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Consumption of Edible Flowers in South Africa: Nutritional Benefits, Stakeholders' Views, Policy and Practice Implications

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Structured Abstract

Purpose: Edible flowers have traditionally been consumed for their nutritional and medicinal properties. *Aponogeton distachyos* is an aquatic flowering plant native to the Western Cape of South Africa (SA) that used to be a wild plant gathered during the winter months, but it is now considered to be underutilised and endangered. Our study aims at gaining insights from different stakeholders into the activities across the plant value chain and their impact on the consumption of *Aponogeton distachyos*.

Design/methodology/approach: The study methodology involved the identification of different stakeholders in the plant value chain and conducting qualitative in-depth interviews during the data collection. Twelve study participants were selected via purposive sampling and interviewed using semi-structured interviews (face-to-face, telephone, and online).

Findings: Nostalgic connection of the flower with local culture and heritage and its unique taste and flavour are key consumption drivers. Promotional and educational efforts by food advocates and at public events help raise consumer awareness, which is generally lacking. Limited geographic and seasonal availability, perishability, price, and quality issues emerged, together with low awareness, as main barriers to more frequent and geographically spread consumption.

Originality: Although wild edible flowers have been consumed for centuries, there has been little attention to their nutritional value and journey to their final consumers. The present study identifies important challenges emanating at different stages of the food value chain to consumption of one particular neglected and underutilised plant, with certain implications for people's dietary quality, environmental sustainability, and biodiversity of natural resources beyond *Aponogeton distachyos* and SA.

Keywords: Edible flowers; Neglected underutilised species (NUS); Consumer behaviour; Value chain approach; In-depth interviews with stakeholders; Nutritional value

1. INTRODUCTION

Aponogeton distachyos is an aquatic flowering plant endemic and native to the Western Cape, South Africa (SA), commonly known as Waterblommetjie (pronounced 'vɑ:tə(r)bləmæci) (SANBI, 2000). It is an edible plant, which falls into the category of indigenous and traditional food crops (ITFC) (Welcome and Van Wyk, 2019; Van Wyk and Gericke, 2000), which is classified as an inflorescence fulfilling the function of a vegetable in SA (Condensed Food Composition Tables for SA, 1996). *Aponogeton distachyos* is recognised by the Ark of Taste, an international catalogue of endangered heritage foods, as (a) a food plant species that is part of a specific geographic area and local, traditional knowledge, (b) has a unique taste, (c) is produced sustainably, (d) is available only in limited quantities, and (e) is at risk of disappearing within a few generations (Slow Food Foundation, n.d). Not only is it an endangered, indigenous edible flower plant, but it is also considered a neglected and underutilised species (NUS) (Modi and Mabhaudhi, 2016).

Aponogeton distachyos was traditionally consumed by the Khoisan hunter-gatherer and forager families, now extinct, and was introduced to the Dutch settlers in the 1700s, who used it in soups and stews as a vegetable. It is a wild-gathered plant that used to be a source of food during the winter months providing carbohydrates, minerals, and vitamins (De Vynck et al., 2016; Welcome and Van Wyk, 2019). Despite its nutritional and functional benefits, and historically high level of consumption by rural households, little is known today about *Aponogeton distachyos*. This is mainly due to the loss of the hunter-gatherer and forager lifestyle after the colonisation of SA, and the aggressive introduction of cereal crops during the green revolution in the 1960s, which brought about profound changes in the SA food system (De Vynck et al., 2016; Pemberton, 2000). Since then, the key focus has become on the production of main staple crops, such as wheat, maize, and rice to provide enough energy to the population at a national level. Consequently, indigenous food crops have been replaced with lower nutrient foods, contributing further to malnutrition and health-related problems (Imathiu, 2021; Akinola et al., 2020; Bvenura and Afolayan, 2014).

Lately there has been a growing scholarly and business interest in indigenous, underutilised, neglected and forgotten foods. It has been advocated that NUS are affordable nutrient-dense foods that can play an important role in food security, contribute to nutritional requirements, and increase dietary diversity (Rampa et al, 2020; Akinola et al., 2020; De Vynck et al., 2016; Mbhenyane, 2017; Bvenura and Afolayan, 2014; Bharucha and Pretty, 2010). Furthermore, improved access to NUS can support the long-term strategy to end world hunger, sustainable management of resources, and ultimately contribute to the attainment of

the Global Sustainable Development Goals (SDGs) (Rampa et al., 2020; Akinola et al., 2020; Welcome and Van Wyk, 2019; Mbhenyane, 2017; Baldermann et al., 2016; Padulosi et al., 2013).

This interest in NUS has been mainly driven by consumers' growing health, sustainability, and food security concerns and related interest in foods from the wild and in their natural environment, which are healthier, natural, diverse, and environment friendly (Pires et al., 2019; Rodrigues et al., 2020, Massawe et al., 2015; Grauso et al., 2019). However, the promotion of NUS on local, national, and global levels faces many challenges, such as a lack of information, knowledge, research and development about NUS, including the absence of nutritional content data (Rampa et al., 2020; Mabhaudi et al., 2017; Massawe et al., 2015). Without the latter, the impact of NUS consumption on people's nutrition and health cannot be established, resulting in ignorance and disregard of indigenous foods in nutrition interventions and policy development (Rampa et al., 2020; Mabhaudi et al., 2017; Massawe et al., 2015). Furthermore, the generally lower status of NUS due to some negative associations (e.g., 'food for the poor', inaccurate labelling as weeds), also contributes to the decline in their use, the loss of valuable knowledge previously passed on from one generation to the next, and lost potential of growing economically viable NUS (Rampa et al., 2020; Akinola et al., 2020; Balderman et al., 2016; Voster et al., 2007). Other challenges relate to perishability and quality retention during the short shelf life (e.g., Najar et al., 2022), as well as the absence of a sustainable value chain analysis (Mabhaudi et al., 2017).

These challenges have shaped the context and the stakeholders' activities in the food value chain, as well as food policy and governance of NUS (Rampa et al., 2020; Mabhaudi et al., 2017). If all stakeholders take actions to tackle these challenges, the NUS market has considerable growth potential around the globe. Hence, further research is needed to close the existing knowledge gaps about NUS nutritional value and the activities of the value chain actors, with a particular focus on their impact on consumers' awareness, perceptions and use of NUS, such as *Aponogeton distachyos*. Consequently, the present study aims to: (1) provide scientific information on the nutrients' composition of *Aponogeton distachyos*; (2) gain insights from different stakeholders across the plant value chain into the drivers and barriers influencing the adoption and consumption of *Aponogeton distachyos*; and (3) discuss knowledge, business practice, and food policy implications of the study findings. The findings of the present research contribute to raising awareness and knowledge about NUS and their nutritional benefits, and the critical role of the value chain analysis with an integrated SWOT (strengths, weaknesses, opportunities, threats) analysis component for

identifying some key issues and challenges to such plants. The study findings also have implications for supporting dietary quality and food system diversification, as well as for stimulating environmental sustainability and biodiversity of natural resources beyond the *Aponogeton distachyos* plant and SA.

