



Review article

The potential repositioning of South African underutilised plants for food and nutrition security: A scoping review

P.S. Shembe^a, N.Z. Ngobese^{b,*}, M. Siwela^a, U. Kolanisi^c

^a School of Agricultural, Earth & Environmental Sciences, University of KwaZulu-Natal, Scottsville, Pietermaritzburg, 3201, South Africa

^b School of Geo and Spatial Sciences, Faculty of Natural and Agricultural Sciences, North-West University, Potchefstroom, South Africa

^c Department of Consumer Sciences, University of Zululand, P/Bag X1001, KwaDlangezwa, South Africa

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STRUCTURED ABSTRACT

Background: In South Africa (SA), there is a reported shift from the consumption of grains, pulses, fruits and vegetables by most households to the consumption of easily accessible, high-energy, ultra-processed foods. Despite their high nutritional value and affordability, indigenous, local, traditional wild and domesticated plant foods abundant in SA are still neglected and less consumed than conventional and exotic foods.

Objectives: The purpose of this study is to undertake a scoping/mapping review to evaluate the potential role of underutilised local, indigenous and traditional plant species in addressing (through improving food and nutrition security) the adverse effects of the nutrition transition, which involves increased use of ultra-processed foods, on the health and nutritional status of current households in SA as well as preventing the same adverse affecting future generations.

Design: Online databases were used to identify literature published between 2000 and 2022.

A total of 88 articles, books, book chapters and literature materials were selected using the Google Scholar search engine, where literature from Sub-Saharan Africa and global that used food and nutrition security, as well as underutilised and indigenous plant species.

Results and conclusion: Evaluation of the gathered literature revealed that the “food security” concept had been measured based on the available quantity of food. In contrast, the quality of food is severely neglected. The literature indicated a strong link between the “food environment” concept, ultra-processed foods and nutrition transition. The shift, especially by the youth, from consuming underutilised plant foods to ultra-processed foods has left older people to be the only consumers of underutilised plant foods. Monotonous preparation, the unavailability of nutritive local traditional and indigenous plant foods at supermarkets and the unappealing packaging methods of such foods were some contributors to the limited or no consumption—these challenges need to be addressed.

1. Introduction

The Food and Agriculture Organization (FAO) [1] has reported that in the year 2020, between 720 and 811 million people in the world (meaning one in three people) have experienced hunger. Further, more than one-third (282 million) of undernourished people are in Africa [1]. The FAO has also approximated that 149.2 million children (22%) below 5 years of age had stunted growth, 45.4

* Corresponding author. ,

E-mail addresses: Nomali.Ngobese@nwu.ac.za, nomalingobese@gmail.com (N.Z. Ngobese).

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million (6.7%) suffered from wasting and 38.9 million (5%) were overweight globally in the year 2020. The children from Asia and Africa were reportedly affected the most. Also concerning are the significant differences in the prevalence of anaemia in women of childbearing age between developed and developing regions. At least 30% of African and Asian women of child-bearing age were anaemic, whereas only 14.6% of women from Northern American and European countries were anaemic [1]. Worldwide, there is also a generally high prevalence of adult obesity. These data and information demonstrate the prevalence of hidden hunger and malnutrition, especially in African and Asian countries. These reports confirm that Sustainable Development Goal (SDG) 2, which is to end world hunger by the year 2030, is far from being achieved without taking appropriate actions to end the causes of food insecurity.

From the 1950s until the early 2000s, food security was measured using the 1st Comprehensive International Data Framework, which only based food insecurity measurement on energy and protein deprivation [2]. This means that the only concern had always been the availability of large quantities of food, neglecting the quality and accessibility of quality foods. Hunger is generally defined by the FAO as an uncomfortable sensation caused by insufficient food and energy intake. It would be insufficient and inaccurate to measure hunger only as energy or calorie intake. Mozaffarian et al. [3] describe this injustice of focusing just on food quantity over quality as “filling people with food but leaving them hungry”. This food security measurement using only energy intake has affected at least two billion people worldwide through hidden hunger [4].

The nutrition transition is a shift from traditional diets to what is referred to as “energy-dense diets”- these are diets consisting mainly of high fat, salt and sugar content [5]. According to a study by Dandala [5], people were more concerned about insufficient food, and the food required in adequate quantities consisted of monotonous starchy staples. As such, those foods led to a nutritionally unbalanced diet. The low-economic status (showing low access to food) of the population groups following monotonous diets seems to be a significant contributing factor in distorting and limiting the food choices of most households.

Hidden hunger occurs when people’s diets are deficient in essential vitamins and micronutrients, with vitamin A, iron, iodine, and zinc being nutrients of significant concern globally [6]. Hidden hunger can result from consuming ultra-processed foods rich in energy and fats and/or following monotonous starchy foods. The inability to consume enough nutritious foods required for a healthy and balanced life leads to nutrition insecurity. Malnutrition in its different forms is currently a concern and is being experienced globally, and as stated above, it is due to the non-optimal diets adopted by most households [7].

The current trends are that consumers prefer fast, more convenient foods that are ready to eat [8]. However, consumer preferences do not single-handedly play a role in what foods are consumed, but also the “food environment”. The food environment is defined by the FAO [9] as all the foods which are available and accessible to people in the settings in which they go about their daily lives, i.e., supermarkets, street food stalls, restaurants, etc. In addition, the physical, economic, political and social-cultural context, which influences consumers’ decisions on acquiring, preparing and consuming food, is also involved [7]. Food environments, therefore, significantly contribute to the hidden hunger of most households since they have to limit their preferences based on what is available around them, which is usually fast, convenient, ultra-processed foods that are not nutritious but relatively affordable. On the other hand, diverse diets containing nutritious foods have become increasingly too expensive for the average consumer.

2. Problem statement

In 2003, the government of SA introduced programmes to assist in fighting micronutrient deficiencies. They included a compulsory food fortification policy for maize meal and flour and a vitamin A supplementation programme for post-partum women and children between 6 months and five years old [10,11]. The South African government also developed a long-term plan in 2012 known as the National Development Plan (NDP), which aimed at providing a better future for all and which will ensure that no individual experiences poverty or goes hungry. Providing adequate nutrition is among the ten elements/goals the NDP aims to achieve by 2030 [12]. Moreover, the Food and Nutrition Policy was developed in 2015, which included many programmes like agricultural programmes (one home, one garden), school feeding schemes, and social grants, to name a few [13].

