(English only / en inglés únicamente / Seulement en anglais)

CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES
OF WILD FAUNA AND FLORA

Nineteenth meeting of the Conference of the Parties
Panama City (Panama), 14 – 25 November 2022

A REVIEW OF EDIBLE ORCHID TRADE

1. This information document is submitted by the Secretariat in relation to document CoP19 Doc. 86 on *Products containing specimen of Appendix-II orchids*.*

2. The report of the study on international trade in edible orchids commissioned by the Secretariat in support of the implementation of Decision 18.237 and referred to in draft Decision 19.AA in paragraph E of the Secretariat's comments is attached as an Annex to the present information document.

* *The geographical designations employed in this document do not imply the expression of any opinion whatsoever on the part of the CITES Secretariat (or the United Nations Environment Programme) concerning the legal status of any country, territory, or area, or concerning the delimitation of its frontiers or boundaries. The responsibility for the contents of the document rests exclusively with its authors.*

A Review of the Edible Orchid Trade

Published July 2022

Prepared under contract from the CITES Secretariat by Kew Gardens - UK CITES Scientific Authority for Flora (Dhanda, S., Bullough, L.-A., Whitehead, D., Grey, J. & White, K).

Produced with the financial support of the CITES Secretariat and the Department for Environment, Food & Rural Affairs, U.K.

Royal Botanic Gardens Kew

Department for Environment Food & Rural Affairs

CITES

A Review of the Edible Orchid Trade

Disclaimer:

The findings, interpretations, and conclusions expressed herein are those of the author(s) and do not necessarily reflect the views of the CITES Secretariat, the United Nations Environment Programme, United Nations or the Parties to the Convention.

The designations employed and the presentation of material on any map in this work do not imply the expression of any opinion whatsoever on the part of the CITES Secretariat, the United Nations Environment Programme or the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Links contained in the present publication are provided for the convenience of the reader and are correct at the time of issue. The CITES Secretariat takes no responsibility for the continued accuracy of that information or for the content of any external website.

Citation:

Dhanda, S., Bullough, L.-A., Whitehead, D., Grey, J. & White, K. 2022. A review of the edible orchid trade.
Royal Botanic Gardens, Kew, Surrey, U.K.

Credits

Photographs:
Front cover: *Disa aequiloba*, Zambia by Nicholas Wightman
Materials and methods: *Orchis* spp. from Kew's Collections by Paul Little
Results: *Dactylorhiza maculata* tubers from Kew's Collections by Paul Little
Conservation impact: Harvested tubers, Zambia by Seoljong Kim

Design: Ines Stuart-Davidson

Royal Botanic Gardens Kew

Department for Environment Food & Rural Affairs

CITES

Acknowledgements

We wish to thank Kim Jacobsen for his knowledge and time on edible orchids and Mark Nesbitt for guidance on sources of data on edible orchids. We are grateful to Ben Hill and Erin Messenger for access to Kew's Economic Botany Collection. We greatly appreciate Sohaib Karous for his assistance on web crawling and technical support. We also wish to thank the following people for sharing their expertise and valuable knowledge for this project: Sarina Veldman, Chelestino Balama, Hugo de Boer, Nicholas Whiteman and Susanne Masters. We are thankful to Carly Cowell and Emma Williams for feedback and support on this project.

Contents

Executive summary

The entire orchid family is listed on CITES to ensure international trade is not detrimental to wild populations. It is the largest family listed with at least 30,000 species. Despite this listing, CITES signatories are aware there are implementation issues in enforcing legal orchid trade.

Orchids are used for food, medicine, cosmetics, and ornamental purposes. Due to the enormity of orchid collection, compiling a list of all orchids in trade has been difficult. This review focuses on one use type of orchids (food, including food additives), identifying those that are edible, their uses and existing trade to provide an understanding of orchid use regionally and globally with a view to providing a starting point for the facilitation of legal trade.

The primary aim of this study is to review the international trade in, and conservation impacts of, food products containing orchid specimens with a focus on chikanda use in Africa and salep use in Central Asia and Europe. An additional aim is to identify other orchids documented as being edible.

This was a desk-based study which included a literature search, trade search using manual crawling techniques and an automated algorithm, and the inclusion of qualitative data from key experts. The project brought together specific CITES knowledge and orchid consumption and trade expertise.

The literature identified 374 edible orchids. Those with documented use for the products known and traded as chikanda and salep accounted for just under half of all identified with 186 species and 188 identified as 'Edible'. For many of the other species, the literature did not provide documentation of use, only edibleness. For those with use documentation, it was not always clear if the historical use is currently in practice. Most edible orchid species did not have an IUCN Red List assessment. Of those that did, most were categorised as Least Concern. Of those that did not, many had a national or regional assessment completed, with 63 being categorised as Threatened.

Chikanda, a food "cake" made with ground terrestrial orchid tubers, is eaten across several African countries, predominately Zambia. The genera most used to make chikanda are *Disa*, *Satyrium* and *Habenaria*. Salep, a powder also made from ground terrestrial orchid tubers, is used in Iran, Greece and predominately Turkey. The genera most utilized when making salep were *Ophrys*, *Dactylorhiza*, and *Orchis*.

Both chikanda and salep are made with terrestrial tubers which are exclusively taken from the wild. They are largely collected indiscriminately, with the destruction of the whole plant. Species level identification is difficult for collectors who rely on tuber traits such as taste and texture rather than above-ground plant characteristics to determine whether they are suitable for trade. There was evidence of some knowledge of the need for and the success of some small-scale sustainable harvesting, as well as the use of substitute ingredients for salep. However, while chikanda tuber collectors noted the scarcity of edible orchids, evidence suggests they travel much longer distances to harvest rather than attempt sustainable harvesting. In addition, the protection of areas such as national parks has not prevented the harvesting of chikanda orchids in those areas.

Salep is now readily accessible in a variety of forms to consumers around the world via well-known online marketplaces. Every aspect of this trade was found to be opaque and, while all the listings offered international shipping, none referred to CITES regulations. This appears to be a clear example of the use of online marketplaces by vendors and consumers who are either unaware of, or willing to circumvent, CITES controls. Without the use of CITES permits and authentication of product ingredients and vendor claims, the impact upon wild populations cannot accurately be assessed, although it is potentially significant.

Both salep and chikanda products have seen a rise in demand and collectors of both have reported seeing a decline in edible orchid populations. The countries with the highest demand for products are increasingly reliant on tubers harvested from other countries. While cross border trade was evident, there was no evidence of CITES registration or declaration. Online trade in chikanda products and raw ingredients is currently limited, suggesting that online international trade is rare.

This scoping review has provided an insight into the extent of edible orchids, and the salep and chikanda trade. It has shown that this trade appears unregulated and is a threat to wild populations. However, it is vital to consider that the trade outlined in this report is an important part of many people's livelihoods. Recommendations from this study include field research and consultations with range states to understand further the potential for cultivated systems for tubers or work towards sustainable harvesting and monitoring practices. Further details are required at a country level for range states for these trades including population data, harvest and regeneration data with support from CITES signatories. A preliminary list of genera and species in the edible orchid trade will facilitate future discussions on CITES orchid exemptions.

Introduction

This report was commissioned by the CITES Secretariat with support from the UK Department of Food and Rural Affairs to contribute to CITES decisions 18.327 - 18.330 on products containing specimens of Appendix-II orchids. It evaluates the threats to wild species posed by the edible orchid trade and the dynamics of the trade to inform discussions on the impact of exempting orchid products and derivatives in line with Decision 18.327(a)(b). Additionally, one of the outcomes of this scoping project aims to inform the Plants Committee on an understanding of the knowledge gaps and research priorities for the edible orchid trade, as suggested in Decision 18.327(c).

All orchids are listed on CITES to ensure international trade is not detrimental to wild populations. There are at least 30,000 species in the orchid family, making it the largest family listed. Orchids are used for food, medicine, ornamental display and cosmetics, in addition, they provide many ecological functions (Hinsley et al., 2018). CITES signatories are aware there are implementation issues in enforcing legal orchid trade. To-date case studies of orchid use have been put forward to CITES, but due to enormity of the orchid family collecting a list of all orchids in trade has been difficult to compile. This report focuses on one use type of orchids, to provide a starting point for the facilitation of legal trade through a deeper understanding of orchid use regionally as well as globally.

We aim to review the international trade and conservation impacts of food products that contain orchid specimens with a focus on chikanda use in Africa and salep use in Central Asia and Europe, and to provide an overview of edible orchids globally. This is a desk-based study with a literature search, trade search using manual and automated crawling techniques, in addition to qualitative data from key experts.

In this study we classified edible as food or a food additive suitable for human consumption. We noted close synergies between edible orchids and medicinal and aromatic orchids, but the focus of this review was on orchids used for food. We found 374 edible orchids documented in the scientific and grey literature as well as databases. This number is likely an underestimate as it is based on available data. Edible orchids are used as flavouring agents in food, and to make dishes such as ice-cream, chikanda, edible flower decorations and consumed as drinks such as salep and teas. Products with orchid specimens are consumed nationally, regionally and internationally.

The trade of orchid specimens has been discussed by CITES. At the 25th Meeting of the Plants Committee, the CITES Secretariat noted that the large trade of orchid tubers affected multiple species and that the data does not appear in the CITES trade database. The trade of orchid tubers is a threat to wild populations and the trade seems to be unregulated and not enforced (CITES, 2020).

CITES context on edible orchids

PC22

The origin of CITES discussions on orchid uses commenced at the 22nd Meeting of the Plants Committee (PC22, Tbilisi, 2015). An intersessional working group was established to discuss the potential risks and benefits of an exemption for orchid components particularly for orchid specimens used in cosmetics. This discussion stemmed from a trade survey commissioned by Switzerland which revealed 39 species of Orchidaceae are found in European commerce. Three of the 39 orchid species in the review were classified as a food supplement; *Cymbidium goeringii* (whole plant), *Dendrobium nobile* (aerial part; stem; whole plant) and *Orchis mascula* (flower, tuber and fecula of the roots, whole plant) (Brinckmann, 2014a) . *C. goeringii* is consumed in the form of a pill with properties of antioxidant, hair and skin conditioning. *Dendrobium nobile* was found in pre-workout tinctures in the form of powders and extracts. *Orchis mascula* were found in herbal dietary supplements in the form of an extract either from the whole plant, tuber or flower.

Additionally, PC22 Inf. 6 by the IUCN SSC Orchid Specialist group presented a summary of the illegal collection and international trade of orchids for food and medicine including salep and chikanda. This document highlighted the breadth of commodities of orchid specimens in trade.

COP17

Decisions were adopted at COP17 directed to the Plants Committee to continue the work of the working group in line with relevant discussions in the annotations working group. The decisions were for the working group to develop a questionnaire to seek information on the trade of orchid parts and derivatives (wild and artificially propagated) to consider the potential conservation impact of exempting orchid products from CITES controls. The questionnaire requested information on the trade in orchid products from source to final product, how NDFs are

made, traceability and identification along the trade chain and trade reporting. The breadth of details included orchid parts and derivatives used in cosmetics, nutritional supplements, traditional medicines, foodstuffs and conservation concerns for wild populations (CITES, 2016).

In response to Decision 17.318 adopted at COP17 Switzerland commissioned in-depth case studies on *Vanda coerulea, Vanda tessellata, Papilionanthe teres, Cypripedium parviflorum var. pubescens* and *Gastrodia elata*, and overviews of salep, chikanda, flower and vibrational essences, orchids and fragrances. The document noted *Gastrodia elata* is also found in herbal dietary supplements, but these are made from cultivated *G. elata* rhizomes, with little evidence it's found in the European market (CITES, 2017).

SC69

At SC69, Inf. 39 submitted by the IUCN Orchid Global Trade Programme presented CITES implementation issues, including trade in edible, medicinal and ornamental orchids worldwide and an outline a series of priority actions for strengthening CITES implementation for orchids. Recommendations for orchids used for chikanda were to consult with key Parties (e.g., Zambia and Tanzania) and undertake field research to evaluate the scale of trade and primary trade routes. Recommendations for orchids used for salep were to consult with key Parties (e.g., Turkey) and domestic experts to determine whether artificial propagation is viable, and to evaluate the scale of trade and existing trade networks for wild plants.

PC24

At PC24 the focus was on orchids used for cosmetic and personal care. Additionally, the working group agreed that additional consideration of the use of orchids in personal care products, medicinal, and foodstuffs is needed, and that such consideration will need to continue to the next intersessional period. The working group also agreed that the evaluation of the use of orchids in cosmetics and personal care products should be concluded before moving on to other sectors. A new set of decisions were adopted at CITES Cop18.

PC25

At PC25 the CITES Secretariat produced a comprehensive assessment of the potential conservation impact of exempting orchid products and derivatives from CITES controls using four guiding questions. The document acknowledged food products such as salep and chikanda were produced from a large and indiscriminate selection of tuberous orchids, and highlighted challenges for the regulation of trade in wild orchids.

PC25 Inf 4 is a collation of all the commissioned reports for products containing orchid specimens. This is predominantly cosmetics, personal care, some perfume and a comprehensive report on salep and chikanda. The salep report identifies 78 species in trade. The chikanda report also identifies a list of 32 orchid species used in chikanda.

The report of the Plants Committee (Decision 18.330) was presented at SC74. This concluded further research is needed and future areas of research could focus on food and medicinal plants, but the scope of the research should be narrowed. To inform the discussions in CITES it is likely that field work is necessary to obtain accurate and sufficient data in source countries that have wild harvest of medicinal or edible orchids (CITES, 2022).

CITES orchid listing

Orchidaceae species are listed on Appendix II of CITES, with the exception of the taxa listed on Appendix I. Appendix I orchids include the genus listings of *Paphiopedilum* and *Phragmipedium* along with the following species; *Aerangis ellisii, Cattleya jongheana, Cattleya lobata, Dendrobium cruentum, Mexipedium xerophyticum, Peristeria elata* and *Renanthera imschootiana* (Govaerts et al., 2019). Appendix II orchids are listed with annotation #4 as follows:

> COP18 #4
> All parts and derivatives, except:
> a) seeds (including seedpods of Orchidaceae), spores and pollen (including pollinia). The exemption does not apply to seeds from Cactaceae spp. exported from Mexico, and to seeds from *Beccariophoenix madagascariensis and Dypsis decaryi* exported from Madagascar;
> b) seedling or tissue cultures obtained in vitro, in solid or liquid media, transported in sterile containers;
> c) cut flowers of artificially propagated plants;
> d) fruits, and parts and derivatives thereof, of naturalized or artificially propagated plants of the genus *Vanilla* (Orchidaceae) and of the family Cactaceae;
> e) stems, flowers, and parts and derivatives thereof, of naturalized or artificially propagated plants of the genera *Opuntia* subgenus *Opuntia* and *Selenicereus* (Cactaceae); and

f) finished products of *Aloe ferox* and *Euphorbia antisyphilitica* packaged and ready for retail trade.

Aims and objectives

The aim of this project was to review the threats to wild species in the international edible orchid trade and evaluate the conservation impacts of food products that contain orchid specimens with a focus on chikanda and salep use.

Our objectives:

- Undertake a global scoping review of principal food products in international trade that contain orchid specimen using online data collection, literature analysis and expert interviews.
- Analyse geographic patterns and temporal dynamics of the availability, trade routes and pricing of salep and chikanda products, using the CITES Trade database, and systematic manual and automated online search for products in trade.
- Compile the taxa principally used in salep and chikanda products and available information on their biology, conservation, sources of harvest and estimated harvest volumes, using scientific and grey literature reviews, IUCN red listing information and expert and key informant interviews.
- Assess the conservation impact of trade in salep and chikanda products using the 9-step guidance for making CITES non-detriment findings for perennial plants.
- Identify knowledge gaps and priorities for follow-up research, including scope and methodologies of pertinent fieldwork.

Materials and methods

Salep powder from Kew's Collections

Materials and methods

A mixed methods approach was used to review the international trade and conservation impacts of food products that contain orchid specimens with a focus on chikanda and salep. The main methods for data collection were a literature search of scientific journals, grey literature and databases, a manual and automated online search for products in trade, and the elicitation of qualitative data from key experts.

Global edible orchids literature review and database

For this study edible orchids were classified as food or food additives suitable for human consumption. A literature review and database were compiled using these data sources: scientific journals, grey literature, databases, books from Kew's ethnobotany library and personal communications. The databases used include Kew's Economic Botany Database, the World Checklist of Useful Plants, the World Checklist of Selected Plant Families, Plants of the World Online, the IUCN Red List and BGCI ThreatSearch. Additionally, CITES documents were reviewed to capture relevant information Parties have presented to-date. The database focuses on edible orchids at species level. The database collated the following information:

- Species name identified in the reference
- Accepted name and author
- Synonyms
- Common names
- Distribution
- Biological descriptions
- Conservation Status
- Local, regional, and international trade
- Source: wild, cultivated
- Trade route origin
- Trade route destination
- Use
- Part of the plant in use
- Use description
- Literature source or reference

The accepted names and synonyms were verified through the World Checklist of Selected Plant Families (WCSP). The WCSP is a collaborative global programme basing the acceptance of species on assessments of the literature, specialist advice and herbarium collections, it's managed by the Royal Botanic Gardens, Kew (Govaerts et al., 2021). Additionally, we requested a download from the WCSP for all species of Orchidaceae which have a tuberous geophyte lifeform.

Common names in various languages were captured from the literature review and the IUCN Red List when the information was available. Data on distribution and biological descriptions were collated from the World Checklist of Selected Plant Families, Plants of the World Online and additional online floras. Distribution occurrences were also obtained from the Global Biodiversity Information Facility (GBIF).

Conservation status was determined using the IUCN Red List and BGCI ThreatSearch and recorded with the year and scope of the assessment (national, regional, or global).

The use was defined by the Economic Botany Data Collection Standard (1995) using the categories; food and food additive, we noted whether the species had another use if recorded from the same data source. The use and trade were all recorded from the literature review and databases. The approach for the recording of information was to capture presence data only.

Journal search for chikanda and salep

An in-depth literature search was conducted for salep and chikanda during January 2022. The systematic journal search adopted the methodology from the Collaboration for Environmental Evidence systematic review methodology (Livoreil et al., 2017). A test was run on different combinations of search terms pertinent to the research question before being finalised. The search terms were compared to a set of core papers found on the topic. The final search terms were "orchid* AND chikanda OR salep OR edible AND trade (1975 – present)." The terms were searched on three scientific databases – SCOPUS, Web of Science and Google Scholar. All titles and abstracts of the papers were loaded into excel and duplicates were removed. These papers were then assessed against the inclusion and exclusion criteria (Table 1).

The criteria were based on the information in the title and abstract. The journal paper had to meet the geographic criteria to be included and one other criteria from consumption, conservation or trade. One limitation of the review was literature was only reviewed if it was in the English language.

Two reviewers read the first 50 papers and either accepted or rejected the papers based on the inclusion criteria. To determine the consistency of implementing the inclusion/exclusion criteria a Cohen's kappa coefficient was used to test the agreeability between the reviewers. The Cohen's kappa coefficient was ranked as 'near perfect agreement' (Kappa score 0.8165137). The remaining titles and abstracts were split between the reviewers to analyse. This resulted in 37 papers used in the literature review. The full text was then reviewed, and the relevant data extracted and recorded in excel, with more detailed relevant information captured in a word document. During the review process, the extracted data included any species or genera mentioned as edible in the paper, country of study, methodology used to collate data and year of study. Additionally, data relating to harvest volumes, trade routes, products mentioned, and scale of trade was also recorded.

Table 1: *Inclusion and exclusion criteria for the chikanda and salep scoping review*

Geography	Literature covers a region of interest to the study; Africa, Europe and Asia. Review is limited to geographical regions.
Trade	Articles that describe orchids as food which are either traded locally, nationally or internationally.
Consumption	Subsistence, edible or drinkable use of orchids
Conservation	Articles that describe the use of orchids, conservation status or information which indicates threat of extinction. Information which includes biological risks, evaluates harvest impact, trade impact or has a management plan.

Semi-Structured Interviews

We used semi-structured interviews to explore expert opinions on the trade in edible orchids across Southern Africa, Europe and the Eastern Mediterranean Region. Experts were identified using the following criteria i) over the age of 18 ii) specialist knowledge of the edible orchid trade (as demonstrated by publications or job role) and iii) residence or study in one of our focus areas. We then found additional experts through snowball sampling (Newing, 2010). We contacted all identified experts (n=16) and five experts agreed to be interviewed (one expert from a scientific authority, and four researchers).

We conducted the interviews throughout May 2022 in English, using the Microsoft Teams platform. We used an interview guide (Annex I) devised from relevant literature reviewed during the initial phase of the project to somewhat guide the conversation, which was reviewed and refined after each interview to reflect any new information gained. With the permission of the interview respondents, the interviews were recorded and later transcribed into Microsoft Word for analysis.

