Trans. Linn. Soc.* **30**, 335.

Brenan, J.P.M. (1983) Manual on Taxonomy of *Acacia* species, FAO, Rome.

Brenan, J.P.M. (1959). [Hubbard, C.L. and Redhead, M. (Editors)]; Flora of Tropical East Africa - Leguminosae: sub-family Mimosoideae, Crown Agents for Overseas Government and Administration (London).

Burtt, B.D. (1942). *Journ. Ecol.* **30**, 96.

Chikamai, B.N. and Banks, W.B., 1993. *Food Hydrocoll.,* **7**(6), 521.

Duvallet, S., Fenyo, J. C. and vendevelde, M.C. (1993) *Food Hydrocoll.*, **7**(4), 319

Glicksman, M. and Sand, R.E. (1973) in Whistler, R. L. (Editor); Industrial Gums: Polysaccharides and their Derivatives. 2nd Ed., Academic Press, New York, p. 197.
JECFA/FAO (1990) Food and Nutrition Paper No. 49, Rome.

Jefferies, M., Pass, G., Phillips, G.O. (1977) *J. Sci. Fd Agric.,* **28**, 173.

Phillips, G.O., Pass, G., Jefferies, M. and Morley, R.G. (1980) in Neukom, H. and Pilnik, W. (Eds). Gelling and thickening Agents in Foods, Foster Publishing Co. Ltd., Switzerland, p. 135.

Mhinzi, G.S. and Mrosso, H.D.J. (1995). *Food Chemistry,* **54**(3), 261.

Mhinzi, G.S. and Mosha D.M.S. (1995). *Discovery and Innovation.* Manuscript in press.

Mhinzi, G.S., and Mosha D.M.S. (1993). Jour. Chem. Soc. Pak., **15**(4), 269.

FAO'S GLOBAL PROGRAMME ON THE DEVELOPMENT OF NON-WOOD FOREST PRODUCTS (NWFP'S)

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FAO and how it works

Established in 1945, the Food and Agriculture Organisation of the United Nations (FAO), is the UN largest technical agency and is among the world's leading international agriculture, forestry and fishery technical development organisations. Today FAO has 174 member governments (including Kenya), a comprehensive regional representation structure (e.g. Ghana, Accra is the Regional Office for Africa; and in Zimbabwe, Harare is the sub-regional office for Southern and East Africa), a physical presence in more than 100 countries, and at its headquarters in Rome, a cadre of specialists in agriculture, fisheries, forestry and related disciplines. The fact that FAO houses under the same roof, all the major disciplines related to overall agriculture development puts it in a unique position with respect to the pursuit of holistic agricultural and agro-industrial development programmes, including those related to the sustainable production of Non Wood Forest Products (NWFP's) such as those discussed at this meeting.

The primary roles of FAO are to serve as:

1) a **neutral forum** for policy dialogue (including international governmental meetings for example on agricultural/NWFP'S trade, on natural resource management and conservation issues),

2) a **source of information** and knowledge (technical information on products, methodologies and statistical data on production and trade on agriculture, forestry and fishery products),

3) a **provider of technical assistance** (field projects to develop/introduce new products or technologies, to assist governments in institutional capacity building, etc.).

Each of these roles offers ample opportunity to advance the cause of NWFP'S through a more sustainable management and utilisation of all forest resources.

How FAO deals with NWFP's

To understand what FAO is doing on these products, we must first recognise that there exist two main categories in producing them:

1) Products which are fully domesticated and which can be cultivated by farmers as agricultural cash crops, such as some spices, medicinal plants, aromatic oils (geranium oil), mushrooms.

This group of plants is covered by several units of FAO's Agriculture Department, such as the 'Industrial Crops Group', which deals with the industrial production of plantation crops for major edible oils, medicinal and aromatics and food additives. The Agriculture Department has accumulated over the years a wealth of information on the production and development of these

plants and their products, and which can be accessed through FAO's publications catalogue or via interment at:
<<http://www.fao.org/WAICENT/FaoInfo/Agricult>>.

2) The second group contains products which are gathered from (wild) sources in forests or other related land uses. This large group of plant and animal products is part of what we call "Non-Wood Forest Products" (NWFP'S) at FAO (also called minor forest products, non-timber forest products and special forest products); and fall under the responsibility of FAO's **Forestry Department.**

For these products, which are used as human food or as food additives, the **Food and Nutrition Division** (of FAO's Economic and Social Department) is providing technical information and assistance regarding food quality control.
Further information on the nutritional use of given NWFP'S is available on their website at:
http://www.fao.org/WAICENT/FAOINFO/ECONOMIC/ESN/NURI.HTM

This paper focuses on the role of FAO's Forestry Department as it's activities in this field may be lesser known.