Despite these interventions by the government, reports by Statistics South Africa indicate that more households in SA are experiencing food insecurity. These interventions have provided dietary diversity for families. However, due to a lack of a food security tool to measure all four pillars holistically, there were still reports of hunger and food insecurity for at least 34.4% of rural households in the KwaZulu Natal province alone in the year 2013 [14]. There were also reports of stunting, wasting and being underweight for boys and girls under 15 [10,11]. Maziya et al. [15] reported that SA is food secure, but only on a national level and not a household level. Household food insecurity increases with a higher number of household members, a decrease in the level of income, households living in rural areas and female-headed households [15].

Fruits and vegetables have always been praised for being high in micro-nutrients and antioxidants. However, their consumption is still reported to be very low [10]. This low consumption of fruits and vegetables is also a significant contributing factor to micro-nutrient deficiencies. Although some reports on the limited consumption of fruits and vegetables are related to their high cost, SA boasts of an abundance of underutilised wild and domesticated (crops) fruits and vegetables, which would be cheaper substitutes for expensive, exotic fruits and vegetables [10]. The underutilised plant species are indigenous and traditional (or naturalised) crops, including grains, vegetables and fruits [11].

Underutilised or neglected plant foods are primarily wild or semi-domesticated species adapted to local environments. These plant species were in the past used as traditional foods but became increasingly neglected when more productive crops were introduced to the farming systems [16]. Some underutilised plants are known for being rich in essential nutrients such as protein, vitamins A and C, iron, calcium and fibre compared to exotic plants. In addition, they grow well in the wild, where there is a limited supply of water and nutrients-they have earned being labelled as “low-input crops”. However, consumption and incorporation (in diets and as crops) of some underutilised plant species that are abundant in SA, like the *Corchorus* and the *Amaranthus* species, is hindered by the perception

that they are “wild species/weeds”, “primitive foods” and “food for the poor”. This perception has led to most underutilised plant foods not being considered for extensive commercial production, which influences their availability in commercial markets, thus, leading to a further decline in their consumption [12].

Currently, SA lacks investment and recognition of underutilised plants through commercialisation by the bigger farming industry to ensure adequate and constant supply all year round. Most underutilised plants currently grow as volunteer plants and are cultivated at a very small scale. This lack of recognition makes underutilised plants ineffective in alleviating micronutrient deficiencies and improving food and nutrition security. As a result, food insecurity persists despite all interventions implemented by SA. The battle should continue to explore other ways of dealing with the challenge. This article, therefore, suggests repositioning underutilised indigenous foods to be part of the SA food system. These underutilised crops must be mainstreamed into the South African food system [17]. Currently, research and innovation on processed indigenous foods are limited in SA. Yet, it would contribute to dietary diversification and potential for home fortification and income generation, contributing considerably to food security.

3. Objectives

This scoping review was therefore conducted to evaluate the current consumption status of underutilised plant species and their potential role in addressing (through improving food and nutrition security) the adverse effects of the nutrition transition, which involves increased use of ultra-processed foods, on the health and nutritional status of current households in SA to prevent the same adverse affecting future generations. Therefore, the following research question was formulated: what is known from the literature regarding the causes of food insecurity and micro-nutrient deficiencies and the consumption/utilisation, perceptions and their potential in addressing the existing food insecurity challenges?

4. Methodology

4.1. Protocol

The protocol for this review was drafted using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis for Scoping Reviews adopted from the Annals of Internal Medicine Journal by Triicho et al. (PRISMA-Sc-R which was revised by researchers (authors of this manuscript) and reviewers from Heliyon: Cell Press. Unfortunately, the protocol has not been registered.

4.2. Eligibility criteria

To be included in the review, literature sources needed to be published between 2000 and 2022 and published in Sub-Saharan

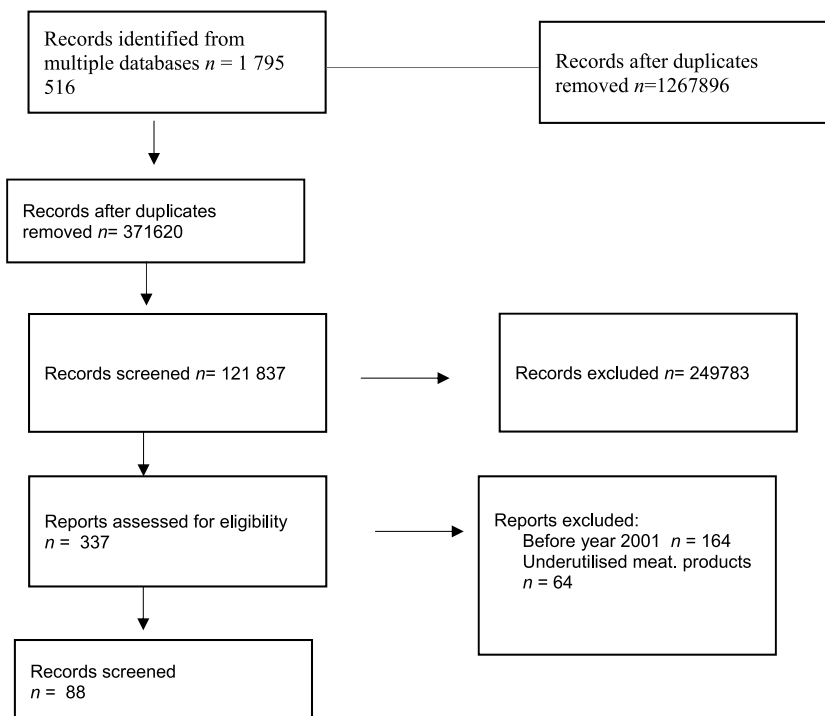


Fig. 1. Selection of sources evidence.

Africa and globally. In addition, literature sources had to be published in English to be considered in this manuscript. Literature sources were excluded if they were published before the year 2000 and if they were discussing other indigenous/underutilised food types like meat. Literature that did not have full text was also excluded from this review.

4.3. Information sources

Relevant literature was identified using the Google Scholar database and literature sources which were searched from 2002 to January 2022.

4.4. Search strategy

The search results were grouped into three categories: reviews/projects/reports, thesis/dissertations and online papers/websites. The key search words used were; food security pillars (availability, accessibility and utilisation), hidden hunger, underconsumption of fruits and vegetables, underutilised foods, indigenous foods, nutrition transition, consumer trends and preferences, food environment, food systems, big food, ultra-processed foods, localised food-based systems, and nutrition-sensitive localised food chains.

