Journal of Applied Pharmaceutical Science Vol. 0(0), pp 001-007, xxx, 2025
Available online at http://www.japsonline.com
DOI: XXX
ISSN 2231-3354

The use and benefits of *Momordica balsamina* L. (*Nkaka*) amongst Bantu people in southern Africa: From traditional food source to modern medicine

Mashilo Ronnie Kgosana, Nsovo Nyeleti Mayimele*
Department of Pharmaceutical Sciences, Tshwane University of Technology, Arcadia Campus, Pretoria, South Africa.

ARTICLE HISTORY
Received on: 10/10/2024
Accepted on: 06/01/2025
Available Online: XX

Key words:
Momordica balsamina, bantu communities, traditional medicine, nutraceuticals, bioactive compounds, functional food, pharmacological properties, southern Africa.

ABSTRACT

Momordica balsamina L, (Cucurbitaceae) commonly known as *nkaka*, has long been recognized among Bantu communities in southern Africa as a versatile plant with both nutritional and medicinal properties. *Momordica balsamina* is common and well distributed in Botswana, eSwatini, Namibia, and most provinces of South Africa. This manuscript reviews the traditional uses, phytochemistry, and biological activity of *Momordica balsamina,* moreover as a food source, and its possible transition to a potential modern therapeutic agent. *Momordica balsamina* has historically been used to manage various conditions including diabetes, hemorrhoids, jaundice, stomach and intestinal complaints, viral infections and even inducing labor. *Momordica balsamina* has been reported to possess antibacterial, antidiabetic, anti-inflammatory, antimalarial, antioxidant, antiparasitic, antiviral, and schistosomicidal activity. The biological activities are explored as they offer the potential for the plant to be developed into a pharmaceutical product. Furthermore, it highlights the potential of *M. balsamina* as a functional food, given its nutritional abundance and medicinal value. Findings from this review show the need for further research into the pharmacological mechanisms and potential pharmaceutical applications of *M. balsamina*. This review discussed the potential commercialization of the plant as a medicinal source and/or a nutraceutical.

INTRODUCTION

Momordica balsamina (M. balsamina) is known as African pumpkin, Balsam pear (Eng.); *Laloentjie* (Afr.); *Masegasegane* (Sepedi); *Mohodu* (Sotho); *Intshungu, Intshungwana yehlathi* (Zulu), and *Nkaka* in a number of languages in southern Africa, including Xitsonga that is spoken in South Africa, Mozambique, and Zimbabwe and further Swahili, which is a common spoken language in southern Africa. It belongs to the Cucurbitaceae family and genus *Momordica*, which includes *Momordica charantia* L, *Momordica foetida* Schumach., *Momordica cochinchinensis* (Lour.) Spreng, *Momordica tuberose* (Cogn) Roxb. Synonyms for *Momordica balsamina* include *Momordica involucrata* E.Mey. ex Sond. and *Momordica schinzii* Cogn [1]. The term "*Momordica*" actually comes from the Latin "*mordicus*" which means "the bite", *M. balsamina* has received the attention of researchers due to its bioactivity and nutritional potential [2,3]. It is an Indigenous and cultivated species in Africa, often found in tropical areas and wastelands. *Momordica balsamina* is used across many African countries including Nigeria, Kenya, and Tanzania where different plant parts are used as tea and poultices. The leaves can be consumed fresh or prepared like a traditional vegetable dish [4]. Traditionally, *M. balsamina* is used to manage diabetes, jaundice, fever, gonorrhoea, tuberculosis, and viral infections [5,6]. Anthropological research has indicated that wild fruits are often neglected in Western medicinal research and use, despite their high nutritional and medicinal values. *Momordica balsamina* is considered to have lost its traditional use as a food source among the Bantu people of Tanzania's Morogoro rural area [7,8]. *Momordica balsamina* holds significant cultural,

*Corresponding Author
Nsovo Nyeleti Mayimele, Department of Pharmaceutical Sciences, Tshwane University of Technology, Arcadia Campus, Pretoria, South Africa. E-mail: MayimeleNN @ tut.ac.za

Figure 1. Images portraying the *M. balsamina* (A) in its habitat, (B) spindle-shaped ripe fruits, and (C) yellow and deeply veined flowers.

medicinal, and culinary. The plant is used in African cuisines as both the staple and famine food. The bitterness of the fruit is appreciated in African traditions which symbolizes resilience. Traditionally and culturally, *M. balsamina* symbolizes resilience healing, and survival. In some African households *M. balsamina* is hung in hoes and cultivated in the homestead and it is believed to offer protection against evil spirits and negative energies. The cultivation of *M. balsamina*, is rooted in the agricultural practices of the Tsonga, Swahili, and other Bantu people in southern Africa, particularly in regions such as northern South Africa, Mozambique, Tanzania, and Zimbabwe. This plant is an integral part of traditional Tsonga horticulture. Which reflects the relationship of the community with the land and their reliance on indigenous crops for sustenance, medicine, and cultural practices [5,9]. With nutrition in dense, the plant has not been given adequate attention in terms of developing a nutraceutical. Previous studies indicate that *M. balsamina* exhibits different biological activities and this sparked an interest in this plant in modern medicine. Different plant parts including the whole plant, leaves, roots, and fruits have ethnomedicinal uses, owing to their chemical composition. The plant has many ethnopharmacological uses which makes it a candidate for further pharmaceutical research. Figure 1 portrays different images of *M. balsamina,* (A) in its habitat, (B) spindle-shaped ripe fruits, and (C) yellow and deeply veined flowers.

