

INDIGENOUS KNOWLEDGE AND PERCEPTIONS OF *CISSUS QUADRANGULARIS* AMONG THE ELDERLY IN KWAZULU-NATAL, SOUTH AFRICA

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ABSTRACT

The possible medicinal and culinary uses of indigenous edible plants have generated a renewed interest in ethnobotanical research. *Cissus quadrangularis*, a plant with significant potential, is becoming more popular because of its ability to improve the nutritional value of food items, yet little information is available about the plant's identification, usage, or perception by its primary consumers. Through key informant interviews with elderly Indian community members, who are the majority of *C. quadrangularis* consumers in South Africa, this exploratory qualitative study aims to determine knowledge, use, and perceptions of the plant to facilitate the development of food products. The data collected from an Indian community in KwaZulu-Natal through key informant interviews was processed using thematic analysis. The sub-themes addressed in this study include plant identification, medicinal applications, health advantages, nutritional advantages, food sources, cooking techniques, recipes, food application recommendations, preparation methods, and adverse consequences. The findings of the study indicate the plant was widely used as a side dish by the participants, who also reported using it for its nutritional benefits and therapeutic reasons, particularly for maintaining bone health. Chutneys, pastes, and fritters were among the most consumed food items prepared from the plant. These findings may be helpful in the development of suitable food products that make use of the advantageous qualities of *C. quadrangularis*, which has the potential to improve the quality of the diet.

Keywords: *C. quadrangularis*, traditional knowledge, bone health, food product development, functional foods, medicinal plants

INTRODUCTION

Among the main causes of food insecurity in Africa is drought, which results in poor harvests for farmers (Ngcamu and Chari, 2020). Drought-tolerant plants are environmentally sustainable and show great promise in improving food insecurity and preventing malnutrition (Mabhaudhi, Chibarabada, Chimonyo, Murugani, Pereira, Sobratee, Govender, Slotow and Modi, 2019). South Africa has a wide range of drought-tolerant indigenous plants that possess both medicinal and nutritional value. With the revival of Indigenous Knowledge Systems (IKS) and botanical decolonisation, the potential of indigenous edible plants as functional foods has come to the fore. One such unfamiliar indigenous plant is *C. quadrangularis*. Despite *C. quadrangularis*'s long history of use in traditional medicine and culinary preparations among South Africa's elderly Indian community members, little information is available about the plant's identification, usage, or perception by these primary consumers. The absence of documentation limits its wider incorporation into functional food production and obstructs initiatives to advance sustainable dietary practices. Comprehending these knowledge systems and perspectives is essential for guiding the development of culturally acceptable and nutritionally beneficial food products.

Taxonomically, *C. quadrangularis*, a member of the Vitaceae family, belongs to the grape family. Morphologically, the stems have a greenish tinge, are dichotomously branched, sub-angular, globular and smooth, with internode measures that are 4-5 cm long and 1-2 cm thick. Leaves are simple or lobed, and flowers are small and greenish white, which produce globose fleshy berries (Sen and Dash, 2012). It is claimed that the plant is native to Malaysia, Indonesia, Sri Lanka, Java, India, and West Africa and is utilised in indigenous medicine in Africa and Asia due to the abundant availability of beneficial components in its stems, roots, and leaves (Pal, Singh, Naicker and Palmer, 2024). The plant boasts a range of benefits due to its medicinal and nutritional value.

