

SALEP ORCHIDS OF TRKİYE (Orchids Used for Salep Production)

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ISBN: 978-625-5923-93-6

Ankara -2025



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DOI: <https://doi.org/10.5281/zenodo.17086055>



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(The Licence Number of Pubicator: 2018/42945)

E mail: ubakyayinevi@gmail.com

www.ubakyayinevi.org

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UBAK Publishing House – 2025©

ISBN: 978-625-5923-93-6

September / 2025

Ankara / Turkey

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Preface

Salep has been an integral part of human life for thousands of years as both a food and medicinal component, forming a significant part of Turkish cuisine and traditional healing methods. The history, cultural significance, and economic value of salep orchids are of great importance. This book aims to provide a comprehensive resource on the cultivation, usage, and conservation of salep orchids.

From the past to the present, salep has been a part of the cuisine of many cultures, including the Ottoman Empire, and has earned a unique place, particularly in the making of ice cream. However, with the increasing demand for salep production, the issues of sustainability and environmental impact have gained prominence. In this context, legal regulations and penalties related to the conservation of orchid species and the regular production of salep have become crucial necessities.

In the first section of our book, we discuss the general distribution of salep orchid species both globally and within our country, their diversity, and their uses. We then provide in-depth information on the pressures exerted on these orchid species, along with details on their chemical and morphological characteristics. Through detailed explanations of their cultivation processes and production methods, we offer a comprehensive perspective on the technical aspects of salep orchid production.

In the following sections, we share practical information on factors to be considered in the cultivation of salep orchids, such as climate, soil preparation, irrigation, fertilization, and weed control. Additionally, we offer guidance on post-harvest processes. Steps such as washing, boiling, shocking, and drying, performed after harvest, are crucial factors that directly affect the quality of salep flour production. Each of these processes requires great precision from salep producers and researchers.

Ultimately, this book aims to be an important resource for both academic circles and salep producers. It seeks to provide in-depth information on the steps to be taken for the conservation of salep orchid species, the development of sustainable production methods, and the preservation of these valuable plants for the future. It is intended to contribute to research in this field and offer practical guidance to producers.

We hope that this book will serve as a valuable resource for salep producers, agricultural engineers, researchers, and anyone interested in this field. We would like to thank everyone involved in the creation of this book and hope it provides beneficial information to our readers.

10.09.2025

Prof. Dr. Ömer ÇALIŞKAN

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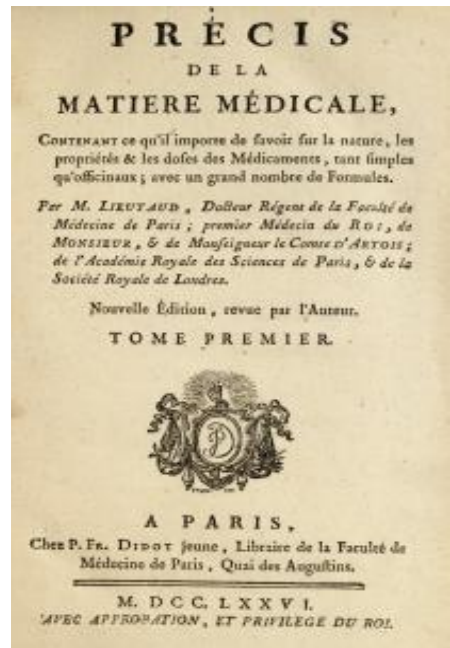
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1 | SALEP FROM PAST TO PRESENT

Humans have lived in harmony with nature since their existence, seeking herbal solutions for both nutritional needs and health requirements. Consequently, the history of medicinal plants has paralleled human history. In ancient times, before the development of modern medicine, many plants were known to be used for health purposes. Naturally, for periods before the invention of writing, we can only estimate the plants used through archaeological findings.

According to historical findings and writings, salep has been among the medicinal and aromatic plants used even thousands of years ago. Salep orchids are an economically important group within the *Orchidaceae* family that produce underground tubers used for medicinal purposes. The first written record about orchids, which initially attract attention

with their distinct floral appearance, was penned by Confucius in China. Confucius documented the fragrances of orchids. The first book on orchid cultivation was written in Chinese around 1000 AD, and in ancient China and Japan, orchids were respected for their aesthetic and artistic values.



Terrestrial orchids that form tubers hold special significance due to their tuber formation. The first record of tuberous salep orchids dates back to 350 BC, attributed to the Greek philosopher Theophrastus, known as the father of botany. Theophrastus named these plants "orchis" due to their tubers and mentioned their medicinal value. Early Greek parents believed that orchid roots could control the gender of their unborn children. They believed that if the father ate the larger tuber, they would have a male child, and if the mother ate the smaller tubers, they would have a female child.

The Greek physician Dioscorides, in his five-volume work "Materia Medica" (Medical Materials) written between 50-70 AD, described

salep by providing information about its flowers, leaves, and colors, particularly using it as an aphrodisiac and in the treatment of venereal diseases. A visual representation of the work is presented on the side.

Salep is a Turkish word, known as salepi in Greek and sahlab in Arabic. All tuber-forming genera and their related orchid species are collectively called salep. The hot beverage prepared from this product is also called salep. It is known that during Oliver Cromwell's time (1599-1658), it was distributed in London and sold as a hot beverage on the streets. In England, the drink known as 'saloop' gained significant popularity during the 17th and 18th centuries.

Before the widespread use of coffee and tea, salep was known as a beverage made from orchid flour, with its popularity spreading from Anatolia to the Middle East, England, and Germany. In Europe, it was recommended for various conditions such as female infertility, miscarriage, tuberculosis, stomach problems, skin irritation, and flu. During the 18th-19th centuries, it was included in British army provisions, serving both as dietary food for sick soldiers and as nutritious sustenance when supplies were low. In England, salep powder was used similarly to Turkey; it was added to water until thickened, then flavored with orange essence or rose water. While salep grew in many places including Eastern Europe, Afghanistan, Bukhara, and India, Turkey has always been the main producer.



Ancient Romans utilized salep tubers particularly to make beverages they called 'Satyrion' and 'Priapiscus,' believing it to be a powerful aphrodisiac. In Indian markets, salep was known and used under the name 'salib misri.'

Turkey, and consequently Anatolian lands, possess numerous salep species. Due to this richness, Turkey has been the land where the most important and highest quality salep has been produced for centuries. For many years, exports from Anatolia were made to Europe, particularly to Germany.

Ibn Sina (Avicenna), born in 980 in Bukhara, Uzbekistan, who earned his medical title at age 19 and was known as the prince of medicine, provided extensive information about salep in his work "el-Kânûn fi't-Tıb" (The Canon of Medicine). In this book, which served as Europe's primary medical reference until the 17th century, Ibn Sina recommended salep as:

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"First, it increases understanding/comprehension, then gives strength to the heart, and benefits liver pain, and is especially beneficial for hemorrhoids, and removes colic, and is beneficial for early arthritis, and it is proven to be beneficial for all ailments - it is the paste of sultans" this statement summarizes the uses of salep.

Salep is also recorded in the ledger of the Ottoman Palace's "Halvahane" (Confectionery), which documented the pastes prepared annually for the sultans. For example, significant amounts of salep were found in the compositions of various pastes such as: Misridat paste (Mithridate), philosophers' paste and refreshing substances paste.

In his travelogue, Evliya Çelebi noted that there were about 200 mobile salep vendors in Istanbul alone, and briefly summarized these vendors' preparation and sale of salep as follows:

"In winter days, they dry it and grind it like flour in a mortar; cook it with sugar until it becomes like pudding, and with copper pitchers heated from below; they pass by calling out 'Comfort of the soul, Health of the body, Education of delicacies' while selling their spiced and rose-water flavored drink."

According to Evliya Çelebi, salep could make even a 100-year-old man strong and agile. Two cups of salep were said to heal recurring pains, improve eyesight, and strengthen the body. Ottoman historian Ahmed Cavid claimed that salep was sold on the streets sweetened with grape molasses, grape juice, or honey, while the upper class sweetened their drinks with sugar and used it as an aphrodisiac. For centuries, salep has been a beloved medicinal beverage consumed in these lands.

In 1764, during Captain Byron's expedition to the South Pole, salep or sago was consumed in the mornings instead of watered alcohol. Salep was also considered beneficial for those suffering from scurvy. In 1768, Captain Cook stored 40 pounds (approximately 18 kilograms) of salep powder during his Pacific voyage to prevent scurvy. In 1800, a French chocolate manufacturer created "analeptic chocolate" using salep. This product was recommended as a light and nutritious food for weak individuals, those with sensitive lungs, and chronic patients.

In 1838, Friedrich Unger described the salep vendors in Greece and Turkey as follows: "They appear early, at the break of dawn. The bottom section of their double-compartmented thin cups is heated with charcoal to keep the salep hot. They wear wide leather belts around their waists. On their belts, they carry cups and ginger cups in narrow, crescent-shaped wooden holders. Their discordant voices can be heard calling

out 'salep, salepi.' They believe that salep is very healthy, especially for strengthening the eyes."



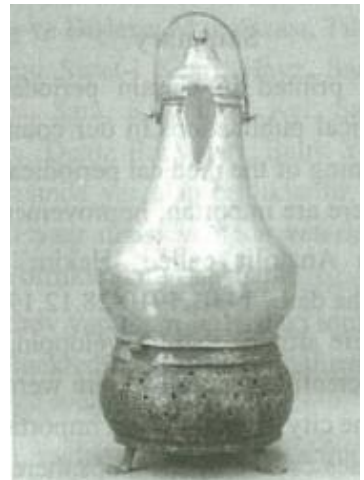
An 18th century salep seller
from an album in Ankara
Ethnography Museum



A salep seller in Athens, 1835,
by Friedrich Unger



Salep tubers strung on ropes



Historical salep pitcher
and heater

Due to its place among medicinal plants, salep was traditionally sold in herb shops (aktars). With the establishment of pharmacies, salep maintained its status as a pharmaceutical drug sold in pharmacies until 50 years ago. In the Official Gazette dated March 10, 1956, based on the Pharmacists and Pharmacies Law No. 6197, packaging fees were determined for all substances sold in pharmacies, with the fee for one gram of salep set at 6 kuruş. On May 30, 1963, this fee was changed to 3 kuruş. These records indicate that salep was sold in pharmacies as a medicinal plant for many years.

Due to its recognized health value and nutritional properties, salep consumption was encouraged and promoted by government officials during certain periods. For example, Article 167 of the 1931 High School and Middle School Regulations mandated that boarding high school and middle school students be given two grams of salep per person daily. The most recent known decision regarding the allocation of salep as food to public institutions appeared in the Official Gazette dated December 20, 1989, in the Regulation on Seafarers' Accommodation, Health, and Provisions. According to this regulation, seafarers were to be given two grams of salep per meal, with the belief that this would increase their work efficiency.



A salep seller on the street in Istanbul (approximately 1900)

The lack of cultivation despite increasing salep consumption, coupled with meeting all demands through wild collection, has increased the risk of extinction for salep orchids in their natural habitats. In response to these negative developments, salep trade was initially banned worldwide and in Turkey, followed by a complete prohibition on wild collection to prevent domestic use.

As of 2025, salep collectors in Turkey face fines of approximately 557,212 Turkish lira. Despite all prohibitions, around 500 tons of fresh salep tubers are collected annually in Türkiye, from which an average of 100 tons of salep powder is produced. These figures are unofficial numbers obtained from buyers, as there are no official records due to the illegal nature of collection and sales.



Mobile salep vendors

2 | LEGAL REGULATIONS AND IMPOSED PENALTIES

Until the last 20 years, salep was among the natural resources that could be freely collected and sold worldwide. Salep varieties are found in the Middle East, Far East, and European countries, where they are collected by local populations. Anatolian lands, possessing the world's greatest salep diversity, have supplied not only domestic needs but also European demands. Particularly during its peak popularity in the 17th-19th centuries, large quantities of salep were exported from Turkey. For example, in 1825-1826, salep worth 35,000 Francs was exported.

From past to present, all salep needs have been met through wild collection. As will be detailed in the production section, salep orchid seeds are as small as dust particles and lack nutritive tissues necessary to nourish the germinating seed. Therefore, they cannot be cultivated in

fields or nurseries. Seeds that manage to germinate in nature require many years to develop into plants with harvestable tubers. The fact that the main tuber produces only one new tuber, and this new tuber has only one growth point, prevents propagation from tubers. Despite increasing global demand for salep, the inability to cultivate these plants has emerged as a significant problem. Intensive collection pressure has begun to lead to decreased salep populations and genetic erosion. Many countries have moved to take measures to preserve biodiversity and pass it on to future generations. Through national laws and international agreements, measures are being implemented and laws enacted to protect salep orchids, as with many other species.

The most comprehensive international agreement for the protection of genetic resources is the United Nations Convention on Biological Diversity. Additionally, the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) was adopted in 2001. Turkey signed the Convention on the Conservation of European Wildlife and Natural Habitats (BERN Convention) on February 20, 1984, with the aim of protecting wild flora and fauna and their natural habitats.

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Additionally, Turkey became a party on December 22, 1996, to the "Convention on International Trade in Endangered Species of Wild Fauna and Flora" (CITES), which entered into force on July 1, 1975. This convention aims to:

- Monitor international trade in species that are endangered or may become endangered
- Prevent the exploitation of ecological balance through international trade
- Ensure sustainable use of countries' biological resources

Some species of the *Orchidaceae* family are listed in Appendix I of the BERN Convention as flora species under strict protection. The species of the *Orchidaceae* family are also listed in Appendix II of CITES as

species that, although not currently facing immediate extinction, could become endangered if their trade is not regulated by strict rules to prevent usage that conflicts with their survival.

In short, all species of the *Orchidaceae* family are in the group of flower bulbs that are prohibited from being collected from nature and exported, as specified in the annual export list of natural flower bulbs.

The collection of salep orchids, which are listed in Appendix II of the CITES convention signed by 183 countries and thus protected worldwide, is strictly prohibited. In connection with these international agreements, Environmental Law No. 2872 is in force in Türkiye. The statement in Article 9/f of the Environmental Law reads as follows: *"The protection of rare plant and animal species, as well as those that are threatened or endangered, is essential for ensuring the sustainability of biological diversity, and their commercial trade contrary to legislation is prohibited."*

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This article of the law encompasses all salep orchid species according to the CITES convention. Monetary penalties for those who violate this prohibition are specified in Article 20 of the Environmental Law. In the 2017 regulation, the penalty amount to be applied between 1/1/2025-31/12/2025 was set at a minimum of 557,212 and a maximum of 2,768,491 Turkish liras.

Legal measures taken to prevent genetic erosion due to intensive collection are being implemented worldwide. Before the prohibition, intensive collection was carried out to meet both domestic consumption and foreign demands. Salep tubers have been among the drugs we have exported for hundreds of years. European sources record that in the 1700s, "Levant Salep" was particularly exported from "Izmir," and salep was obtained from the regions of Muğla, Milas, and Kastamonu. The same sources indicate that annual exports were 5000 okka (6.5 tons). Export quantities reached up to 15 tons in some years. Domestic

consumption figures are even higher, due to both ice cream production and beverage consumption.

In Türkiye, the first regulation published for the protection of salep orchid species was encountered in 1974. With a circular published in the Official Gazette No. 14973 dated August 11, 1974, natural orchid species were added to the list of products subject to export licensing for the first time. During these years, it was reported that the average export amount was 10 tons, and the annual salep usage, including domestic consumption, was 20 tons.

With the regulation on "Collection, Production and Export of Natural Flower Bulbs" published in the Official Gazette No. 21016 dated 09.10.1991, the communiqué issued by the Ministry of Agriculture and Rural Affairs completely prohibited the export of Orchid (salep) species.

Despite preventing the export of fresh or dried tubers, to also prevent the export of processed products, the "Communiqué on Amendment to the Communiqué Regarding Prohibited Exports and Goods Subject to Preliminary Permission" published in the Official Gazette No. 23407 dated July 19, 1998, completely prohibited the export of all forms of salep derivatives including flour, powder, tablets, etc.

Despite legal regulations, salep is still being sold in the domestic market. This is because the perception of the collection ban has only been established for forested areas.

Monetary fines are imposed on salep collectors when they are caught either during collection or with collected salep tubers in their vehicles. The penalty enforcement process is carried out by the General Directorate of Nature Conservation and National Parks. For example, the directorate's 2013 seizure report was communicated with the following statements:

- During routine field inspections conducted by the Ulaş District Gendarmerie Command near Eskikarahisar village in Sivas, individuals were found collecting salep plants despite the prohibition, and the Sivas Branch Office under our Ministry's 15th Regional Directorate was immediately informed. In the investigation, a total of 3 kilos and 225 grams of salep plant bulbs were found in the subjects' vehicles, and pursuant to Article 20 of Environmental Law No. 2872, an administrative fine of 33,863 TL was imposed on each of the 3 individuals who collected these plants illegally, totaling 101,589 TL.
- There are many collectors who view salep gathering as a source of supplementary income, and similar news reports appear every year. In a news channel report dated April 19, 2016, it was reported that two people collecting salep in Kırklareli were fined a total of 80,000 lira. According to another news report dated May 11, 2016, a person named Ahmet H. (61), who was caught in the İlkadım district of Samsun, was fined 40,000 lira (Figure 2.1).



