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Introducing indigenous and orphan crops (IOCs) in a menu: A case study inquiry into the attitude formation of diners

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ABSTRACT

The global agricultural system is reliant on an increasingly smaller number of species, reducing resilience. Shifts to simplified diets have increased non-communicable diseases in consumers, and there is an urgent need for transitioning to an alternative food system to provide food and nutritional security in an environmentally sustainable manner. Despite their potential at building resilience and addressing poor nutrition, Indigenous and Orphan Crops (IOCs) are largely underutilised due to a lack of knowledge amongst consumers. This case study, conducted in two distinct sections, illustrates the incorporation of IOCs in a set menu, whereafter diners were asked to share their attitudes towards IOCs. All seven steps of the Culinary Innovation Development Process were followed in the conceptualisation of the set menu, while diners' attitude formation (cognitive experience, emotional experience, conative behaviour) is described along the three-component (ABC) model of attitude formation. The dinner was successful in exposing attendees to a broad range of new IOC species and associated flavours, with more than 90 % of respondents being exposed to at least 15 new species in a single sitting. Most of the diners indicated that, following the dinner, they would be likely consumer more IOCs in the future with the majority (97 %) indicating that they would be at least likely to order dishes which include IOCs in restaurant settings, 87 % at least likely to buy ready-made meals which contain IOCs, and 91 % at least likely to buy IOCs from a greengrocer.

1. Introduction

The global agri-food system is at the heart of global economic and social challenges, and is a significant driver of climate change, diminishing natural resources, degradation of ecosystems, and the loss of biodiversity (Araújo et al., 2023). Agriculture is one of the most significant threats to wild plant species, with the largest land footprint of any anthropogenic activity, with grazing and croplands accounting for 24.6 % and 12.5 % of the world's land surface, respectively (Ritchie and Roser, 2024).

At the same time, agrobiodiversity within the agri-food system is under threat, with an estimated 75 % of plant genetic diversity lost over the last century as farmers have transitioned to increasingly fewer crop species (FAO, 1999). As a result, the global agri-food system is heavily reliant on very few species, with six of the world's 400 000 plant species accounting for 57 % of the 9.5 billion tonnes of primary crop production in 2021 (FAO, 2023). This reliance on a few key species leaves the food system vulnerable to environmental shocks and outbreaks of disease, both of which are predicted to increase in frequency and intensity in the near future as a result of anthropogenic climate change (Lesk et al., 2016; Savary et al., 2019).

Despite being dependent on increasingly fewer crop species, the global agri-food system produces enough food to meet the nutritional needs of the global population. Still, food insecurity problems persist, revealing an extreme need for a transition towards alternative food systems to provide food and nutritional security equitably (FAO, 2023). Indigenous and Orphan Crops (IOCs), also referred to as Neglected and Underutilised Plants, show great potential to contribute to a more equitable, sustainable and resilient food system through enhanced food security, dietary diversity, culinary variation, increased health outcomes, and improved income generation (Govender et al., 2017; Okigbo and Anyaegbu, 2021).

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Transition towards more simplified diets has resulted in negative health outcomes, and it has become painfully apparent that the global food system, from production to distribution to consumption, is no longer fit for the purpose of nourishing all people of the world while sustaining the health of the planet (Steiner, 2021). Indigenous and agricultural knowledge about agrobiodiversity practices should be used to address climate change and the food insecurity that arose from the abandonment of many of Africa's native crops (Kuta et al., 2003) and other crop varieties that have shown particular environmental resilience (Kerr, 2014).

As a developing country, South Africa has the capacity to develop large-scale alternative sustainable food production options. In the foreword of a three-part publication, Lost Crops of Africa, Noel D. Vietmeyer writes, "Africa has more native cereals than any other continent. It has its own species of rice, as well as finger millet, fonio, pearl millet, sorghum, tef, guinea millet, and several dozen wild cereals whose grains are eaten from time to time. This is a food heritage that has fed people for generation after generation, stretching back to the origins of humankind. It is also a local legacy of genetic wealth upon which a sound food future might be built. But, strangely, it has largely been bypassed in modern times" (National-Research-Council, 1996). Promoting the use of IOCs can contribute to the increase of genetic diversity within the commercial agri-food production system. It could also build resilience to external stresses, such as environmental difficulties, as many of these unique plant species are well-adapted to local (often adverse) conditions and pests. Furthermore, the expansion of such nutrient-dense IOCs offers opportunities for addressing 'hidden hunger' as well as reinforcing, and in many cases rebuilding, cultural and social connections with the food system.

Diversifying diets to include a wider number of plant species will increase health outcomes for consumers and build greater resilience into the food system. Yet despite their potential, IOCs are largely underutilised. The underutilisation of IOCs may be a result of a lack of consumer awareness of what they are and their potential to be functionally incorporated in a modern diet (Akinola et al., 2020).

Elsewhere in the world, consolidation of traditional recipes into culinary collections has shown to aid in the preservation of traditional food knowledge, foster cultural connections, and increase interest in traditional foods (Nagina et al., 2025; Sánchez et al., 2024; Skinner et al., 2020). A large untapped opportunity therefore exists in South Africa within culinary innovation, celebrating and utilising IOCs, particularly within the hospitality and restaurant environments. This research, therefore, aimed to illustrate how IOCs can successfully be introduced in a predetermined set menu. Specific objectives were to apply the Culinary Innovation Development Model in order to develop a suitable five-course dinner menu, and thereafter to determine consumers' attitude formation (cognitive experience, emotional experience, conative behaviour) in regard to the set menu, utilising a selection of IOCs.

2. Materials and methods

The research followed a mixed-methodology within a case-study, which was accomplished in two distinct parts. The first qualitative part was to develop a suitable set menu for a once-off event offered to >100 diners, hosted on the Future Africa campus, University of Pretoria, on June 1, 2024, in collaboration with Culinary Arts assistants from the Department of Consumer and Food Science at the University of Pretoria. Thereafter, in a second quantitative part of the research, where diners had the opportunity to consume the dishes on the set menu, diners were asked to complete a questionnaire regarding their attitudes towards IOCs incorporated into the menu.