C. quadrangularis has been used in ayurvedic medicine for many years to treat diseases such as arthritis, osteoporosis and in bone healing (Malathi, 2014). *C. quadrangularis* is said to promote bone healing, prevent bone degradation, and aid in bone growth (Staughton, 2018a). Among some people in South Africa, especially the older Indian generation, it is quite popular and often referred to as "Hadjod" (translated as "Bone-Setter"), and is used in a wide range of food applications and in traditional medicine. In addition, *C. quadrangularis* is also said to possess anti-inflammatory properties, lower cholesterol levels, aid in weight loss, lessen menstrual discomfort, heal wounds, lessen the severity of respiratory disorders or prevent them, boost immune systems, as well as aid in the treatment of skin diseases, colic, epilepsy, anorexia, swelling chronic ulcers and flatulence (Malathi, 2014). Whilst the medicinal value of *C. quadrangularis* is noted, the nutritional value has also been documented by researchers. Indigenous food crops are crucial contributors to the diet by providing essential micronutrients and health benefits (Mbhenyane, 2017). *C. quadrangularis* has a high amount of vitamin C, vitamin A and calcium, as well as potassium, iron and zinc (Brahmkshatriya, Shah, Ananthkumar and Brahmkshatriya, 2015). A study reporting on Indigenous Knowledge (IK) of local communities in KwaZulu-Natal, South Africa, reported that *C. quadrangularis* was used to treat gastrointestinal parasites in goats (Ndlela, Mkwazazi and Chimonyo, 2022).

A recent study conducted in South Africa revealed that the development of "energy bites" utilising *C. quadrangularis* powder was well-received by young adults as a low-fat and low-salt snack (Pal et al., 2024). Another study conducted in India where *C.*

quadrangularis powder was added to a standard bread recipe. The bread was tested for nutritional analysis and sensory acceptability. The findings of this study showed that the protein content of the bread containing *C. quadrangularis* stem powder was higher (13.89%) than that of the control recipe (Nawghare, 2017). The results also revealed that adding 8% of *C. quadrangularis* stem powder to the baked product reduced the total carbohydrates by 7.79% (Nawghare, 2017). Another study used *C. quadrangularis* stem powder to make roti, an Indian flat bread. The study blended the dough with *C. quadrangularis* and rice flour in a 1:3 ratio, yielding 6.44g of protein, 74.36g of crude fibre, 0.73g of fat, and 63.73g of carbohydrates per 100g. The researcher in this study stated that out of all the ratios tested, the ratio of 1:3 of *C. quadrangularis* and rice flour had the best consumer acceptability (Malathi, 2014).

Indian immigrants brought *C. quadrangularis* to South Africa in the late 1800s and early 1900s. They also carried with them traditional medicine practices, such as using this plant for bone health and overall well-being. As time went on, its use became common in Indian society, especially among the elderly generations who continue to practice this traditional knowledge. Although it has been used by Indigenous and other South African populations, its acceptance outside of this community has been limited. Local context might be greatly enhanced by expanding the scope of this investigation to include various cultural groups in South Africa (Wyk and Gericke, 2000). Also, the important role of indigenous food plants has been overshadowed by the globalisation of food systems. If revived, indigenous food plants such as *C. quadrangularis* can play an important role towards a healthy food system and long-term sustainable food security in South Africa as it has been well documented that formative research plays an important role in designing an intervention (Corey, 2011).

This investigation was directed by two major research questions: What knowledge and practices related to *C. quadrangularis* are held by the elders of the Indian community? How do individuals perceive the health benefits, culinary uses, and potential concerns regarding the consumption of *C. quadrangularis*?

In this study, IK means plant knowledge that has been passed down through generations among older people of Indian descent who live in South Africa. Many of these people are naturalised citizens or descendants of Indian immigrants. This use of the word is different from Indigenous peoples since it refers to the native African people who live in South Africa (United Nations, 2004; Republic of South Africa, 1996).

The findings of this study can provide product developers with valuable information that can guide potential applications in the development of functional foods and nutritional products. This study also seeks to understand the cultural significance and perceptions of *C. quadrangularis* among elderly community members, particularly in relation to its use in traditional medicine and food preparation

MATERIALS AND METHODS

Study design

This study used a qualitative phenomenological design within an interpretivist framework. As qualitative research, it aided the researchers in understanding the participants' views, behaviours and perceptions. Also, phenomenology enabled the researchers to look into the lived experiences, significance and knowledge systems held by the older Indian community members on the usage of *C. quadrangularis*. This

design helped better understand how people from different cultures and times perceive the plant's medicinal and nutritional significance (Moustakas, 1994; Creswell and Poth, 2018). It allowed the researchers to look at the participants' experiences and traditional knowledge from an emic (insider) perspective, which is very useful when working with IKS retained by the community (Denzin and Lincoln, 2018).

