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Pumpkin (*Cucurbita ssp.*): A neglected and underutilized crop with potential for production in Africa

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Abstract: The genus *Cucurbita* includes 20-27 species of which 5 are the most cultivated in the world. The 5 species are *Cucurbita argyrosperma, Cucurbita ficifolia, Cucurbita maxima* D (giant/tropical/African pumpkin*), C. moschata* D (butternut/winter squash) and *C. pepo* L. (Courgette/Zucchini). *Cucurbita moschata* D, *C. pepo* L *and C. maxima* D are the most cultivated species worldwide and have high production. This review paper discusses the 3 species of *Cucurbita* that are commonly grown worldwide. In addition, it looks at their production and utilization in some African countries. *Cucurbita* species are native to Central and South America and are distributed from United States to Argentina. They are warm-season annuals, thriving in hot and humid conditions. The term 'pumpkin' refers to the 5 species commonly cultivated globally. Pumpkins are grown in almost all arable regions of the world, from cool temperate to warm tropical zones. They are grown for their fruits, leaves, flowers and seeds. Asia is the largest producer of pumpkins followed by Europe with Africa coming a far third. China is the world's largest producer accounting for more than 30% of global production. Pumpkin is highly nutritious; the leaves, fruits, flowers and seeds are health promoting food. Pumpkins are used to cure many diseases. The fruit is an excellent source of vitamin A which the body needs for proper growth, healthy eyes and protection from diseases. However, pumpkins are neglected and underutilized in Africa. They are considered poor man's food and receive minimal attention from researchers and policy-makers. There is need to promote pumpkin production and utilization in Africa.

Keywords: Africa; *Cucurbita ssp.*; Production; Pumpkins.

Introduction

All members of *cucurbitaceae* family originated in Latin America especially Northern Mexico and parts of United States (OECD, 2016; Jeffrey, 1990) as well as the northern parts of South America. The cultivated species are now widely grown throughout tropical, subtropical and temperate regions of the world (Whitaker and Bemis, 1975), including Africa where they have become naturalized and are categorized among indigenous vegetables (Abukutsa-Onyango, 2007). The genus *Cucurbita* belong to the order *Cucurbitales*, subfamily *Cucurbitoideae* and family *Cucurbitaceae*, respectively (Jeffrey, 1990). The genus *Cucurbita* is divided into two groups according to the ecological characteristics and life cycle of the different cultivated species (OECD, 2016). Xerophytic species are perennial plants adapted to drought conditions and have tuberous storage roots. Mesophytic species are determinate (annual) or indeterminate (perennial) plants adapted to humid climates, they are short-lived and have fibrous roots. The genus *Cucurbita* includes 20-27 species (Esquinas-Alcazar and Gulick, 1983) of which 5 are the most cultivated in the world. These are *Cucurbita argyrosperma, Cucurbita ficifolia, Cucurbita maxima* D (giant/tropical/African pumpkin*), C. moschata* D (butternut/winter squash) and *C. pepo* L. (Courgette/Zucchini). These five belong to the group of mesophytic species (OECD, 2016; Gbemenou et al., 2022). *Cucurbita moschata* D, *C. pepo* L *and C. maxima* D are the most commonly cultivated species worldwide and have high production (Martins et al., 2015). Members of the genus *Cucurbita* are not closely related to other *Cucurbitaceae* genera (OECD, 2016). *Cucurbita* species are warm-season annuals, thriving in hot and humid conditions (Aruah et al., 2010). They are native to Central and South America (Uduwerella et al., 2021) and are distributed from United States to Argentina (Wu et al., 2007). Generally, *C. moschata* is the most widely cultivated *Cucurbita* in the tropics, where it is primarily grown on a small-scale basis for domestic consumption (Andres, 2004) while *C. pepo* is of high economic value in developed countries with temperate climates (Paris and Brown, 2005)

Cucurbita moschata Duch. ex Poir is the most heat-tolerant, widely grown, and common species cultivated in tropical Africa (Grubben and Chigumira-Ngwerume, 2004; Gwanama et al., 2000). In tropical Africa, it is primarily grown on small-scale basis for local consumption and its cultivation is mainly based on many landraces with a high degree of autogamy (Gwanama et al., 2000). Unlike *C. pepo* and *C. maxima, C. moschata* is best adapted to the warm tropical climates hence it is called 'tropical pumpkin' (OECD, 2016); it is more prominent in tropical areas in less-developed countries (Paris and Brown, 2005). Cultivars adapted to temperate conditions tend to be moderate in size with non-lignified rinds (Swanepoel, 2021). *Cucurbita moschata* is the most important and widely cultivated cucurbit in India, Africa, Latin America, southern Asia and the United States (Naik and Prasad, 2016); it is commonly produced on small-scale basis and for local consumption (Andres, 2004). Although the nativity of this species has not yet been confirmed, it most probably originated from Belize, Guatemala, Central Mexico, Gulf of

Mexico, Northeast Mexico, Southeast Mexico, Southwest Mexico (KEW, 2021) and was domesticated in Colombia (Whitaker and Davis, 1962). Studies reported that *C. moschata* underwent two independent domestications: in Mexico and the northern South America (Merrick, 1990; Whitaker, 1974). These assertions were supported by linguistic evidence (Robinson and Decker-Walters, 1997). Studies by Filov (1966) reflected several centers of diversity of *C. moschata* such as Columbia, Japan, Mexico, Central America, the western United States, Florida, India and Asia Minor. *Cucurbita moschata* fruits are large and vary from globose to flatten in their shape. The peel is tough and strong, consequently, the fruit keeps well and is not easily damaged during transportation. It can be stored for more than 3 months under normal temperatures (Men et al., 2021). *Cucurbita moschata* is usually grown for consumption of its mature fruits which possess high-quality flesh (OECD, 2016).

