Agrobiodiversity for Improving Nutrition, Health and Life Quality

A Review

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Seasonal variety of selected indigenous plant raw materials and foodstuffs available for consumption in Namibia

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Article Details:
Received: 2023-10-04
Accepted: 2023-11-15
Available online: 2023-11-30

DOI: https://doi.org/10.15414/ainhlq.2023.0016

This review is based on the nutritional content of the available indigenous foods to identify area of future research. Most indigenous foods are affordable and has good source of micronutrients, but the consumption rate of these foods is declining. It is important to increase awareness of the need to consume indigenous foods to reduce food insecurity and malnutrition. Most indigenous foods are seasonal and range from cereal-based foods to beverage drinks. In Namibia, the most important part of the human diet are pearl millet, sorghum, and maize. These crops mostly are rich in complex carbohydrates (starch), protein, mineral compounds (potassium, calcium, iron and zinc), vitamins and polyphenols. From legumes crops are widely used cowpeas, groundnut and marama beans. Most legumes are a good source of protein, starch, dietary fibre, fats, and micronutrients. Legumes with high sources of protein can be used as meat alternatives, which is very actual and attractive in the food industry. Fruits and plant-based foods are very common in Nigeria are monkey oranges, marula fruits, bird plums, jackal berries, makalani palm, manketti and water lilies, tiger nuts, and roselle. These fruits contain carbohydrates, proteins and some micronutrients. Indigenous fruits have the potential to be used in medicine for treating diseases due to the high level of bioactive compounds, especially antioxidants. Some plants like roselle (*Hibiscus sabdariffa* L.) have the potential to control diseases like type 2 diabetes and hypertension. Most vegetables used in Namibia provide nutrients such as beta-carotene, ascorbic acid, mineral compounds (iron and calcium) protein, and phytochemicals. Traditional fermented beverages – oshikundu, omagongo, oshinwa, and mutete juice and known to provide a wide range of nutrients including vitamins A, C, B_{12}, iron, and calcium. Based on this review, we recommend sustainable promotion of these foods and regular consumption of indigenous foods as a solution to malnutrition. There is a great potential to grow indigenous foods in community nurseries and home gardens to increase the availability.

Keywords: traditional foods, crops, nutrients, Africa, bioactive compounds

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Introduction

The least populous and driest nation in the Sahara Desert is Namibia. It has a population of roughly 2.2 million and a total area of more than 824,000 km^2. Fortunately, Namibia has a diverse ecosystem that is home to over 690 uncommon, endemic, or nearly endemic plant species. Many of them are drought-tolerant plants that have real or potential agricultural significance (Maggs-Kölling et al., 2014; Rampa and Lovo, 2023). The country must import a considerable portion of its cereal needs, frequently well over half, even in the best years because total cereal production varies greatly according to rainfall. However, due to well-established commercial distribution networks, there is no national food security issue. In the past, the country has been able to easily and without government assistance meet its regular commercial import requirements. In years of drought, these are typically supplemented to some extent with food aid. Fish, cattle, and meat exports from Namibia are significant (Maggs-Kölling et al., 2014; Onwujekwe and Ezebma, 2021).

Indigenous foods can be defined as plant and animal-based foods that naturally found and produced in the specific place and eaten as part of traditional diets (Rampa and Lovo, 2023). Indigenous foods can be used to reduce hunger and malnutrition (Cheikhyoussef et al., 2013). Research shown that food and nutrition security can be improve by consuming indigenous foods as they are rich in nutrients (Rampa and Lovo, 2023). The availability and access of these foods may be declining due to increase of development, thus this causes the decrease in consumption (Mbhenyane, 2017). Information on nutritional value of most indigenous foods is scare in Namibia (Cheikhyoussef, Bille and Shikongo – Nambabi, 2013). There is a need in recognizing the benefits of indigenous foods in rural and urban areas in order to create consumption patterns along the nation (Mbhenyane, 2017).

Most of the traditional/indigenous foods are mainly grown or found in the locations of the cultures presented in northern, some central and southern parts of Namibia such as Oshiwambo, Rukwangali, Zambezi, Herero and Damara/Nama speaking groups. These indigenous foods are mostly domesticated, cultivated and grows in the wild at different part of the country. Cereal and legume crops like pearl millet, sorghums, maize, cowpeas, and bambara groundnuts are grown during rainy seasons in the northern part of Namibia while legumes crop like marama beans are wild – growing legumes.

Most fruits are known with several health benefits (Nyambe et al., 2019). Namibian depends on wild fruits for micronutrients sources, which provide most health benefits (Nyambe et al., 2019). Indigenous wild fruits harvested includes monkey orange, marula fruit tree, bird plum, makalani palm, manketti fruits. Wild plants and shrubs can be found in water ponds or grown on the land, this includes water lilies, tiger nuts, roselle and indigenous mushrooms. Majority of wild-growing plants/trees are found in the northern parts of Namibia. Indigenous cereals, fruits, vegetables, and beverages are mostly fermented and includes cereal based (oshikundu), fruits – based (omagongo, oshinwa and mutete). Indigenous fermented foods varies depending on the cultures in Namibia (Misihairabgwi and Cheikhyoussef, 2017).

This is a critical review on available information regarding nutritional value of some selected indigenous foods found in Namibia. There are a variety of indigenous foods available for consumption in Namibia that includes: indigenous cereals, legumes, fruits, plants, vegetables-based foods, and beverages. It is important to find solution to food security. Hence, the purpose of this review is to offer information about some indigenous foods available in Namibia.

Indigenous cereals and legume-based foods in Namibia

Pearl millet (*Pennisetum glaucum* L.), locally named mahangu in Oshiwambo is the traditional stable preferred crop in Namibia. Pearl millet is processed into flour, which is used to make porridge, bread and fermented drinks (Misihairabgwi and Cheikhyoussef, 2017). Traditional fermented foods and drinks made in Namibia mostly from milk, wild fruits, cereals, and cassava are sold to generate cash (Figure 1). They have social and nutritional value. Major drawbacks of spontaneous fermentation processes include their inefficiency, low yields of products, and variable product quality. Traditional fermented foods are primarily produced at the household level using largely uncontrolled spontaneous inoculation methods in which microorganisms associated with the raw food material and the processing environment serve as inoculants.

