4.7 Cucumis metuliferus

Latin: *Cucumis metuliferus*
Family: Cucurbitaceae
English: Horned cucumber, Jelly melon, Kiwano
Shona: Magaka
Ndebele: Umhlagahlaga
Regions in Zimbabwe: Zambezi, Kalahari, Central Save-Limpopo

Botanical Description

Cucumis metuliferus, the horned cucumber, is one of the many important food plants of its genus. It is an annual climbing or occasionally trailing herb. The vegetative parts are rough with spreading hairs. Stems grow up to 3 m long, radiating from a woody rootstock and are covered in bristly hairs. The leaves are broadly ovate in outline, up to 90 x 100 mm, usually palmately 3-5-lobed, with the veins below very roughly hairy and the margins minutely toothed. The petioles are up to 100 mm long. Male and female flowers appear on the same plant (monoecious). They are usually solitary or in small clusters, yellow or pale orange, up to 2.5 cm in diameter (Hyde et al., 2002). The fruit is ellipsoid-cylindrical, 60-150 mm long, 30-60 mm across when ripe, and is covered in stout spines. The fruits are grey-green to orange yellow, often mottled, turning bright orange-red when ripe and edible. Seeds are flattened, 6-9 mm long, numerous, embedded in a light green or emerald-green, jelly-like flesh.

Cucumis metuliferus grows naturally in tropical Africa. In Zimbabwe, it is cultivated across all ecological regions. This species generally grows in shallow or deep, well-drained sand, mostly in alluvial soil on river banks, in river beds or flood plains; it is also recorded from clay or loam soil and rocky slopes. The horned cucumber also grows in disturbed areas and abandoned land. (Welman, 2009)

Traditional Uses

It is mainly the fruits of *C. metuliferus* that are eaten, although in some parts of Africa the leaves are also used as a vegetable. The fruit has an intense, tangy flavour, often described as being a combination of lime, cucumber and banana. In Zimbabwe fruits are eaten raw and young leaves are stripped from the stems, washed and boiled just like musk pumpkin leaves (*Cucurbita moschata*), with peanut butter added prior to serving (Wilkins-Ellert, 2004). Fruits from wild-growing plants are often bitter and considered inedible/poisonous. The Khoisan roast the fruit and then strain the flesh (Usman et al., 2015). The leaves are also cooked like spinach or mixed with maize meal (Welman, 2009). The fruits are peeled and eaten in either the immature or the mature stages. Mature fruits may also be split open and dried in the sun for later use. In Botswana the San prepare the fruits by roasting them on the coals of the fire (Wilkins-Ellert, 2004). In the wild, the horned cucumber tends to yield more bitter fruits which contain significant levels of the toxic triterpene. This is absent from the sweeter cultivated varieties.

The species has also been used as traditional medicine to cure a number of ailments. The leaves widely reported as a cure for malaria. The seeds are used to treat worms and parasites, being dried, ground into a fine flour and then made into an emulsion with water and eaten. The boiled root is used for the relief of pain after childbirth, and is also known as an effective treatment for gonorrhoea (Welman, 2009). There are strong magico-spiritual properties associated with the plant. In the Okavango region of Botswana, for example, the roots are pounded, mixed with fat and smeared on the body to prevent evil spirits from entering the house. The decorticated fruit, macerated in distilled palm wine or lemon juice. is used to treat smallpox and skin rashes (Wilkins-Ellert, 2004).

Commercial History

The horned cucumber is well-known to Zimbabwean consumers and has been traded on informal fruit and vegetable markets for years. It is occasionally found on supermarket shelves as well. It has a similar story in many other African countries, and is a popular fruit with Africans in the diaspora. It has also gained some prominence internationally. Export production started in New Zealand in the 1980s, having allegedly been introduced there by Zimbabwean farmers in the diaspora. Early marketing attempts ran into problems with the name (neither "horned cucumber" nor "jelly melon" apparently having sufficient appeal to help market this odd-looking fruit). It was then rebranded as the "Kiwano" fruit, in an attempt to make it more appealing to consumers in the target markets of the US and Japan. This was moderately successful, and it is now grown commercially in California for the United States market, and in Israel and Kenya from where the fruits are exported to markets in Europe (Wilkins-Ellert, 2004).

It has become naturalized in Australia, and is reported as adventives in Croatia (Lim, 2012). In some Western countries, C. metuliferus is currently mostly marketed as an ornamental for its decorative fruit, with a unique appearance and extended keeping qualities (Wilkins-Ellert, 2004).

Potential Commercial Uses

The horned cucumber meets many of the requirements of a novelty health food. It has a respectable balance of vitamins and minerals (vitamin A and C, potassium and zinc), is low in sodium, lipids and carbohydrates (Rani et al., 2019) and is cholesterol free. The seeds contain a rich oil with a high content of unsaturated fatty acids, which help in controlling of blood pressure and preventing cardiovascular diseases (Ferrara, 2018). It also has considerable visual appeal, being an unusual and striking fruit, and has a remarkable shelf-life of at least 6 months or more from harvest.

There is also potential for value addition in the food industry. Some observers noted that the fruit can be eaten like an ordinary cucumber, while Parsley (1981) suggests that the refreshing jelly is best scooped out of the shell with a spoon or used in fruit salad. A jelly can be made from the fruit by boiling it until soft, straining it and boiling the fruit pulp again with a cup of sugar for each cup of water. The fruit can also be cut into cubes and pickled in vinegar or added to cocktails (Welman, 2009). Sun-dried slices of the fruit make an interesting vegan alternative to biltong. The fruit pulp also makes an excellent beverage ingredient in mixed fruit smoothies.

