

Kigelia africana (syn. Kigelia pinnata) (Bignoniaceae)

English: Sausage tree, cucumber tree, African sausage tree **French:** Saucissoner

German: Leberwurstbaum

African vernacular names:

Shona: Impfungvani, muvete, muzangula, vunguti **Suahili:** Mwegea

Zulu: Umgongoti, umzingulu

The plant

A small, spreading tree with pendulous racemes of dull liver coloured flowers and a long stalked large gourd-like fruit.

It is widely grown in the tropics and is introduced in India. The species exhibits a range of features. Earlier several species were thought to exist but now only one is recognized with the name *Kigelia africana*. The fresh fruit cannot be eaten because it causes blisters in the mouth and on the skin. Therefore it is said to be toxic.

Plant parts used

The fruits, the roots, the wood, the bark of the stem, the bark of the roots, the leaves

Constituents

The **roots**, the **wood** and the **leaves** have been investigated chemically. They contain naphthoquinones, dihydroisocoumarines, flavonoids and aldehydic iridoids. Among the naphthoquinones kigelinole, isokigelinole, pinnatal and isopinnatal were isolated (1). From the **root** and its **bark** the usual plant substances stigmasterol, β -sitosterol, ferulic acid, the naphthoquinones lapachol, 6-methoxymellein and two new phenolic compounds could be isolated.

Kigelin is the main component of the plant, (mp 144°C, molecular formula C₁₂H₁₄). A minor one, (mp 76.-77°, molecular formula C₁₁H₁₂O₄) was commonly referred as 6-methoxymellein (4).

In a special investigation the attributes of two cyclopenta-c-pyran aldehydes were determined:

- 1) Sonovoburtinal, a yellow compound, subliming at ambient temperature, molecular formula C₉H₆O₂.
- 2) Pinnatal, a phenolic substance with aromatic protons. The molecular formula is C₂₀H₁₈O₅. Biogenetically pinnatal is probably formed by cyclisation of geranylquinone (6).

The **root bark** and **stem bark** from plants collected in Zimbabwe were successively extracted in a soxleth apparatus with different solvents. The isolation with thick layer chromatography (Kieselgel PF₂₅₄, 0.75 mm) afforded four naphthoquinones:

- Kigelinol (1)
- Isokigelinol (2)
- Isopinnatal (3)
- 2-(1-hydroxyethyl)-naphtol (2,3-b) furan-4,9-quinone (4)

They all were assessed for their biological activity (8). In the polar (methanolic) extract of the fruit from *K. africana* verminoside (C₂₄H₂₈O₁₃), an iridoid as a major constituent and among a series of polyphenols verbascoside could be isolated (11).

Traditional uses

In the African folk medicine *K. africana* is used against dysentery, venereal diseases and as a topical application on wounds and abscesses. In the area around Nsukka, Nigeria the preferred use of the bark is the treatment of venereal diseases.

The stem bark is ground in a mortar and macerated with palm wine (ca 20 % alcohol) for two or three days. The macerate is then diluted to 3 l palm wine. 100 ml of the resulting liquid is drunk daily, for 8 days successively.

In addition *K. africana* has a reputation for the treatment of dysentery (1), and in contradiction to it as a purgative. For these reasons it is sold in markets (5). Leaves and ground wood soaked with water and pressed through a sieve were mixed with *Strophanthus gratus* seeds. The concentrated sirup is then used as a hunting poison by the Gbaya in the Southwest of the Central African Republic (9).

In Togo the stem bark is the component of a prescription against cancer:

100 g stem bark of *Kigelia africana* and 25 g fruits of *Xylopiya aethiopica* are cooked in one litre of water. Then three tablespoons of this mixture are drunk three times daily during two months.

In order to enlarge the penis young males enrub the sap of the fruit into cuts of the penis skin. Young females do the same with the flesh of ripe fruits for enlarging their bosom.

Great *Kigelia* fruits are used as a fetish against whirling winds by hanging one of it in the houses (9).

Results of experimental studies

Biological activity

The four naphthoquinones (No 1-4) from the root and stem bark of *K. africana* were assessed for antiprotozoal activity in the bloodstream form trypanomastigotes of *Trypanosoma brucei brucei* and *Trypanosoma brucei rhodiense* in vitro. Compound 4 with a furanonaphthoquinone structure possessed a pronounced activity against both parasites with IC₅₀ values of 0.12 and 0.045 μ M, respectively. Compounds 2, 3 and 4 were less active than the standard drug pentamidine. In a similar way cytotoxicity was assessed with KB cells (human oral epidermal cell line). The inhibition of the growth was measured microscopically. The MIC values of the ethylacetate extracts of the root bark were 1 - 90 μ g/ml and of the stem bark 3 - 90 μ g/ml, for the control pentamidine 0.12 μ g/ml. The IC₅₀ values of the substance No 4 was 3.9 \pm 1 μ M, for isopinnatal 14.8 \pm 0.2 μ M, substances No 1 and 2 IC₅₀ 148 \pm 11 μ M and 167 \pm μ M, respectively. The value of the control pentamidine was 4.2 \pm 0.4 μ M. (8).