Oshikundu is prepared by mixing water, pearl millet flour, sorghum flour and pearl millet bran, a certain amount of previously fermented oshikundu is also added (Figure 2). The mixture ferments for several days at room temperature. The resulting drink has a brown colour and a thick texture, it is rich in lactic bacteria

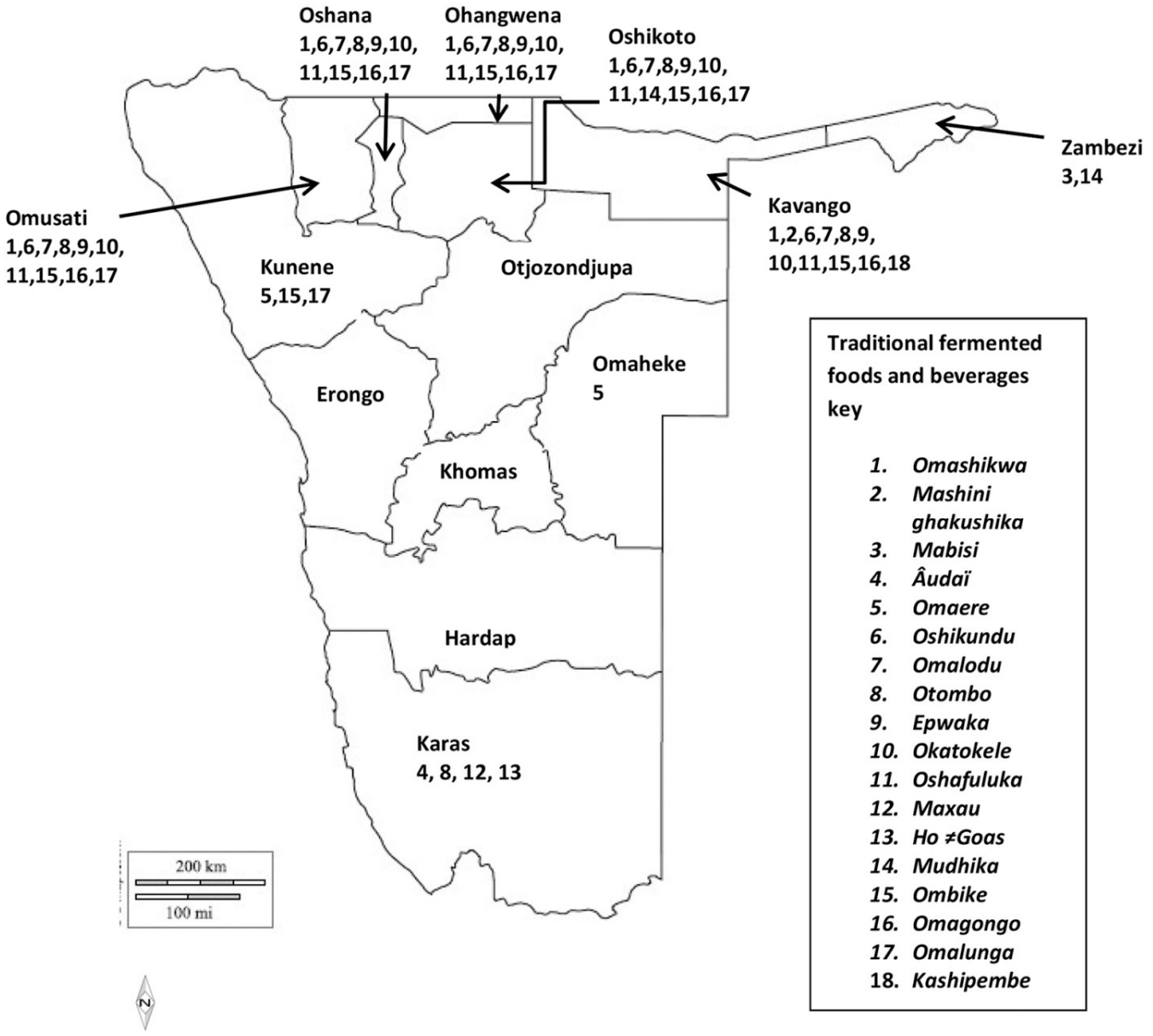

Figure 1 Namibian traditional fermented food and drink distribution
Source: Misihairabgwi and Cheikhyoussef, 2017

that increase the palatability of the drink. Oshikundu is usually cooked at home, playing an important role in social gatherings. Millet flour is rich in protein, carbohydrates, and minerals (calcium, zinc, iron and potassium) (Animasaun et al., 2019). Proteins are rich in albumin and globulin fractions, which contain a wide range of health-promoting amino acids (valine, leucine, isoleucine, threonine, methionine, and lysine). Millet is also an important source of vitamins B_1 and B_2. Millet does not contain any anti-nutritional substances. Polyphenols are dominated by gallic, protocatechuic, *p*-hydroxybenzoic, *p*-coumaric, syringic, and ferulic acid (Satankar et al., 2020).