Cucurbita maxima is considered the earliest *Cucurbita* species domesticated in South America and associated with human consumption for more than 12000 years (Castellanos-Morales et al., 2019). Like *C. pepo*, *C. maxima* is well adapted to warm-temperate and temperate regions. Studies show that *C. maxima* originated in the warm-temperate regions of Northeast Argentina, Northwest Argentina and Bolivia (KEW, 2021). Secondary centers of diversity include Bangladesh, Myanmar, India and the southern Appalachians of the United States (OECD, 2016). *Cucurbita* is Latin word for gourd and *maxima* is Latin for largest, because these plants can produce very large fruits. *Cucurbita maxima* is well named, as its fruits are the largest in the plant kingdom. *Cucurbita maxima* produces large fruits that can weigh between 4-35 kg; records show that *Cucurbita maxima* pumpkins exceeding 450 kg have been grown. The fruits are characteristically flattened resembling the typical pumpkin shape (Kiramana and Isutsa, 2017). In South America, *C. maxima* is grown for its immature and mature fruits, but elsewhere, it is almost always grown for the consumption of the mature fruit flesh, for ornament and, for consumption of the seeds.

Cucurbita pepo is the most widely grown species in the genus *Cucurbita*. It is the most important commercial species worldwide (Paris, 2001; OECD, 2016) and has high economic value in developed countries with temperate climates (Paris and Brown, 2005). *Cucurbita pepo* is planted in all countries of Africa on a limited scale, even though it is less tolerant of tropical conditions than *C. moschata* (Grubben and Chigumira-Ngwerume, 2004). In tropical Africa C. *moschata* and *C. maxima* are known to be more important than C. *pepo* (OECD, 2016). *Cucurbita pepo* most likely originated from Mexico and was also domesticated there (Chomicki et al., 2020). In North America, *C. pepo* is a morphologically and ecologically diverse species composed of genetically distinct groups of cultivars and free-living populations (i.e. self-sustaining wild populations), all of which are interfertile (OECD, 2016). It has been suggested that *C. pepo* was domesticated on at least two occasions and in two different regions of North America: in Mexico and in the United States (Decker, 1988, 1986). As with *C. maxima* and *C. moschata*, in addition to the diversity seen in the Americas, multiple centers of diversity exist for *C. pepo*, primarily as landraces, around the world (OECD, 2016). *Cucurbita pepo* is well adapted to all temperate regions and is grown mostly for the use of its immature fruits, also known as summer squash. In cool regions, it is also grown extensively for the culinary use of the flesh of its mature fruits, for consumption of the seeds or extraction of seed oil (Chomicki et al., 2020), and as ornaments. Fruits of *C. pepo* is smaller relative to those produced by other species and, it shows a broad diversity in fruit colour and size among different varieties. Fruits range in size from less than 100 g to over 20 kg, ranging in shape from round to extremely long to flat; can be with or without ribs, grooves, furrows, wrinkles, or warts; and can be green, yellow, or orange ranging in intensity and shading from almost black to almost white and possess patterns of striping, which is longitudinal, or bicolor, which is latitudinal. In the United States and Canada, *C. pepo* is a popular Halloween and Thanksgiving staple (Kumar et al., 2018). *Cucurbita argyrosperma* Huber (formerly known as *C. mixta* Pang) is native to warm lowland regions of Mexico. It is not widely cultivated but it is important in its native country, more for consumption of its seeds than for its fruit flesh. Studies have indicated that *C. argyrosperma* is the wild ancestor of *C. moschata* (Gwanama et al., 2000; Sanjur et al., 2002). *Cucurbita ficifolia* Bouché is commonly known as the fig-leaf gourd rather than as a squash or pumpkin. The precise location of its center of origin is still uncertain although some have proposed that it to be Central America or southern Mexico/Central America (OECD, 2016). *Cucurbita ficifolia* is grown in the cool, highland regions in low latitudes of the Americas. Although adapted to cooler temperatures, it is day length-sensitive and does not flower in the long days of summer of the mid-latitude regions. C*ucurbita ficifolia* has large, spreading vines with leaves that usually resemble those of fig leaves. It has less variation in fruit characteristics than the other cultivated species of the genus *Cucurbita*. The white, fibrous fruit flesh is most often used for making sweets or preserves.