The **FAO Forestry Programme** is unique among international organisations. FAO's Forestry Department is in fact among the largest and oldest international forestry units of its kind with a broad and comprehensive charter that addresses all forests and all forest products in a comprehensive and interdisciplinary way; this is done in a manner which recognises that environmental protection and economic development are mutually dependent.

FAO is a major source of information on the world's forest resources and forest products. Currently, FAO undertakes a global forest assessment every 10 years, highlighting forest cover, deforestation and forest degradation. We work collaboratively with many countries on this. In addition, we make use of satellite imagery and other means of obtaining accurate data. We are now developing a detailed plan for assessment for the year 2000.

FAO also regularly provides information on production of wood products, trade and capacity statistics; regional and world forestry outlook studies; and forest sector studies. FAO will also attempt to broaden the range of statistical data to include non-wood forest products and to undertake long-term strategic outlook for the forest sector on global and regional scales, taking into account impacts on forests from other sectors, such as population, agriculture, energy and mining.

FAO is also a major source of information on forest science, technology and practice. It develops and facilitates the exchange of technical information, often in multiple languages, on the environmental, economic and social dimensions of forestry including, the protection and management of forests and other natural resources; rehabilitation of degraded or marginal lands; tree planting, especially in a land-use context; enhancing the value, efficiency and environmental soundness of harvesting, utilisation and marketing of wood and non-wood forest products; and policy analysis, planning and institution strengthening.

A good example of the information provided on technology is the work in community forestry, which is one of FAO priority activities. For a number of years, FAO has been pioneering work on the social dimension of sustainable forest management, with a focus on self-reliance and participatory approaches involving local communities. Through this community forestry initiative, FAO stresses decentralised planning, communal management of forests and tree resources, conflict resolution among user groups, equity issues, the role of gender, and the contribution of forests, trees, and NWFP's to food security and nutritional well-being.

FAO's Forestry Department has published many publications on the issues dealing with sustainable forestry development. However, its flagship publication is the "State of the World's Forests", a report published every two years, which is providing a comprehensive overview of the status of the world's forests and its products (including NWFP'S). More detailed information regarding FAO's activities and publications can be obtained at its web site:
htp:www.fao.org/WAICENT/FAOINFO/FORESTRY/forestry.htm.

FAO's Forestry Department programme and publications on NWFP's

Three main activities make up our programme on NWFP'S:

i) information gathering,
ii) partnerships
iii) technical assistance.

i) Information gathering

Successful implementation of programmes on NWFP'S require comprehensive, quality information on the plants themselves, the forest ecosystems in which they grow, on their harvesting and processing practices and on the marketing and trade aspects of these products. The collection, analysis, interpretation and dissemination of such information world-wide has been a priority of FAO from the very beginning.

Essentially, we provide three types of information, namely;

- descriptive information on given NWFP'S
- information on technologies, methodologies and best practices for their production, harvesting, processing and marketing
- production and trade statistics.

In our NWFP'S work programme, we have two types of publications:

a) the "**Non Wood Forest Products Series**": which are in-depth technical documents on specific NWFP'S or issues. Examples of already published issues with particular relevance to this Conference, are:

- "Flavours and fragrances": dealing with cinnamomum, sassafras, rosewood, eucalyptus, sandalwood, litsea cubeba, frankincense, cedarwood, myrrh and opopanax oils (including product and resources description, uses, world supply, demand trends, harvesting, processing)
- "Gum naval stores: turpentine and rosin from Pine resin"
- "Gums, resins and latexes of plant origin" (gum arabic, carob, tara, copal, damar, benzoin, copaiba, chicle, balata).
- "Natural colourants and dyestuffs" (annatto, henna, lac, cochineal)
- "Nutmeg and derivates"; "Edible nuts"
- "Marketing and information systems for NWFP'S"
- "Domestication and commercialisation of NWFP'S in agroforestry systems"; "NWFP'S for rural income"

- "Non Wood Forest Products from Tropical Palms", (in preparation is an issue on Medicinal Plants)
- "International trade in NWFP'S: an overview"; "Trade restrictions affecting international trade in NWFP'S";

Copies of some of these publications are put on display for your information.

b) the "**Non Wood News**" bulletin: which is a newsletter published yearly by FAO of approximately 60 to 80 pages compiling all relevant information on ongoing activities dealing with NWFP'S world-wide, and for which text contributions are made by readers themselves. The bulletin links some 1400 people, institutions and agencies which are involved in one way or other with the promotion and development of NWFP'S.