CULTIVATION

The Bantu people typically cultivate *M. balsamina* in small-scale, family-owned plots or communal gardens. The plant is tropical and therefore thrives in warm temperatures with seasonal rainfall. The cultivation usually begins at the start of the rainy season, which coincides with the planting period for most traditional crops [1]. The seeds are sown directly into the soil, often in well-drained, fertile ground, where they can receive sunlight. Given its climbing nature, *M. balsamina* is often grown along fences, trellises, or intercropped with other crops such as maize, beans, or cassava. This intercropping system not only maximizes land use but also provides natural support for the vine to spread [4,8]. The plant is relatively low maintenance, requiring minimal intervention once established, as it is adapted to local soil and climate conditions. Harvesting of *M. balsamina* occurs once the fruits ripen, typically turning from green to a bright orange or red hue. The fruits, leaves, and sometimes the roots are collected, depending on the intended use. For food purposes, the young leaves and fruits are harvested and prepared as vegetables, often boiled or cooked with other ingredients. The fruits are also used in traditional medicine, particularly when they reach full maturity [8,10]. Among the Bantu people, including Tsonga people, *M. balsamina* is more than just a crop, it is a symbol of traditional knowledge and cultural heritage. The plant is used in various medicinal applications, including the treatment of ailments such as malaria, gastro-intestinal disorders, and skin infections. The bitter taste of the fruit, a characteristic feature, is believed to have therapeutic properties, especially in cleansing the body and improving digestion [3,4].

TAXONOMY AND DISTRIBUTION

The cultivation of *M. balsamina* by the Tsonga people extends across northern South Africa, particularly in the Limpopo province, where the climate and soil conditions are ideal for its growth. In Mozambique, the plant is widely grown in the southern and central regions, particularly in rural areas where traditional farming practices prevail. Similarly, in Tanzania and Zimbabwe, *M. balsamina* is commonly found in smallholder farms and home gardens, cultivated alongside other staple crops. *Momordica balsamina*, also known as balsam pear, belongs to the Cucurbitaceae family and is a straggling annual herb that can be found climbing or sprawling along the ground. The plant features stems that range from 1 to 3 m in length, varying greatly in size from very slender to becoming slightly woody at the base. Both the stem and petioles are covered with stiff hairs, and the leaves are alternate, simple, and have hairy lower surfaces, with small shingles sprouting above the apparent veins when viewed through a magnifying glass [7,10]. The fruit is a spheroid to ellipsoid berry that initially appears green with stripes of green/yellow and gradually changes to orange, turning red at maturity. *Momordica balsamina* is native to tropical areas in India, Southeast Asia, and Australia, although it is notably absent from within Wallace's line. The species has been introduced to various regions, including the Americas, southern and eastern Africa, Madagascar, the Mascarene Islands, and the Arabian Peninsula. In African rural villages and towns, particularly in Zimbabwe, it is common to encounter *M. balsamina* growing along hedges and in gardens. The plant is actively cultivated by many people and serves as a source of food, natural remedies, and even leisure crafts [7,10,11].

Table 1. Bioactive compounds associated with the pharmacological activities of *M. balsamina.*

Compounds	Biological activity	References
Cucurbitane glycoside	Antidiabetic	[12,13]
Karavoate A	Anticancer	[14]
Karavoate B	Antimalarial	[14]
Karavoate C	Anticancer	[14]
Karavoate E	Anticancer	[14]
Kuguacin J	Anticancer	[12]
Karavilagenin C	Antibacterial, anticancer, antimalarial	[12,15]
Balsamin	Antibacterial, Anti-HIV	[14]
Balsaminagenin A	Antibacterial, anticancer	[14,15]
Balsaminoside B	Anticancer	[14,15]
Balsaminol F	Schistosomicidal	[14,15]
Momordin I	Antiviral	[16]
Momordin II	antiviral	[16]
Balsaminapentaol	Antimalarial	[14,15]
Cucurbalsaminol	antiparasitic	[33,36]

TRADITIONAL USES

Ethnobotanical surveys of traditional medicinal knowledge and use were conducted and reported the use of roots of the *M. balsamina* against hemorrhoids as well as gonorrhoea [18]. It is noted the use of the *M. balsamina* plant by the local Bantu communities for a variety of purposes including food, medicine, and ritual practices. It is used as food or medicine, by many of the different Bantu tribes encountered, also with emphasis on the treatment of venereal diseases and sores [10,19,20]. Numerous records of traditional medicinal use amongst diverse ethnic groups exist in the southern African region. Both the nutritive and potential medicinal properties of the fruit of this bitter plant and their possible relation to each other are further discussed in later sections.

Central to ethnobotanical research is the recognition that different practices may be observed in different communities, as is the ubiquity of these fruits in predominantly summer-rainfall savannas. So, it is not surprising that the Bantu people, who resided as locally dispersed and isolated groups in numerous communities across the warm Limpopo valley, Nevrijezwamps, and the Okavango and Zambezi valleys, found that the fruit of the watermelon-like *M. balsamina* vine was an edible and sometimes medicinal source of water and nutrients. The first specific name with walnut is intended to describe the tropical origin of the plant, of Balsamaceae, a family in the order Cucurbitales, which is also the order of watermelon and cucumber. The vine producing the small watermelon-like fruit is native, having been a component of the African flora since well before the continental breakup [10].