We used the Framework Method to systematically review the interview transcripts and discern themes that emerged from the conversation that would enable us to answer our research question (Ritchie & Spencer, 2002). After familiarising themselves with the interview transcripts, one researcher developed a thematic framework of recurrent subject-matters and applied this framework to each transcript as part of the analysis.

Trade data

The literature review resulted in a list of scientific names identified in trade both at genus and species level (Annex II). Additionally, a list of trade names was compiled to search marketplaces (Annex III). These lists of taxa were used for both the automated and manual trade search. CITES trade data was queried through the CITES Wildlife Tradeview tool (https://tradeview.cites.org/). The time frame searched was between 2015-2021, using the trade terms Roots (ROO) and Powder (POW). The details recorded included the number of specimens and kilograms (kg) reported both by the importers and the exporters.

For the automated search, based on preliminary searches through standard search engines, 7 online marketplaces selling products of relevance to the salep or chikanda trades were selected for detailed analysis. These websites represented 4 global marketplaces and 3 smaller more specialist online retailers. Each website was searched using a combination of web crawling and manual search techniques, with data captured during a 1-month period, spanning April and May 2022.

Key words based on relevant scientific, common and trade names were collated to form a search lexicon, these were used to direct a custom-built web crawler to search websites of interest. Search results returned by the crawler were exported as browsable Excel (.xlsx) files. This enabled human interpretation of the data to be efficiently performed, following the `FloraGuard' methodology for the analysis of online trade (Lavorgna et al., 2020; Lavorgna & Sajeva, 2020; Whitehead et al., 2021). As several of the websites were global marketplaces containing millions of products, the web crawler was directed to start searching from a specific menu point within each site. In three of the marketplaces, we found that the web crawler required additional coding to be able to search their complex menu structures, and as this software adaptation was beyond the scope of the project, these web sites were searched using manual searches.

A combination of web crawling and manual inspection of web sites enabled the following information (where available) to be extracted from each online product listing:

- Product name
- Product type (e.g. powder/root)
- Product purity (e.g. pure/processed)
- Product price
- Product availability (in stock and production capacity)
- Vendor (shop) name
- Vendor (shop) location
- Orchid origin (country/region)
- Orchid source (wild, artificially propagated)
- Marketing terms
- Shipping policies (e.g. offers of international shipping, dispatch time, courier/postal services)
- References to CITES procedures
- Other relevant trade or shipping policies

In automated searches, all relevant search results were compiled. In manual searches, where available, the first 30 unique vendor-product combinations of interest within the website were captured. While this did not provide an exhaustive search of 3 of the 7 sites, this provided a thorough representation of trade activity within each marketplace. In total, product listings for 5 chikanda and 133 salep products were analysed, representing 3 chikanda and 95 unique salep vendors.

Information contained within online product listings was assessed and categorised, to enable quantitative and qualitative analysis of trade and a comparison of the websites to be performed. The following approaches were taken to estimates of price per kg and numbers of orchid tubers in trade:

Price per kilogram

As online analysis was performed from the UK, most websites presented the price per item in GBP (£). For this reason, analysis of prices was conducted in GBP, with other currencies (US dollars and Turkish lira), converted to GBP using an online currency convertor. To enable a comparison of prices for products sold by weight to be made, each product's unit price was extrapolated to calculate the equivalent price per kilogram, with the following limitations:

The price of pure powders and roots often decreased when ordered in 'bulk', with the cost per gram of smaller purchases (e.g. 25g-50g) often double that of a purchase of 1kg. As not all vendors offered bulk buys, and as it might be anticipated that a majority of sales would be for smaller volumes, rather than in bulk, the lowest unit cost for each item was selected for extrapolation to produce the price per kg figure. The mean price per kilogram calculations therefore remain an estimate, although we believe they are representative of the values that could be achieved by vendors who sell their products in a range of quantities. The prices of processed products which contained salep as an ingredient, were likely to be influenced by the proportion of salep powder which they contained. As this was rarely detailed in the product descriptions, it was impossible to place a representative price on the salep content itself, but rather on the product as a whole.

Price per Tuber

Estimating the number of orchid tubers contained within salep products, is extremely challenging and is subject to a large margin of error. This is due to the mass of orchid tubers varying between species and region (Ghorbani et al., 2014). Following Masters et al., (2022), an average salep tuber weight of 0.94g/tuber (1,063 tubers per kilogram) was used to make similar estimates in the current study, although as the species identity was not declared in 49% of online product listings observed, our calculations of the number of tubers within each product and hence the price per tuber, are very approximate. As our survey of online marketplaces provided a snapshot of online trade but did not record the number of products sold by each vendor over time, it was also beyond the scope of this study to estimate the number of orchid tubers that may be sold within online transactions, within a given time period.

Results

Dactylorhiza maculata tubers from Kew's Collections

Results

Scoping review of edible orchids globally

Food security and nutrition are locally and globally important, emphasising the importance of edible plant research. It's estimated there are at least 7,039 edible plant species and documenting further edible plants will contribute to wider discussion on food security (Ulian et al., 2020). In this study based on the literature reviewed, we found 374 documented edible orchids (Supplementary material 1). These were categorised into salep, chikanda and other edible orchids (Figure 1). We identified 72 genera of edible orchids (Annex IV); the taxa were verified as accepted names using the World Checklist for Selected Plant Families. All the species in our review are listed on CITES Appendix II.

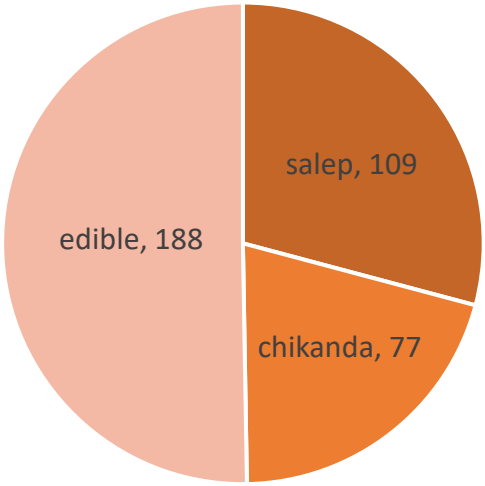

Figure 1: *Number of orchid species with documented edible use. Many species identified as edible in the literature are used to make chikanda (77) and salep (109), both of which are discussed later. For salep, the most species belonged to the genera of Ophrys (29), Dactylorhiza (18) and Orchis (15). The top genera for chikanda were Disa (30), Satyrium (28) and Habenaria (26). The genera with the highest number of species for other edible orchids were Pterostylis (29), Diuris (14), Dendrobium (11) and Prasophyllum (11).*

Globally, one of the most important edible orchids belongs to *Vanilla.* There are over 115 species of *Vanilla* found across the tropics and sub-tropics, however the most cultivated species is *Vanilla planifolia* (Teoh, 2016). *V. planifolia* contains vanillin which provides "vanilla" flavouring, a dominant flavour in desserts (Teoh, 2016). In 2020, vanilla beans were the world's 1,974th most traded product with Madagascar ($539M) and Indonesia ($66.9M) being the top exporters (OEC, 2022). Vanilla is widely cultivated, and as artificially propagated vanilla fruits are exempt from CITES, we did not focus on this industry for the study.

The leaves and fruits of other orchids are used to add flavour to a variety of foods. Historically, there has been documentation of *Selenipedium chica* being utilised as a flavouring in Panama (Bulletin of Miscellaneous Information, 1892). The leaves of *Jumellea fragrans* and *J. rossii* are used to flavour rum in Réunion (Hinsley et al., 2018). They have a vanilla-like odour and were also historically used to flavour a tea in Réunion, Mauritius and France called "Faham" and "Bourbon tea". The name "Bourbon tea" refers to Réunion Island, formerly named Bourbon (Bulletin of Miscellaneous Information, 1892; Chicago Botanic Garden, 2022; Hinsley et al., 2018). Faham tea was intended as an alternative to Chinese tea in France as it did not have the then undesirable effect of wakefulness. The leaves were marketed not only for their vanilla-like aroma but also for the lasting fragrance left in the mouth after being drunk (Hinsley et al., 2018). The fruits of another species, *Leptotes bicolor* have been used to flavour ice cream (Teoh, 2016). As well as sweet flavours, orchids add savoury flavour to main dishes. In Malaysia, the leaves of *Dendrobium salaccense* are used to flavour a condiment for rice (Lohar, 2019) and the buds of *Cymbidium hookerianum,* and *C. elegans*, are added to curry (POWO, 2022).

In some cases, parts of the orchid plant are cooked and eaten while others are treated as vegetables. The roots of *Epipactis royleana*, *Dienia cylindrostachya*, and *Herminium clavigerum*, and the pseudobulbs of *Satyrium nepalense* are eaten boiled in Nepal (Lim, 2016). The roots and rhizomes of *Gastrodia cunninghamii* are roasted or steamed in New Zealand and Australia (Crowe, 2004), the tubers of *G. sesamoides* are roasted (Low,

1991) and the large (7-8 mm thick and as long as a man's finger) fibrous tubers of *Dipodium squamatum* offer a substantial meal when cooked (Teoh, 2019). The tubers of *Habenaria socotrana* are eaten either raw or cooked in Yemen, and the tubers of *H. epipactidea* and *H. walleri* are boiled and eaten like potatoes or powdered to make a cake in Tanzania (Palzer, 2002).

Other orchid parts eaten as vegetables are the roots of *Gastrodia falconeri* (Royal Botanic Gardens, 2012), the leaves and roots of *Cypripedium cordigerum* (Pant, 2013) and the leaves, roots and tubers of *Habenaria intermedia* (Rawat et al., 2014). As well as providing food in themselves, cooked orchids are eaten as ingredients in main dishes. The tubers and roots of *Habenaria keayi* are ingredients in a ground meat dish (Lim, 2016) and in India, the entire plant of *Vanda tessellata* is eaten as a snack or food source (Rutherford & Groves, 2017b). In Bhutan, *Cymbidium hookerianum* flowers are an ingredient in the popular dishes Olatshe and Olachota. They add a bitter flavour which is desirable but can be overcome with spices when not desired (Lohar, 2019). Olatshe is made by adding flowers cooked with cheese and spices to noodles or rice, and Olachota is made by cooking flowers with chilli and cheese (meat can be added) or stir-frying them (Lohar, 2019).

Some orchids are not cooked at all and are versatile enough to be eaten either raw or cooked. In Chile, the aerial parts of *Myrosmodes nervosa* are eaten as a salad (Paniagua-Zambrana & Bussman, 2020), as are the leaves of *Ceratostylis latifolia* in Java (Teoh, 2019). Although there is little nutritive content in them, thickened stems and pseudobulbs of *Cymbidium canaliculatum*, *C. madidum*, *Dendrobium canaliculatum*, *D. kingianum*, and *D. speciosum* can be chewed for their starch or rendered into powder, much like sago (Teoh, 2019). In Australia, the pseudobulbs of *D. caniculatum* are substantially large (80-120 mm by 30-40 mm) and easy to find as they grow in clumps from tree hollows making them a useful species for eating in the bush. (Teoh, 2019). The pseudobulbs of *Dendrobium speciosum* var *hillii* can be eaten raw (Lim, 2016) and in India and Malaya the fruit of *Vanilla griffithii* is sweet and edible, resembling small bananas (Tanaka, 1976). Known as the "food orchid" in the United States, *Dendrobium bigibbum* flowers are eaten as edible decorations (Lohar, 2019).

Orchids are used to prepare a variety of beverages such as tea and herbal or food supplements. Many species in *Dendrobium*, the second largest genus in the orchid family, are utilised as ingredients in food and tea (Zhao et al., 2021). The canes of *D. moniliforme* are dried and prepared as tea (Lohar, 2019) and in China, the flowers of *D. officinale* and *D. chrysotoxum* are traditionally used to prepare tea (Lohar, 2019; Zhao et al., 2021) and a new tea made from the latter has become popular in some Chinese provinces (Teoh, 2016). In the Turks and Caicos Islands, the pseudobulbs of all *Encyclia caicensis* are used to create a cooling drink (IUCN Red List, 2022a). The entire plants of *Dendrobium nobile* and *Cymbidium goeringii* are ingredients in food supplements reported to be sold online (Brinckmann, 2014b).

In Nepal, *Dendrobium longicornu* flowers (Orchids-World, 2012) and in the Maluku Islands of Indonesia *Renanthera moluccana* leaves (Teoh, 2019), are pickled. The tubers of *Habenaria rumphii* are used to make preserves and candy ((Tanaka, 1974; Teoh, 2019), and in Malawi, the tubers of *H. walleri* are made into a jelly served with peanuts (Palzer, 2002).

In our review, we captured the part of the plant in use and at least 272 of the orchid species listed the tuber as the most utilised part of orchids for edible use. We are aware of the limitations of collecting data on documented edible orchids only, particularly as the trade appears to be indiscriminate of species. We recorded 26 *Habenaria* species and there are 893 *Habenaria* species recorded on WCSP. This patten was similar for other tuberous species we documented, we likely have an underestimate of edible orchid species. This is because many of the orchids documented in the literature could not be identified to a species level, this requires further interrogation and field data.

Global edible orchid trade

Most of the trade documented on the CITES trade database were for non-tuberous species, and therefore an underestimate of the global edible orchid trade. We also note the trade data here could be for medicinal trade and not necessarily edible purposes. Chikanda and salep trade data are presented later in the report.

The other edible orchids searched for in CITES Wildlife Tradeview included *Cymbidium spp.* in which, as reported by exporters, 472 roots were traded from India to Germany and the USA in 2020, as artificially propagated. However, *C. hookerianum* (8th top taxa traded) was the only orchid that appeared in the 'Edible Orchid Database' and only 30 of this species roots were traded.

As reported by exporters, 27,465 kg of *Dendrobium spp.* powder, which appear as 'Edible' in the 'Edible Orchid Database' were exported as artificially propagated by New Zealand, China, Malaysia and Switzerland. The top importers were New Zealand, Singapore, China, Republic of Korea and the

Philippines. The top species traded were 27,348kg of *Dendrobium officinale,* 115 kg of *Dendrobium* spp. and 2kg *Dendrobium fimbiratum*, the latter of which does not appear in the 'Edible Orchid Database'. The exporters and importers of *D. officinale* were identical to *Dendrobium* spp. with the absence of Switzerland as an exporter.

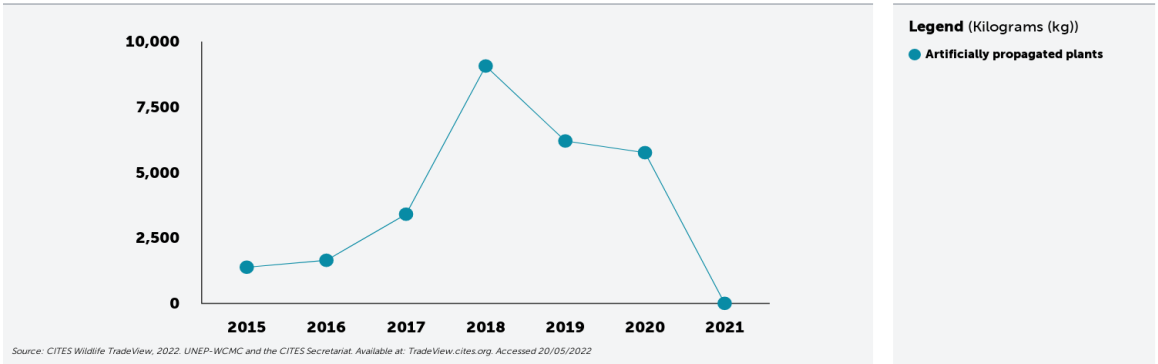

Figure 2: *Trade in Dendrobium spp. as roots and powder, in kg as reported by exporters from 2015-2021 as obtained from CITES Wildlife Tradeview. Accessed 20/05/2022.*

Exporters reported 1377 *Dendrobium spp.* roots of artificially propagated origin, were exported from India to the USA and Germany in 2020. Only the 19th top taxa in trade, *D. chrysotoxum*, and the 28th top taxa in trade *D. nobile,* appeared in the 'Edible Orchid Database' as 'Edible'. *D. nobile* only had 3 roots traded in 2020, whereas *D. candidum* had 7 roots traded in 2020 and both were exclusively from India to the USA.

As reported by importers, Thailand and China were the top exporters of *Dendrobium* spp. (counted by number of specimens) and the top importers were Brazil, India, Belgium and the USA. 60,608 roots and 35 powders were traded including artificially propagated specimens (Figure 3), including some from Appendix I, made up of *Dendrobium chrysanthun, Dendrobium anosmum, Dendrobium* spp. and *Dendrobium albosanuineum*, none of which are found in the 'Edible Orchid Database'. There were four confiscations/seizures in 2016.

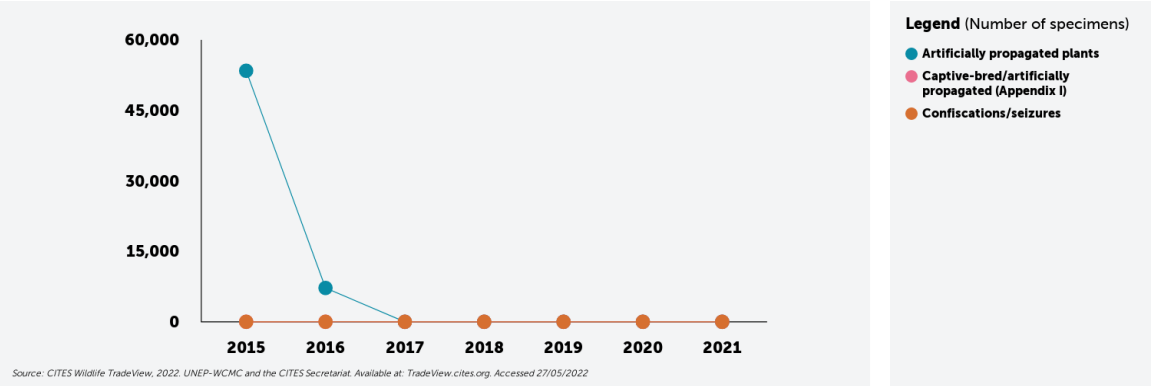

Figure 3*: Trade in number of species of Dendrobium spp. as roots a powder as reported by importers from 2015-2021 as obtained from CITES Wildlife Tradeview. Accessed 27/05/2022.*

China, Netherland, Canada, Malaysia and Switzerland were the top exporters of *Dendrobium* spp. when measured in kilograms. There were 15,647 kg of powder and 10 kg of roots traded, with the top imports New Zealand, Hong Kong Special Administrative Region, Belgium, Switzerland and Australia. The top taxa traded were *Dendrobium officinale, Dendrobium* spp., *Dendrobium fimbriatum* and *Dendrobium chrysanthum* all of which were artificially propagated. There were 10 seizures of *Dendrobium* in 2015 (Figure 4).

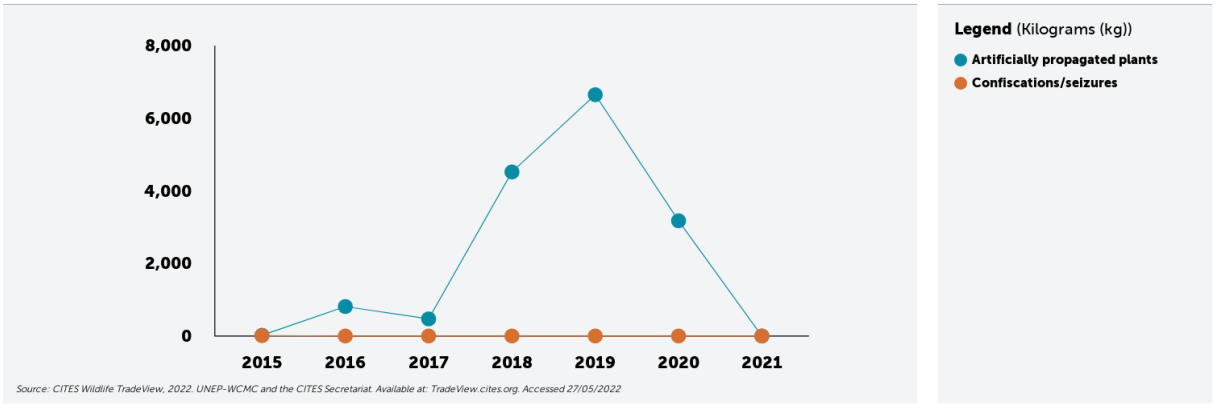

Figure 4: *Trade in Dendrobium spp. as roots and powder in kg, as reported by importers from 2015-2021 as obtained from CITES Wildlife Tradeview. Accessed 27/05/2022.*

There was trade of 14,333 kg of powder of artificially propagated *Dendrobium officinale* as reported by importers. Top exporters were China, Netherlands, Canada, Malaysia and New Zealand, with top importers New Zealand and Hong Kong Special Administrative Region.