Sorghum (*Sorghum bicolor* L. Moench), local name iilyavala in Oshiwambo is a type of cereal crop cultivated in the Northern central regions of Namibia (Misihairabgwi and Cheikhyoussef, 2017). Sorghum can be eaten fresh as roasted grains, dried cooked grains, or processed into flour. Sorghum flour is used to make porridge and fermented beverage known Ontaku or oshikundu and Namibian opaque beer (Misihairabgwi and Cheikhyoussef, 2017; Embashu et al., 2019). Sorghum grains are rich in starch, mainly polysaccharides, protein and mineral compounds such as zinc, copper, manganese and iron, vitamin B_1, B_6 and beta-carotene (Cardoso et al., 2017). Sorghum has a high energy value and a low protein, fat and fibre content. The starch content is around 70% (amylase

Figure 2 Oshikundu – fermented drink based on cereals
Source: Misihairabgwi and Cheikhyoussef, 2017

content is 21–34% and amylopectin 65–80%), protein content ranged from 8–16%, fat content ~ 3.3%, ash 1.9%, and ~fibre 1.9%. The content of tannin (proanthocyanidin) and some other anti-nutritional substances, which can adversely affect digestibility, is listed as negative. However, this is more tied to varieties of sugar sorghum or varieties with coloured grains. Due to the low gluten content below 10 mg per 100 g of dry matter, it is advisable to use sorghum in a gluten-free diet. From polyphenols protocatechuic, hydroxybenzoic, vanillic, syringic, sinapic, *p*-coumaric, caffeic and ferulic acid were identified. These acids are important for their antioxidant properties (Kulamarva et al., 2009).

Figure 3 Maxau – fermented maize meal
Source: Misihairabgwi and Cheikhyoussef, 2017

Figure 4 Oshingali – traditional Namibian meal
Source: Misihairabgwi and Cheikhyoussef, 2017

Maize (*Zea mays* L.) is a cereal crop grown in Namibia. Maize contained two edible parts: kernel and germ. The kernel is consumed fresh by cooking or processed into products such as maize flour, starch, or breakfast cereals (Shah et al., 2016). Maize flour is used to make porridge (Shah et al., 2016) and fermented beverages known Maxau consumed by Damara/Nama people in the Karas region (Misihairabgwi and Cheikhyoussef, 2017). Maxau is a fermented maize meal product to which sugar is added for flavour (Figure 3). Water and maize meal are combined to create a slurry known as maxau. To create a thin mixture, water is added to the slurry after first being boiled separately. The maxau pot is then filled with sugar and wheat flour and let stand for 24 hours before being kept at room temperature. This combination is then boiled for 5 to 10 minutes. Maize kernels are good sources of starch, mineral compounds, especially potassium, magnesium and phosphor; vitamins that include ascorbic acid, pantothenic acid, niacin and thiamine while the germ parts provide mainly vitamin E benefits (Shah et al., 2016). Maize contains approximately 12% protein, but they are deficient in the content of essential amino acids, especially lysine and tryptophan.

Legumes are considered inexpensive meat alternatives, providing protein, complex carbohydrates and dietary fibre nutrients. Most legumes found in Namibia include cowpeas, groundnuts, and marama beans. Cowpeas (*Vigna unguiculata* L.) is a legume crop also known as black-eyed peas in Namibia. It can be eaten fresh or dried and can be processed into a soft product called Oshingali. A popular and nutrient-dense Oshiwambo traditional food is oshingali, or

black-eyed mashed beans (Figure 4). It is delicious and has a thick, creamy texture. Oshingali is served with pap and drizzled with marula oil. Cowpeas provide nutrients such as complex carbohydrates, fibre, protein, and micronutrients (iron, thiamine, and folate, copper (Enyiukwaet al., 2018; Jayathilake et al., 2018). Mostly, cowpea contain high-quality protein, but differs depending on the variety. Major protein, in cowpea are albumins and globulins (Jayathilake et al., 2018).

Groundnuts (*Arachis hypogea* L.) are a type of legume cultivated in Namibia. Groundnuts are consumed fresh by cooking or when dried can be roasted or cooked. It provides nutrients such as starch, oil, protein, and vitamin E. Groundnuts are a good source of mineral compounds such as potassium, magnesium, calcium, and phosphorus (Toomer, 2018). Raw, boiled, oil-extracted, roasted (as a snack), energy bars and sweets, and by blending peanut paste with other snack foods are all ways that people have consumed peanuts. With their nutrients (lipid profiles) and bioactive substances like phytosterols, phenolic compounds, stilbenes, lignans, and isoflavonoids, peanuts and peanut products have a good impact on human health. These bioactive substances offer defense against cancer, type 2 diabetes, and cardiovascular disease (Ciftci and Suan, 2022).

Marama bean (*Tylosema esculentum* Burch.) is a type of wild legume crop (Nepolo et al., 2009). It has two consumable parts – seed and tuber (Cullis et al., 2019). It has a high protein content (30–39%) and a low-cholesterol oil content (35–43%) that is rich in mono- and di-unsaturated fatty acids. It is also claimed to be a source of phytonutrients like isoflavones, tannins, trypsin inhibitors, phytates, and oligosaccharides. These nutrients have been linked to improved health, particularly the prevention of non-communicable diseases like cardiovascular disease, diabetes, and some cancers, and have been found in other foods. Marama bean seeds are good sources of complex carbohydrates, protein and oil (mono and poly-unsaturated fats). These beans contain micronutrients (vitamin A, E, B_3, B_6, B_{12}, folic acid, iron, zinc, and iodine) (Nepolo et al., 2009; Cheikhyoussef et al., 2010). The seed's protein level is on par with or slightly higher than that of soybeans. The oil content is close to that of peanuts and is two times that of soybeans. The immature tubers are more nutrient-dense than potatoes and yams and also contain protein (Maggs-Kölling et al., 2014).

Indigenous fruit-based foods in Namibia

Monkey orange (*Strychnos cocculoides* L.) is a type of indigenous wild fruit tree found in Namibia. Its fruits are eaten fresh straightaway after cracking because if exposed to air become inedible (Cheikhyoussef et al., 2013; Ngadze et al., 2017). This fruit provides carbohydrates, vitamins B, and C, iron, and zinc. To allow the fruit pulp to liquefy, monkey orange's fruit is buried in sand near homesteads. The ripe fruit can be consumed raw or sun-dried to make jam, fruit rolls, juice, and wines. The fruit is rich in vitamin C and B vitamins; however, the seeds of the monkey orange are toxic. In most cases, monkey oranges nutrient content varies depending on the plant species for instances *Strychnos innocua* reported to have a highest total carbohydrate content compared to others (Ngadze et al., 2017). Another species with brown colour such as *S. cocculoides*, *S. spinosa* and *S. pungens* has a good sources of phytochemicals (Ngadze et al., 2017).