PHYTOCHEMISTRY OF *M. BALSAMINA*

Momordica balsamina contains various biologically active compounds. These include saponins, flavonoids, alkaloids, glycosides, phenols, steroids, and triterpenoids. Different plant parts are used according to their chemical composition and a specific condition that needs intervention. The bark, fruits, leaves, and seeds stems contain constituents that include the alkaloids, anthocyanins, flavonoids, resins, saponins, and tannins [3,10]. The diverse phytochemistry of *M. balsamina* makes it have a diverse therapeutical property and its potential properties have been substantiated by numerous biological assays, indicative that *Momordica balsamina* is not only a nutritious food source but can be used in developing new therapeutics. Metabolites with biological activities that have been identified in *Momordica balsamina* include; balsamin, keampferol, quercetin, isorhamnétine, quinic acid, *karavilagenin C, balsaminagenin B, cucurbalsaminone B, balsaminoside A, and karavilagenin E* [3,21,22]. Table 1 shows different compounds found in M. balsamina with their relevant biological activity.

PHARMACOLOGICAL ACTIVITY AND HEALTH BENEFITS OF *M. BALSAMINA*

The pericarp decoction is used in many cultures to treat inflammation-related ailments, such as asthma, diabetes, and obesity (Fig. 2). Some cultures also use the fruits as a purgative to treat parasites or to facilitate childbirth and milk production [23–25]. People with diabetes are frequently recommended to take this plant over confirmed antidiabetics, such as glibenclamide, possibly due to its lower cytotoxicity [26,27]. It also protects against complications that result from ongoing hyperglycaemia, such as nephropathy or retinopathy [28,29]. A pronounced recuperative effect on the liver has also been reported. In addition, the plant has been found to have an insulin sensitizing effect, making it effective in type 2 diabetes.

A leaf-rich diet alleviated obesity in rats and helped reduce body mass index in overweight or obese Bantu people. Inflammation is a common driver of obesity and associated diseases, such as insulin resistance and diabetes, as well as fatty liver disease and its many related health problems. In sum, the pharmacological actions of *M. balsamina* have roots in African traditional knowledge and clinical confirmations and are also in agreement with the present-day nutritional zeitgeist [30–32]. Therefore, this plant and the compounds it contains should be increasingly used to improve human health.

Momordica balsamina has proven anti-inflammatory, antioxidant, hypoglycaemic, hepatoprotective, and lipid-reducing effects [33–35]. Given its medicinal and 'therapeutic' effects, different parts of this plant are widely used in various forms to treat or prevent many diseases (Fig. 2). Some of the great healing potential of *M. balsamina* is attributed to the fruit. They are rich in fibre and minerals and have a significant content of proteins and complex carbohydrates. The fruit also contains significant amounts of vitamins, mainly vitamin C and carotenes, and other compounds with known antioxidant activity [34–36].

Antibacterial activity

Momordica balsamina has been found to inhibit bacterial growth by interfering with essential metabolic processes. Flavonoids and alkaloids in the plant have been shown to inhibit bacterial enzymes critical for DNA replication,

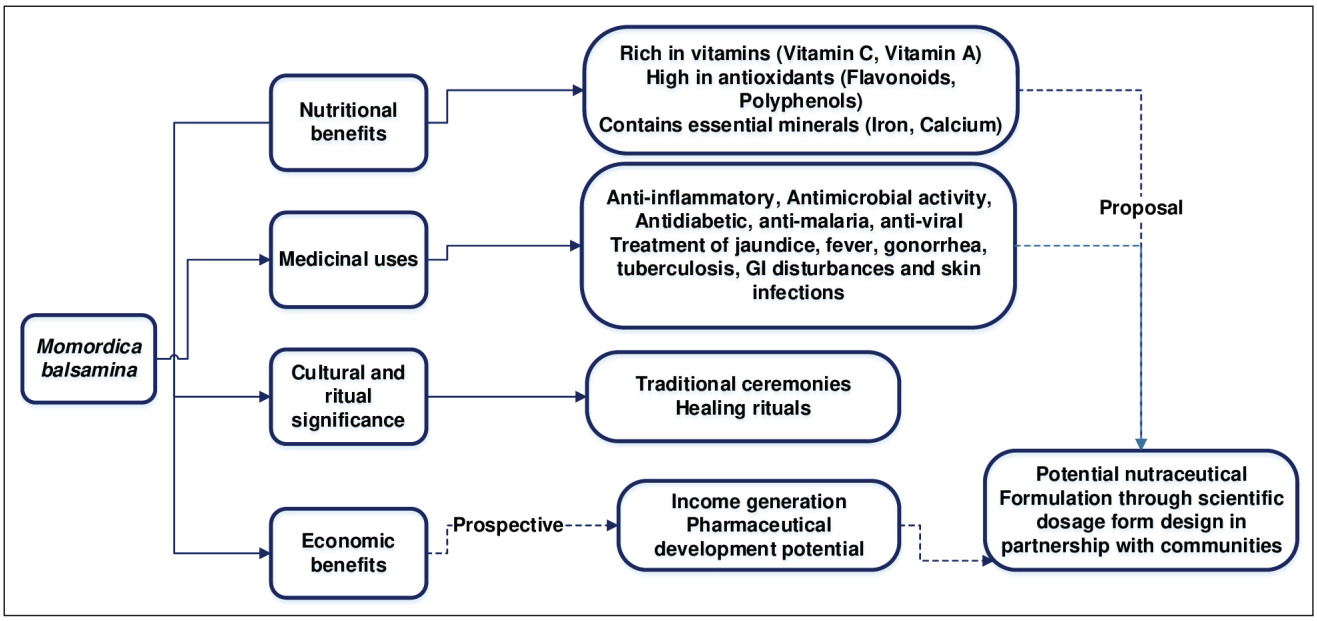

Figure 2. Pharmacological actions and health benefits.