2. LITERATURE REVIEW

2.1. Neglected Underutilised Species (NUS)

Native, indigenous plants occur naturally in a particular environment with no human intervention. Indigenous plants have been traditionally used as food or medicine by many generations since ancient times, and thus are part of unique local traditions (Grivetti and Ogle, 2000; Fernandes et al., 2020; PFAF, n.d.; Enviropedia, n.d.). Plant parts are used and consumed as (a) cereals, (b) seeds and nuts, (c) fruits and berries, (d) vegetables, (e) roots, bulbs, tubers, and (f) beverages (Fox and Norwood Young, 1982; Van Wyk and Gericke, 2000).

NUS belong to a biodiverse group of wild or semi-domesticated foods primarily grown in their original location and environment with the potential to become commercial food crops but have been neglected by the actors in the agri-business industry for a variety of reasons. As a result, these foods have limited value chains, and they are marketed locally and not necessarily as commodities (Modi and Mabhaudhi, 2016). Selling at local markets is usually a non-controlled activity, making it difficult to collect accurate market data (Takahashi et al., 2020). Adequate information is also missing about the nutritional value, cultivation, production, availability, and preparation of NUS, which has been considered as one of the main reasons for the low levels of demand and consumption of indigenous plants, and also for their neglect by agri-business stakeholders, research networks, policymakers, and investments in research and development (Padulosi et al., 2013; Rampa et al., 2020; Mabhaudi et al., 2017; Massawe et al., 2015).

NUS are typically rich in nutrients and thus can contribute to dietary quality. Being part of local nature, their integration in people's daily diet has the potential to alleviate food insecurity and to stimulate socio-economic transformation, particularly in poverty-stricken and rural areas (Rampa et al., 2020, Mbhenyane, 2017; Padulosi et al., 2013, Akinola et al., 2020; Schönfeldt and Pretorius, 2011).

2.2. NUS Consumption

Studies suggest that the main reasons for consuming NUS, and edible flowers in particular, are their healing (Mbhenyane, 2017; Penafiel et al., 2016), nutrient and sensory (i.e., taste-related) properties (e.g., Senyolo et al., 2014; Matyjaszczyk and Śmiechowska, 2019). On the other hand, accessibility and availability have been identified as two key barriers to their consumption (Bharucha and Pretty, 2010; Mbhenyane, 2017; Senyolo et al., 2014).

The health benefits and nutritional profile of edible flowers as sources of fibre, protein and low lipid content make them attractive to vegetarians and vegans and align well to the growing consumer demand for vegetarian/vegan, natural and healthy foods (Fernandes et al., 2020; Takahashi et al., 2019; Rodrigues et al., 2017; Pires et al., 2019). Recently attention to phytoalimurgical practices have increased due to the rediscovery of the use of food ingredients for human health, leading to revaluation of the traditional wild edible plants for their sensory, nutritional, functional and biological properties (Grauso et al., 2019; Padulosi et al., 2013; Takahashi, et al., 2019). The increasing interest in bioactive components makes edible flowers appealing for their potential to be used as nutraceuticals and in the development of functional foods (Takahashi, et al., 2019; Pires et al., 2019; Kumari et al., 2021). Research evidence also suggests cross-country variations in the valued properties of edible flowers. For example, Guiné et al. (2020) found that nutritional value, antioxidant activity, and taste were more frequently mentioned reasons for edible flowers' consumption by Costa Rican than Portuguese consumers, whereas novelty, decoration, and aroma seemed more important to Portuguese consumers. Furthermore, edible flowers also have social-symbolic value related to the preservation of traditions, shared consumption rituals and practices, which are endangered to extinction due to urbanisation, migration, lifestyle and nutrition changes (Fernandes et al., 2020).

Last but not least, although the popularity of edible flowers has been growing (Fernandes et al., 2020; Takahashi et al., 2019; Kumari et al., 2021; Rodrigues et al., 2017, Pires et al., 2019), their consumption is still marginal and not included in official statistics; thus, its level remains largely unknown (Mbhenyane, 2017; Bharucha and Pretty, 2010, Akinola et al., 2020). Along similar lines, Fernandes et al. (2020) and Takahashi et al. (2019) assert that (a) there is a lack of information about specific legislation, production, and consumer awareness, (b) data on the production, marketing, and consumption of edible flowers could not be found in the literature or on government websites, and (c) no official lists of edible and nonedible flowers are published by an official body, such as FAO, WHO, FDA, EFSA or Codex

Alimentarius. Such arguments further ascertain the need and urgency for multi-faceted research on edible flowers.

2.3. NUS-related Food Policies

It is currently estimated that 690 million people worldwide suffer from malnutrition and food insecurity which will surpass 840 million by 2030 (FAO, 2020). Food security now largely depends on a few commercial cash crops (12-20 species) accounting for 80-90% of total dietary intake. In contrast, ITFCs comprises approximately 7,000 wild species (Akinola, et al., 2020; Baldermann, et al., 2016; Bharucha and Pretty, 2010; Padulosi et al., 2013), of which 1740 edible species were identified in SA (Welcome and Van Wyk, 2019). NUS can be vital for the reshaping of the global food system to become more inclusive, produce more food, and improve access to healthier and nutritious foods (Akinola et al., 2020; Baldermann, et al., 2016; Grivetti and Ogle, 2000). This, however, requires actions at local, national, and global levels (FAO, 2020; Akinola et al., 2020; Ericksen, 2008).

A recent report by the FAO (2020) states that food policies in the past aimed to increase food availability and energy intake as part of continuous efforts to end hunger. However, this strategy is changing, with a growing focus being placed on improving the quality of people's diets. According to the SA National Food and Security Policy (2014), dietary diversity is considered crucial for the achievement of food security, and indigenous foods can contribute to more diverse nutritious diets. This policy stipulates that increased consumption of indigenous foods will encourage their production and create markets for these foods, which will also boost rural economies. However, it has been argued that more needs to be done in terms of policy actions to assist with the promotion of knowledge, use, and preservation of indigenous foods (Mbhenyane, 2017; Mabhaudi et al., 2017; Padulosi et al., 2013).

2.4. NUS Food Value Chain

During their journey from the growers to the final consumers, NUS are handled by different stakeholders constituting parts of the NUS value chain. The food value chain can be characterised as the range of activities during production, processing, delivery, marketing and consumption, which are divided by time and space and add value to products as they pass from one link in the chain to the next (Kaplinsky & Morris, 2001; Mabhaudi et al., 2017). According to the stakeholder theory, all of those involved in the value chain must "create value" to optimise economic viability (Argandoña, 2011; Hörisch et al., 2014).

The environmental, economic, and social impact of food value chains has attracted the attention of a wide range of stakeholders (Toussaint et al., 2021); however, not many studies can be found on the value chains of NUS and the involvement of the different stakeholders. Little has also been done to develop sustainable value chains for NUS (Mabhaudi et al., 2017). A study by Senyolo et al. (2018) found that the links amongst the value chain actors involved in indigenous foods are weak, these foods are excluded from mainstream markets, the infrastructure is poor, policy and governance interventions are limited, and access to finance is lacking. Similarly, Padulosi et al. (2013) state that the lack of coordination, interaction and cooperation between stakeholders limits the market potential of NUS, valuable knowledge is lost, and value chains are poorly organised or non-existent. Given the limited and fragmented knowledge of NUS value chains, the present study draws particularly from the framework proposed by Ericksen (2008) for studying the multiple interactions of broadly defined food systems and adapts it to the context of *Aponogeton distachyos* (see Figure 4 further below).