Marula tree (*Sclerocarya birrea* L.) is a type of indigenous tree in Namibia (Cheikhyoussef et al., 2013). Marula fruits have two edible parts: fruits and nuts (kernels). These fruits can be eaten in fresh or fermented beverages (Mariod and Abdelwahab, 2012; Hiwilepo-van Hal et al., 2014) and processed into products like juice, jam and muffin (Cheikhyoussef et al., 2013). Marula fruits contain nutrients such as carbohydrates, monounsaturated fat, protein, micronutrients, and vitamin C. The nuts are consumed or used to extract oil (Martin, 2007). This nut is rich in protein, oil (monounsaturated fat), mineral compounds (Mg, P and K and phytochemical such as phenolic and antioxidant content. Marula tree (stem-bark ethanol extract) also have good medicinal properties by treating diabetics (Mariod and Abdelwahab, 2012; Hiwilepo-van Hal et al., 2014). Fresh or processed fruit is eaten. Dietary fibre, protein, vitamins (A, B_3, C, E, and carotene), mineral compounds, amino acids, and fatty acids are all present in significant levels in the fruit. Polyphenols, flavonoids, condensed tannins, and polysaccharides (pectin) are the main structural classes of marula fruit, and these substances can fend off chronic and degenerative illnesses. The marula fruit is a functional food because it contains substances that are good for health and can prevent sickness. Much research have shown that marula fruit is used in the production of juice, alcohol-based goods, jams and jellies, fruit leather, vinegar, and animal feed. When fully mature, the fruit's flavour is described to be pleasant rather than acidic and bitter. The marula is regarded as a multifunctional plant since the fruit kernels can be consumed or utilized to obtain oil (Mashau et al., 2022).

Cold-pressed oil from the seed kernels is a valued ingredient for skin-care products. It naturally softens, nourishes and revitalises the skin. It is absorbed easily and contain high levels of oleic and linoleic fatty acids, making it ideal for topical application. High in natural antioxidants, and one of the most stable oils available (ten times more resistant to oxidation and rancidity than olive oil), marula oil has been shown to use in cosmetic and for cooking (Maggs-Kölling et al., 2014).

Bird plum fruits (*Berchemia discolor* (Klotzsch) Hemsl) is an indigenous tree that grows in northern central Namibia. The fruits of this particular tree are eaten fresh or dried and processed in juice and jam. Bird plum fruits known as eembe in Oshiwambo are good sources of carbohydrates (sugar), vitamin C, mineral compounds (K, Ca, Mg, P), and phytochemicals such as flavonoid, total phenols, tannins, saponins, cardiac glycoside and tannins. To generate a potent indigenous alcoholic beverage like spirit or wine, eembe can be fermented. The fruit has a highly sweet flavor and can be used to flavour beer or porridge. The fruit juice is used to heal bleeding gums in traditional medicine (Cheikhyoussef et al., 2010). The fruit has a high sugar content in the pulp (30%), seeds that taste like walnuts, and 65 mg of vitamin C per 100 g of fruit. Eembe fruit harvesting takes place in northern Namibia between March and April. This occurs right at the end of the season when food crops are being cultivated at their peak. For the majority of farmers, picking wild fruits at this time of year is very convenient because it allows them to continue farming without interruption. In addition, after farmers have done their seasonal agricultural tasks, the bird plum fruits can be dried, stored, and processed (Nyambe et al., 2019).

Jackal berry (*Diospyros mespiliformis* L.), locally named Omwandi in Oshiwambo is an indigenous tree found mostly in the northern part of Namibia. Omwandi fruit trees bear fruits that are eaten when fresh or dried (Cheikhyoussef and Embashu, 2013). These fruits are rich in carbohydrates, protein, mineral compounds (calcium, copper, magnesium, sodium, iron, and potassium), and vitamin C (Magaji, 2019; Nyambe et al., 2019). Jackal berry fruits can be processed in jam and juice and when dried can be pounded and the powder is mixed with millet meal to make porridge called oshihenyandi (Danermark, 2019; Nyambe et al., 2019). The leaves are used for medicinal purposes, by treating conditions such as gingivitis, toothache, malaria, fever, wounds, sleeping sickness and helminths (Cheikhyoussef et al., 2011). The Diospyros species are widely used in traditional medicine in the tropical areas. As a tonic, powder, and poultice, leaves, barks, fruits, hardwoods, and roots have been used to treat a variety of ailments, including asthma, dermatitis, hypertension, atherosclerosis, lumbago, hemorrhage, sleeplessness, and biliousness, among others. Vermifuge, febrifuge, carminative, astringent, sedative, anti-hypertensive, constipation, and antidiuretic are among the common uses (Rauf et al., 2017).

Makalani palm (*Hyphaene petersiana* Klotzsch ex Mart) is an indigenous wild tree that grows in Namibia (Cheikhyoussef and Embashu, 2013). Makalani palm has two edible parts: fruits and the young trunk core eaten as a fresh vegetable. Makalani palm fruits are eaten when dried. This fruit is rich in protein, carbohydrates, micronutrients (potassium, zinc and iron), calcium and phosphorus are present in trace amounts. Intakes of 4,700 $mg.day^{-1}$ are approved to lower blood pressure level and decrease the risk of kidney stones (Nyambe et al., 2019). The trees may eventually die if the growth point is repeatedly cut off to extract sap for making palm wine. The stem pith can be consumed. A white endosperm core known as vegetable ivory, which is initially soft and edible and contains some liquid like coconut milk, lies beneath the fruit's outer fibrous husk. The Makalani palm's fruit, known as eendunga, is used to make ombike, the local alcoholic beverage (Cheikhyoussef and Embashu, 2013).