protein synthesis, and energy metabolism. By disrupting these fundamental processes, *M. balsamina* effectively halts bacterial growth and replication [10]. A study by Abdulhamid [37] evaluated the phytochemical composition and antibacterial activity of *M balsamina* leaf extracts and their fractions. The leaves were first extracted using methanol (crude extract) and further fractionated using solvents of varying polarities. Phytochemical screening revealed the presence of phenols, saponins, glycosides, tannins, terpenoids, cardiac glycosides, and alkaloids, while flavonoids and anthocyanins were absent [16,17]. Antibacterial activity, assessed using the agar well diffusion method, showed that the methanol crude extract and the n-butanol fraction exhibited the highest antibacterial activity against tested bacteria at both concentrations (100 mg/ml and 300 mg/ml). In contrast, the n-hexane, ethyl acetate, and aqueous fractions displayed lower antibacterial effects. The results suggest that *M. balsamina* leaves hold potential as a natural antibacterial agent and provide a basis for further research on antimicrobial compounds from plants [22,37]. These antibacterial properties have been described in other studies with similar findings [10,24,38].

Antidiabetic activity

Momordica balsamina has phytochemicals that have a role in regulating blood glucose levels through multiple mechanisms. One of the main ways is by enhancing insulin secretion from pancreatic β-cells, which helps improve glucose uptake by tissues, thereby lowering blood glucose levels. *Momordica balsamina* has been shown to improve insulin sensitivity in peripheral tissues like the liver and muscles [38,39]. This improvement in insulin sensitivity is significant in facilitating efficient glucose uptake and utilization, ultimately helping to manage hyperglycemia. Another key mechanism involves the inhibition of enzymes responsible for carbohydrate metabolism, particularly α-amylase and α-glucosidase. By inhibiting these enzymes, *M. balsamina* slows down the breakdown of complex carbohydrates into glucose, which results in a reduced postprandial blood glucose spike [40–42]. The antioxidant properties help to combat oxidative stress, a condition that exacerbates diabetes by damaging pancreatic cells and impairing insulin function. By reducing oxidative stress, *M. balsamina* helps preserve the function of pancreatic β-cells and insulin activity. These combined mechanisms make *M. balsamina* a promising candidate for the management and treatment of diabetes, especially in traditional medicine [43]. However, more clinical studies are needed to fully understand its efficacy and safety in human populations [27,44,45].

Antiparasitic activity

Momordica balsamina is used traditionally for the treatment of malaria because of its antiparasitic and antiplasmodial activity. The antiparasitic activity of *M balsamina* is due to its rich composition of bioactive compounds such as alkaloids, flavonoids, saponins, and terpenoids. These compounds contribute to its effectiveness against a variety of parasites, including protozoa, helminths, and other parasitic organisms. The antiparasitic mechanisms of *M. balsamina* are primarily attributed to its ability to disrupt the life cycle of parasites, impair their mobility, and interfere with their reproductive systems [24,46,47].

One key mechanism of *M. balsamina* antiparasitic activity is its ability to damage the cellular membranes of parasites, leading to increased permeability and eventual cell death. Saponins, a class of compounds abundant in *M. balsamina*, are known to disrupt the lipid bilayers of parasitic cells, weakening their structure and function. This membrane-disrupting activity has been particularly effective against protozoan parasites, such as *Plasmodium* species, which are responsible for malaria. *Momordica balsamina* has demonstrated anthelminthic properties, making it effective

against parasitic worms. Its bioactive compounds interfere with the energy metabolism of helminths, leading to paralysis and expulsion of the worms from the host. Studies have also reported that the plant's antioxidant activity contributes to its antiparasitic action by reducing oxidative stress in the host, which is often exacerbated during parasitic infections [4,46,48]. The broad spectrum of *Momordica balsamina* antiparasitic effects, combined with its traditional use in treating parasitic diseases, highlights its potential as a natural antiparasitic agent, though further research is required to establish standardized doses and to confirm its efficacy in clinical settings.