4.5. Selection of sources of evidence

A total of 1 775 000 results were populated from Google Scholar. Research Gate populated a total of 196 articles, 5176 results were populated from Science Direct, and 15 144 were obtained from Web of Science (see Fig. 1). Mendeley also provided suggestions via email of relevant documents used in this review based on the keywords and bibliography information used in the Mendeley library. From the populated results, a total of 88 literature sources in the form of journal papers, books and dissertations were used for this review. As a percentage of the total number of the literature sources used, 16% was on ultra-processed foods, ethics of food consumption as well as consumer trends and preferences, 27% on food security and nutrition as well as hidden hunger and micro-nutrient deficiencies and 57% on pulses, grains, fruits and vegetables. No tool was used to screen the literature sources.

5. Synthesis of results

5.1. The concept of food and nutrition security

When the World Food Summit in 1974 introduced the food security concept, the measure of food security was about the availability of sufficient quantities while neglecting other food security parameters whose focus is on an individual's food quality and nutrition status [2]. The measure of food security that considered adequate and balanced nutrition was only properly introduced in 1996 and further refined by the FAO in 2001 [2]. There is a known argument by scholars that food security does not guarantee nutrition security because of the focus on food quantity rather than quality, resulting in less costly and affordable food [13,14]. The main driving factor for food made available by economists and policymakers is the demand for food to alleviate hunger, consequently aggravating hidden hunger since the food quality is neglected. The FAO [13] also states that all hungry people are food-insecure, but not all food-insecure people are hungry since other causes of food insecurity are related to micronutrient deficiencies.

Food and nutrition security is defined by the Committee on world food security [15] as the concept that exists when macro and micro-nutrient requirements are fully met for a good quality of life. Consumption of sustainable diets to address nutrient requirements via the consumption of nutritionally adequate foods produced ethically, non-detrimental to the environment, accessible and affordable to everyone is one way to ensure healthy populations as well as economic, social and environmental sustainability for future generations [18,19].

The evolution of the food security concept states that food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food. However, nutrition transition only embraces the 'availability of sufficient food, at all times' part whilst neglecting the other three parameters: access, utilisation and stability. As a result, the nutrition transition has compromised the 'quality of food' by a great deal. Therefore, to bridge this gap and holistically embrace all four food security concepts, the best term to adopt would be food and nutrition security (FNS).

5.2. Complexities of nutrition security that are linked to food security

In recent decades, most individuals and households have shifted from well-balanced and highly nutritious diets of vegetables, fruits, pulses, grains etc., to consumption of ultra-processed foods that are high in calories and energy but less nutritious [16]. Ultra-processed foods are manufactured using high-end industrialised technologies to alter (mould, pre-fry etc.) ingredients to turn them into highly profitable, convenient, and palatable enough to replace home cooking of unprocessed food products. Examples include; energy and carbonated drinks, pastries, pizzas, burger patties, meal replacement shakes, ice creams, candies etc. [20] This nutrition transition has primarily been influenced by the food environment, which only makes available ultra-processed foods at affordable prices and nutritious foods at expensive rates. Ultra-processed foods, nutrition transition and the food environment are interlinked in contributing to individuals' and households' food and nutrition security (see Fig. 2 below). The food that is easily made available by the food environment is ultra-processed, yet not nutritious, which forces households to transition towards the consumption of that which is made available to them, thus leading to poor food and nutrition security status. Buying power has been

linked to distorted food choices by many households since ultra-processed foods are available at reasonable prices [5]. However, having sufficient money to afford expensive nutritious food does not guarantee that one would stick to a nutritionally balanced diet which can, therefore, still lead to nutritional transition and food insecurity.

5.3. Nutrition transition (NT) and ultra-processed foods (UPFs)

The nutrition transition is described as a change in nutrient consumption influenced by modernisation and urbanisation due to economic development and social and lifestyle changes, which expose society to new food products which are usually ultra-processed and easy to prepare [21]. Similarly, Kearney [17] confirms that nutrition transition creates a scenario where healthy, traditional staple diets consisting of pulses, vegetables, and grains are replaced by high sugar and fat content diets deemed tasty by society. NT has led to many countries shifting to high rates of malnutrition, obesity and non-communicable diseases due to an exponential rise in the consumption of unhealthy foods. There were reports that SA was the most African country that showed an epidemiological nutrition transition on obesity trends amongst its' adult population of different race groups. This included under and over-nutrition due to inconsistency in macro and micro-nutrients [5,22]. This was even higher in black African adult females, children and adolescents, which is highly concerning [5,23]. Micronutrient deficiencies, especially vitamin A, were reportedly more common among the black African population in SA than other ethnic groups [5,23].

Most ultra-processed foods have been directly linked by the World Health Organization (WHO) to obesity and chronic non-communicable diseases [24,25]. Processing food products involves the incorporation of synthetic food additives like colourants, flavourants, meat extenders, emulsifiers etc., to make them more attractive and tastier to consumers [26]. However, synthetic additives like colourants are derived from coal tar, which produces carcinogenic effects after long-term use in the liver and the bladder, according to Roelofzen et al. [27]. Synthetic additives have also been reported to lead to hyperactivity in children [28]. Although popular with the general population, due to their vigorous marketing and convenience, ultra-processed foods still do not provide balanced nutrition for a good quality of life [24–26].

5.4. Big food influences on the SA food environment

As the food security concept evolves, a research-based understanding of emerging critical issues in global and regional food security