Manketti (*Schinziophyton rautanenii* Schinz) is another indigenous tree found in Namibia (Cheikhyoussef et al., 2019). Manketti has two edible parts nut or seed. The seed is eaten fresh or dried. The nuts can be milled and make products such as porridge and fermented juice, alcoholic drink and can be supplemented as food thickener when meat, fish and vegetable soaps and oil. This fruit is rich in carbohydrates, protein, and vitamins. Roasted seeds have a flavour akin to Brazil or cashew nuts. 60% of the seed's weight is oil. It is cooked using locally. The distinctive conjugated fatty acid, α-eleostearic acid, as well as other fatty acids including linoleic, oleic, and linolenic acids, are present in the edible yellow oil that is produced from the nut of the egg-shaped fruits (Maroyi, 2018).

Water lilies (*Nymphaea lotus* L.), the local name Omavo in Oshiwambo is found growing in ponds as a wild plant. The edible part is the seeds which are a good source of carbohydrates, lipids, and vitamins (Adelakuna et al., 2016). Water lilies roots can be made into products such as tea that can be used for treating sore throat and mounth irritation and the leaves can be used for lotion (soften skin). The flower stalks are consumed raw or cooked, the seeds are pickled or

roasted, the unripe fruits are consumed raw, the tubers are consumed raw or roasted for the starch, or they can be dried and processed into flour. The flour made from the mashed tubers can be kept in storage for several months (Wasagu et al., 2015).

Tiger nuts, scientific name *Cyperus esculentum* L. is a plant like glass with tubers. Tiger nuts have one edible part: tubers which can be eaten fresh, when dried or roasted, or baked as vegetable and can be processed into flour. Tiger nuts contain nutrients such as oil, protein, sugar, and fibre. Tiger nuts are rich in micronutrients (Cu, P, Zn, K, Na) (Wayah and Shehu, 2013; Adel et al., 2015; Nina et al., 2019). It also has bioactive components such as phenols, organic acids, and alkaloids. The tiger nut is a good source of monounsaturated fatty acid-rich edible oils. Tiger nut oil has a similar nutritional value to olive oil. Starch, a food element that is both renewable and inexpensive, is also widely present. Despite the relatively low protein content, it has been proven to be suitable for diabetic patients and people with digestive disorders, and after intake, it may help prevent heart disease. This tuber's dietary fibre helps to reduce gastrointestinal problems, colon cancer, and obesity. The tiger nut has strong antioxidant qualities and can be utilized as a source of natural antioxidants because flavonoids are present in it (Yu et al., 2022).

Hibiscus sabdariffa L. is herbal shrub plant local name in omutete in Oshiwambo and mutete in Rukwangali (Hilger, 2005; Ismail et al., 2008) The edible parts are calyxes and it is used to prepare herbal drink, beverages, and jam. *Hibiscus sabdariffa* calyxes are good sources of vitamin C, protein, beta-carotene, and total sugar. This nutrient content differs from leaves and seeds (Khan, 2017). Mutete is fermented beverages made from *Hibiscus sabdariffa*. Mutete is rich in vitamin A (beta carotene), iron, calcium, protein and organic acids (Anel et al., 2016; Khan, 2017). The safe medicinal plant known as *Hibiscus sabdariffa* is well known for its deliciousness as well as for its nutritional and therapeutic benefits. It contains a variety of medically significant substances known as phytochemicals. The use of plants in treating many medical conditions, such as cancer, inflammatory illnesses, and various cardiovascular problems, has been thoroughly studied by various academics in various contexts (Singhet al., 2017).

Indigenous vegetable-based foods in Namibia

There are several indigenous leaf vegetables consumed countrywide and known to have nutritional benefits (Hilger, 2005).

Amaranth (*Amaranthus thunbergia* Moq.) grows naturally in Namibia. This vegetable contains two edible

Figure 5 Nara (*Acanthosicyos horridus* Welw. Ex Hook.f.) processing in Namibia Desert
Source: Maggs-Kölling et al., 2014

parts: grains and leaves. This can be eaten when fresh or dried. The leaves are good sources of vitamin C, and dietary fibre. It can be used as spinach, combined with milk or fat and sorghum or maize, or eaten with pearl millet porridge. The grains contain protein nutrients. It is possible to cook the grains whole, and it turns very gelatinous in this form. However, because it is challenging to crush all of the little seeds in the mouth, some of the seeds will pass through the digestive system undigested (Venskutonis and Kraujalis, 2013; Maurya and Arya, 2018). Comparing 100 g of fresh amaranth leaves to 100 g of cabbage, the nutrients in amaranth are higher in protein (4.0 vs. 1.4%), calcium (480 vs. 44 mg), iron (10 vs. 0.8 mg), β-carotene (10.7 vs. 1.2 mg), and vitamin C (135 vs. 33 mg). *Amaranthus* leaves are a great source of antioxidant phytochemicals such as vitamin C, phenolic acids, and flavonoids as well as antioxidant pigments like betalain, β-xanthin, β-cyanin, anthocyanins, carotenoids, and chlorophyll. Amaranth contains antioxidants that act as a natural defence against a number some illnesses, including arthritis, emphysema, cancer, cataracts, atherosclerosis, retinopathy, cardiovascular diseases, and neurological diseases (Obianuju and Olubukola, 2022).

Nara (*Acanthosicyos horridus* Welw. Ex Hook.f.) is a melon-bearing bush that only grows in the Namib Desert and lacks leaves (Figure 5). The Namib Desert is the only place where plants may be found, and they are largely connected to the rivers that finish there or run through it, as well as the palaeochannels that they create. The stony desert plains are devoid of them. Nara resemble melons and typically weigh between 1 and 2.5 kg. Even when fully ripe, they have a pale green exterior and are spiky. It has a watery, orange-yellow flesh that is sweet and aromatic and has a taste similar to avocado or a cucumber-pineapple hybrid. Currently being studied in nara are cucurbitacins, which are bitter substances that are both toxic and potentially medicinal. The huge seeds have buttery kernels and are white or cream in color. The sweet, juicy flesh is eaten raw or cooked into a pulp. The pulp is used to make "nara chocolate" by drying it in the sun for several days straight on the sand or, more recently, on plastic sheets. The pulp is also consumed with oatmeal. Consumed alone or with cooked maize porridge, this fruit-roll product is high in vitamins, minerals, and trace elements. The dried seeds, which are incredibly tasty and healthy and contain 31% protein and 57% oil, are enjoyed as a snack. Both the chocolate and the seeds are easily transportable, retain their freshness for long periods, and are consumed frequently. The oil made from the seeds is either packaged or combined with other substances to make food or cosmetic items (Maggs-Kölling et al., 2014; Cheikhyoussef et al., 2017).