A food service establishment (restaurants, fast-food establishments, or any number of other establishments that serve a selection of food items) menu, is understood to be a list of food dishes that are available in the establishment. It outlines the establishment's strategic marketing plan and serves as the first impression for a consumer who has to make selections from this "card" (McCall and Lynn, 2008). From a review article by Ozdemir and Caliskan (2015), a menu is understood to have four main dimensions: menu item position, menu item description, menu item label and menu card characteristics. A set menu is understood to be a menu with limited menu item choices, usually offering a set number of courses that are available at a fixed price, which was the type of menu used in this research. Menus, in general, are designed to build revenue, and even though the set menu in this research was also offered at a predetermined price, the aim was not to generate profit.

For the first part of this research, co-researchers followed the seven steps of the Culinary Innovation Development Process to develop and execute a multi-course set menu. Research indicates that menu design is often built on intuition and experience rather than hard science. For example, research has indicated that the way menu items are described on a menu can influence the item's popularity (Mifli, 2000). The IOCs used in the development of the menu were sourced from the Future Africa Indigenous and Orphan Crops Collection of the University of Pretoria's Manie van der Schijff Botanical Garden. Species were selected based on suitability for incorporation into the menu, availability of appropriate harvestable material in sufficient quantities, and storage potential.

The seven steps of the Ottenbacher and Harrington (2007) (Fig. 1), Culinary Innovation Development Process were applied in the conceptualisation of the menu, namely: idea generation, screening, trial and error, concept development, final testing, training and finally commercialisation.

During the first part, the multi-course set menu was developed through the application of the Culinary Innovation Development Process and further informed by traditional menu development considerations. A set menu composition would be informed by, amongst others, the type of event, the target audience, the season, and the time of day. In order to develop a multi-course set menu, the menu designer would want to avoid repetition of ingredients or cooking techniques, the over-utilisation of a particular plating style, colours, and textures of foods. In this research, the number of courses, as well as the particular type of dishes (e.g. a soup course) and sequence of the menu, were established before the actual menu items were developed.

Aspects that were considered in the development of the specific courses that comprised the set menu were as follows: the all-important philosophy of the event – to showcase IOCs in a set menu; the set menu size (five courses); dietary options (not too many courses featuring a protein); pricing strategy (in order to encourage people to take part in the research an affordable menu was favoured); diversity within the dishes (visual aspects/aesthetics, textural interest, taste, flavour and nutritional diversity, portion sizes, plate choices and garnishes); availability of table equipment, such as crockery and cutlery (no glassware consideration – see limitations); style of service, including waitron abilities; production facility considerations (including large and small scale equipment availabilities) as well as plating space considerations; production staff capabilities; primary IOCs and secondary ingredient availability; service times (time spaces between courses to allow for plating (n = 131) plates of food, which included temperature considerations); food labelling regulations (even though there was an emphasis on the utilisation of IOCs in the menu, care was taken to only include plants of which evidence existed that they are safe for consumption – however, a participant consent form was signed by participants).

Aspects that were not considered: target audience (the diner was open to anyone who wanted to attend); customer satisfaction derived from sociocultural background or any customer food habits or preference, no demographic or psychographic considerations (this was an open-sign up diner, and customers were privy to the menu prior to booking and paying for their meal); supply chain of ingredients (the IOCs were sourced on the university campus where they are grown and harvested – the remaining ingredients were basic, commercially available goods); dietary restrictions (customers had knowledge about the