Figure 2.1. Salep tubers seized in Kırklareli and Samsun provinces and tools used in collection process

- Along with the salep tubers seized in Kırklareli, long-handled iron digging tools resembling spoons used for tuber collection were also found. The highest penalty amount comes from news dated 02.06.2016. It was announced that 8 people caught in Erzincan would be fined 40,913 lira per person, totaling 327,304 lira in administrative fines (Figure 2.2).



Figure 2.2. 327 thousand lira fine for 8 people collecting wild orchids in Erzincan

As evident from the examples in the arrest reports, collecting salep carries heavy monetary penalties. Although news reports create fear among collectors when circulated, collection activities still continue. This is because collectors are typically people who lack sufficient land, and salep represents a significant source of income for them.

Here, it is necessary to mention a legal loophole. Despite the prohibition on collection and heavy fines imposed on violators, processed salep can still be sold in the market. Processing facilities can offer salep purchased from collectors for sale after processing by adding 8% value-added tax. In other words, salep is the only product that is prohibited to collect but legal to sell.

3 | GENERAL DISTRIBUTION AND SALEP ORCHIDS

3.1 Global Diversity of the *Orchidaceae* Family

The *Orchidaceae* family is the second richest family in the world in terms of species number. Looking at their general distribution, they can be found almost everywhere in the world except polar regions. Along with this wide distribution, the Orchid family is reported to have around 25-35,000 species. Species within the family show great diversity both in their habitats and physical dimensions. For example, the truly miniature *Bulbophyllum minutissimum* has leaves only 1-2 mm in length. In contrast, *Sobralia* species can grow up to 8 meters tall. Some orchids like *Vanilla* can reach 30 meters in length when grown as vines. Besides botanical differences, the environments where species of the Orchid family thrive and grow are also very diverse. Therefore, they are biologically the most complex group in the plant kingdom and are grouped according to their basic similarities. Based on their growing

environments, the *Orchidaceae* family is primarily divided into 5 groups. These are:

1. Epiphytic orchids (attaching to trees with aerial roots)
2. Terrestrial orchids (rooted in soil in temperate zones)
3. Lithophytic orchids (attaching to rocks)
4. Saprophytic orchids (decomposer group)
5. Parasitic orchids (parasitic group)

Epiphytic orchids, which have adapted to tropical climate zones and grow on trees, have the greatest species diversity within the family. They constitute approximately 75% of all orchids and have high temperature requirements. Among epiphytic orchids, the genus *Vanilla* is commercially the most valuable. The genus, which produces the raw material for vanilla spice, contains around 100 species. Only 3 varieties (*Vanilla planifolia*, *V. tahitensis*, and *V. pompona*) are cultivated for their fruits. *Vanilla planifolia* is the species with the highest commercial value (Figure 3.1). Indonesia is the most important producer of *Vanilla planifolia*, which is common in Madagascar, Comoros, and Mayotte islands.



Figure 3.1. Flowers and vanilla fruits in the *Vanilla planifolia* orchid species

Another significant group among epiphytic orchids consists of species with large and showy flowers. These species, with a trade volume exceeding 500 million dollars, are used as ornamental plants. Festivals are even organized for orchid species that have emerged as an important industrial branch in the ornamental plant sector. Due to the size of the sector, new hybrids with different visual characteristics are being developed through new crossbreeding, adding new varieties to the orchid family.

Japan and Singapore hold important positions in Asian orchid markets. The main importing countries are Japan (30%), United Kingdom (12%), Italy (10%), France (7%), and the USA (6%). Generally, species belonging to the genera *Cymbidium*, *Phalaenopsis*, and *Dendrobium* are preferred (Figure 3.2).



Figure 3.2. Some orchids belonging to genera *Cymbidium*, *Phalaenopsis* and *Dendrobium*

Orchids distributed in temperate climate zones, which are cooler compared to tropical regions, are called middle-zone orchids. Salep orchids belong to the middle-zone orchids (terrestrial) group that are rooted in soil. Seed germination and survival occur thanks to certain

fungus microorganisms present in the soil. For this reason, the terrestrial orchid group that produces salep tubers is also called ground orchids. Ground orchids have around 600 species and subspecies, distributed across Europe, the Mediterranean basin, the Caucasus, and Asia Minor. Within terrestrial orchids, only tuber-producing species are called salep orchids and are used for obtaining salep powder.

Türkiye holds an important place in the world in terms of plant species diversity due to several factors:

- Presence of three different phytogeographic regions (Euro-Siberian, Irano-Turanian, and Mediterranean)
- Location at the intersection of two important gene centers (Mediterranean and Near East)
- Different soil characteristics
- Diversity of climate types and geomorphological features
- Presence of various wetland types (seas, lakes, rivers, fresh, salt, and soda lakes)
- Altitude variations ranging from 0-5,000 meters

According to recent research, there are over 12,000 plant taxa in Türkiye. This richness is better understood when compared to the European continent, which is 15 times larger than Turkey yet has around 12,500 vascular plant taxa including gymnosperms and angiosperms. Furthermore, the approximately 30% endemism rate in our flora establishes Türkiye as an important gene center. Indeed, while Greece has the highest number of endemic species in Europe with 800 taxa, this number exceeds 3,000 in Türkiye.

In parallel with our general plant diversity and natural richness due to our geographical location, the same can be said for salep species. Indeed, Turkey is the richest region in Europe and the Middle East in terms of middle-zone salep orchids. The Turkish plants data system lists 24 genera and 187 taxa belonging to the *Orchidaceae* family. In some

sources, our species number is stated as 204, including hybrid species. However, it is difficult to give an exact number for various reasons. Primarily, there are challenges in making correct species distinctions and classifications, therefore new taxonomic studies are being conducted.

The orchids found in Türkiye belong to the terrestrial orchids group. After Turkey, excluding Greece, Italy follows with 140 species, and Germany with 80 species. Albania has 68 species and 15 subspecies, while the Netherlands has 60 species. Latvia has listed 33 orchid species. Across all of Europe, there are reported to be 200 terrestrial orchid species. The Asian region, covering a vast area from Siberia to the Korean peninsula and from eastern China to Japan, has an estimated 400 terrestrial orchid species. When compared to this mentioned area, Türkiye's orchid richness is better understood.

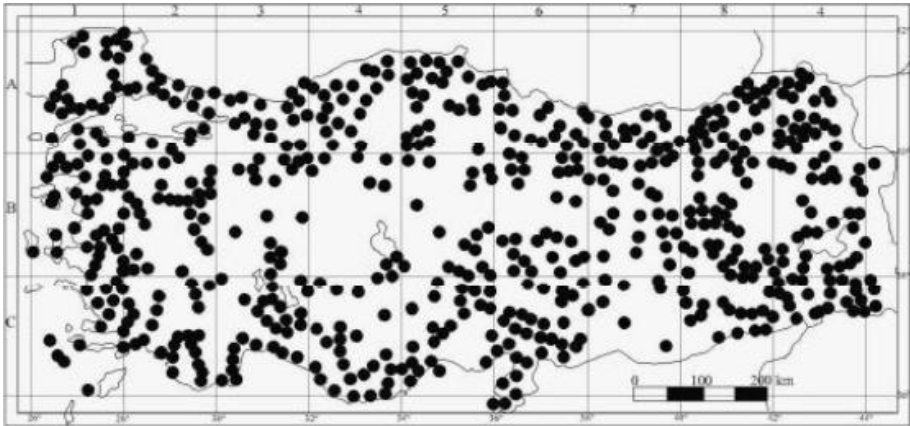


Figure 3.3. Areas where species belonging to the *Orchidaceae* family are found according to the Turkey Plants Data System (Tubives 2017)

It is possible to see orchids throughout Türkiye. In the Turkish plants data system, where floristic studies are listed, the areas where these species have been observed are marked on the presented map (Figure 3.3). Also, in Table 3.1 presented below, the genera included in

Türkiye's *Orchidaceae* family and the number of species within these genera are given.

Table 3.1. Genera belonging to the Orchid family in Turkey and number of species (Tubives 2017)

Genus	Number of species	Genus	Number of species
<i>Aceras</i>	1	<i>Anacamptis</i>	1
<i>Barlia</i>	1	<i>Cephalanthera</i>	9
<i>Coeloglossum</i>	1	<i>Comperia</i>	1
<i>Corallorrhiza</i>	1	<i>Dactylorhiza</i>	26
<i>Epipactis</i>	10	<i>Epipogium</i>	1
<i>Goodyera</i>	1	<i>Gymnadenia</i>	1
<i>Himantoglossum</i>	3	<i>Limodorum</i>	2
<i>Listera</i>	2	<i>Neotinea</i>	1
<i>Neottia</i>	1	<i>Ophrys</i>	77
<i>Orchis</i>	32	<i>Platanthera</i>	4
<i>Serapias</i>	8	<i>Spiranthes</i>	1
<i>Steeniola</i>	1	<i>Traunsteinera</i>	1

3.2 Tuber-Producing Genera and Species Used as Salep in Türkiye

Not all orchids belonging to the 24 genera listed in Table 3.1 have the ability to produce tubers. The genera that produce tubers and whose tubers are used as salep are:

1. *Anacamptis* 2. *Barlia* 3. *Comperia* 4. *Dactylorhiza* 5. *Himantoglossum*
6. *Ophrys* 7. *Orchis* 8. *Platanthere* 9. *Serapias* 10. *Steeniola*

According to the numbers given in the table, the total number of species, subspecies, and hybrids belonging to these genera is 154. However, in various sources, the number of species used as salep shows variation. For example, Sandal (2009) mentioned 30 species, Tamer et al. (2006) cited 90 species, and Arslan (2012) referred to 120 orchid species from which salep is obtained. Therefore, it is not possible to give a definitive number.

When examining the distribution patterns of salep orchid species in Türkiye, there are various species that have adapted to each region's climate and soil structure, altitude differences, and consequently show distribution in specific areas. In other words, salep orchids have different ecological requirements at the species level, and therefore, their growing areas vary. For example, a species that is abundant in the coastal belt of Samsun province disappears towards the inland areas, being replaced by other species.

The citation of different numbers for our salep species diversity indicates a significant deficiency. To date, no gene bank or variety garden for salep orchids has been established anywhere in Türkiye. However, salep species native to each province could have been collected together in variety gardens established in forest nurseries or research institutes of each province, and research infrastructure could have been developed. These gardens could have enabled the identification of salep orchid species. However, studies on salep orchids have remained limited to floristic studies conducted only to list plant diversity. Researchers have only shared their identifications made during field trips as plant diversity observations. Therefore, when trying to locate any particular species, it is necessary to conduct new searches in rural areas.

Samsun province can be given as an example in this regard. When listing the flora studies conducted by many researchers in different regions of Samsun province, it becomes apparent that there are numerous salep orchid species. However, when it is necessary to access all these species and collect samples, it becomes necessary to repeatedly visit all rural areas. Even then, the chance of success in reaching all species is low. Due to insufficient location information, you would need to take the original researchers with you and conduct field studies again to find and sample all species.

To summarize the work of researchers addressing Samsun's salep diversity, the three-year study by Kevseroğlu et al. (2014) titled "Medicinal and Aromatic Plants Identified in the Natural Flora of Central and Eastern Black Sea Region" first draws attention. In this study, they identified pharmaceutical and aromatic plant species belonging to 26 families. The most striking finding of the study is that among medicinal-aromatic plants in Samsun, the *Orchidaceae* family ranks first in terms of diversity, with 8 genera and 21 species belonging to these genera. In this study, the 21 species belonging to the *Orchidaceae* family identified in and around Samsun are:

- | | | |
|----------------------------------|-----------------------------|------------------------------------|
| 1. <i>Anacamptis pyramidalis</i> | 8. <i>Ophrys apifera</i> | 15. <i>Orchis pallens</i> |
| 2. <i>Comperia comperiana</i> | 9. <i>Orchis punctulata</i> | 16. <i>Orchis provincialis</i> |
| 3. <i>Dactylorhiza romana</i> | 10. <i>Orchis purpurea</i> | 17. <i>Orchis palustris</i> |
| 4. <i>Dactylorhiza osmanica</i> | 11. <i>Orchis simia</i> | 18. <i>Orchis laxiflora</i> |
| 5. <i>Himantoglossum affine</i> | 12. <i>Orchis morio</i> | 19. <i>Serapias vomeracea</i> |
| 6. <i>Ophrys sphegodes</i> | 13. <i>Orchis spitzelii</i> | 20. <i>Serapias feldwegiana</i> |
| 7. <i>Ophrys mammosa</i> | 14. <i>Orchis mascula</i> | 21. <i>Steveniella satyrioides</i> |

When examining floristic studies conducted in specific areas of Samsun, record information about many orchid species is provided. The *Orchidaceae* species and their localities identified in 5 different floristic studies are summarized below. The *Orchidaceae* species and their localities identified in 5 different floristic studies:

1. Kızılırmak Valley Research (Korkmaz and Engin, 2001):
 Vezirköprü Alan Village: *Neottia nidus-avis*, *Cephalanthera rubra*
 Aşağısusuz Village: *Epipactis condensate*
2. Terme-Gölyazı Nature Protection Area (Korkmaz et al., 2011):

<i>Listera ovata</i>	<i>Epipactis pontica</i>
<i>Platanthera chlorantha</i>	<i>Ophrys apifera</i>
<i>Anacamptis pyramidalis</i>	<i>Orchis papilionacea</i> var. <i>papilionacea</i>
3. Kızılırmak Delta (Korkmaz, 2010):

<i>Ophrys mammosa</i>	<i>Orchis coriophora</i>
<i>Orchis laxiflora</i>	<i>Orchis palustris</i>

4. Orchid Species Distributed in Nebyan Mt (Kutbay et al., 1995):

<i>Neottia nidus-avis</i>	<i>Cephalanthera rubra</i>
<i>Cephalanthera longifolia</i>	<i>Platanthera chlorantha</i>
<i>Ophrys oestrifera</i> subsp. <i>oestrifera</i>	<i>Ophrys holoserica</i>
<i>Anacamptis pyramidalis</i>	<i>Orchis tridentata</i>
<i>Orchis purpurea</i>	<i>Orchis provincialis</i>
<i>Dactylorhiza romana</i> subsp. <i>Romana</i>	<i>Dactylorhiza urvillean</i>

5. Orchid Species Found in Kunduz Mountain (Vezirköprü) Flora (Özen and Kılınç, 2002):

<i>Neottia nidus-avis</i>	<i>Cephalanthera rubra</i>
<i>Cephalanthera damasonium</i>	<i>Epipactis pontica</i>
<i>Epipogium aphyllum</i>	<i>Platanthera chlorantha</i>



Figure 3.4. Some commonly encountered salep orchid species throughout Samsun

When examining all studies conducted in Samsun, 44 orchid species have been identified throughout the province. Within this diversity, there are 9 genera (*Anacamptis*, *Comperia*, *Dactylorhiza*, *Himantoglossum*, *Platanthera*, *Ophrys*, *Orchis*, *Serapias*, *Steveniellas*) that produce tubers and whose tubers are collected for salep purposes. The number of species belonging to these genera is understood to be 33. This high diversity is based on the geographical characteristics of Samsun province. However, as mentioned above, the named species

have not been brought together, and agricultural studies have not been conducted on this richness. Figure 3.4 shows 17 species placed side by side.

As with the floristic studies conducted in Samsun, similar studies have been carried out in many provinces and regions. As an example, a thesis study investigating the habitat characteristics of orchids growing in the Eastern Mediterranean Region can be cited. In the study covering Adana, Hatay, Kahramanmaraş, Mersin, and Niğde provinces, 34 orchid species were identified. The species detected during the mentioned research trips are:

<i>Cephalanthera kurdica</i>	<i>Ophrys ferrum-</i>	<i>Orchis italica</i>
<i>Cephalanthera longifolia</i>	<i>equinum</i>	<i>Orchis laxiflora</i>
<i>Cephalanthera rubra</i>	<i>Ophrys fusca</i>	<i>Orchis mascula</i>
<i>Comperia comperiana</i>	<i>Ophrys holoserica</i>	<i>Orchis palustris</i>
<i>Dactylorhiza iberica</i>	<i>Ophrys isaura</i>	<i>Orchis papilionaceae</i>
<i>Dactylorhiza osmanica</i>	<i>Ophrys lutea</i>	<i>Orchis punctulata</i>
<i>Epipactis helleborine</i>	<i>Ophrys mammosa</i>	<i>Orchis simia</i>
<i>Himantoglossum affine</i>	<i>Ophrys reinholdii</i>	<i>Orchis spitzelii</i>
<i>Limodorum abortivum</i>	<i>Ophrys umbilicata</i>	<i>Orchis tiridentata</i>
<i>Ophrys apifera</i>	<i>Ophrys vernixia</i>	<i>Serapias vomeracea</i>
<i>Ophrys bornmuelleri</i>	<i>Orchis anatolica</i>	subsp. <i>laxiflora</i>
<i>Ophrys cilicica</i>	<i>Orchis collina</i>	
	<i>Orchis coriophora</i>	

According to the researcher who conducted this study, altitude above sea level was identified as the most influential environmental factor in the distribution of orchid species. As mentioned above, the high level of diversity, both throughout Türkiye and in different areas of a region, primarily stems from the geographical structure and the ecological variables that form depending on this structure.

During our field trips, different species were observed even in areas close to each other. Around the same village, different genera and species were distributed across different areas. These observations

reveal that salep orchids have specific ecological requirements at the species level. While some species thrive in open areas like meadows and pastures, others have settled in forests with low light intensity. It is understood that many factors such as soil characteristics, altitude, humidity, light intensity, temperature, precipitation, land aspect, and pressure are effective in the distribution of orchids.