The newsletter is available on internet (from issue No. 3 onwards) at: http:/www.fao.org/waicent/faoinfo/forestry/nwnews/default.htm

ii) Partnerships

Although FAO is an intergovernmental organisation, and as such its main line of communication is with our member governments, it also needs to receive a welcome input from a broad range of interest groups, including the private sector, universities, forest industries and non-governmental organisations representing environmental and developmental interests. There is need, therefore, to ensure collaboration and to avoid duplication of effort so that skills and resources are most efficiently utilised.

To increase awareness on NWFP'S and strengthen national collaboration at the regional level, FAO's Wood and Non-Wood Products Utilisation Branch (FOPW) has organised three regional expert consultations. The first was for Asia and the Pacific Region in Bangkok, Thailand, in 1991, the second was for Anglophone African Countries, held in Arusha, Tanzania, in 1993; and the third was for Latin America and the Caribbean, and was organised in Santiago, Chile, 1994.

Two global expert consultations have also been organised. A 'Social, Economic and Cultural Dimensions of NWFP'S', was organised in Bangkok, Thailand, in 1994; and an "Inter-regional Expert Consultation on NWFP'S', was organised in Yogyakarta, Indonesia, in 1995. During 1997, a workshop was organised by FOPW on: 'Medicinal, Culinary and Aromatic Plants in the Near East', in Cairo, Egypt, from 19 to 21 May.

For 1998, an 'Expert Consultation on NWFP'S in the Congo Basin', is planned to be held in Cameroon. In addition, preparations have started for expert consultations on 'NWFP'S from Boreal Forests' and on 'NWFP'S from the North American Region.

Especially related to FAOs networking activity on NWFP'S, is the identification, through a questionnaire of all interested partners involved in one way or the other with the development and promotion of NWFP'S. The results of processing this questionnaire will lead to the development of a global Directory on "Who is Who" in the field of NWFP'S (including government, private sector, universities, funding agencies, etc.) Later on this Directory will also serve as a base to further develop FAO's statistical knowledge on global production and trade figures on NWFP'S.

iii) Technical assistance

To help put into practice policies and technologies on NWFP'S management, production and commerce, FAO offers technical assistance to all member countries. The objective of such assistance is to strengthen national capacities to effectively plan and carry out the full project cycle of improving or introducing new products and or techniques for NWFP'S development in a sustainable manner. Technical project-level assistance covers most dimensions of sustainable NWFP'S development, but with emphasis on resource protection and management, information gathering and processing, improved people's participation through community forestry, and institutional strengthening.

At the project level, FAO is currently active in some 250 forestry technical assistance projects in 90 countries, in which for many of them NWFP'S activities are an essential component. Financial support for such projects comes from a variety of sources including FAO, but especially from donor governments, the United Nations Development Programme (UNDP) and the World Bank and others.

Conclusion

Developing and implementing sustainable production and conservation of NWFP'S, with rigid product quality control, efficient marketing and equitable distribution of benefits to all concerned along the full chain from the producer till the consumer, is a key component for a successful programme to achieve more sustainable management of the forest resources, including better conservation of their biodiversity.

FAO, by serving as a neutral policy forum, a source of technical information and by assisting countries in field projects, can do a great deal to help with the successful development and sustainable production of NWFP'S.

THE ROLE OF IGAD IN PROMOTING COLLABORATION NETWORKS AMONG MEMBER COUNTRIES

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Background

The Intergovernmental Authority on Development (IGAD) sub-region has been in the limelight with problems associated with recurring droughts, internal and sub-regional conflicts, food insecurity and environmental degradation. In an attempt to address these problems, while also convinced that drought and desertification can be combated effectively through development, the Member States, (Djibouti, Ethiopia, Kenya, Somalia, Sudan and Uganda) established in 1986 the Intergovernmental Authority on Drought and Development (IGADD). In 1993, the State of Eritrea became the seventh member of the Authority.

At the beginning of 1995, it became clear that the original IGAD priorities and strategies required revisiting to enable the institution to respond to the emerging sub-regional challenges. The member states were convinced that the current economic problems as well as poverty can be addressed effectively through closer economic co-operation, infrastructure development, food security and environment protection and conflict prevention, management and resolution. As a result, a declaration to revitalise and expand the mandate of IGAD was signed in April 1995. The Declaration took into account the development issues. The Declaration which was signed by the Heads of State paved the way for the birth of a dynamic institution on development, ably revitalised in content, orientation and structure.