In the light of the above discussion, the future of NUS depends on concrete actions to turn their potential into real benefits to both consumers and the environment. Achieving this will require a “systems approach, multidisciplinary analysis, multi-stakeholder consultation, and cross-sector coordination” (FAO, 2018; see also Padulosi et al., 2013). An ecosystemic framework with a stakeholder mindset is particularly useful for improving the activities from producers to consumers (Senyolo et al., 2018) and ultimately for driving economic viability of NUS and food system diversification (Argandoña, 2011, Rampa et al., 2020; Mabhaudi et al., 2017). To put it differently, this approach allows understanding of the food system activities from a holistic perspective that can lead to harnessing the market potential of NUS (Erickson, 2007; Groverman et al., 2018).

2.5. *Aponogeton Distachyos* as a NUS

2.5.1. Classification

Aponogeton distachyos refers to the scientific name of the plant that belongs to the scientific family species *Aponogetonaceae*. In SA it is commonly known as Waterblommetjie, literally meaning water flower (Van Wyk and Gericke, 2000; Pemberton, 2000), and categorised as an inflorescent vegetable with an edible flower (Benlloch et al., 2007). Inflorescences like broccoli, cauliflower and artichokes are examples of flowers valued all over the world, although consumers hardly ever associate these vegetables with flowers (Takahashi, et al., 2019).

2.5.2. Ecology

The natural habitat for *Aponogeton distachyos* is perennial dams, ponds, and slow-flowing water that are well adapted to the winter-rainfall climate of the regions around the Western Cape province (Pemberton, 2000; Van Wyk and Gericke, 2000; SANBI, 2000). See Figure 1 for a map of the Western Cape region in SA from where *Aponogeton Distachyos* originates. *Aponogeton distachyos* has been naturalised in some parts of the world in south-eastern Australia, France, United Kingdom, New Zealand, Argentina, and California (United States), and the tubers are used and planted for ornamental purposes and are not used or cultivated for consumption. It is considered an invasive plant in some parts of the world (Queensland Government, n.d.)

Figure 1. Map of Western Cape region, SA



Source: D-maps (n.d.)

2.5.3. Cultivation, Harvesting and Post-Harvesting

The cultivation, domestication, and commercialisation of *Aponogeton distachyos* started around 1980 after a decline in wild populations was noticed, mainly due to the Green Revolution, urbanisation, herbicide runoff from agricultural production, and overcollection of plant species (Pemberton, 2000; Welcome and Van Wyk, 2019). Propagation involves the seeds that are sown in the spring in approximately 3cm deep water on peat soil with a planting depth of about 45cm that will germinate in 1-2 months in full sun at 20 °C (PFAF, n.d.; Pemberton, 2000).

Harvesting takes place during the winter months (from April to October), when the flowers are in full bloom and picked when the bracts are green. Harvesting is labour intensive; workers wade waist-deep in the ponds with small drums, pull upwards and snap the flower stems at the surface and toss them into floating drums that trail behind them (Pemberton, 2000; Van Wyk and Gericke, 2000). When the winter rainfall season comes to an end and the ponds dry up during summer, the flowers that were not harvested sink to the bottom, become dormant and produce new seedlings that will germinate during the next season, when the ponds start to fill up with water (Van Wyk and Gericke, 2000; PFAF, n.d.; SANBI, 2000).

2.5.4. Characteristics and Product Attributes

Aponogeton distachyos have oblong leaves with inflorescences that are forked, bearing white, wax-like, sweetly scented, one-petalled flowers that drift on the water surface, with the stems submerged and the rhizomes (often referred to as tubers) embedded in the mud (see Figure 2) (Van Wyk and Gericke, 2000; PFAF, n.d.; SANBI, 2000).

Figure 2. *Aponogeton distachyos* watercolour illustration (by Edwards Sydenham Teast)



Source: Curtis's Botanical Magazine (1810)

The discussion below examines the flower intrinsic and extrinsic product attributes. This categorisation is typically used in sensory, consumer and food science studies for exploring consumer preferences and food choices.

Intrinsic attributes refer to the unique inherent characteristics of a food product, such as appearance, taste, smell, texture, and sound (Symmank, 2019), as well as its chemical and physical composition. The small white flowers of *Aponogeton distachyos* have a waxy appearance that matures in green bracts and ripens into different shades of pink, yellow, and red once harvested (Pemberton, 2000; Slow Food Foundation, n.d.). The texture of the flowers is compared to those of miniature artichoke leaves, and the taste is reminiscent of asparagus and green beans with a hint of lemon (Van Wyk and Gericke, 2000).

To our knowledge, there is no evidence of any sensory profiling or consumer tests of *Aponogeton distachyos* to describe its sensory attributes or consumer preferences. Similarly, there is no prior knowledge about its nutrient composition. However, this information is essential for determining its application, benefits, uses, and contribution to a diet (Elmadfa and Meyer, 2010). It is also essential for product labelling, an information that is currently missing on the flower packaging in SA. What is more, food composition data is critical for nutrition and health claims and guidelines (Schönfeldt et al., 2019). The nutritional value of *Aponogeton distachyos* was investigated for the purposes of the present study and constitutes one of its contributions. Table 1 presents the nutritional composition of *Aponogeton distachyos* per 100g raw, 100g cooked, and 100g canned portion and comprises the macro and micronutrients, and their value per unit of measurement. The nutrients' information in the table below indicates that *Aponogeton distachyos* offers health and dietary benefits in terms of being a fat-free and cholesterol-free vegetable, and a good source of protein, dietary fibre, iron, Vitamin C, and folic acid. Information about the methods, samples, and procedures used to assess nutrient composition is available from the study authors.

Table 1. Nutrient composition of *Aponogeton distachyos*

Nutrient	Unit	Value per 100g raw	Value per 100g boiled	Value per 100g canned
Moisture	G	89.9	91.9	
Energy	kJ	160.0	95	60
Protein	G	1.3	1.2	0.5
Fat	G	0.2	0.1	tr
Cholesterol	Mg	0	0	
Carbohydrates	G	3.5	4.9	3
Dietary Fibre	G	3.1	3.3	1.4
Ash	G	0.8	0.3	
Vitamins				
Vitamin A	µgRE	57		
Thiamin	Mg	0.04		
Riboflavin	Mg	0.12		
Niacin	Mg	0.7		

Nutrient	Unit	Value per 100g raw	Value per 100g boiled	Value per 100g canned
Vitamin B6	mg	0.094		
Folic Acid	µg	14		
Vitamin B12	µg	0		
Vitamin B5 Pant	mg	0.29		
Biotin	µg	1		
Vitamin C	mg	8		
Vitamin D	µg	0		
Vitamin E	µg	0.60		
Minerals				
Ca	mg	46		
Fe	mg	0.92	0.87	
Mg	mg	21		
P	mg	47		
K	mg	245		
Na	mg	45		
Zn	mg	<0.14	<0.14	
Cu	mg	0.32		
Mn	mg	267		

Extrinsic attributes are the external characteristics of a product, such as price, brand name, and packaging. *Aponogeton distachyos* can be obtained in fresh batches during harvesting at some major retailers, such as Spar, Pick ‘n Pay, Checkers, Food Lover’s, delis, farm stalls, and street vendors at major road networks, mainly in the Western Cape region (Mbhenyane, 2017; Van Wyk and Gericke, 2000). The selling price ranges from R55-R60 (4.22-3.51 USD, depending on exchange rate) per kg if sold directly to the public from the farmer (Rhenostervlei Waterblommetjies, 2020) and between R75-R90 (4.68-5.85 USD, depending on exchange rate) per kg if sold at a local supermarket. A canned variety of *Aponogeton distachyos* used to be available at local stores at R23.99 a can but was discontinued in 2018 (Riverside Farm Waterblommetjies, 2020). See Figure 3 for an example of the packaging attribute.