Figure 6 Ombidi (*Cleome gynandra* L.) – wild vegetable in Namibia
Source: West African plants, 2023

Ombidi (*Cleome gynandra* L.) is a wild vegetable in Namibia (Hilger, 2005) (Figure 6). It is eaten cooked as a vegetable mixed with amaranth. This vegetable is rich in protein, and micronutrients such as iron, calcium, vitamin A, fats, and vitamin C (Mishra et al., 2011). Some mashed foods have fresh leaves as an ingredient, and other weaning foods contain dried leaves that have been ground and added. Vitamin C concentration in leaves can be reduced by up to 81% when they are boiled, while it is reduced by 95% when they are dried (Heever and Venter, 2007). The tender leaves or young branches, and frequently the blooms, are boiled and eaten as a potherb, pleasant condiment, stew, or side dish throughout Africa. Other mashed foods have fresh leaves as an ingredient, other weaning foods contain dried leaves that have been ground and added. Due to their bitterness, the leaves are typically boiled with other green vegetables including cowpea, amaranth, and blackjack. The vegetable provides a great source of vitamins (A and C) and minerals (calcium and iron), in particular. Vitamin C concentration in leaves can be reduced by up to 81% when they are boiled,

while it is reduced by 95% when they are dried. The vegetable is a staple diet in rural parts of Namibia. This leafy vegetable, which in some nations is the only one available during the relish-gap period, is crucial to household food security during drought. To prepare a remedy that is consumed to treat illnesses like scurvy, leaves can be pulverized. In some cultures, leaves are cooked, marinated in sour milk for two to three days, and then consumed as a wholesome meal that is thought to enhance vision, give energy, and treat marasmus. It is a meal that is strongly advised for expectant and nursing mothers (Mishra et al., 2011).

Leaf rape (*Brassica napus* L.) is a traditional leafy vegetable widely grown Zambezi region. This vegetable consists of high-quality micronutrients (β-carotene and vitamin C), oil, proteins, and mineral compounds. The leaves can be used as a potherb, added to salads, or eaten raw or cooked. Also, the leaves are fermented for later use (Batista et al., 2011).

In Namibia are also used indigenous mushroom as a seasonal food. These mushrooms are a good source of protein, crude fibre, mineral compounds, and vitamins and are low in lipids. It also possesses good properties of anticancer, cardiovascular, and antibacterial effects (Olusegun, 2007).

Conclusion

Food and nutrition security can be improved by increasing indigenous foods intake. Better knowledge of the nutritional value needs to be provided to consumers, to increase the consumption of these foods. People in urban towns are willing to purchase indigenous and traditional products, particularly if they are proven to be nutritious and of health benefits. The majority of native foods are inexpensive sources of fibre, phytochemicals, micronutrients, unsaturated fat, complex carbohydrates, and protein. Traditional foods are crucial to include in our diets since they promote healthy lifestyles and lessen the risk of non-communicable diseases, including diabetes and hypertension. Native cuisine may also serve as a starting point for the creation of numerous therapeutic foods. Through international trade with developed markets, sustainable wild gathering and selling of indigenous goods have the potential to make a significant contribution to the reduction of rural poverty and the preservation of natural resources.

Conflicts of interest

The authors have no conflicts to declare.

Ethical statement

This article doesn't contain any studies that would require an ethical statement.

Funding

This publication was supported by the project NITT SK II "Národná infraštruktúra pre podporu transferu technológií na Slovensku".

References

Adel, A.A.M., Awad, A.M., Mohamed, H.H., & Iryna, S. 2015. Chemical composition, physicochemical properties and fatty acid profile of Tiger Nut (*Cyperus esculentus* L.) seed oil as affected by different preparation methods. In *Food Research Journal*, 22(5), 1931–1938.

Adelakuna, K.M., Kahinde, A.S., Amali, R.P., Ogundiwin, D.I., & Omotaya, O.L. 2016. Nutritional and phytochemical quality of some tropical aquatic plants. In *Poultry, Fisheries & Wildlife Sciences*, 4, 2–5. https://doi.org/10.4172/2375-446X.1000164

Anel, T. C., Thokchom, R., Subapriya, M. S., Thokchom, J., & Singh, S. S. 2016. *Hibiscus sabdariffa*. A natural micronutrient sources. In *International Journal of Advanced Research in Biological Sciences*, 3(4), 243–248.

Animasaun, D., Rathod, H. P., & Krishnamurthy, R. 2019. Analysis of forage yield and nutritional contents of *Pennisetum glaucum* (pearl millet) and *Pennisetum purpureum* (Napier grass) accessions. In *Cuban Journal of Agricultural Science*, 52(4), 1–10.

Batista, C., Barros, L., Carvalho, A. M., & Ferreira, I. C. F. R. 2011. Nutritional and nutraceutical potential of rape (*Brassica napus* L. var. *napus*) and "tronchuda" cabbage (*Brassica oleraceae* L. var. *costata*) inflorescences. In *Food and Chemical Toxicology*, 49(6), 1208–1214. https://doi.org/10.1016/j.fct.2011.02.02

Cardoso, L. de M., Leandro, Pinheiro, S.S., Martino, H.S.D., & Pinheiro-Sant'Ana, H.M. 2017. Sorghum (*Sorghum bicolor* L.): Nutrients, bioactive compounds, and potential impact on human health. In *Critical Reviews in Food Science and Nutrition,* 57(2), 372–390. https://doi.org/10.1080/10408398.2014.887057

Cheikhyoussef, A., & Embashu, W. 2013. Ethnobotanical knowledge on indigenous fruits in Ohangwena and Oshikoto regions in Northern Namibia Ethnobotanical knowledge on indigenous fruits in Ohangwena and Oshikoto regions in Northern Namibia. In *Journal of Ethnobiology and Ethnomedicine*, 34, 1–15.