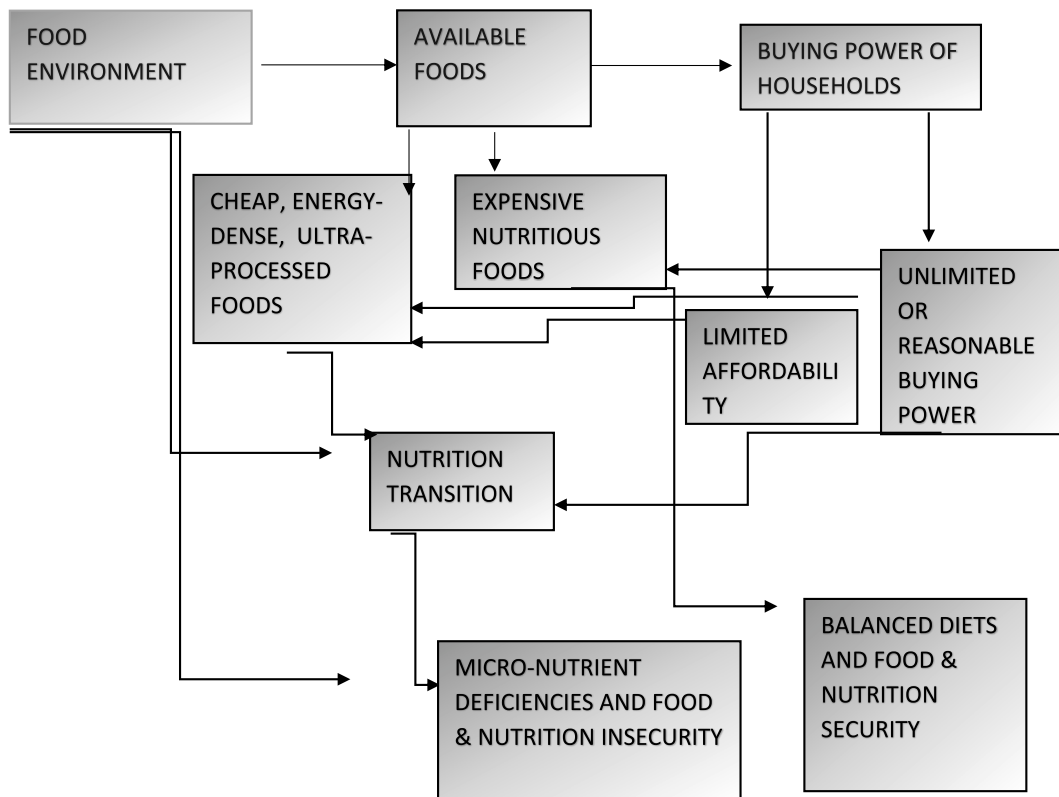


Fig. 2. Relationship between the food environment, ultra-processed foods and nutrition transition.

has impacted local food security and the role of private sector influences. One of the significant challenges South Africa faces is that of large commercial entities that influence the food and beverage industry, also referred to as “big food”. These entities account for at least 51,8% of sales of packaged foods [29] and 79% of soft drinks in South Africa [30]. Such entities include Pioneer foods which is based in South Africa, has an international presence in some African countries and was a partner with Heinz US as well as Coca Cola which is the largest big food influencer in the beverage industry with at least 49,8% sales of soft drinks in 2012. This number increases by 10–12% every year [29]. In a survey conducted in August 2020 by Statista, 89% of the respondents preferred the Coca-Cola-carbonated beverage over others. Although, generally, food service outlets and retailers, including restaurants, food trucks, kiosks etc., somewhat provide influence on consumers’ food choices, larger entities like Nando’s and KFC are major “big food” influencers on consumer food choices [30]. The South African government (South African Revenue Service) has recently introduced the sugar tax whereby non-alcoholic, sugary beverage producers excluding fruit juice, have to pay a 10% per cost per litre of beverage produced. Perhaps this regulation policy may cause companies to reduce the amount of sugar added in carbonated drinks, iced teas etc. or maybe opt to produce healthier beverages that are mostly plant-based.

5.5. *The food systems concept*

Kennedy et al. [31] highlight fundamental strategies that can assist in transforming food systems to curb the existing food insecurity challenges in South Africa. These include the re-invention of agriculture, transformation of food environments for healthy diets, mitigating climate change, engagement of the private sector, and influencing public policy priorities. In essence, this calls for collaboration between various sectors and disciplines to ensure sustainable agricultural practices that promote healthy, disease-free diets (addressing the food quality challenges) that are not harmful to the environment (plants, animals and the planet as a whole). This transformation will not only assist in ending world hunger (SDG 2), but it will also reduce poverty, improve people’s health and well-being and lead to sustainable communities and cities, thus achieving other Sustainable Development Goals. However, this can only be achieved if policymakers have a shared goal and understanding with researchers from different disciplines. Rampa et al. [32] asserts that underutilised plant species can contribute to achieving some of the goals in the SDG 30 agenda through their ability to provide necessary essential nutrients, enhancing economies of households through the provision of less expensive, nutritious food which is mainly sold by local smallholder farmers, some who are women and youth. Underutilised plants can promote sustainable agriculture, which does not harm the environment (since they require minimal fertilisers, pesticides and water usage), and preserve their indigenous knowledge and its transfer to future development technologies.

Climate-smart agriculture would involve the production of plant and animal-sourced foods that satisfy human diets without compromising the environment. Food-based dietary guidelines and consumer education, together with incentivising “big food” companies to produce foods that are considered inclusive of necessary nutrients for a balanced diet. This would include producing less sugary drinks and using more plant-based drinks from under-utilised fruits and vegetables. Most countries are placing more emphasis on adopting non-staple crops that are rich in micro-nutrients by commercial farmers, and under-utilised plants should naturally be the first choice. This job rests on the shoulders of policymakers.

5.6. *Consumer trends and preferences*

In the past, the food chain was a linear process from field/farm to consumer. In contrast, due to the evolution of demographics, consumer preferences and globalisation, a much more complex food chain has formed over the years [8]. This evolution has been brought about by new technologies like food processing, online food applications for ordering food (like Uber eats) etc., that ensure direct access to processed, fast foods that are ready to eat and available at all times. More and more consumers prefer to eat food from their favourite restaurant or kitchen due to convenience compared to preparing food from scratch.

Furthermore, there is a growing trend of consumers preferring to order groceries online and have them delivered to their door at ‘the click of a button’ [8]. O’Kane & Pamphilon [33] add that people prefer going to supermarkets and ordering online. This saves time compared to driving to farmers’ markets where various fruits and vegetables are available, which requires more time and consumer engagement. This means that consumers’ diets are governed by what is available at their restaurants or supermarket. This also means that consumers’ preferences and habits will always evolve as restaurants and other food producers introduce the latest ‘trendy’ foods and advances in food technology.

More individuals consider meat and ultra-processed meat products an essential part of their diets. However, the high consumption of meat and its products is being condemned due to environmental, ethical and social concerns. For example, meat production has been reported to account for two-thirds of greenhouse gas emissions and reduce the freshwater footprint for humans [34] Furthermore, the International Agency for Research on Cancer (IARC) in 2015 reported red meat and processed meat products as possible carcinogens to humans. Gonzalez et al. [35] further reported that since meat and its products are high in soluble fats, they are the primary derivative of cardiovascular disease, colorectal cancers and virus infections, mainly caused by wild meat consumption. Alternatively, plant-based protein sources provide a better substitute that is more environmentally, socially and ethically sustainable than meat and ultra-processed derivatives [20].