Development of the interview guide and its pilot testing

The interview guide was based on the examination of the relevant literature and covered key aspects such as the identification of *C. quadrangularis* with emphasis on medicinal and health benefits, as well as the uses of the plant in culinary applications. The interview guide was pilot-tested with two individuals from the target population before data collection to make sure it was valid. Feedback from pilot interviews led to minor adjustments in wording and sequencing. To make sure the data was reliable, the same methods were used to gather it.

Sampling and recruitment of participants

The key informant interviews were conducted in KwaZulu-Natal (KZN), South Africa, in the eThekweni municipality. Eligibility criteria for key informant interviews were that participants had to be Indian, over the age of 50, and had used or had knowledge of *C. quadrangularis*. The study was conducted to determine the traditional use of *C. quadrangularis* as well as their views on the plant's medicinal properties, culinary applications, and consumer safety. The knowledge, personal experiences and culinary perceptions were used to determine the guidelines used to create food items with *C. quadrangularis*. The eligible participants were thus chosen purposively, and ten key informants were selected.

The recruitment of key informant participants was done via a session aired on a local community radio station with a frequency reach throughout KZN. The radio station used was chosen because many elderly individuals did not have access to other digital means of interaction. The session was interactive, where the researchers spoke on air about the research study, and the listeners called through. The researchers explained the study, its aim and data collection processes, and the listeners who were eligible and interested provided their contact details to the radio station. The researchers also provided the prospective participants with a cell number to call if they were willing to partake in the study. The researchers then contacted those who consented to participate in the study, and appointments were scheduled to conduct the interviews at their convenience.

Data collection

To maintain uniformity and allow for simultaneous notetaking, data was captured by two trained interviewers—the principal researcher and a research assistant. Each interviewer received formal training in qualitative research methods, including question formulation, data analysis and ethical considerations. Each interview was audio-recorded, and non-verbal clues were captured by a skilled note-taker. By the ninth interview, the study had reached saturation. One more interview was conducted to confirm redundancy (Saunders, Sims, Kingstone Baker, Waterfield, Bartlam, Burroughs and Jinks, 2018; Hennink, Kaiser and Marconi, 2017).

All interviews were conducted in English at the participants' residences. Participants were asked questions by the researchers, and their responses were recorded using a

digital recorder, and notes were taken by the research team. Each interview took about 45 minutes. Prior to each interview, guidelines were explained to each participant to allow for free communication. The participants were assured that even though they were being recorded, their identities would remain anonymous throughout the study.

Ethical considerations

Informed consent was sought from the participants prior to their participation in the study. The participants were also verbally informed about the details of the study and assured of anonymity and confidentiality throughout the research process. They were also informed that they would participate in the study voluntarily and were free to refuse to answer any questions. This study was granted approval by the Institutional Research Ethics Committee (IREC), bearing an IREC Number 076/19.

Data analysis

The collected data consisted of the translated, verbatim transcripts of the interviews. A thematic analysis was used to analyse the data using Braun and Clark's (2006) six-phase framework. This process involved researchers familiarising themselves with data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report. They transcribed the recordings of the interviews manually, and from these transcriptions, common themes were identified, refined and finalised. The participants were coded as P1-P10.

RESULTS AND DISCUSSION

Participants' biographical information

The interviews were conducted with ten elderly Indians, eight of whom were women (P1-P8) and two, men (P9-P10). The men were aged between 70 and 79, four women between 60 and 69 (P1-P4), three women between 70 and 79 (P5-P7), and one woman 80 and above (P8).

Thematic analysis

Interviews with key informants revealed several important topics related to the individuals' knowledge of and use of *C. quadrangularis*. These included the plant's identification, therapeutic use, nutritional benefits, and culinary preparation methods. Table 1 provides an overview of the main themes and subthemes that emerged from the thematic analysis of the interview. Responses from participants about their knowledge, experience, and opinion of *C. quadrangularis* formed the basis of the evaluation. The main themes identified in the study were IK, use, food preparation and toxicity of *C. quadrangularis*. The sub-themes identified included plant identification, medicinal value, health benefits, nutritional benefits, food source, cooking methods, recipes, food application suggestions, preparation methods and side effects (Table 1).