IGAD Priority areas

The IGAD strategy is based on its overall policy objectives which is sustainable economic development in which regional co-operation and integration is given special impetus and high priority to promote long-term collective self-sustaining and integrated social-cultural and economic development. However, due to its limited capacity, IGAD currently concentrates on its three priority areas which are Food, Security and Environment Protection, Conflict Prevention, Management and Resolution as well as Humanitarian Affairs, and Infrastructure Development. IGAD's vision is based on determination of the governments of the sub-region to pool resources and co-ordinate development activities thus enabling the sub-region to interact and compete in global economy on behalf of its inhabitants; this will eventually lead to regional integration.

Policy organs and function of the Authority

IGAD has three policy levels of operations namely the Heads of State and Government level, who are the ultimate decision makers for sanctioning and ratifying new initiatives and policies; the Council of Ministers, who administer the operation of the organisation at policy level and ensure that implementation at the national levels takes place; and the Committee of Ambassadors who work closely with the Secretariat on matters already approved by the Council but may need further clarification to put them into concrete programmes and plan of actions. The policy organs provide direction and advice to the executive secretariat as and when required.

The Assembly of Heads of State and Government meets once a year and at any time upon request of any member state if accepted by a two thirds majority. The Council of Ministers is composed of Ministers of Foreign Affairs and one other focal Minister designated by each member state. The Council may establish ad hoc sectoral ministerial committees to deal with issues in their respective sectors. The Council meets twice a year at any time upon request of any member state. The committees meet as often as is necessary for the attainment of their objective. The Committee of Ambassadors comprises member state Ambassador at the headquarters of the organisation (Djibouti) and in major partners' capitals. The committee of Ambassadors holds meetings as and when necessary. These committees in donor capitals are chaired by the Ambassador representing the country chairing the Authority.

Project identification, formulation, implementation and resource mobilisation

In selecting projects, IGAD ensures that a project must fall under the IGAD priority areas; a project must be sub-regional in nature; there should be an expressed interest by at least two member states; the proposed project is manageable, has funding potentiality, is sustainable and economically feasible.

With the understanding that each project is a joint undertaking of two or more countries, and agreed upon by all member states, the project preparation is a joint responsibility of the IGAD secretariat and experts from member states. However, member states themselves are directly in charge of project implementation. The IGAD secretariat is involved in planning, fund mobilisation, monitoring and evaluation. IGAD's structure includes a section specifically devoted to resource mobilisation. IGAD's resource mobilisation has been further strengthened by the establishment of the IGAD Partners' Forum (IPF). In the spirit of partnership building, the financing agencies (donors) and other relevant and interested institutions and NGOs can be involved in the appropriate states of the project development. For example, in order to enhance dialogue and transparency, IGAD partners in development can participate in technical committee meetings and contribute in discussing the programmes.

Depending on the nature and size of the project, two institutional approaches have been envisaged:-

- Apart from the political focal point from the Ministry of Foreign Affairs, the technical focal points are designated by each member state for the co-operation of overall IGAD sub-regional programmes. However, member states participating in the project identify technical ministries, departments or other institutions and set-up a national technical committee. The chairman (or representatives) in each country constitute the sub-regional technical committee of the project, chaired by the project co-ordinator at the IGAD secretariat.

- As a matter of expediency and where the secretariat does not have sufficient capacity, IGAD may decided to appoint a Centre of Excellence, a Host Centre or a consortion to function as an executing agency for project implementation, with the secretariat still remaining with facilitation, co-ordination, planning, monitoring and evaluation functions.

Interaction of IGAD with the international community, other sub-regional, regional and international institutions, NGOs and the private sector

The role of the International Community is to actively support, individually or jointly, the efforts of IGAD in implementing its programmes by, *inter alia*, providing financial and technical means, promoting and facilitating access to appropriate technology, know-how and knowledge and capacity building. In implementing its mandate, IGAD finds itself performing similar activities in some areas with other organisations. Towards the spirit of co-operation and collaboration to avoid duplication of efforts and enhance synergy, IGAD endeavours to participate in joint programming with these organisations and indicate where joint action is possible. These institutions support the efforts of IGAD in the exchange of information and experience, capacity building, research and networking in different relevant fields. Some institutions sometimes may be or are contracted to do specific jobs for IGAD where the capacity within IGAD is limited. In preparation of projects/programmes, IGAD identifies collaborating institutions and agencies in all the projects within the three priority areas.