There is also a growing trend of consumers wanting to eat ethically and sustainably produced foods and foods that go with their social beliefs like Halaal, animal welfare, meat-free, gluten-free, non-genetically modified (non-GMO), locally produced etc. In a study conducted by Vergeer et al. [36], respondents that were more conscious about their food’s ethical and sustainable production were mostly pescatarian, vegan and vegetarian compared to meat-eating respondents. This trend may assist in shifting from consuming unhealthy, ultra-processed foods to much healthier diets that are nutritionally balanced which will combat hidden hunger and

micronutrient deficiencies. Furthermore, aspiring chefs who prepare food based on the growing social media trends of ‘Insta-worthy’ food, as well as food from television food channels which is more appealing, are developing a culture of bringing families and friends together [8]. This trend can lead to promising consumption of healthier foods if utilised wisely.

5.7. Position and the underconsumption of fruits, vegetables, grains and pulses

There is a perception that grains, pulses, fruits and vegetables are expensive. More often than not, fruits and vegetables have a shorter shelf-life, which makes it challenging to purchase and keep them for a long time. These are reasons people do not buy fruits and vegetables in comparable quantities to processed food. Unlike in the olden days, when various grains, pulses, fruits and vegetables were more popular, plant-based diets as sources of protein are insufficient to provide a balanced diet. However, fruits and vegetables are vital vitamins, minerals, and fibre sources. They are essential for obtaining adequate micro-nutrients to reduce risks of chronic diseases and obesity and to ensure sustainable diets. A high risk of non-communicable diseases and poor health is mostly attributed to reduced or no intake of fruits and vegetables, according to the WHO [37].

Fruits and vegetables have been considered a source of antioxidants, which protect the body cells from free radicals, diseases like heart diseases and certain cancers [10]. Grains and pulses are no exception to the crops that are underutilised for human consumption and medicinal use. In 2021, Grain SA reported very limited cultivation of leguminous crops like chickpeas, groundnuts and pigeon peas. This was due to these crops’ narrow genetic base and the fact that they are only produced from local landraces by smallholder farmers. Leguminous crops help improve soil fertility through atmospheric nitrogen fixation [38]. Leguminous crops are rich in starch, protein, calcium, fats, manganese, fibre and minerals, making them an ideal source of protein-rich cereals, as illustrated in Table 1. However, studies that have been conducted in recent years still showed that consumption of grains, pulses, fruits and vegetables is still very low, despite their obvious health benefits [10,37]. The WHO recommends consuming 400 g of fruits and vegetables, which are also diversified into five different fruits and vegetables per person daily. Underconsumption of grains, pulses, fruits and vegetables causes a regression in the ongoing fight against non-communicable diseases, hidden hunger, malnutrition, and obesity which necessitates calls for interventions to ensure an increase in their intake globally.

A study conducted in SA on the intake of the most commonly available fruits and vegetables discovered that urban township dwellers purchased fruits and vegetables more than rural dwellers. However, the study also discovered that overall fruit and vegetable intake was still very low and below the recommended daily intake. Furthermore, it found that consuming fruits and vegetables was substituted by the common culprit, sugary, fizzy drinks [42]. However, in most African countries, there is an increase in the consumption of African leafy vegetables among participants, but strong food cultural beliefs and taboos are still a hindrance to their effective consumption and utilisation [43,44].

In a study conducted by Thurber et al. [45] on barriers to nutrition for underutilised children, “dislike” of fruits and vegetables was the main barrier to those children’s nutrition. The “dislike” was mainly related to picky eating, described as discomfort in consuming known or unknown foods. Picky eating leads to poor-quality diets due to the deliberate avoidance of fruits and vegetables and a high intake of energy-rich snacks and sweets. Home carers are conflicted in this regard because as much as they would like for children to be healthy, there is also a need to let them exercise their right to choose the types of food to consume.

5.8. Underutilised foods for food and nutrition security

Traditional plant foods are defined as those that have been used for an extended period and can either be indigenous or indigenised. They are referred to as traditional because of the abundant indigenous knowledge system that constitutes them. Indigenised species are those species in which a specific group of people occupying a particular area have learned how to find those species and produce and

Table 1
Different types of underutilised leguminous grains and pulses (per 100 mg boiled, unsalted sample).

Nutrient	Unit	Pigeon peas [39]	Chickpeas [40]	Cowpeas [41]
Energy	kJ/100 g	5.2 (%)	164	116
Protein	g/100 g	24.6 (%)	8.86	7.73
Calcium	mg/100 g	16.3	49	24
Magnesium	mg/100 g	78.9	48	53
Starch	mg/100 g	57.6 (%)	4.8	–
Sodium	mg/100 g	247	7	4
Potassium	mg/100 g	–	291	278
Copper	µg/100 g	1.3	0.35	–
Zinc	mg/100 g	3.0	1.53	1.29
Iron	mg/100 g	2.9	6.1	2.51
Fibre	mg/100 g	1.2 (%)	0.76	6.5
Folate	µg/100 g	–	172	208
Choline	mg/100 g	–	42.8	32.2
Thiamine	mg/100 g	0.03	0.01	–
Riboflavin	mg/100 g	0.03	0.09	–
Carotene	µg/100 g	3	3	–
Vitamin C	mg/100 g	27.9	1.3	0.4

prepare for consumption [27]. This knowledge is transferred through generations. The process where a particular people adopt an external technology, in this case, which is a particular food, into their culture is known as indigenisation. Once this process has fully advanced, the species can be considered indigenised. In contrast to indigenised species, indigenous plants were not consciously introduced into an area but will grow mainly due to their natural dispersal from their origin [28]. On the other hand, exotic plants are recently introduced into the continent or a country [27].

Nutrition-sensitive localised food chains have promoted agriculture that also focuses on yielding impact on the nutritional status of individuals and households, thus resulting in their good health and well-being [29]. The purpose of nutrition-sensitive localised food chains is to meet households' nutritional requirements through the sustainable production of micro-nutrient-rich diversified species while reducing food waste [30]. Studies conducted by Irungu et al. and Gido et al. [31,32] showed the adoption of nutrition-sensitive localised food chains in Kenya, where local-based food systems were adopted to improve food and nutrition security. Adopting local food-based systems was assumed by promoting African leafy vegetables (ALVs) to households. These studies reported an increase in the utilisation of ALVs by households. This increase in usage was also linked to the proper packaging and promotion of ALVs by Kenyan supermarkets.