As reported by importers, there were no results for *Dendrobium nobile, Dendrobium candidum* or, *Cymbidium* spp.

Chikanda

Background

Across several African countries, a food substance, often called chikanda (with some local variation), is made from ground terrestrial orchid tubers (Davenport & Ndangalasi, 2003; de Boer et al., 2017; Ghorbani et al., 2014; Rutherford & Groves, 2017a). When mixed with peanuts and heated, it forms a 'cake' or 'meatless sausage' that is eaten as a snack. From expert consultation, as well as scientific literature covering the topic, it is documented that chikanda is consumed across numerous countries – but the demand for orchid tubers to make into chikanda is highest in Zambia. Tanzania, and more recently Malawi and other bordering countries, supply Zambia with raw orchid tubers to satisfy this demand (Rutherford & Groves, 2017a).

Throughout Africa, chikanda was previously eaten and sold locally, with harvesting, cooking and consumption occurring in small areas. However, in more recent years, demand for chikanda has increased as it has become a popular dish to serve at events such as weddings and is now easily found in restaurants and supermarkets (Interviewee one; Davenport & Ndangalasi 2003). As a result of this commercialisation, supply chains for these orchid tubers have become widespread, with cross-border trade common and large-scale production now occurring, alongside continued local trade (Interviewee three). Without long-term data to underpin this, it is difficult to discern when this shift to widespread large-scale trade occurred.

Distribution

We identified 77 species of orchids used for chikanda with the top genera being *Disa* (30), *Satyrium* (28) and *Habenaria* (26).

The genus *Disa* is native to Angola, Burundi, Cameroon, Central African Republic, Democratic Republic of the Congo, Ethiopia, Gabon, Guinea, Ivory Coast, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mozambique, Niger, Nigeria, Rwanda, Réunion, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania, Uganda, Yemen, Zambia, Zaïre, Zimbabwe. and has been introduced to Australia and Tasmania (POWO, 2022). In GBIF, *Disa* have been recorded with 20,548 occurrences (Figure 5).

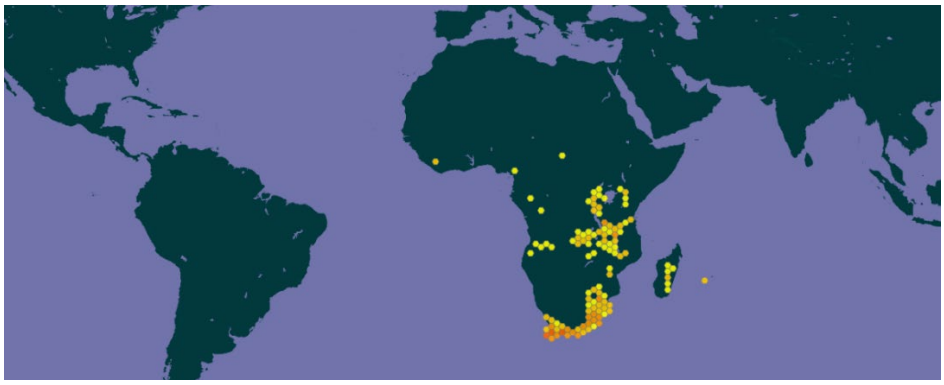

Figure 5: *Occurrences of Disa species recorded between 1982 – 2022, source* (GBIF, 2022)

Satyrium is found in Angola, Assam, Burundi, Cameroon, Central African Republic, China, Comoros, Democratic Republic of the Congo, Ethiopia, Guinea, India, Kenya, Lesotho, Madagascar, Malawi, Mozambique, Myanmar, Nepal, Nigeria, Pakistan, Rwanda, Réunion, Sierra Leone, South Africa, Sri Lanka, Sudan, Swaziland, Tanzania, Thailand, Uganda, Yemen, Zambia, Zaïre, and Zimbabwe (POWO, 2022). According to GBIF, there are 14,352 occurrence records of *Satyrium* (Figure 6).

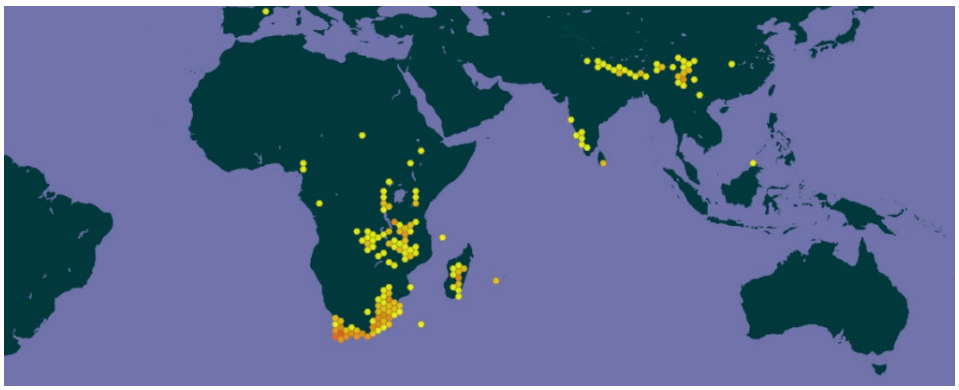

Figure 6: *Occurrences of Satyrium species recorded between 1982 – 2022, source* (GBIF, 2022)

Habenaria has a wide distribution across a tropical and sub-tropical range. It's native to Afghanistan, Angola, Argentina, Australia, Bahamas, Bangladesh, Belize, Benin, Bolivia, Borneo, Botswana, Brazil, Burkina, Burundi, Cambodia, Cameroon, Central African Republic, Chad, Chile, China, Colombia, Comoros, Democratic Republic of the Congo, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Equatorial Guinea, Eritrea, Ethiopia, Fiji, French Guiana, Gabon, Georgia, Ghana, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, India, Mongolia, Ivory Coast, Jamaica, Japan, Jawa, Kenya, Korea, Laos, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritius, Mexico, Mozambique, Myanmar, Namibia, Nepal, New Guinea, Nicaragua, Nigeria, Oman, Pakistan, Panamá, Paraguay, Peru, Philippines, Puerto Rico, Rwanda, Réunion, Samoa, Senegal, Sierra Leone, Somalia, Sri Lanka, Sudan, Sulawesi, Sumatera, Suriname, Swaziland, Taiwan Province of China, Tanzania, Thailand, Togo, Trinidad-Tobago, Uganda, Uruguay, USA, Venezuela, Vietnam, Yemen, Zambia, Zaïre, and Zimbabwe (POWO, 2022). According to GBIF, 61,287 occurrences were recorded between 1983 – 2022 (Figure 7).

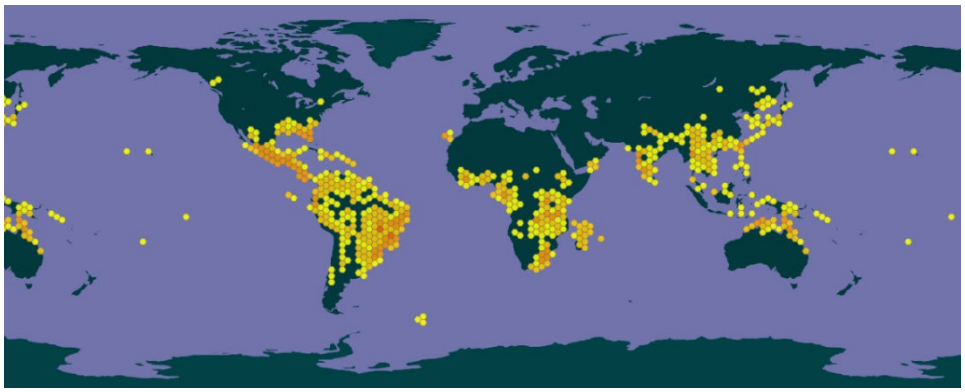

Figure 7: Occurrences of Habenaria species recorded between 1983 – 2022, source (GBIF, 2022)

Harvesting and sourcing

Orchid species used in chikanda are collected exclusively from the wild and the entire plant is removed when harvested (Veldman et al., 2018). This method of harvesting has been shown to cause changes to habitats and possibly even overall biodiversity (Davenport & Ndangalasi, 2003). Most often, tubers are harvested when in flower, as it is easiest to find them at this time. However, in the experience of in-country researchers, the harvest is not taking place in a controlled manner, or at a controlled time to allow for regeneration of species (Interviewee four). Additionally, species are collected indiscriminately (Veldman, 2018; Interviewee three; Interviewee four), and smaller tubers are more often found in markets now. This could be due to different species now being harvested or could be indicative that juvenile orchids are increasingly being harvested where mature individuals are no longer found.

In Zambia, the preferred orchids used to prepare chikanda are from the genera *Disa, Habenaria* and *Satyrium* (Challe & Struik, 2008; Davenport & Ndangalasi, 2003; Rutherford & Groves, 2017a). *Disa erubescens, D. robusta* and *Satyrium atherstonei* were found in high abundance in Tanzania, but Challe & Struik (2008) identified a strong decline of these species, totalling an 82.7% decline. Less desirable species are now harvested, often being mixed with desirable species when sold (Interviewee three). Species preference could be due to a number of factors such as ease of collection such as some species dropping inflorescences after the flowering and fruiting period therefore, becoming harder to spot, (Veldman et al., 2018), variation in tuber consistency which affects the chikanda produced (less desirable tuber species create a less palatable, 'runny' chikanda) (Interviewee three), and variation in tuber taste (preferred tubers are sweet and less desirable are bitter) (Challe, Struik & Price, 2018). Collectors in Tanzania identify preferred tubers, marketable to Zambia, as sweet with crystalline, elastic flesh while those less desirable and rejected by middlemen, as bitter and lacking elasticity (Challe, Struik & Price, 2018). To determine which species are best to sell, collectors and middlemen tend to classify and name them by the harvest area, texture and internal patterns of tubers rather than using species names (Veldman et al., 2018).

Rutherford & Groves (2017a) stated that Zambia has the highest consumption of chikanda, and due to resulting depletion of their orchid populations, those of other countries are now being exploited. Tubers are being imported into Zambia from Democratic Republic of Congo, Mozambique, Malawi and Angola (Veldman et al., 2014). Zambia sees an import of around 5 million tubers from surrounding countries (Rutherford & Groves, 2017a), with 2.2 - 4.1 million tubers imported from Tanzania alone in 2003 (Davenport & Ndangalasi, 2003).

There is evidence of CITES non-compliance due to orchids being moved across borders without evidence of registration or declaration (Davenport & Ndangalasi 2003). However, prohibiting orchid collection alone has not been enough to prevent continual harvesting (Interviewee four), and can result in negative social outcomes for harvesters or sellers of tubers, who may rely on this trade as an essential income to provide sustenance for their household (Challe et al., 2011). Whilst the management of orchid harvesting needs to be investigated further, interventions must be sensitive, considering social, spiritual, and economic implications of regulation as well as conservation (Davenport & Ndangalasi 2003). For instance, if tuber collection was to be effectively prohibited, alternative sustainable livelihoods would be needed (Challe et al., 2011).

Those who participate in the chikanda trade do so for different reasons: the possibility of a profitable venture, introduction to the trade by someone they know, or simply that orchids grow nearby and are easily accessible (Veldman et al., 2018)). There is a social dimension to the collection and trade of tubers, as wild edible plants can act as a safety net for households, such as those who have lost parents. People may trade because their options are limited, and collection requires only an investment in time, not money and resources. This is particularly pertinent in households that are headed by a child, due to the death or their parent or parents

(Challe et al., 2011). In some areas, there has been evidence that women are harvesting most often as they have less access to land, and therefore have less opportunity to make money from agriculture (Challe et al., 2011). There is also evidence that a lack of money for agricultural inputs (maintenance of equipment, irrigation, fertilizer etc.) is a factor in not cultivating food crops and instead switching to collecting wild edible plants (Challe et al., 2011). In their study of trade between four villages in Malawi, Mahonya et al. (2019) found that edible orchids were used by 64% of all households. These orchids occurred nearby to one of the villages, Kasonga, in which their value chain was managed exclusively by women and girls. In the Southern Highlands of Tanzania, tuber collection was observed to be carried out by men and women, young and old (Davenport & Ndangalasi, 2003).

As chikanda has become increasingly commercialised, it has been noted by both the collectors and the middle-people (those who buy from harvesters to sell to vendors), that orchids are being depleted, and therefore becoming rarer (Veldman et al 2018). Species level identification of orchid tubers is challenging (Veldman et al., 2014, 2017, 2018) and therefore it is difficult to quantify the sale of orchids at markets to evaluate specific offtake levels. It has been suggested that in some areas, there has been an attempt to control the harvest of chikanda tubers by chiefs of tribes (Interviewee three), for example, where in other areas regulation has not been implemented at all (Veldman et al 2018). The establishment of protected areas, such as Kitulo National Park, has not prevented the harvesting of orchids in Tanzania (Davenport & Ndangalasi 2003; Veldman et al., 2018), with researchers suggesting that collection continues within the park's borders (Interviewee four).

Orchid populations are in decline, forcing those who collect to travel further to collect enough to keep up with demand (Interviewee one). Davenport & Ndangalasi (2003) found that the time spent travelling to a harvest site increased from 30 minutes to 5 hours to reach a site over a period of 10 years. The reason for the decline has been attributed to an increase in traders, an increase in cultivated land and an increase in collectors as well as people harvesting a larger number of tubers per harvesting trip (Davenport & Ndangalasi, 2003).

Evidence shows that numbers of edible orchids has decreased, and once species were harvested, they would not grow in the same spot (at least within one year). These areas where edible species had been harvested are often replaced with inedible species instead (Challe & Struik, 2008), a trend which could indicate local extinctions of certain species. Challe et al. (2011) found that collectors were aware of the harvesting pressure on the orchid populations. In Tanzania, for example, gatherers were aware of the rules but would break them regardless because it's an important livelihood venture to collect the tubers from Kitulo National Park (Challe & Struik, 2008), or simply because it is lucrative (Davenport & Ndangalasi, 2003).

People may continue to engage because economic benefit is high enough to outweigh the risk, which appears to be low. Trading of orchids tends to not carry a large risk as they are easily disguised as potatoes when moving the species, and the trade may well be an 'open secret' amongst enforcement officers (Interviewee four). Additionally, people with limited livelihood options may have no choice but to collect despite any risk. Orchid populations, such as that of *Dactyloriza hatagirea* were found to be higher in the protected areas, but this may not be solely attributed to enforcement of rules around harvesting in the park. Population density of this species outside protected areas could also be affected by other pressures, such as trampling and grazing, and not just harvest (Chapagain et al., 2021).

Cultivation

There have been methods suggested to aid in mitigating threats to wild edible orchids, such as a possibility to replace tubers in the making of chikanda with a starch alternative (Veldman et al., 2018), or techniques to artificially propagate orchids. The Cape Institute of Micropropagation, for example, is in collaboration to try and develop sustainable cultivation of orchids (Veldman et al., 2018). However, there has been limited success so far with propagation techniques – which would need to produce a high yield at a low cost to be a viable alternative for wild collection – something that is yet to be achieved (Interviewee four). DNA barcoding would also help to assist in identifying the species of orchid tubers, which would aid in the mislabelling of those in trade (Ghorbani et al., 2014), but this technique is currently expensive and time consuming and therefore not time nor cost effective enough for use at border controls. 'Orchid Conservation Areas' as suggested by Ghorbani et al (2014), could aid in the mitigation of illegal harvesting of orchids with the added benefit of potential tourism, if enforcement was in place without disenfranchising those who rely on this trade for their livelihoods.

Chikanda products in trade

The following observations were made for chikanda products using a systematic automated and manual online search for products in trade, using the key word 'chikanda', along with other scientific, common and trade names associated with this trade (Annex II and III).

Online trade search and observations

Searches of the 7 selected websites for examples of chikanda trade returned only a small number of relevant search results (Table 2).

***Table 2**: Characteristics of online marketplaces sampled for chikanda products, detailing marketplace type, the number of vendors and products observed and the location of products within the website under specific menu headings*

					Number of vendor-Chikanda product combinations			
Site	**Description**	**No. Products sampled**	**No. Of vendors**	**Website menu category**	**Pure Powder**	**Roots**	**Processed Powder (non-pure)**	**Chikanda Cake**
1	**Global online marketplace**	1	1	Health and beauty -> Natural and alternative remedies -> Herbal remedies and resins	0	1	0	0
2	**Global online marketplace**	1	1	N/A	0	1	0	0
7	**Traditional Zambian Foods**	3	1	N/A	2	0	0	1
Total		**5**	**3**		**2**	**2**	**0**	**1**

The search term `chikanda' returned 3 products of relevance, offered for sale by 1 of the 7 online marketplaces searched (Table 2), while the search term '*Habenaria*' returned two further results from two of the global online marketplaces that were searched. In summary:

- Website 1: One product listing for *Habenaria intermedia* roots, offered by a vendor located in India. The roots were priced at £17.53 per 100g (the equivalent of £175.3 per kg). This product was marketed as having benefits for natural health/blood health.
- Website 2: One product listing for *Habenaria dentata* roots, offered by a vendor from China. The roots were advertised at a price of £18.66 per 100g (the equivalent of £186.6 per kg). This product was marketed as being for use in tea and described as being harvested from the wild.
- Website 7: This website for a business specialising in Zambian food, offered a small range of chikanda products, including pre-cooked chikanda cake (£40 for a medium sized cake), chikanda powder (£10 per 200g, the equivalent of £50 per kg), and African Polony chikanda powder (£10 per 160g, the equivalent of £62.5 per kg). No species names or details of the origin of the ingredients were provided. It was not clear from the website if international shipping was available for these products.

From the chikanda product listings observed, two species-country combinations were recorded (Table 3).

***Table 3:** Species-country-combinations recorded for chikanda products observed within 3 online marketplaces sampled, with country representing the vendor's physical location. Countries which form part of the species natural range are indicated as range States.*

Orchid taxa	Country (vendor location)	Species Range State	Total Products
Habenaria intermedia	India	Yes	1
Habenaria dentata	China	Yes	1

A search of the CITES Trade Database from 2015 to 2020 recorded no imports or exports of these species to or from China or India, other than an import of a single specimen of *Habenaria dentata* into China in 2019, for scientific purposes.

Summary of Online Trade Analysis – chikanda

The small number of search results for chikanda species and products in trade, suggests chikanda is rarely traded within international online marketplaces. Some of the products observed included pre-prepared chikanda cake and powders preserved in plastic, potentially long-life, packaging, although whether these supply chains could be scaled to meet an increase in demand is unclear.

The vendors observed in websites 1 and 2 both offered international shipping of *Habenaria* roots. It was unclear from Website 7, whether international shipping was available for the processed chikanda products that were

listed on this website. None of the product listings referred to CITES procedures or took account of the costs and timeframes involved to obtain CITES permits, to fulfil international orders.

Both vendors advertising *Habenaria* roots were based in range States for those species, although neither product listing provided information about the origin of the roots. The vendor for website 7 was not located in a chikanda producing range State, with CITES permits therefore required for them to import the finished products and raw ingredients that were being sold, although no reference to CITES or the origin of the orchids was provided by the website.

In summary, our results suggest that the online trade in chikanda products and raw ingredients is currently limited, although the trade that does occur lacks transparency and may be conducted absent of CITES controls.

Literature and database summary of chikanda trade

Tubers exported from Tanzania to Zambia often travel through the town 'Tunduma', however some trade is directed via Sumbawanga and through Tatanda to Zambia (Davenport & Ndangalasi, 2003). In Tunduma, sale of tubers is completed through brokers, who claimed they are able to visually identify the edible orchids (Davenport & Ndangalasi, 2003). There is a possibility to sell directly to Zambians across the border during the low seasons (Davenport & Ndangalasi, 2003). It has been noted that chikanda crosses borders, labelled as different food items (IUCN SSC Orchid Specialist Group Global Trade Programme, *pers comms*).

Satyrium spp. was searched in the CITES Wildlife Tradeview database due to it being a top genus evident from the literature review. Reported by exporters, *Satyrium nepalense* of artificially propagated origin, was the only species to appear as traded on CITES Wildlife Tradeview, for 20 roots traded from India to the USA in 2020. However, there were no results reported by importers.

Habenaria spp. was searched for in the CITES Tradeview database, whilst there had been exports from Thailand to Japan, the USA, Switzerland, Lao PDR and Singapore of a total of 459 roots of artificially propagated origin (Figure 8), the top taxa in trade did not appear in our literature search. There were no results when searching on the CITES Tradeview database for roots or powder of *Disa* spp. as reported by both exporters and importers.