The Authority places a lot of importance on information generation and exchange among member states apart from other institutions/organisations as pointed out above. Information is crucial for policy co-ordination, harmonisation and co-operation. Due to this fact, IGAD makes use of different institutional arrangements developed and approved by its policy organs, in implementing its mandate. The mention but a few:-

- IGAD's political and technical focal points are strengthened with the necessary and modern communication and transport facilities in order to facilitate IGAD related activities in the member state. The focal points organise Intersectoral and Inter Ministerial Committees on relevant sub-regional issues,

- To enhance synergy, IGAD creates and maintains networks with most national, sub-regional, regional and international organisations dealing with issues relevant to IGAD's mandate,

- As a sub-regional organisation dealing with development aspects of the sub-region, IGAD assists and co-ordinates the sub-regional common positions, represents the sub-regions in negotiations of major meetings and conferences and in other relevant fora of sub-regional interest,

- Undertake national sub-regional workshops and seminars to enhance coherence between national and sub-regional policies, strategies sand actions of sub-regional interest,

- With respect to publicity and public awareness, IGAD has an Information and Documentation Section that regularly produces information and press releases on IGAD. In addition, IGAD involves the sub-regional media professionals in publicising its activities from time to time and intends to institutionalise a sub-regional media network,

- Apart from the regular meetings of IGAD policy organs, sectional ministerial meetings are also being convened to enhance the co-operation between member states and harmonise policies set out in the amended Charter.

Besides, IGAD has several information projects that are at different stages of implementation. These projects seek to promote collaboration among such networks as environmental information systems/networks, food security and early warning information systems, library and documentation networks, as well as improving member states' communication via the Internet.

Capacity building of member states' institutions is another area where IGAD promotes regional collaboration and co-operation. This may be in form of provision of equipment and/or regional training seminars, or on the job backstopping. Currently, IGAD has two EU-funded projects aimed at training the government and Private Sector staff in grain marketing as well as artisanal fisheries. Training in water resource management is another priority area for which IGAD is soliciting donor support. However, to improve the internal IGAD operational capacity, the Secretariat continues to utilise in-house as well as external training.

Conclusion

IGAD activities are demand-driven, and the Secretariat is ready to work with any individuals to address development challenges of the sub-region.

ROLE OF NETWORKS IN ADVANCING NATURAL PRODUCTS RESEARCH IN AFRICA: THE EXAMPLE OF NAPRECA

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Introduction

Most natural products chemists in Africa, as is indeed the case with scientists in other fields are often forced to work with inadequate facilities, both in terms of appropriate infrastructure and modern equipment. The disadvantaged researcher is forced to send samples for analysis to laboratories in developed countries. It is difficult to conduct meaningful research under such circumstances as samples often get lost in the mail, decompose on long standing and the measurements sometimes do not come to the full satisfaction of the researcher. These problems coupled with lack of full access to the scientific literature and inadequate financial resources pose as serious stumbling blocks to the development of natural products research in Africa.

The establishment of networks with the aim of initiating, developing and promoting research in natural products is one way of accelerating the development of this science both at the local and regional levels.

An example of a network, with which the author is familiar, is the Natural Products Research Network for Eastern and Central Africa (NAPRECA), which was established in 1984 to promote the science of natural products in our sub-region. NAPRECA set out to achieve its goals not by attempting to build infrastructure of its own but instead to work towards strengthening capabilities through regional and international cooperation. It called for sharing of existing facilities and resources in the sub-region. This cooperation was accelerated through information dissemination and exchange of ideas, effected by means of publications, workshops, symposia, exchange visits and fellowship schemes.

This paper is an attempt to briefly present the efforts of NAPRECA in the past 13 years in promoting natural products research in the sub-region.

Historical Background and Basic Objectives

The main aim of NAPRECA as articulated in its constitution is to "initiate, develop and promote research in the area of natural products in the Eastern and Central African sub-region." Dissemination of information pertaining to natural products research is one of the major objectives of NAPRECA. The importance of establishing links with counterparts in other parts of the world was emphasised right from the outset, as one of the objectives of the network is to "foster and maintain links with such scientists who are actively working in specific areas of natural products that are pertinent to Africa." The sections that follow will attempt to show to what extent NAPRECA has been successful in putting these aims to practice.