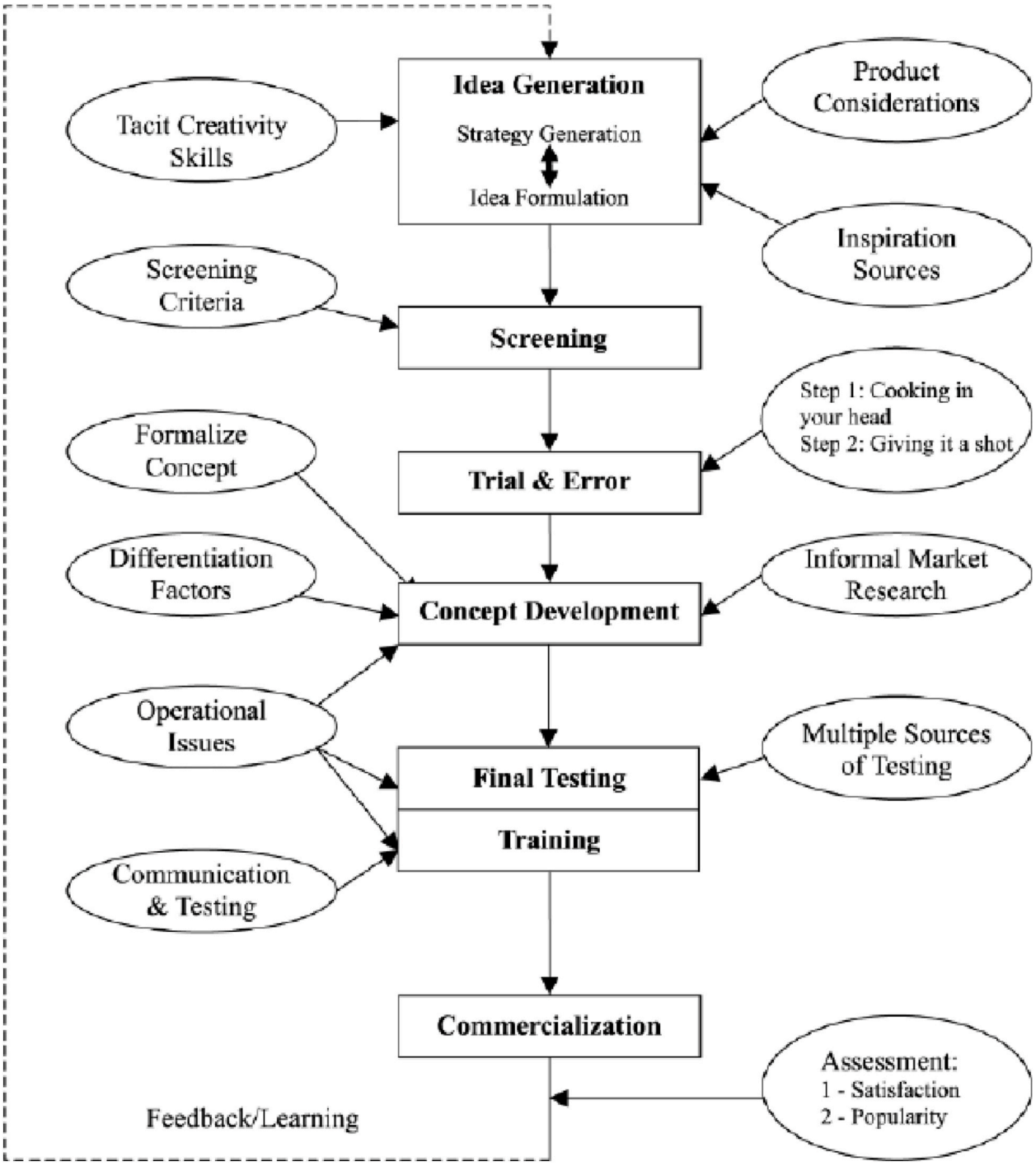

Fig. 1. Culinary innovation development process (Ottenbacher and Harrington, 2007; Stierand et al., 2009).

menu content prior to making a reservation – however, a vegetarian option was offered in place of the main course meat); competitive analysis.

During the idea generation step (step 1) of the Culinary Innovation Development Process, the products (composite dishes for each course of the set menu) were strategised, taking the availability of IOCs and their volumes into account. The Culinary Arts assistants used their tacit skills and creative thinking to generate harmonious and flavourful ideas through the use of consultation with senior Culinary Arts personnel as well as cooking literature (Stierand et al., 2009). Culinary Arts assistants were tasked to first generate a list of IOCs that would have been available two months in the future. Some IOCs were also picked earlier in the season, and frozen, as their harvest season would have been over. Next, the order of the menu was determined, with specific ideas generated for each course. The menu creators were tasked to use the combined availability list (which included actual and potential volumes of IOCs) as well as the designated course to generate a number of potential dishes. This was a focus group discussion with senior chefs as well as garden curators. A potential menu with potential food courses were generated.

During step 2, the screening stage, final IOC seasonality, availability, and product quality were considered, along with the personal cooking abilities of the Culinary Arts assistants. At this stage, financial considerations, such as cost efficiencies, profitability, and additional ingredient product costs (the non-IOCs), were considered in the context of

what an acceptable selling price of the set menu would be. The balance within the plates themselves was considered, along with some discussions of what food items the customers may find acceptable (Stierand et al., 2009). The non-alcoholic beverage served upon arrival set the stage by introducing some delicate IOC flavours that would prepare customers' palates for what was to come. For the first course, it was decided that a bread course which would include IOCs in the actual bread, along with various dips and spreads and butters, would allow for maximum opportunity to showcase the IOCs. Furthermore, the interactive nature of the course, where guests would serve themselves from a platter, would be most engaging and offer consumers the opportunity to find gustatory pleasure/or not. Individual plating would be limited, as such platters were done according to the sizes of tables reserved together, which minimised individual plating. A vast amount of Jerusalem artichoke (*Helianthus tuberosus*) was available, and previous trials have shown that it makes an excellent soup. Crockery at the venue was, however, a problem, and the soup was turned into a frothy cappuccino so that it could be served in a cup and saucer. Plating and food decoration were minimal, which would assist with the speed at which this course could be served. This was followed by a palate cleanser, prior to the main course, which showcased the frozen, previously collected indigenous fruits. Three sorbets from fruits of three species from the genus *Syzygium*, were pre-portioned and kept frozen until service, to minimise melting of the delicate sorbets, as a large amount of sugars and stabilisers may have diminished their delicate flavours. For the main course, an inexpensive cut of beef was slow-cooked and served in a 'pulled' fashion along with a set-custard timbale produced from two green leafy vegetables (*Galinsoga parviflora* and *Bidens pilosa*), which was prepared the day before and re-warmed in order to lessen last-minute plating complexities. The main course further consisted of a starch in the form of a mash made from fresh taro (*Colocasia esculenta*), along with a healthy fermented kimchi-type condiment made from kale (*Brassica oleracea*) and Strelitzia root (*Strelitzia reginae*), as well as an old-fashioned British cuisine type jelly made from crab apples (*Ceratonia siliqua*). The menu concluded with individual baked puddings, considered to be South Africa's national dessert, the Malva pudding, but adapted with the inclusion of two IOC berries, num-num (*Carissa macrocarpa*) and Cape Ash (*Ekebergia capensis*). This was served along with carob (*Ceratonia siliqua*) custard and mondia (*Mondia whitei*) ice cream, as well as a whole carob pod, dusted in edible gold.

Step 3, the trial-and-error phase, consisted of the Culinary Arts assistants adding their recipes along with specific elements and components, as well as volumes for each course that they were responsible for, on a shared Excel sheet. The dishes were produced twice in an iterative process and presented, along with the final cook-off – step 6, to the garden curator and other plant science and consumer and food sciences Faculty members. Each time, each Culinary Arts assistant took meticulous notes of what the senior Culinary Arts staff members, as well as botany experts, suggested, recording all the details before making alterations and amendments prior to the next cooking iteration. Final yield testing and determination were also done during this step.

During step-4, the concept development phase, the Culinary Arts assistants standardised their recipes, along with written working instructions, presentation and plating instructions (after stock control of available tableware), final dishes were photographed, and a kitchen working schedule was developed that included all the courses, with individual components developed over a three day pre-preparation timeframe (Stierand et al., 2009). The final expenses were also determined in order to finalise the menu price.

Steps 5 and 6, which took place in sequence, are where the final testing took place, along with any training of front-of-house (FOH) and back-of-house (BOH) employees. For this research, this step was not executed to its full potential, as an outside venue was used for the once-off set menu dinner, and the Culinary Arts assistants were not able to utilise either the kitchen or dining-room facilities of this venue prior to the event. However, the final menu was prepared and presented to relevant role-players, along with training of FOH and BOH employees. Culinary Arts assistants were also able to test the sequence of how courses should be eaten, although not in the same atmosphere as the final restaurant atmosphere.