Antiviral activity

Momordica balsamina has demonstrated notable antiviral activity, attributed to its diverse of bioactive compounds such as momordin. These compounds work through several mechanisms to inhibit the replication and spread of various viruses. The antiviral activity of *Momordica balsamina* have been studied against a range of viruses, including human immunodeficiency virus, herpes simplex virus, and influenza, among others [48]. A study by Ampitan *et al.* [9] investigated the prophylactic efficacy of methanolic extract of *Momordica balsamina* against Avian Paramyxovirus-1 in broiler chickens. Thirty 5-week-old birds were divided into six groups, including a positive control, negative control, and four groups receiving different doses (200, 250, 300, and 350 mg/kg body weight) of the extract. All birds were exposed to the virus in the seventh week, and symptoms were monitored for 21 days. Results showed that the extract, particularly at higher doses, reduced hemorrhagic liver lesions, mortality, and clinical symptoms of Newcastle Disease. The mortality rate was 20% in the group given 350 mg/kg and 40% in the group receiving 300 mg/kg. Birds treated with the extract exhibited significantly lower cholesterol and Alkaline Phosphatase (ALP) levels compared to the positive control, although there were no significant changes in Aspartate transaminase levels. Lower serum ALP and Alanine transferase levels were also observed in extract-treated groups. The study concluded that *M. balsamina* extract has potential prophylactic activity against Avian Paramyxovirus-1 in broiler chickens [9].

Hypocholesterolemic activity

Momordica balsamina has been found to positively influence lipid profiles by reducing low-density lipoprotein (LDL) cholesterol, while simultaneously increasing high-density lipoprotein cholesterol. The flavonoids and sterols present in *M. balsamina* contribute to this lipid-regulating effect by modulating enzymes involved in cholesterol biosynthesis and promoting the clearance of LDL from the bloodstream. The antioxidant properties play a supportive role in its hypocholesterolemic activity [2,30,34]. By reducing oxidative stress, which can contribute to the oxidation of LDL cholesterol, *M. balsamina* helps prevent the formation of oxidized LDL, a key factor in the development of atherosclerosis. This protection against oxidative damage further supports cardiovascular health by reducing the risk of plaque formation in blood vessels.

POTENTIAL FOR DEVELOPING PHARMACEUTICAL PRODUCTS

Research evidence increasingly indicates that the safety and efficacy of natural remedies, including plant-based treatments, derive from ancestral and culturally inherited knowledge. *Momordica balsamina* has been used for generations to treat various diseases among Bantu people [45,49,50]. They administer the plant in powdered form, as a decoction, or dried sap in access points. *Momordica* species present a high potential for exploiting a wide range of activities such as antimicrobial, antidiabetic, antioxidant, antidiarrheal, antihelminth, and anti-inflammatory [46,50,51]. The demand for natural products for pharmaceutical applications and increases in technology for their development, production, and characterization have led various research groups to investigate the use of Indigenous plant species for their potential in producing pharmaceutical products [41,42,50].

Bioprospecting on African flora brings Indigenous knowledge and the accumulated evolutionary potential of a mega-diverse continent not yet fully characterized by science [52–54]. Traditional medicine systems have been developed over thousands of years and shaped by cultural, social, environmental, and metagenomic selection pressures. Notwithstanding their inherent value as a source of new drugs and active principles, traditional medicine as a system may offer other useful perspectives on the understanding of disease versus drug target models. Such perspectives include but are not limited to, a holistic approach to most often multifactorial diseases, the concept of duality—which includes both the beneficial and toxicological aspects of a given environmental constituent and a certain level of ethical considerations.

CONCLUSION

Momordica balsamina has the most uses among other species within the *Momordica* family. It is known to stimulate hunger, cure various diseases, and is generally associated with excellent health. The numerous uses of this species provide scientific evidence that it is a deeply rooted cultural crop, especially among the Bantu people in sub-Saharan Africa. The popularisation of this plant has the potential to bring extensive benefits to the communities that have hosted and developed Indigenous knowledge systems on it. The *M. balsamina* holds one of the most diverse uses among other cultivated *Momordica species*. The species has been used for food, ethnomedicinal care, and rituals, among others in sub-Saharan Africa. Its unique contribution is in its use for rituals, temple uses, and aphrodisiac services. Several products are derived from *M. balsamina*, including its flowers, ashes, leaves, fruits, and roots. It holds such diverse uses that whatever part is available, a product could be extracted from it. It is in the use of these parts that the ethnobotanical properties of the species become of utmost significance. It is concluded that *M. balsamina* is a valuable vegetable with an array of potential and actual health benefits. When translated to say that science, modern medicine, and nutrition should be more of the positive traditional know-how instead of the active arrogant handler that currently seems to have an attitude of contempt for anything traditional, less chemically modulating, or pharmaceutical.

AUTHOR CONTRIBUTIONS

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work. All the authors are eligible to be an author as per the International Committee of Medical Journal Editors (ICMJE) requirements/guidelines.

FINANCIAL SUPPORT

There is no funding to report.

CONFLICTS OF INTEREST

The authors report no financial or any other conflicts of interest in this work.

ETHICAL APPROVALS

This study does not involve experiments on animals or human subjects.

DATA AVAILABILITY

All data generated and analyzed are included in this research article.

PUBLISHER'S NOTE

This journal remains neutral with regard to jurisdictional claims in published institutional affiliation.

