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Erroneous Classification of *Brassica juncea* L. in South African Studies: Consequences for Agricultural Extension Services

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ABSTRACT

Agricultural extension services play a crucial role by providing expert guidance on enhancing production and processing and facilitating the dissemination of knowledge and scientific findings into practical use. For this reason, researchers must generate accurate information for agricultural extension officers to relay to the ultimate beneficiaries - the farmers. In this paper, we highlight an instance of misidentification by researchers about one of South Africa's extensively researched vegetables, Brassica juncea L. Due to its broad adaptability, this crop has been the focus of numerous South African studies aimed at maximising its production for resource-poor farmers. Regrettably, the accumulated research on B. juncea reveals a prevalent issue of inconsistent naming and classification, leading to confusion with Chinese cabbage (Brassica rapa subs. chinensis). Such inaccurate species identification fosters a disjointed body of knowledge, potentially generating conflicting results and thereby restricting the applicability of the research findings to farmers and other stakeholders. This literature review examines 20 years of South African research to guide future studies and extension efforts on B. juncea. It underscores the necessity for accurate species identification and nomenclature, thereby enhancing the reproducibility and relevance of research outputs.

Keywords: Knowledge Transfer, Science Communication, Misnaming, Chinese Cabbage, Chinese Mustard, Indigenised Vegetables, Medicinal Value

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1. INTRODUCTION

The crucial role of agricultural advisory services in supporting farmers in navigating the multifaceted challenges associated with agricultural production is undeniable. Such extension services are indispensable, providing more than mere advice on production and processing enhancements. They are conduits for information flow and knowledge transfer, translating scientific findings into practical applications. Agricultural extension and research are intimately interconnected; advisors primarily transfer knowledge produced by researchers through applied and adaptive research. Consequently, the technologies and information disseminated to farmers by these advisors are largely products of researcher recommendations. This strong tripartite link among researchers, agricultural extension officers and farmers necessitates creating and disseminating precise information. Any inaccuracies by researchers or advisors can lead to farmers receiving incorrect or irrelevant information. The situation is especially problematic if the researchers are at fault, as the advisors and farmers rely on the research results.

Misinformation, defined as unintentionally disseminated false or inaccurate information, can often stem from misnaming or providing incorrect labels. Contrarily, disinformation refers to deliberately providing misleading information. Such misinformation in scientific communication can harmfully affect researchers, advisors, farmers, and the general public's comprehension of science. When prevalent over a prolonged period, misinformation can become normalised, leading to inappropriate recommendations and confusion among agricultural stakeholders. This underscores the importance of standardising the names of widely cultivated food crops in South Africa.

2. THE CASE OF *BRASSICA JUNCEA* L.

Brassica juncea L. is highly regarded among South African researchers as a key leafy vegetable in enhancing food security and combating poverty in the country's resource-poor communities. In Europe, its seeds are cherished for mustard preparation, while in Asian countries, the plant is primarily valued for its medicinal properties found in its roots, leaves and seeds. *B. juncea* thrives in marginal soils and is adapted to virtually all South African production environments, including dryland production. Research interest in B. juncea surged in South Africa in the early 2000s. The common viewpoint was that this vegetable had been underused and overlooked in mainstream research, possibly due to its limited commercial value in the country. The

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Agricultural Research Council - Vegetables and Ornamental Plants (ARC-VOP) established a dedicated indigenous vegetable research unit in 2001, primarily focusing on *B. juncea,* among other species. The Water Research Commission (WRC) has also funded multiple *B. juncea* research projects since 1998 (Van Vuuren, 2013). Despite these efforts, their impact appears limited, as suggested by the minimal adoption and commercialisation of *B. juncea* and other similarly categorised vegetables.

As Charles Kettering's renowned saying suggests, "a problem well stated is half solved." In scientific research, a misused or misplaced word can dramatically alter the interpretation of a research problem, confusing and potentially misleading findings. The crux of the issue is that most research conducted in South Africa since 2000 has incorrectly referred to *B. juncea* L. as Chinese cabbage (*Brassica rapa* subs. *chinensis*). The repeated publication of these misused terms has led the South African scientific community to normalise the error unwittingly. This could contribute to limiting the applicability of research findings and making them seemingly fruitless.