After the 6th step of the Culinary Innovation Development Process, the final menu was prepared for diners – this is the 7th step in the process, Commercialisation. This step was functionally executed through the collection and analysis of data from the survey that was presented to guests after they had consumed the dishes presented in the set menu.

During the second part of the research, a self-administered survey in the form of an electronic questionnaire was used to ascertain diners' attitudes towards IOCs. The questionnaire was divided into two parts. Diners were informed of the nature of the menu prior to the event, and on arrival were asked to complete a short introductory questionnaire providing consent to participate in the research study as per University of Pretoria ethics approval (NAS134/2019). This part of the questionnaire was completed on their smartphones via a scannable QR code through Google Forms. The section required minimal input and was primarily used to inform diners that they would receive a follow-up questionnaire by email for completion. On completing the first section of the questionnaire, the second, more comprehensive part of the questionnaire was automatically sent via email to the diner's email. Diners could then complete this second section of the questionnaire at their leisure on the electronic medium of their choice (smartphone, tablet, laptop, or PC). The aim of dividing the questionnaire into two sections is, firstly, not to intrude during a public dinner where diners paid for their meal; not expecting diners to suspend their social interactions to complete the questionnaire; to prevent diners' opinions being influenced by feeling obliged to complete the questionnaire on the evening; to prevent gustatory influences affecting their ability to complete the questionnaire; to prevent survey fatigue influencing their willingness and ability to complete the questionnaire; and lastly, to allow diners time to reflect on the meal and provide contemplative responses.

The questionnaire was informed by applying the three-component (ABC) model of attitude formation, as illustrated by Fig. 2 (Brock et al., 2022). The purpose of applying this model is to expose the influence of cognitive, affective, and behavioural assessments on diners'

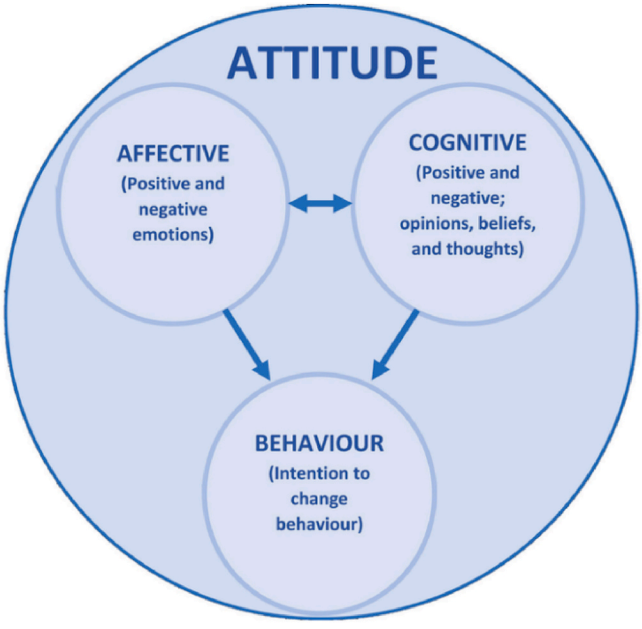

Fig. 2. Adapted ABC model diagram demonstrating relationships between different attitude components (Brock et al., 2022).

attitude formation towards IOCs incorporated in a multi-course meal. Theory explains that attitude formation is the result of a multicomponent process which consists of certain components (cognitive, affective, and behavioural). Within this three-component model of attitude formation, attitude formation consists of successive components that can be defined as cognitive (experience), affective (emotional) and conative (behavioural) (Bakanauskas et al., 2022). Attitudes are formed as a multi-level process. This multi-level process of attitude formation is a combination of cognitive, affective, and conative components. When attitudes are formed, consumers often rely on pre-existing knowledge and opinions to ensure they are consistent in their beliefs. The ABC model was therefore most suitable for this research, as it allows researchers to understand diners' attitude formation, which is the correlation among knowing, feeling, and doing. Diners would first form a belief through cognition about the attitude object, in this case, the incorporation of IOCs into the menu they consumed. Thereafter, or during the meal, they would make positive or negative evaluations about the utilisation of the incorporation of IOCs into the meal, and finally, they would have some actions (behaviour), such as seeking out more IOCs, planting such crops, or even advocating for better uses of such plants.

In the case of a multi-course meal incorporating IOCs, diners had an experience by consuming the different dishes that included IOCs. Thereafter, they had certain emotions (either positive or negative) towards IOCs. Finally, in the questionnaire, the researchers determined their conative or behavioural attitudes by asking them questions regarding their potential future behaviour towards IOCs.

3. Results and discussions

The following results and discussions are presented following the two separate parts of the research - an initial menu development part and, after consumption, the determination of diners' attitudes that may have formed. Below is the final menu as served on the evening of the event.

Final Menu:
Pelargonium (*Pelargonium graveolens*) and rose-apple (*Syzygium jambos*) drink
∞
Chinese water chestnut (*Eleocharis dulcis*) and Lowveld chestnut (*Sterculia murex*) bread, and African moringa (*Moringa stenopetala*) bread served with lemon and orange citrus butter, bambara groundnut (*Vigna subterranea*) hummus, ginger-rosemary oil (*Rosmarinus officinalis 'Ginger*), spekboom (*Portulacaria afra*) pesto
∞
Jerusalem artichoke (*Helianthus tuberosus*) soup with wild garlic (*Tulbaghia* X 'Ashanti'), crème fraiche and roasted marula (*Sclerocarya birrea*) nuts
∞
Syzygium sorbets: Water berry (*Syzygium cordatum*), Woodland water berry (*Syzygium guineense*), and Brush cherry (*Syzygium paniculatum*)
∞
Slow braised beef brisket with crab-apple (*Malus sylvestris*) jelly served with morogo (*Galinsoga parviflora* and *Bidens pilosa*) timbale, kale (*Brassica oleracea*) and Strelitzia kimchi (*Strelitzia reginae*), and taro (*Colocasia esculenta*) mash
∞
Num-num (*Carissa macrocarpa*) and Cape ash (*Ekebergia capensis*) malva pudding with Mondia (*Mondia whitei*) ice cream and carob (*Ceratonia siliqua*) chocolate sauce

Fig. 3, 4, 5, 6, 7 (left to right, row one and two) Specific courses presented to diners in sequence of the Final Menu (see previous paragraph - excluding the arrivals beverage)

Fig. 3. Bread course including spreads and butters.