The pumpkins

The term pumpkin refers to the five main species of genus *Curcubita* that are cultivated around the world (Ekanayaka et al., 2019). The word pumpkin originates from the word pepon, which in Greek means “large melon", something round and large (Kumar et al., 2017). The original meaning of the word “pumpkin” referred to an edible round or nearly round fruit while “squash” referred to an edible non-round fruit (Paris and Brown, 2005). In addition, immature fruit of any of the *Cucurbita* species are referred to as “summer squash” and mature fruit as “winter squash”, respectively. Summer squash consists of varieties such as vegetable marrow, zucchini, scallop, acorn, cocozelle yellow straightneck and yellow crookneck; they are harvested in the immature stage and boiled, baked, fried or otherwise processed and eaten (Oluoch, 2012). Most of these cultivars mature in 45 to 60 days (Oluoch, 2012). Winter squash includes butternut, buttercup, delicata, hubbard, kabocha, turban and spaghetti squash (Robinson and Decker-Walters, 1997); they are harvested when the fruits mature. Pumpkin (2n = 2x = 40) is a seasonal vegetable crop; most are day neutral and monoecious. Pumpkins are warm season crops that are sensitive to cool temperatures and are frost intolerant. For maximum production, they prefer temperatures ranging from 20 to 35^0 C with an optimum of 25-30^0 C, and should be free from freezing periods and high humid conditions (Ahmad and Khan, 2019). Fruits maturing when daily mean air temperatures are below 20^0 C have poor quality. At extremely high temperatures only male flowers may be formed, flowers may drop, fruits may get sunburned, and soft fruit at harvest with reduced shelf life. Soil temperature should be above 16^0 C at seed germination; the minimum soil temperature for good field germination is approximately 18^0 C and the maximum 30^0 C. Seed germinates poorly below 16^0 C and no germination takes place at temperatures below 10^0 C. Of the cultivated *Cucurbita* species, *Cucurbita maxima* is the most tolerant of low temperatures. It is cultivated in temperate and subtropical regions worldwide (OECD, 2016). It is primarily cultivated in regions with temperate climate, and very rarely in warm and damp regions (Robinson and Decker-Walters, 1997). *Cucurbita moschata* is the least tolerant of low temperatures, but is relatively drought tolerant. It is cultivated in subtropical and tropical regions worldwide, but can also be cultivated sporadically elsewhere (OECD, 2016). *Cucurbita pepo* can grow in a variety of ecological conditions; it tolerates altitudes ranging from 8-2300 meters above sea level. It grows best when day temperatures are between 24^0 C and 28^0 C and night temperatures between 16^0 C and 24^0 C, although it can tolerate monthly average day temperatures of 18-28^0 C. Many of the commercial cultivars of C. *pepo* are widely grown around the

world, demonstrating the ability of varieties to adapt to different environments. *Cucurbita pepo* may be grown in temperate, subtropical and tropical regions worldwide (OECD, 2016). *Cucurbita* species prefer soils that are well-drained and fairly fertile with pH 6.0-6.5 (Ruwanthika et al., 2023) although they will tolerate both slightly acidic and slightly alkaline soils. Maximum yields are achieved on medium-textured soils with high water-holding capacity and good internal drainage. Although they can be grown on a wide range of soils, heavy clay soils are not recommended. A crop rotation cycle of 2-3 years between planting members from the *Cucurbitaceae* family is required when pathogen populations are very high. Maize, sorghum or legumes like cowpea and beans are good rotation crops.

Pumpkins have a good shelf-life; a whole fruit may keep up to 6 months before spoiling; mature pumpkin fruits when harvested can stay for up to eight months (Nakazibwe et al., 2019). The fruit is covered by an outer protective epidermis which is in turn typically covered by a natural waxy cuticle layer containing the polymer cutin (Lequeu et al., 2008). Once the outer covers are destroyed by bruising or slicing the fruit, water loss and eventual spoilage ensure; slicing the fruit drastically reduces shelf-life to 3-5 days (Kiharason and Isutsa., 2019). When harvesting, a long stem (peduncle) should be left on the pumpkins to enhance the shelf-life of the fruit (OECD, 2016; Oluoch, 2012). It was reported that many farmers in Zimbabwe store undamaged whole pumpkin fruit with the peduncle attached under the shade of the granary for periods ranging from 2 to 6 months; removal of the peduncle greatly reduced the storage period of the pumpkin fruit (Ndoro et al., 2007). In Zambia, the ripe fruit flesh is dried for longer preservation (Grubben and Chigumira-Ngwerume, 2004). It has been found that after harvesting pumpkin at the proper maturity stage under optimum temperature and humidity conditions, most pumpkins can store for up to 8 months (Carren, 2004). Storage duration depend on the harvesting process and the post-harvest handling practices. Pumpkins should be harvested when mature to allow for longer storage. They are often "cured" at 24-30^0 C and 80% high relative humidity (RH) for 5 to 10 days before long-term storage to heal any wounds that may occur during harvesting (Oluoch, 2012). Curing heals wounds, helps ripen immature fruit, enhances colour, and ensures a longer post-harvest life (OECD, 2016). After curing, the temperature and relative humidity should be reduced to 10-13^0 C and 50-75%, respectively. Another way of curing is by leaving the fruits in the field in warm and dry conditions for ten days to two weeks or by keeping them inside at room temperature for a month (OMAFRA, 2011). Pumpkin and squash are chilling-sensitive and should not be stored below 10^0 C (Oluoch, 2012). The most common way of preserving pumpkins in Nigeria is by drying. After drying, it can be stored for years without significant loss of nutrients (Tunde-Akintunde and Ogunlakin, 2013). It has been reported that pumpkin shreds, granulated powder and fine powder as well as pumpkin seed powder are used as nutritional supplements in instant and ready to cook food mixes in India (Swanepoel, 2021). Pumpkin powder has a long shelf life and is used as a supplement in cereal flours in the formulation of bakery, snacks, and confectioneries in numerous countries such as Korea, Poland, Iraq, China, Russia, and India (Sharma and Lakhawat, 2017).