It is clear that orchid species have very different ecological requirements and settle in areas where these requirements are met. To better understand this concept, it's necessary to recall their seed characteristics. As mentioned in the morphological characteristics section, orchid seeds consist of only a primitive embryo. These ash-like seeds can be carried by wind to distances of 100-250 km, reaching very different regions. However, they only survive in areas where they can meet their soil and climate requirements.

When considering the factors affecting the distribution of salep orchids, it is necessary to examine regional compatibility at the species level and conduct preliminary trials before starting production studies. Otherwise, salep tubers brought from different regions have a low chance of successful production. For example, it is meaningless to attempt growing a salep orchid species that finds suitable growing conditions and has adapted to the ecology around İzmir in the Çorum region.

4 | NEGATIVE PRESSURES ON SALEP ORCHIDS

Türkiye holds a significant position in the world in terms of plant diversity. Parallel to our natural richness in general plant diversity, the same can be said for the diversity of salep species. Indeed, Turkey is one of the richest countries in Europe and the Middle East in terms of salep orchids. It is possible to find salep varieties in every region across Turkey, except for some barren areas of Anatolia. However, incorrect practices and negative factors in salep areas are leading to a decrease and even extinction of our species richness.

The decline in salep populations that find habitat and spread in natural flora is entirely due to human-caused negative factors. Salep, which is a valuable product for health, has been collected in Anatolian lands for centuries due to high demand. Intensive collection was carried out not

only for domestic needs but also to meet international demands until 1998. Due to its prohibited collection status, there are no official data on how much is being collected. However, it is known that about 20 companies in Türkiye purchase salep. According to unofficial figures obtained from companies, 500-600 tons of fresh salep tubers are processed in Türkiye. This figure does not include amounts sold directly to ice cream manufacturers or herbalists. This is because some collectors process and dry their products themselves and market them to nearby herbalists.

Human destruction is not only related to illegal collection but also to many other factors. The main human-caused negative factors can be summarized as: Unconscious and excessive collection, uncontrolled animal grazing, conversion of natural areas into agricultural lands, opening natural areas for development, and collection of flowers for ornamental purposes.

Today, one of the methods that especially low-income farmers without land resort to is wild plant collecting. There are two main products these collectors gather to provide for their families. One of these products is mushrooms, and the other is salep. In rural areas, it is observed that some low-income people, shepherds, children wanting to earn pocket money for school, or adults seeking additional income collect salep around their villages.

A notable point is the existence of shops that purchase products collected from nature, depending on the natural wealth of the regions. Collectors know these businesses and convert their collected products into money there. In small towns, collectors who bring their products to public markets wait for buyers and sell their products. Sometimes, a mini salep market can form in these bazaars, and the product changes hands several times.

Apart from those who collect salep around their own vicinity, there are also people who have turned collecting into a profession and base their entire livelihood on it. Especially during May and June, itinerant salep collectors travel from village to village to gather salep. These traveling collectors, who stay in each area for two to three days, generally live in tents and spend their evenings washing and boiling the products they collected during the day, then leaving them to dry. The collection process starts from areas showing early development and continues for about 2 months towards high-altitude areas where development occurs later. Itinerant salep collectors usually consist of several families or groups of 3-5 friends. In Figure 4.1, families who have come from another region to Bafra district and their tents can be seen illegally collecting in salep areas. When asked about their work, these people claim they are waiting for agricultural work, but it is known that their real purpose is to collect salep from the region where they are located.



Figure 4.1. Several families who identify themselves as agricultural workers but are known to collect salep

Salep orchids are found and collected throughout Türkiye. Collection continues despite all prohibitions and heavy fines. In a study investigating the culture of salep collection, surveys were conducted with a total of 103 salep collectors: 20 in Kahramanmaraş, 18 in Ermenek, 10 in Gülnar, 18 in Silifke, 12 in Adana, 9 in Pozantı, 5 in Tarsus, 4 in Mut, 3 in Erdemli, and 2 each in Hatay and Osmaniye. In this study, it was determined that 62.1% of the subjects were male and

37.9% were female, with 29% in the 10-20 age group, 35% in 21-30, 15.5% in 31-40, 6.8% in 40-50, 7.8% in 51-60, and 5.9% in the 61-70 age group. Of the collectors, 70.9% reported collecting 1-5 kg, 24.2% collecting 5-10 kg, and 4.9% collecting 10-15 kg of salep orchids annually. They stated that they sold 10.6% of their collected salep orchids at the market, 9.8% to herbalists in the nearest province or district, and 79.6% to merchants who come to the village during certain periods.

The number of collector families increases in areas where population and diversity are abundant. This is because salep is an important source of income for low-income families in rural areas, finding buyers at high prices and having no marketing problems. This situation sometimes even becomes the subject of national news. For example, the image below was taken on the Söke-Aydın Road and was reported with the headline "These are salep tent cities."



Figure 4.2. Salep city tents (URL 1)

According to the news; dozens of families from different provinces gathered near Lake Bafa and began camping along the roadsides. Abdülkadir Kalem, who stated that they are trying to earn money by digging up naturally growing salep in the mountains during spring,

explained that many families from different provinces dig for salep in the mountains because they are unemployed. He said, "Salep is used both for drinking when boiled in winter and in making ice cream in summer. There are dozens of families coming here from different provinces of the country every spring. This region is quite productive in terms of salep," expressing their satisfaction with the harvest (Figure 4.2).

The main factor increasing the extent of destruction in salep areas is unconscious collection. Unconscious collectors uproot the entire plant to obtain fresh salep tubers and discard it. Plants subjected to this treatment not only lose their new tuber, which would be next year's generation, but also cannot mature and release their seeds into the soil, making the extent of destruction irreversible. However, if harvested plants are replanted, seeds could mature and meet with nature. Some unconscious collectors, acting ruthlessly to increase their yield, remove both the fresh tuber and the old tuber (which cannot be used as salep) and discard the plant. In a sense, they act roughly and mercilessly. Conscious collectors, on the other hand, replant the plants after taking their fresh tubers to collect salep from the same locations each year, allowing plants to mature and disperse their seeds.

All the pressures mentioned above are human-caused negative factors. It's also important to note that various animals use salep as food. Indeed, in wildlife, all animals must obtain their food from nature. Apart from carnivorous animals, many creatures prefer fresh tubers as food, especially during the maturation period of new tubers. Among these creatures, wild boars and certain bird species, particularly crows, are the main consumers.

5 | CHEMICAL PROPERTIES

Salep is primarily a healthy hot beverage and also an indispensable raw material in the production of Maraş-type ice cream. It is particularly important in forming the consistency of ice cream, delaying melting, and enhancing flavor. As a beverage, it has medicinal qualities. These qualities depend on the chemical composition of salep, especially the glucomannan ratio that varies according to species.

The main active ingredients in the product are expressed as chemical composition or chemical components. Salep, used as a food product, is processed by boiling and drying the tubers, and then grinding them before consumption. The resulting ground product is called salep flour. The determination of chemical composition is performed on the ready-to-use salep flour. Since salep flour is obtained from many genera and

numerous species belonging to the *Orchidaceae* family, and due to the effects of ecological differences in growing environments on components, a standard chemical composition cannot be specified. The proportions of main components that make up salep flour not only vary according to species but also show differences in component quantities of the same species in different ecologies. In short, the species of salep and the regional ecology where it grows affect its chemical composition. Below are shared data obtained from some species-based research conducted to date.

In analyses conducted on 10 different salep species belonging to 4 genera collected from the Eastern Mediterranean region, the glucomannan content, which is the main component giving salep its distinctive properties, varied between 17.7-54.6%. As shown in Table 5.1, the protein content of these 10 species varied between 3.11-4.95%, while the starch ratio ranged from 5.44-38.7%. Both starch and glucomannan are carbohydrate derivatives. There is a negative correlation between them. An increase in starch ratio leads to a decrease in glucomannan ratio.

Table 5.1. Main chemical composition of some salep orchids (g/%)
(Tekinşen and Güner 2010)

Species	Moisture (%)	Protein (%)	Ash (%)	Glucomannan (%)	Starch (%)	pH
<i>Orchis italica</i>	11.02	3.92	0.97	54.6	5.44	5.64
<i>Orchis morio</i>	10.83	4.95	1.91	51.2	7.99	5.61
<i>Dact. osmanica</i> <i>sb.osmanica</i>	9.35	3.11	2.80	22.5	38.7	5.61
<i>Orchis simia</i>	11.78	3.53	1.95	38.3	10.4	5.93
<i>Ser. vomeracea</i> <i>sb. orientalis</i>	10.25	4.83	1.96	44.8	13.4	6.20
<i>Orchis anatolica</i>	10.71	3.20	1.94	43.5	14.7	5.71
<i>Orchis tridendata</i>	12.40	4.94	1.92	42.4	15.2	5.73
<i>Orchis coriphora</i>	11.64	3.16	2.83	29.0	17.0	6.04
<i>Orchis palustris</i>	11.90	3.17	0.95	20.5	27.6	5.91
<i>Ophrys mammosa</i>	11.36	3.25	1.76	17.7	33.8	5.69

In a more comprehensive study published in 2016, chemical analyses were conducted on 20 salep orchid species belonging to 8 genera. In the study, products collected from different parts of Türkiye (Tokat, Trabzon, Yozgat, İzmir, Bilecik, Ordu, İstanbul, Kocaeli, Kastamonu, Bolu, Erzincan, Muş) showed dry matter content varying between 89.15-93.53%. Ash content was found to be between 1.46-6.72%, protein between 2.70-11.83%, glucomannan amount between 7.84-48.54%, and starch ratio between 4.58-43.98% (Table 5.2). Here too, a negative correlation is observed between the glucomannan and starch contents of the tubers, as both substances are carbohydrate derivatives.

It is known that more than 100 orchids belonging to 10 genera produce tubers in Türkiye. Chemical content studies conducted to date have remained limited. In other words, the chemical properties of many species are still unknown. This situation demonstrates the insufficiency of studies on salep orchids, which is one of our genetic riches.

Salep quality is determined by the amount of glucomannan it contains. Good quality salep is expected to contain around 40% glucomannan. Different species growing in the same area can show great variations in their glucomannan ratios. This indicates that chemical properties are determined by hereditary factors. With some exceptions, salep species with palmate tuber structure generally have higher glucomannan content than species producing oval tubers. The genus that produces palmate tubers is *Dactylorhiza*.

In a study conducted in Iran, the glucomannan content of species belonging to the *Dactylorhiza* genus that produce palmate tubers (58.22%) was found to be higher than species producing oval tubers (22.13%). The image below shows palmate and oval tuber visuals. This factor is also taken into consideration during pricing. Since it is known that the *Dactylorhiza* genus with palmate tubers has high glucomannan content, these species find buyers at 25-30% higher prices compared to

others. Due to their high price, they are collected and processed separately (Figure 5.1).

Although *Dactylorhiza* species are collected separately, all other species are collected mixed together. During processing and grinding stages, species with oval tubers are all processed together. At this stage, regional-based evaluations come into play. This is because it is known that processed products contain not just a single species but a combination of many species found in the region where the salep flour is obtained.



Figure 5.1. A) Palmate tubers B) Oval tubers

This situation becomes clearer when looking at the distribution areas of salep. As recalled from Section 3 where general distribution was summarized, in an area where salep collection takes place, there are not just one but 3-5 species adapted to that region coexisting and being collected together. Therefore, in some sources, when describing chemical properties, regional names such as Kastamonu salep, Maraş salep, Muğla salep, and Van salep are used, referring to the collection area. Additionally, it is known that there are differences in species distribution among districts and villages of the same province. In floristic studies of a city, it is notable that different species thrive in different districts and villages. A sample study related to this subject is presented in Table 5.3 below.

Table 5.2. Basic chemical composition (g/%) in 20 salep orchids collected from different regions of Türkiye (Şen 2016)

Species	Collection location	% Dry matter	Ash (%)	Protein (%)	Glucom. (%)	Starch (%)
<i>Ser. levantina subsp. feldwegiana</i>	Trabzon	89.92	1.91	4.12	42.76	13.30
<i>Orchis punctulata</i>	Arsin	89.15	2.32	6.67	21.55	36.42
<i>Comperia comperiana</i>	Tokat	92.23	1.95	7.27	35.66	25.65
<i>Dact. romana sub. georgica</i>	Nisar	90.21	1.74	5.94	48.54	12.73
<i>Orchis tridendata</i>	Yoz.	89.95	3.86	5.20	42.27	17.08
<i>Orchis sancta</i>	Akdağmadeni	93.53	3.42	7.81	17.41	41.61
<i>Orchis pallens</i>	İzmir	89.95	1.65	4.05	45.53	15.24
<i>Anacamptis pyramidalis</i>	Menemen	89.32	2.22	6.38	14.60	43.98
<i>Ophrys apifera</i>	Yoz.	92.27	3.55	5.28	16.10	40.07
<i>Or. mascula subsp. pinetorum</i>	Akdağmadeni	90.67	1.72	3.94	43.67	21.92
<i>Ser. vomeracea ssp. laxiflora</i>	Bilecik	91.93	3.24	11.83	35.66	24.61
<i>Orchis morio subsp. picta</i>	Bozüyük	90.15	2.13	7.11	19.14	40.21
<i>Himantoglossum affine</i>	İzmir	92.44	1.46	5.51	36.64	35.00
<i>Ser. vomeracea subsp. vomeracea</i>	Ordu	90.87	2.02	2.70	47.36	15.07
<i>Orchis laxiflora</i>	Tuzla	91.48	1.84	2.96	14.96	12.22
<i>Anacam. coriophora sb. fragrans</i>	Kocaeli	91.47	2.38	3.20	25.08	13.50
<i>Dactylorhiza saccifera</i>	Gebze	92.39	3.74	5.92	32.97	8.94
<i>Orchis spitzelii</i>	Kast.	91.50	2.21	3.72	39.18	4.58
<i>Plathanthra chlorantha</i>	Hanönü	92.56	6.72	5.08	35.82	5.96
<i>Orchis palustris</i>	Bolu	91.87	3.83	11.93	7.84	12.24
	Mudurnu					
	Erzincan					
	Refahiye					
	Muş					
	Malazgirt					

Glucomannan, which is the main component that gives salep its distinctive quality among chemical components, is a polysaccharide formed by the binding of β -D-glucose and α -D-mannose molecules through β -1,4 bonds.

Table 5.3. Chemical analysis findings of salep samples obtained from some regions of Kastamonu (Sezik and Özer 1983)

Location	Glucomannan (%)	Starch (%)	Moisture (%)	Ash (%)
Araç	31.08 (30.43–31.85)	11.95 (11.86–12.03)	7.77 (7.75–7.80)	2.29 (2.28–2.30)
Devrekani	40.28 (40.18–40.42)	15.17 (15.15–15.18)	8.30 (8.26–8.35)	1.57 (1.56–1.58)
Azdavay	41.62 (41.26–41.82)	13.71 (13.6–13.80)	13.09 (13.06–13.11)	1.57 (1.56–1.58)
Daday	32.47 (32.16–32.79)	9.12 (9.08–9.16)	10.36 (10.36–10.37)	1.39 (1.39–1.40)
Taşköprü	46.70 (46.49–46.82)	7.31 (7.20–7.36)	7.89 (7.86–7.90)	2.04 (2.04–2.05)
Ilgaz	45.34 (45.19–45.51)	8.84 (8.83–8.90)	8.32 (8.29–8.34)	1.86 (1.86–1.87)

One gram of glucomannan has the ability to absorb 200 ml of water. Thanks to this ability, it gives consistency to salep as a hot beverage and firmness to Maraş-type ice cream. The starch found in salep also assists glucomannans due to its swelling ability. The main determining factor for glucomannan ratio is species and therefore genetic factors. However, geographic and ecological factors, as well as plant cultivation practices, also affect the chemical structure of the tuber. The total nitrogen amounts of salep tubers do not differ much from each other and are not important in determining salep quality. Moisture and ash amounts are important for storage and detection of adulteration. For long-term storage of tubers, the moisture content should be less than 10%, and for obtaining white salep powder, the ash content should be less than 5%.

Since it is a food product, nutritional values can also be mentioned here. The general nutritional composition of a 200-milliliter cup of salep is presented in Table 5.4 below. As shown in the table, salep as a nutritious beverage provides 79 kcal of energy. Another source reported that it provides 150 kcal of energy when prepared with whole milk.