The need to consistently use correct terminology in scientific publications cannot be overstated. Such precision enables a common understanding when interpreting research findings. Blum (2016) notes that consensus definitions can make or break research and that inconsistent definitions undermine efforts to replicate specific research and its results. Nonetheless, ensuring accurate terminology in a scientific article is challenging and demands a meticulous approach to writing, rigorous reviews and consultation with subject matter experts.

In this article, we have reviewed the naming of *B. juncea* in South Africa to address the ongoing confusion associated with its nomenclature. We have also assessed articles published from South Africa to understand the scope of the misnaming issue and to discern why *B. juncea* research has had a limited impact on the country. Our intention is not to disparage researchers or call for retractions but to offer solutions, raise awareness among the scientific community to curb ongoing misnaming, and provide guidance for future research on this vital vegetable.

3. CLASSIFICATION OF *BRASSICA JUNCEA* L.

The *B. juncea* L. species is diverse, encompassing over 150 varieties with distinct characteristics. A compilation of information on common mustard green varieties and their respective names can be found in Table 1. B. juncea var. rugosa is the preferred variety in South

Africa, especially in the Limpopo Province. A visual representation of *B. juncea* var. rugosa is displayed in Plate 1. The Tshivenda people of Limpopo refer to it as "mutshaina", translating to "Chinese." This name likely originated from another common name for *B. juncea* - Chinese mustard, which may have been the initial cause of confusion, leading South African research scientists to erroneously label *B. juncea* as Chinese cabbage (*B. rapa* var. *chinensis*). The latter is not a favoured vegetable among indigenous people due to its poor adaptability to marginal soils and drought conditions, likening it to Western staples such as lettuce, cabbage and broccoli. It also demonstrates significant vulnerability to various vegetable pests in South Africa. An image of Chinese cabbage is provided in Plate 2. Asia is widely considered the origin of *B. juncea* (Dixon, 2007), which likely explains its commonplace label of Chinese mustard in many English-speaking countries. Just across the border in Zimbabwe from Limpopo, *B. juncea* is known as "tsunga", translating to "bitter" in Shona, a reference to the vegetable's bitter taste that intensifies in older leaves or under conditions of drought or heavy nitrogen fertilisation (Maereka, Madakadze, Mashingaidze, Kageler & Nyakanda, 2007). The exact timeframe of this vegetable's introduction to African nations remains uncertain.

The term "indigenous", as initially defined by Vavilov (1926), refers to a crop whose genetic diversity is unique to a specific region. As suggested by Modi (2003) and Schippers (2006), indigenous vegetables are those whose diversity centres are located within South Africa. Conversely, indigenised crops are those whose centres of diversity are outside of South Africa but have been domesticated within the country over centuries, becoming integral to the local food culture (Phillips-Howard, 1999). It is crucial to note that, unlike indigenised vegetables, indigenous vegetables typically grow spontaneously in natural ecosystems and do not require human intervention to flourish and maintain their populations over time in their native habitats. They are usually harvested from the wild. This does not apply to *B. juncea*; therefore, it should more appropriately be classified as an indigenised crop of South Africa, in accordance with the definition provided by Phillips-Howard (1999). Mislabelling *B. juncea* as an indigenous crop of South Africa may give the false impression that this species is abundantly available for wild harvesting.

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TABLE 1: **Some Known Varieties and Common Names of Mustard Greens**

Scientific Name	Common names
B. juncea var. *capitata*	Capitata mustard, mustard cabbage
B. juncea var. *crassicaulis*	Bamboo shoot mustard
B. juncea var. *crispifolla*	Cut-leaf mustard, curled mustard
B. juncea var. *foliosa*	Small leaf mustard
B. juncea var. *gemmifera*	Gemmiferous mustard
B. juncea var. *involuta*	Involute mustard
B. juncea var. *latipa*	Wide petiole mustard
B. juncea var. *leucanthus*	White-flowered mustard
B. juncea var. *longepetiolata*	Long petiole mustard
B. juncea var. *megarrhiza*	Tuberous-rooted mustard
B. juncea var. *multiceps*	Tillered mustard
B. juncea var. *utilis*	Peduncled mustard
B. juncea var. *strumata*	Strumous mustard
B. juncea var. *tumida*	Swollen stem mustard
B. juncea var. *rugosa*	Large-leaf mustard, Indian mustard, broadleaf mustard
B. juncea var. *multisecta*	Flower-like leaf mustard

PLATE 1: Chinese Mustard (*Brassica Juncea* L Var. Rugosa). (Source: Cabi Digital Library, 2017)

PLATE 2: Image of Chinese Cabbage (*Brassica Rapa* Subs. *Chinensis*) Confused with *Brassica Juncea* L. Var. *Rugosa*.