Production of pumpkins

Pumpkins are grown in almost all continents, except Antarctica; they are grown in almost all arable regions of the world, from cool temperate to warm tropical zones. Pumpkin production globally increased from 6.23 million tonnes in 1973 to 22.8 million tonnes in 2022 growing at an average annual rate of 2.77% (World Data Atlas, 2024). In 2022, Asia led the pack producing 11.52 million tonnes followed by Europe (4.83 million tonnes), Africa (2.72 million tonnes), South America (1.01 million tonnes) and Oceania (0.23 million tonnes) (World Data Atlas, 2024). China is

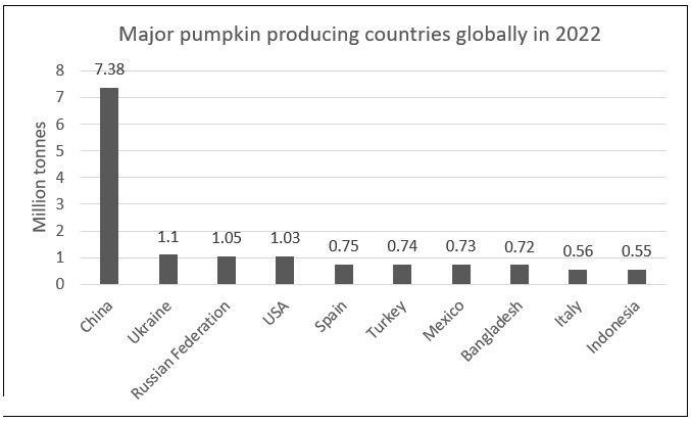

Figure 1. Major pumpkin producing countries globally in 2022. Source: World Data Atlas, 2024.

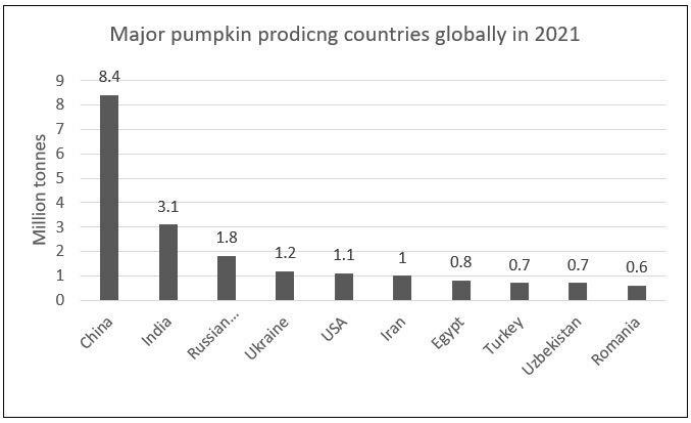

Figure 2. Major pumpkin producing countries globally in 2021. Source: Mapsofworld.com, 2024.

the world's largest producer of pumpkins (Yang et al., 2016; Zhao et al., 2009); in 2022, the country produced 7.38 million tonnes accounting for 32.34% of the world's production. It was followed by Ukraine, Russian Federation, the United States of America, and Spain in the top five. These top five countries accounted for 49.52% of the world's production (World Data Atlas, 2024, Figure 1). In 2021, China was still the largest producer of pumpkins, accounting for more than half of the world's production (Figure 2; Mapsofworld.com, 2024). In 2020, China contributed 27% of the total global output (FAOSTAT, 2022; Figure 3). Pumpkins are one of the most important gourd vegetables in China and they occupy the ninth largest acreage among vegetables in China. The three main species, *Cucurbita moschata, Cucurbita maxima*, and *C. pepo* are grown in China (Chu et al., 2007) although they mainly cultivate *C. moschata* and *C. maxima* and pay less attention towards the *C. pepo* (Zhou et al., 2017). Cultivars such as Miben (*Cucurbita moschata*), Hongli (*Cucurbita maxima*), Lvli (*Cucurbita maxima*) and Xihulu (*Cucurbita pepo*) are the principal pumpkin varieties in the China markets (Zhao et al., 2015). Because of its high starch content and sweet taste, more *C. maxima* species were introduced into the country from abroad since the early 1990s, and its acreage has been expanding each year. However, there is still a problem of low yield in the extensive cultivation of this species (Jia et al., 2007; Liu et al., 2008). In addition, the yield and quality of *C. maxima* fruits are susceptible to early spring frost damage, powdery mildew, and different cultivation conditions (Chen et al., 2019). Researchers have been developing cold-resistant varieties for production in the cold temperate regions (Chen et al., 2019). In Sri Lanka, varieties of both C. *maxima* and *C. moschata* are cultivated (Ekanayaka et al., 2019).

In Africa, pumpkin production is very low compared with other continents (Gbemenou et al., 2022). Pumpkins are generally underutilized in Africa despite their food advantages; pumpkins

can help tackle malnutrition that ravages most poor Africans. Algeria, Egypt, Malawi, South Africa, Nigeria, Kenya, Cameroon, Congo and Niger are among the African countries that produce pumpkins (Gbemenou et al., 2022). In 2022, the countries that produced the highest volumes of pumpkins in Africa were Algeria, Malawi and Egypt; together they comprised 45% of the total continental production (Mapsofworld.com, 2024). In recent years, there have been a steady increase in pumpkin production in Africa (Figure 4). Northern Africa is the major pumpkin producing region in Africa (Figure 5). In Egypt, *C. pepo* is the most popular and is cultivated to a greater extent than C. moschata and C. maxima (Hashash et al., 2017). It is cultivated all the year round, outdoor during summer and indoor, either in green houses or in tunnels, during winter. It is mostly cultivated for domestic consumption where the fruit flesh is cooked (Mady, 2009). In Algeria, *C. pepo* has been widely cultivated in several areas for many decades and it is one of the major vegetable crops (Benalia et al., 2015). Morocco is a major producer of pumpkins which are mostly exported to the UK. By the end of January 2023, pumpkin exports from Morocco to the UK reached an impressive 11,000 tonnes; from January 2022 to January 2023, Morocco's exports accounted for a significant 13% share of the UK pumpkin market, establishing the country as the third-largest supplier after Spain and Portugal, respectively (Morocco World News, 2024). Pumpkins have significant economic importance in Tunisia; however, their production is based on local accessions and landraces (Chikh-Rouhou et al., 2019). Roasted pumpkin seeds are a popular snack in many African countries, especially in Tunisia (Rezig et al., 2012).