Fig. 4. Jerusalem artichoke soup course.

Of the 131 attendees, 60 (45 %) participated in the pre-dinner questionnaire. Due to the nature of the event, it was expected that participants would be largely self-selecting as having adventurous palates. This was reflected in the data with 18 (30.0 %) and 36 (60.0 %) considering themselves to be adventurous and very adventurous food wise respectively (Fig. 8). A minority of respondents considered themselves unadventurous eaters (6.7 %) and very unadventurous eaters (3.3 %, Fig. 8). Respondents represented a wide but evenly spread age demographic ranging from 24 to 68 years of age, with a median age of 39 (Fig. 8). In terms of promoting IOCs, the respondents represented an important demographic, as a large majority (78.3 %) indicated that they were the main purchasers of food within their respective households (Fig. 8).

Fig. 5. Syzygium sorbet course.

Fig. 6. Main course including brisket, morogo timbale, Strelitzia kimchi and taro mash.

The post-dinner questionnaire received fewer responses than the pre-dinner questionnaire, with 34 (25.9 %) of the 131 attendees responding. This was a smaller dataset than expected and is further discussed under the limitations of the study.

Respondents were evenly split regarding knowledge of IOCs, with 19 (52.9 %) agreeing or strongly agreeing with the statement that they believed they possessed knowledge of IOCs (Fig. 9). Respondents largely believed it to be important to increase the promotion of IOCs, with 20 (58.8 %) strongly disagreeing and 10 (29.4 %) disagreeing with the statement that encouraging the increased promotion of IOCs is not important (Fig. 9). Additionally, a large majority (85.3 %) of respondents believed it was important to increase the number of

Fig. 7. Dessert course featuring Num Num and Cape Ash Malva pudding.

commercially farmed plant species, with 11 (32.4 %) and 18 (52.9 %) agreeing and strongly agreeing with the statement, respectively (Fig. 9). Nearly all respondents (88.2 %) believed that the responsibility of increasing consumption of IOCs lies with both consumers and retailers, with most (67.6 %) believing that the responsibility lies with growers/farmers, researchers, consumers, and food retailers (Fig. 9). This indicates that respondents are aware that accessibility to and consumption of IOCs is a complex system requiring collaboration of multiple actors across the supply chain. Nearly all (91.2 %) of respondents believed that changing their own eating behaviours could increase the commercial availability of IOCs, with 10 (29.4 %) strongly agreeing with the statement (Fig. 9). This indicates that respondents viewed themselves as an integral component of the IOC production-consumption ecosystem and recognised that demand would have a direct impact on accessibility to IOCs in the future by creating markets for producers and distributors.

Respondents largely did not believe that IOCs required special cooking techniques compared to conventional crops, with 19 (57.6 %) and 2 (6.1 %) respectively disagreeing and strongly disagreeing with the statement (Fig. 9). Belief in personal knowledge of IOCs did not influence belief that IOCs required special cooking techniques, with both those who believed they possessed knowledge of IOCs and those who did not possess knowledge of IOCs responding at an approximate 60:30 split on IOCs requiring special cooking techniques (Data not shown). However, of the respondents, 14 (41.2 %) had never cooked IOCs before, while thirteen (38.2 %) found cooking with IOCs to be more challenging in comparison to conventional crops (Fig. 9).

Respondents indicated a wide range of previous exposure to the IOCs on the menu, with a range of 0–18 species and a median of 4 (Table 1). Spekboom, marula, and wild garlic were the three crops which the most respondents had tasted prior to the event, with 22 (64.7 %), 20 (58.8 %), and 14 (41.2 %) respondents indicating prior exposure, respectively Table 1). All three are indigenous to South Africa and common in cultivation, so these results are expected. The dinner was considered successful in terms of exposing attendees to a broad range of new IOC species and associated flavours, with more than 90 % (31) of respondents being exposed to at least 15 new species in a single sitting (Fig. 10).

When asked to identify elements of the dinner that they did and did not enjoy, respondents reported substantially more positive experiences

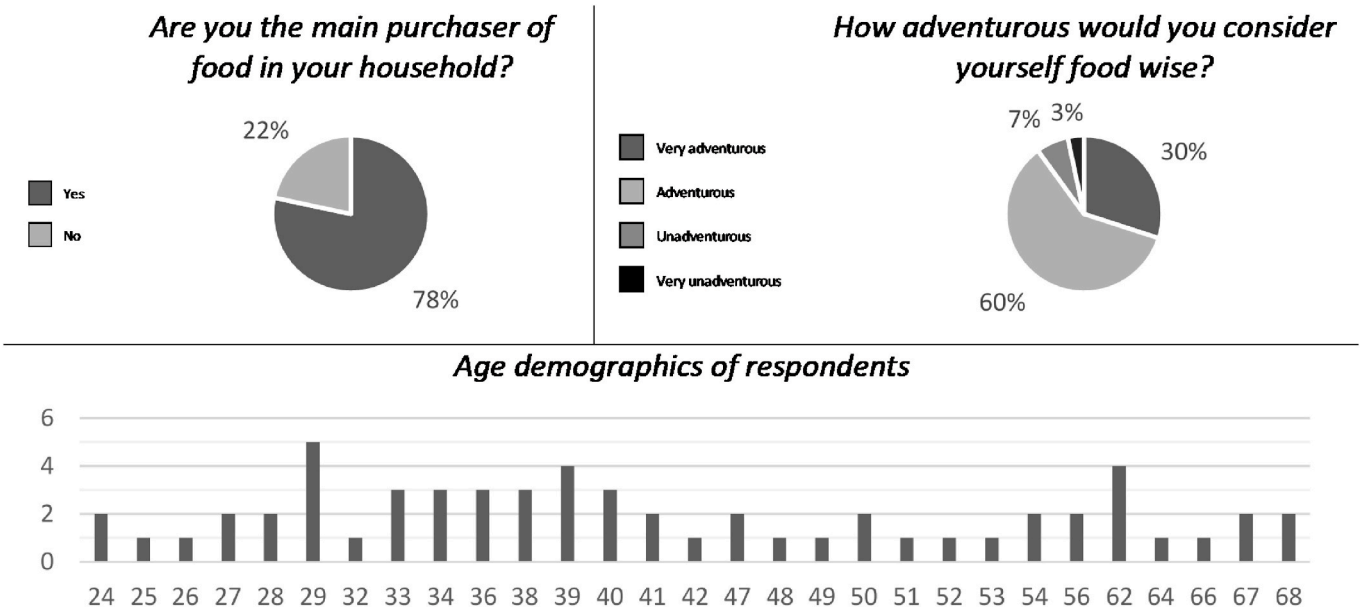

Fig. 8. Responses to the pre-dinner questionnaire (n = 60).