Table 5.4: Nutritional composition in a 200 ml cup of salep beverage

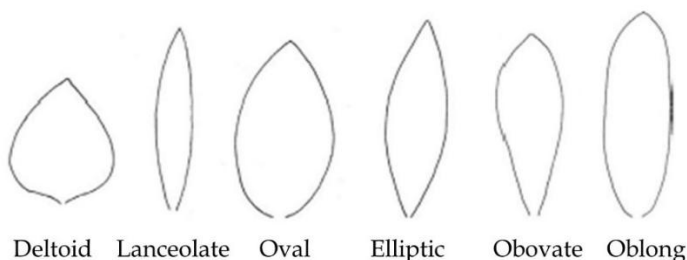
Salep Components	Levels per One Serving
Protein	4.1 g
Fat	2.4 g
Carbonhydrate	10.2 g
Calsium	153 mg
Iron	0.1 mg
Phosphorus	119 mg
Zinc	1 mg
Sodium	63 mg
Vitamin A	256 IU
Thiamine	0.05 mg
Riboflavin	0.21 g
Niacin	0.13 g
Vitamin C	1 mg
Cholesterol	10 mg
Energy	79 kcal

6 | MORPHOLOGICAL PROPERTIES

Terrestrial orchid species generally show distribution in temperate zones. These species have tuber, root, or rhizome structures underground. Species with tubers are called and used as salep orchids. Salep orchids have a single main stem and are characterized as having monopodial growth in terms of growth structure. Although they share similar characteristics due to including numerous genera and species, morphological differences are also observed. Within the same genus, some species are known to be very similar to each other. Therefore, the distinguishing characteristics of each organ of the plant are of great importance. Flower parts are especially important in species identification. Below, leaf, root, flower, seed, and tuber characteristics are briefly discussed.

6.1 Leaves

In salep orchids, leaves can form in various shapes. Specific names have been given to describe leaf shapes. Depending on genus and species, leaves are simple and can be deltoid, lanceolate (spear-shaped), oval (egg-shaped), elliptic, obovate, or oblong in shape. Leaf thickness and dimensions are species-specific characteristics.



Color is generally in light green shades, while in *Ophrys* species, it appears in grayish-green tones. Reddish leaf color is seen only in the *Steveniella satyrioides* species. Salep leaves have parallel venation, with veins more prominent on the lower surface.

The basal leaves are arranged in a rosette around the stem or are spread flat, adhering to the soil surface, or oriented upward at various angles with the stem. In the portion up to the flower structure, they either form a sheath surrounding the stem or are arranged regularly on the stem at specific intervals. There may be shape differences between the basal leaves and stem leaves of the same plant. On the upper surface of leaves, purple-colored spots and marks can be found in some genera and species. The images below show photographs taken at the beginning of winter season (December 20) of some species (Fig 6.1).



Orchis morio



Ophrys mammosa



Dactylorhiza euxina



Ser. vomeracea sb. orientalis



Steveniella satyrioides



Orchis tridendata

Figure 6.1. Leaf appearances of some salep species

6.2 Flowers

Orchids, like most other flowering plants, have all flower parts (sepals, petals, male and female organs). However, these organs are not easily distinguishable due to modifications. The outer perianth parts are called sepals, while the inner ones are called petals.



Anacamptis pyramidalis



Orchis tridendata



Ophrys mammosa



Serapias vomeracea



Hi. caprinum



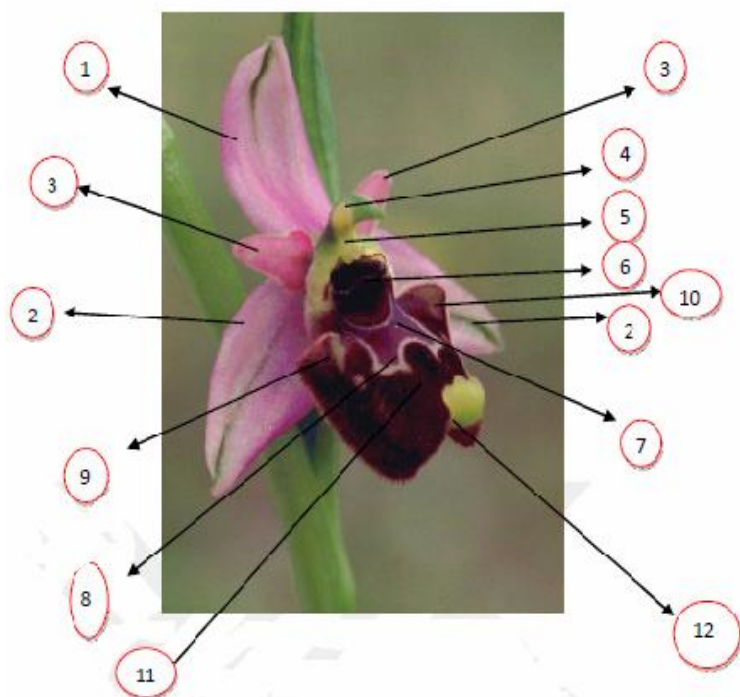
Platanthera chlorantha

Figure 6.2. Flower clusters in some species

Sepals and petals each consist of three parts. The outer perianth parts are arranged to form a triangle. While the two lateral pieces of the inner perianth parts are similar to each other, the middle one is usually highly differentiated in terms of shape, color, and structure. This differentiated petal is called the lip (labellum). Flower images of some salep orchid genera can be seen below (Figure 6.2).

The labellum (lip), which is the most colorful and striking part of the orchid flower, is usually the largest part of the flower. The labellum, which should normally be located in the upper part, is positioned at the bottom due to the flower's 180-degree rotation. For this reason, salep orchids have sometimes been called "tongue-protruding."

In salep orchid species, male and female organs have interestingly merged to form a reproductive organ called the column or gynostemium. Although the stamen and pistil are very close to each other within this organ, self-pollination of orchids is prevented thanks to a formation called the rostellum, which separates them and prevents the flower's pollen from falling onto its own stigma.



Basic structures in *Ophrys apifera* flower

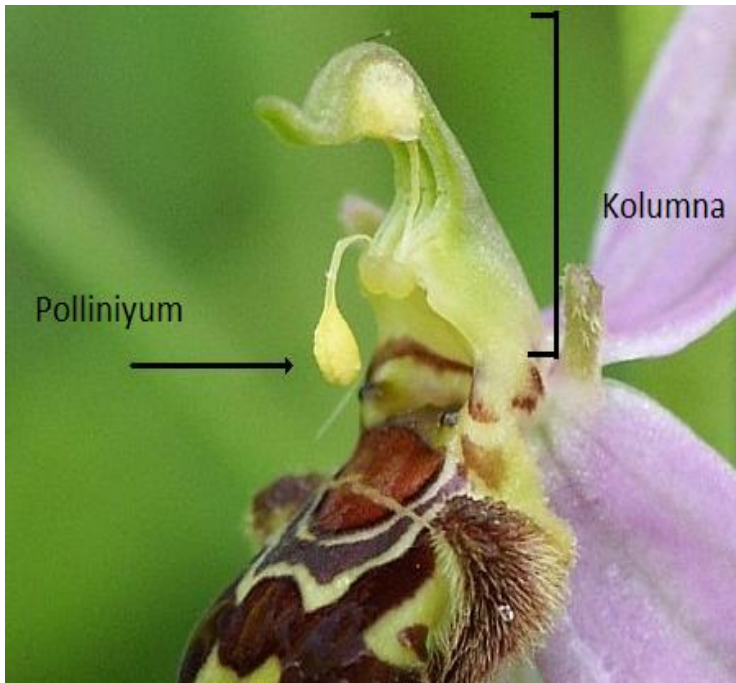
1. Median Sepal
2. Lateral Sepal
3. Petal
4. Reproductive Organ (Column)
5. Stamen Connection Extension
6. Stigma
7. Basal Area
8. Lip (Labellum) Pattern
9. Hump
10. Lateral Lobe of Lip
11. Median Lobes
12. Appendage at Tip of Lip

Figure 6.3. Basic flower parts on a single flower

The structure of the column, formed by the merger of male and female organs, resembles figures such as humans, insects, bees, birds, or masks. Due to this structural form, their ability to attract pollinating insects makes them the most interesting part of the flower. The basic flower parts can be seen in Figure 6.3.

Another unique formation in the orchid flower is the pollinium. Pollinia, formed by hundreds of thousands of pollen grains coming together in various ways, number 2-8 depending on the species. Pollinia are attached to the rostellum by a small stalk (Figure 6.4). When flowers open, they rotate 180 degrees on their axis and the ovary twists (resupination). This characteristic is typical for the orchid family. Flowers are gathered in racemes or spikes. The dense or spaced arrangement of flowers is one of the distinguishing characteristics that can be used in species differentiation.

The variation seen in flower shape also appears in flower numbers. The distribution and number of flowers on the stem vary according to genera and species. Additionally, the size of the main tuber, along with the size of the plant mass, leads to an increase in the number of flowers. For example, in *Ophrys mammosa* species, which doesn't develop very large tubers, 8-10 flowers form. In *Himantoglossum caprinum* species, which can form large tubers, it has been observed that a 30-gram main tuber can produce 72 flowers.



Column (gynostemium): Structure formed by the combination of male and female organs

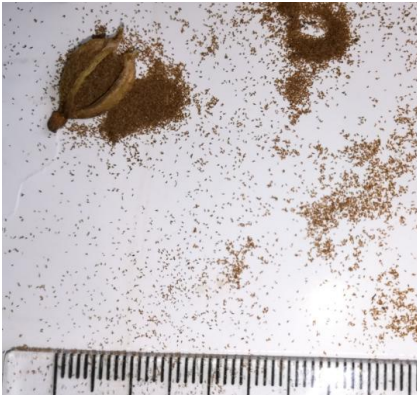
Pollinium: Structure formed by many pollen grains clustered together

Figure 6.4. Column and pollinium

6.3 Fruit and Seed

After fertilization in flowers, the developing ovary forms the fruit. In orchids, the fruit is capsule-shaped and consists of 3 carpels. It contains thousands of shuttle-shaped seeds. A common characteristic of all orchids is that they have very small, dust-like, microscopic seeds. These are among the smallest known seeds in the plant kingdom. Seed length ranges from 0.18-3.85 mm, with a weight of 0.3-14 mg. The seeds lack endosperm, and their embryos are composed of relatively few cells. Thanks to their miniature structure and lightness, seeds can be carried by wind to distances of 100-250 km.

A capsule-shaped fruit of *Orchis simia* species and tens of thousands of seeds inside it



Cellular image of a single seed in *Dactylorhiza majalis* salep orchid species (scale bar 0.1 mm)

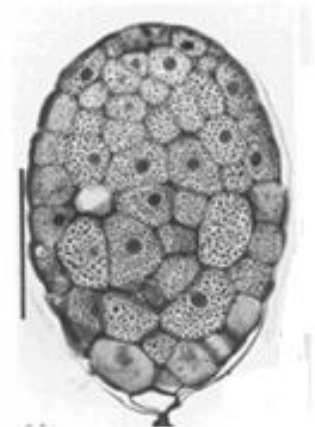


Figure 6.5. A fruit (capsule) taken from *Orchis simia* species and seeds dispersed from it, microscopic image of *Dactylorhiza majalis* species seed

When examining the microscopic structures of the seeds, it can be seen that they consist of around 40-50 cells (Figure 6.5). The most notable deficiency in seed structure is the absence of nutritive tissue that should feed the germinating embryo. Therefore, during germination, seeds cannot develop without support from a different living organism. More detailed information about germination is provided in the cultivation section.

Another notable aspect of seed structure is that the parts that will form plant components such as root, stem, and shoot after germination are not yet formed. For this reason, orchid embryos are called primitive embryos. In short, orchid seeds are seeds that lack nutritive tissues, have few cells, cells are not differentiated to form roots and shoots, and need helper organisms for germination. Before germination, differentiation must occur in the few cells present, and parts that will form components such as root, stem, and shoot must be shaped through task distribution.

6.4 Stem

All salep orchids have a single stem. In these orchids with a short stem, leaves encircle and surround the stem. It is understood that the generally short-structured stem is white in color as it is located underground and does not receive light. Depending on the planting depth of the tuber, a stem section of approximately 2-10 cm can form.

Genetic structure is also a factor determining stem length. Particularly in species such as *Orchis purpurea*, *Platanthera chlorantha*, and *Himantoglossum caprinum*, which have larger structures and broader leaves with a more massive build compared to other species, the stem sections are also long.

Since salep tubers have a single sprouting point, a single stem form. Roots begin to elongate first from the part where the stem joins the main (old) tuber. When root development reaches a certain stage, a protrusion thicker than the roots, which will form the new tuber, begins to appear. This period is generally observed before winter begins in most species. Figure 6.8 shows the development status in the first week of December in *Himantoglossum comperianum* species. As can be seen from the image, the new tuber draft is forming from the point where the stem joins the old tuber. The part connecting the new tuber to the plant, which is thicker than the roots, can be called the umbilical cord.

The length of the umbilical cord depends on the species of tuber and its depth in the soil. Studies indicate that salep species can perceive soil depth. This is because the umbilical cord length varies in tubers of the same species placed at different depths. Tubers at or near the soil surface form a long umbilical cord during their development, forming their new tubers 5-7 cm deep from the soil surface. Tubers planted deeper develop their new tubers with a very short cord. An image showing the stem along with the old and new tubers is presented below (Figure 6.6).

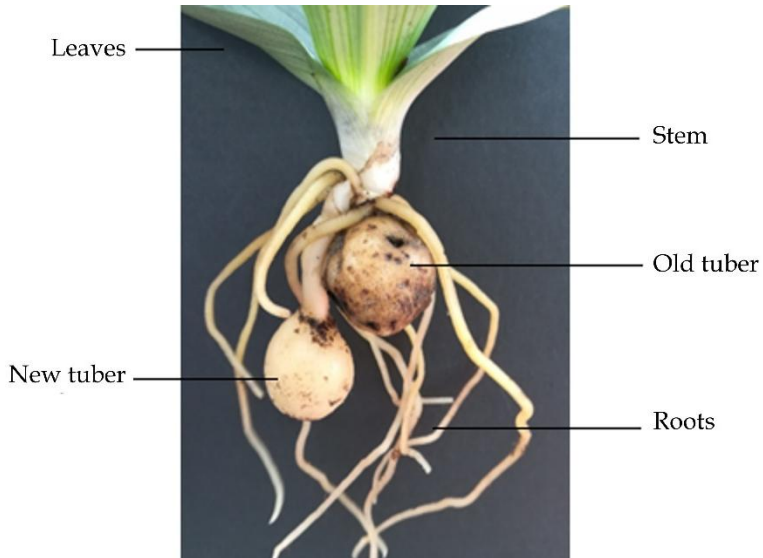


Figure 6.6. Underground parts of *Ophrys mammosa* species at the beginning of flowering

6.5 Roots

Thick, spherical, and longitudinally cylindrical roots form in different numbers depending on the species and tuber size. As shown in Figures 6.6 and 6.7, roots emerging from growth points at the bottom of the shoot develop by extending sideways and downward. Unlike developed plants, orchid roots lack capillary root structures where absorbing hairs form. Due to this structure, they cannot obtain needed nutrients from the soil by themselves. They can meet their mineral needs with the help of certain fungal organisms living in the soil. The fungi that assist in seed germination also help with the plant's nutrition throughout its entire life.

Shoot and root emergence in *Dactylorhiza romana* species



Shoot and root emergence at the beginning of development in *Orchis morio* species



Figure 6.7. Root formations of two species during development stages

In salep orchids, root emergence and development continue until the stage when flower primordia begin to appear. A rapid increase in roots is seen in the early stages of development. Root number depends on tuber size and species characteristics. Large-tuber saleps have more roots parallel to their mass size. In main tubers that will form a certain number of roots, all roots emerge and begin to develop before the new tuber primordium appears. As seen in Figure 6.8, when development begins in the new tuber primordium, roots have already reached a certain size.

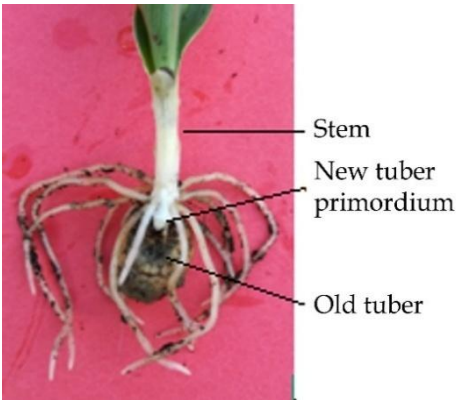


Figure 6.8. Root development status in *Himantoglossum comperianum* species before new tuber formation

Unlike developed plants, it is noteworthy that salep orchids lack root repair capability. In other words, after flower primordia begin to form, roots that are damaged or broken for any reason cannot be replaced with new ones. This aspect should be considered in the dig-and-plant method mentioned in the cultivation section, and roots should not be damaged during harvesting.

6.6 Tubers

Tubers are round, ellipsoid, elongated, or palmate in structure. Most genera and their species show oval, elliptical, and near-round formations. *Dactylorhiza* genus salep orchids produce palmate tubers and are commonly called forked salep or compared to a hand. The *Platanthera* genus produces more longitudinal tubers compared to others. These types are generally compared to carrots. Tuber images of some species belonging to six different genera are presented below (Figure 6.9).

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Tuber shape is species-specific, while its size varies according to both the genetic structure of the species and which generation tuber it is. Tubers have increasing size each year within the limits of their genetic capacity. In the developmental years beginning with seed germination, a very tiny tuber (3-5 mm in size) form in the first year. In each subsequent year, the new tuber formed achieves a slightly larger structure than the previous one. The production of a larger daughter tuber during each tuber development process is an important characteristic observed in salep orchids. This topic is explained in more detail in the development process section.



Dactylorhiza euxina



Dactylorhiza romana



Orchis purpurea



Serapias vomeracea



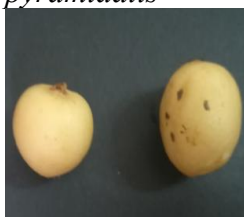
Anacamptis pyramidalis



Orchis papilionacea



Platanthera chlorantha



Ophrys apifera



Orchis laxiflora

Figure 6.9. Tuber images of some species

7 | PRODUCTION PROCESS IN SALEP ORCHIDS AND ONE-YEAR VEGETATION PERIOD

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To explain the growth and development characteristics in salep orchids, two different expressions need to be used. This is because, as detailed below, the plant's one-year vegetation cycle (period) is a separate topic, while the development (production) process over many years is a different matter.