Pumpkin is one of the fruit vegetables consumed and relished by most local people in the sub-Saharan Africa (Aruah et al., 2011). Pumpkins grow well in most African countries such as Kenya, Malawi, Nigeria, South Africa, Uganda, Zambia and Zimbabwe (Grubben and Chigumira-Ngwerume, 2004). However, pumpkins have been reported as lacking commercial importance in the sub-Saharan Africa countries such as Nigeria and Kenya (Kiramana and Isutsa, 2017; Aruah et al., 2011). Pumpkin value chains in sub-Saharan African countries such as Uganda, Kenya, South Africa, Malawi and Mozambique have neither received much attention from policymakers nor been widely promoted as a viable enterprise (Ndegwa, 2016). As such, investment in the pumpkin value chains remain low. The potential of pumpkins remains untapped due to several reasons, such limited knowledge and awareness of its nutritional benefits, and lack of catalytic finance and investment needed to transform pumpkin production and processing into a highly profitable industry. The limited investment in this value chain negatively affects the level of research and innovation, extension services provision as well as infrastructural and capacity development in the sector (UAA, 2018).

Pumpkin is one of the high-potential yet untapped vegetables in East Africa. The lower production of pumpkin in the East African region compared to the other parts of the world could be due to the over-reliance of the region on some staple crops like cassava, maize, sorghum, millet (Nakazibwe et al., 2019). In addition, pumpkin production for commercial purposes is eclipsed by other mostly exotic vegetables. Very little has been done to commercialize pumpkin (Isutsa and Mwaura, 2017; Muendo and Tschirley, 2004) even though it has excellent nutritional value, a long shelf life, is relatively easy to grow and can do well in most agroecologies in East Africa. In East Africa, research on traditional crops such as pumpkins is inadequate compared to most mainstream and exotic crops (Hamisy et al., 2002). This is partly because few people use traditional crops as staple foods (Republic of Kenya, 2003; Hamisy et al., 2002). Like other traditional crops, pumpkin production is limited although the crop has potential to improve food security, nutritional status and livelihoods of rural households (Kiharason et al., 2017; Ondigi et al., 2008). In the Lake Victoria basin in Kenya, Uganda and Tanzania, Ondigi et al. (2008) found that pumpkins were mainly planted for domestic consumption and only the surplus could be sold. They were mostly grown by low-income members of the community who mainly utilize the leaves as vegetables and occasionally consume the fruit when cooked.

Pumpkin is one of Uganda's resilient traditional crops adapted to diverse climatic conditions. Its economic importance is attributed to its food security, nutritional and health/ medicinal attributes (UAA, 2018). In Uganda, the main districts that grow pumpkins for commercial and household consumption include Kabale, Jinja, Mbale, Mityana, Mubende, Luwero, Nakaseke and Kabarole (Ondigi et al., 2008). In Uganda, most households use pumpkin leaves as vegetables while seeds are used as a sauce and snack (Musinguzi et al., 2006). A recent study showed that pumpkins are grown by 85.7% of respondent farmers from 28 districts in nine sub-regions of Uganda (Masika et al., 2022); most of the growers were women (65.7%). Majority of the pumpkin farmers are women (UAA, 2018). A study conducted in five agro-ecological zones of Uganda showed that male pumpkin farmers (52.8%) were slightly more than the female respondents (47.2%) (Nakazibwe et al. (2019). They also found that most of the respondents (66.7%) cultivate pumpkin on small scale basis and in most cases (63.9%) pumpkin is intercropped. Although pumpkins were mainly grown for domestic consumption previously in Uganda, there has been a change and in recent times, they are also being grown as a source of income (Nakazibwe et al., 2019; UAA, 2018). Most pumpkin fruits produced in Uganda are exported to neigbouring countries with Kenya being the biggest trading partner accounting for about 92% of the pumpkin exports by volume. Other trading partners are Tanzania (25%), South Sudan (25%), Rwanda (25%) and Sudan (16.67%). Pumpkin processing in Uganda is slowly emerging; the most processed products are roasted pumpkin seeds, pumpkin flour, dried pumpkin seed and powdered pumpkin leaves. There have been efforts to boost pumpkin production in Uganda; between 2020 and 2023, Pumpkins in Africa project (the Pumpkin Project) was undertaken in Uganda by East-West Seed Knowledge Transfer Foundation (EWS-KT) (East-West Seed Knowledge Transfer, 2021). The objective of the Pumpkin Project was to accelerate the growth of the pumpkin sector in Africa. The goal was to develop a hub of expertise and knowledge in pumpkin production in Uganda, which can then drive growth in other East African countries, and even in West Africa if the potential is there. The emphasis was on quality seeds and good agricultural practices.