Figure 3. Examples of packaging of *Aponogeton Distachyos* on retail shelf displays



2.5.6. Consumption and Promotion

Aponogeton distachyos is typically consumed cooked, and it is usually prepared with onions, mutton or lamb and sorrel leaves in a stew (Leipoldt, 1943; SANBI, 2000). The flowers should just be opening and bright green with a blush of pink on the tips, but not hard and woody when used for cooking (Olivier, 2015). The flowers, petals, and softest stalks of fresh flowers are soaked in salty water to remove grime and then steamed or boiled until tender and reddish-brown to extract any bitterness. Thereafter, the flowers are drained and the water is discarded (Leipoldt, 1943). *Aponogeton distachyos* can be also canned, pickled, frozen, or served in salads or soups (Van Wyk and Gericke, 2000; SANBI, 2000).

In 2009, the annual Waterblommetjie Festival was launched, promoting amongst other things traditional stew, soups, and ice cream in a fun, family-focused environment. Other initiatives involve wild food community gardens that grow wild foods (historically foraged but mostly forgotten) (Slow Food Foundation, n.d.). These gardens aim to raise consumers' awareness and engagement with the knowledge, use, and cultivation of local indigenous foods to create a new market space (Cape Wild Food Garden, n.d.). Also, Pereira et al. (2019) identify the value of kitchens as a platform to expand on the potential of NUS by combining the indigenous knowledge and creativity of chefs and cooks, and thus transforming the existing food culture into one that supports healthy people and a healthy environment.

3. METHODOLOGY

The general lack of knowledge about the different food system activities involving *Aponogeton distachyos*, as well as the diverse issues arising at each stage of the food value chain, motivated the adopted value chain approach to our data collection and data analysis. We have integrated in this approach the SWOT analytical framework to pinpoint key factors that can contribute to increased consumption, as well as to identify others that can potentially hamper the market growth of the flower.

3.1. Sampling

Purposive sampling was used to select relevant study participants. Specifically, informants, who were connected to the value chain activities of *Aponogeton distachyos* by either growing, distributing, selling, consuming, cooking, or writing about *Aponogeton distachyos* were identified from referrals from friends, professional colleagues, and acquaintances, as well as from Internet searches and social media channels. Due to limited information available about the *Aponogeton distachyos* value chain stakeholders and their activities, the sampling of the study participants depended mostly on individual referrals. Consequently, a list of stakeholders within each of the above-mentioned categories, who were considered knowledgeable, experienced and familiar with *Aponogeton distachyos*, was compiled, and potential study participants were approached for interviews. Given the different stakeholder categories, during the sampling a minimum of 3-4 participants in each category was aimed at. The Covid-19 restrictions on travel between geographical regions during the data collection phase affected physical access to growers and distributors. Consequently, from the commercial growers of *Aponogeton distachyos*, participants from two well-known and easily accessible farms from the Western Cape region were interviewed. Retail intermediaries who regularly stock their produce consisted of supermarkets, farm stalls, delis and food markets across the Western Cape region. Site visits were conducted by the first author to determine the shelf space allocated to the flowers in the store and take images of the packaging, display and price of the flowers. From the different types of intermediaries, outlets and procurement managers approached for interviews, one wholesale distributor, one meal kits provider, a caterer, a restaurateur & food critic, and a chef took part in our study.

The stakeholders related to the consumption part of the value chain were a restaurateur & food critic, a chef, a caterer, a local indigenous foods activist, a culinary historian, a community garden distributor, a curator of trees and plants, and a tour agent offering outdoor

hikes paired with food experiences. These participants were chosen not only because of their specific knowledge of and experiences with *Aponogeton distachyos*, but also because of the diverse perspectives (e.g., food processor and consumer) informing their views on the flower. The total sample size for the in-depth interviews comprised 12 participants. While this sample size is not particularly large, the adopted purposive sampling approach allowed rich data to be generated. Our sample size is also in line with previous recommendations of a minimum sample size of at least 12 to reach thematic saturation (Guest et al., 2006; Fugard and Potts, 2015). Therefore, it is considered sufficient for the purposes of the present study, which sought to gain insights into largely unexplored phenomena and not to build interpretative theories typically achieved with a theoretical sampling approach nor to achieve representativeness of its results. Nonetheless, we address this potential study limitation in Section 6. The demographic profile of the study participants is presented in Table 2.

Table 2. Demographic profile of study participants

Participant ID	Gender	Age	Interview type	Geographical location	Professional status
P1	Male	69	Zoom	Western cape	Farmer A Indigenous food activist & consumer
P2	Female	57	Zoom	Western cape	Farmer B
P3	Male	58	Face-to-face	Western cape	Caterer & consumer
P4	Female	63	Zoom	Western cape	Culinary historian & consumer
P5	Female	65	Zoom	Western cape	Wholesale distributor & consumer
P6	Male	45	Face-to-face	Western cape	Meal kits provider
P7	Male	41	Phone	Western cape	Tour agent & consumer
P8	Female	35	Phone	Western cape	Chef & consumer
P9	Male	45	Phone	Western cape	Restaurateur, food critic & consumer
P10	Male	65	Phone	Western cape	Nutritionist & researcher
P11	Female	56	Phone	Gauteng	Curator & consumer
P12	Male	57	Phone	Gauteng	

3.2. Data Collection

The data collection took place in the form of face-to-face, telephone, and online in-depth interviews. Three face-to-face interviews were conducted during a visit to the Western Cape region while *Aponogeton distachyos* was still in season and freshly available. Detailed notes were taken during and after these interviews. From the remaining interviews, four were

online Zoom and five were telephone interviews. These were recorded and transcribed verbatim. A semi-structured interview guide with open-ended questions was prepared before the start of the data collection to provide guidance and comparability of the data across the different interviews. However, the interview approach was flexible to provide room for sharing and elaboration on points most relevant to the participant's field of expertise. Prior to the interviews, ethical clearance was obtained from the Research Ethics Committee of a University in the United Kingdom.