4. THE HISTORICAL MISNAMING OF *BRASSICA JUNCEA* L. VAR. RUGOSA

The inaugural documentation of *B. juncea* research in South Africa was conducted by Charleston & Kfir (2000), affiliated with the ARC Plant Protection Research Institute in Pretoria. They explored the potential of *B. juncea* as a trap crop for the diamondback moth, *Plutella xylostella*, within South Africa. As the first publication from South African researchers in the Crop Protection journal, the article accurately named the vegetable. An excerpt from this article reads, "Five different plants were tested … Chinese cabbage, *Brassica pekinensis* (Lour.); and Indian mustard, *Brassica juncea* (L.) Czern" (variety not specified). Notably, this research did not focus on the traditional utilisation of vegetables.

Following Charleston & Kfir's initial report (2000), approximately 43 additional publications concerning *B. juncea* research in South Africa have been identified via Google Scholar, dating from 2000 to June 2020. These include 29 peer-reviewed journal articles, one popular article, three theses (2 PhD and 1 MSc), five WRC Reports, one book chapter, and four conference proceedings. The WRC has published the most articles on this subject (11 in total), comprising five peer-reviewed journal articles (all published in the journal Water SA), five research reports, and one popular article in the Water Wheel magazine. The four peer-reviewed articles published by Water SA in 2007 were a product of a special issue focusing on indigenous crops, water, and human nutrition, following an "International Symposium on the Nutritional Value and Water Use of Indigenous Crops for Improved Livelihoods" held in September 2006 in

Pretoria. The theses were associated with the University of KwaZulu-Natal, Wageningen University, and the University of South Africa. Notably, over half of the work on *B. juncea* was conducted by the Centre of Organic and Smallholder Agriculture in the Department of Crop Science at Tshwane University of Technology (Pretoria) and ARC-VOP. Most of the research leading to these publications was financed by the WRC and ARC-VOP. Based on the current number of research articles, approximately R20 million has been spent on *B. juncea* research, averaging one million rand per annum.

Among the 43 publications, *B. juncea* was accurately named as broadleaf mustard only by Maboko (2013), who assessed the "Effect of plant density and harvesting frequency on yield components of hydroponically grown mustard spinach (*Brassica juncea*)." An excerpt demonstrating correct usage reads, "*Brassica juncea* (mustard spinach) is a leafy vegetable grown in Southern Africa under the name leaf mustard (*B. juncea* ssp. 'Rugosa') …". Another publication featuring a commendable attempt was by Van der Walt, Van der Linde, Alberts, Modjajdi, Jivan & Bezuidenhout (2006). However, the species name was misspelt, and the specific variety was not identified, as highlighted in this excerpt: "The South African National Biodiversity Institute identified the following plant species used as traditional morogo by rural … *Brassica juncae* (L.) Czern. & Coss…"

Maboko & Du Plooy (2019) accurately mentioned the two crops in a recent research article. In the opening statement of the abstract, they correctly asserted, "Bolting of mustard spinach [*Brassica juncea* L. (Czern)] and non-heading Chinese cabbage [*B. rapa* L. subsp. chinensis (Halnelt)] is a constraint to realising optimal yield." Yet, confusion arose when the authors incorrectly cited Van Averbeke, Tshikalange & Juma (2007) in support of their statement that *B. juncea* and *B. rapa* are commonly used leafy vegetables in South Africa. The cited article, titled "The Commodity System of *Brassica rapa* L. subsp. chinensis and *Solanum retroflexum* Dun. in Vhembe, Limpopo Province, South Africa," actually concentrated on *B. juncea* but misnamed it as Chinese cabbage. Consequently, the authors mistakenly believed they were comparing two different crops when examining the same one. Misnaming in previous articles has led to ambiguity and perpetuated the misconception that Chinese cabbage is a truly indigenous African vegetable.