These themes have a link to the study's aim, which was to investigate the knowledge and behaviours of elderly people regarding *C. quadrangularis*, as well as their perceptions of its health advantages, culinary applications, and concerns over its consumption. The analysis underlines how IK helps people understand and continue to use the plant for nutrition and good health. The goal of evaluating the plant's perceived health and medical value aligns with the concept of "Use." "Food Preparation" is also related to how the plant can be used in everyday meals and to make new products. "Toxicity" provides insight into perceived safety and concerns about consumption, which aids in determining barriers to wider acceptability. These

elements together give a whole picture of the plant's social, nutritional, and functional importance, which is the basis for its possible use in future food systems.

Thematic interpretation was guided by concepts of ethnobotanical research and food systems analysis, both of which emphasise the importance of IK in directing sustainable nutrition and health solutions.

Table 1: Thematic analysis of key informant interviews

Pre-defined domains	Themes	Sub-themes	Summary	Representative quotes
What is <i>C. quadrangularis</i> ?	IK	Plant identification	The participants explained that <i>C. quadrangularis</i> is a cactus-type plant that creeps.	<p>“Hadjod is a creeper plant” (P7)</p> <p>“Hadjod is part of the cactus family” (P2)</p>
Do you know of any medicinal properties of <i>C. quadrangularis</i> ?		Medicinal value		<p>“Hadjod is a medicinal plant”. “I have heard that Hadjod aids with ulcers” (P8)</p> <p>“Hadjod can be used for stomach sores and broken/fractured bones” (P5)</p> <p>“Hadjod has great medicinal and healing properties” (P6)</p>
What do you use <i>C. quadrangularis</i> for?	Uses	Treatment for ailments	Most participants explained that they had used <i>C. quadrangularis</i> for sprains, other inflammations, rib fractures, shoulder injuries, rashes and body pain.	“I used Hadjod for a sprain in my ankle and pain I had from a shoulder injury, I applied a paste I made on the injured area for 3-4 days. I also used Hadjod for rashes” (P8)
Do you know of any health benefits of <i>C. quadrangularis</i> ?		Health benefits	One participant believed that ever since they have been consuming <i>C. quadrangularis</i> they do not have to take cholesterol medication.	“I started drinking Hadjod in the morning and evening and did not have to take any cholesterol tablets” (P7)

Pre-defined domains	Themes	Sub-themes	Summary	Representative quotes
		Nutritional benefits	Another participant explains that consuming <i>C. quadrangularis</i> makes your bones stronger and that the plant has a similar effect as taking a calcium tablet.	"Cooking and eating the Hadjod will help with making your bones stronger especially when you get older, like a calcium tablet" (P2)
		Food source	Many participants used <i>C. quadrangularis</i> in food applications to receive its health benefits.	"I fry Hadjod with onion, green chilli" (P2) "I cook Hadjod as a curry" (P4)
Have you cooked <i>C. quadrangularis</i> before?	Food preparation	Cooking methods	Ninety percent of the participants had cooked <i>C. quadrangularis</i> .	"Yes, I have cooked it with onion and Hurdee (turmeric powder)" (P3) "Yes, I have added it to my bhajia mixture" (Indian savoury deep-fried snack/ chilli bite)" (P7)
What are some methods (fry, simmer, add to curries) you have use to cook it?		Recipes	Most participants made pastes, chutneys and added blended or small pieces of <i>C. quadrangularis</i> to chilli bite mixture, then fried the mixture.	"I cooked it in a chutney". "I added it to my bhajia mix" (P1) "I made a paste with Hurdee (turmeric powder) and Hadjod" (P10)
Are there any recipes using <i>C. quadrangularis</i> you are willing to share?		Food application suggestions	Many participants said they have not tried it any other way than they have already mentioned, however, a few participants	"You can bake it into a scone" (P9)