The activities of the network fall under five main categories of:

- Dissemination of information
- Exchange of Researchers Scheme
- Natural Products Summer Schools and Workshops

- Natural Products Symposium
- Post-graduate scholarship programme

Dissemination of Information

Much emphasis was given within the framework of NAPRECA to create a condusive atmosphere in the region for the exchange and wider dissemination of research results in the natural products field. This has been made possible in part through publication of the NAPRECA Newsletter. The first issue of the NAPRECA Newsletter was published in September 1984, immediately after founding NAPRECA in July the same year. One of the objectives of the Newsletter is to disseminate information on progress made in the natural products field of relevance to Africa. About 1000 copies of each issue of the Newsletter are published twice a year and are distributed free of charge to readers in various parts of the world.

The suggestions and criticisms of NAPRECA readership greatly contributed to sustaining the Newsletter for 12 years (Vol. 1 to 12). The new NAPRECA Coordinating Office in Dar es Salaam under the leadership of the Executive Secretary, Prof M.H.H. Nkunya is successfully maintaining the momentum and has since published the subsequent issues of Vol. 13 and 14.

A popular column in the Newsletter, "African Plants in the Current Phytochemical Literature" lists reports on African plants that appeared in the three leading natural products journals namely: *Phytochemistry, Journal of Natural Products and Planta Medica.* The reason for selecting these journals lies in the fact that these are the leading fora for the publication of research results on the chemistry and biological activities of plants and their products originating from many parts of the world including Africa. The column serves to alert researchers to the appearance in the literature of articles in particular on African plants

Consequently, since a large body of information has accumulated over the years we felt that it should be treated systematically in a searchable format. For this reason the citations dealing with African plants that appeared in these three journals in the period 1984-1994 were entered in a computer using the commercially available Bibliographic Retrieval Program System known as "Reference Manager" developed by Research Information Systems Inc., USA. This helped us build a useful database of interest to phytochemists and other natural products researchers.

When the database had nearly 1000 entries, a NAPRECA Monograph Series No 8 (1995) was published showing the potential of the information it offered then. At the moment there are over 4000 records in the database and plans are under way to raise this to 6000 by June 1998 with support from the Network of Analytical and Biological Services (NABASA). The database has enabled us to render limited literature search for scientists in the region, with the result sent by ordinary or electronic mail.

The Table below shows the current number of papers available in the database on African plants indicating the country of origin of the plants.

Country	Entries	Country	Entries	Country	Entries
Algeria	13	Ethiopia	213	Rwanda	29
Angola	7	Ivory Coast	34	Senegal	33
Benin	4	Kenya	153	Sierra Leone	9
Botswana	3	Lesotho	1	Somalia	24
Burkina Faso	3	Libya	8	South Africa	339
Burundi	2	Madagascar	95	Sudan	22
Cameroon	128	Malawi	30	Tanzania	56
Central Afr. Rep.	5	Mali	44	Togo	2
Chad	4	Mauritius	14	Tunisia	9
Congo	6	Morocco	36	Uganda	5
Gabon	15	Mozambique	6	Zaire	61
Ghana	68	Namibia	14	Zambia	6
Guinea	35	Niger	6	Zimbabwe	37
Egypt	325	Nigeria	233	Miscellaneous	1700

NAPRECA's effort for dissemination of information has also included the publication of a series of monographs as shown below. Nine monographs have been published so far, the first one of which came out in 1992 and the ninth on March 1996. A summary is presented below.

Monographs published by NAPRECA in 1992-96

No. 1: Z. Asfaw (ed) 1992. NAPRECA Year Book: Eight Years of Existence and Four Years of Intensive Activities, 16 pp.
No. 2: S. Edwards and Z. Asfaw (eds) 1992. The Status of Some Plant Resources in Tropical Parts of Africa, 66 pp.
No. 3: N. Saleh (E. Dagne and W. Mammo, eds) 1992. Flavonoids in the African Flora, 85 pp.
No. 4: M.H.H. Nkunya (B.M. Abegaz and W. Mammo, eds) 1992. Progress in the Search for Antimalarials, 36 pp.
No. 5: S. Edwards and Z. Asfaw (eds) 1992. Plants used in Tropical Medicine as Practiced in Ethiopia and Uganda, 35 pp.
No. 6: NAPRECA 1993 Report, 14 pp.
No. 7: Proceedings of the DAAD-NAPRECA Follow-up Conference, Addis Ababa, Nov. 5-9, 1993, 65 pp
No. 8: African Plants in the Current Phytochemical Literature: List of Papers in Three Leading Phytochemical Journals, 1996, 103 pp.
No. 9: Remigius Bukenya-Ziraba (1996). The Non-cultivated edible plants of Uganda. 60 pp.