than negative experiences in respect of all but one of the elements on the menu. Of the 17 elements, 14 received negative comments from less than 10 % (4) of respondents. In the instance of both the Spekboom pesto and the *Syzygium* sorbets, the majority of the respondents who indicated negative experiences (75 % and 83 % respectively) specifically referred to the texture of the dish (Table 2). Negative comments referring to the pesto typically referred to it as "gooey", which is likely a by-product of the succulent nature of the plant. Negative comments related to the sorbets indicated that respondents found the texture to be mealy and left a 'dry' feeling in the mouth. The majority of comments indicated that one of the three sorbets had a mealier texture than the others. Although respondents did not indicate which of the three sorbets this was, it was likely the sorbet made from *Syzygium paniculatum*. This example reinforces the need to develop species-specific recipes, as even species within the same genus can demonstrate a wide range of physical properties. The kale and *Strelitzia* kimchi received negative comments from 26 respondents (76.5 %), of which 21 pertained to the taste (Table 2). However, 18 of these specifically refer to flavours related to other ingredients rather than the flavour of either the kale or the Strelitzia root. Eleven respondents found the dish too salty, and seven found the dish too spicy. One respondent made specific reference to the flavour of the *Strelitzia* root, stating they wished "the Strelitzia root was featured more forward; it had an incredibly subtle flavour and the texture was great". Additionally, contradictory feedback was received from different respondents. For example, the kale and *Strelitzia* kimchi, which was described as both authentic and not authentic kimchi, too spicy and perfectly spiced, and both overpowering and perfectly complementary by different respondents. This was somewhat expected given the number of new, and typically strong, flavours participants were exposed to in a single sitting. Kimchi is not a typical South African flavour, and potential cultural preferences may have had a significant impact on the responses to this food. Despite the broad range of individual taste preferences indicated by the examples of contradictory feedback, the overwhelming majority of positive comments indicates that the predetermined set menu was a successful approach to exposing consumers to a broad range of IOCs in a single sitting.

Respondents indicated that they believed they would be able to distinguish mash made from IOC tubers from mash made from conventional tuber crops. Nine (27.3 %) respondents strongly agreed, and 17 (51.5 %) respondents agreed with the statement (Fig. 9). Similarly, 5 (14.7 %) of respondents strongly agreed and 23 (67.6 %) agreed that certain types of cooked leaf IOCs have a different texture to conventional leaf crops (Fig. 9). In both instances, no respondents strongly disagreed with either statement.

With respect to what barriers would potentially prevent respondents from consuming IOCs more readily if these crops were commercially available, responses could be grouped into three categories: cost, lack of knowledge and/or information resources related to specific IOCs, and unwillingness of other household members to eat IOCs. An understanding of the potential barriers consumers may face is important to assist farmers who are bold enough to grow alternative crops can reduce risk when taking their product to market. The most common barrier indicated by respondents was a lack of knowledge and/or information resources related to specific IOCs, as identified by 15 (44.1 %) of respondents. This reinforces the need for academic and research institutions to make knowledge generated through research accessible to consumers. Cost was mentioned by 7 (20.6 %) respondents, indicating a need to ensure that IOCs are economically competitive compared to more conventional crops. This may be a challenge for farmers, given the economies of scale associated with conventional crops as well as the lower yields commonly found amongst IOCs. However, many IOCs are better suited for production in marginal or harsh environments where conventional crop options are unsuitable. By making use of these unconventional spaces, producers can potentially increase their production and build resilience against external shocks such as droughts. One respondent (2.9 %) identified the unwillingness of other household members to eat IOCs as a potential barrier. This is an important consideration, and likely one that is underrepresented in a sample which largely classifies themselves as adventurous eaters.

All but one respondent indicated that, following the dinner, they would be likely to order dishes which include IOCs in restaurant settings, with the majority (64.7 %) indicating that they would be very likely (Fig. 9). A smaller majority indicated that following the dinner, they would likely buy ready-made meals which contain IOCs, with 14 (45.2 %) likely and 13 (41.9 %) very likely (Fig. 9). A similar proportion indicated that, following the dinner, they would buy IOCs from a fresh produce market if available, with 16 (47.1 %) indicating this to be likely and 15 (44.1 %) indicating this to be very likely (Fig. 9). The only scenario where a respondent indicated that they were very unlikely to buy IOCs following the dinner was in the form of ready-made meals, with the singular respondent further clarifying that this was because they "don't buy processed foods". However, while participants indicated the