Cheikhyoussef, A., Bille, P., & Shikongo-Nambabi, M. 2013. Value addition and processed products of three indigenous fruits in Namibia. In *African Journal of Food, Agriculture, Nutrition and Development*, 13(1), 7192–7212. https://doi.org/10.18697/ajfand.56.11495

Cheikhyoussef, A., Mapaure, I., Shapi, M. 2011. The use of some indigenous plants for medicinal and other purposes by local communities in Namibia with emphasis on Oshikoto region: A review. In

Research Journal of Medicinal Plant, 5(4), 406–419. https://doi.org/10.3923/rjmp.2011.406.419

Cheikhyoussef, A., Naomab, E., Potgieter, S., Kahaka, G., Raidron, C., & Ashekele, H.M. 2010. Phytochemical properties of a Namibian indigenous plant; Eembe (*Berchemia discolor*). *National Research Symposium 2010*. Available on: http://hdl.handle.net/11070/1731

Cheikhyoussef, N., Kandawa-Schulz, K., Böck, R., de Koning, Ch., Cheikhyoussef, A., Hussein, A, A. 2017. Characterization of *Acanthosicyos horridus* and *Citrullus lanatus* seed oils: two melon seed oils from Namibia used in food and cosmetics applications. In *3 Biotech*, 7, 297–305. https://doi.org/10.1007/s13205-017-0922-3

Ciftci, S., Suna, G. 2022. Functional components of peanuts (*Arachis hypogaea* L.) and health benefits: A review. In *Future Foods*, 5, 1–10. https://doi.org/10.1016/j.fufo.2022.100140

Cullis, C., Lawlor, D. W., Chimwamurombe, P., Bbebe, N., Kunert, K., & Vorster, J. 2019. Development of marama bean, an orphan legume, as a crop. In *Food and Energy Security*, 8(3), 1–12. https://doi.org/10.1002/fes3.164

Danermark, B. 2019. Applied interdisciplinary research: a critical realist perspective. In *Journal of Critical Realism*, 18(4), 1–15. https://doi.org/10.1080/14767430.2019.1644983

Embashu, W., & Nantanga, K.K. M. 2019. Pearl millet grain: A mini review of the milling, fermentation and brewing of ontaku, a non-alcoholic traditional beverage in Namibia. In *Transactions of the Royal Society of South Africa*, 74(3), 276–282. https://doi.org/10.1080/0035919X.2019.1650310

Embashu, W., O., & Nantanga, K.K.M. 2019. Namibian opaque beer: A review. In *Journal of the Institute of Brewing*, 125(1), 4–9. https://doi.org/10.1002/jib.533

Enyiukwa, D.N., Amadioha, A.C., & Ononuju, C.C. 2018. Nutritional significance of cowpea leaves for human consumption greener. In *Trends in Food Science and Nutrition*, 1(1), 1–10. https://doi.org/10.15580/GTFSN.2018.1.061818085

Heever, E.V., Venter, S.L. 2007. Nutritional and medicinal properties of *Cleome gynandra*. In *Acta Horticulture*, 752(752), 127–130. https://doi.org/10.17660/ActaHortic.2007.752.17

Hilger, P. 2005. The potential of traditional green leafy vegetables – processing potential. In *Ministry of Agriculture, Water and Forestry, Directorate of Agricultural Research and Training*, 95, 1–4.

Hiwilepo-van Hal, P., Bille, P.G., Verkerk, R., van Boekel, M.A.J S., & Dekker, M. 2014. A review of the proximate composition and nutritional value of marula (*Sclerocarya birrea* subsp. *caffra*). In *Phytochemistry Reviews*, 13, 881–892. https://doi.org/10.1007/s11101-014-9352-6

Ismail, A., Hainida, E., Ikram, K., Saadiah, H., & Nazri, M. 2008. Roselle (*Hibiscus sabdariffa* L.) seeds – nutritional composition, protein quality and health benefits. In *Foods*, 2(1), 1–16.

Jayathilake, C., Visvanathan, R., Deen, A., Bangamuwage, R., Jayawardana, B. C., Nammi, S., & Liyanage, R. 2018. Cowpea: an overview on its nutritional facts and health benefits. In *Journal of the Science of Food and Agriculture*, 98(13), 4793–4806. https://doi.org/10.1002/jsfa.9074

Khan, M. 2017. Nutritional and health importance of Hibiscus Sabdariffa: A review and indication for research needs. In *Journal of Nutritional Health & Food Engineering*, 6(5), 125–128. https://doi.org/10.15406/jnhfe.2017.06.00212

Kulamarva, A.G., Sosle, U.R., & Raghavan, V.G.S. 2009. Nutritional and rheological properties of sorghum. In *International Journal of Food Properties*, 12(1), 55–69. https://doi.org/10.1080/10942910802252148

Magaji, S. 2019. Study on the chemical composition of jackal berry (*Diospyros mespiliformis*) fruit edible part. In *FUDMA Journal of Sciences*, 3(3), 576–580.

Maggs-Kölling, G., Lileke, R., Bottlieb, R., Uushona, E. 2014. *Indigenous plant products in Namibia.* Venture publication: Namibia. 144 pp.

Mariod, A.A., & Abdelwahab, S.I. (2012). *Sclerocarya birrea* (Marula), An African Tree of Nutritional and Medicinal Uses: A Review. In *Food Reviews International*, 28(4), 375–388. https://doi.org/10.1080/87559129.2012.660716

Maroyi, A. 2018. Contribution of *Schinziophyton rautanenii* to sustainable diets, livelihood needs and environmental sustainability in Southern Africa. In *Sustainability*, 10(3), 1–3. https://doi.org/10.3390/su10030581

Martin, I. 2007. Fruits for the Future. Monkey Orange *Strychnos cocculoides*. In *Experimental Agriculture*, 43, 1–5.

