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## The multi-purpose Moringa tree: Ethiopia



### GENERAL INFORMATION

#### ◆ **Implementing institution**

Institute of Pathobiology, Addis Ababa University

#### ◆ **Head**

Dr. Yalemtehay Mekonnen (director)

#### ◆ **Details of institution**

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#### ◆ **Implementation period**

The time frame of the project was from 1996 up to June 2002. However, the project is still ongoing.

#### ◆ **Costs**

The project was supported by: the Research and Publication Office, Addis Ababa University (US\$1,400); the International Foundation for Science (US\$11,450); and the Third World Academy of Sciences (US\$7,500). In addition, the Alexander von Humboldt Foundation of the Government of Germany financed research work at Martin Luther University, Halle, Germany, for nine months.

## SUMMARY

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In 1996, a pilot project to document the uses of *Moringa stenopetala* in the areas of Ethiopia where it grows widely was carried out. The survey showed that the tree is used for a variety of purposes. In most households, for example, the fresh leaves are cooked and eaten. Communities also use the roots for treating malaria and other internal health problems. Laboratory experiments conducted on the basis of the information obtained from the survey indicated that the anti-trypanosomal, anti-fertility and, in particular, the antimicrobial properties of the seeds could be exploited in the production of phytopharmaceuticals. The survey also led to the establishment of an ad hoc national committee that intends to promote and popularize *Moringa* trees in Ethiopia. It is hoped that the efforts of the research team and other interested groups will be instrumental in developing methods to promote the sustainable exploitation of *M. stenopetala* as both a food source and a medicinal plant.

## BACKGROUND AND JUSTIFICATION

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Among the main staple crops of Ethiopia are maize, sorghum, teff (a native grain somewhat similar to millet) and wheat. People also exploit other indigenous plants, including wild banana (*Ensete ventricosum*), eating the starch-containing pith of the stems, and *Moringa* trees, the leaves of which have a distinctive strong, mus-

tard-like taste, contain calcium, iron and other trace minerals, and are eaten as a supplement to the major staple foods.

Worldwide, some 14 species of the *Moringa* tree (family Moringaceae) have been described. Among these, the best studied with regard to potential medicinal uses and the identification of compounds of potential therapeutic importance, is *M. oleifera*, which is native to the Indian subcontinent.

Based on a review of the literature concerning *M. oleifera*, a project was developed to investigate the traditional uses of *M. stenopetala*, a species that grows widely in southern parts of Ethiopia (fig. 1).

As well as being eaten, *M. stenopetala*, also known as *aleko* or *shiferaw* among local communities, has a variety of uses, many of them medicinal. Thus, as with *M. oleifera*, there is good potential to exploit the plant both as a nutritious food supplement and to isolate and characterize lead compounds for pharmaceutical product development.



**Figure 1 |** The *Moringa stenopetala* tree grows widely in southern Ethiopia.

## DESCRIPTION

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The project can be divided into three main phases.

### PHASE I: DOCUMENTATION OF THE USES MADE OF *M. STENOPETALA*

Between March and September 1996, a survey to document the uses to which local communities put *M. stenopetala* was carried out in southern Ethiopia. In the surveyed regions, particularly in the Arba Minch and Wollayta areas, the local people cook the leaves of the *M. stenopetala* tree (fig. 2) and eat them with their traditional *kurkufa* (a cereal dish made with

maize and sorghum). In contrast, the people of Konso use the tree not only for food but also as a medicine and they cultivate it in large areas around their villages (fig. 3). There are claims that the leaves, boiled in water, can cure malaria, hypertension and stomach pain, whereas the roots, chopped and mixed with water, are also used for treating severe cases of malaria. *M. stenopetala* is used as a herbal medicine in areas where visceral leishmaniasis or kala-azar (caused by the *Leishmania* parasite) prevails.

In addition, there are reported cases of *M. stenopetala* leaves being used to expel the retained placenta in women who have just given birth, and the seeds are used to clear muddy water.



**Figure 2** | Leaves of the *Moringa stenopetala* tree are used as both food and medicine.



**Figure 3** | Villages around Konso in southern Ethiopia cultivate the multi-purpose *M. stenopetala* trees in plantations.

## PHASE 2: LABORATORY EXPERIMENTS

A series of laboratory experiments were performed to evaluate the claims that *M. stenopetala* leaves could be used to treat malaria and other parasitic diseases.