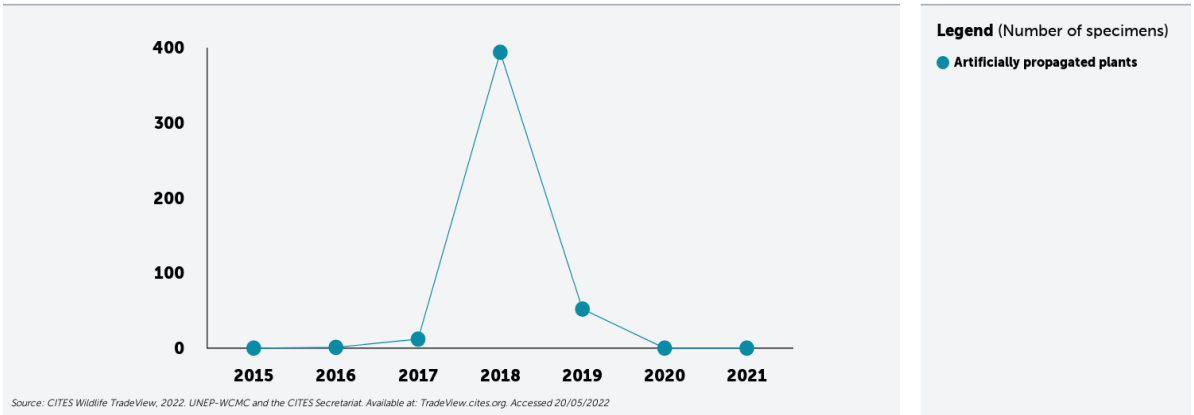

***Figure 8**: Trade in Habenaria spp. as roots and powder, in number of specimens, as reported by exporters from 2015-2021 as obtained from CITES Wildlife Tradeview. Accessed 20/05/2022.*

As reported by importers, the top exporters of *Habenaria* spp. were Thailand, with the top importer being India. There was a total of 15 roots of artificially propagated source, traded in 2016 which included taxa *H. rhodocheila* and H. *rostellifera*. Neither of these species were found in our literature review.

This review of chikanda trade demonstrates trade is occurring in Africa but it is not reported on the CITES trade database and is not regulated.

Salep

Background

In certain parts of the world, tubers from terrestrial orchids are ground into a powder, referred to as salep (de Boer et al., 2017; Kasparek & Grimm, 1999; Kreziou et al., 2016). Salep is used to make a hot drink, (referred to as salep or salepi) in Greece and Turkey (de Boer et al., 2017; Kreziou et al., 2016), confectionary and ice cream (called maraş dondurma) (Kasparek & Grimm, 1999; Kreziou et al., 2016). An innovative study used

patent analysis to explore the commercial interest of salep (Masters et al., 2020). The study by Masters et al (2020) analysed 244 patent applications over a period of 163 years. It found 89 patents were granted across the world and interestingly uses included contemporary medicine formulations and industrial materials. This research illuminates salep trade as more global and commercially valuable than previously thought as the research focus has been on salep use as a drink and use in ice-cream.

The ground tubers are desirable due to the presence of glucomannose, which acts as a stabilizer (Tekinşen & Güner, 2010), as well as delaying melting (i.e ice-cream) (Rutherford & Groves, 2017b). Salep is produced in Iran, Greece and Turkey from wild orchids (Boer et al 2017). Salep is available to purchase online from these countries, including from Lebanon where commercial; companies source ingredients listing salep or salep powder as ingredients (Rutherford & Groves, 2017b).

In one study, it was noted *Orchis mascula* and *Orchis morio* produce the 'best', and therefore most desirable, salep (Rutherford & Groves, 2017c). Eighty five percent of the orchids found in Turkey are tuberous, mainly from the genera *Orchis, Serapias, Ophrys, Anacamptis, Dactylorhiza, Cephalanthera*, and *Epipactis* (Sezik, 2002a). Tuberous orchids are collected from the wild, and some species populations have suffered declines and local extinctions – yet the consumption of salep remains high (Kasparek & Grimm, 1999).

An increase in orchid collection has been documented in Turkey, with estimates ranging from 30-120 million tubers collected annually (Kasparek & Grimm 1999; Sezik, 2002; Kreziou et al., 2016). With resources in Turkey depleting, the trade is increasingly reliant on tubers harvested from abroad (Interviewee two). In Iran, for example, between 5.5 and 6.1 million orchids are harvested annually, and are exported to predominantly Turkey (Ghorbani et al., 2014). The demand for salep ice cream decreased in 1999 with only a few sellers found in Ankara, Turkey (Rutherford & Groves 2017). However, demand has now increased sufficiently enough to support large commercial enterprises. One Turkish ice-cream brand have around 300 outlets worldwide and manufactures its ice-cream using salep equating to about 0.8-1% of the ice cream ingredients (Kasparek & Grimm, 1999). On their Greek website, they state that the ice cream is made with milk from goats which are fed herbs and wild orchids flowers, which is then mixed 'with salep collected from the tubers of these orchids.'

Salep also has medicinal properties and has been claimed to treat a range of conditions such as stomach issues (Kasparek & Grimm, 1999), infertility, tuberculosis (Ari et al., 2005; Caliskan et al., 2020; Kreziou et al., 2016) and was even once used as a form of nutrition for the British Army (Caliskan et al., 2020). Other uses have also been documented, such as the use of salep misri, or Indian salep, which is made from *Eulophia* species and is sold as an aphrodisiacs (Rutherford & Groves, 2017b). In Iran, salep was also used to treat impotence (Ghorbani et al., 2014), however Kasparek & Grimm (1999) argue that salep does not produce properties that can be used to promote "sexual potency", even though it may be sold as such.

Distribution

We identified 109 orchid species used for salep. The genera with the most species belonged to *Ophrys* (29), *Dactylorhiza* (18) and *Orchis* (15).

Ophrys is native to Albania, Algeria, Austria, Belarus, Belgium, Bulgaria, Cyprus, Denmark, Finland, France, Germany, Great Britain, Greece, Hungary, Iran, Iraq, Ireland, Italy, Lebanon, Libya, Morocco, Netherlands, Norway, Palestine, Poland, Portugal, Romania, Russia, Spain, Sweden, Switzerland, Syria, Tunisia, Turkey, Turkmenistan, Ukraine (POWO, 2022). In GBIF, 392,031 occurrences were found between 1983 – 2022 (Figure 9).

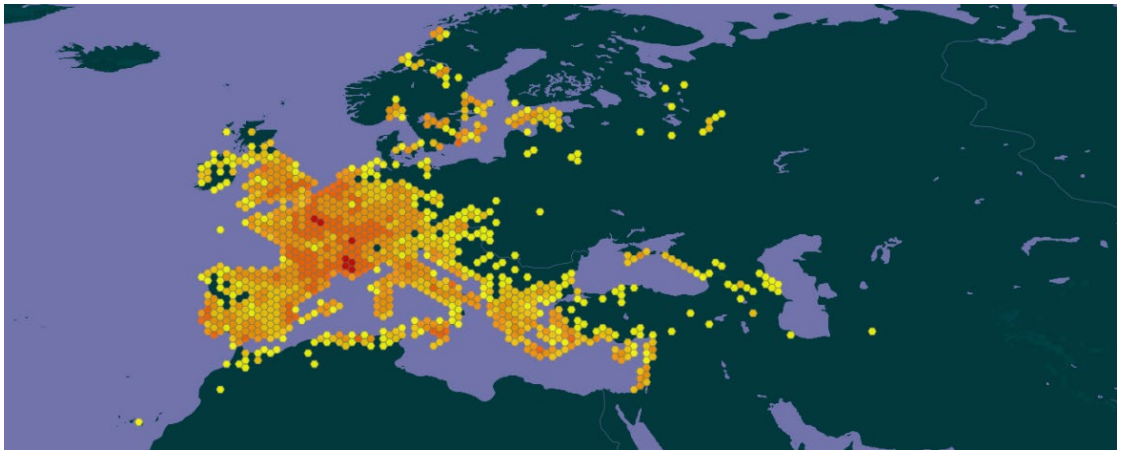

***Figure 9**: Occurrences of Ophrys* species *recorded between 1983 – 2022, source* (GBIF, 2022)

Dactylorhiza is found in Afghanistan, Austria, Belarus, Belgium, Bulgaria, Canada, China, Cyprus, Denmark, Finland, France, Germany, Great Britain, Greece, Hungary, Iceland, Iran, Iraq, Ireland, Italy, Japan, , Kazakhstan, Kyrgyzstan, Korea, Lebanon, Madeira, Mongolia, Morocco, Nepal, Netherlands, Norway, Pakistan, Palestine, Poland, Portugal, Romania, Russia, Spain, Sweden, Switzerland, Syria, Tajikistan, Tunisia, Turkey, Turkmenistan, Ukraine, USA, Uzbekistan (POWO, 2022). Between 1982 – 2022 GBIF recorded 806,503 records for this genus (Figure 10).

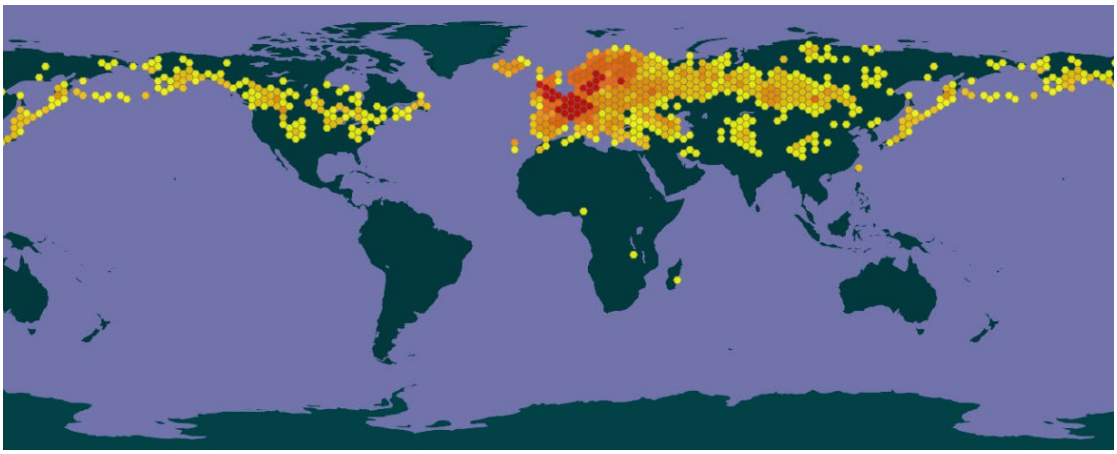

Figure 10: *Occurrences of Dactylorhiza* species *recorded between 1982 – 2022, source* (GBIF, 2022)

Orchis is native to Afghanistan, Albania, Algeria, Austria, Belarus, Belgium, Bulgaria, Cyprus, Denmark, Finland, France, Germany, Great Britain, Greece, Hungary, Iran, Iraq, Ireland, Italy, Kazakhstan, Lebanon, Libya, Madeira, Mongolia, Morocco, Netherlands, Norway, Palestine, Poland, Portugal, Romania, Russia, Spain, Sweden, Switzerland, Syria, Tunisia, Turkey, Turkmenistan, Ukraine (POWO, 2022). Between 1983 – 2022, GBIF recorded 459,988 occurrences for this genus (Figure 11).

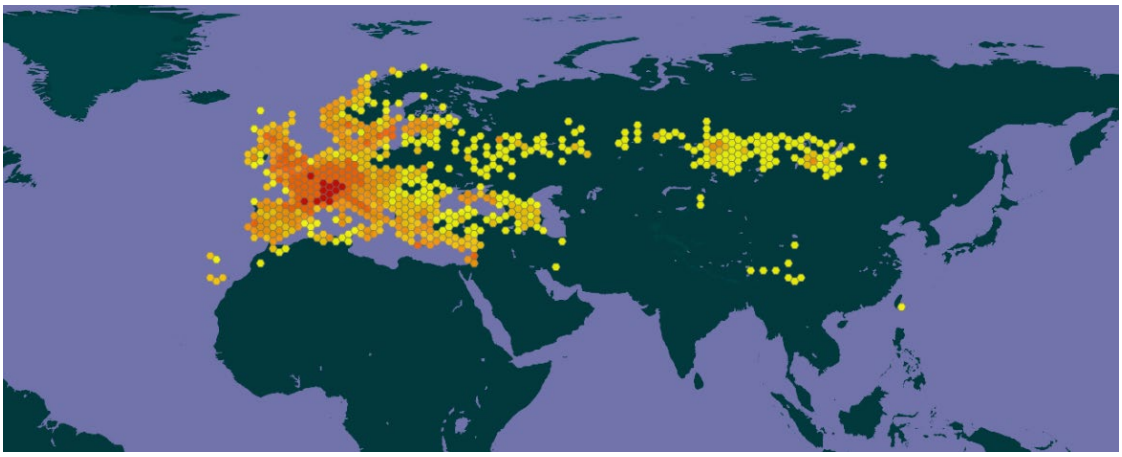

Figure 11*: Occurrences of Orchis* species *recorded between 1983 – 2022, source* (GBIF, 2022)

Harvesting and sourcing

To create the salep, once harvested, tubers are washed and then boiled in milk or water or are alternatively air or sun dried (Rutherford & Groves, 2017b). Once dried, the tubers can be stored for years and remain consumable (Kasparek & Grimm, 1999). The number of tubers required to produce 1kg of salep is dependent on the genus of the species harvested. For example, in Western Azerbaijan an average of 980 tubers were required from *Dactylorhiza* (palmate shaped) to make 1kg of dried salep, whereas an average 1380 tubers were required from other species (ovoid shaped) to make 1kg of dried salep (Ghorbani et al., 2014).

In Turkey it is estimated that 2000 kg of salep is used annually to produce Maraş ice cream (Kasparek & Grimm, 1999). This study demonstrated the scale of demand using a case study of an owner of one of the four well-established cafes selling this ice-cream in Ankara, Turkey. Here, it is estimated that one café requires 75-100kg of salep annually, to produce Maraş ice-cream. Kasparek & Grimm (1999) also estimated that 3750-7500kg (dry weight) of salep is harvested annually in Turkey, with the official figure of 28000kg annually exported. To

produce one kg of salep, it is estimated that 1000-4000 tubers would be required (Kasparek & Grimm, 1999) which would need 40-50 million orchid tubers to be harvested annually, in Turkey alone (Sezik, 2002b). Ghorbani et al (2014) does state that "there are no reliable estimates of the annual genuine salep harvest in Turkey" however, it is estimated that 30-120 million orchids are harvested in Turkey annually, and in Iran, 5.5-6.1 million orchids are harvested annually (Ghorbani et al., 2014).

Orchids are harvested indiscriminately from wild populations in predominantly Turkey, Iran and Greece. Salep from certain species of orchid are not suitable for use in Maraş ice cream, but due to harvesting practices are often still collected and therefore removed from the ecosystem. The preferred species for salep are *Serapias lingua, Orchis mascula*, *Dactylorhiza majalis*, *Ophrys sphegodes*, and *Habenaria repens* (Turkmen et al., 2021). There have been fluctuations in collecting over time due to demand, which is influenced by not only location but trade and cultural exchange (Charitonidou et al., 2019). In Greece, there has been a recent increase in demand for salep, and subsequently, prices have increased to 55-150 euro per kilo (£47-128) (Kreziou et al., 2016). Kreziou et al. (2016) explained that in 2012, a company owner paid 55-85 euro per kilo (£47-72) to collectors for Greek harvested salep, for which they estimated that packaged salep could retail for 143 euro per kilo (£122).

In the 1970s, salep prices began to increase, reaching up to $20 for 1kg (£16) in the mid-80's. However, the increased use of substitutes, such as Carboxymethyl-cellulose (CMC) or rice powder, forced the price to decline to $5 per kilo (£4) in 1994 (Kasparek & Grimm, 1999). Substitutes are cheaper than salep, and therefore are used to replace salep more frequently. Major ice cream producers in Turkey now use a mix of substitutes and salep, but with ice cream production moving to become industrially produced in the 1980's, traditional ice cream vendors saw a reduction in profit (Kasparek & Grimm, 1999).

Those who collect tubers from the wild are often people from rural areas who have access to meadows where these tuberous orchids grow. Though it may not be their only source of income, collecting these tubers is a vital source of income for many people (Interviewee two), and so when designing conservation interventions, this must be considered. Some local people who harvest orchids from graveyards in Turkey for salep can differentiate between orchid genera and identify new, and rare, populations (Attila et al., 2017) . They categorised species by similar morphological features (Challe & Struik, 2008; Molnár V. et al., 2017), whilst other species are determined by the shape of tubers (Charitonidou et al., 2019). It is more worthwhile collecting orchids when the density of the plant is highest, which has been suggested to allow for the plants to recover (Kasparek & Grimm, 1999). There is evidence of success of sustainable harvest in community managed protected areas, for species such as *D. hatagirea*, when compared to unprotected areas (Chapagain et al., 2021).

Cultivation

It has also been shown that small groups of individuals among communities have been able to sustainably harvest salep, annually, without a decrease in population (Molnár V. et al., 2017) so there is the potential, with careful management, that sustainable harvest can be achieved. In the Western provinces of Iran, where orchid collection has been practices for a long time, people have reported a decline in orchid populations. This has sparked a change in harvesting practice, where people are attempting to replant the orchids after removing the tubers (however, the success of this practice is not reported). In the Northern provinces, however, local people believe that orchids are a gift to provide them with supplemental (and vital) income (Ghorbani et al. 2014), and so sustainable harvest practices may not be employed here, as there is a belief that the resource will be replenished regardless.

Other methods to aid the conservation of salep orchids include the use of substitutes. Carboxymethyl-cellulose (CMC) and rice powder are commonly used instead of salep (Ghorbani et al 2014; Kasparek & Grimm, 1999). CMC is used in a variety of foods, as it a modified starch with a consistency like salep and has good thermostability when mixed in water which has a similar consistency to dried salep (Kasparek & Grimm, 1999). Glucomannan, which is found in orchid tubers, can also be found in other plants (Kasparek & Grimm, 1999), although customers still seek 'authentic salep', thus demand for wild orchids remains high (Kasparek & Grimm, 1999). One company in Germany does produce a salep product that is made is from starch instead of authentic salep (Kasparek & Grimm, 1999), and more research needs to be conducted to understand whether or not this is 'accepted' by consumers as a replacement for salep from tubers.

Orchis mascula and *O. morio* can be cultivated, as shown by a nursery in Belgium. The nursery grows orchids mainly for the European cosmetic industry, which equates to 100,000-300,000 plants in vitro, annually (one kilogram = 1000 plants in vitro). However, they are trialling a large-scale cultivation of orchids for salep production, with both *O. morio* and *O. mascula* (Rutherford & Groves, 2017b). Interviewee five commented that people would likely accept salep from artificially propagated orchid tubers, if the taste and consistency was identical. Consumers do not appear to be driven by a desire for wild tubers, but instead real tubers, as opposed to artificial substitutes, or 'fake' salep (Interviewee five). Salep that is made from orchid tubers is seen as

authentic, whereas chemical alternatives are seen as sub-par in comparison. Thus, research into artificial propagation of natural tubers is an important step in meeting the demand for 'real' salep and conserving wild orchid populations, as substitutes will not curb the demand for 'authentic' salep.

Salep products in trade

The following observations were made for salep products using a systematic automated and manual online search for products in trade, using the key word 'salep', along with other scientific, common and trade names associated with this trade (Annex II and III).

Online trade search and observations

Analysis of listings for salep products offered for sale in the online marketplaces sampled, provided the following observations. Six of the 7 websites returned relevant search results for salep products. Table 4 details the key characteristics of these online marketplaces.

Table 4 shows that the online marketplaces sampled fill slightly different niches within the online marketplace. Websites 1 and 2 contained many products based on pure salep powders or roots, with fewer processed products. Pure powders and roots were offered for sale in relatively small quantities (often 50-100g), although quantities of up to 1kg could often also be selected. Website 3 offered a smaller range of products, which were virtually all processed food items. Website 4 was markedly different, as it offered a range of wholesale powdered products, largely made from *Dendrobium* species. These vendors were predominantly based in China, particularly the Shaanxi region, with these listings representing around a dozen industrial facilities involved in the production of herbal extract products. Many of these vendors claimed to be able to fulfil orders exceeding 500kg-1000kg, with a production capacity of up to 10,000kg per month. Websites 5 and 6 represented smaller outlets, which provide traditional Turkish foodstuffs. Based in Turkey, these websites advertised processed products such as salep and coffee/salep beverages, although each website also offered a single product listing for pure salep powder, alongside their other salep products.