However, utilisation for most African countries is limited because most underutilised plants grow voluntarily and not through cultivation. As a result, there is limited availability [12]. Post-harvest handling of underutilised plants could impact increasing or decreasing consumption. For instance, poor storage and handling of most underutilised foods reduce their quality and availability, making them less appealing to consumers. Preserving underutilised foods to improve shelf-life and make them available at all times may appeal to rural dwellers but not to the youth and urban dwellers who are usually impressionable to aesthetics [46]. Policymakers must invest in research and development of new varieties available all year round to increase availability and consumption.

There are a variety of underutilised crops that grow well in SA. However, only a few of these species are utilised as vegetables, also known as African leafy vegetables (ALVs). They include *Cucurbita* spp (pumpkin), *Brassica rapa* (Chinese cabbage), *C. Olitonus* (jute mallow), *Vigna Unguiculata* (cowpeas), *Amaranthus Cruentus* (pigweed), *Corchorus species*, *Citrullus Lanatus* (bitter melon) and *Cleome Gynandra* (spider plant) with pigweed and pumpkin leaves being the most commonly used [12]. Underutilised fruits that are available and grow well in SA include, marula (*Sclerocarya caffra*), red milkwood (*Mimusops zeyheri*), mobola plum (*Parinari curatellifolia*), wild medlar (*Vangueria infausta*), num-num (*Carissa macrocarpa*), kei apple (*Dovyalis caffra*), and monkey orange (*Strychnos spinosa*) [11]. The vast distribution and frequent use of pigweed and pumpkin leaves could be linked to these species' ability to grow without being formally cultivated. It also signifies the ability of pigweed and pumpkin species to adapt to most geographical environments despite harsh conditions.

Pumpkin leaves, also known as curcubits (*Curcubita Olarecia*), amaranthus (*Amaranthus Cruentus*) and blackjack (*Bidens Pilosa*), are some of the most common ALVs widely grown in parts of Southern Africa which are mostly in KwaZulu-Natal and Limpopo [11]. The main parts assumed in cucurbits are the leaves, flowers, fruits and seeds [47]. In amaranth and blackjack, leaves are mostly consumed, and in some parts, seeds of the amaranth are also consumed. Amaranth and blackjack are not largely cultivated in SA but grow as volunteer plants after the first Spring rains [11]. Research has demonstrated that amaranth can produce very high yields of ± 40 t. ha⁻¹ [11]. The availability of these ALVs during the first rains when other vegetables are still growing and their ability to grow with little to no inputs makes them an easily accessible, cheaper and nutritious alternative to exotic vegetables. There are at least 70 species and 400

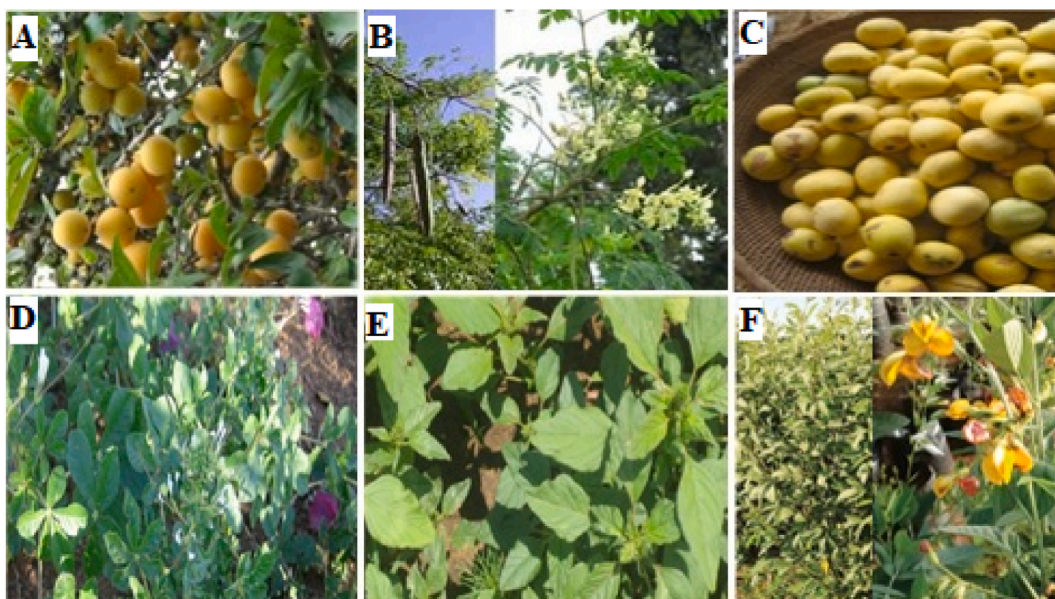


Fig. 3. Different types of underutilised plant species: (A) Kei apple (*Dovyalis caffra*), (B) *Moringa oleifera*, (C) Amarula (*Sclerocarya birrea*), (D) Cleome (*Cleome gynandra*), (E) Amaranth (*Amaranthus dubius*) and (F) Pigeon peas (*Cajanus cajan*) [11].

varieties of amaranthus worldwide, which also contributes to it being one of the most common vegetables [38,39].

Akinola et al. [40] discovered that more underutilised foods are cultivated and utilised in Africa than in SA. This is linked to the perceptions deeply rooted during the Apartheid era, which also forced the relocation of different people from their original ecological environments. This is also evident in the South African database of food composition [41], where only 21 African leafy vegetable species are part of the 1472 foods which are consumed. This proves a huge gap in studies focusing on knowledge of underutilised plants and their benefits. Further studies on improving perceptions of underutilised foods and awareness about their nutritional benefits could play a vital role in influencing youth and the general population to utilise them more and to increase the number of consumed underutilised foods in the South African database of food consumption.

In SA, the challenge scholars have reported regarding the consumption of underutilised plants is the issue of socialisation whereby underutilised foods no longer form part of daily foods consumed [12,48,49]. Also, the youth have shifted away from consuming underutilised foods leaving the elderly to be the main consumers of these crops. Earlier studies have mentioned the issue of monotonous preparation of underutilised foods, the issue of these foods being mainly found in informal markets, not being packaged like exotic fruits and vegetables, as well as the promotion of fertilisers and GMOs by local extension workers as factors that are hindering the progress of the repositioning of underutilised foods for future consumers. Fig. 3 (a to f) illustrates different types of underutilised plants found mostly in Southern Africa [11].