Exchange of Researchers' Scheme

Under the Exchange Scheme, a selected fellow is granted the opportunity to spend a month or two in a laboratory within the sub-region. One consequence of exchange programs is that it encourages African researchers to cooperate with each other. It also helps to create an active research environment. The outcome of these efforts can be gauged by the increasing number of publications that are coming out with African researchers from different universities appearing as authors of scientific papers. The list below comprises some of the publications of our research group that resulted from the above mentioned exchange programmes with the country of the exchange fellow indicated in parenthesis.

Dagne, E., Mammo, W., Bekele, A., Odyek , O. (**Uganda**), and Byaruhanga, M.A. Flavonoids of *Millettia dura*. *Bull Chem Soc Ethiop*, *5:* (2). 81-86(1991).

Dagne, E., Yenesew, A., Asmellash, S., Demisseew, S. and Mavi, S. (**Zimbabawe**), Anthraquinones, pre-anthraquinones and isoeleutherol in the roots of *Aloe* species, *Phytochemistry* **35**, 401-406 (1994).

Midiwo, J.O. , Owino, N.O. (**Kenya**) and Dagne, E. (1994). Flavonoids of *Polygonum senegalense* part III: Isolation of dihydrochalcone glucoside and quercetin glycosides. *Bull. Chem. Soc. Ethiop*., **8**, 79-84.

Mirghani, M.E.S. (**Sudan**), I.H. Hussein , E. Dagne and T. Bekele, A comparative study of seedoils of *Chrozophora brochiana* and *Guizotia abyssinica,* Bull. *Chem. Soc. Ethiop.*, **10**, 161-164 (1996).

Muchori, P. (**Kenya**), Manguro, L., Chikamai, B., Dagne, E. and Bekele, T. (1997). Essential oils of five *Eucalyptus* species grown in Kenya,. Sinet: Ethiop. J. Sci., 20, 139-143.

Nkengfack, A. E. (**Cameroon**), Kouam, J. , Vouffo, W. T. Fomum, Z. T., Dagne, E., Sterner, O., Browne, L. M.and Ji, G. Further flavonoids from *Erythrina* species, *Phytochemistry*, **32**, 1305-11 (1993).

Noamesi, B.K. (**Ghana**), Bogale, M. and Dagne, E. Intestinal smooth muscle spasmolytic actions of the aqueous extract of the roots of *Taverniera abyssinica, J. Ethnopharmacol.* **30**, 107-113 (1990).

Van Wyk, B.E., (**South Africa**), Yenesew, A. and Dagne, E. (1995) Chemotaxonomic survey of anthraquinones and pre-anthraquinones in roots of *Aloe* species. *Biochem. Syst. Ecol.* **23**, 267-275.

Yankep, E. (**Cameroon**), Fomum, Z.T. and Dagne, E. (1997). An O-geranylated isoflavone from *Millettia griffoniana*, *Phytochemistry*, 46, 591-593.

Natural Products Summer Schools and Workshops

A regular activity of NAPRECA is the organisation of Natural Products Summer Schools. The main aim of the Summer School is to enhance the research capabilities of participants, in particular in chromatographic, spectroscopic, and bioassay techniques. Seven such programmes have been organised so far. Research scientists and technical assistants working for various institutions in the region have used the opportunity to improve upon their laboratory skills. Usually about 12 participants take part in the Summer School, half of which come from outside the country where the programme takes place.
Likewise workshops are organised from time to time to upgrade skills of researchers. Among the successful workshops mention could be made of:

- IFS-NAPRECA Workshop on NMR techniques (Addis Ababa, Dec. 1991)
- Workshop on bioassay methods (Antananarivo, Sept. 1993)
- Workshop on herbarium techniques (Addis Ababa, April B June 1993)
- Training program on glass blowing techniques (Makerere, Jan. 1995)

Natural Products Symposia

As the NAPRECA concept got off the ground in an IUPAC Symposium on Natural Products, it is only natural for the network to pay special attention to organising similar conferences in

Africa. So far seven natural products symposia have been organised in five member countries. The first symposium was indeed a modest one, convened immediately after the first meeting of the NAPRECA Coordinating Board in March 1988. No book of abstracts came out of that event, the second was held quickly thereafter in Nairobi in September 1988. Sixteen participants came from outside Kenya to this symposium.