Pre-defined domains	Themes	Sub-themes	Summary	Representative quotes
			suggested ways to use the plant in food development. The suggestions are as follows: roast, juice and add to baked items such as bread/scone/sweet doughs.	
How do you prepare the <i>C. quadrangularis</i> ?		Preparation methods	Some of the participants explained that you must wash the plant first as it gets very sticky if washed after it is cut. The participants explained that when preparing <i>C. quadrangularis</i> you must remove the thorns and a thin layer of the outer skin. Once this process is done you may chop the plant into small pieces or blend into a paste.	<p>"I wash the hadjod before cutting the plant otherwise it becomes too sticky to peel and cut" (P3)</p> <p>"I remove the thorns from the hadjod and peel out a thin layer of, once I finish cleaning the hadjod I cut it into pieces" (P7)</p>
Were there any side effects when you ate <i>C. quadrangularis</i> ?	Toxicity	Side-effects	All participants said that they did not experience any side effects after eating the plant.	"No side-effects" (P1-P10)

Indigenous Knowledge

Participants in this study provided extensive information about *C. quadrangularis*. The first main theme identified was knowledge, with sub-themes as plant identification and medicinal value. They described *C. quadrangularis* as a Cactus type creeper plant. They identified hadjod as part of the cactus family and creeper plant. *C. quadrangularis* is a member of the *Vitaceae* family and known by other names, including veldt grape; yet the two participants who took part in this study gave the impression that it is a creeping cactus (Siddiqua and Mittapally, 2017). The striking physical similarity between *C. quadrangularis* and *Hylocereus undatus*, a dragon fruit plant that is also abundant in KZN, suggests that it may be best classified as a member of the *Cactaceae* family (Joubert, 2012). Five participants (P2, P5, P6, P7, P8) recalled medicinal knowledge of *C. quadrangularis* through shared information and own use. "I have heard that Hadjod aids with ulcers" (P8). "Hadjod can be used for stomach sores and broken/fractured bones" (P5).

These responses highlight the deep well of traditional IK surrounding this plant. The preservation and formal documentation of such knowledge is crucial for increasing the plant's visibility and potential value in modern food systems, an opportunity similarly recognised in the promotion of other indigenous plants, such as *Moringa* and *Baobab*, in sustainable food systems (Mbhenyane, 2017).

Uses and health benefits

The second main theme identified was the use of *C. quadrangularis* with sub-themes as treatment for ailments, health benefits, nutritional benefits and food source. Five participants (P2, P5-P8) explained that they had used *C. quadrangularis* for medicinal purposes; sprains, inflammations, rib fractures, shoulder injuries, rashes and body pain. "I used Hadjod for a sprain in my ankle and pain I had from a shoulder injury. I applied a paste I made onto the injured area for 3-4 days. I also used Hadjod for rashes" (P8). The traditional medicinal usage of *C. quadrangularis* has been extensively documented (Justin and Baby, 2011; Malathi, 2014; Goli, Vaddi, Pal and Srikanth, 2019). Similarly, this study verifies that *C. quadrangularis* is used for medicinal purposes by participants for a variety of conditions, including rashes, ulcers, arthritis, fractures, overall body pain, and inflammation. A study conducted by Joseph, George and Mohan (2013) highlights the potential of *C. quadrangularis* in the treatment and prevention of many bone disorders, including low bone density. According to research by Banu, Varela, Bahadur, Soomro, Kazi and Fernandes (2012), *C. quadrangularis* may help with bone loss after menopause. One participant believed that ever since they have been consuming *C. quadrangularis*, they do not have to take cholesterol medication.

It is interesting to note that opinions among participants varied. While some stressed medical applications, particularly for bone health and inflammation, some participants noted the plant's use as a preventive health food, beyond its medicinal application: "I started drinking Hadjod in the morning and evening and did not have to take any cholesterol tablets" (P7). These diverse perspectives highlight *C. quadrangularis*' potential dual role as a therapeutic and functional food. There is some evidence that *C. quadrangularis* can help with chronic ulcers, reduce cholesterol levels, and inflammation (Staughton, 2018b). According to Sundaran, Vasanthi, Kamalpathy Bupesh and Sahoo (2020), *C. quadrangularis* also effectively reduces the occurrence of chronic ulcers. It is interesting to observe that some participants highlighted the plant's frequent use in meals as a preventive health precaution, while others focused on its medical benefits, especially for bone health.