Production process: It is the development process that continues from seed germination until flowering size, that is, until transformation into adult individuals capable of producing seeds to continue their generation. This process is reported to vary between 2-12 years in salep orchids, depending on the species.

Vegetation period (cycle): It is the process that starts with tuber sprouting and continues until withering in one growing (vegetation)

season (6-10 months). The majority of salep species begin growing by sprouting in late August-early September and wither after maturing their seeds in April-June. This period, which covers growth and development within one year, is called the vegetation period.

The vegetation period is the term used to express annual development. The production process refers to the years it takes for an individual starting from seed to reach seed maturation size and takes many years. For better understanding, the topic has been examined under separate headings below.

7.1 Production Process

In the kingdom of seed plants, seeds, which are generative (sexual) production material, basically consist of embryo, endosperm (nutritive tissue), and a protective shell covering these structures. The embryo is the living part that will form the new plant. The embryo, which begins to develop in suitable germination conditions, obtains all necessary nutrition entirely from the nutritive tissue in the seed until it forms roots and leaves and produces its own nutrients.

The most important aspect distinguishing the orchid family from other seed plants is the absence of nutritive tissue in orchid seeds. In other words, orchids lack necessary nutrients during germination, which is the beginning of plant life. In this respect, we can call them incomplete seeds. An adult salep orchid can produce at least 8-10 seed capsules containing tens of thousands of seeds. However, it is impossible for seeds as small as dust particles and lacking nutritive tissue to survive on their own. Figure 7.1 shows several capsules and tens of thousands of seeds emerging from an opened capsule.

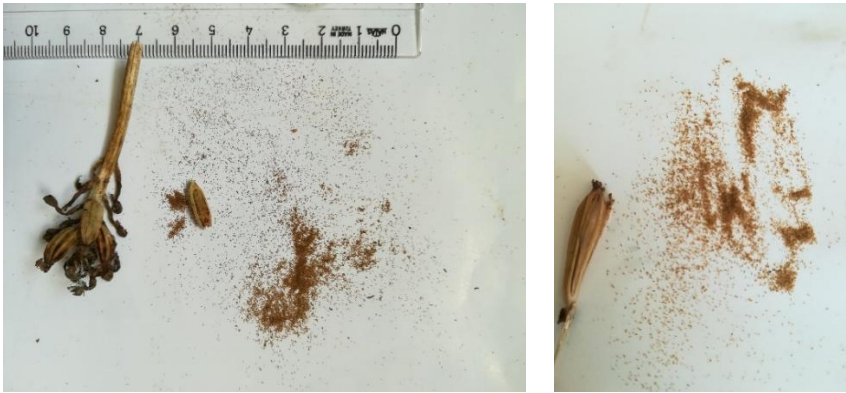


Figure 7.1. Capsules where seeds develop and seeds extracted from a capsule

Like all orchids, salep orchids must be nourished with help from another living group during germination, their first life phase. Fungi from the mycorrhiza group help salep seeds germinate and provide necessary nutrients. In their initial development period, salep orchid seeds enter into a symbiotic relationship with fungi.

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Mycorrhizal fungi feed orchid seeds by providing nutrients obtained from organic residues in the soil and help them grow. This relationship between mycorrhizal fungi and seed is called symbiotic life. The first structure developed by the seed through germination with microorganisms is called a protocorm.

Very few of the numerous seeds released by adult individuals have a chance to survive this way. The images below show a salep orchid that has reached a certain size and released its seeds. Examining the small sprouts in Figure 7.2, one can see that a few seeds have found a chance to germinate. The undeveloped root structure in these plantlets called protocorms indicates they are being fed by microorganisms. These rootless protocorm structures collected from around the plant have been photographed on a separate surface.

Seeds generally germinate in September-October with autumn rains, and it is known that in their first year of development, they form a few small leaves and a tiny 3-5 mm tuber. During this process, tubers developing their own root system continue their symbiotic life with fungi and dependence on them. In natural environments, germination can occur not only in autumn but also in spring. During field trips, individuals beginning to germinate and newly emerging from the soil surface have been observed during February-March period.



Figure 7.2. Germinating seeds around adult individual and rootless seedlings beginning to grow.

Individuals beginning to germinate in autumn find more opportunity to develop compared to those finding a chance to germinate in spring, and their first-year tubers are larger. The seed, establishing symbiotic life with fungi for germination, produces its tiny tuber in the first vegetation year. The formed tiny tuber remains dormant through the summer season until the next vegetation beginning.

The tiny tuber formed in the germination year begins its second vegetation year by awakening in late August-early September in many salep orchid species. In the second growing season, the old tuber, which produces a slightly larger tuber than itself, completes its duty and disappears through decay. In the continuing development process where larger tubers are produced each passing year, tubers reaching a certain size transform into adult individuals and reach flowering size by forming reproductive organs.

We can call the period from seed germination until reaching flowering size the production process. This is because only individuals reaching generative maturity can produce seeds. This process varies depending on the genetic characteristics of species. There are insufficient sources about how many years it takes for which salep orchid species to complete their production process. Although seed germination in tissue culture medium and subsequent plant development from protocorms has been achieved worldwide, the development processes of obtained seedlings have not been monitored. There is a lack of information on this subject.

Tissue culture and in vitro studies remain limited to germination studies on a species basis. Here, observations of some researchers in natural environments can be mentioned. For example, in their studies on seed production in salep orchids, Tutar et al. (2013b) stated that germinated seeds could reach flowering size after 3-4 years. Sezik (1984) reported that leaves and tubers form from germinated seeds after many years. According to the same researcher, the average minimum period is 2-4 years.

The production process can be clearly seen during field trips. The process for *Ophrys apifera* species is visualized in the image below. A germinated *Ophrys apifera* seed completes its development in the first year with two leaves and a 3 mm tuber. This tiny tuber shows an

increasingly growing structure in the second year and beyond. As can be understood from Figure 7.3a, this salep species flowers and can produce seeds in the third year.



Figure 7.3a. Four-year development process of *Ophrys apifera*



Figure 7.3b. First flowering of *Dactylorhiza romana* salep orchid species is observed in the third year in its natural environment

A similar development is seen in *Dactylorhiza romana* species. However, individuals of this species mostly form only one leaf in the first year, which is the germination year. The first-year leaf size completes at an average of 4-6 mm width and 7-12 cm length, depending on germination time and environmental ecology. The first-year tiny tuber was measured at only 0.25 g. In the second year, the new individual developing 3 leaves produced a 0.9-1.0 g tuber. In the third year, besides forming 6-7 leaves, it reaches flowering maturity and develops 5-6 flowers. Therefore, the production process for this species has been determined as 3 years (Figure 7.3b).

Another notable aspect is the sizes of old and new tubers. The old tuber completes its vegetation process by producing a slightly larger new tuber at the end of vegetation. Each year, a larger tuber forms compared to the previous year. The larger the main tuber at the beginning of

vegetation, the larger the plant it will form and the new tuber it will develop. Regarding this subject, tuber weight can be exemplified for the *Dactylorhiza romana* species pictured above. It was determined that the first-year single-leaf individual produced a tuber weighing 0.25 g. When this tuber is planted, it forms a second-year tuber weighing 0.98 g, and the old tuber decays. The new tuber formed in the third year measured 2.18 g, and the new tuber developing in the fourth year measured 3.14 g. In short, each tuber completes its vegetation process by producing a slightly larger tuber than itself.

However, questions such as how many years this characteristic continues and what the maximum tuber size for species can be remain unanswered. This is because it is necessary to follow individuals on a species basis for many years.



Figure 7.4: Development process over years in *Dactylorhiza euxina* salep orchid

One of the best examples showing that the old tuber produces a larger new tuber over the years is the *Dactylorhiza euxina* species. In *Dactylorhiza euxina*, also known as fingered salep, shown in Figure 7.4,

if you notice, the first tuber has one finger. This tuber formed a two-fingered tuber in the second year and reached maturity to produce flowers and seeds. The two-fingered tuber then produced a three-fingered tuber larger than the main tuber in the third year. In the following year, a four-fingered tuber is seen forming from the three-fingered main tuber. In short, tubers produced new tubers larger than themselves each year up to a certain size. This situation can be seen in all salep orchids. Only the question of how many years it takes to reach maximum tuber size remains unanswered.



Figure 7.5. Salep communities spreading in pasture and forest areas

When considering that a single salep orchid produces tens or even hundreds of thousands of seeds, it becomes clear that salep seeds have a survival chance of one in a million or less. However, floristic studies and field trips show that they find suitable environments in some areas. Particularly in rural areas and forests away from human activities, numerous germinated and developed salep communities can be seen covering certain areas.

A notable point is that salep orchids begin to reappear in areas that have been abandoned and left to their own devices after years of agriculture. Salep varieties can be seen beginning to redevelop even in fields left

uncultivated for at least 4-5 years. This situation demonstrates that seeds can disperse everywhere with the help of wind due to their very light weight and find chances to germinate (Figure 7.5).

7.2 Vegetation Period

The period from shoot emergence in mature tubers until the plant completes its harvest maturity is called the vegetation process or annual development cycle. In many salep orchids, the vegetation process begins in September and completes in May-June. Salep tubers spend the hot summer months as dormant tubers, in other words, in a state of dormancy. The vegetation process and growth and development stages during this process are shown in the drawing below.

Depending on species and regional climate characteristics, salep tubers that become active in late August to early September first begin to show shoot emergence that will form roots and leaves. It is observed that leaf development occurs parallel to root elongation (Figure 7.6).

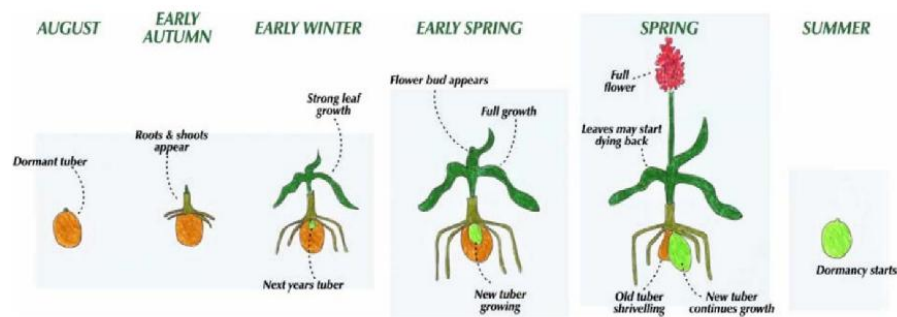


Figure 7.6. One-year vegetation cycle

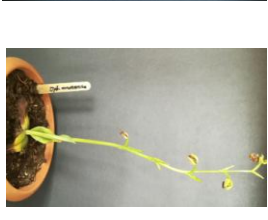
A notable point here is that plants begin shaping the draft of the new daughter tuber they will form before the cold winter season begins. Growth rate increases with warming weather in spring. Until the beginning of flowering, the daughter tuber grows parallel to the plant's

mass growth. However, the daughter tuber reaches its full size during full flowering period. During this period, the old tuber begins to hollow out and decay.

Flowering progresses from bottom to top. After pollination and fertilization in flowers, capsules form. Each capsule contains thousands of seeds as small as dust particles. There is approximately one month from the beginning of flowering until seed maturation. As seeds mature, plants begin to wither. The newly formed tuber spends the summer season again in a dormant state, waiting for the next vegetation process.

In the vegetation process summarized schematically above (Figure 7.6), seasonal expressions without specific dates were used. This is because this process, as mentioned before, depends on species and ecological characteristics of the growing environment. Below, the development process of *Ophrys mammosa*, *Dactylorhiza romana*, *Orchis morio*, and *Orchis purpurea* species in Samsun Bafra ecological conditions has been photographically documented chronologically.

Some growth and development stages during the vegetation process in *Ophrys sphegodes* subsp. *mammosa* salep orchid

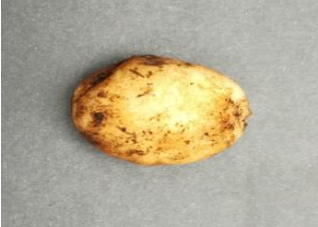
28 August	10 December	22 January	3 March	22 March	15 April	10 May
						
12 September						

At the end of August, when the *Ophrys mammosa* tuber awakens, the shoot elongates and root protrusions become distinct within 15 days. Initial development is slow; in the three-month period covering September–November, a small seedling with two leaves develops. Growth continues in the plant, albeit slowly, during December and January. During this period, roots develop and the growth point of the new tuber becomes distinct. Until the end of January, the connection channel (umbilical cord) where the new tuber will develop extends, and its tip begins to swell. By March, the new tuber forms along with development in other plant parts. At the end of March, the flower primordium shows itself. Flowers appear in April. During flowering, the new tuber has reached approximately its full size. After fertilization in flowers, capsule and seed development within is completed, and the plant withers.

Some growth and development stages during the vegetation process in <i>Dactylorhiza romana</i> salep orchid									
25 November Emergence above soil surface		21 January Seedling development		3 March Flower bud appears		10 April Full flowering		30 April Seed maturation period	
The leaf primordia of the tuber that awakens in October begin to emerge above soil surface towards the end of November. In <i>D. romana</i> species, it is observed that the new tuber primordium also begins to develop in the first stage of growth. The flower primordium appears at the beginning of March in the plant that completes the winter period as a small seedling. During full flowering period, it is seen that the new tuber has reached its full size. At the end of April and beginning of May, the plant begins to wither and vegetation is completed. At the beginning of flowering, the old tuber starts to hollow out. The fresh tuber spends the summer season in dormancy.									
									

One-year growth and development stages in <i>Orchis morio</i> salep orchid species						
05 October	01 December	22 January	03 March	25 March	10 April	30 April
						
						
In the tuber that awakens in September, shoot and root emergence is observed in October. By December, the number of leaves and roots the plant will produce is completed, and the section where the new tuber will develop emerges. Until the end of January, new tuber formation continues at the tip of the umbilical cord. The flower primordium appears in March. By the end of March, the new tuber has grown and the flower stem begins to appear. During 50% flowering period, the new tuber reaches its full size; the plant matures its seeds in May and withers. The new tuber spends the summer heat in dormancy before moving into the next production season.						

One-Year growth and development process in *Orchis purpurea* salep orchid species

10 September	22 January	03 March	21 March	13 April	30 April	25 May
						
10 October						
						

From the main tuber that awakens in August, shoot emergence begins in September. In October, root development and leaf primordium formation are observed. Until January, the emergence of new tuber primordium is seen. Growth accelerates in spring, and growth continues in leaves and underground parts until the end of March. Flower primordia appear in mid-April. During 50% flowering period, new tuber growth is completed and the plant directs its energy to seed formation. Seed formation continues until the end of May, and the vegetation process completes at the end of May. The new tuber is dormant during summer.

8 | PRODUCTION (PROPAGATION) METHODS IN SALEP ORCHIDS

In plant production, cultivation is done using two different methods.

1. When seeds formed by fertilization of the female organ in flowers are used as production material, this method is called generative production or sexual propagation method.

2. Plant cultivation using plant parts other than seeds (tubers, rhizomes, stolons, bulbs, stem and leaf cuttings, etc.) is called vegetative production or asexual propagation. For example, while cereals are produced by generative method using seeds, potatoes are produced by vegetative method using tubers. Some plants can be produced by both methods. For example, plants like thyme and sage can be propagated both from their seeds and stem cuttings.

Unfortunately, there are great difficulties in producing salep orchids from either seeds or tubers. Due to blocked production pathways, their cultivation has not yet been successful. The reason behind putting salep orchids under protection and prohibiting their trade is also the limited production possibilities. In recent years, many researchers have been conducting trials to achieve successful production. Generative and vegetative production methods are discussed under the headings below.

8.1 Production from Seeds (Generative production, Sexual propagation)

Adult salep orchids form an average of 10-20 flowers. The fruits that form following pollination and fertilization in flowers are in capsule form. It is known that each capsule contains around 7,000-30,000 seeds, indicating that a single plant produces hundreds of thousands of seeds. These seeds, lacking nutritive tissues, cannot achieve germination and seedling formation on their own. They must receive external help during the process until they transform into individuals that can provide their own nutrients. At this stage, they need to maintain symbiotic life with mycorrhizal fungi and be nourished with their help. Additionally, seeds have inherent high levels of dormancy. In cellular-level photographs taken during initial seed formation, it was observed that they consist of 40-50 cells, and these embryo-forming cells are not structurally differentiated. The fact that embryo cells are not differentiated to form shoot and root structures suggests morphological dormancy in seeds.

During germination, mycorrhizal fungi provide the seed with nutrients such as soluble carbohydrates, mineral salts, and organic nitrogen necessary for seedling development. However, it is difficult for seeds scattered in soil to find suitable germination conditions and become infected with fungi. Orchid seeds have complete dependency on nutrients provided by mycorrhizal association during germination and

seedling stages. In the relationship called symbiotic life, there is coexistence between two different organisms (orchid seed and fungus).