Activity in cell cultures and enzymes

The polar (methanolic after defatting with n-hexane) extract of the fruit and verminoside show anti-inflammatory activity tested on a skin model. The epidermal inflammation, measured as optical density at 570 nm calculated by MTT assay as percentage of cytotoxicity compared to the calculated control of PBS treated epidermis was not reduced after application of either the extract or verminoside. Histological analysis of in vitro reconstituted epidermis treated with the polar extract and verminoside gave no significant modifications in the tissue morphology neither in stratum corneum nor in viable epidermis cells, compared to the control. In macrophage cells verminoside (0.01-1 mM) inhibited the NO release significantly. Verbascoside had a significant effect on the inducible nitric oxide synthase expression and on nitric oxide biosynthesis at the highest concentration of 1 mM (11).

Toxicity

The subchronic toxicity of an aqueous extract from *K. africana* was investigated in male Wistar albino rats, to which a daily dose of 100 or 500 mg/kg extract was given over 30 days. As indices for the organ specific toxicity haematological, urinary and plasma

biochemical parameters and some cytochrome P450 isozymes were measured. The following markers were not affected:

Plasma aspartate-aminotransferase,
alanine aminotransferase,
alkaline phosphatase, and
albumin or creatinine kinase.

Furthermore the extract neither changed MCV nor blood HB, RBC, reticulocytes, platelets, lymphocytes or granulocyte levels. However, it caused significant dose-dependent reductions in WBC counts at day 15 with varying degrees of recovery by day 30.

No changes were observed in the organ weights at the end of the observations. It did not significantly affect zoxazolamine-induced reverse paralysis and pentobarbital-induced sleeping times as well as certain CYP 450 isozyme activities in the rats (10).

Antimicrobial activity

In order to investigate the traditional use of *K. africana* against venereal diseases and dysentery, ethanolic extracts and substances isolated from the extracts were investigated against microorganisms. It could be shown that ethanolic extracts had a pronounced inhibitory activity against *B. subtilis*, *E. coli*, *Staphylococcus aureus*, *Ps. aeruginosa* and *Candida albicans*, against which the strongest activity was noted. Comparison of the results for pure iridoids with the extracts showed that the extracts do have a greater activity than the iridoids alone though the concentration of the iridoids was the same in both cases. The authors conclude that further compounds may be present in the extract (1).

A biologically monitored fractionation of the methanolic extracts of the roots and fruits led to the isolation of the naphthoquinones kigelinone (1), isopinnatal (2), dehydro-a-lapachone (3), lapachol (4) and the phenylpropanoids p-coumaric acid (5) and ferulic acid (6) as the compounds responsible for an antibacterial and antifungal activity of the root. Kigelinone (1) and caffeic acid (7) were responsible compounds in the fruits. Among the tested naphthoquinones 1-4, No 1 was the most effective substance only against the Gram positives, but not significantly against the Gram negatives. Compounds 5-7 showed antibacterial and antifungal activity, No 7 had a fungistatic effect. But in all cases MIC-values were high -which means not very effective -compared with available antimicrobials. The authors believe that these results are giving some support to the established claims of herbalists and traditional healers (3).

Molluscicidal activity

The crude extract, the evaporated water extract and the methanolic extract of *K. africana* were screened for molluscicidal activity in the laboratory reared *Lymnaea natalensis*. All three were active and LC 50 values were determined (but not communicated in the abstracts) (7).

Results of clinical studies

There were no results available

Evaluation

The polar methanolic defatted extracts and verminoside show promising anti-inflammatory activity and appear acceptable for cutaneous applications, based on the lack of cytotoxicity. Thus the extract and verminoside seem to be safe for topical uses. Therefore, it would be better to investigate watery preparations because there are no experimental data available. It is possible to use water extracts of *Kigelia africana* for snail controlling in fish ponds. But prior to it the toxic effects against fishes and mammalians must be determined.

The findings of manifold effects of the aqueous extract with rats suggest that it has no specific organ toxicity nor any potential for drug interaction via cytochrome mediated metabolism in the rat organism on subchronic administration.

Though the plant *Kigelia africana* is a rich source of many chemical compounds as it is usual for Bignoniaceous plants one cannot say that this plant is an extreme toxic one. Extraction by organic solvents may bring the more toxic compounds like naphthoquinones, coumarines and iridoids. But the extraction by water may be favourable for some applications like such ones on the skin.

Alcoholic extracts made with palm wine bring naphthoquinones and other cyclic substances. As seen by results of experimental studies such mixtures are toxic. They can not be applied with human beings or animals. All these uses must be advised against.

Kigelia africana

Water extracts:

for the external use on wounds and abscesses	* * *
for the biological control of snails in fish ponds	* *
against cancer	- - -

References *Kigelia*

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