These different viewpoints highlight the possibility of *C. quadrangularis* as a functional food ingredient and medicinal plant. Researchers in Cameroon looked at the effects of taking *C. quadrangularis* capsules daily on fasting blood glucose, total cholesterol, and body mass index levels. They found that the supplement reduced glucose levels by 14.6%, cholesterol by 18%, and BMI by 5.4% in the study's participants, who did not alter their diet or exercise routines (Oben, Enyegue, Fomekong, Soukontoua and Agbor, 2007). Furthermore, one participant explained that consuming *C. quadrangularis* makes one's bones stronger and that the plant has a similar effect as taking a calcium tablet. No distinct patterns in perceptions of *C. quadrangularis* use were observed across gender or age groups. However, future research could explore demographic variations in knowledge and use of the plant "Cooking and eating the

Hadjod will help with making your bones stronger, especially when you get older, like a calcium tablet” (P2).

Food preparation

The third theme identified was food preparation and sub-themes as cooking method, recipes, food application suggestions and preparation methods. In this study, participants confidently used *C. quadrangularis* as a food source in their diet. Almost half of the participants (P1, P3, P7, P9 and P10) had cooked with *C. quadrangularis* before. “Yes, I have cooked it with onion and Hurdee (turmeric powder)” (P10), “Yes, I have added it to my bhajia mixture” (Indian savoury deep-fried snack/ chili bite) (P1). Three (P1, P2, P7) participants made pastes, chutney’s and added blended or small pieces of *C. quadrangularis* to chilli bite mixture, then, fried the mixture. “I cooked it in a chutney” (P1). “I added it to my bhajia mix” (P7), “I made a paste with Hurdee (turmeric powder) and Hadjod” (P10). Participants (P1- P8) said they have not tried it any other way than they have already mentioned; however, P9 suggested ways to use the plant in food development. The suggestions are as follows: roast, juice and add to baked items such as bread/scone/sweet doughs. “You can bake it into a scone” (P9). While nine participants (P1- P8, P10) had not experimented beyond these methods, P9 suggested additional applications, including roasting, juicing, and incorporating the plant into baked goods such as scones and bread. These suggestions demonstrate the plant’s versatility and potential for functional food development.

The different cooking methods provided by participants indicate a long-standing history of including *C. quadrangularis* in household meals. These traditional methods to prepare food not only help people keep their cultural identity, but they also give modern food product developers an excellent foundation to start when they want to come up with novel concepts. The versatility demonstrated by these methods, such as producing pastes, chutneys, and putting the plant into batters, suggests that they could be used in scalable functional food formulations. Although there may be challenges to overcome to maintain the plant's therapeutic qualities and sensory characteristics in commercial products, these approaches could provide the groundwork for future food product development. The culinary use of indigenous plants to enhance both nutrition and cultural identity is well documented (Mbhenyane, 2017). Likewise, the traditional preparation of *C. quadrangularis* offers a valuable starting point for modern food product developers. Prior research has shown the successful incorporation of the plant in food products in other countries (Malathi, 2014; Nawghare, 2017). *C. quadrangularis* is notably rich in nutrients, including zinc, calcium, iron, potassium, vitamin C, carotene, and ascorbic acid (Brahmkshatriya et al., 2015; Oben et al., 2007). However, challenges in making preparation methods consistent, keeping beneficial ingredients intact after processing, and ensuring that many consumers will accept the product may limit its quick success in the market. When developing mass-produced foods from traditional recipes, it is important to keep these factors in consideration.

Some of the participants explained that the plant must be washed first, as it gets very sticky if washed after it is chopped. The participants explained that when preparing *C. quadrangularis* you must remove the thorns and a thin layer of the outer skin. Once this process is completed, the plant can be cut into small pieces or blended into a paste. “I wash the Hadjod before cutting the plant, otherwise it becomes too sticky to peel and cut” (P3). “I remove the thorns from the Hadjod and peel out a thin layer of it.