Many researchers have suggested that orchids use the mycobiont's carbohydrate, mineral, and water resources without providing any benefits to the fungus. In other words, orchids exploit the fungus's carbohydrate, mineral, and water resources while germinating, and the fungus expects nothing in return. Some other researchers have argued that there are mycorrhizal interactions involving mutual exchange of photosynthetic plant-derived carbon in return for access to soil nutrients such as nitrogen, phosphorus, vitamins, and/or amino acids, and have defended that a mutualistic partnership (coexistence established through mutual benefit) is formed.

The nature of orchid-mycorrhizal association is therefore complex. The mutualistic relationship probably encompasses a process that turns into complete exploitation of the fungal partner by the orchid. With orchid maturation and increasing photosynthetic capacity, dependency on mycobionts decreases and transforms into partial mycoheterotrophy.

Because the symbiotic relationship needs to be established and continue for a certain period, perhaps only one in a million of the immeasurable number of seeds scattered in nature can find a chance to germinate. Very few of the germinated seeds can survive by forming their own roots and leaves.

In terms of nutrition, salep orchids are heterotrophic (obtaining nutrients externally) in the first stage of their development. The first structure formed after seed germination through fungi is called a protocorm. The protocorm develops to form the plant's own roots and leaves. Thus, they produce their own organic nutrients through photosynthesis and gain autotrophic characteristics (producing their own nutrients). A representative diagram of the subject is presented below (Figure 8.1).

In addition to forming only one new tuber, this disadvantage in seeds has led researchers to pursue rapid propagation through in vitro studies in tissue culture medium. As mentioned above, orchid seeds cannot be grown by planting in fields or nurseries.

Tissue culture can be summarized as growing any sterilized plant part in a prepared nutrient medium and climate. Work conducted by expert teams in laboratories is based on the fact that micropropagation can be done in all plant varieties, when necessary, nutrients, vitamins, hormones, and culture medium are provided. It is a method requiring special laboratories, expensive consumables, and expert staff. For salep orchids, in vitro studies are implemented by sowing seeds in nutrient media prepared for them in tissue culture laboratories. Micropropagation from seeds gained significant emphasis after researcher Knudson first demonstrated that many orchids could be germinated asymbiotically under in vitro conditions.

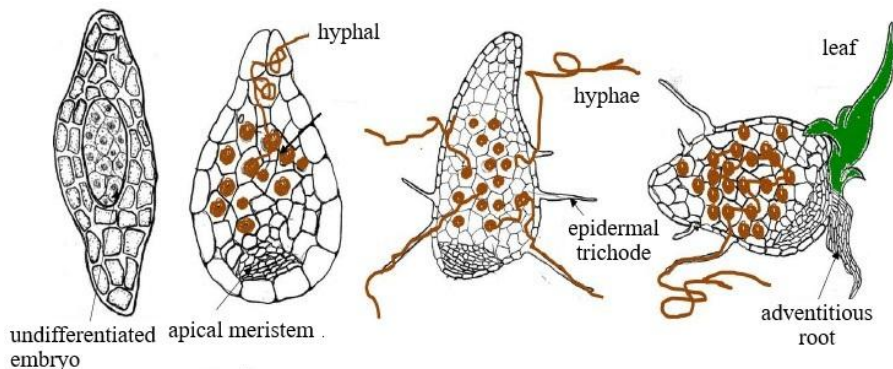


Figure 8.1. Representative presentation of events in the process from seed germination to protocorm formation in orchid species

To date, numerous in vitro studies have been found in orchid species. Various nutrient medium compositions providing germination medium in different orchid genera and species have been established. For example, artificial nutrient media such as Murashige and Skoog medium (MS), Orchimax, Knudson C orchid medium, Lindeman

orchid medium, Van Waes & Deberg medium, containing different amounts of macro and micro elements, different vitamins and organic substances, are utilized. Additional nutrients have been determined to support the nutrition of germinating seeds. Adding supplementary nutrients is called modifying the nutrient medium. For example, in an in vitro propagation study of *Or. anatolica*, *Oph. bommuelleri*, *Or. coriophora*, *Oph. phrigma*, *Serapias vomeracea*, *Himantoglossum affine* species, the highest germination rate (2.39%) was obtained by adding tomato extract and activated carbon to Van Waes & Deberg medium.

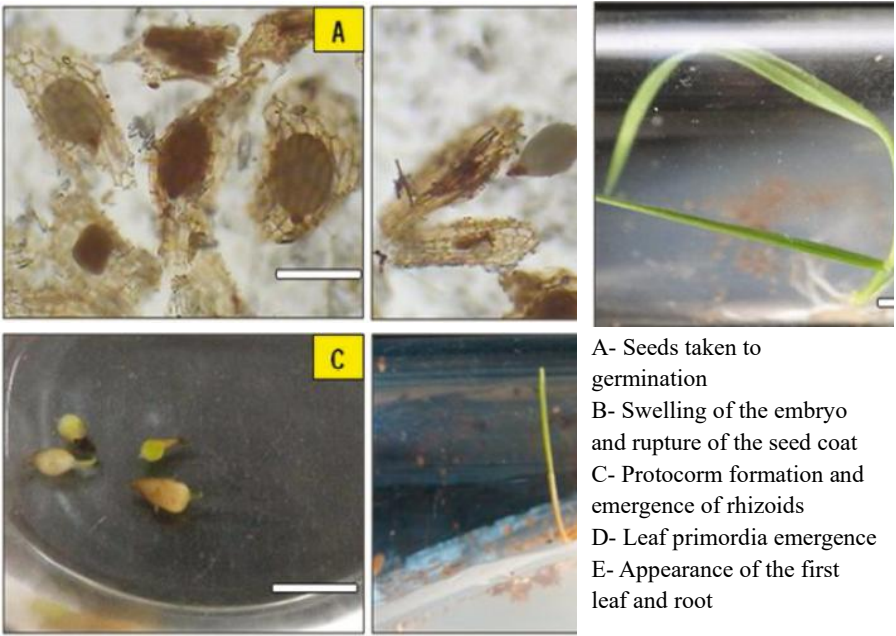


Figure 8.2. Seed to seedling development stages of *Dactylorhiza hategirea* orchid species under in vitro conditions (Warghat et al. 2014)

Due to the richness in orchid species and the development of numerous modified nutrient media, there are thousands of studies on in vitro work. An example study is included here to convey the transformation of seed into plantlet in laboratory conditions. Warghat et al. (2014), investigating the germination and development of *Dactylorhiza*

hategirea orchid species under in vitro conditions, documented seed to seedling development with their findings through images. In their study, researchers used 10 different germination media and achieved maximum germination rate (37.1%) in Lindeman orchid medium in 17 days. Maximum shoot number, highest shoot length, maximum root number, highest root length were obtained in Murashige and Skoog (MS) medium enriched with 3 mg/l IBA and 1 mg/l Kinetin. The researchers' visuals related to development stages are presented below (Figure 8.2).

In another study, Bektaş et al. (2013) investigated germination and initial plantlet formation in *Orchis coriophora* species under in vitro conditions. The researchers tested 4 different basic nutrient media combined with auxins and cytokinin/cytokinin-like substances. The highest germination rate (44.2%) was observed in Orchimax medium containing 1 mg/L indole-3-acetic acid with activated charcoal addition. Protocorms developed in all media. According to the study, Orchimax medium containing activated charcoal and supplemented with 0.25 mg/L 6-benzyladenine was found to be the most suitable medium for forming seedlings from protocorms. Figure 8.3 shows an example seedling obtained from germination and development of mature seeds.

As in the examples mentioned above, many orchids can be micro propagated and tiny tubers can be produced. However, it takes years for tuber formation from seed to reach harvest maturity. When considering field cultivation, it does not seem possible for producers to use this method and establish fields. Considering the development process mentioned in Chapter 7, it takes many years for a seedling developing from seed to reach flowering maturity and form a tuber of sufficient size for harvest. Therefore, millions of tiny tubers can be obtained through in vitro studies, these tubers can then be grown with dense planting in nurseries, and subsequently transferred to field cultivation.

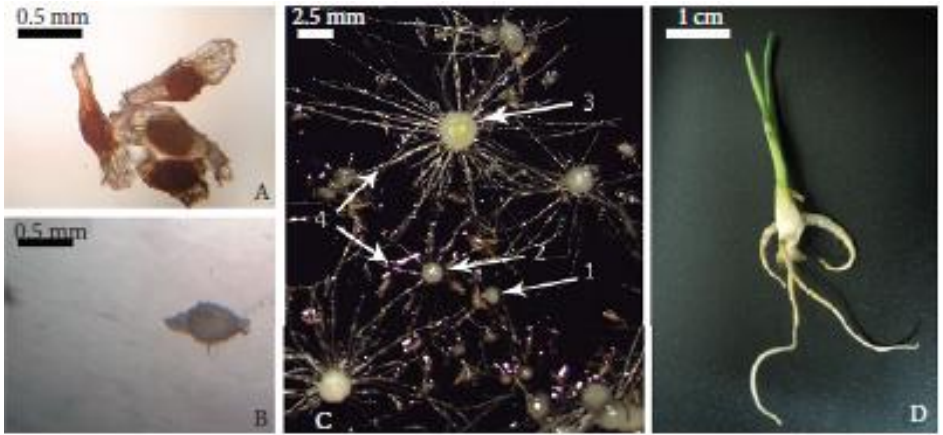


Figure 8.3. A. Seeds taken for germination trial, B-C. Embryo development during germination stage, rhizoid formation, D. Plant formation 8 weeks after protocorm formation

8.2 Production from Tubers (Asexual propagation, Vegetative reproduction)

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As known, salep plants produce a single daughter tuber for the next year during their vegetation process. Therefore, hundreds of salep species have remained as non-producible species to date. Additionally, the tuber has only one shoot bud. Consequently, propagation cannot be done by dividing the tuber. The formation of a single new tuber and the presence of a single growth point in the formed tuber makes vegetative production, and ultimately field agriculture, impossible. While one tuber is obtained from a planted tuber, the old tuber decays.

This negative situation is seen in almost all species. However, some promising results have been achieved in production studies with common varieties. Regionally collected salep varieties are being tested in production trials, and species capable of producing multiple tubers are being identified. In research conducted on Aegean region orchids regarding this subject, two salep orchid species named *Orchis sancta* and *Serapias vomeracea* were found to produce between two to five

new tubers. Production continuity can be maintained by setting aside one of the tubers produced by these species as seed tuber.

In the Black Sea region, *Serapias vomeracea* species is also seen to be common. Additionally, it has been determined that some adult individuals of species such as *Orchis coriophora*, *Ophrys mammosa*, *Anacamptis pyramidalis*, and *Orchis papilionacea* can produce two to three tubers in cultivation conditions. Especially in *Serapias vomeracea* species of salep orchids, the number of new tubers can reach up to five under good care conditions. Images of new tubers belonging to some species are presented below in Figure 8.4.

Five tubers can be obtained from *Serapias vomeracea* species in field conditions.

Development of three new tubers in *Ophrys mammosa* species

Development of three new tubers in *Orchis papilionacea* species



Figure 8.4. New tubers of varying sizes developing together with old tuber in *Serapias vomeracea*, *Ophrys mammosa*, and *Orchis papilionacea* species.

In researching tuber production, working on a regional basis and developing varieties is important. This is because salep orchids are

plants with high selectivity for climate and soil on a species basis. Species showing high performance in their own region sometimes cannot show normal development when transferred to different regions. Therefore, when seed tubers are transferred from one region to another, to a different ecology, the expected yield cannot be obtained. For this reason, if salep seed tubers are to be obtained from a different ecology for cultivation, it is necessary to conduct adaptation trials beforehand.

The difficulty and long years required for seed production, and the impossibility of tuber production except for a few species, have led to the protection of salep orchids worldwide and heavy fines for collectors.

Worldwide, new searches for the production of salep orchids, which cannot be produced and have been collected from nature for centuries, continue constantly. This is because the demand for salep, especially for use as beverage and ice cream raw material, has never decreased, and illegal collection could not be prevented.

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The fact that they have not become extinct despite intensive collection for centuries suggests that there might be some promising applications. Some studies and observations we have made in recent years have revealed that many species can form new tubers when their tubers are harvested early and replanted, and this method has been named the dig-and-plant method. The dig-and-plant method, which is tried to be explained as a separate method below, is a successful method applied to some species, if not all, especially in species with the potential to produce two or three tubers.

8.3 Dismantle and Re-plant Method in Tuber Production

Some salep orchids can be forced to produce tubers twice in one production season. This new method can be called the dismantle and re-plant method. This method cannot be applied to all species. This is because in some salep orchid species, the old (mother) tubers become

hollow in early stages of development. For example, in *Orchis purpurea* species or species belonging to the *Himantoglossum* genus, the old tubers lose their vitality early. The dismantle and re-plant method can be applied to species whose old tubers remain viable until the flowering stage. Before discussing the details of the method, it would be appropriate to mention the sources that were influential in shaping this method.

First, it is necessary to divide salep collectors into two groups: Conscious and unconscious collectors. Unconscious collectors uproot saleps without thinking about the future, driven by immediate profit, and discard the remaining plant parts on the soil surface after removing the fresh tuber and even the old tuber to which the plant's upper parts are attached. This unconsciousness creates two-fold damage:

1. Plants that cannot mature their seeds lose their chance to leave seeds in the natural flora.
2. The formation of new tubers that the old tuber could develop is prevented.

Conscious collectors, on the other hand, take the fresh tuber during the flowering period and replant the plants with their old tuber. In salep discussions in the Black Sea region, some statements from conscious collectors who have adopted salep collecting as a source of income are as follows: "I have been collecting salep for 30 years, I collect from the same place every year, I take the fresh tuber and replant the old one." Another collector's statement is noteworthy: "There are many salep collectors here, those who don't want to lose their saleps to others start collecting early, at the beginning of flowering, and when we go there a few weeks later, we see that the harvested saleps have started to form new tubers." These experienced collectors mention that sustainable salep cultivation can be done with early harvest. Similarly, the experiences of farmers in the Aegean region who have been making a living from collecting for years support the above words. For example, Güzel (2012), who has collection experience in Bucak district of Burdur

province and deals with salep trade, mentions in his article sharing his experiences that forest villagers consciously collect orchids to obtain income from salep every year. Collectors gather salep from the same region where they collected salep tubers the previous year. According to local collectors, although villagers have collected their saleps from the same places for many years, salep does not disappear in these areas; when collected consciously, its reproduction increases.

Important research finding supporting conscious collectors' observations was presented by Sevgi et al. (2014) from the biology department. Researchers who brought *Serapias bergonii* E.G. Camuc salep species to the laboratory to examine its morphological characteristics recorded and photographed an important observation during the plant's time in the laboratory. According to their observations, after individuals of *S. bergonii* species were removed from soil and their fresh tubers were removed, measurements were made in the laboratory. Some individuals whose fresh tubers were removed formed a second new tuber at the end of their waiting period in the laboratory.

They shared this special situation that caught their attention as an addition to their work in their article and suggested the idea that the plant removed from soil formed a second tuber as a result of stress. Images related to the new tubers they said formed after removing the fresh tuber can be seen below in Figure 8.5.



Figure 8.5. Secondary tuber formation from old tubers of *S. bergonii* species as a result of stress after removal of new tubers

As a similar finding, Kreutz (2002; 2009) states that based on his trials, plants whose new fresh tubers were taken continue their lives from where they left off when replanted, can still produce seeds despite everything, and in many cases continue their lives with emergency shoots from old tubers. The removal of the tuber that will be the new generation developed by the plant for the next year is perceived by the plant, and the old (mother) tuber spends all its energy on producing new tubers to overcome this adversity.

Another trial supporting the above findings regarding the dismantle and re-plant method was conducted at the Aegean Agricultural Research Institute. In the study presented by institute researchers, *Orchis sancta* and *Serapias vomeracea* species were used. The study results are summarized in Figure 8.6.

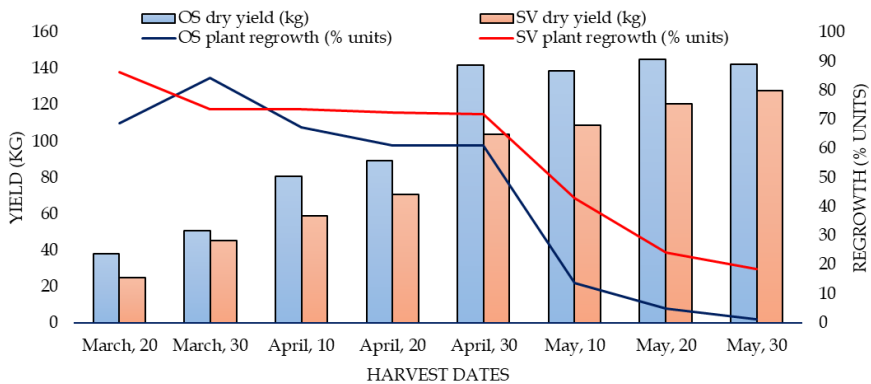


Figure 8.6. Secondary tuber formation rates according to harvest times in *O. sancta* (OS) and *S. vomeracea* (SV) species.

As can be understood from the graph, in the species used as study material under İzmir conditions, a higher number of tubers was achieved through harvesting in late March-early April (early period harvest). An important point that draws attention in Figure 8.6 is that in the second harvest, the number of tubers, and consequently the number of plants that will re-emerge and develop, shows an increase of up to 140%.