5.9. Technology development efforts using underutilised fruits and vegetables

The WHO describes a fortification as the act of deliberately increasing the content of one or more micronutrients (vitamins and minerals) in a food or condiment to improve its nutritional quality; thus, promoting public health plays a pivotal role in the improvement and development of new food technologies using underutilised fruits and vegetables. Although there is reported general neglect of underutilised plants, some scholars have taken up research initiatives to research new ways of incorporating underutilised plants into modern cuisine and daily diets of consumers to improve food and nutrition security.

A study was conducted recently in KwaZulu-Natal province, in SA, on indigenising instant noodles by incorporating amaranthus leaves to make instant noodles more nutritious [50]. What this study highlighted was that popular as they are, especially to the youth, instant noodles are a high-calorie and sodium food which lacks a great deal of essential nutrients. Table 1 illustrates the undeniably high-quality nutritional value of both micro and macro-nutrients of amaranthus and other African leafy vegetables essential for a balanced diet. Zuniga et al. [51], Huh et al. [52] and Qumbisa et al. [53] state that noodles and other pasta foods made from grains like buckwheat, rice etc., lack vastly proteins, potassium and other essential nutrients, which leads to malnutrition-related diseases. The study by Qumbisa et al. [53] discovered that amaranthus leaf powder could help improve the nutritional quality of instant noodles, thus improving the food and nutrition security of consumers. This is confirmation of earlier studies conducted by Ebru & Hayta [54] and Eyidemiir & Hayta [55] that reported using vegetables instead of wheat flour to produce pasta foods can improve their nutritional quality, thus offering healthier food options for consumers. Table 2 shows different studies that conducted sensory acceptability on different underutilised plants in South Africa. Some studies found that some of the plants' bitter taste and strange green color reduced their acceptability by participants.

Table 3 below illustrates the nutrient quantities of different kinds of African leafy vegetables (ALVs) after boiling and draining 100 g of raw ALVs in a study conducted by van Jaarsveld et al. [60] at Tshwane University of Technology in Pretoria. The ALVs were collected from various places ranging from farmers' fields under irrigation to controlled field trials at the Agricultural Research Council in SA. It is evident from this table that ALVs are an excellent source of nutrients, especially Vitamin A, which is primarily contained in

Table 2
Sensory acceptability studies on underutilised plants.

Title	Author	Area	Findings
1. Potential of using <i>amaranthus</i> leaves to fortify instant noodles in the South African context	Qumbisa Nothando D, Ngobese Nomali and Kolanisi Unathi (2020)	South Africa	Instant noodles can be fortified using <i>amaranthus</i> , but youth might be disinterested due to queer color of <i>amaranthus</i> leaves and the perception that it's backward and meant for the poor [56]
2. Evaluation of the functional quality of cowpea-fortified traditional African sorghum foods using instrumental and descriptive sensory analysis	Joseph O. Anyango, Henriëtte L. de Kock, John R.N. Taylor* (2011)	South Africa	Cowpeas can be added to the production of traditional sorghum foods, but the functional quality of the fortified sorghum food will be influenced by the type of sorghum cultivar used. There was a good response from participants concerning the texture of traditional African cowpea-fortified sorghum foods [57]
3. Preserving TLVs using indigenous knowledge-based (IK) drying technologies to improve household food security	Nyembe Sinenhlanhla (2015)	Limpopo Province, South Africa	The green color was an important quality factor. IK-based technology preserved color better. Sundried more preferred than oven-dried vegetables [58]
4. Acceptability of a moringa-added complementary soft porridge to caregivers in Hammanskraal, Gauteng province and Lebowaqomo, Limpopo province, South Africa	Sithandiwe Ntlaab, Ashwell R. Ndhlab, Unathi Kolanisic, Hafiz Abdelgadairb and Muthulisi Siwela	Gauteng Province, South Africa	Acceptability of the traditional soft porridge decreased with the increased quantity of moringa leaf powder added due to the bitter taste of moringa [59].

amaranth and cowpea leaves and Iron which is mainly high in pumpkin leaves, black nightshade and bitter melon.

The addition of amaranth leaf powder to provitamin-A biofortified snacks in a study conducted by Beswa et al. [63,64] showed that the amino acid content of these snacks increased with the amount of amaranthus leaf powder that was added. However, the popularity and acceptability of these snacks decreased with the increased addition of amaranthus leaf powder [63]. This is proof of the existing discrimination of underutilised plants by most consumers which calls for more research on how the generally negative perception and acceptability can be changed.

Marula fruit (*Sclerocarya birrea*) is commonly known for its use in producing jellies, jams, as well as traditional and commercial juices and wines [65]. A study conducted by Ndlovu [66] on how marula fruits can be used to produce fruit leathers to preserve their nutritional quality using different temperature drying methods proved to be acceptable among subjects at which it was tested due to its appealing appearance even after drying. Furthermore, incorporating Natal plum (*Carissa carpa*) to produce mango fruit leathers in one study in the Gauteng province of SA helped to improve the phytochemical content of this food and increased the intake of these fruit leathers by adolescents and children [67].

In addition, a study was conducted by Ntila et al. [68] on the addition of *Moringa oleifera* Lam. leaf powder into a porridge of 7–12 months old children in two provinces in SA, namely, Gauteng and Limpopo to improve the nutritional quality of porridge. Although the acceptability of the porridge decreased with the increased addition of moringa leaf powder, which was attributed to its bitter taste, mothers and caregivers were still willing to incorporate moringa leaf powder into their children's diets [68].

Table 4 below illustrates the nutritional composition of different underutilised fruits in Sub-Saharan Africa. The nutritional composition is per 100 g of the edible part of the fruit or pods, respectively.