Mashau, M.E., Kgatla, T.E., Makhado, M.V., Mikasi, M.S., Ramashia, S.E. 2022. Nutritional composition, polyphenolic compounds and biological activities of marula fruit (*Sclerocarya birrea*) with its potential food applications: a review. In *International Journal of Food Properties*, 25(1), 1.11. https://doi.org/10.1080/10942912.2022.2064491

Maurya, N.K., & Arya, P. 2018. *Amaranthus* grain nutritional benefits: A review. In *Journal of Pharmacognosy and Phytochemistry*, 7(2), 2258–2262.

Mbhenyane, X. G. 2017. Indigenous foods and their contribution to nutrient requirements. In *South African Journal of Clinical Nutrition*, 30(4), 5–7.

Mishra, S. S., Moharana, S. K., & Dash, M. R. 2011. Review on *Cleome gynandra*. In *International Journal of Research in Pharmacy and Chemistry*, 1(3), 681–689.

Misihairabgwi, J., & Cheikhyoussef, A. 2017. Traditional fermented foods and beverages of Namibia. In *Journal of Ethnic Foods*, 4(3), 145–153. https://doi.org/10.1016/j.jef.2017.08.001

Nepolo, E., Takundwa, M., Chimwamurombe, P.M., Cullis, C.A., & Kunert, K. 2009. A review of geographical distribution of marama bean (*Tylosema esculentum* (Burchell) Schreiber) and genetic diversity in the Namibian germplasm. In *African Journal of Biotechnology,* 8(10), 2088–2093. https://doi.org/10.5897/AJB09.089

Ngadze, R. T., Linnemann, A. R., Nyanga, L. K., Fogliano, V., & Verkerk, V. 2017. Local processing and nutritional composition of indigenous fruits: The case of monkey orange (*Strychnos* spp.) from Southern Africa. In *Food Reviews International*, 33(2), 123.142. https://doi.org/10.1080/87559129.2016.1149862

Nina, G.C., Ogori, A.F., Ukeyima, M., Hleba, L., Císarová, M., Okuskhanova, E., Shariati, M.A. 2019. Proximate, mineral, and functional properties of tiger nut flour extracted from different tiger nuts cultivars. In *Journal of Microbiology, Biotechnology and Food Sciences*, 9(3), 653–656. https://doi.org/10.15414/jmbfs.2019/20.9.3.653-656

Obianuju, Ch. E., Olubukola, O.O. 2022. Amaranth production and consumption in South Africa: the challenges of sustainability for food and nutrition security. International In *Journal of Agricultural Sustainability*, 20(4), 449–460. https://doi.org/10.1080/14735903.2021.1940729

Olusegun, O. V. 2007. Mushrooms indigenous to Nigeria as potential source of myconutraceuticals – perspective paper. In *Agro Food Industry Hi-Tech*, 18(6), 20–22.

Onwujekwe, E.CH., Ezemba, C.CH. 2020. Food security and safety: africans perspectives A review. In *Archives of Current Research International*, 21(8), 14–20. https://doi.org/10.9734/ACRI/2021/v21i830260

Rampa, A., Lovo, S. 2023.Revisiting the effects of the Ethiopian land tenure reform using satellite data. A focus on agricultural productivity, climate change mitigation and adaptation. In *World Development*, 171, 1–26. https://doi.org/10.1016/j.worlddev.2023.106364

Rauf, A., Uddin, G., Patel, S., Khan, A., Halim, S.A., Bawazeer, S., Ahmad, K., Muhammad, N., Mubarak, S. 2017. Diospyros, an under-utilized, multi-purpose plant genus: A review. In *Biomedicine & Pharmacotherapy*, 91, 714–730. https://doi.org/10.1016/j.biopha.2017.05.012

Satankar, M., Patil, A. K., Kavtkar, S., Kumar, U. 2020. Pearl millet a fundamental review on underutilized source of nutrition. In *Multilogic in Science*, 10(34), 1080–1084.

Shah, T., Prasad, K., & Kumar, P. 2016. Maize-A potential source of human nutrition and health: A review. In *Cogent Food & Agriculture*, 2(1), 1–9. https://doi.org/10.1080/23311932.2016.1166995

Singh, P., Khan, M., Hailemariam, H. 2017. Nutritional and health importance of *Hibiscus sabdariffa*: a review and indication for research needs. In *Journal of Nutritional Health & Food Engineering*, 6(5), 125–128. https://doi.org/10.15406/jnhfe.2017.06.00212

Toomer, O. T. 2018. Nutritional chemistry of the peanut (*Arachis hypogaea*). In *Critical Reviews in Food Science and Nutrition,* 58(17), 3042–3053. https://doi.org/10.1080/10408398.2017.1339015

Venskutonis, P. R., & Kraujalis, P. 2013. Nutritional components of amaranth seeds and vegetables: a review on composition, properties, and uses. In *Comprehensive Reviews in Food Science and Food Safety*, 12(4), 381–412. https://doi.org/10.1111/1541-4337.12021

Wasagu, R., Lawal, M., Galadima, L., & Aliero, A. 2015. Nutritional composition, antinutritional factors and elemental analysis of *Nymphaea lotus* (water lily). In *Bayero Journal of Pure and Applied Sciences,* 8(1), 1–3. https://doi.org/10.4314/bajopas.v8i1.1

Wayah, S. B., & Shehu, S. 2013. Assessment of the nutritional and antinutritional components of tiger nut residues. In *International Journal of Science and Research*, 4, 2319–7064.

West African plants 2023. [online, 2023 09 26]. Available from: URL: http://www.westafricanplants.senckenberg.de/root/index.php?page_id=14&id=371

Yu, Y., Lu, X., Zhang, T., Zhao, X., Guan, S., Pu, Y., Gao, F. 2022. Tiger nut (*Cyperus esculentus* L.): Nutrition, processing, function, and applications. In *Foods*, 11(4), 601–610. https://doi.org/10.3390/foods11040601