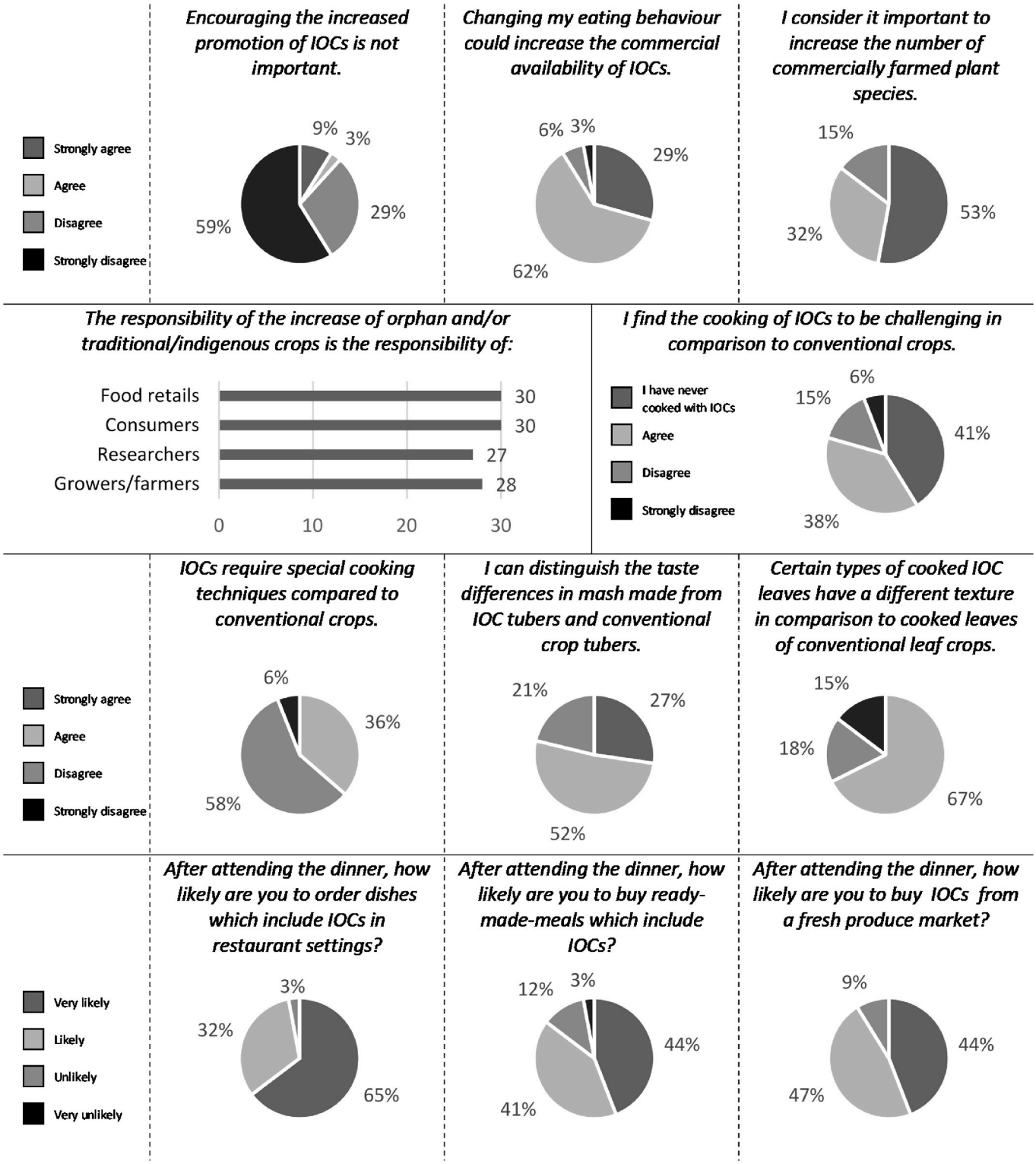

Fig. 9. Responses to selected questions of the post-dinner questionnaire (n = 34).

likelihood of behavioural changes, it is beyond the scope of this study to prove that such behavioural changes did occur.

Apart from the results mentioned here, Step 7 of the Culinary Innovation Development Process is often executed through "direct conversational customer feedback" (Stierand et al., 2009), but in the case of this dinner, the overwhelming response through ticket sales could also be an indication towards positive attitudes towards the incorporation of IOCs in a set menu environment.

Fewer responses were received on the post-dinner questionnaire, which limited the sample size. The sample size of 34 was considered sufficient, and this was further validated by the consistency of responses across the sample. However, future work of this nature should consider incorporating the post-event feedback into the dining experience to make better use of the 'captive audience'. Some additional feedback received following the event was requests for a more educational element to be incorporated into the event structure.

Table 1
Number of respondents exposed to each IOC species.

Species	Number of respondents
Spekboom (Portulacaria afra)	22
Marula (Sclerocarya birrea)	20
Wild garlic (Tulbaghia spp.)	14
Carob (Ceratonia siliqua)	13
Num-num (Carissa macrocarpa)	13
Crab-apple (Malus spp.)	11
African moringa (Moringa stenopetala)	9
Pelargonium (Pelargonium graveolens)	9
Waterberry (Syzygium cordatum)	8
Taro (Colocasia esculenta)	7
African moringa (Moringa stenopetala)	6
Brushcherry (Syzygium paniculatum)	6
Sunchoke/Jerusalem artichoke (Helianthus tuberosus)	6
Chinese water chestnut (Eleocharis dulcis)	4
Rose apple (Syzygium jambos)	4
Bambara groundnuts (Vigna subterranean)	3
Mondia (Mondia whiteii)	3
Rose apple (Syzygium jambos)	3
Bambara groundnuts (Vigna subterranean)	2
Blackjack (Bidens pilosa)	1
Cape ash (Ekebergia capensis)	1
Chaya (Cnidoscolus aconitifolius)	1
Lowveld chestnut (Sterculia murex)	1

As the food offerings were in the form of a predetermined multi-course menu, and participants purchased tickets, with the knowledge that they would be offered a fixed set menu, no menu design dimensions that may affect participants' menu item perceptions were determined. This work furthermore did not ascertain consumers' perceptions regarding the intricacies of specific foods within the context of a menu. Even though menu design, as a variable, has a considerable potential in influencing customers' item-ordering behaviour and other perceptions (Ozdemir and Caliskan, 2015), the aim of this research was only to determine the viability of the incorporation of IOCs into a commercial multi-course set menu and determine diners' consequent conative responses.

No beverage pairing considerations incorporated in the engineering of the menu – apart from a newly developed non-alcoholic (for diners with such requirements) arrivals drink, participants had the opportunity to purchase their own drinks at a cash bar.

4. Conclusions

While the introduction of IOCs in food menus holds immense potential, their utilisation also presents many challenges. Several factors must be considered when introducing such foods into menus, from sourcing, storage, pre-preparation and cooking, to sensory aspects such as unfamiliar tastes, flavours, and textures. Such aspects need to be carefully considered to ensure a successful dining and sensory experience.