In Kenya, pumpkins play an important role in the agricultural sector due to their versatility, serving a wide range of purposes including food consumption, medicinal applications, and livestock feed. Pumpkins are mainly grown as a subsistence crop in a wide range of agro-ecological zones and are well adapted to the local conditions in Kenya. In most regions of Kenya, majority of pumpkin growers are low-income farmers who cultivate it mainly for domestic consumption and only the surplus is sold locally (Ondigi et al., 2008, Nyamwamu et al., 2023). However, pumpkins are listed among the neglected and underutilised crops (Nyabera et al., 2019); as such, they remain underutilized in Kenya. Pumpkin receives minimal attention from researchers and government policymakers. The crop is underdeveloped with low production; it is mostly produced by smallholder farmers in marginal areas producing less than the potential of 20 tonnes per hectare (HCDA, 2013). Previous research showed that pumpkin productivity by smallholder farmers in Eastern and Central Kenya regions was below the national average of 20 tons per hectare (Ndegwa, 2016). A previous study found married men to be the main adopters of butternut squash (*C. moschata*) farming in Suba district in Kenya (Isaboke et al., 2012). This could be due to economic consideration given that butternut squash (*Cucurbita moschata*) is an emerging commercial crop in Kenya with ready market and high nutritional value. This observation is like those obtained by Ezin et al. (2021) in Benin. In recent times, the importance of pumpkin as an important food crop in Kenya is increasingly being recognized mainly due to increased awareness about its nutritional value and its ease of cultivation

in several agro-ecological zones of the country. Traditionally considered a "poor man's food", pumpkin is now becoming a highly priced commodity in urban and peri-urban areas in Kenya (Ngugi et al., 2007). It is becoming a particularly important crop in most semi-arid areas of Kenya providing food when other crops are unable to thrive. In the face of changing climatic conditions, pumpkin production is therefore being promoted due to its ability to adapt to increasingly stressful growth environment. Butternut squash (*Cucurbita moschata*) has been promoted for production and consumption as a nutritious crop especially for children and as a security crop for food insecure families. Consequently, it is emerging as an economically important crop with ready market and high nutritional value (Isaboke et al., 2012). Despite these positive attributes of pumpkin and the growing commercial interest, its yield is still very low in Kenya. Some of the main contributing factors include less emphasis on crop improvement and protection against pests and diseases (Gotor and Irungu, 2010), negative perception associating pumpkins with food for primitive and poor households (Chweya, 1997) and change in food habits from traditional to exotic vegetables; especially among the youth who make a huge percentage of the population. Consequently, few households in Kenya eat pumpkins regularly, leading to low demand. There is also lack of good quality varieties, poor crop management, threats of pests and diseases, post-harvest losses and high transport costs (Tanui, 2023).

Cucurbits are widely grown in Southern Africa (Chigwe and Saka, 1994) for their leafy vegetables, fruits, flowers and seeds that are consumed. The leafy vegetables, fruits and flowers are simply boiled and eaten (Chigwe and Saka, 1994) while the seeds can be roasted as a snack and made into a paste like peanut butter. Pumpkin leaves are widely consumed as a leading leafy vegetable during the rainy season; in Zambia, 40% of the households use pumpkin leaves as relish daily during the rainy season (Oluoch, 2012). In most of Southern Africa, pumpkin production is from seeds of landraces that have been maintained by farmers over long periods of time (Gwanama et al., 2000, Chigwe and Saka, 1994).

In Zimbabwe, pumpkin leaves are one of the most preferred traditional leafy vegetables (Maroyi, 2011; Ndoro et al., 2007). They were found to be the third most important vegetable in Mashonaland West Province and were also quite important in Mashonaland East Province of Zimbabwe (Jackson, 1997). A previous study showed that pumpkin leaves were consumed 3.9 times a week during the rainy season in Mashonaland East Province of Zimbabwe (Van der Sluijer et al., 1997). Ndoro et al. (2007), established that consumption frequency of pumpkin leaves when in season ranged from 2 to 7 times a week with a mean of 3.94. They also found that most farmers (85%) intercropped pumpkins with maize and other crops probably because of lack of land and labour in most rural areas in Zimbabwe. In addition, they found that insect pests and diseases were the biggest production constraints (60.7%) while gluts in the market were a major marketing issue (52.5%) during periods of abundance. Most farmers use retained seed (71.9%) for plant in the next season. Most of the farmers selected landraces to grow based on size of the fruit (38.6%), fast growth (28.8%) and good taste/ quality (19.7%) (Ndoro et al., 2007).

In South Africa, pumpkins and squash (*Cucurbita maxima, C. pepo* and *C. moschata*) are widely cultivated for their fruit and by some farmers, for the leaves (Jansen van Rensburg et al., 2007). Pumpkin leaves are very popular leafy vegetables in South Africa and one of the few African leafy vegetables that are cultivated. When harvested as a leafy vegetable, the leaves, flowers and young fruit are picked and cooked. The roasted seed is also a very popular snack (Vorster et al., 2002; Hart and Vorster, 2006). *Cucurbita pepo* landraces are widely grown and used as a traditional leafy vegetable (Faber et al., 2010). In a study carried out in the Northern KwaZulu-Natal, seven distinct landraces of *C. argyrosperma, C. maxima* and *C. pepo* were identified by their local (isiZulu) names (Ntuli et al., 2016); the *C. pepo* had the

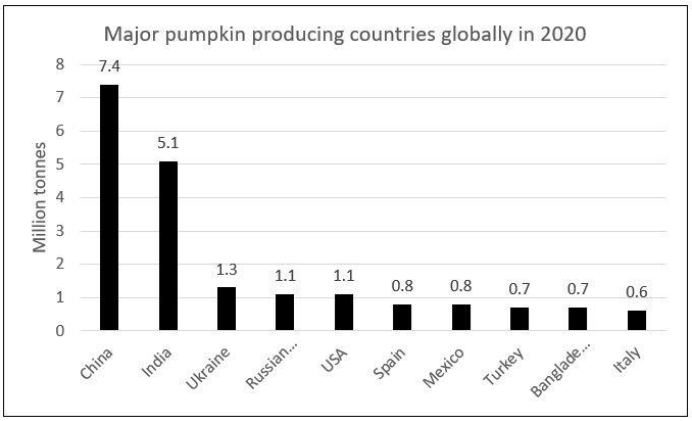

Figure 3. Major pumpkin producing countries globally in 2020. Source: FAOSTAT, 2022.