3.3. Data Analysis

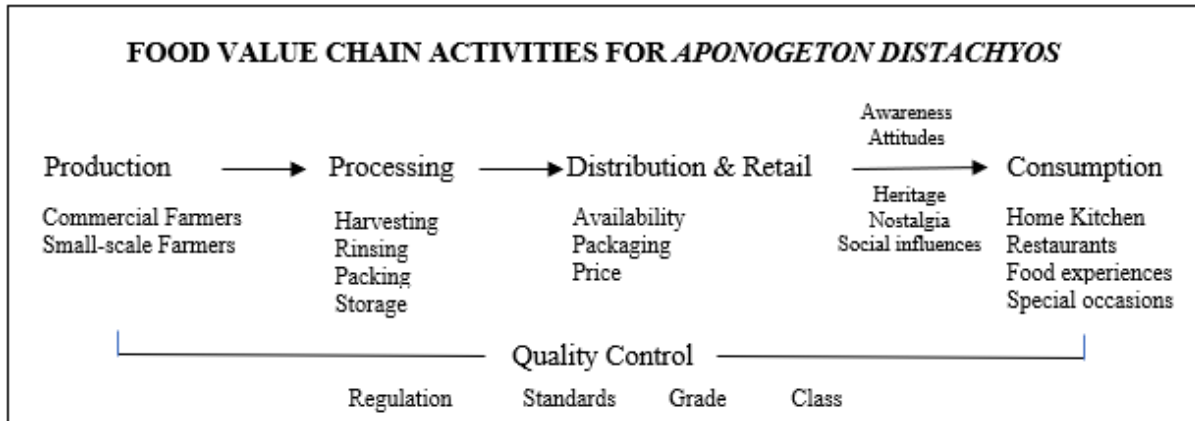
The textual data from the interviews were coded, managed and analysed with NVivo 12 software for qualitative data analysis (QSR International, 2020). The data were organised and analysed using thematic analysis (Guest et al., 2012; Braun and Clarke, 2013; Nowell et al., 2017). Thematic analysis is commonly applied in the Social Sciences to understand people's views, values, experiences, and behaviour. The transcripts were read and reread several times to identify and code a variety of themes/categories, which contributed to answering the study research questions. Similar pieces of text were attributed to a particular category. With deeper understanding of the data developed, the initial codes were combined into overarching themes to accurately represent the data. Some distinctive themes emerged that were tied to particular stakeholders. The themes identified at the different stages of the flower value chain were linked to establish a more comprehensive understanding of the consumption and the potential of consumption of *Aponogeton distachyos*. To enrich our analysis, the content of the themes in Sub-section 4.4. Consumption of *Aponogeton distachyos* was further examined to ascertain whether the identified themes belonged to the broader categories of strengths or weaknesses, opportunities or threats (see our earlier SWOT discussion). The issues constituting each theme were demonstrated with relevant excerpts from the stakeholders' interview transcripts.

4. RESULTS

This section presents the findings from the thematic analysis of the interview data. The key issues and challenges to the consumption of *Aponogeton distachyos* are presented under the different food system activities of the *Aponogeton distachyos* food value chain: Production, Processing, Distribution & Retail, Consumption, and Quality Control (see Figure 4). The use of this framework was instrumental for identifying key recurring themes about diverse issues and factors affecting the consumption of *Aponogeton distachyos*. Quality

control cannot be isolated on its own as a separate activity as it takes place during all stages of the value chain; this fact is reflected in Figure 4.

Figure 4. Food value chain activities for *Aponogeton distachyos*



Source: Adapted from Ericksen (2008)

4.1. Production of *Aponogeton Distachyos*

The commercial production of *Aponogeton distachyos* crops consists of only a few farmers (growers) in the Western Cape region with at least several ponds that can provide sufficient produce to keep up with demand. The small-scale farmers have one or two ponds at the most and usually sell their produce to local, informal outlets, such as caterers or farm stalls. The farmers interviewed have been growing *Aponogeton distachyos* for more than 30 years. According to them, growing the crop for commercial purposes can be somewhat complicated, as it involves a very labour-intensive process in an environment that poses diverse threats to the volumes and quality of the produced plant. The issues raised by the growers impact on labour productivity, market availability, quantity, quality and price levels at which the plant is sold to consumers, with ultimate effect on growers' ability to meet current and/or to handle increases in market demands.

As *Aponogeton distachyos* is a wild plant, it requires special conditions resembling its natural environment. Securing such conditions can be challenging, especially when managing a larger number (i.e., 10-15) of ponds. If ponds' water levels are not deep enough, the plants will die. These challenges are captured in the following excerpt:

“Most of the experts say the depth of the ponds should be 600mm, but the depth of our ponds varies and I’ve seen the flowers grow in deeper and lower levels of water. You need to constantly monitor the water levels. We are pumping fresh water into the ponds

to adjust the water levels. But it is tricky because if it rains too much the flowers can drown, but then we open the outlets to adjust". (Farmer B)

Aponogeton distachyos is also threatened by other externalities that are difficult to manage. Birds in particular can be a big threat to the flowers, as illustrated in the following excerpt:

"... from many trials and errors, we've seen that bird scare tape and gas cannons work the best, otherwise, "they will devour everything". Covering the ponds with nets also does not seem to work because "the plants want sun and need to grow in conditions closest to its natural environment". (Farmer B)

Another threat to *Aponogeton distachyos* is the pesticides' use in agriculture. Pesticides are widely sprayed to protect the mainstream staple crops (e.g., wheat) in the agricultural sector. The presence of chemical compounds from pesticides is detrimental to growing *Aponogeton Distachyos* and edible flowers in general (see Matyjaszczyk and Śmiechowska, 2019). This issue is demonstrated in the following excerpt:

"The flowers are very sensitive to pesticides and the spraying of the wheat crops is one of the main reasons why flowers are not growing naturally anymore in the ponds of many farms around the Western Cape region that always used to flourish with flowers". (Farmer A)

A further challenge mentioned by the farmers is the need to grow flowers of an acceptable size, which is driven by consumers' preferences for bigger flowers. Hence, further efforts are required by the farmers to achieve this goal, as illustrated below:

"... thinning of the bulbs frequently is important to prevent the flowers from clustering too close together and producing small flowers". (Farmer A)

The seasonality of production defines its market availability, which is for a limited time period. Even when in season, the supply of the flower is volatile and uncertain. These issues are captured in the following two quotes:

"I think demand has increased in recent years, gaining popularity again as traditional food, but supply and availability cannot always be guaranteed. It all depends on if the producers had a good season or not". (Wholesale distributor & consumer)

*“I would say that *Aponogeton distachyos* is only available for a very limited time, and custom-made hikes paired with waterblommetjie food experiences in the Overberg Mountains of Bot River is not a service we can offer outside the season”.* (Tour agent & consumer)

Last but not least, given the high water demand for the production of *Aponogeton distachyos*, its growing is vulnerable to threats from persistent droughts and water supply crises, which have impacted SA in the past decades (see Pamla et al., 2021). The negative impact of this natural threat on the supply of canned *Aponogeton distachyos* is demonstrated in the following excerpt:

“We were the only producer and supplier of canned Waterblommetjies. It is challenging to produce canned variety in volume and we discontinued this after the drought and water crisis in 2017 and 2018”. (Farmer A)