Excluding the two accurate citations and the one commendable attempt, *B. juncea* was mislabelled as Chinese cabbage in 40 out of 43 South African publications. An influential

publication by Jansen van Rensburg, Van Averbeke, Slabbert, Faber, Van Jaarsveld, Van Heerden, Wenhold & Oelofse (2007) titled “African Leafy Vegetables in South Africa” provides a comprehensive overview of green leafy vegetable usage and status in South Africa, both indigenous and indigenised. As of January 2024, this article had garnered 310 citations on Google Scholar. One excerpt misleadingly reads, "Chinese cabbage (*Brassica rapa* L. subsp. chinensis) is known as Chinese cabbage, rape or Chinese mustard cabbage in English, “Sjinese kool” in Afrikaans and “Mutshaina” in Tshivenda and other local African languages." This misnomer is a clear example of the early confusion surrounding this crop’s name because Chinese cabbage is neither an indigenous nor an indigenised crop of South Africa. The authors were referring to *B. juncea*. The propagation of this naming error has continued to the present day due to repeated citations of this preliminary work. A chronological presentation of these publications is provided in Table 2.

TABLE 2: Misnaming of Chinese Mustard as Chinese Cabbage in South African Research

Year of publication	**Examples of wrong usage excerpt**
Van Averbeke & Khosa (2004)	Two indigenous vegetables, namely dabadaba, also called mutshaina or Chinese cabbage (*Brassica rapa* ssp. *chinensis*), and muxe (*Solanum retroflexum* Dun. were the most important…
Van Averbeke & Mohamed (2006)	White cabbages (*Brassica oleracea*) produced the highest gross income per unit area followed by Swiss chard (*Beta vulgaris* var. cicla), muxe (*Solanum retroflexum* Dun.) and Chinese cabbage (*Brassica rapa* L. ssp. *chinensis*).
Laker (2007)	…Van Averbeke *et al*. discuss the commodity systems of 2 green leafy vegetables in South Africa, viz. *Brassica rapa* L. subsp. chinensis and *Solanum retroflexum*…
Jansen Van Rensburg et al. (2007)	Chinese cabbage (*Brassica rapa* L. subsp. *chinensis*) is known as Chinese cabbage, rape or Chinese mustard cabbage in English, Sjinese kool in Afrikaans and mutshaina in Tshivenda and other local African languages.
Van Averbeke, Tshikalange & Juma (2007)	In this study, the smallholder commodity systems of *Brassica rapa* L. subsp. *chinensis* and *Solanum retroflexum* Dun. are described and analysed. In South Africa, these two vegetables are exclusively produced and consumed by African people.

Van Averbeke, Juma & Tshikalange (2007)	In this study, the growth and yield response of *Solanum retroflexum* Dun. (nightshade) and *Brassica rapa* L. subsp. chinensis (non-heading Chinese cabbage) to … three nutrients were determined by means of pot experiments in a greenhouse. *Brassica rapa* L. subsp. chinensis (non-heading Chinese cabbage) is an indigenised vegetable in the northern parts of South Africa.
Van Averbeke (2008)	Detailed study of the smallholder vegetable commodity chain … focused on two African leafy vegetables, namely, Chinese cabbage (*Brassica rapa* subsp. chinensis) and nightshade (*Solanum retroflexum* Dun.). Two traditional leafy vegetables, namely Chinese cabbage (*Brassica rapa* subsp. chinensis), called mutshaina in Tshivenda and nightshade (*Solanum retroflexum* Dun.), called muxe in Tshivenda, were the most important.
Backeberg & Sanewe (2010)	A detailed study of the smallholder vegetable commodity chain was conducted at the Dzindi irrigation scheme, and focused on two African leafy vegetables, namely, Chinese cabbage (*Brassica rapa* subsp. chinensis) and nightshade
Van Averbeke & Netshithuthuni (2010)	Non-heading Chinese cabbage is an important indigenised leafy vegetable in the Vhembe District of Limpopo Province …
Annandale, Stirzaker, Singels, Van Der Laan & Laker (2011)	It is important to keep in mind that in the case of leafy vegetables deficit irrigation usually leads to significant yield losses, as for example found by Van Averbeke & Netshithuthuni (2010) with Chinese cabbage in a WRC-sponsored study.
Oelofse & Van Averbeke (2012)	Chinese cabbage is known as rape in English, Sjinese kool in Afrikaans and mutshaina in Tshivenda and other local African languages. In South Africa, *B. rapa* subsp. chinensis is the most popular type of Chinese cabbage among Black people, who use it as a relish… In Vhembe District leaf yield of Chinese cabbage was found to be heavily dependent on planting date (Van Averbeke, 2008).
Jansen van Rensburg et al. (2012)	This publication contains many references to Chinese cabbage, which is in fact *B. juncea*. This clear from the title of the WRC Report: "Production Guidelines for African Leafy Vegetables."