Crude ethanol extracts of the leaves and the roots were tested on promastigotes of *Leishmania donovani* (the infective stage of the disease inoculated into the blood by the bite of the sandfly vector). After incubating for 48 hours, the parasite had undergone morphological changes, indicating an adverse reaction to the *M. stenopetala* extract.

Leaf and root extracts of *M. stenopetala* were also tested against the infective stages of *Trypanosoma brucei* (a parasite that causes a sleeping-sickness-like disease of horses, cattle and sheep that is common in tropical Africa), *T. cruzi* (the causal agent of Chagas' disease in South America) and amastigotes (the stage that lives inside the host cells) of *L. donovani*. Of particular note, an ethanol extract of fresh root wood and an acetone extract of dried leaves both showed activity against *T. brucei*.

Further studies using ethanol extracts of *M. stenopetala* leaves demonstrated that, in mice, fertility was reduced by some 75 per cent. The leaf ethanol extract also showed some oxytocic activity (or a speeding up of labour) in experiments using guinea pig and mouse uteri. On the other hand, higher concentrations of the extract abolished spontaneous contractions in the mouse uterus. It is not known

which compounds in *M. stenopetala* exert the reported effects.

## PHASE 3: ISOLATION AND IDENTIFICATION OF BIOLOGICALLY ACTIVE COMPOUNDS

Both leaves and seeds, which are rich in oils, were subjected to bioassay-guided fractionation to develop extraction methods for bioactive molecules and as an initial step in determining their identity. For example, powdered seeds (without their seed coat) were incubated with an enzyme (myrosinase) for 6 hours in 1.5 litres of water before the mixture was filtered and reduced to a volume of 20 millilitres by evaporation. This viscous liquid was then suspended in a mixture of chloroform and methanol (in a 9:1 ratio), filtered and dried. One gramme of this product was added to a silica gel column and washed through 200 millilitres of each of four different eluents: a 1:1 mixture of chloroform and hexane, a 3:1 mixture of chloroform and hexane, followed by two washes of chloroform.

After evaporation, these fractions were used in agar diffusion bioassays against *Staphylococcus aureus*, *Salmonella typhi* (the causal organism of typhoid), *Shigella* (the causal organism of dysentery) and *Candida albicans* (a fungus that causes candidiasis or thrush). Using a known antibiotic (penicillin) as a control, it was possible to determine whether the purified fractions had any antibiotic activity. In fact, the fourth fraction, obtained using the second chloroform wash, had the greatest antibiotic activity (fig. 4).

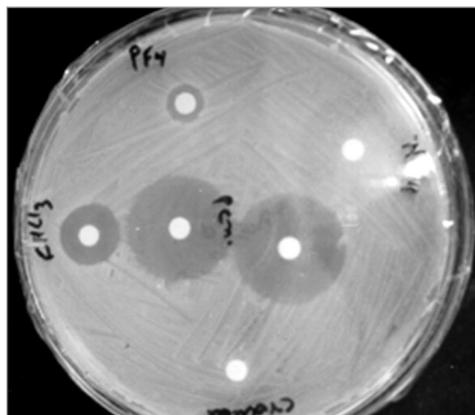
Analytical techniques, including electro-spray ionization mass spectrometry (ESI-MS), high performance liquid chromatography (HPLC), thin layer chromatography (TLC) and nuclear magnetic resonance (NMR) imaging, were used to further characterize and identify purified samples of *M. stenopetala* secondary metabolites. Of particular interest were the glucosinolates — a group of chemicals commonly found in plants of the Brassicaceae family, including cabbage and mustard — which have been shown to have useful antioxidant and anti-cancer properties. Two main compounds were identified from *M. stenopetala* seeds, glucoconringiin and O- (rhamnopyranosyloxy) benzyl glucosinolate, which were present at three per cent and 19 per cent of the dry mass of the seeds, respectively. However, although these compounds have potential therapeutic value, degradation products of glucosinolates have also been shown to interfere with some metabolic pathways, including the synthesis of thyroid hormone. Further tests and analyses are required, therefore,

before these compounds can be declared lead compounds for development into potential phytopharmaceutical products.

## PARTNERSHIPS

The research team investigating the *Moringa* tree plays the primary role in promoting the many uses of the tree. However, the recently established ad hoc national committee made up of a local non-governmental organization, a commercial company (Teppo Agricultural and Trade plc), researchers from national and international institutions and other interested individuals will combine their expertise to promote the dissemination and use of *M. stenopetala*. Together, this forum will introduce the benefits and usefulness of the *Moringa* tree to a range of individuals, including farmers, researchers, agricultural experts and policy-makers.