Based on the above studies supporting the dismantle and re-plant method, plants are made to produce tubers twice consecutively in one vegetation period. While tubers collected in the first harvest can be evaluated as commercial products, tubers formed in the second harvest can be used as seed tubers.

In salep species that form single tubers, the most important point to consider in the dismantle and re-plant method is monitoring the harvest time. For sustainable cultivation in any species, it is necessary not to miss the harvest time. As seen in the graph above, the earlier the harvest is done, the higher the probability of plants forming new tubers.

A similar study on this subject was tested with *Ophrys mammosa* species. In our study, one hundred plants each harvested at the beginning of flowering, 50% flowering, and end of flowering were replanted in their places. It was observed that early harvested plants quickly formed new tubers when replanted. At the end of vegetation, an average of 2.21, 2.10, and 1.04 tubers per plant were produced respectively. It was concluded that especially with harvesting up to the 50% flowering period, *Ophrys mammosa* species could be made to produce more than two tubers, and consequently, its cultivation would be possible. After the 50% flowering period passes, second tuber production is not possible. Therefore, timing the harvest operation correctly is the most important aspect in the dismantle and re-plant method.

In a similar study we conducted with *Serapias vomeracea* species, the first harvest was done when plants were at 40-50% flowering stage. After being harvested and replanted, plants were removed from soil at the end of their development to check their new tuber formation. From 100 individuals in the trial, a total of 210 new tubers were produced in one production season, with 100 in the first harvest and 110 in the second harvest.

In this method, it is important to conduct species-based trials with common species of each region and identify species suitable for the dismantle and re-plant method. As mentioned above, some species have low chances of success even with this method. New studies are continuing to produce and spread seed tubers of suitable species.

21 March 2018	45 days	5 May 2018		
1st Harvest		2nd Harvest		
Plants are removed from soil at the onset of flowering, tubers are harvested, and the plants are replanted in their original location.	Survives for 45 days until complete desiccation	After seed maturation and complete desiccation, plants are excavated and secondary tubers are collected.		
				
Flowering initiation	1st harvest	Replanting	Drying	2nd harvest

Figure 8.7. Implementation and chronological visualization of dig-and-replant method in *Ophrys mammosa* salep orchid species

For better understanding of the method, the application is illustrated below for three species. If noticed, plants harvested when the first few flowers begin to appear find the strength to produce new tubers during the period until withering, and a second tuber forms. In this method, strong individuals can sometimes form two new tubers when they lose their first tubers.

First, *Ophrys mammosa* species, which shows the earliest flowering in the Samsun coastal zone, is presented as an example (Figure 8.7). Mature individuals of *Ophrys mammosa* species produce 8-10 flowers.

Flowering progresses from bottom to top. This species generally flowers in mid-March. The individual in the example has just opened two flowers on March 21 and is at the beginning of flowering. At this stage, the plant is uprooted, its fresh tuber is removed for the first harvest. The plant is replanted in its place without damaging its roots, old tuber, and above-ground parts, then watered and maintenance operations continue.

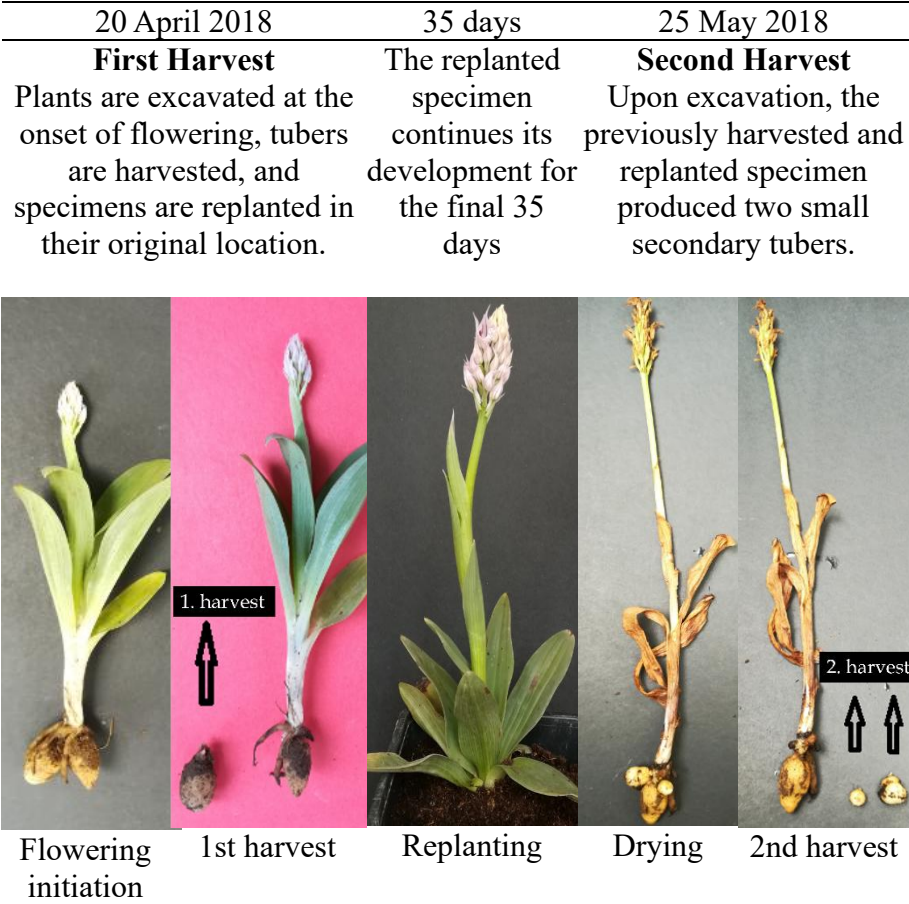


Figure 8.8. Documentation and chronological visualization of dig-and-replant method in *Orchis papilionacea* salep orchid species

This individual, continuing its vital activities, survived for approximately 45 days until all flowers opened, fertilization occurred, capsules and seeds within matured, and withering. When the plant, determined to be completely dry on May 5, was removed from soil, it had been able to produce new tubers during its last 45 days of life. This new tuber is taken as the second harvest tuber. Thus, tuber production occurs twice consecutively in one production season with the dismantle and re-plant method. The second formed tuber is smaller than the tuber taken in the first harvest. However, both new tubers are productive and can be used as seed tubers.

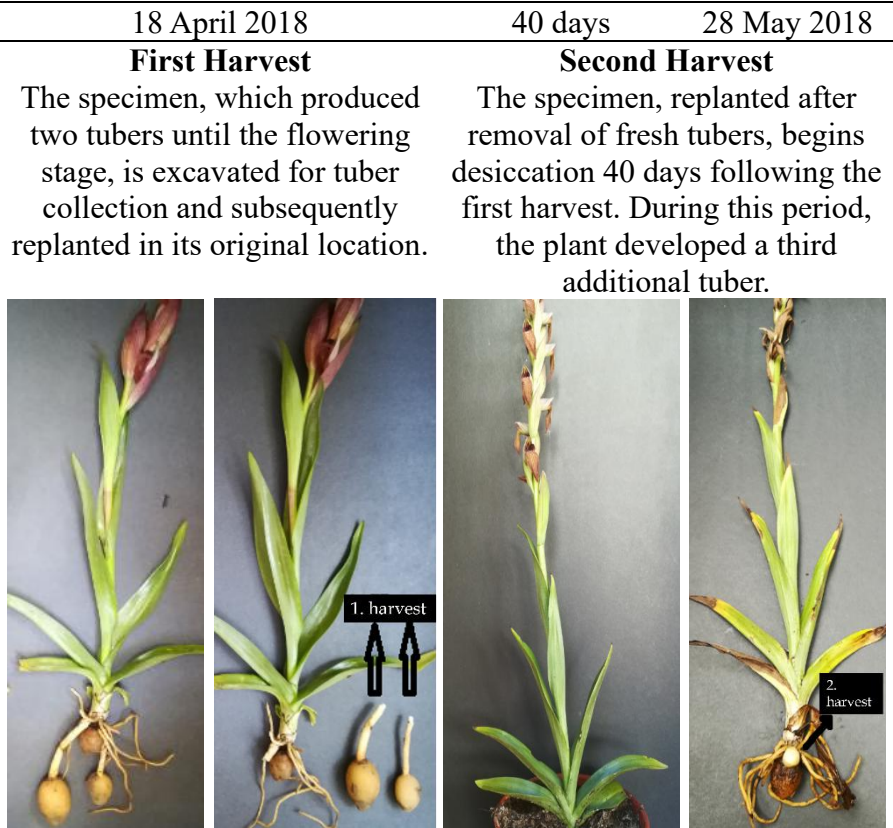


Figure 8.9. Chronological visualization and characterization of dig-and-replant method in *Serapias vomeracea* salep orchid species

The application and stages of the dismantle and re-plant method in *Orchis papilionacea* and *Serapias vomeracea* species, which begin flowering about a month after *Ophrys mammosa* species, are presented in Figures 8.7 and 8.9. In these species, there is a shorter period (35-40 days) between the beginning of flowering and the end of vegetation because air temperatures are warmer than during the generative period of *Ophrys mammosa*. This is because rising temperatures cause physiological activities to accelerate and consequently shorten the maturation period. If Figure 8.8 is noticed, the individual of *Orchis papilionacea* species taken for trial produced two new tubers when it lost its first tuber, resulting in a total of 3 new tubers.

The *Serapias vomeracea* salep orchid species taken for trial and presented in Figure 8.9 formed two tubers during normal development process. Both were removed in the first harvest, and the plant was replanted. As can be seen from the image, the plant at first harvest is at the beginning of flowering. During the 40-day period after planting, the formation of a third tuber occurred, and this tuber was also harvested when the plants withered. Thus, three new tubers were produced in one vegetation period.

Both the tubers taken in the first harvest at the beginning of flowering and the tubers formed by the plant in its final period and taken in the second harvest can be used as seed tubers. All of these harvested tubers were taken for production trials, and all were found to be productive. What is notable here is that the tuber taken in the second harvest is smaller than the tuber taken in the first harvest. Considering the vegetation period, there is a short time for second tuber development, and naturally, a smaller tuber was produced.

9.1 Soil and Climate Requirements

The prerequisite for successful production is providing the soil and climate characteristics required by the salep species. Soil characteristics play a very important role in salep orchids' life cycles. Initially, soil microorganisms play a vital role in the germination and subsequent shoot development of seeds lacking nutritive tissue. In this respect, many factors such as organic matter content, water holding capacity, and mineral content, along with soil texture, affect productivity.

Seeds that find a chance to germinate and develop can develop a tiny 3-5 mm tuber at the end of the first year's vegetation. In subsequent years, soil's physical structure and richness in nutrients are important for

tubers to enlarge. However, since we are not talking about a single species or genus, it is not possible to make a definitive statement about salep's soil requirements. Even species belonging to the same genus show differences in soil requirements. For example, it is reported that *H. comperianum* and *A. papilionaceae* species prefer soils with high bulk density, while *Oph. apifera* and *A. laxiflora* prefer soils with low bulk density.

The importance of soil structure can be clearly seen during field trips. In narrow areas with the same climatic characteristics, for example around the same village, we can see different species spreading. Since climatic characteristics are the same, it is estimated that soil factors affect species distribution here. However, due to the high number of species and lack of cultivation, there is a significant lack of information regarding soil requirements in salep species where cultivation practices have not been clarified. These deficiencies can be addressed in the future with new studies.

Some studies conducted to date reveal that salep species are highly selective about soil and that basic soil qualities need to be investigated on a species basis. For example, *Orchis coriphora* salep orchid species is called sand salep and spreads in sandy soils along the coastal strip. *A. laxiflora*, *Oph. apifera*, and *Oph. umblicata* species have notably adapted to soils with low sand content according to particle size classes.

In a study conducted in the Karaburun peninsula, where thirty-three different orchid species were identified, it was concluded that salep species generally spread in calcareous soils with high lime content. Topcuoğlu et al. (1996), sampling in the Kahramanmaraş region, reported that in areas where *Dac.iberica* species spreads, soils are mostly low in lime content, sandy clay loam to clay loam in texture, and slightly alkaline in reaction.

There is also wide variation in pH requirements. Terrestrial orchids are reported to grow in soil pH ranging from 4.5-8.0. *O. spitzelii* has been identified in areas where pH values are below 6.5. It has been determined that pH values in soils where *D. urvilleana* is found range from 4.57-7.10, while *Oph. apifera*, *Oph. umblicata*, and *A. laxiflora* notably spread in soils with pH values above 7. *A. papillionacea* can grow in a wide pH range from 5.16 to 8.16.

According to these results, there are three types of relationships between the distribution of salep species studied and soil pH. The first are those found in low pH: *O. spitzelii* and *D. urvilleana*; those found in high pH values: *Oph. apifera*, *Oph. umblicata*, and *A. laxiflora*; and third, those found in both low and high pH: *A. papillionacea*. Species that spread in high pH soils in Türkiye are also reported to be found in soils with high pH values in studies conducted in Estonia and England.

Due to soil requirements not yet being adequately determined, producers must conduct preliminary trials on a variety basis. The high diversity and different requirements of each species make preliminary testing mandatory.

Evaluating the climate requirements of species to be cultivated is a matter requiring more attention, and preliminary trials are also important for determining climate effects. As recalled from Chapter 3 discussing general distribution of salep orchids, species distribution is primarily determined by climatic factors. It is known that salep orchid seeds can spread to very distant locations. However, species thriving only in ecologies that meet their ecological requirements indicates they are very selective in terms of climate.

Different climate requirements have led to the spread of different species in different geographies worldwide and even the emergence of endemic species. Some species are very selective and cannot survive when transferred to areas with different climatic structures than their

native environment. However, there are also species with high adaptation capabilities. For example, it is possible to encounter *Orchis purpurea* species in many areas from sea level to plateaus with 1500 meters elevation.

When considering cultivation, species spreading around the production region should be preferred first. When bringing seed tubers from different regions, the distribution and adaptation capability of the species to be brought should be investigated. Otherwise, the chance of success is low.

Many negative experiences have been observed when cultivation activities were started by transferring seed tubers between regions without species selection. For example, it has been observed that when some species thriving in the Aegean region coastal strip were transferred to the Central Anatolia region, the imported tubers were damaged by cold after emergence. In another example, it was determined that species transferred from İzmir to Samsun could not adapt to the climate and showed developmental retardation.

In short, salep orchids are affected by all ecological factors surrounding them, primarily including temperature, duration and intensity of light, precipitation, relative humidity level, wind intensity, land aspect, and soil qualities of the region where they grow. The practical way of selecting suitable varieties for salep agriculture conducted for profit is recognizing regional varieties, researching their suitability for production, and selecting appropriate varieties through preliminary trials.

9.2 Soil Preparation

Primary attention should be paid to soil preparation for comfortable development and elongation of aerial roots in the soil. Heavy and compacted soils negatively affect plant development. Therefore, soil

aeration and provision of suitable development medium are necessary before planting. Well-rotted manure should be spread on the soil surface before pre-planting soil cultivation and mixed in during tillage.

Beds of 1-1.5 meters width should be created in the field for better implementation of cultivation practices such as planting, maintenance, harvesting, and replanting. There should be about 20 cm walking space between beds, and beds should be raised about 15 cm. Giving a slight inverted V-shaped slope to the bed surface is important for excess water drainage. This is because salep tubers remaining in a very humid environment cause various fungal diseases. Soils should be prepared for planting by creating horizontal or vertical lines on the bed surface. Figure 9.1 shows prepared beds and longitudinal lines opened for planting. Horizontal lines should be preferred for plantings in small areas. In large areas, longitudinal lines are more suitable for using drip irrigation systems.



Figure 9.1. Prepared beds and longitudinal furrows opened for planting

9.3 Planting

Salep production is done using tubers. Tubers spend the hot summer season dormant. Generally, in temperate coastal areas, tubers awaken and shoot emergence begins in late August to early September. In climates with high altitude and colder than the coastal strip, vegetation begins with a delay of several months. Additionally, there are salep varieties that awaken and begin development later on a species basis.

Mostly, awakening and shoot emergence in tubers coincides with the end of August. Below are images showing the beginning of sprouting in different *Orchis* species in the first week of September (Figure 9.2).



Figure 9.2. Emergence patterns observed in diverse species of *Orchis* genus salep orchids (September 5)

In tuber planting, attention must be paid to planting time, planting density, and planting depth. It is appropriate to plant tubers before sprouting. Earlier development begins in early-planted and irrigated tubers compared to late-planted and dry-kept plants. Naturally, they have a longer development process. Their development becomes stronger by taking advantage of autumn warmth. Thus, fresh and dry tuber yield increases. Therefore, it is beneficial to plant as early as possible.

However, planting time is a flexible process in salep tubers beginning to sprout according to species and climate characteristics. Initial stages of development proceed slowly. In case of incomplete soil preparation or other adverse conditions, sprouted tubers can be kept in a cool storage for planting and can be planted without damaging shoots when suitable planting medium is prepared. At this stage, it is important not to damage roots. Because it has been determined that damaged roots cannot repair themselves or form new roots in cases of seedling planting

or when plants are uprooted and replanted at different times for control. Therefore, it is mandatory not to damage roots during seedling planting.

A planting depth of 4-5 cm for tubers is sufficient. Although salep orchids benefit from air humidity, tubers remaining on or very close to the surface develop more slowly and may dry out. Planting density is an even more important issue. This is because salep plants occupy different living spaces according to species. Of course, during production, maximum number of plants per unit area is desired. Density affects plant development and is particularly important for maintenance operations. In sparse plantings, more labor and cost arise for weed control.