5.10. Recommendations to change the negative mindset towards underutilised plant species

Developing proper packaging, where underutilised plants become available in chopped packets, can help increase youth and urban dwellers' utilisation of underutilised plants. Availability of recipe books developed by the value-adding directorates from South African Universities and providing underutilised foods in a pre-cooked or prepared form in markets would ensure convenience for the urban dwellers and youth with a busy lifestyles and do not want to spend too much time preparing food. Local extension officers from the Department of Agriculture can train smallholder farmers from villages to produce, can and supply underutilised foods to local supermarkets, providing a variety of flavours to choose from Ref. [73]. This would also help increase their appeal and awareness and improve perception by the youth since there are already other canned foods in markets currently. Canning can reduce the stigma that underutilised foods are food for the olden days. However, there may still be issues of trustworthiness in the nutrition, presence of preservatives and changes in aroma and texture of underutilised plants if canned [48,74,59]. Likewise, the preservation of underutilised fruits and vegetables through the re-adoption of underutilised knowledge systems technologies, which are most familiar to smallholder farmers in villages, like drying, can assist in extending the shelf-life of these crops and can also help increase their availability even during seasons of scarcity [75,60].

Furthermore, post the Covid-19 pandemic, more households have realised the importance of consuming fruits and vegetables as part of their daily routines to improve their food and nutrition security status [76,77]. As a result, there is a call to integrate and adopt nutrition-sensitive local food systems promoting the consumption of underutilised fruits and vegetables since these plants proved resilient during the Covid-19 pandemic over exotic crops [76]. Policymakers need to work hand in hand with researchers and have a common goal to achieve effective food systems governance. In addition, there needs to be penalties and incentives by the South African Revenue Service for big food companies that produce unhealthy, salty, oily and sugary foods and those that produce healthy foods in a sustainable manner.

Table 3

Nutritional composition of different African leafy vegetables (ALVs) per 100 g of cooked samples [61,62].

Nutrient	Unit	Amaranth	Bitter melon	Blackjack	Cowpea leaves	Jew's mallow	Pumpkin leaves	Spider Flower
Energy	kJ/100 g	272	296	162	280	319	222	195
Protein	g/100 g	4.2	3.5	0.5	4.7	3.2	2.9	5.0
Calcium	mg/100 g	421	201	189	378	295	168	220
Magnesium	mg/100 g	230	56	87	59	82	64	72
Phosphorus	mg/100 g	73	107	33	45	106	92	125
Sodium	mg/100 g	9	9	8	10	10	11	14
Potassium	mg/100 g	413	234	232	214	366	316	337
Copper	µg/100 g	161	188	152	129	181	196	238
Zinc	mg/100 g	0.66	0.70	0.53	0.40	0.54	0.71	0.99
Iron	mg/100 g	4.9	6.1	6.9	4.5	3.4	8.8	2.0
Manganese	mg/100 g	2.34	0.76	2.08	2.69	0.79	0.54	0.58
Thiamine	mg/100 g	0.03	0.01	0.07	0.06	0.02	0.03	0.05
Riboflavin	mg/100 g	0.05	0.09	0.16	0.08	0.08	0.09	0.20
Folic acid	µg/100 g	49	44	37	68	68	30	79
Vitamin C	mg/100 g	1	6	3	5	5	1	1
Vitamin A	µg/100 g	510	356	401	510	510	309	412

Table 4
Nutritional composition of different underutilised fruits.

Nutrient	Unit	Monkey Orange (<i>Strychnos</i> spp.) [69]	Kei apple (<i>Dovyalis caffra</i>) [70, 71]	Marula (<i>Sclerocarya birrea</i>) [72]	<i>Moringa oleifera</i> [72]
Energy	KJ	1681	257	2703	154.8
Protein	g/100 g	9.0	0.9	28.3	2.10
Carbohydrates	g/100 g	28.7	14.2	3.7	8.53
Magnesium	mg/100 g	81.2	–	462	45
Phosphorus	mg/100 g	60.3	21.7	808	50
Sodium	mg/100 g	23.3	9.6	3.81	42
Potassium	mg/100 g	1342.4	232	601	461
Copper	mg/100 g	0.62	–	2.81	–
Zinc	mg/100 g	0.5	–	5.19	0.45
Iron	mg/100 g	3.3	2.6	4.87	0.36
Manganese	mg/100 g	–	–	–	–
Thiamine	mg/100 g	–	0.1	0.42	0.053
Riboflavin	mg/100 g	–	0.1	0.12	0.074
Niacin	µg/100 g	–	–	0.72	0.68
Vitamin C	mg/100 g	69	347	–	–
Vitamin A	µg/100 g	–	137	–	74

6. Conclusion

The purpose of this scoping review was to evaluate the potential role of underutilised local, indigenous and traditional plant species in addressing (through improving food and nutrition security) the adverse effects of the nutrition transition, which involves increased use of ultra-processed foods, on the health and nutritional status of current households in SA as well as preventing the same adverse affecting future generations. Food security is addressed in four pillars, availability, access, utilisation, and stability. The review shows that while a lot of attention has been given to food security regarding availability and access to high-calorie foods, there has been very little focus on food quality. Food quality is addressed through three food security pillars: access, stability, and utilisation. These pillars are vital in ensuring food and nutrition security and should not be neglected. Nutrition transition has increased globally over the years. Still, it has mostly been influenced by the food environment, which has made ultra-processed foods available as food for everyday consumption and thereby rendering most households food insecure and susceptible to malnutrition-related health conditions. In addition, big food influences consumers' consumption of unhealthy foods and beverages since they determine the type of foods they make available in large quantities to consumers to generate high-profit margins.

There is the evolution of the latest consumer trends whereby consumers prefer ethically produced, nutrient-rich, yet convenient food. This evolution provides an opportunity to integrate underutilised local, indigenous and traditional foods into diets through the provision of pre-packed, canned, underutilised plant foods in supermarkets which can significantly contribute to addressing the issue of transition to unhealthy, ultra-processed foods. Restaurants and fast-food outlets have become popular due to their convenience and provision of tasty foods. They can contribute to countering the unhealthy dietary trend stated above by including underutilised plant foods in their menus. This can be achieved by developing versatile and aesthetic underutilised dishes in salads, relishes, stir-fries, noodles, fresh smoothies, etc. There are still strong beliefs and taboos about underutilised plant foods, like being considered “wild foods or weeds”, “food for the poor”, etc., which supermarkets and restaurants can eliminate through appropriate marketing strategies. There needs to be a lot of investment into commercialising the farming of underutilised grains, pulses, fruits and vegetables to ensure adequate and constant supply all year round. Currently, most underutilised plants grow as volunteer plants, or if cultivated, it is done so at a very small scale. Hidden hunger can be eradicated only if underutilised local, indigenous and traditional plant foods are given the value they deserve.

Author contribution statement

All authors listed have significantly contributed to the development and the writing of this article.

Data availability statement

No data was used for the research described in the article.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

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