Sixty-six (49%) products were pure powders, 26 of which were offered in wholesale quantities. These products were usually derived from *Dendrobium* or *Cymbidium* species, with 9 appearing to be derived from *Dendrobium* flowers, 4 from stems and 2 from leaves, with the origin of many other undeclared. These wholesale products, however, usually included the word `salep' within their product descriptions, with one product listing claiming the powder was derived from orchid bulbs.

Twenty-two (16.5%) products were offered as whole roots (tubers), which were otherwise advertised in a similar way to pure powders. 40 (30%) of the product listings were for processed products, such as powders for ice creams and beverages. In these listings, the proportion of salep within the ingredients was rarely declared. These products included several brand names, including one well-known global brand. 5 (3.7%) of the product listings were for whole tubers, which were being sold as 'lucky charms'. These so called 'lucky hand roots' are tubers which have a number of natural protrusions giving them a vague, hand like appearance. The vendors of these products were located in the USA, Greece and the UK.

Table 4: *Characteristics of online marketplaces sampled for salep products, detailing marketplace type, the number of vendors and products observed and the location of products within the website under specific menu headings*

					Number of vendor-salep product combinations				
Site	**Description**	**No. Products sampled**	**No. Of vendors**	**Website menu category**	**Pure Powder from tubers**	**Roots**	**Processed Powder (non-pure)**	**Lucky Charms**	**Observations**
1	**Global online marketplace**	30	26	Home Furniture and DIY -> Food and Drink -> Other food and drink	15	11	3	0	Majority of trade in pure powders or roots, with vendors located in India, Greece, Albania, the UK and USA.
2	**Global online marketplace**	43	36	Home and Living	20	10	8	5	Majority of trade in pure powders or roots, with more processed products than for website 1. Vendors located in Turkey, Greece, Albania, UK, United States, India and Jordan,
3	**Global online marketplace**	15	10	Grocery and Gourmet food: > Beverages > Breads/bakery > Herbs/Spices	2	0	13	0	Fewer items than other websites, with a majority of processed products, and few pure powders. Vendors located in Greece, Turkey, USA and Israel.
4	**Global online marketplace**	32	22	Heath/Medical/ Extract/Plant Extract	27	1	5	0	Website specialises in bulk products available for wholesale orders.All vendors located in China, aside from one located in Pakistan.
5	**Traditional Turkish products**	5	1	Turkish Drink/Turkish Coffee	1	0	4	0	Specialist website for Turkish foodstuffs. Vendor located in Turkey.
6	**Traditional Turkish products**	8	1	Turkish Drinks/Turkish Salep	1	0	7	0	Specialist website for Turkish foodstuffs. Vendor located in Turkey.
Total		**133**	**95**		**66**	**22**	**40**	**5**	

In the following analysis, these results have been aggregated, to provide an overview of the trends in the online trade in edible orchid products that were observed.

Species-Country Combinations

Online vendors were based in ten different countries (Figure 12, Table 5). Turkey was represented by the greatest number of vendors (35), followed by China (20), India (17) and Greece (16). In 51% of the product listings, a species or genus name was identified within the product description, while in 49% of product listings, this information was not declared (Figure 13 & 14 and Table 6).

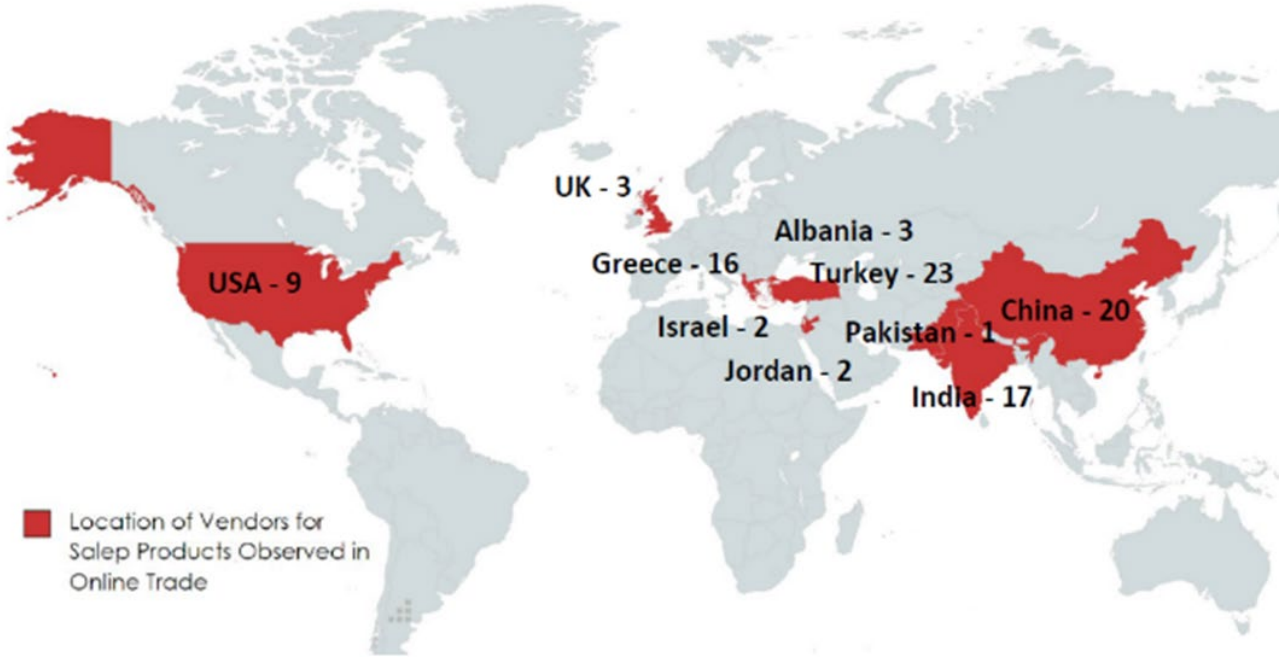

***Figure 12**: Number and location of vendors observed trading salep products online, within 6 online marketplaces sampled (n = number of different vendors located within each country). (Map template adapted from www.mapchart.net)*

***Table 5**: Number and location of vendors observed trading salep products online, within 6 online marketplaces sampled.*

Country	Number of Vendors	Number of Products
Turkey	23	35
China	20	30
India	17	19
Greece	16	28
United States	9	9
United Kingdom	3	4
Albania	3	3
Israel	2	2
Jordan	2	2
Pakistan	1	1

Of the 133 salep products observed, 68 product listings provided a species or genus name within their product descriptions, with these descriptions encompassing 4 genera and 8 species. Information relating to species identity was not declared in the product descriptions of the other 65 (49%) items (Figs 10 and 11).

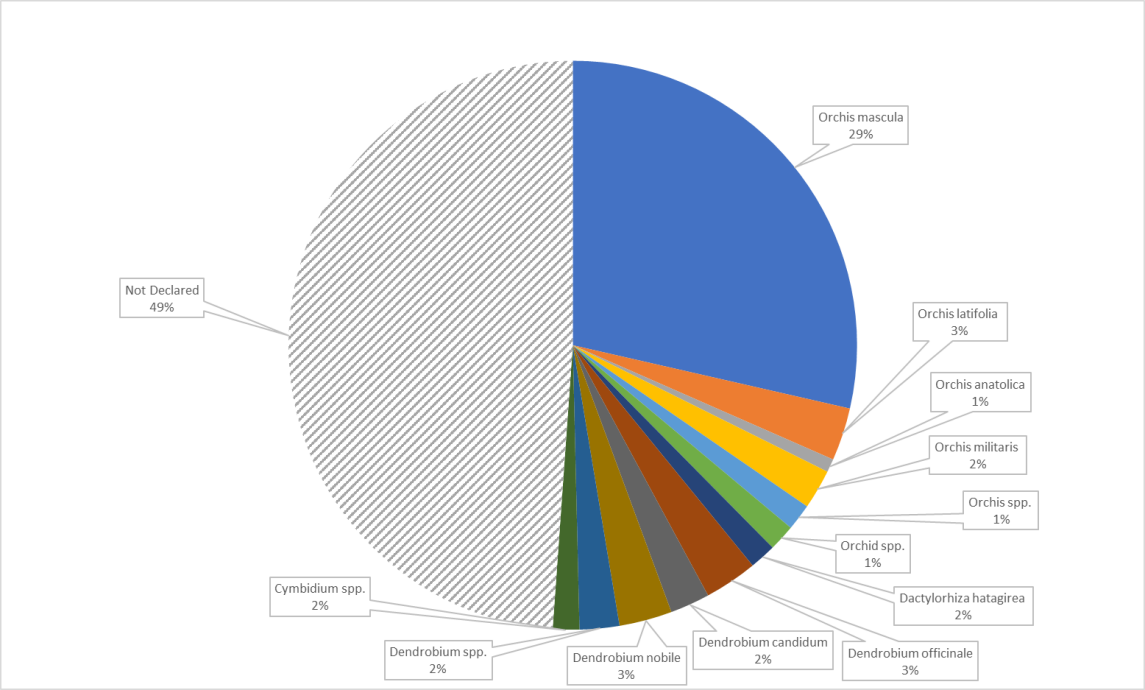

***Figure 13**: Genera and species named within 133 product descriptions for salep products observed in searches of 6 online marketplaces.*

As outlined in the figure below, 8 species from 4 genera were cited within online product listings, which is a relatively narrow range compared to the total number of species potentially used to make salep products. *Orchis mascula* is the species most frequently declared in product descriptions, occurring in 38 product listings, 20 of which were from vendors located in Greece, 5 in Turkey, 5 in India, 3 in Albania 2 in the United Kingdom and 1 each in Jordan, Pakistan and the United States of America. Three other Orchis species were also cited in a smaller number of product listings - *Orchis latifolia* (4 products), *Orchis militaris* (3 products) and *Orchis anatolica* (1 product).

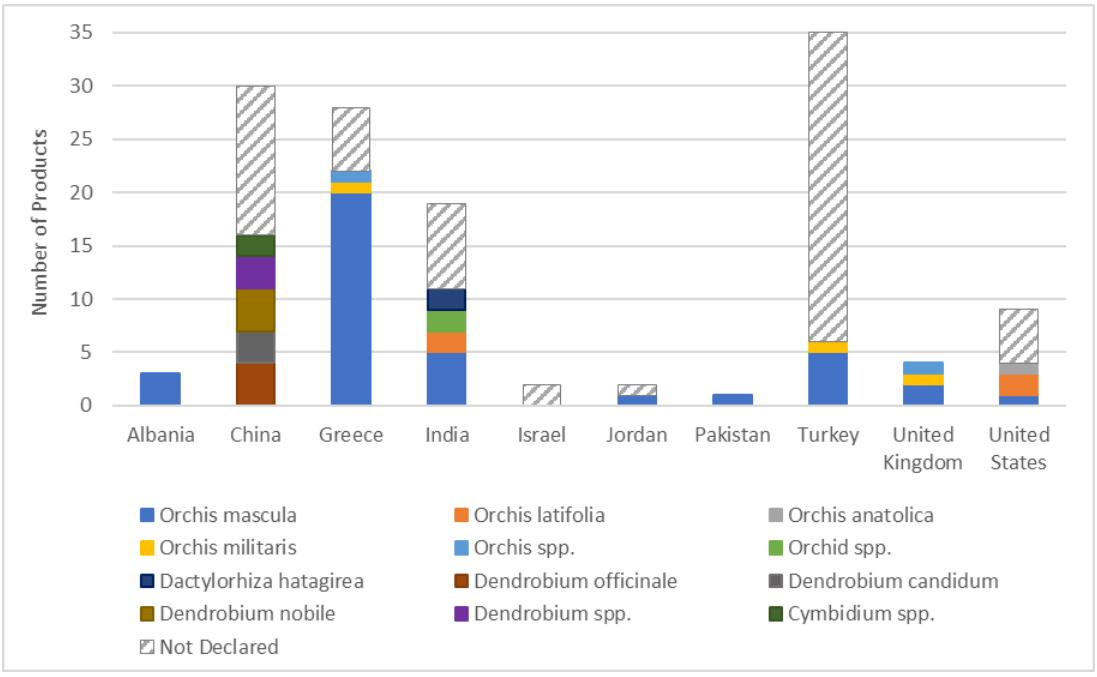

***Figure 14**: Salep products categorised by vendor location and genera/species named in product descriptions, for 133 salep products offered for sale in the 6 online marketplaces sampled.*

Table 6: *Species–country-combinations recorded for salep products observed within 6 online marketplaces sampled, with country representing the vendor's physical location. Countries which form part of the species natural range are indicated as range States.*

Orchid taxa	Country (vendor location)	Species Range State	Total Products
Orchis mascula	Greece	Yes	20
Orchis mascula	Turkey	Yes	5
Orchis mascula	India	No	5
Orchis mascula	Albania	Yes	3
Orchis mascula	United Kingdom	Yes	2
Orchis mascula	Jordan	No	1
Orchis mascula	Pakistan	No	1
Orchis mascula	United States	No	1
Orchis militaris	Greece	Yes	1
Orchis militaris	Turkey	Yes	1
Orchis militaris	United Kingdom	Yes	1
Orchis latifolia[1]	India	No	2
Orchis latifolia	United States	No	2
Orchis anatolica	United States	No	1
Orchis spp.	Greece	Unclear	1
Orchis spp.	United Kingdom	Unclear	1
***Dendrobium* species**			
Dendrobium officinale	China	Yes	4
Dendrobium nobile	China	Yes	4
Dendrobium candidum	China	Yes	3
Dendrobium spp.	China	Unclear	3
***Cymbidium* species**			
Cymbidium spp.	China	Unclear	2
***Dactylorhiza* species**			
Dactylorhiza hatagirea	India	No	2
Other			
Orchid spp.	India	N/A	2
Not declared	China, Greece, India, Israel, Jordan, Pakistan, Turkey, United States.	N/A	65

Three *Dendrobium* species were named within online product listings: *D. officinale* (4 products), *D. nobile* (4 products) and *D. candidum* (3 products).

In some cases, product names or descriptions were found to mirror or duplicate information provided in relation to products sold by apparently unconnected vendors. This observation, combined with the narrow range of species and lack of other contextual information, leads us to speculate that in at least some cases, species names may be used as something of a standard product description, which may not accurately represent the identity of the species being traded in every case.

In 49% of the product listings, no indication of species identity was provided at all. A further lack of transparency is created by the use of *Orchis latifolia* within product descriptions, which is not a CITES accepted name and is a potential synonym of three other species[1]. Several genera were notable for their absence, with searches for the genera *Anacampis*, *Gymnadenia*, *Himantoglossum*, *Neotinea*, *Ophrys*, *Platanthera*, or *Serapias* only returning results for low volumes of bulbs intended for the horticultural trade.

Based on the information provided within product listings, 18 species-country combinations were identified, along with a further 3 genus-country combinations (Table 6). *Orchis mascula* - Greece was the most observed combination (20 products), followed by *Orchis mascula* from Turkey, India and Albania. *Dendrobium* and

[1] *Orchis latifolia* is cited as a synonym of *Dactylorhiza majalis subsp. majalis and Dactylorhiza incarnata subsp. incarnata* (source: World Checklist of Selected Plant Families https://wcsp.science.kew.org/)

Cymbidium species were all traded from China, while *Dactylorhiza hatagirea* was traded from India. For 10 of these combinations, the country of origin was also a range State of the species in question, while for 8 it was not. For the 4 genus-country combinations that were noted, a lack of information about the specific species in trade makes this assessment unclear. These observations suggest that to facilitate online trade, some cross-border movement of raw materials and finished products between suppliers and vendors must also occur. Additionally, given the wide geographic range of some species including *Orchis mascula* and *Orchis militaris*, the fact that these orchids are being sold from within a range State does not mean that the tubers necessarily originate from that country, with the cross-border movement of orchid tubers between range States known to occur.

Our analysis of the CITES trade database (UNEP-WCMC, 2022) demonstrates that between 2015 to 2020 for *Orchis, Dactylorhiza* and *Cymbidium* species, and from 2018 to 2020 for *Dendrobium* species, there are few entries in the database that might potentially reflect trade resulting from online retail sales, which was considered as trade relating to the shipments of extracts, powders, derivatives, stems and medicines, rather than trade in live plants and cosmetics. For *Orchis* species, including *O. mascula*, a similarly small number of exports of extracts and medicines are recorded for India and the United Kingdom, and a similarly small number of imports recorded for India, Turkey and the USA, all from artificially propagated sources, with many shipments originating from Belgium. There is, however, no trade within the database representing the small volumes and frequent shipments that might be expected to be generated by online trade, and no entries for wild sourced *Orchis* species, which are often advertised online. Shipments of artificially propagated *Orchis morio* derivatives produced in Belgium occur with some frequency in the database, although *O. morio* was not cited within any online product listings observed.

Exports of medicines and derivatives of artificially propagated *Dendrobium officinale*, *Dendrobium nobile* and *Dendrobium* species from China are recorded in the database, which may potentially reflect aspects of online trade, although these do not occur with the frequency that might be expected from such large scale and established industry, and these supply chains warrant closer examination to determine their potential relationship to online trade. From 2018 to 2020, only two imports of *Dendrobium* extracts into China were recorded in the database, although this is not surprising, as it is likely that the products offered for sale online are produced within China.

No exports of *Cymbidium* extracts from China were recorded during this period. *Cymbidium* imports to China displayed one interesting trend, with regular imports of artificially propagated *Cymbidium kanran* extracts from Korea occurring between 2018 and 2020, although *C. kanran* does not appear within the online product descriptions observed, and these shipments may be unconnected to online retail trade. From 2015 to 2020, no imports or exports of *Dactylorhiza hatagirea* to or from India were recorded in the CITES Trade Database.

Orchid Source and Harvest Site

In 67% of product listings, the vendor did not declare the source of the orchids within their products. Twenty-one (15.7%) product listings referred to wild sourcing, which was usually highlighted for marketing purposes. Two adverts (1.5%) contained references to artificial propagation, one through the supply of photographs of a plant nursery, and one through a reference to *'industry elites who have years of experience in plantation'.* For a further 22 product listings (16.5%) for wholesale products, artificial propagation can be inferred from the volumes offered for sale, with volumes of powder in excess of 500 to 1000Kg offered for sale, and with a production capacity of >10,000Kg/month cited by some vendors.

Table 7*: References to the origin of orchids within online product listings for salep products, observed in 6 online marketplaces. Where available, this information was usually contained within product titles and product descriptions. observed.*

Site	Wild Sourced (claimed)	Artificially Propagated (claimed)	Artificially Propagated (assumed based on volumes)	Not Declared/ Unclear
1	7	0	0	23
2	12	0	0	33
3	2	0	0	13
4	0	2	22	8
5	0	0	0	5
6	0	0	0	8
Total	**21**	**2**	**22**	**90**

Ten (7.5%) of product listings appeared to provide details of the harvest location. These details were, however, fairly vague, and referred to the Pindos region in Greece, Macedonia and the Bucak/Nigde, Taurus Mountains, Kastamonu, and Kahramanmara regions of Turkey, and Southern Turkey. Four vendors based in Greece suggested the harvest occurred in Greece, four vendors based in Turkey claimed the harvest occurred in Turkey, and two USA vendors claimed their products were sourced from Turkey (1) and Greece (1). Three product listings provided a year of harvest, citing 2018 in one case, and 2021 in two cases. Two other product listings gave the time of harvest as being between April and October. Four product listings provided some basic details of the harvesting method, describing the orchids as hand-picked, with two product listings claiming that not more than 50Kg were harvested per season.

Cost per Kg and Numbers of Orchids in Trade

For 114 of the 133 products sampled, sufficient information was provided in the online product listing to enable the cost per kg of product to be calculated (Table 8).

Table 8: *Cost of salep products observed in online trade in 6 online marketplaces. Where smaller units were offered, extrapolated to price per kg where .*

Product Type	Number of products	Range (£/kg)	Mean (£/kg)	Notes
Powdered Salep (Pure)	41	£86.9 to £1,382/kg	£456.7/kg	Usually offered for sale in small quantities, typically of between 25g and 950g as a suggested order size.
Whole Roots (Salep)	14	£94.71 to £1,115/kg	£458.38/kg	Two products exceeded £1,000/kg. These were both Dactylorhiza hatagirea, from Indian suppliers.
Wholesale Powders	26	£5.77 to £82.36/kg	Mean Low (bulk orders): £17.3/kg Mean High (smaller orders): £34.7/kg	Price varies dramatically depending on the volume ordered.
Processed Products (containing salep)	28	£1.65 to £329.64/kg	£99.6/kg	The % of salep within products was rarely declared and is likely to vary widely The most expensive product (equivalent of £329.64/kg) was described as a salep flavoured instant powder drink, sold in small quantities at unit price of £9.23 per 28g.
Whole Roots (Lucky charms)	5	£6.94 to £11.56/tuber	£10.38/tuber	Offered for sale individually or in pairs. As the weight of these large tubers is unknown, it was not possible to calculate a price per Kg for these items.