Recently, German researchers have shown interest in developing a joint project to examine the use of *M. stenopetala* seeds to clarify dirty water.



**Figure 4** | Agar diffusion test of bacterial inhibition by *M. stenopetala* seed extract fractions. Bacteria are grown across the whole plate. The two central discs are the positive control, penicillin, and have a clear ring around them, representing the region in which the antibiotic activity is killing off the bacteria. Likewise, the second chloroform fraction from *M. stenopetala* seeds (see text) also shows some antibiotic activity.

## REPLICABILITY

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The survey and laboratory procedures followed by the Institute of Pathobiology could easily be replicated in similar agro-ecological and social situations to analyse the medicinal properties of other traditional herbal remedies. In addition, given that there are reports of *Moringa* seeds being used to clarify dirty water in Sudan and that the leaves and pods are eaten in parts of Kenya, it is likely that people in these areas would also accept that the tree can be used medicinally. Therefore, the project has a direct relevance not only to Ethiopia but also to other African countries.

## POLICY IMPLICATIONS

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There are plans to attempt to influence government policy and/or legislation, for example with regard to the proper conservation and planting of *M. stenopetala*, by lobbying Ethiopia's agricultural research institutions and the Science and Technology Commission that have mandates for such initiatives.

## LESSONS LEARNED

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The promotion of pharmaceutical products derived from medicinal plants is a new experience in Ethiopia. Traditionally, however, making the public accept new medicines is not easy. In this regard, public awareness of the benefits of the

*Moringa* tree must be raised by a series of promotional campaigns. The trees must be introduced into areas where they are not currently grown and people encouraged to eat the leaves along with their staple foods. Eventually, with the aid of public information campaigns, people will also become aware of the trees' medicinal uses.

## IMPACT

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The implementation of the innovative experience — i.e., the dissemination of *Moringa* trees throughout Ethiopia — is still in its early stages. Thus, a more complete assessment of the impact of the project requires some time. The continuing effort of the research team provides a good opportunity to introduce the benefits of the *Moringa* tree to the wider population.

## FUTURE PLANS

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Future work will focus on the following areas:

- *Strengthening the research component.* Further work on *M. stenopetala* is required to identify the active ingredients in the extracts and to test preparations for their efficacy under different experimental regimes. One such project that the Institute has already begun is to test the anti-malarial and anti-leishmanial effects of the extracts. In the long term, the Institute

envisages developing formulations of purified active compounds, preclinical trials and clinical trials with eventual pre-commercial product development.

- *Networking.* National and international organizations that are interested in similar programmes will be contacted. In particular, contacts should be made with the neighbouring countries, Kenya and Sudan. These will be useful for sharing experiences and developing a wider programme. There is also a need to popularize the multi-purpose uses of the tree and to invite local pharmaceutical companies, many of which have been created in the past few years, to exploit the plant for drug development.
- *Community outreach.* Interested researchers and the ad hoc national committee that was recently established will be instrumental in promoting the use of the plant as both a food and a medicine. This could be facilitated by organizing workshops and visits to villages and local community centres.
- *Need for finance.* Research and other related activities, such as promoting the use of the tree, require financial resources. Grant proposals will be developed and potential contributors invited to join this innovative exercise.

## PUBLICATIONS

The project resulted in the publication of the following peer-reviewed scientific papers:

Mekonnen, Y. (1999). Effects of ethanol extract of *Moringa stenopetala* leaves on guinea pig and mouse smooth muscle. *Phytotherapy Research*, 13:442-444.

Mekonnen, Y. and Dräger, B. (2003). Glucosinolates in *Moringa stenopetala*. *Planta Medica*, 69:380-382.

Mekonnen, Y. and Gessesse, A. (1998). Documentation on the uses of *Moringa stenopetala* and its possible antileishmanial and antifertility effects. *SINET: Ethiopian Journal of Science*, 21:287-295.

Mekonnen, Y., Yardley, V., Rock, P. and Croft, S. (1999). *In vitro* anti-trypanosomal activity of *M. stenopetala* leaves and roots. *Phytotherapy Research*, 13:538-539.

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### **Project participants:**

*Amare Gessesse*: Documentation of the use of *M. stenopetala* in southern Ethiopia.

*Ermias Dagne*: Advisory role during the initial phase of the project.

*Wendimagegn Mamo*: Nuclear magnetic resonance (NMR) imaging to identify *M. stenopetala* seed extract fractions.

*Birgit Draeger*: Research collaborator, identification and characterization of the glucosinolates from *M. stenopetala*.

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