C. metuliferus possesses several phytochemicals of pharmaceutical interest, and has considerable and diverse potential uses as a herbal remedy. Researchers have shown strong antimalarial activity, analgesic effects, antiviral activity, antimicrobial activity, anti-ulcer activity, anti-diabetic activity and anti-protozoan activity. Doses of fruit pulp extract have also been shown to improve sperm count and motility (perhaps associated with the very high levels of zinc), suggesting potential use to help boost male fertility.

Another interesting potential industrial application is derived from the exceptional shelf-life of the fruit, most likely associated with free radical scavenging anti-oxidants in the peel. Researchers have shown that adding a fruit extract into a cellulose acetate can create an active coating for food packaging that significantly extends shelf-life (Arrieta et al., 2020), suggesting a possible application of the extract at an industrial scale for fatty food and fresh fruit packaging.

Market Potential

There is already a niche market in Europe and North America for C. metuliferus as a novelty/ornamental fruit. The market size is hard to assess, but the overall market for organically-certified fruit and vegetables was USD 30.7 billion/yr in 2019 and is expected to reach USD 55.8 billion/yr by 2027. Other market opportunities include the Ready To Drink fruit beverage market (USD 34 billion/yr), the craft spirits market (currently growing at an astonishing 33.4% annually around the world, and heading for USD 80 billion/yr by 2025) and the vegan market (USD 13 billion/yr).

Locally, there is also significant growth potential in demand for horned cucumber products as a fresh fruit. Zimbabwean consumers are becoming steadily more interested in the health benefits of indigenous fruits and vegetables, as evidenced through the appearance of these products in speciality restaurants and on supermarket shelves around the country. There are also several initiatives being promoted by the Government and other stakeholders to increase awareness and uptake of these products by Zimbabwean consumers, including cooking demonstrations and competitions. The 2020 Zimbabwe Vulnerability Assessment found that 80% of rural households in Zimbabwe were consuming at least one indigenous vegetable type on a regular basis.

As the world fights a global pandemic, and set against the backdrop of growing antibiotic resistance, the global herbal medicine market has undergone a dramatic resurgence. Currently estimated at USD 148 billion/yr in 2020, it is projected to reach USD 219 billion by 2026 (Market Watch, 2021). In China, 40% of all pharmaceutical sales are from herbal medicines, and the herbal medicine industry is estimated at US$36 billion/yr. There is also a well-documented male infertility crisis around the world, with an overall decline of over 50% in male sperm counts. This is particularly pronounced in some Western countries, and is primarily attributed to diet. This would appear to create a substantial opportunity for herbal products from C. metuliferus marketed specifically to improve male fertility.

Finally, the global fresh food packaging market is estimated at USD 80 billion/yr in 2020 (Markets and Markets 2021), growing to USD 95 billion/yr by 2025. This is on the back of rising demand for meat, vegetables and fruit.

Cultivation/ Domestication Potential

The horned cucumber has been cultivated for years in Zimbabwe by small scale farmers, usually intercropped with maize. It is a warm-season crop which grows in tropical to subtropical and warm temperate regions. It tolerates a wide range of soil types but grows best in rich and well-drained moisture-retentive soils, usually clay or loamy soil with a pH range of 6.0 to 6.5. Choosing an area near a trellis or fence is essential to promote climbing. A planting density of 10,000 plants per ha have produced good yields in Israel. A planting depth of 1-2 cm is recommended. In-row spacing of 45-60 cm, leaving a space of 1.8 m between rows. The soil should be consistently kept moist down to about 2.5cm for the seed to germinate. Germination usually occurs within two or three weeks.

Under irrigation the plant should be provided with 25 mm of water per week, although the soil should be allowed to dry between irrigation sessions. Fertilizer with a 4-8-5 or 6-10-10 N-P-K ratio can be applied according to the soil analysis results (Ketchum, 2020). Organic mulch can be applied, such as straw or wood chips, around the base of the plant to help the plant retain moisture and prevents weed growth. Picking the weeds by hand as they appear is known to be useful in preventing diseases such as the cucumber mosaic virus and tobacco ringspot virus. Under large scale production it might be necessary to employ other efficient methods of controlling weeds such as mechanical methods or herbicides application. Like all cucurbits they seem to be prone to mildew and whitefly. From recent trials, it appears that *C. metuliferus* is resistant to the root-knot nematode and some mosaic viruses (Exposito *et al.,* 2017). Integrated Pest Management can be employed to address the respective diseases.

Flowering starts about 8 weeks after sowing the seed, with male flowers appearing first, followed after several days by female flowers. Under field conditions, it takes approximately 15 weeks for the species to reach maturity from sowing (Wilkins Ellert, 2004). Stems of horned cucumber die back at the end of the growing season while the fruits remain attached and continue ripening to a bright orange colour. They may be harvested over successive months. Care is needed during picking because the stiff sharp hairs on the stems and the spiny 'horns' on the fruits can easily pierce the skin; it is recommended that gloves be worn during harvesting. New Zealand growers have recorded a harvest of 20 tonnes of fruit per hectare, in California about 8 tonnes/ha whilst growers in Israel have harvested up to 46 tonnes/ha(Welman, 2009). There are some known and named varieties of the horned cucumber making it easy to select cultivars for commercial production. Another commercial advantage is that the fruit remains in good condition for about 6 months without cold storage (Arrieta *et al.,* 2020).