The third symposium was held in Arusha, Tanzania, in May 1989 followed by the fourth symposium in Addis Ababa, in December 1991. The increased number of papers required for the first time, the holding of parallel sessions. The fifth symposium held in Antananarivo, Madagascar, in September 1993, enabled a large number of researchers from South Africa to participate in a NAPRECA activity for the first time. The sixth symposium that took place in Kampala, Uganda, in September 1995 attracted about 80 participants who came from various countries in Africa, Europe and North America. Three pre-symposium short courses on Nuclear Magnetic Resonance (NMR), Mass Spectrometry, and Organic Synthesis were held at the same venue. The 7th NAPRECA Symposium was successfully organised in August 1997 in Dar es Salaam by the new Coordinating Office of the Network based in Tanzania.

Post Graduate Scholarship Programme

In the DAAD-NAPRECA scholarship programme NAPRECA is responsible for selecting candidates, who must enroll in a post-graduate programme in a university outside their own country. DAAD scholarships cover tuition, research costs, and subsistence allowances of the fellows in universities in the sub-region. The first beneficiaries were two Ethiopians who, in September 1988, joined the MSc programme of the University of Nairobi and three Kenyans who came to Addis Ababa to join postgraduate programmes in biology and chemistry. Since then nearly 50 post graduate students have benefited from the scheme.

It may be fitting to conclude this brief presentation by stating that NAPRECA has helped natural products researchers in the region to get to know each other and assist one another.

Reference

Dagne, E. 1996. NAPRECA and its Role in the Dissemination of Information in Africa. In: *Bridge Builders, African Experiences with Information and Communication Technology.* National Academy Press, Washington D.C. p. 217-231.

GARA AND ITS INITIATIVES IN THE DEVELOPMENT OF PLANT GUMS AND RESINS IN KENYA

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Abstract
Gum Arabic and Resins Association (GARA) was founded out of the desire by various stakeholders to have a coordinating body/organisation with the responsibility of promoting and developing gum arabic and resins in Kenya. The overall aim is to improve production and quality of the product. This is expected to result in increased income to rural communities where the resources are found while meeting the specifications for international trade. GARA is a non-profit making organisation with membership that includes gum/resin farmers, traders/merchants, government and non-governmental organisations, development agencies, manufacturing industry; exporters and importers. It is already registered and has technical and financial assistance from research institutions and development agencies respectively. It has embarked on a programme of enlightening the communities and traders in sound production practices. However, being at an infant stage it requires more support. This brief paper presents the aspirations and initiatives of the association.

Introduction
Gum Arabic and Resins Association (GARA) is a non-profit making organisation with the responsibility of promoting and developing gum arabic and resins in Kenya. It brings together members from varied fields, including farmers/collectors, traders, government and non-governmental organisations, exporters and importers who have a common interest to improve the production and quality of locally produced gum arabic and resins (myrrh and frankincense) for the domestic and export markets.

GARA's Activities and Organisation
Since its formation over a year ago, GARA has been at the fore front of highlighting critical issues affecting the gum and resin industry in the country. It operates in the form of consultative meetings where pertinent issues are discussed. During the early meetings, two workshops were organised to identify and prioritise problems affecting production and marketing. The outcome of the workshops were:

- Formation of a data base of major stakeholders in gum and resin industry
- Formation of GARA
- Development of a plan of GARA's activities. Based on this, two groups (sub-committees) namely research and extension were established.

The research group attempts to answer questions from collectors, traders, exporters and importers concerning the new sources of gum and resin species, potential quantities, appropriate harvesting times, storage and quality through generation of data. The information generated is made into user-friendly packages by the extension group and relayed to the relevant stakeholder group such as collectors. For example, a simple field manual is being elaborated by the extension group from information generated by the research group.

One of the significant achievements made by the organisation is removing suspicion between collectors and traders/merchants. This has been done by explaining the trend in market prices and how this affects purchase price at farmer/collector level and reasons that lead to low prices or rejection of gum from farmers/collectors. Building confidence between the two groups eliminates cheating and leads to willingness to accept introduction of new ideas at the grassroots without resentment. The organisation has also established a continuous purchase programme of gums and resins through its members. In this way, it will be solving problems facing the industry, in promoting better management and handling of the product so as to meet export quality requirements. Meanwhile, GARA is working on a policy framework for adoption by the government which will create an enabling environment supportive of the industry.

GARA is still a young organisation very much dependent on the goodwill of her members for operation. It has to date received facilitational support from Integration of Tree Crops into Farming Systems Project (ITFSP), technical input from the Kenya Forestry Research Institute (KEFRI) and some financial assistance from Mennonite Central Committee among others. To make it self-sustaining and more focused, a project has been drawn up to elaborate the organisation's operational mechanisms. It is hoped that a strong self-sustaining GARA will result in a viable gum and resin industry in the country.

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