Taleni, Nyoni & Goduka (2012)	These are amaranth (Amarathus), spider flower (*Cleome gynandra*), rape or Chinese cabbage (*Brassica rapa* subsp. *chinensis*), nightshade (*Solanum retroflexum* and selected other species …
Van Vuuren (2013)	The project placed particular emphasis on African leafy vegetables, such as …, Chinese cabbage, nightshade, …
Van Jaarsveld et al. (2014)	Thus, the primary aim of this study was to determine the nutrient content of eight cultivated African leafy vegetables. The eight species were non-heading Chinese cabbage (Brassica rapa L. subsp. chinensis), …"
Njume, Goduka & George (2014)	*Brassica rapa*… is a non-heading type of Chinese cabbage… It is known as isiqwashumbe in IsiXhosa and mutshaina in Tshivenda. It is a common plant in plant in Vhembe District, north of the Limpopo Province…
Manyelo, Van Averbeke & Hebinck (2014)	Non-heading Chinese cabbage and night shade are traditional leafy vegetables, which are grown during winter…
Motsa, Slabbert, Van Averbeke & Morey (2015)	Using laboratory incubation, the response of seed germination and emergence to variability in temperature and light was examined for …, non-heading Chinese cabbage (*Brassica rapa* L. subsp. chinensis) …" Seeds of the non-heading Chinese cabbage (*B. rapa* subsp. chinensis) (land race dabadaba, van Averbeke et al., 2007) and black nightshade (*S. retroflexum*) were obtained from Mr. Mabulannga, a smallholder farmer at Dzindi Irrigation Scheme (Itsani village) in Limpopo Province of South Africa.
Slabbert, Motsa & Van Averbeke (2015)	The eight African leafy vegetables that were …, non-heading Chinese cabbage (*Brassica rapa* L. subsp. chinensis), and nightshade (*Solanum retroflexum* Dun.).
Mampholo, Sivakumar & Thompson ((2016)	… reported that Chinese cabbage (*Brassica rapa* L. subsp. chinensis), … are amongst the most important and the most widely consumed traditional leafy vegetables in Southern Africa.
Mayekiso, Taruvinga &	The major indigenous leafy vegetables grown from the study area included the following vegetables … and Chinese cabbage…

Mushunje (2017)	
Maseko et al. (2017)	*Brassica rapa* L. subsp. chinensis, referred to as non-heading Chinese cabbage… locally referred to as mutshaina, is an indigenised leafy vegetable in South Africa
Mabhaudhi, Chimonyo, Chibarabada & Modi (2017)	Consistent with the results of the resource identification, the majority of crops on both … and the South Africa list were indigenous leafy vegetables (bottle gourd, blackjack, jews mallow, amaranth, nightshade, wild water, melon and Chinese cabbage).
Managa, Remize, Garcia & Sivakumar (2019)	Chinese cabbage is an indigenous African leafy vegetable and it is grown in smallholder cropping systems or in-home gardens. Since the indigenous African leafy vegetable is …
Maboko & Du Plooy (2019)	Bolting of mustard spinach [*Brassica juncea* L. (Czern)] and non-heading Chinese cabbage [*B. rapa* L. subsp. chinensis (Halnelt)] is a constraint to realising optimal yield. Non-heading Chinese cabbage is commonly grown in rural areas…
Maseko et al. (2020)	Similarly, … reported that Brassica species such as Chinese cabbage are sensitive to water stress.
Managa, Sultanbawa & Sivakumar (2020)	Chinese cabbage (*Brassica rapa* L. subsp. chinensis) and Nightshade (*Solanum retroflexum* are popular traditional leafy vegetables consumed predominantly by rural Africans.