Once I finish cleaning the Hadjod, I cut it into pieces” (P7). Participants indicated confidence in the preparation of *C. quadrangularis*. There was a strong emphasis on washing the plant before cutting it, since the plant would get too sticky otherwise. According to the participants, the plant was treated in a way that minimises secretions from chopped mucilage cells during preparation. Such practices likely reduce mucilage release and improve texture, as supported by anatomical studies showing the presence of mucilage cells and calcium oxalate crystals in *C. quadrangularis* (Sundaran et al., 2020). The participants prepared fritters, paste, and chutney using *C. quadrangularis*.

Toxicity

The fourth theme identified was toxicity, and the sub-theme was side effects. All participants said that they did not experience any side effects after eating the plant. “No side effects” is a consensus statement said by all (P1-P10). “I have eaten this for years and experienced no side effects” (P7). Consistent with previous research on the plant's safety, participants did not report any adverse effects (Malathi, 2014). However, additional research is necessary to validate the plant's safety and guarantee its extensive use in food ingredients. In a study conducted by Karadbhajne, Kumbhare and Bombaywala (2014), *C. quadrangularis* was processed in dry form and baked into cookies and biscuits, the baked products were tested for sensory acceptability, the findings of this study indicated that when a ratio of 10% of *C. quadrangularis* powder was added to the biscuit, a slight throat irritation was recorded as compared to when a 15% ratio of the powder was added, where the irritation was prominent. However, other sensory attributes, such as texture, colour and taste, were pleasant and constant throughout the study. Interestingly, in the study by Goli et al. (2019), *C. quadrangularis* was soaked in tamarind to reduce the itching sensation in the oral cavity and the throat. Key informant interviews revealed valuable information about the medical applications of *C. quadrangularis* as well as traditional methods for cleaning and preparing the plant.

CONCLUSION AND RECOMMENDATIONS

Overall, the findings from this study suggest that *C. quadrangularis* holds significant promise as both a functional food and a medicinal plant. IK and practical uses described by participants underscore the plant's potential for integration into modern food product development, particularly for promoting bone health and contributing to food and nutrition security in South Africa. *C. quadrangularis* has the potential to help South Africans meet essential nutrient needs and address health issues linked to both undernutrition and overnutrition. In particular, it shows promise in managing conditions such as arthritis, osteoporosis, and general bone health. *C. quadrangularis* is commercially available in powder and supplement form globally, as well as in South Africa, through bioprospecting.

IK shared by local Indian community members regarding the preparation, uses, and properties of *C. quadrangularis* offers a valuable resource for innovative food product development. Preserving and transferring this traditional knowledge is vital to ensure that the health benefits of *C. quadrangularis* can be passed on to younger generations. Furthermore, the emic perspective of IK obtained from the key informant interviews brings new insight into undocumented information on *C. quadrangularis* use in South Africa. This highlights the importance of integrating IKS into both academic research and practical applications in public health and nutrition.

The following recommendations were made regarding the study:

- Promotion of planting and processing: There should be an increased focus on planting and processing (such as drying/ Capsule form) of *C. quadrangularis* in South Africa to enhance its availability and usability.
- Revival of indigenous foods: Develop recipe books and infographics to support the revival of and wider use of indigenous foods. These resources can help raise awareness about the plant's uses and encourage its incorporation into everyday diets.
- Food product development and sensory acceptability: More efforts should be directed toward the development of *C. quadrangularis*-based food products, with an emphasis on sensory acceptability. This will ensure that the plant can be integrated into mainstream food products, enhancing its potential as a nutritional source.
- Health outcome study: Health outcome studies to evaluate the effects of timed consumption of *C. quadrangularis* on specific health markers and conditions should be conducted to provide empirical evidence supporting its medicinal uses and pave the way for incorporating it into healthcare practices.

In conclusion, *C. quadrangularis* offers opportunities for contributing to both health promotion and cultural preservation, reinforcing the importance of further research and innovation in this area.

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