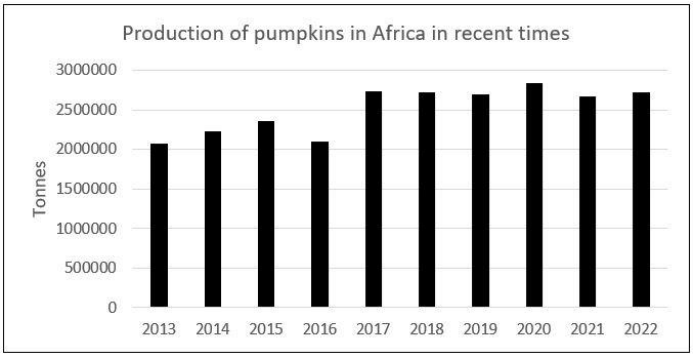

Figure 4. Pumpkin production in Africa in recent times. Source: FAOSTAT, 2024.

highest number of landraces. Communities of northern KwaZulu-Natal consume leafy shoot tips, flowers, young and mature fruits, and seeds of *Cucurbita* landraces. A study found that pumpkin fruit (64.2%), is the most cultivated indigenous vegetable in the North West Province of South Africa followed by bean-leaves (57.8%) and then pumpkin leaves (44.1%) (Lekunze, 2014). However, amaranths (90.8%), followed by cowpea-leaves (87.5%) and pumpkin-leaves (56%) are the most harvested indigenous vegetables. Pumpkin leaves are mostly harvested from dump areas, where they grow as wild vegetables. This is because those who cultivate pumpkins mostly do so for the fruits and harvesting of the leaves reduces fruit yields. In addition, he found that pumpkin-fruit, pumpkin-leaves and bean-leaves are the most marketed indigenous vegetables, in that order. Pumpkin-fruits have a fairly high demand; pumpkin leaves production is hence secondary. He also found that majority of participants involved in indigenous vegetables production and marketing are elderly women (Lekunze, 2014).

In Nigeria, *C. moschata*, *C. maxima*, and *C. pepo* are cultivated (Agbagwa and Ndukwu, 2004). *Cucurbita moschata*, is cultivated in northern Nigeria for the fruits; in southern part of the country, it is cultivated for both the leaves and fruits (Okoli, 1984; Ndukwu and Okoli, 1992). Pumpkin leaves constitute an important vegetable. In some parts of eastern Nigeria, the leaves of *C. moschata* are wrapped around fresh cornmeal and winged termites, cooked and then eaten as a delicacy, mostly by women and children (Okoli, 1984). *Cucurbita pepo* and C. *maxima* are cultivated in the northern parts of Nigeria where they constitute an important part of the local diet. They are cooked and the fruit pulp is eaten alone, with yam/potato or used in making palatable stew. The fruit pulp may sometimes be eaten raw without cooking. The seeds are often fried and eaten by children (Agbagwa and Ndukwu, 2004). *Cucurbita maxima* is mainly cultivated for its leaves, fruits and seeds (Mohammed et al., 2014). However, pumpkin is one of the underutilized crops in Nigeria. It is cultivated on small scale basis for subsistence use; the average yields are low and the crop has virtually no

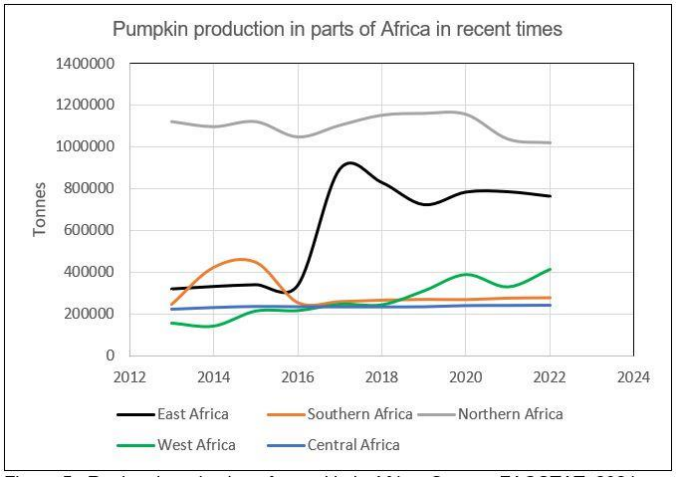

Figure 5. Regional production of pumpkin in Africa. Source: FAOSTAT, 2024

commercial importance (Okoronkwo and Okoli, 2021). The crop is regarded as traditional food mainly for the low-income earners. It has not benefited from the same level of research attention given to other vegetable crops like cucumber, fluted pumpkin and melon, among others (Aruah et al., 2011). Farmers also receive inadequate education on pumpkin production from the agricultural extension agents. In addition, the problem of pests and diseases may be contributing to low pumpkin yields even further (Girei et al., 2017).