4.2. Processing of *Aponogeton Distachyos*

The processing stage of *Aponogeton distachyos* includes harvesting, rinsing, sorting, packaging, and storage. The processing activities are diverse and also labour-intensive, which add further costs to the final price of the flower. They also have significant impact on the product quality and down the chain on consumer purchase behaviour. The laborious nature of the processing activities was outlined in our earlier discussion in section 2.5.3., and it is also illustrated by the following excerpt:

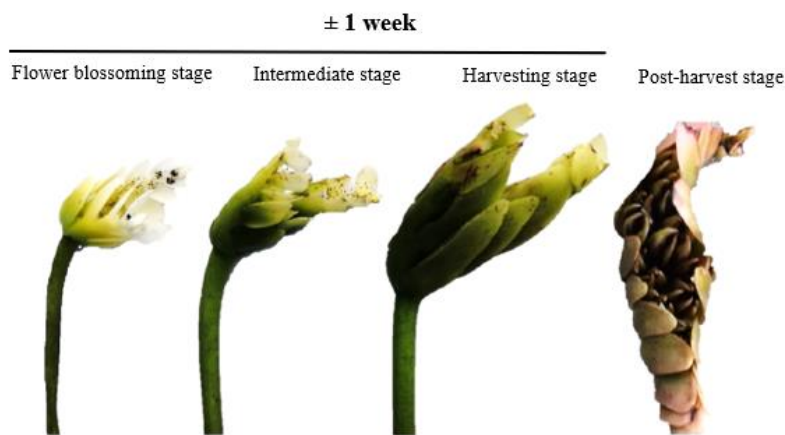
*“Many people don’t know that it is not the white blossom stage of the flower that gets harvested and that the flowers mature into green bracts that are in actual fact the part that gets harvested, cooked, and eaten. ...
Once the floating drums are full, they are removed from the ponds the flowers are rinsed very well several times. Thereafter they are soaked in salt water to remove any remaining bugs and sand. The bracts are then sorted according to quality and packed into 5kg clear plastic bags that can last for 14 days in the cold room and shouldn’t get any air during storage”.* (Farmer B)

Aponogeton distachyos can be also harvested and consumed during the blossoming stage, as stated by a participant from the team that harvested the flowers from the aesthetic pond of the University of Pretoria, and also tasted them raw:

“Although it was traditionally harvested when fully matured, it can be harvested at any stage and can be used for different applications”. (Curator & consumer)

The different growing stages of the flowers from blooming, to harvesting and post-harvesting are shown in Figure 5.

Figure 5. Growing stages of *Aponogeton distachyos*



Source: Images taken and artwork compiled by the first author

4.3. Distribution and Retail of *Aponogeton Distachyos*

Aponogeton distachyos is sold through direct and indirect channels. Distribution beyond the Western Cape province is currently not possible due to existing infrastructure and logistical challenges. Hence, the plant is currently marketed to a rather limited geographic market, which reduces substantially its accessibility. The most cost-effective way to distribute the plant, according to its growers, is through bigger suppliers, such as “*some selective supermarkets, specialty shops (such as bistros and delis), and farm stalls, depending on demand*”. (Farmer B)

Given the highly perishable nature of the flower, farmers also distribute directly to local consumers. However, due to the small orders, selling directly to consumers is not perceived as cost-effective as selling through intermediaries. This sentiment is captured in the following quote:

“*We are overwhelmed with all the many individual requests and orders and people don’t understand that it takes a lot of time and effort to distribute directly to the customer in small quantities*”. (Farmer B)

In the past, people were either gifted with a bundle of flowers by friends, family, or neighbours, or would buy them from roadside stalls, as illustrated in the following two quotes:

“Back then we didn’t buy Waterblommetjies, we were given them by friends, neighbours, colleagues... anyone who had family in the Boland. I still don’t enjoy buying them from the supermarket”. (Culinary historian & consumer)

“We used to be able to buy them along the side of the road. It’s slightly dodgy these days, with pollution and all, so it is probably best to buy them from someone you can trust”. (Restaurateur, food critic & consumer)

4.4. Consumption of *Aponogeton Distachyos*

The preceding discussion identified certain issues and challenges emanating from the earlier activities in the value chain and their impact on consumer demand. The analysis that follows applies the SWOT analytical framework; hence, the themes related to different consumer behaviour aspects are grouped under the broader categories of strengths, weaknesses, opportunities, and threats.

4.4.1. Potential Strengths

Taste and flavour. The flower has its own unique taste, flavour and texture, which is one of the particularly appealing to consumers plant attributes. A member of the team that harvested and ate the raw flowers from the aesthetic pond of the University of Pretoria while the flowers were still white and blossoming shared his tasting experience:

“I tried some of the raw small flowers during harvesting and it tasted fresh and crisp and can be used in salads and becomes chewier as it matures and is probably why it was used in slow cooking methods”. (Curator & consumer)

The other study participants shared similar experiences:

“Waterblommetjie smell exactly how they taste: delicate, like a fresh pond.”

“I think Waterblommetjie has a very distinct flavour profile and that is what makes it special to cook with”. (Chef & consumer)

“Waterblommetjie has a very unique taste and flavour and for many, it brings back childhood memories of when Waterblommetjie was freely available in the ponds and river streams”. (Culinary historian & consumer)

Nutritional value. The nutritional value of *Aponogeton distachyos* is considered as one of its strengths, which also creates market opportunities especially in the context of the growing demand for plant-based protein alternatives. However, the responses of our participants indicate that the nutritional value of the flower is largely unknown, while its taste and evoked nostalgic feelings emerged as more important during the interviews. This issue is illustrated by the following excerpt:

“I’m sure it is a nutritious food, but I mostly cook with it because of the taste and the memories associated with a Waterblommetjie stew that is part of our heritage”.

(Caterer & consumer)

Heritage and nostalgic feelings. Emotional connect with the flower emerged as one of the main reasons for *Aponogeton distachyos* consumption. SA consumers feel a deep connection with *Aponogeton distachyos*, which ties them to their roots and heritage, takes them back to their childhood and evokes happy memories shared with family and friends, as demonstrated in the following quotes:

“Being a simple dish, recipes weren’t written down but passed from mother to daughter, forming a strong emotional bond that makes stews a comfort food to this day for locals and descendants...”

The first stew of the season is a special occasion for many Cape families. The scent of the bredie fills the house as mothers and grandmothers watch over slowly simmering pots...

The stew is much more than a dish. For many, it is a link to a time, a place, and people. I have a deep love for the dish and will never stop making it”. (Culinary historian & consumer)

4.4.2. Potential Weaknesses

Price. *Aponogeton distachyos* is perceived to be an expensive food product compared to other marketed vegetables. Hence, price is a barrier to the consumption of this indigenous flower as illustrated in the following excerpt:

“[I get Waterblommetjie] from the farm Patatskloof at R55/kg. It is too expensive to buy in the shops”. (Caterer & consumer)

Packaging. The flowers are usually packaged in 5kg bags by the farmers, and in punnets of 500g or 1kg bags by the retailers with limited information about the nutritional value and

origin of the product, as well as cooking instructions. The excerpt below and Figure 3 provide insights on the packaging attribute.