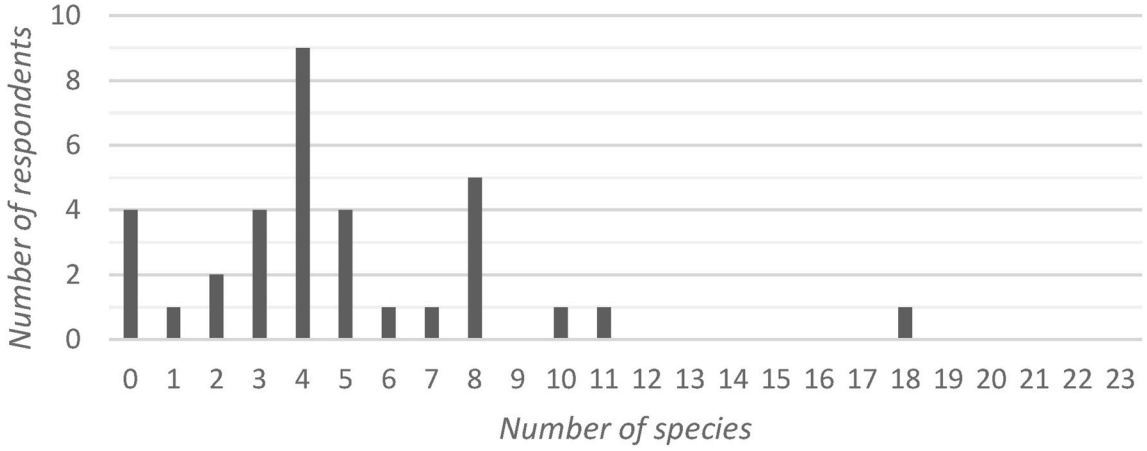

Fig. 10. Previous exposure to IOC species on the predetermined set menu.

Table 2
Number of respondents who provided positive and negative of each menu element.

	Negative				Positive			
	General	Taste	Texture	**Total**	General	Taste	Texture	**Total**
Pelargonium and rose-apple drink				**0**	11	1		**12**
Chinese water chestnut and Lowveld chestnut bread		1		**1**	24	6		**30**
African moringa bread				**0**	22	5		**27**
Bambara groundnut hummus				**0**	22	6		**28**
Ginger-rosemary oil		1		**1**	18	5		**23**
Citrus butter				**0**	17	1		**18**
Fig vinaigrette				**0**	17	1		**18**
Spekboom pesto	1		3	**4**	19	5		**24**
Jerusalem artichoke soup with wild garlic crème fraiche and roasted marula nuts	1	1		**2**	18	8		**26**
Syzygium sorbets	5		6	**11**	7	3		**10**
Crab-apple jelly				**0**	7	3		**10**
Morogo timbale				**0**	11	3	1	**15**
Kale and Strelitzia kimchi	4	21	1	**26**	7	5	1	**13**
Taro mash		1		**1**	10	3		**13**
Num-num and Cape ash malva pudding		2	1	**3**	10	2		**12**
Mondia ice cream	1	1		**2**	14	2		**16**
Carob chocolate sauce		1		**1**	9	1		**10**

Despite the complexities of working with IOCs, role-players in this research were able to develop a menu (following the 7-step Culinary Innovation Development Process) for a dinner that was hosted on the Future Africa campus, University of Pretoria, on June 1, 2024, embracing South African culinary diversity and food heritage. Each dish, containing IOCs, became a tribute to the resilience of our diverse cultural communities, the beauty of South African biodiversity, and the power of food to connect us across cultures and continents.

This research makes a valuable contribution of the successful application of the Culinary Innovation Process, even in light of certain researchers who believe that the process of culinary innovation is not a well-structured process – rather that a culinary innovation, as a process which includes creativity "must be highly non-linear, with circular and iterative components, involving multiple feedback and feedforward loops" (Stierand et al., 2009).

This research furthermore makes a positive research contribution to the ABC model in the sense that there was compelling evidence that the positive emotions experienced during the event affirmed pre-existing positive beliefs regarding IOCS and will likely contribute to real-world purchases of products containing IOCs. While some factors identified which would prevent respondents from consuming more IOCs in the future are beyond the control of individuals, such as the market cost of IOCs, the majority of respondents recognised that they are an important component of the production-consumption ecosystem and that their actions would play a role in future commercial access to IOCs.

Although the predetermined multi-course menu is considered to have been a successful approach to exposing consumers to a broad range of IOCs, more work is needed to understand crop-specific factors which would limit the consumption of individual IOC species at both the retail and household levels. Additionally, more work is needed to quantify the full potential extent of behavioural influence which a predetermined multi-course menu could have on consumer trends.

5. Implications for gastronomy

Indigenous and Orphan Crops (IOCs) increase the resilience of the global food system, ensuring future food security, as these species are typically drought, heat, and pest tolerant. These traits can play a part in breeding of more conventional crop species through modern breeding techniques, and thus IOCs are an important source of novel genetics for future crop breeding. Diversifying diets to include a wider variety of species has been shown to improve health outcomes for consumers. In particular, the inclusion of IOCs in diverse diets increases nutritional quality and IOCs are typically more nutrient dense than more common commercially available cultivars. Incorporating diverse IOC plantings into the urban landscape also increases the species richness of urban biodiversity. Culinary innovators, chefs, R&D sectors would all benefit from increased availability of IOCs. They provide a much larger, more interesting 'library' of foods that gastronomy can benefit from.

CRediT authorship contribution statement

Hennie Fisher: Writing – review & editing, Writing – original draft, Visualization, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Richard Hay:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Ethics

Ethical clearance was obtained from the Ethics Committee of the Faculty of Natural and Agricultural Sciences, University of Pretoria, number NAS134/2019.

Declaration of competing interest

The authors have no conflicts of interest to declare. All co-authors have seen and agree with the contents of the manuscript and there is no financial interest to report. The authors certify that the submission is original work and is not under review at any other publication. Both authors hereby declare equal contributed to the entire manuscript.

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Data availability

Data will be made available on request.

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