In Cameroon, both *C. moschata* and *C. maxima* are grown. Pumpkin is mainly cultivated by women (90%) (Mbogne et al., 2015); similar observations have been reported in Ivory Coast (Irié et al., 2003). According to Mbogne et al. (2015) the choice of pumpkin morphotypes grown by farmers in Cameroon is based on the organoleptic characteristics of the fruits, fruit texture, leaf size and fruit yield, among others. Priori et al. (2018) reported that commercialization of *C. maxima* fruit for consumption is related to the fresh matter (size and weight of the fruit), a characteristic of quality that is essential for the consumer market. Mbogne et al. (2015) indicated that in Cameroon, most pumpkins are grown in monoculture (80%) while mixed cropping (20%) was generally done with groundnut, maize, cassava, soybean and yam. *Cucurbita moschata* is the most cultivated species (up to 90%) in Cameroon (Mbogne et al. (2015). This corroborates the findings of Gwanama et al. (2000) who showed that *C. moschata* is one of the most cultivated vegetables in tropical Africa. This pumpkin species seems to be hardier and sweeter. In Cameroon and other parts of central and west Africa *C. moschata* is grown for the seeds. The seeds are first roasted, the shells removed, and naked seeds are then squashed/pounded into a paste and consumed with the main dish. Roasted seeds are also salted and eaten as a snack.

In Benin, pumpkins are underutilized crops. Little information is available on the uses, conservation and commercialization of the crop (Ezin et al., 2021). A study showed that men (53%) were the main producers of pumpkin while 47% of the women are interested in its production (Ezin et al., 2021). Pumpkin is not included in Benin's agricultural policy despite being an extraordinary vegetable with the potential to be used as a medicinal as well as a nutritious multifunctional food (Gbemenou et al., 2022).

Utilization of pumpkins

Most parts of the pumpkin are useful: the leaves, fruits (immature and mature), male flowers, tips of the vines and seeds of pumpkins are all consumed as food (Fu et al., 2006). Leaves and growing tips are consumed as a vegetable in Africa and Mexico, while in Italy, both male and female flowers are used in soups and other foods (Andres, 2004). In Latin America, flowers are consumed as vegetables (Merrick 1992; Nee 1990). The vines and fruits are used as fodder for domestic animals (Noguera, 2002). In parts of America, Europe and Asia pumpkins are cultivated on large scale for animal feed (Nyabera et al., 2019). Pumpkin is also used as raw product for agro-industrial processing for the production of powder as a natural colouring agent for pasta and flour (Dhiman et al., 2017). The fruit is also used in the food industry as an ingredient of pastries, baked goods, sweets, and baby food (Kim et al., 2012). In recent years, consumption of pumpkin seeds, which are good sources of protein and vegetable oils, has increased significantly. The oil is cholesterol-free and used for cooking, soap making and as domestic and industrial lubricants (Lawal, 2009). In Austria and some countries of Eastern Europe, pumpkins are grown primarily for the production of seeds that can be used for extraction of salad oil (Murkovic and Pfannhauser, 2000); the oil is usually exported to other countries for income generation (Nyabera et al., 2019). Pumpkin seed oil, also known as pepita oil can be a substitute of conventional edible oils currently in use (Sharmin et al., 2022). Although pumpkin seed oil is not produced commercially to a large extent, it is consumed as salad oil, soup ingredient and minced meat seasoning or frying oil in some countries like Austria, Slovenia and Hungary (Türkmen et al., 2017).

In Africa, cultivation of pumpkins is done by small scale farmers mostly for domestic consumption, and less often for commercial purposes (Nyabera et al., 2019). The pumpkins are used as food and vegetables for human consumption and, are both a commercial and home garden crop (Oluoch, 2012). In most cases, pumpkin is regarded as a poor man's food and cultivated mainly for its fruits and leaves; the seeds are generally thrown away as waste or preserved for planting later (Ndegwa, 2016; Karanja et al., 2014). The most important pumpkin product in most African countries is the mature fruit which is cooked and the flesh eaten (Oluoch, 2012). In Cameroon and other parts of central and west Africa *Cucurbita moschata* is grown for the seeds. The seeds are first roasted, the shells removed, and pound into a paste and consumed with the main dish; roasted seeds are also salted and eaten as a snack (Oluoch, 2012). Pumpkin seeds are consumed directly as a snack in many cultures throughout the world; they are especially popular in Arab countries after salting and roasting (Al-Khalifa, 1996; Benalia et al., 2015). The pumpkin seeds are also used as additives to some food dishes (Alfawaz, 2004). In Egypt, pumpkin seeds are the alternative to the western popcorn as they are commonly eaten for leisure as a part of the Egyptian lifestyle (Abdel-Rahman, 2006).

Conclusion

Pumpkins (*Cucurbita ssp.)* are highly nutritive, easy to grow and have long shelf life. They are warm-season annuals grown for their fruits, leaves, flowers and seeds. They are grown in almost all arable regions of the world, from cool temperate zones to the warm tropics. They can do well in diverse ecologies and soil types. Asia is the largest producer of pumpkins followed by Europe with Africa coming a far third. China is the world's largest producer accounting for more than 30% of global production. In Africa, pumpkins are neglected and underutilized. They are mostly produced by small scale farmers for subsistence use and are rarely commercialized. Pumpkin production and utilization in Africa should be promoted to enhance food and nutrition security in the continent.

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