“The flowers must be rinsed very well and soaked in salt water to remove any bugs and sand. Thereafter packed into plastic bags at 5kg per bag. Can last for 14 days in the cold room and shouldn’t get any air either”. (Farmer B)

General lack of awareness and lost knowledge emerged from the analysis as a key weakness. Specifically, the flower appears to be better known in the rural rather than the urban areas, and by older rather than younger consumers. There is also a general lack of knowledge about how to cook with the plant. These issues are demonstrated in the following excerpts:

“They are not well enough known in the city though, because I often see them on the shelves looking rather sad, clearly having been there for too long. By contrast, in rural areas at farmstalls or at roadside stalls, they are clearly still known as wherever I see them they are very fresh and often sell out fast”. (Indigenous food activist & consumer)

“The younger generation doesn't know the difference in quality from the different producers”. (Farmer B)

“But people that didn't grow up with it say they don't know how to cook with it”. (Indigenous food activist & consumer)

To tackle this weakness, certain efforts have been exerted to raise consumer awareness by recovering the lost knowledge of forgotten foods such as *Aponogeton distachyos*, to increase interest and generate demand for them. The following statement sheds light on this:

“Much of my work revolves around drawing attention to the mostly forgotten indigenous foods of the winter rainfall region. I am engaging people (growers and end users, cooks and chefs, as well as researchers) in getting to know them, grow them, and use them”. (Indigenous food activist & consumer)

4.4.3. Potential Opportunities

Fresh, Frozen, Canned or Powdered. The study participants expressed buying preference to the fresh plant, as captured in the following quote: *“Fresh is always best”* (Caterer & consumer). However, apparently the product freezes well, as illustrated in the excerpt below:

“Flowers can be blanched before freezing and can last a very long time in the freezer and taste the same as fresh once defrosted”. (Farmer B)

The frozen product provides a solution to the currently limited geographic market coverage of the Western Cape province. The plant can be also canned. However, as discussed in Sub-section 4.1., the canned option had been discontinued after the drought and water crises in 2017 and 2018. While conserving the product provides market opportunities, as it overcomes the seasonality, perishability and accessibility limitations, the discontinuation of this product form can be considered a weakness. Furthermore, drying the plant and using it as a soup powder is also a way to increase market exposure. However, the powder product is very expensive and not economical because not much of it is left after the flower is dried.

Consumption context. Different consumption contexts provide opportunities for increased consumption. The consumption of *Aponogeton distachyos* takes place in various settings, such as the household kitchen, restaurants, and organised events offering special food experiences. According to the study participants, the majority of people and customers they deal with daily buy *Aponogeton distachyos* to cook at home the traditional stew commonly known as ‘Waterblommetjie Stew’. The essence of this very traditional home-made stew and its unique sensory properties are well captured in the following statement:

“The WB stew is not the same as the stew everyone is accustomed to and is quite unlike anything else in the world. It is the holy unity of meat and vegetable that all become one and was originally inspired by the Cape Malay slaves who brought their cooking methods with them. Slow-cooking brings out the best of this seasonal treat. Typically South African, it also showcases the dish, a method of cooking which is also part of our culinary heritage. This is if you keep the end result in mind. Stew takes its time but rewards the cook greatly with a delicious one-ness of all the various ingredients”. (Culinary historian & consumer)

The Meal kit is a recent product offering developed in cooperation between farmers and a local provider of meal boxes. Recipes with indigenous ingredients are also included in the meal boxes, such as recipes for the traditional stew with lamb, but also for the vegetarian and vegan consumers who use *Aponogeton distachyos* as a protein alternative. Some insights about this meal box are provided in the following excerpt:

“This is different from the normal meal kit boxes and is a fresh farmers’ box, aimed at the customer that wants to use local foods. The customer base for the market box is

slightly different and those interested in new and interesting recipes. We usually use Aponogeton distachyos in our meal kits when it is in season and when we usually have a heritage drive in September”. (Meal kits’ provider)

Restaurants, chefs, and caterers get requests to serve this stew on their menu. The stew “*remains a popular dish amongst locals and visitors*” (Restaurateur, food critic & consumer). Lately, many other dishes have been invented and cooked with *Aponogeton distachyos*. For example, a favourite dish for the chefs is to fry the flowers in a tempura batter and serve with chakalaka aioli or any other relish or dressing, or to serve them steamed with Hollandaise sauce or watercress-bearnaise sauce or add a classic Italian Gremolata (a seasoning consisting of lemon zest, garlic and parsley) at the very end of the *Waterblommetjie* stew to revive it a bit.

Special food experiences, such as culinary and outdoor experiences with *Aponogeton distachyos*, create awareness, spread knowledge about cooking, and engender long-lasting shared memories involving the consumption of the flower. For example, one company offers custom-made hikes paired with food experiences in the Overberg Mountains of Bot River that “*take customers on a waterblommetjie experience, going to where the flowers grow and prepare some waterblommetjie dishes that were harvested from the wild and en route*”. (Tour agent & consumer)

Broader market appeal. Another market opportunity arises from the fact that the flower consumption is not linked to a specific ethnic group, as illustrated by the following excerpt:

“Rather than being ‘invented’ or owned by a particular ethnic group, the dish evolved from many people and cultures from the 17th Century”. (Culinary historian & consumer)

4.4.4. Potential Threats

Amongst the potential threats with impact on the quantity, quality and price levels of the supplied plant and its market size and growth potential, identified earlier in the Results section, are the labour-intensive production and processing methods, the use of pesticides in modern agricultural practices, the seasonality of production and other externalities such as droughts, as well as the limited geographic distribution coverage.

4.4. Quality Standards and Quality Control of *Aponogeton Distachyos*

Quality control involves the processes that are carried out during all system activities in the value chain by different role players to ensure that the quality of *Aponogeton distachyos* complies with the required standards as well as consumer expectations. A key issue that emerged from the interviews is the lack of adequate regulations, standards, controls, or specifications about the quality of the product. There is also wide scale foraging from natural ponds that is sold by street vendors on the roadside at a much lower price; however, the quality of these flowers is questionable. The following two excerpts demonstrate this theme:

“The biggest challenge in the industry is that there are no standards, controls, or specifications about the quality of the product that ends up on the shelves and with the consumer. The flower punnets sold next to the roads were mostly foraged from the wild and these flowers have most likely been exposed to filthy and even contaminated water. Products from the different producers are packed into similar punnets and sold at the same price without differentiation in terms of producers, standards, grades, or class”. (Farmer B)

“We are required to provide a food audit certificate to the retailers that procure from us but then retailers pack their stock from all the different farmers into similar punnets and you can see there is a big difference in quality, but customers don’t know the difference or might think and associate the poor quality with my farm”. (Farmer A)

Figure 6 below provides an illustrative example of two punnets sold by the same retailer, without any differentiation in terms of standards, grade, class, price, or where the flowers originate from.

Figure 6. Examples of flower punnets sold by the same retailer



Such practices are likely to affect consumers' perceptions of the quality and integrity of the entire industry, and their attitudes, preferences and consumption of the product negatively.