A wide range of prices were observed for both pure and processed salep products. While most products were offered for sale in small quantities, their price per kg was usually significant, with very similar mean values of just over £450/kg observed for pure powders and roots. Processed powders were considerably lower in value, with a mean value of just less than £100/kg and were also usually sold in far smaller quantities. Wholesale powders varied in price considerably depending on the volume being ordered and could be as high as £82/kg

and as low as £5.77/kg. In either case however, the value of wholesale dendrobium/cymbidium powders) was an order of magnitude lower than the value of salep powders made from ground or whole pure orchid tubers. Lucky hand roots were sold individually or in pairs, at a mean price of £10.38 per tuber.

As outlined in the methodology, using an estimate of an average mass of 0.94g/tuber (1,063 tubers/kg), a price per tuber within pure products can also be calculated (Masters et al., 2022) . Applying these estimates to the prices for tuber-based products above, the mean value of an orchid tuber sold as a pure powder or as roots, is £0.43 per tuber in both cases.

Marketing

The marketing of online products provides insights into the motivation of consumers. The marketing of the salep products observed fell into 5 broad categories (Table 9).

Table 9: Broad categories of marketing claims associated with salep product listings observed within 6 online marketplaces.

Marketing Emphasis	Number of products
Health benefits	48
Traditional food/drink product with health benefits	25
Traditional Food/drink product	39
Quality (top grade etc…)	5
Lucky charm	8
None	8

Claims to the health benefits of salep formed the dominant marketing strategy, with benefits to health highlighted in 73 of the 133 products sampled (54%). These claims related to a wide range of health conditions, from increased energy levels to anti-aging properties to aphrodisiac effects. In total, salep products were claimed by vendors to be used in the treatment of 50 health conditions (see Annex V for a complete list), with many product listings noting that these claims are not FDA approved. In some cases, products were presented as traditional products, in use for centuries or more. Wholesale dendrobium powders were particularly associated with pre-work out supplements.

In many cases, health benefits were listed alongside the product's role as a source of food and nutrition, which was highlighted in 47% of product listings. Adverts focusing on food and nutrition often highlighted the use of powder in traditional Greek and Turkish winter drinks, as being tasty and healthy, and conveyed a sense of luxury (see Annex V for a full list).

Lucky hand charms were described as bringing the owner luck, for help with finances, relationships, gambling and games of chance (Annex V).

International Shipping

Product listings for 128 of the 133 products sampled (96.2%) included offers of international shipping. While it was not possible to determine the amount of international trade undertaken by vendors, that the offer of international shipping was clearly presented in the majority of product listings, suggests that the vendors were willing to cater for an international consumer base.

For 90 of the 133 products sampled, the timeframe for dispatching a product following an order was <7 days, with 1-3 days commonplace. These dispatch times would not allow for CITES permits to be applied for, with some destinations including the EU and UK, also requiring an import permit to be issued by the importing country.

Shipping to the UK was used as a comparative benchmark, with free shipping offered in 44 adverts, and relatively low shipping costs in the region of £10-£15 offered in many other cases. The only exception was for shipments of wholesale powders, where the shipping costs reached >£70/kg, although this cost rapidly reduced as the volume of the shipments increased. These low shipping costs would therefore be insufficient to cover the cost of CITES permits required for international shipping.

Vendors claimed to make use of the following courier and postal services: air and sea freight, economy international shipping, international economy untracked, standard and expedited international shipping, tracked mail.

Vendors located in non-range State countries would need to import the products that they had available for sale. This may include the 5 vendors of lucky hand charms from the USA, although as the identity of these tubers is unclear, it isn't possible to determine whether they originated in the USA or required prior importation.

References to CITES

None of the product listings sampled contained references to CITES or advice on the need for CITES permits for international shipments. In many cases, the terms and conditions stated that any customs considerations were the responsibility of the buyer. A variety of wording was used to convey this, although in some cases, the standard terms and conditions of the host website provided this message within their standard text provided for vendors to make use of. No references to CITES were recorded in either bespoke or the more standard template terms and conditions that were linked to the advertised products.

Theoretically, consumers and vendors could communicate through closed channels to discuss arrangements for CITES permits, but the lack of information within the product listings, combined with the short timeframes for dispatch and low costs of delivery noted above, strongly suggests that international trade arranged via these platforms is routinely conducted absent of CITES controls.

If so, this also suggests that when shipped internationally, salep products are mis-declared in customs paperwork, and/or have their salep content omitted from customs declaration forms. As the identify of products would be more difficult to conceal for large shipments of wholesale powder, a request for information from wholesale vendors regarding their processing of international orders may provide useful insights into this branch of the trade.

References to Conservation

Only two advisements contained information relating to the conservation status of orchid species. In one case, it was stated that the harvest was restricted to 50kg/season, although the rationale for this harvesting strategy was not explained. In the second example, in relation to health benefits, the vendor based in Turkey stated: '*Salep is an expensive plant because it is endemic and some species are dangerous for extinction. But even a small gram of it is very effective.'* No references to the conservation status of orchid species were recorded in the other product listings sampled.

Summary of Online Trade Analysis – Salep

The survey of online trade performed in this study provides a snapshot of the role that online markets play in the marketing and distribution of salep products. A total of 95 vendors located in 10 countries, advertising 133 different products associated with the key word 'salep', demonstrates that through the internet, salep is readily accessible to a global consumer base in a wide variety of forms, catering for a range of consumers and budgets. The marketing of these products based on a vast array of purported health benefits, alongside salep's role in traditional food sources, suggests that consumers may consider these products to have unique properties, for which there may be few substitutes. The high mean price of £450/kg commanded by pure powders and roots, (equating to an estimated £0.43/tuber), may provide a strong economic incentive to promote these qualities to an international consumer base. The use of orchid tubers as lucky charms (Lucky hand roots) was an unexpected element to trade, which appears at occur at sufficiently low volumes to be of low-conservation concern, although the identity of species used for these charms remains unclear.

Despite salep products being readily available within a variety of well-known online marketplaces with global reach, every aspect of the online trade in salep products remains opaque. Species-country combinations identified in online trade appear poorly represented within the CITES Trade Database, with the nature and frequency of international shipments made with CITES permits bearing little resemblance to the patterns that would be expected from an online industry that appears prepared and ready to supply a global consumer base.

Almost half of product listings provided no information on the species being sold, with species that were referenced only representing a narrow selection of the species commonly cited within the literature as being used within salep products. While a small number of product listings offered information on the location or timing of harvest, this falls far short of the level of detail required to enable these claims to be verified, or harvesters or producers to be identified. Wild sourcing was frequently used as a marketing plus, with only 2 adverts providing suggestions of artificial propagation, although this must be assumed to be the mode of production for wholesale products, given the volumes of shipments on offer.

While virtually all product listings offered international shipping, none referred to CITES procedures. Coupled with low (or free) shipping costs and speedy dispatch times of just a few days, strongly suggests that international trade in these products is routinely conducted without CITES controls. In order to evade CITES, it is likely that these goods are mis-declared on courier and postal packages, with vague terms and conditions

pertaining to customs regulations being the buyer's responsibility common among vendors, who frequently use the websites' standard terms and conditions to convey this to their customers.

The online trade in salep therefore appears a clear example of the use of online marketplaces by vendors and consumers who are either unaware of, or willing to circumvent, CITES controls. Without the uses of CITES permits supported by non-detriment findings for these supply chains, coupled with authentication of products to verify the claims of online vendors, the impact upon wild populations of species used for salep production cannot be accurately assessed, although is potentially significant.

Trade is often without CITES permits from Iran to Turkey and is often labelled as other food items when crossing border (Ghorbani et al., 2017). There has been an increase in the annual export of dried tubers from Turkey, with an estimate of 6500kg during the Ottoman Empire (Kasparek & Grimm, 1999), but in 2021, Turkey produced a yield of 425kg of salep (Turkish Statistical Institute, n.d.). The export of salep from Turkey is prohibited, and no import by CITES Parties should be accepted (Kasparek & Grimm, 1999). As production and trade of orchids are prohibited, production of salep for food purposes is under the supervision the 'Provincial/District Agriculture and Forestry Directorates', and farmers must be registered in the 'Farmer Registration System' in order to produce salep (Ministry of Agriculture and Forestry, 2022). They recommend that CITES Parties should control the import and export of salep, as well as the use of substitutes for salep to be advertised in an attempt to reduce demand for wild orchid salep (Kasparek & Grimm, 1999). Previously, Germany, Netherlands and Northern Cyprus have been listed as major salep importers, with other countries noted as importers are Switzerland, Austria, Saudi Arabia, United Kingdom, Bulgaria, Israel, Lybia, Rumania, Russia, Azerbaijan, United Arab Emirates, former USSR, and Denmark (Kasparek & Grimm, 1999). Salep was exported from Greece, Turkey or Syria to Germany, whereas now, it is imported from China via Hong Kong Special Administrative Region by one supplier (Kasparek & Grimm. 1999).

On the CITES Tradeview database (reported by exporters), there were only four exports of wild sourced *Epipactis* spp*.,* exclusively *Epipcactis helleborine* in root form, traded from Belarus to the United States of America. According to importers, the top exporter of *Epipactis* spp. was the United Kingdom, and the top importer was Japan. 200 roots artificially propagated sourced were traded in 2015, and all were *Epipactis palustris*, which does not occur in the 'Edible Orchid Database'. The top exporter of *Eulophia* spp. was Thailand and the top importer was India. 15 roots were trade in 2016, all artificially propagated sourced, and consisted of *Eulophia flava, Eulophia herbacea* and *Eulophia macrobulbon.* These taxa were not found in our literature review.

There were no results when searching on the CITES Tradeview database for *Eulophia* spp. as reported by exporters. *Dactylorhiza hatagirea, Gymandenia* spp*., Himantoglossum* spp*., Neotinea* spp*., Ophrys* spp*., Orchis anatolica, Orchis latifolia* (A synonym of both *Dactylorhiza majalis subsp. m*ajalis and *Dactylorhiza incarnata* subsp*. incarnata*)*, Orchis mascula, Orchis militaris, Orchis* spp*., Platanthera* spp*. or Serapias* spp*,* was reported by both importers and exporters.

Conservation impact

Harvested tubers, Zambia

Conservation impact

Assessment of the conservation impact of trade in salep and chikanda products requires the creation of Non-detriment Findings (NDFs) by CITES Scientific Authorities. NDFs establish the sustainability of trade for species-country or region-country combinations, as well as verifying the legality and sustainability of harvests contributing to individual international shipments containing CITES listed species.

To conduct an NDF, a broad suite of up-to-date information is required, relating to intrinsic (e.g. biological) and extrinsic (e.g. anthropogenic) factors affecting wild populations of the species in question (see Cohen et al., 2020 for a detailed summary). While complete data covering every relevant factor may not always be available, the information must be sufficiently complete and reliable, in order for a risk-based assessment of the impact of harvest upon the species to be made.

While there is no officially proscribed approach to conducting NDFs, the 9-step guidance for making CITES non-detriment findings for perennial plants (Wolf et al., 2016), provides a structured approach to capturing and assessing the key information required for conducing edible orchid NDFs.

We documented a large volume of edible orchids, and only found a few of these identified to a species level in trade. We have taken a broad overview to the data available to make NDFs for edible orchids using the 9-step guidance.

Step 1: Identification

Taxonomic verification of species names was checked using the World Checklist of Selected Plant Families and CITES orchid checklists. There are plentiful resources relating to species taxonomy, however, many of the orchids in trade were not identified to a species level. There are also numerous names in trade both at marketplaces and online markets which do not have scientific names. We identified various trade names for salep; ‘Salepi,’ ‘Sahlab,’ ‘Sahleb,’ ‘Sahlep’ and other names as detailed in Annex III. Additionally, one study found the shape of tubers were being used to distinguish between in Iran, with tubers identified as palmate called ‘Panĵeh-ey’ or alternatively round/oval shaped tubers named ‘Qolveh-ey’ (Ghorbani et al., 2014).

A plethora of chikanda trade names were found in the literature, from root shaped tubers called ‘mshilamshila’ in Bemba, Zambia and heart shapedtubers called ‘mampanda’ (Veldmen et al., 2018). Names for tubers are also based on their origin, with Veldman et al (2017) stating that “mwinilunga, chozi, luwingu and kasama are all Zambian city names, sumbawanga and iringe refer to Tanzanian cities and angola refers to one of the countries bordering Zambia”. However, the terms original ‘myala’, and fake or low quality (Veldman et al., 2014) ‘mbwelenge or msekelele’, are the most common terms (Veldmen et al., 2018). There are many generic terms for chikanda orchid tubers as found by Davenport and Ndangalasi (2003): “chikanda (Fipa, Nyamwanga), finaka (Malila), finsekeni (Kinga, Nyakyusa, Wanji), kikanda (Safwa), kikande (Ngoni), kinaka (Nyiha), Mansekeni (Kinga), Ngulingusi (Wanji) and Vinaka (Nyiha, Safwa)”, as well as kikanu, kikanda or African poloni (Rutherford & Groves, 2017a).

CITES permits require scientific names so other forms of identification are essential for CITES implementation. Orchids that are traded as live plants, stems or roots can sometimes be identified to species level, but most commonly to genus level. It is difficult to identify highly processed products without DNA or other authentication techniques. Those that have had a lower level of processing, such as powders, drinks, foods, may be able to be identified (Rutherford & Groves, 2017b) . Some of the literature we reviewed used DNA barcoding or metabarcoding of salep products to identify to a species level (de Boer et al., 2017; Ghorbani et al., 2017).

Step 2: Review artificially propagated compliance

The edible trade is predominantly wild harvested and this step of the NDF is not applicable. Cultivation trials have been discussed earlier in this report.

Step 3: Review relevant exclusions and previously made NDFs

There are a few orchid NDFs available, primarily for ornamental or epiphytic orchids (AC26/PC20, 2012) but we found none for edible orchids. There was also a published study on an ornamental orchid which had used the 9-step guidance for perennial plants, this was for an endemic orchid species in Jamaica (Cohen et al., 2020). This study also highlighted that making NDFs is difficult with the lack of resources, available data and the ability to adequately monitor species populations.

Step 4: Evaluate conservation concerns

According to the intergovernmental expert panel on biodiversity, the main drivers of biodiversity loss are agriculture, exploitation of plants and animals, climate change, pollution, and invasive species (IPBES, 2019). To-date around 1850 orchid species have been assessed on the IUCN Red List, this is a small number of conservation assessments in comparison to the number of species in the family Orchidaceae (IUCN Red List, 2022b). A summary of the IUCN Red List Orchidaceae conservation status and number of orchid species; Least Concern (628), Endangered (422), Data Deficient (254), Vulnerable (234), Critically Endangered (209), Near Threatened (101), Lower risk (2) and Extinct (5) (IUCN Red List, 2022). Many of the orchid species documented in this study did not have an IUCN Red List assessment, and from the species which had an assessment the largest group of species were placed under IUCN Red List Least Concern (Table 10).

Table 10: The number of edible orchid species and their extinction risk on the IUCN Red List

	Red List Category	Number of species
	Not Evaluated	260
	Data Deficient	15
Not Threatened	Least Concern	69
	Near Threatened	10
Threatened	Endangered	11
	Vulnerable	6
	Critically Endangered	3

For the species which had a 'Not Evaluated' status we checked national and regional assessments on the BGCI ThreatSearch tool and found 63 of these species were categorised as Threatened. We interpreted 'threatened' from the following categories used by BGCI ThreatSearch tool: Critically Endangered, Endangered, Vulnerable, Threatened or Rare.

Step 5: Evaluate intrinsic biological risk

The most recorded species for chikanda belong to the genera *Disa, Satyrium* and *Habenaria. Disa* and *Satyrium* species have a small distribution range and wild species with narrower species ranges are at more of an extinction risk (Nic Lughadha et al., 2020). *Habenaria* had a greater range globally across tropical and sub-tropical areas which places it at less risk, but localised extinctions are possible. Similarly, the most frequent genera in *Ophrys, Dactylorhiza* and *Orchis* all have wide-spanning ranges. We recommend further analysis at the species and country population level to assess the biological risk more comprehensively.

From the papers we analysed as part of the salep and chikanda review, 15 of the papers focused on orchids from Turkey, followed by 5 papers focusing on orchids from the Southern Highlands of Tanzania, with only two papers on Greece and two papers on Nepal. The source of the orchid harvest as identified by the papers were predominantly wild, with one paper discussing in vitro source. One study focusing on *Ophrys sphegodes subsp. mammosa*, an orchid used for salep saw positive results for a tuber propagation method (Caliskan et al., 2019). The study looked at the tuber growth throughout the flower period for the orchid and discovered orchids which were harvested at the early flowering stage were able to develop new tubers (Caliskan et al., 2019). A further two species, *Orchis mascula* and *Anacamptis morio*, are already cultivated in Belgium for the cosmetic industry and trials are being conducted on the feasibility of large-scale cultivation for salep production. As detailed in the chikanda section of this report, there are trials to propagate species used in this trade in Southern Africa.

Step 6: Evaluate harvest impacts

Chikanda and salep are comprised of tuberous orchids often found in grassland habitat. It appears as a high biological risk to the orchid species as the harvest of the tubers uproots the whole plant. Based on the harvesting information presented in this report, we found a high threat of harvesting impact. This is due to the harvest practice of the whole plant being uprooted for the tubers, and that the species collection is indiscriminate, it appears to be tuberous orchids available in the habitats accessible to harvesters. The reviewed literature indicated declining populations of orchids used for salep and chikanda.

A review of the main threats listed for the family Orchidaceae on the IUCN Red List listed the following threats for the orchid species which have been assessed:

1. Small-holder farming
2. Unintentional effects (subsistence/small scale) [harvest]

3. Intentional use (species is the target)
4. Mining and quarrying
5. Shifting agriculture
6. Housing and urban areas
7. Increase in fire frequency/intensity
8. Unintentional effects (large scale) [harvest]
9. Droughts
10. Tourism and recreational areas

These assessments of threats support harvesting of orchids are one of the main threats attributing to their decline. In a recent study, automated conservation assessments were adopted to review the 13,910 species or orchids globally distributed, this provided a rapid assessment for a wider selection of orchid species (Zizka et al., 2021). Their results found 4,342 orchid species were evaluated as possibly threatened. In detail they classified 718 species as Critically Endangered, 2,567 species as Endangered and 68 species as Vulnerable. This study has limitations but provides an indication to the conservation status of orchids globally.

Step 7: Evaluate trade impacts

The magnitude of legal trade is low, as most of this trade is unregulated and traded without CITES permits. The prices of some of the salep products available online indicate this is a valuable source of income. It is difficult to quantify the trade volumes, however literature about the salep trade estimated 30 - 120 million orchids are harvested in Turkey annually, and in Iran, 5.5 - 6.1 million orchids are harvested annually (Ghorbani et al., 2014). For chikanda, figures indicate that Zambia imports around 5 million tubers from surrounding countries (Rutherford & Groves, 2017a), with 2.2 - 4.1 million tubers imported from Tanzania alone in 2003 (Davenport & Ndangalasi, 2003).

The online trade search for salep, suggested the quantities and authenticity of the product is difficult to determine. It also recognised substitutes or synthetic products may be sold in place of wild orchids, and so trade calculated from product descriptions can only provide an estimate of trade volumes.

Step 8: Evaluate effectiveness of management measures

No management plans exist in the CITES NDF database for wild harvested chikanda or salep species. We recognise preliminary research and studies have attempted to address this through case studies in Zambia and Tanzania but these projects are also investigating cultivation techniques and the feasibility of propagating these tuberous species.

Step 9: Make a Non-Detriment Finding or related advice

A positive NDF decision is not likely at this time, further information and understanding on harvesting practices are required.

Socio-economic dimensions of edible orchid conservation

It is pertinent to point out that this trade does not occur in a vacuum. Additional threats to these orchid populations are occurring in tandem to harvesting. Land use change, conversion to agriculture or housing has encroached on many orchid habitats. In Turkey, for example, the conversion of ancient olive groves into other land uses is irradicating an important habitat that tuberous orchid species thrive in (Interviewee two; Interviewee five). In Southern Africa, land that would previously be habitat for wild orchid species is being rapidly transformed into avocado plantations to meet the growing demand across the world (Interviewee one). It is unlikely that harvesting alone will lead to species extinctions, as it is likely that some individuals of a species are left behind after harvest (Interviewee three; Interviewee five). However, reducing a species to a few individuals in turn reduces the gene pool from which that species re-populates. This can mean that a species is less diverse, and therefore potentially less able to adapt to diseases or changes in the environment due to climate change.