REFERENCES

1. Foden W, Potter L. *Plumbago auriculata* Lam. National assessment: red list of South African plants version 2017.1. Available from: http:// redlist. sanbi. or g/species. php. 2005:3567
2. Muronga M, Quispe C, Tshikhudo PP, Msagati TA, Mudau FN, Martorell M, *et al.* Three selected edible crops of the genus *Momordica* as potential sources of phytochemicals: biochemical, nutritional, and medicinal values. Front Pharmacol. 2021 May 13;12:625546. doi: https://doi.org/10.3389/fphar.2021.625546
3. Thiaw M, Samb I, Genva M, Gaye ML, Fauconnier ML. *Momordica balsamina* L.: a plant with multiple therapeutic and nutritional potential—a review. Nutraceuticals. 2023 Nov 17;3(4):556–73. doi: https://doi.org/10.3390/nutraceuticals3040040
4. Ramalhete C, Gonçalves BM, Barbosa F, Duarte N, Ferreira MJ. *Momordica balsamina*: phytochemistry and pharmacological potential of a gifted species. Phytochem Rev. 2022 Apr;21(2):617–46. doi: https://doi.org/10.1007/s11101-022-09802-7
5. Mushaphi LF, Magoro M, Tshiambara P. Nutritious edible indigenous vegetables. In: Mulaudzi FM, Lebese RT, editors. Working with indigenous knowledge: strategies for health professionals. Cape Town, South Africa: AOSIS; 2022.
6. Das LA, Mishra S, Das A, Dimri R, Kumar S. Some common flora of temple city of Odisha, India: source for ethno-medico-cultural values. Indian Forester. 2022 Jun 29;148(2):207–12.
7. Kock KT. The influence of culture on the utilization of traditional leafy vegetables among VaTsonga and Ba-Pedi women of Bushbuckridge, Mpumalanga Province (Doctoral dissertation, North-West University (South Africa). 2020. Available from: https://repository.nwu.ac.za/bitstream/handle/10394/35588/Kock_KT.pdf?sequence=1
8. Tshidzumba SE. Nutritional composition of traditional mixed-dishes eaten by elderly women in Vhembe District (Doctoral dissertation). Submitted to the University of Venda. 2020. Available from: https://univendspace.univen.ac.za/bitstream/handle/11602/1729/Dissertation%20-%20Tshidzumba,%20s.%20e.-.pdf?sequence=1
9. Ampitan T, Garba MH, Adekambi DI, Ampitan A, Adelakun K. Prophylactic potency of methanolic extract of *Momordica balsamina* L. against avian paramyxovirus-1 infection in broiler chickens. Egypt J Agric Res. 2023 Feb 1;60(1):25–32. doi: https://dx.doi.org/10.21608/ejap.2023.163641.1049
10. Mabasa XE. Phytocompound profiling and assessment of antioxidant antibacterial, anti-inflammatory, and cytotoxic activities of *Momordica* balsamina leaf extracts (Doctoral dissertation). Submitted to the University of Venda. 2021. Available from: https://univendspace.univen.ac.za/bitstream/handle/11602/1817/Dissertation%20-%20Mabasa,%20x.%20e.-.pdf?sequence=1
11. Soomro KB, Alaghmand S, Andriyas S, Khan MR, Talei A. Soil salinity and economic analysis of bitter gourd (*Momordica charantia* L.) production using the drip irrigation method. Sarhad J. Agric. 2021 Jun 1;37(2):331–713. doi: https://dx.doi.org/10.17582/journal.sja/2021/37.2.511.520
12. Spengler G, Ramalhete C, Martins M, Martins A, Serly J, Viveiros M, *et al.* Evaluation of cucurbitane-type triterpenoids from *Momordica balsamina* on P-glycoprotein (ABCB1) by flow cytometry and real-time fluorometry. Anticancer Res. 2009 Oct 1;29(10):3989–93.
13. Farooq U, Pan Y, Lin Y, Wang Y, Osada H, Xiang L, *et al.* Structure characterization and action mechanism of an antiaging new compound from Gastrodia elata Blume. Oxid Med Cell Longev. 2019;2019(1):5459862. doi: https://doi.org/10.1155/2019/5459862
14. Ramalhete C, Mulhovo S, Lage H, Ferreira MJU. Triterpenoids from *Momordica balsamina* with a Collateral sensitivity effect for tackling multidrug resistance in cancer cells. Planta Med. 2018;84:1372–9. doi: https://doi.org/10.1055/ a-0651-8141
15. Thakur GS, Bag M, Sanodiya BS, Bhadauriya P, Debnath M, Prasad GB, *et al. Momordica balsamina*: a medicinal and neutraceutical plant for health care management. Curr Pharm Biotechnol. 2009 Nov 1;10(7):667–82. doi: https://doi.org/10.2174/138920109789542066
16. Ramalhete C, Magalhães LG, Rodrigues V, Mulhovo S, Da Silva Filho AA, Ferreira MJ. *In vitro* schistosomicidal activity of balsaminol F and karavilagenin C. Planta Med. 2012 Dec;78(18):1912–7. doi: https://doi.org/10.1055/s-0032-1327832
17. Villarreal-La Torre VE, Guarniz WS, Silva-Correa C, Cruzado-Razco L, Siche R. Antimicrobial activity and chemical composition of *Momordica Charantia*: a review. Pharmacogn J. 2020;12(1). doi: http://dx.doi.org/10.5530/pj.2020.12.32
18. Malik K, Ahmad M, Öztürk M, Altay V, Zafar M, Sultana S. Herbals of Asia: prevalent diseases and their treatments. Springer; 2021 Nov 16.
19. Olarewaju OO, Fajinmi OO, Arthur GD, Coopoosamy RM, Naidoo KK. Food and medicinal relevance of Cucurbitaceae species in Eastern and Southern Africa. Bull Natl Res Centre. 2021 Dec;45:1–7. doi: https://doi.org/10.1186/s42269-021-00659-y
20. Fajinmi OO, Olarewaju OO, Arthur GD, Naidoo K, Coopoosamy R. Cucurbitaceae species used as traditional medicine in West Africa. J Med Plant Econ Dev. 2022 Nov 29;6(1):9. doi: https://doi.org/10.4102/jomped.v6i1.163
21. Rathod V, Behera TK, Munshi AD, Gaikwad AB, Singh S, Vinay ND, *et al.* Developing partial interspecific hybrids of *Momordica charantia*× *Momordica balsamina* and their advance generations. Sci Hortic. 2021 Apr 30;281:109985. doi: https://doi.org/10.1016/j.scienta.2021.109985
22. Gayathry KS, John JA. A comprehensive review on bitter gourd (*Momordica charantia* L.) as a gold mine of functional bioactive components for therapeutic foods. Food Prod Process Nutr. 2022 May 25;4(1):10. doi: https://doi.org/10.1186/s43014-022-00089-x
23. Sarkar T, Salauddin M, Chakraborty R. In-depth pharmacological and nutritional properties of bael (Aegle marmelos): a critical review. J Agric Res. 2020 Dec 1;2:100081. doi: https://doi.org/10.1016/j.jafr.2020.100081