5. THE IMPACT OF *B. JUNCEA* RESEARCH IN SOUTH AFRICA AND DIRECTIONS FOR FUTURE WORK

As previously indicated, research on *B. juncea* in South Africa over the past two decades, primarily financed by the WRC and ARC-VOP, concentrated on the assessment of nutritional characteristics, water use efficiency, marketing potential, post-harvest handling, and agronomic strategies for production in under-resourced communities. Despite these efforts, the research seems to have made modest progress in adopting and utilising *B. juncea* within South Africa. A survey conducted by Shackleton, Paumgarten, Mthembu, Ernst, Pasquini & Pichop

(2010) among smallholder farmers in South Africa reveals that market demand for indigenous vegetables is insufficient to support viable business models based on their sales.

Studies indicate that traditional vegetables are typically more readily accepted by rural populations than urban ones, with the eldest, poorest and those furthest from formal vegetable markets being the most inclined to accept them (Gido, Ayuya, Owuor & Bokelmann, 2017). This trend suggests that as South Africa experiences rapid urbanisation and a growing middle class, the demand for these vegetables may decline. Moreover, compared to other countries with limited resources, South Africa possesses well-established marketing channels for commercially produced staple vegetables like cabbage (*Brassica capitata*) and Swiss chard (*Beta vulgaris*). These vegetables, often in surplus, are widely available and affordable to the majority.

It is worth noting that *B. juncea* and many other traditional vegetables usually possess a somewhat bitter or astringent flavour due to their high phytonutrient content. While responsible for the vegetable's medicinal properties, modern consumers generally deem these bioactive compounds undesirable in staple foods. Consequently, breeders strive to eliminate these compounds from fruits and vegetables (Drewnowski & Gomez-Carneros, 2000). Considering these sensory factors, it is unlikely that *B. juncea* will be accepted by modern consumers as a substitute for cabbage or Swiss chard. However, Maereka *et al*. (2007) investigated strategies to reduce the bitterness of *B. juncea* and concluded that harvesting the mustard at sunset, after exposure to sunlight, could help alleviate its bitterness and reduce the intake of free nitrates.

The medicinal properties of *B. juncea* leaves have been largely overlooked in South African research, mainly championed *B. juncea* as a food security crop or an alternative to staples like Swiss chard for the resource-poor. There could be a significant opportunity for increasing acceptance by promoting antioxidant-rich *B. juncea* leaves as a medicinal vegetable in South Africa. Kumar, Thakur, Barothia & Chatterjee (2011) posited that little progress has been made in developing pharmaceutical-grade drugs from *B. juncea* in African countries. In contrast, in Asia and Europe, there is a significant research effort exploring the pharmacological properties of *B. juncea.*

The primary phytochemical components of *B. juncea* leaves are known, and their concentrations fluctuate across different genotypes (Sharma & Rai, 2018; Nawaz, Shad &

Muzaffar, 2018). These chemicals could potentially exhibit anti-viral, anti-diabetic, anti-inflammatory, analgesic, antipyretic, cardiac tonic, and anti-asthmatic properties, among other health benefits (Sharma & Rai, 2018). Notably, Bae *et al*. (2019) demonstrated that an ethanol extract of *B. juncea* could be an anti-viral drug against a strain of influenza H1N1 virus. More recently, Dave et al. (2020) suggested that *B. juncea* might have potential applications in treating COVID-19. Future local research should focus on screening genotypes for phytochemical concentration, developing agronomic strategies to increase their content, and conducting clinical trials to evaluate the efficacy and safety of various *B. juncea* leaf products and formulations. Lastly, innovative research is necessary to design consumer products that combine other ingredients to increase consumer acceptance of *B. juncea* medicinal products.

6. CONCLUDING REMARKS

As stated at the outset of this research article, a problem accurately identified is half resolved. This paper aimed to draw attention to agricultural advisors and researchers on the consequences of misnaming important agricultural plants in South Africa. In addition, it also aimed to rectify misperceptions regarding the naming of Chinese mustard and Chinese cabbage, two distinct species, rather than merely pointing out shortcomings in existing research. This is crucial in creating a precise and trustworthy knowledge base that agricultural advisors can utilise to educate and empower farmers. Drawing upon South African research, this review also clarified the path for future research related to *B. juncea*. Such clarity is essential for ensuring the reproducibility and applicability of future research findings and agricultural extension services. Although the cultivation of *B. juncea* is largely overshadowed by other leafy vegetables such as Swiss chard and cabbage, it is crucial to sustain research efforts into the medicinal value of *B. juncea*, an area that has been inadequately explored.

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