Additionally, it is vital to consider that the trade outlined in this report is an important part of many people's livelihoods. Often, it is a source of income that enables households to overcome 'economic shocks' such as the loss of a parent, failure of other income streams (such as crops) or to overcome additional costs due to life events (such as weddings) (Interviewee two; Interviewee three). As fewer orchids are available for collection through declining populations, it is likely that prices for the end products will increase due to increased costs in the supply chain (eg. Transportation of orchids from further away, more time finding viable harvest sites etc.) Experts believe that an increase in price, due to less and less tubers being available, will be unlikely to affect demand for salep as end-consumers are more able to absorb the inflation. However, when it comes to the trade in chikanda, an increase in price due to reduced supply could end up in one of two scenarios. Either the demand

will decrease as people buy less, or the harvesters will be compensated less for the tubers they collect (Interviewee three). Harvesters usually have lower economic power and are unable to dictate the prices for the tubers (which is particularly true in Southern Africa), and so as orchid populations decline, it is the already disenfranchised in the supply chain who will suffer further economic loss. Though trials of artificial propagation of these species are underway, the limited success seen so far is an indication that further work needs to be done to find a viable way to protect both orchid populations, cultural traditions, and livelihoods.

Limitations and further study

Literature

The edible orchid database has considerable gaps in information due to the lack of information available and the time to access resources. The study was limited by searching literature in the English language only and many other resources are likely available in different languages. The main gaps to the database include ecological information, conservation status and evidence and details of trade routes. In some of the literature there was a deficiency of scientific names, genus or family indexing (e.g. Multiple edible plant field guides were ordered and indexed by common name only). Often species (and plant parts) are identified only as edible (unclear if species are edible and used for food or edible but not used). Date of species use is not present or, if present, didn't indicate if the use was still in practice (unclear if the use is historical, current or both). We likely have geographical bias as the written resources reviewed (those written in English language tended to be from English speaking countries).

The literature review was based on the available papers and grey literature we identified and available in the English language. There is a reasonable but not comprehensive volume of literature to draw summaries and conclusions from. The methodologies of the papers that were used for the literature review were identified as field research, lab-based research or desk-based research. 26 papers included field-based methodologies, 13 labs based and 8 desk based. 10 papers included cross overs between the methodologies, with only one paper being identified as using all three methodologies. Only two papers were exclusively desk based. 10 of the papers conducted interviews with local people and six of the papers undertook lab-based DNA work. For harvesting and trade data further in-field research is required in range states and engagement with stakeholders, particularly as elements of this trade are important for livelihoods.

NDF data

In future work, it would be useful to collect further data from CITES scientific authorities in countries that experience high volumes of trade in edible orchids. One limitation of this study is the small sample size of experts we were able to interview. This is partially due to time, but also due to non-responses or inability to engage. The limitations of conducting NDFs at a species level would currently be difficult without further population, harvest and regeneration data. It would be useful to have further NDF focus on orchids more broadly as well as for the edible orchid trade, with range States collaborating with perhaps support from the CITES Plants Committee.

For more biological information we recommend further research to verify the current use of historically used edible orchids, this could be done by connecting with ethnobotanists and in-country researchers. It's also important to verify trade and use data to species level (including products on the market) (resources often referred to genera rather than species). Additionally, it would be critical to verify status of cultivation of orchids several resources stated that various cultivation projects were in progress, feasibility of cultivation due to costs. Further research on the uses of orchids would add to this body of knowledge, particular as there is a close link between medicinal plants and edible plants.

Additionally, there was not time to review the legal status of orchids for each of the range states. The literature indicated orchids are nationally protected and banned for export from several of the range States.

Trade

Our analysis of online trade provided a snapshot of trade across a range of website types, including 4 sites with global reach and branding. Information on the number of transactions completed would enable the volume of trade to be more accurately assessed, although this information would only have been readily available from one of the websites sampled. The inclusion of a survey of vendors and manufacturers within future research might be an alternative way to measure this data, along with gaining other useful insights into their trade in chikanda and salep products.

Improving the transparency of online trade will require collaboration between range States, manufacturers, vendors and online technology companies. Transparency in trade would be improved through raising awareness with consumers, updates to online trading policies which are enforced by measures to remove or flag online product listings which do not adhere to these policies for edible orchid products. The courier and postal companies facilitating shipments of these product should also be consulted, regarding any potential measures to detect salep and chikanda products being shipped internationally via their services.

Any control of online trade will of course have an impact on livelihoods, by introducing frictions and costs which may make some international trade more difficult or economically unfeasible. A survey of online vendors might also provide a clearer understanding of the supply chains involved in online trade, which may help with strategies to support sustainable trade and mitigate some of these impacts where it is possible and appropriate to do so.

The lack of transparency around online trade extends to the identity of the species involved. Forensic research to authenticate products and identify the species in trade through DNA barcoding would enable the composition and proportion of species in trade to be established, building on work previously conducted by Masters et al (2022).

This study has identified a range of species-country combinations of relevance to the online trade in salep and chikanda products. Analysis of the CITES Trade Database supports the theory that online trade may be conducted largely absent of CITES controls. More information about the supply chains observed in the CITES Trade Database would, however, be a useful exercise, to establish to what extent these shipments may or may not relate to online trade activity, and the potential relevance of species recorded in the trade database, but which are not cited within product listing information.

With the threat to wild populations due to unsuitable collection, more research is needed to understand what species are collected, any harvesting patterns and what levels of harvesting would be required to enable this trade to work towards being sustainable.

Summary

Edible orchid trade

We found a total of 374 documented edible orchids in the literature. For many, the literature did not provide documentation of use, only edibleness. For those with use documentation, it was not always clear if the historical use is still practiced.

Many of those species did not have an IUCN Red List assessment. The category most represented in those that did was Least Concern. Many species without IUCN Red List assessments had national or regional assessments. Of these, 63 were categorized as Threatened (all species categorized as Critically Endangered, Endangered, Threatened, Vulnerable or Rare was interpreted as Threatened). Edible orchids with documented use for the products known and traded as chikanda and salep accounted for just over half of those identified. Chikanda, a food “cake” made with ground terrestrial orchid tubers, is eaten across several African countries, predominately Zambia. The genera most used to make chikanda were *Disa*, *Satyrium* and *Habenaria*. Salep, a powder also made from ground terrestrial orchid tubers, is used in Iran, Greece and predominately Turkey. The genera most utilized when making salep were *Ophrys*, *Dactylorhiza*, and *Orchis*.

Orchids harvested to make chikanda are exclusively taken from the wild and the whole plant is harvested. They are collected indiscriminately, without controls in place to allow time for regeneration. Species level identification is challenging for collectors and harvest is often based on the ability to sell the tubers. Collectors use locality, texture, shape and flavour to determine which harvested tubers the middlemen will buy. Both collectors and middlemen have noted that orchids are becoming rarer, forcing collectors to travel much farther and harvest less-desirable species to keep up with demand.

Protecting areas such as Kitulo National Park in Tanzania and Nyika National Park in Malawi has not prevented the harvesting of orchids within. Prohibition of collecting orchids is not enough to prevent continual harvesting. Collectors often rely on the income from selling tubers and will need alternative sustainable livelihoods.
From its local beginnings, chikanda has become a popular dish and is now found in restaurants and supermarkets. This rise in popularity has resulted in an increase in demand and a move to commercialisation. The demand is highest in Zambia. Tanzania and more recently Malawi and other bordering countries are supplying Zambia with orchid tubers to meet the demand. While cross border trade is evident, there is no evidence of CITES registration/declaration. Online trade in chikanda products and raw ingredients is currently

limited, suggesting that online international trade is rare. The trade that does occur however, lacks transparency and may be conducted without CITES control.

A large number of species are harvested to make salep, a powder used to make beverages and as an ingredient in both confectionery and ice cream. The orchids are harvested from wild populations, again with the removal of the entire plant. Species other than those targeted, and not suitable for use as salep, are also removed due to indiscriminate harvesting practices. Increased harvesting in Turkey has caused populations to decline and salep trade there is increasingly reliant on tubers harvested from other countries such as Greece, Albania, and Iran. Iran is now also seeing its populations decline.

There are some efforts underway to harvest sustainably. In Western Iran, some individuals are replanting orchids after harvesting to maintain populations and in Turkey, small groups of individuals have been able to sustainably harvest salep annually within their communities without a decrease in populations. There are other methods which could aid in the conservation of wild orchids, one of which is cultivation. Cultivation of salep species which produce one tuber annually has not been thought to be cost-effective. Another conservation method is the use of substitutes. It is believed that consumers don't specifically desire wild tubers in salep products and would likely accept artificial alternatives which replicate the taste and consistency expected. The modified starch, carboxymethyl-cellulose, is used in a variety of foods. It and rice powder are commonly used as substitutes for salep in Turkey. Glucomannan, a substance occurring in the orchid tuber, acts as the stabilizer and thickener in salep and can be found in plants other than orchids. While there may be potential to finding alternative supplies or even producing it artificially, there is little incentive to do so as it is unlikely to be cost-effective due to the low cost of accessing wild tubers.

Salep has also moved from local use to a commercial industry supporting large-scale enterprises in Turkey where demand is highest. It is now readily accessible in a variety of forms to consumers around the world via well-known online marketplaces as well. Traders frequently used a statement alluding to wild sourcing of orchid ingredients as a marketing tactic and almost half the products advertised provided no information as to species used. Every aspect of online trade in salep products was opaque and, while all the listings offered international shipping, none made any reference to CITES regulations.

The orchids identified as edible with uses other than chikanda and salep were spread over 46 genera with *Pterostylis*, *Diuris*, *Dendrobium, Prasophyllum* and Vanilla being the most represented. All parts of the orchid plant were documented as edible, although in most cases only one or two parts per species was documented. The tuber was the part most identified as edible. Documentation of the food use of orchids showed that they are prepared and consumed in a variety of ways. Some parts are eaten boiled, steamed or roasted, often compared to being used like potatoes, some are likened to vegetables, while others are pounded into a powder which aids in storage. Some orchid parts are used to flavour food and beverages, some to prepare preserves and jellies, and some are eaten raw, providing sustenance away from home.

Implications for orchid exemptions on CITES

This review supports that the trade of orchid tubers is a threat to wild populations and the trade seems to be unregulated. A preliminary list of genera and species in the edible orchid trade will facilitate future discussions on orchid exemptions on CITES. There have been discussions relating to exempting certain orchid taxa from cosmetic products, the species for consideration are: *Bletilla striata, Cycnoches cooperi, Gastrodia elata, Phalaenopsis amabilis* and *Phalaenopsis lobbii.* Only one of these species appeared in our review, *Gastrodia elata* as it has a documented medicinal, edible and cosmetic use. Predominately the use of this species is for medicinal purposes and as the species native range native range is the Himalayas and across temperate East Asia (POWO), it was not included in one of our in-depth reviews. This species requires an updated IUCN Red List assessment, but in 2004 it was listed as Vulnerable (China plant group). However, we found limited data and evidence that this species is in trade for edible purposes. We found one occurrence for trade of this species as a health food and an online marketplace offering international shipping for this purpose. It's previously been documented that collection of wild seed for cultivation has been an important source of income (BGCI) and the CITES trade database only shows artificially propagated trade of *Gastrodia elata* when queried between 2010 – 2019 with the main exporting countries as Republic of Korea and China and trade predominantly as an extract or powder (CITES Trae view). We found a close link between edible and medicinal orchids, so a review of species used medicinally and for other uses for orchids is recommended to facilitate informed discussions in CITES.

References

AC26/PC20. (2012). *Non-detriment findings DRAFT GUIDANCE ON THE MAKING OF NON-DETRIMENT FINDINGS*. http://www.cites.org/esp/cop/15/doc/S15-16-02-02.pdf

Ari, E., Polat, I., Gocmen, M., Karaguzel, O., & Onal, K. (2005). Phylogenetic relationship of turkish terrestrial orchids. *Acta Horticulturae*, *673*, 155–160. https://doi.org/10.17660/ACTAHORTIC.2005.673.17

Attila, M. v., Süveges, K., Molnár, Z., & Löki, V. (2017). Using traditional ecological knowledge in discovery of rare plants: a case study from Turkey. *Acta Societatis Botanicorum Poloniae*, *86*(3). https://doi.org/10.5586/asbp.3541

Brinckmann, J. A. (2014a). *Quick scan of orchidaceae species in European commerce as components of cosmetic, food and medicinal products*.

Brinckmann, J. A. (2014b). *Quick scan of orchidaceae species in European commerce as components of cosmetic, food and medicinal products*.

Bulletin of Miscellaneous Information. (1892). Faham Tea. (Angræcum fragrans, Thouars.). *(Royal Botanic Gardens, Kew)*, *1892*(67/68), 181–183. https://doi.org/10.2307/4102602

Caliskan, O., Kurt, D., & Cirak, C. (2019). Development of New Sustainable Sahlep Production Methods Using Ophrys sphegodes subsp. mammosa (Desf.) Soo ex E. Nelson. *Journal of Agricultural Science and Technology*, *21*(6), 1547–1555. http://jast.modares.ac.ir/article-23-19310-en.html

Caliskan, O., Kurt, D., & Odabas, M. S. (2020). Morphological Developments of Orchis purpurea Huds. Salep Orchids. *Brazilian Archives of Biology and Technology*, *63*, 2020. https://doi.org/10.1590/1678-4324-2020190769

Challe, J. F. X., Niehof, A., & Struik, P. C. (2011). The significance of gathering wild orchid tubers for orphan household livelihoods in a context of HIV/AIDS in Tanzania. *African Journal of AIDS Research : AJAR*, *10*(3), 207–218. https://doi.org/10.2989/16085906.2011.626287

Challe, J. F. X., & Struik, P. C. (2008). The impact on orchid species abundance of gathering their edible tubers by HIV/AIDS orphans: a case of three villages in the Southern Highlands of Tanzania. *Https://Doi.Org/10.1016/S1573-5214(08)80011-5*, *56*(3), 261–279. https://doi.org/10.1016/S1573-5214(08)80011-5

Chapagain, D. J., Meilby, H., Baniya, C. B., Budha-Magar, S., & Ghimire, S. K. (2021). Illegal harvesting and livestock grazing threaten the endangered orchid Dactylorhiza hatagirea (D. Don) Soó in Nepalese Himalaya. *Ecology and Evolution*, *11*(11), 6672–6687. https://doi.org/10.1002/ECE3.7520

Charitonidou, M., Stara, K., Kougioumoutzis, K., & Halley, J. M. (2019). Implications of salep collection for the conservation of the Elder-flowered orchid (Dactylorhiza sambucina) in Epirus, Greece. *Journal of Biological Research (Greece)*, *26*(1), 1–13. https://doi.org/10.1186/S40709-019-0110-1/FIGURES/3

Chicago Botanic Garden. (2022). *Jumellea fragrans | Chicago Botanic Garden*. https://www.chicagobotanic.org/plantinfo/jumellea_fragrans

CITES. (2016). *COP17 Doc. 83.3 Annotations for Appendix II orchids*.

CITES. (2017). *PC23 Doc.32 Annotations for Appendix II orchids*.

CITES. (2020). *PC25 Doc. 37 Products containing specimens of Appendix-II orchids [Decision 18.329]*.

CITES. (2022). *SC74 Doc. 84 Products containing specimens of Appendix-II orchids: Report of the Plants Committee (Decision 18.330)*.

Cohen, J. E., Williams, H. N., Strong, Y. E., & Fisher, H. C. E. (2020). Non-Detriment Findings for international trade in wild orchids from developing countries; a case study for Broughtonia sanguinea in Jamaica. *Journal for Nature Conservation*, *56*, 125840. https://doi.org/10.1016/j.jnc.2020.125840

Crowe, A. (2004). *A Field Guide to the NATIVE EDIBLE FOODS of New Zealand* (4th ed.).

Davenport, T. R. B., & Ndangalasi, H. J. (2003). An escalating trade in orchid tubers across Tanzania's Southern Highlands: assessment, dynamics and conservation implications. *Oryx*, *37*(1), 55–61. https://doi.org/10.1017/S0030605303000127

de Boer, H. J., Ghorbani, A., Manzanilla, V., Raclariu, A. C., Kreziou, A., Ounjai, S., Osathanunkul, M., & Gravendeel, B. (2017). DNA metabarcoding of orchid-derived products reveals widespread illegal orchid trade. *Proceedings of the Royal Society B: Biological Sciences*, *284*(1863). https://doi.org/10.1098/RSPB.2017.1182

GBIF. (2022). *Global Biodiversity Information Facility* . https://www.gbif.org/

Ghorbani, A., Gravendeel, B., Naghibi, F., & de Boer, H. (2014). Wild orchid tuber collection in Iran: A wake-up call for conservation. *Biodiversity and Conservation*, *23*(11), 2749–2760. https://doi.org/10.1007/s10531-014-0746-y

Ghorbani, A., Gravendeel, B., Selliah, S., Zarré, S., & de Boer, H. (2017). DNA barcoding of tuberous Orchidoideae: a resource for identification of orchids used in Salep. *Molecular Ecology Resources*, *17*(2), 342–352. https://doi.org/10.1111/1755-0998.12615

Govaerts, R., Caromel, A., Dhanda, S., Davis, F., Pavitt, A., Sinovas, P., & Vaglica, V. (2019). *CITES Appendix I Orchid Checklist*. Royal Botanic Gardens, Kew and UNEP-WCMC. https://www.kew.org/sites/default/files/2019-08/CITES%20Appendix%20I%20Orchid%20checklist%20-%20Second%20version_12.07.2019.pdf

Govaerts, R., Nic Lughadha, E., Black, N., Turner, R., & Paton, A. (2021). The World Checklist of Vascular Plants, a continuously updated resource for exploring global plant diversity. *Scientific Data*, *8*(1). https://doi.org/10.1038/s41597-021-00997-6

Gov.uk. (2022). *UK Integrated Online Tariff*. https://www.trade-tariff.service.gov.uk/browse