24. Sarkar A, Alam M, Roy P, Biswas R, Haque M.I. Physicochemical, antioxidant and antimicrobial activities of green teas manufactured from common tea clones of different gardens in Bangladesh. J Agric Res. 2022;10:100407. doi: https://doi.org/10.1016/j.jafr.2022.100407
25. Arunachalam K, Sreeja PS, Yang X. Mechanisms and therapeutic actions of edible fruits in inflammatory bowel disease: a review of pre-clinical studies. Adv Chem Ser. 2023 Dec 1;3:100498. doi: https://doi.org/10.1016/j.focha.2023.100498
26. Gargantiel M, Faller EM. A perspective review on diabetes mellitus and the potential antidiabetic activity of medicinal plants. Int J Sci Technol Educ Res. 2021 Jun;10(6).
27. Malode LL, Manwar JV, Panchale WA, Bartere SA, Bakal RL. Potential of medicinal plants in management of diabetes: an updates. GSC Adv Res Rev. 2021 Jul 30;8(1):149–59. doi: https://doi.org/10.30574/gscarr.2021.8.1.0151
28. Huang DD, Shi G, Jiang Y, Yao C, Zhu C. A review on the potential of Resveratrol in prevention and therapy of diabetes and diabetic complications. Biomed Pharmacother. 2020 May 1;125:109767. doi: https://doi.org/10.1016/j.biopha.2019.109767
29. Nellaiappan K, Preeti K, Khatri DK, Singh SB. Diabetic complications: an update on pathobiology and therapeutic strategies. Curr Diabetes Rev. 2022 Jan 1;18(1):31–44. doi: https://doi.org/10.2174/1573399817666210309104203
30. Wu Y, Tan F, Zhang T, Xie B, Ran L, Zhao X. The anti-obesity effect of lotus leaves on high-fat-diet-induced obesity by modulating lipid metabolism in C57BL/6J mice. Appl Biol Chem. 2020 Dec;63:1–1. doi: https://doi.org/10.1186/s13765-020-00541-x
31. El-Shehawi AM, Alkafafy M, El-Shazly S, Sayed S, Farouk S, Alotaibi S, *et al. Moringa oleifera* leaves ethanolic extract ameliorates high fat diet-induced obesity in rats. J King Saud Univ Sci. 2021 Sep 1;33(6):101552. doi: https://doi.org/10.1016/j.jksus.2021.101552
32. Momoh BJ, Okere SO, Anyanwu GO. The anti-obesity effect of Allium cepa L. leaves on high fat diet induced obesity in male Wistar rats. Clin Complement Med Pharmacol. 2022 Sep 1;2(3):100035. doi: https://doi.org/10.1016/j.ccmp.2022.100035
33. Sabiu S, Aruwa CE, Mohanlall V, Baijnath H. *Momordica balsamina* L.: an appraisal on morphology, ecological diversity, phytochemistry, pharmacological and biotechnological applications. Curr Tradit Med. 2021 Aug 1;7(4):482–92. doi: https://doi.org/10.2174/2215083806999200909115721
34. Choudhary BR, Berwal MK, Ram H, Choudhary MK, Singh D. *Momordica balsamina* L.: An unexploited vegetable crop rich in medicinal and nutritional properties. J Agric Ecol. 2022 Oct 20;14:84–92. doi: https://doi.org/10.58628/JAE-2214-212
35. Jaichand V, Mellem JJ, Mohanlall V. The proximate composition and phytochemical screening of *Momordica Balsamina* (balsam apple) fruit and leaves. J Food Sci Technol. 2024 Apr 11;44. doi: https://doi.org/10.5327/fst.00177%20
36. Kadiri OJ, Okafor SI, Ogaji JI. Safety and health benefits profile studies of leaf extracts of *Momordica balsamina* Linn (Cucurbitaceae) found in North Central Nigeria. GSC Biol Pharm Sci. 2020 May 30;11(2):278–86. doi: https://doi.org/10.30574/gscbps.2020.11.2.0039
37. Abdulhamid A, Jega SA, Sani I, Bagudo AI, Abubakar R. Phytochemical and antibacterial activity of *Mormodica balsamina* leaves crude extract and fractions. Drug Discov. 2023;17(39):e11dd1012. doi: https://doi.org/10.54905/disssi.v17i39.e11dd1012
38. Singh V, Kaur R, Devashree Y, Kaur D, Gupta S. *In vitro* antimicrobial activity of cucumis L. and *Momordica* L. against human pathogens. Dokl Biol Sci. 2022 Jun;504(1):85–93. doi: https://doi.org/10.1134/S0012496622030048