5. DISCUSSION

The value chain for *Aponogeton distachyos* involves a combination of diverse activities that shape the key drivers and barriers to the consumption of *Aponogeton distachyos* in the SA marketplace. One of the consumption-related *strengths* that emerged from the study is the *fond memories* attached to cooking and consumption of the flower on family occasions and the associated nostalgic feelings. This socio-cultural embeddedness of the flower induces strong positive emotions and enduring attitudes, which have the potential to motivate purchase and consumption in longer run. This finding is consistent with our earlier discussion on the role of NUS in local traditions (e.g., Grivetti and Ogle, 2000; Fernandes et al., 2020) and consumption rituals (Fernandes et al., 2020). It also highlights the importance of cultural context in defining how, why, when and where NUS are consumed and, hence, provides support to the discovered by Guiné et al. (2020) cross-cultural variations in NUS consumption.

The *sensory properties* of the flower, with their ability to enhance the taste of the traditional stew, are frequently mentioned as another factor influencing positively consumption. This finding is in line with the food preference literature, acknowledging the primary importance of taste and flavour in liking (e.g., Kaneko et al., 2017) and sensory preferences of edible flowers (Andersen et al., 2019; Guiné et al., 2020). However, contrary to some earlier studies (e.g., Chen and Wei, 2017; Mbhenyane, 2017; Penafiel et al., 2016),

the nutritional and healing reasons for consuming the flower were not prominent in the findings of our research. A possible explanation for this finding is that the nutritional value is generally unknown, as it is not displayed on any packaging of the product. Another possible explanation could be that our study participants might have taken for granted this benefit from the plant consumption on the basis of general historic knowledge linking NUS to their medicinal use. The impact of nutritional value on the flower consumption is likely to become more prominent if nutrients' composition is made widely known to consumers through different channels, such as supermarkets, caterers, and promotional activities discussed earlier and also below.

A further consumption driver and market opportunity relates to the *promotion* activities of organisations, chefs, and food activists, which increase awareness, access and appreciation of NUS such as *Aponogeton distachyos*. These efforts also align well with the growing sustainability and food security concerns and the observed gradual shift in consumer preferences from meat to plant-based diets (Alae-Carew et al., 2022).

The consumption shift discussed earlier has moved the plant into the NUS category and a niche market position. Our findings indicate that special consumption occasions can nurture an appreciation of the product. This together with additional promotion efforts can in longer-run stimulate consumer demand.

This study also identified several *weaknesses* and *threats* to the plant consumption. On the consumer side, the *lack of awareness and knowledge* about the nutritional benefits of *Aponogeton distachyos*, particularly by the younger generations, as well as about how to cook with it, emerged as a weakness to consumption. The insufficient information on the *product packaging* (focused on price and quantity contained in a bag/punnet) does not help either the decision making of consumers, who may be initially attracted to the product due to publicity efforts (e.g., the Waterblommetjie Festival) and/or word-of-mouth. The *price* of the product emerged as another deterrent to its consumption. Amongst the identified threats are the flower *seasonal availability* and *labour-intensive processing* related to the cultivation and production of *Aponogeton Distachyos*. Also, *accessibility* constraints arise from the generally limited and inconsistent availability of the product, which prevent its more widespread consumption. These findings are consistent with previous research (Imathiu, 2021; Rampa et al., 2020).

Finally, the general *lack of quality standards and regulations* emerged as another barrier that can influence negatively consumers' attitudes and ultimately the consumption of *Aponogeton distachyos*. The mixing of the flower bracts from different growers and quality

grades in the same packaging can reduce the overall quality of the marketed product and, hence, its purchase and consumption.

6. POLICY, PRACTICE AND KNOWLEDGE IMPLICATIONS

The study findings are interesting and relevant to a broad audience, which includes nutritionists, dieticians, consumers, marketers, and other stakeholders in the flower value chain. Specifically, given the identified awareness issues, consumers and other stakeholders need to be well informed about the nutritional value of *Aponogeton distachyos*, which can be done through improved labelling, packaging and branding of the product offered to the end users. The special events organised by different stakeholders can be suitable venues for informing and educating consumers, nutritionists, dieticians, and caterers about the nutritional benefits and uses of the flower. Online social influencers can also be engaged to amplify the effect of the promotional activities. These activities need to go hand in hand with actions from the policy makers to ensure that adequate food quality standards are in place and are enforced accordingly. Extending the discussion beyond *Aponogeton Distachyos*, such standards and regulations may be even more important in view of the fact that some edible flowers may not be safe for consumption or may require special preparation before use.

Concerning product availability, increased cultivation of *Aponogeton distachyos* can widen the availability of this product. However, our study found that current consumption levels, labour-intensive production and processing practices, and wide pesticides' use in agricultural practices are key deterrents to a larger-scale production. Adequate regulations of pesticides' use in agricultural practices are necessary to support production growth in line with increasing demand. Given the seasonality of production, post-harvest processing of the flowers by freezing, canning or drying can help increase their availability during out-of-season and to wider geographic areas. Governments could also provide more support for the development and adoption of technologies for preserving and storing of NUS, which are largely missing (see FAO, 2018). Close cooperation between retailers and farmers is also needed to improve product quality and availability. Our findings identify the need bigger, cost-effective suppliers, such as supermarkets and specialty shops, to get more involved in distributing the plant to final consumers.

In view of the fact that *Aponogeton distachyos* is perceived as an expensive vegetable compared to other vegetables, and its price can limit access mainly to those who can afford it, more research and development efforts are needed to understand how *Aponogeton distachyos* can be cultivated in more cost-effective ways, which can involve the adoption of modern

agricultural technologies (e.g., digital farming, drone and other aerial imagery). Concerning future research recommendations, given our relatively small sample size, future studies could consider involving additional stakeholders, amongst which consumers from more diverse age groups and different levels of knowledge and consumption of *Aponogeton distachyos* to address the need for further insights on consumers' views, motives, uses and consumption (both past and present) of NUS plants. Such knowledge will help identify appropriate actions by the different stakeholders in the food value chain in order to revive and stimulate their consumption. Future studies should be extended to other NUS and geographic regions and also use survey-based methods in order to examine and test for possible cross-cultural variations in shoppers' preferences and consumption. Last but not least, the nature-based-business model could be applied in the context of edible flowers to address further the type of challenges identified in the present study through a sustainable production, distribution and consumption lens (see Pauli, 2010; Weetman, 2017).

7. CONCLUSION

Our study highlighted the traditional role of *Aponogeton distachyos* in South African peoples' diet and subsistence, as well as for tackling some pressing issues related to malnutrition, environmental sustainability and biodiversity. Besides, it provides valuable information for the nutrient's composition of the plant, which was lacking until now. The adopted holistic approach that considered the connected network of different activities in the food chain, and the integrated in it SWOT analysis, allowed us to gain a better understanding of the key issues related to the production, distribution and consumption of *Aponogeton distachyos* in SA. This approach also helped us to identify several drivers and barriers to its adoption and use, which emanate from different activities in the plant value chain. Finally, our findings suggest some interesting recommendations for the different value-chain stakeholders, such as growers, retailers, and policy makers, which may have important long-term implications for peoples' nutrition and health, as well as for environmental sustainability and biodiversity.

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