Hinsley, A., de Boer, H. J., Fay, M. F., Gale, S. W., Gardiner, L. M., Gunasekara, R. S., Kumar, P., Masters, S., Metusala, D., Roberts, D. L., Veldman, S., Wong, S., & Phelps, J. (2018). A review of the trade in orchids and its implications for

conservation. In *Indonesia Botanical Journal of the Linnean Society* (Vol. 186). https://academic.oup.com/botlinnean/article-abstract/186/4/435/4736317
IPBES. (2019). *Global assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*.
IUCN Red List. (2022a). *IUCN Red List of Threatened Species: Orchidaceae*. IUCN Red List. https://www.iucnredlist.org/search?taxonomies=101295&searchType=species
IUCN Red List. (2022b). *IUCN Red List of Threatened Species: Orchidaceae*. IUCN Red List. https://www.iucnredlist.org/search?taxonomies=101295&searchType=species
Kasparek, M., & Grimm, U. (1999). European trade in Turkish Salep with special reference to Germany. *Economic Botany 1999 53:4*, *53*(4), 396–406. https://doi.org/10.1007/BF02866718
Kreziou, A., Boer, H. de, & Gravendeel, B. (2016). Harvesting of salep orchids in north-western Greece continues to threaten natural populations. *Oryx*, *50*(3), 393–396. https://doi.org/10.1017/S0030605315000265
Lavorgna, A., Middleton, S., Whitehead, D., & Cowell, C. (2020). *FloraGuard: Tackling the illegal trade in endangered plants report. Royal Botanic Gardens, Kew.* Available at kew.org/science.
Lavorgna, A., & Sajeva, M. (2020). Studying Illegal Online Trades in Plants: Market Characteristics, Organisational and Behavioural Aspects, and Policing Challenges. *European Journal on Criminal Policy and Research*. https://doi.org/10.1007/s10610-020-09447-2
Lim, T. K. (2016). *Edible Medicinal and Non-Medicinal Plants: Modified Stems, Roots, Bulbs* (Vol. 11). Springer. https://doi.org/10.1007/978-3-319-26062-4
Livoreil, B., Glanville, J., Haddaway, N. R., Bayliss, H., Bethel, A., de Lachapelle, F. F., Robalino, S., Savilaakso, S., Zhou, W., Petrokofsky, G., & Frampton, G. (2017). Systematic searching for environmental evidence using multiple tools and sources. *Environmental Evidence*, *6*(1), 1–14. https://doi.org/10.1186/S13750-017-0099-6/TABLES/1
Lohar, A. (2019). Edible orchids for human consumption. *AGRICULTURE & FOOD: E-Newsletter*, *1*(6), 27–31. www.agrifoodmagazine.co.in
Low, T. (1991). *Wild Food Plants of Australia*. Angus & Robertson.
Mahonya, S., Shackleton, C. M., & Schreckenberg, K. (2019). Non-timber Forest Product Use and Market Chains Along a Deforestation Gradient in Southwest Malawi. *Frontiers in Forests and Global Change*, *2*, 71. https://doi.org/10.3389/FFGC.2019.00071/BIBTEX
Masters, S., Anthoons, B., Madesis, P., G. Saroja, S., Schermer, M., Gerritsen, W., Karahan, A., Verdoes, R., Schwallier, R., van Andel, T., de Boer, H., & Gravendeel, B. (2022). Quantifying an online wildlife trade using a web crawler. *Biodiversity and Conservation*, 1–15. https://doi.org/10.1007/S10531-022-02367-Z/FIGURES/5
Masters, S., van Andel, T., de Boer, H. J., Heijungs, R., & Gravendeel, B. (2020). Patent analysis as a novel method for exploring commercial interest in wild harvested species. *Biological Conservation*, *243*, 108454. https://doi.org/10.1016/J.BIOCON.2020.108454
Ministry of Agriculture and Forestry. (2022). *Salep production for food purposes (Circular 2022-1). General Directorate of Vegetable Production.* https://kms.kaysis.gov.tr/Home/Goster/185740
Molnár V., A., Nagy, T., Löki, V., Süveges, K., Takács, A., Bódis, J., & Tökölyi, J. (2017). Turkish graveyards as refuges for orchids against tuber harvest. *Ecology and Evolution*, *7*(24), 11257–11264. https://doi.org/10.1002/ECE3.3562
Newing, H. (2010). Conducting research in conservation: Social science methods and practice. *Conducting Research in Conservation: Social Science Methods and Practice*, 1–376. https://doi.org/10.4324/9780203846452
Nic Lughadha, E., Bachman, S. P., Leão, T. C. C., Forest, F., Halley, J. M., Moat, J., Acedo, C., Bacon, K. L., Brewer, R. F. A., Gâteblé, G., Gonçalves, S. C., Govaerts, R., Hollingsworth, P. M., Krisai-Greilhuber, I., de Lirio, E. J., Moore, P. G. P., Negrão, R., Onana, J. M., Rajaovelona, L. R., … Walker, B. E. (2020). Extinction risk and threats to plants and fungi. *Plants, People, Planet*, *2*(5), 389–408. https://doi.org/10.1002/PPP3.10146
OEC. (2022, April 7). *Vanilla beans (HS: 090500) Product Trade, Exporters and Importers | OEC - The Observatory of Economic Complexity*. https://oec.world/en/profile/hs92/vanilla-beans
Orchids-World. (2012). *EDIBLE ORCHIDS*. https://www.orchids-world.com/evergreen/edible.pdf
Palzer, C. (2002). *Tree nursery manual for Eritrea* (C. , B. A. & T. B. Ruffo, Ed.). Regional Land Management Unit.
Paniagua-Zambrana, N. Y., & Bussman, R. W. (Eds.). (2020). *Ethnobotany of the Andes* (Vol. 2). Springer Nature Switzerland.
Pant, B. (2013). *African Journal of Plant Science Medicinal orchids and their uses: Tissue culture a potential alternative for conservation*. *7*(10), 448–467. https://doi.org/10.5897/AJPS2013.1031
POWO. (2022). *Plants of the World Online | Kew Science*. https://powo.science.kew.org/
Rawat, S., Andola, H., Giri, L., Dhyani, P., Jugran, A., Bhatt, I. D., & Rawal, R. S. (2014). Assessment of Nutritional and Antioxidant Potential of Selected Vitality Strengthening Himalayan Medicinal Plants. *International Journal of Food Properties*, *17*(3), 703–712. https://doi.org/10.1080/10942912.2012.654563
Ritchie, J., & Spencer, L. (2002). Qualitative data analysis for applied policy research. In A. M. Huberman & M. B. Miles (Eds.), *The Qualitative Researcher's Companion* (pp. 305–329). Routledge . https://books.google.co.uk/books?hl=en&lr=&id=46jfwR6y5joC&oi=fnd&pg=PA305&dq=Ritchie,+J.,+and+Spencer,+L.+(2002).+%E2%80%9CQualitative+data+analysis+for+applied+policy+research,%E2%80%9D&ots=spERHQwAJR&sig=zlsgHt4fs9jY41n2IWQNVp-C4ak#v=onepage&q=Ritchie%2C%20J.%2C%20and%20Spencer%2C%20L.%20(2002).%20%E2%80%9CQualitative%20data%20analysis%20for%20applied%20policy%20research%2C%E2%80%9D&f=false
Royal Botanic Gardens, Kew. (2012). *Economic Botany Collection online database*. www.kew.org/ecbot/database
Rutherford, C., & Groves, M. (2017a). *Chikanda: An Overview. Regional trade in edible terrestrial orchids in Africa*.

Rutherford, C., & Groves, M. (2017b). *Salep: An overview. The trade in terrestrial orchid tubers in Turkey, Iran and Greece*.

Rutherford, C., & Groves, M. (2017c). *Salep: An overview. The trade in terrestrial orchid tubers in Turkey, Iran and Greece*.

Sezik, E. (2002a). Turkish Orchids and Salep. *Acta Pharmaceutica Turcica*.

Sezik, E. (2002b). Turkish Orchids and Salep. *Acta Pharmaceutica Turcica*.

Tanaka, T. (1974). *Tanaka's Cyclopedia of Edible Plants of the World* (S. Nakao, Ed.). Keigaku Publishing Co.

Tekinşen, K. K., & Güner, A. (2010). Chemical composition and physicochemical properties of tubera salep produced from some Orchidaceae species. *Food Chemistry*, *121*(2), 468–471. https://doi.org/10.1016/J.FOODCHEM.2009.12.066

Teoh, E. S. (2016). *Medicinal Orchids of Asia*.

Teoh, E. S. (2019). *Orchids as Aphrodisiac, Medicine or Food*. Springer.

Turkish Statistical Institute. (n.d.). *Data portal for statistical. Other Crop Products; Edible Roots and Tubers.* Retrieved May 27, 2022, from https://data.tuik.gov.tr/Kategori/GetKategori?p=Agriculture-111.

Turkmen, N., Gursoy, A., Akal, C., Unal, E. M., & Keskin, E. (2021). Evaluation of salep obtained from different wild orchid species of Turkey and their use in Maras type ice cream. *Journal of Food Processing and Preservation*. https://doi.org/10.1111/JFPP.16063

Ulian, T., Diazgranados, M., Pironon, S., Padulosi, S., Liu, U., Davies, L., Howes, M. J. R., Borrell, J. S., Ondo, I., Pérez-Escobar, O. A., Sharrock, S., Ryan, P., Hunter, D., Lee, M. A., Barstow, C., Łuczaj, Ł., Pieroni, A., Cámara-Leret, R., Noorani, A., … Mattana, E. (2020). Unlocking plant resources to support food security and promote sustainable agriculture. *Plants, People, Planet*, *2*(5), 421–445. https://doi.org/10.1002/PPP3.10145

UNEP-WCMC. (2022). *CITES trade statistics derived from the CITES Trade Database, UNEP World Conservation Monitoring Centre, Cambridge, UK.* https://trade.cites.org/

Veldman, S., Gravendeel, B., Otieno, J. N., Lammers, Y., Duijm, E., Nieman, A., Bytebier, B., Ngugi, G., Martos, F., van Andel, T. R., & de Boer, H. J. (2017). High-throughput sequencing of African chikanda cake highlights conservation challenges in orchids. *Biodiversity and Conservation*, *9*(26), 2029–2046. https://doi.org/10.1007/S10531-017-1343-7

Veldman, S., Kim, S.-J., Andel, T. R. van, Font, M. B., Bone, R. E., Bytebier, B., Chuba, D., Gravendeel, B., Martos, F., Mpatwa, G., Ngugi, G., Vinya, R., Wightman, N., Yokoya, K., & Boer, H. J. de. (2018). Trade in Zambian Edible Orchids—DNA Barcoding Reveals the Use of Unexpected Orchid Taxa for Chikanda. *Genes 2018, Vol. 9, Page 595*, *9*(12), 595. https://doi.org/10.3390/GENES9120595

Veldman, S., Otieno, J. N., van Andel, T., & et al. (2014). *Efforts urged to tackle thriving illegal orchid trade in Tanzania and Zambia for chikanda production*. 47–50.

Whitehead, D., Cowell, C. R., Lavorgna, A., & Middleton, S. E. (2021). Countering plant crime online: Cross-disciplinary collaboration in the FloraGuard study. *Forensic Science International: Animals and Environments*, *1*. https://doi.org/10.1016/j.fsiae.2021.100007

Wolf, D., Oldfield, T. E. E., Schippmann, U., Mcgough, N., & Leaman, D. J. (2016). *CITES Non-detriment Findings Guidance for Perennial Plants A nine-step process to support CITES Scientific Authorities making science-based non-detriment findings (NDFs) for species listed in CITES Appendix II Version 3.0*. https://static1.squarespace.com/static/5f31306336006c736780d6b3/t/60abe5fa59865a022877f0eb/1621878280184/perennial-plants-9steps.pdf

Zhao, M., Fan, J., Liu, Q., Luo, H., Tang, Q., Li, C., Zhao, J., & Zhang, X. (2021). Phytochemical profiles of edible flowers of medicinal plants of Dendrobium officinale and Dendrobium devonianum. *Food Science and Nutrition*, *9*(12), 6575–6586. https://doi.org/10.1002/fsn3.2602

Zizka, A., Silvestro, D., Vitt, P., & Knight, T. M. (2021). Automated conservation assessment of the orchid family with deep learning. *Conservation Biology : The Journal of the Society for Conservation Biology*, *35*(3), 897–908. https://doi.org/10.1111/COBI.13616

Annex I: List of Interview Questions

Edible orchid project Semi-structured interview guide – Management/Scientific Authority

Information about the informant

Name

Role (in management authority or scientific authority)

Introductions from the edible orchid project team and a summary of the project.

"The CITES Secretariat is currently commissioning Kew to research the conservation impacts of trade in products of wild-harvested edible orchid species, with a focus on salep and chikanda. The results of this research are expected to be available in time for the documentation deadline of CoP19. This is desktop study and we are collecting data through a literature review and interviews. The outcome of this work is to inform discussions on on products containing specimens of Appendix-II orchids.

If asked further details of the output, activities to be carried out by RBG Kew:

a) Undertake a global scoping review of principal food products in international trade that contain orchid specimen using online data collection, literature analysis and expert interviews.

b) Analyse geographic patterns and temporal dynamics of the availability, trade routes and pricing of Salep and Chikanda products, using the CITES Trade database, and systematic manual and automated online search for products in trade.

c) Compile the taxa principally used in Salep and Chikanda products and available information on their biology, conservation, sources of harvest and estimated harvest volumes, using scientific and grey literature reviews, IUCN red listing information and expert and key informant interviews.

d) Assess the conservation impact of trade in Salep and Chikanda products using the 9-step guidance for making CITES non-detriment findings for perennial plants.

e) Identify knowledge gaps and priorities for follow-up research, including scope and methodologies of pertinent fieldwork.

Confirm PIC verbally and data anonymization

Will it be okay to include in the report we spoke to country x.

Would it be okay to include information you give us today – any information we do include in the final report will be anonymised and our name or job role will not be included.

Questions:

- Tell me about your role in the management/scientific authority
- What are the main uses or types of orchid trade in {insert country]? Define if its national or international trade.
- In your opinion, what is the scale of the edible orchid trade in [insert country] Is the trade cross border or localised?
- Can you tell us about which species you know to be involved in the trade? (or local names)
- What can you tell us about the harvesting of edible orchids?
- Can you tell us about the products being traded that contain edible orchids?
- And what about the sale of edible orchids? Where are these products being sold? - markets? - online trade?
- In your opinion, what portion of the trade occurs online? How is this regulated?
- Is this harvest or trade regulated by local or national laws?
- Do you receive applications for CITES permits for edible orchid species? In what sort of volumes? How does this compare to the actual levels of trade seen/reported?
- Can you describe who is involved in the harvest, trade and sale or edible orchids? – who? – where? – how often? – how easy is it to access the end product?
- Enforcement – how is CITES enforced in this trade?

- Can you tell us about the trends in this trade that you have seen/documented - what was the trade like 10 years ago? How does that compare to today? What do you think it will look like in 10 years time?
- (If applicable) when do you think the trade became international?
- Do you have concerns about the conservation/survival of these orchids? Why/Why not?

Thank you for your time. Do you have any questions for us?

Edible orchid project Semi-structured interview guide – In-country researchers

Information about the informant

Name
Country they work in
How long they have conducted this research
Role in research team

Introductions from the edible orchid project team (see above)

Questions:

- Can you tell us a bit about your role researching the edible orchid trade
- What are the main uses or types of orchid trade in {insert country]? Define if its national or international trade.
- In your opinion, what is the scale of the edible orchid trade in [insert country] Is the trade cross border or localised?
- Can you tell us about which species you know to be involved in the trade? (or local names)
- What can you tell us about the harvesting of edible orchids?
- Can you tell us about the products being traded that contain edible orchids?
- Can you tell us about the end products – how often are they consumed? Are they for sustenance? Business?
- And what about the sale of edible orchids? Where are these products being sold? - markets? - online trade?
- (If applicable) when do you think the trade became international?
- In your opinion, what portion of the trade occurs online? How is this regulated?
- Is this harvest or trade regulated by local or national laws?
- What groups of people are involved in the trade?
- How do people become involved in the trade?
- How do the groups interact with each other?
- Legality – is there enforcement of rules regarding harvesting? Or cross border trade?
- Can you tell us about the trends in this trade that you have seen/documented - what was the trade like 10 years ago? How does that compare to today? What do you think it will look like in 10 years time?
- Can you tell us about the propagation of these species – what results can you share from the propagation project?
- Do you have concerns about the conservation/survival of these orchids? Why/Why not?

Thank you for your time. Do you have any questions for us?

Annex II: List of Species and Genera in Trade

Webcrawl
Orchis mascula- salep
Orchis militaris- salep
Dactylorhiza hatagirea- salep
Dendrobium officinale- edible
Dendrobium nobile- edible
Dendrobium candidum- not in database
Orchis anatolica- salep
Orchis spp.- salep
Dendrobium spp.- edible
Cymbidium spp.- edible

Chikanda
Satyrium spp.
Habenaria spp.
Disa spp.

Salep
Eulophia spp.
Epipactic spp.
Gymnadenia spp.
Himantoglossum spp.
Ophrys spp.
Platanthera spp.
Serapias spp.

Annex III: Key words for Online Trade Searches

Web crawler search lexicon of key words

The following scientific, common and trade names and terms were selected for online searches performed using the web crawler:

1. chikanda
2. orchid tubers
3. orchid flour
4. kinaki
5. kikanda
6. african polony
7. chikanda powder
8. Meatless sausage
9. Chikanda cake
10. chinaka
11. Salep
12. Salepi
13. Sahlab
14. Sahleb
15. Sahlep
16. sakhlav
17. saloop
18. salep tubers
19. salep tuber powder
20. salep powder
21. salep aroma
22. dondurma [ice cream]
23. salepi dondurma
24. maraş
25. maraş dondurma
26. roots of *orchis*
27. orchis tubers

Following Rutherford & Groves 2017b and 2017a, the following terms and genera names were selected for additional manual searches performed within each of the selected websites:

Relating to Chikanda trade: Chikanda, *Habenaria, Satyrium, Brachycorythis, Eulophia, Roeperocharis.*

Relating to Salep trade: Salep, salap, *Orchis, Anacamptis, Neotinea, Ophrys, Serapias, Himantoglossum, Dactylorhiza, Gymnadenia, Platanthera,*

Annex IV: Summary of Genera (A-Z) and the Number of Species found in the Literature

Genera	No. of species
Acianthus	2
Anacamptis	13
Anoectochilus	3
Aplectrum	1
Brachycorythis	2
Bulbophyllum	1
Caladenia	10
Calanthe	1
Calypso	1
Ceratostylis	1
Chiloglottis	9
Coelogyne	1
Corybas	3
Cremastra	1
Crepidium	1
Cryptostylis	4
Cymbidium	6
Cynorkis	1
Cypripedium	1
Cyrtochilum	1
Cyrtostylis	1
Dactylorhiza	18
Dendrobium	11
Dienia	1
Dipodium	1
Disa	30
Disperis	1
Diuris	14
Encyclia	1
Epipactis	4
Eriochilus	1
Eulophia	9
Gastrodia	6
Genoplesium	7
Geodorum	1
Glomera	1
Goodyera	2
Gymnadenia	4
Habenaria	26
Herminium	1
Himantoglossum	5
Jumellea	2
Leptotes	1
Limodorum	1
Lyperanthus	1
Malaxis	1
Microtis	1
Myrosmodes	1
Neobolusia	2
Neotinea	3
Neottia	1
Ophrys	28
Orchis	15
Orthoceras	1
Peristylus	1
Platanthera	4
Platycoryne	1
Prasophyllum	11
Prosthechea	2
Pterostylis	29
Pyrorchis	1
Renanthera	1
Roeperocharis	1
Satyrium	28
Selenipedium	2
Serapias	4
Stanhopea	1
Steveniella	1
Thelymitra	9
Vanda	1
Vanilla	11
Zeuxine	1
Grand Total	374

Annex V: Marketing Terms used in Online Product Listings

Health

A natural medicine; analgesic and antipyretic effects; anti-aging effect; can repair the damage of sensitive skin; anti-fatigue; aches and pains; anti-inflammatory; anti-bacterial compounds; antioxidant and immunomodulatory effects/immune support; anti-menopause; aphrodisiac (a virility enhancer; boosts the libido with strong aphrodisiac properties); astringent properties; boost mood/keep you in a good mood; pre-workout supplement to boost athletic performance; boost metabolism; blood sugar support; facilitates blood circulation, stimulating the function of kidneys and the heart; relieves headaches, menstrual pain and menopausal syndrome; facilitates brain function (improves memory; strengthens the mind); preventive of colds and flu (relieves cough, asthma, stomach-ache; upper respiratory tract infection; bronchitis; catarrh and flu); relieves constipation and bloating; Dendrobium nourishes Yin and clears away heat; dry mouth and throat; helps regulate diabetes (sugar-free); diuretic; used to regulate digestive problems through history by many civilizations in the Anatolian region; enhanced energy level; emollient; expectorant; enhance fertility (male infertility; impotence; in Greece it is called sernikovotano, because they believed that if the prospective father ate large tubers salep will be born male child); chases fatigue, both physical and mental; helps in gastric ulcer and duodenum; good for the heart; against heartburn, and gastroesophageal reflux disease; improved breathing; increases fat burning speed; against indigestion and stomach disorders and dysentery; against nausea; soothes nerves, eliminates stress and fatigue; relieves the problems of the prostate gland and hemorrhoids; reduce the heart rate; improve sleep; against sinusitis, testosterone booster; traditional herbal medicine with 1300 year history; woman's health; helps reduce worms in the gut; eating dendrobium soup every day has health benefits for the family; helps in quick recovery of weakened institutions, children and elderly; used in the Unani and Ayurvedic systems of medicines; rich in vitamins but does not contain tein or caffeine (phosphorus and calcium; vitamin-B beneficial for long term memory; calcium and phosphorus invigorates the body after illnesses; rich in starch and minerals); against vomiting; warming.

Food

Excellent coffee substitute; drink/dessert/ice cream ingredient; enjoy at any time of day; consume in soup, with meat dishes or in bubble wine (immersed in liquor); can also be eaten dried and chewed; food grade; powder for ice cream; tubers contain a nutritious, starchy polysaccharide called glucomannan; for drinks and ice creams; hot and cold drinks – no additives; nutritive health drink unique to middle east/Ottaman empire; traditional Turkish/Greek drink (400 years old; popular in many parts of the Middle East, especially the Levant); sugar-free salep has about 15 calories per serving (1 teaspoon of 15 grams); salep flavoured instant powder drink; winter drink/dessert; usually sold on the streets as a hot beverage during the cold months of the year; a winter heating, emollient and nutritious beverage; unique taste, it leaves a wonderful taste in the mouth; vegan healthy drink.

Magic charm

Magic charm; lucky charm; Lucky Hand Root; specially shaped roots; individually selected; Helping Hand; used to bring luck and new opportunities in all areas; Lucky hand used in filters and elixirs to attract love; believed that it provides protection from any evil and that it brings luck to anyone who has it on them; they say that if you put that root in your wallet, you will have plenty of money; brings winnings to gambling; lucky hand is also known for its aphrodisiac properties; strengthens relationships; a symbol of fertility and has traditionally been used as a gift to newlyweds to have children soon; Lucky Hand Root is a powerful hoodoo curio; keep it with you for luck with money and luck with gambling, lottery and other games of chance.

Royal Botanic Gardens
Kew

kew.org