39. Ma J, Krynitsky AJ, Grundel E, Rader JI. Quantitative determination of cucurbitane-type triterpenes and triterpene glycosides in dietary supplements containing bitter melon (*Momordica charantia*) by HPLC-MS/MS. J AOAC Int. 2012;95(6):1597–608.
40. Bouknana S, Rherabi AE, Abdnim R, Berraaouan A, Bnouham M. Medicinal plants and bioactive compounds with potential anti-inflammatory and antidiabetic activities: a Rrview. Lett Drug Des Discov. 2024 Sep 1;21(11):1985–2007. doi: https://doi.org/10.2174/1570180820666230509115220
41. Bhardwaj N, Gauttam V, Kalia AN. Evaluation of antidiabetic activity of *Momordica balsamina* Linn seeds in experimentally-induced diabetes. J Chem Pharm Res. 2010;2(5):701–7.
42. Nasim N, Sandeep IS, Mohanty S. Plant-derived natural products for drug discovery: current approaches and prospects. Nucleus. 2022 Dec;65(3):399–411. doi: https://doi.org/10.1007/s13237-022-00405-3
43. Sani AA, Idris SB, Yakubu SA. Anti-diabetic activity of methanolic extract of *Momordica balsamina* in rabbits. Sci Res J. 2019;7:1–6. doi: http://dx.doi.org/10.31364/SCIRJ/v7.i6.2019.P0619657
44. Balasubashini MS, Rukkumani R, Viswanathan P, Menon VP. Ferulic acid alleviates lipid peroxidation in diabetic rats. Phytother Res. 2004;18(4):310–4. doi: https://doi.org/10.1002/ptr.1440
45. Kasali FM, Kadima JN, Peter EL, Mtewa AG, Ajayi CO, Tusiimire J, *et al.* Antidiabetic medicinal plants used in Democratic Republic of Congo: a critical review of ethnopharmacology and bioactivity data. Front Pharmacol. 2021 Oct 27;12:757090. doi: https://doi.org/10.3389/fphar.2021.757090
46. Yadav A. Traditional utilization and pharmacological properties of medicinal plants: a review. Scripown Publications; 2021. 28.
47. Benoit-Vical F, Grellier P, Abdoulaye A, Moussa I, Ousmane A, Berry A, *et al. In vitro* and *in vivo* antiplasmodial activity of *Momordica balsamina* alone or in a traditional mixture. Chemotherapy. 2006 Oct 20;52(6):288–92. doi: https://doi.org/10.1159/000095960
48. Ramalhete C, Lopes D, Mulhovo S, Molnár J, Rosário VE, Ferreira MJ. New antimalarials with a triterpenic scaffold from *Momordica balsamina*. Bioorgan Med Chem. 2010 Jul 15;18(14):5254–60. doi: https://doi.org/10.1016/j.bmc.2010.05.054
49. Saive M, Frederich M, Fauconnier ML. Plants used in traditional medicine in the Comoros archipelago: a review. Biotechnol Agron Soc et Environ. 2020;24(2). doi: https://doi.org/10.25518/1780-4507.18553
50. Byamukama R, Asiimwe S, Lutaaya A, Namukobe J. An ethnobotanical study of medicinal plants used in the management of dermatological disorders in Buyende and Kayunga Districts, Uganda. European J Med Plants. 2021 Mar 16;32(2):15–40. doi: https://doi.org/10.9734/ejmp/2021/v32i230367
51. Bhat SG. Medicinal plants and its pharmacological values. Nat Med Plants. 2021 Oct 20;12:217–28.
52. Aware CB, Patil DN, Suryawanshi SS, Mali PR, Rane MR, Gurav RG, *et al.* Natural bioactive products as promising therapeutics: a review of natural product-based drug development. S Afr J Bot. 2022 Dec 1;151:512–28. doi: https://doi.org/10.1016/j.sajb.2022.05.028
53. Henkhaus N, Bartlett M, Gang D, Grumet R, Jordon-Thaden I, Lorence A, *et al.* Plant science decadal vision 2020–2030: reimagining the potential of plants for a healthy and sustainable future. Plant Direct. 2020 Aug;4(8):e00252. doi: https://doi.org/10.1002/pld3.252
54. Amenyogbe E, Ayisi CL, Droepenu EK, Afumwaa G, Boamah RQ, Ayivor N, *et al.* Challenges and opportunities in advancing microbiology research in Africa: a review. Afr J Bacteriol Res. 2023;15:36–49. doi: https://doi.org/10.5897/JBR2023.0359

How to cite this article:
Kgosana MR, Mayimele NN. The use and benefits of *Momordica balsamina* L. (*Nkaka*) amongst Bantu people in southern Africa: From traditional food source to modern medicine. J Appl Pharm Sci. XXXX;XX(XX):XX–XX.