Figure 9.3. Pre-transplantation selection of specimens and their establishment in cultivation beds with vertical planting channels

Density should be adjusted according to the species being grown. In a study conducted with *Serapias vomeracea* species, tubers planted at 15x15 cm spacing yielded 19.17 mm tuber diameter and 1.77 g dry tuber yield per plant, producing 44.15 kg dry tubers per decare at this density. At 15x15 spacing, approximately 45,000 tubers are planted per decare, requiring 180 kg of tubers averaging 4 grams each. In studies conducted in Samsun, planting density is kept around 15x5 cm for *Serapias* and *Ophrys* genera. Thus, more plants exist per unit area. At this density, 500 kg of tubers averaging 4 grams each are used per

decare. In small areas, planting can be done by square meter calculations. Some studies have found planting 50-60 tubers per square meter appropriate. This number can be increased up to 120-130 tubers in dense plantings.

Salep orchids have a very different root system from other plants. As mentioned in the morphological characteristics section, salep plants have cylindrical and fleshy but few roots. They don't have taproot or fibrous roots that surround the soil with capillary roots like other cultivated plants. This characteristic makes it possible to uproot and transplant them at any stage of development, as long as their roots are not damaged. Therefore, salep tubers can be planted before sprouting, after shoot emergence is observed, or when they are seedlings of certain size (Figures 9.3 and 9.4).



Figure 9.4. Horizontal alignment and transplantation of experimental specimens in prepared cultivation beds

Of course, when applying the dismantle and re-plant method mentioned in the production section, plants are again uprooted and replanted in their places. According to the dismantle and re-plant method, when plants removed from soil at the beginning of flowering have their fresh tubers harvested and are replanted in their places, they continue their lives from where they left off. This characteristic mentioned in the production section has not been tested for all species. Application of the dismantle and re-plant method in species thought to be suitable for

production is necessary for continuing cultivation. As mentioned above, roots should not be damaged during seedling planting, and irrigation must be done 1-2 times after planting to ensure reintegration with the soil.

9.4 Irrigation

Salep orchids are quite superior to other plants in utilizing air humidity. This is clearly demonstrated when delayed planting tubers sprout and begin growing in storage. Tubers awakening at summer's end become active by utilizing ambient humidity while waiting in storage before or during delayed soil planting, initiating enzyme activities and showing shoot emergence. Additionally, when seedlings of certain size need to be transferred to different areas, it has been observed that uprooted seedlings don't dry out when kept in a humid and dark environment for several days. It has been determined that uprooted seedlings can be kept in cool environments away from sunlight for more than a week. However, water is one of the most important development factors for salep orchids, as with all plants.

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The fact that salep plants' growth period generally coincides with rainy periods creates an advantage in terms of irrigation. For example, it has been reported that salep production can be done without any irrigation in İzmir conditions. In the Black Sea region, autumn and spring rains meet water needs. From a natural perspective, salep orchids are plants that develop on their own in nature and continue their generations with natural rainfall.

Of course, in field agriculture, providing plant needs at optimal levels increases salep yield. Therefore, irrigation during dry periods when seasonal rains decrease or delay accelerates plant development and increases yield. First irrigation should be done especially when autumn rains are insufficient during initial development periods. Almost all salep species enter winter as small seedlings.

Rapid development period begins after winter. During this period, second irrigation should be done considering field moisture. Especially in plants where the dismantle and re-plant method is applied, irrigation must be done when plants are replanted after first harvest at the beginning of flowering.

Soil moisture content should be considered regarding irrigation. Three or more irrigations can be done during the production season. Irrigation can be applied as drip or sprinkler irrigation. Drip irrigation system is a more suitable method for water conservation and plant welfare. The criterion to consider in irrigation is not to go to excess and to keep soil moisture at medium level. Excessive water is always an invitation to fungal diseases. It should be remembered that salep plants have few and short roots. Roots are approximately 10-15 cm deep in the soil. Considering the root system, small amounts of frequent irrigation can be done. In irrigation, moistening the root zone is sufficient.

9.5 Fertilization

Plant nutrition in field agriculture is one of the important factors increasing yield. The basic plant nutrients used by all plants during their vegetation process are the same and are called essential nutrients. Although plants need the same elements, their usage amounts and ratios differ on a species basis. Through agricultural trials, the amount of nutrients many commonly cultivated plant species remove from soil has been determined, and fertilizer doses to be applied have been established accordingly. However, cultivation and growing studies of salep species have just begun. Knowledge accumulation regarding nutrient requirements and therefore fertilizer recommendations has not yet occurred. Besides being newly cultivated, it is not possible to make general recommendations for salep orchids, which have numerous genera and species. This is because while some species spread to areas with high organic matter content, some species are known to prefer and spread in more sandy soils with lower mineral content.

The positive effect of plant nutrients on salep species was first demonstrated by comparing fertilized and unfertilized areas in their natural environments. In a review conveyed by Arslankaya (2012), researcher Crawley (1990) applied fertilizer to one part of natural areas divided into two sections for eight years and not to the other part. As a result of his research, he determined that fertilization showed significant effect in increasing orchid numbers. Trials conducted as field agriculture after being taken from their natural environments are just now taking shape.

There are hesitations about plant nutrition in salep orchids, which have a very different root system from other cultivated plants we grow. Additionally, the roots of small-mass plants are very close to the soil surface. According to some observations, chemical fertilizer applications have a burning effect on orchids. Therefore, caution should be exercised in fertilizer applications. Each producer should conduct preliminary trials in a section of their salep field and find the appropriate dose according to soil structure or avoid chemical fertilizer.

A nitrogen fertilizer trial with different doses on *Serapias vomeracea* (Burm. fill.) Brig. species revealed noteworthy results regarding this subject. The effect of 0, 5, 10, 15 kg/da pure nitrogen applications on all characteristics examined in the study was found statistically insignificant. In fact, as can be understood from Table 9.1, higher dry tuber yield was achieved from the area where no nitrogen fertilizer was applied. This situation reveals the negative effect of chemical fertilizer. While dry tuber yield of 24.877 kg/da was obtained from the area with no fertilizer application, yield decreased to 15.35 kg/da when 10 kg/da nitrogen was applied. A different study conducted on *Dactylorhiza majalis* populations showed similar results again, with chemical nitrogen fertilizer application to salep areas negatively affecting the population.

Table 9.1. Effects of different nitrogen doses on yield and yield components

Nitrogen application rates (kg/da)	Plant height (cm)	Tubers per plant (n)	Mean tuber diameter (mm)	Fresh tuber mass (g/plant)	Dry tuber mass (g/plant)	Fresh tuber yield (kg/da)	Dry tuber yield (kg/da)
0	26.90	1.333	17.563	3.876	0.995	96.913	24.877
5	28.53	1.433	15.620	3.642	0.910	91.063	22.747
10	24.56	1.380	15.867	3.163	0.614	79.160	15.350
15	24.47	1.330	15.393	3.232	0.730	114.14	18.243

Through soil analyses in natural flora, soil characteristics in areas where orchid populations spread are determined, thus preliminary information about soil requirements can be obtained. For example, Rasmussen (1995) indicated that soils in natural orchid areas are characteristically poor in nitrogen, but can be quite high (30%) in organic nitrogen that can be used by fungi in humus content, and many orchid soils generally have low mineral content and are especially poor in inorganic nitrogen.

It should be known that there are differences among cultivated species. Above, a finding showing the negative effect of chemical nitrogen fertilizer was shared. A different result was revealed in a fertilization trial with another species. Parlak and Tutar (2014) tested foliar fertilizer application containing 10% nitrogen, 40% phosphorus, 10% potassium, 0.01% copper, 0.02% iron, 0.01% magnesium, and 0.01% zinc on *Anacamptis sancta* species. According to the researchers' findings, foliar fertilizer application provided 22.2% yield increase compared to the control application without fertilizer. From an economic perspective, a 13.5-unit price increase was achieved against one unit of fertilizer cost.

In a fertilization trial conducted for two years under Aydın conditions with *Orchis sancta* species, 10 kg/da phosphorus and potassium were applied as base fertilizer. The study examined the effect of 0, 5, 10, and 15 kg/da nitrogen fertilizer on chemical components. According to research findings, nitrogen application positively affected starch and

protein ratios and negatively affected mucilage ratio. In the study where nitrogen application was not deemed necessary for high mucilage ratio, the highest starch ratio was achieved with 5 kg/da, protein ratio with 10 kg/da, and ash ratio with 15 kg/da nitrogen applications. Average values for two years are presented in Table 9.2. As can be understood from the data obtained from the study, plant nutrition and fertilization is one of the important factors affecting plants' chemical composition.

Table 9.2. Influence of varying nitrogen application rates on key chemical parameters

Nitrogen application rates (kg/da)	Starch concentration (% w/w)	Mucilage concentration (% w/w)	Crude protein content (% w/w)	Total ash content (% w/w)
0	17.134	24.0	13.230	13.99
5	25.099	16.0	12.054	11.39
10	21.025	21.5	13.426	13.45
15	17.146	21.0	12.657	9.82

When considering the studies exemplified above regarding chemical fertilizer application, it is understood that the subject is a sensitive application. Therefore, caution should be exercised, and preliminary trials should be conducted in a section of our field after soil analysis.

Soil organic matter content is also a very important criterion in terms of plant nutrition and fertilization. Soil organic matter content is effective not only for plant nutrition but also in many aspects such as soil aeration, increasing water holding capacity, and improving soil structure. Most salep species require soils with high organic matter content. This is because organic matter, which increases soil vitality, has a positive effect on salep orchids' nutrition. Therefore, it positively affects tuber development. However, a large majority of Türkiye's soils are very low (1%) and low (2%) in terms of organic matter.

After soil analysis evaluation, it is recommended to increase organic matter content to 5% level. Therefore, well-rotted manure must be applied to the field where salep will be grown before planting.

When considering salep orchids' root structure, the importance of soil organic matter amount is better understood. In salep plants lacking capillary roots and root hairs, nutrient exchange is provided by fungi. From this perspective, the feeding pattern of mycorrhizal fungi living in symbiosis with their roots should be taken into account for feeding salep species. As known, these types of fungi utilize soil organic matter rather than inorganic mineral substances in the soil.

In short, increasing the amount of organic matter in soil accelerates the development of mycorrhizal fungi found in salep roots that provide their nutrient exchange, and they in turn increase salep plant's nutrition and yield.

9.6 Weed Control

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From cultivation practices perspective, weed control is one of the important criteria requiring attention. The first step for weed control is preparing the field soil clean and suitable for planting. Tubers generally activate and sprout in late August to early September. Field establishment is carried out by planting sprouting tubers. When the field is cultivated before planting, a clean seedbed will be provided where all germinating or emerging weed seeds are destroyed.

Salep orchid species are short and small-bodied plants. According to species, they generally form around 5-7 leaves, with leaves growing in rosette form close to the ground. They spend most of their development process with plant parts very close to the soil surface. Their height from the ground is around 5-10 cm until flowering period. Therefore, especially tall weeds restrict plants' utilization of sunlight and compete

for their water and nutrients. In salep orchids, plant height increases only during flowering period due to flower stem elongation.

Mechanical control should be emphasized in field cultivation. Especially in controlling tall weeds, scythes can be used, and mowing prevents these weeds from forming seeds, ensuring their elimination over time. Manual mechanical control in small areas is effective but has labor costs. Mechanical control methods using hand and scythe in small areas are recommended applications for field cleaning. Control with hoe requires attention. This is because both tubers and roots are 5-10 cm deep from soil surface, and if not careful, there is a risk of injury to tubers or roots with hoeing.

Chemical control is an easier and cheaper method, as with all plants. However, salep plant cultivation has come to the agenda in recent years, and agricultural trials regarding cultural practices have just begun. Accordingly, making herbicide recommendations for weed control for species or genera will be one of the agronomists' subjects.

In weed control trials conducted for *Anacamptis sancta* species under İzmir conditions, seven treatments including Lenacil (Adol), Bentazon (Basagran), Acetochlor (Cengaver), Aclonifen (Challenge), Pendimethalin (Herbimat), Trifluralin (Treflan), and control were applied at recommended pre-emergence doses after tuber planting in the third week of September. After application, the active ingredients used reduced the number of weeds per square meter compared to control: Lenacil ineffective, Bentazon 54%, Trifluralin 71%, Acetochlor 95%, Aclonifen 97%, Pendimethalin 93%. However, it was observed that Trifluralin, Acetochlor, and Aclonifen also negatively affected salep development, and Pendimethalin was determined to be the most suitable active ingredient in terms of both weed control and normal development of saleps.

9.7 Shading

Shading should be applied over the garden especially in the last one or two months of plant development to reduce the burning effect of direct light. When evaluating the natural habitats of salep orchids, it is possible to divide species into two groups. Some species are found in open areas, together with other short grasses in meadows and pastures. Species living together in collective life both provide partial shading to each other and prevent excessive soil heating by completely covering the soil surface. In short, species found in open areas are known to be partially shaded while receiving direct light.

Some salep species have completely avoided direct light and settled in forests. These species have thinner leaf structure and continue their development by utilizing reflected light.

In field agriculture, saleps being exposed to direct light throughout the day due to weed control and maintaining a clean field causes sun burns and developmental retardation. Therefore, shading is recommended for healthy plant development. Some producers reduce weed control for plant shading and leave other weeds in the field while only cleaning tall weeds. They create partial shading by forming a structure similar to their natural environment.

Today, shade nets with different characteristics are produced for shading purposes. Many products are available in the market according to manufacturing company and buyer requirements. Generally, shading materials are produced with properties that reduce light by 15% - 35% - 55% - 75% - 85% - 95%. Shade nets, mostly produced in green and dark green, are also available in black or cream colors.

In terms of application, shading is not needed throughout the entire growing season. Considering the growing season, seedling emergence occurs in autumn, and saleps spending winter as small seedlings begin

to develop rapidly in spring. Shading application is recommended during the period when air temperature and light intensity begin to increase. As known, depending on region and climate characteristics, some species complete their development in April and some in May. It is sufficient to apply shading material in the last two months of plant development.

9.8 Harvest

For a few species that can produce two or more new tubers, it is appropriate to harvest during full flowering period. However, harvest timing is very important for species that produce only one new tuber in normal development process and are forced to produce a second tuber with the dismantle and re-plant method. For species suitable for the dismantle and re-plant method, the harvest stage is the most important phase for sustainable salep agriculture. As mentioned under the tuber production heading, early harvest should be done to allow plants both to produce tubers for a second time in their final period and to mature and release their seeds into the soil. This is because except for a few species, all salep species produce one new tuber during normal development process. The cultivation of some single-tuber producing species can be entirely achieved through early harvesting.

Tuber harvesting is a manual operation. Care should be taken not to damage the old tuber during harvesting. The old tuber is darker in color and has a looser structure compared to the newly formed tuber. The new tuber used as salep is connected to the plant by a thin stem. It can be easily removed. After the fresh tuber is removed, the plant should be replanted (Figure 9.5).



Figure 9.5. Documentation of traditional salep harvesting: collectors and manual harvest methodology

As can be understood from figures and images summarizing the annual development process, tubers reach their full size during full flowering period. There is approximately 20% difference in tuber yields between the beginning of flowering and full flowering period. In other words, plants grow somewhat more during the period from flowering beginning to full flowering. However, for sustainable salep cultivation, it is necessary to accept yield loss and harvest early.

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In studies conducted with *Orchis sancta* and *Serapias vomeracea* species that produce two or more new tubers, the highest values in tuber diameter and consequently fresh and dry tuber yields were reached during full flowering period. Therefore, the beginning of flowering for single-tuber producing species and full flowering period for multiple-tuber producing species are suitable times for harvest.

In medicinal plants, there is variation in the amount of active ingredients according to plant development stages. This situation, called ontogenetic variability, is one of the aspects that should be considered in determining harvest time. It is important for obtaining quality drugs. In salep orchids, mucilage, protein, and starch ratios also

show variation according to development stages. Ontogenetic variability was investigated in *Serapias vomeracea* species, which is one of the species producing multiple tubers. Average values obtained from the two-year study are presented in Table 9.3 below.

The data summarized in the table shows that main components affecting salep quality change according to development stages. Especially starch ratio increases approximately 2.5 times from the beginning of flowering (8.41%) towards the end of flowering and then tends to decrease. Protein ratio, which is 11.21% at the beginning of flowering, increases as plant age advances and reaches 15.45% during seed maturation period. Ash ratio reaches its lowest value at the end of flowering.

Table 9.3. Influence of differential harvest timing on chemical composition of *Serapias vomeracea*

Harvest timing	Total dry matter (% dry weight)	Mucilaginous content (% dry weight)	Total starch content (% dry weight)	Total protein content (% dry weight)	Ash content (% dry weight)	102
Flowering initiation	90.71	20.6	8.415	11.21	5.27	
Full flowering	90.43	21.5	14.016	12.24	5.04	
End of flowering	90.57	20.0	21.413	12.69	3.82	
Seed maturation	91.53	21.6	17.417	15.45	4.53	

Since salep harvest is done by removing plants from soil and collecting their fresh tubers, the person performing the harvest is called a collector. The most important aspect in harvesting is removing the fresh tuber and replanting the old tuber with the plant. This is because harvesting is generally done during flowering period, and plants have 3-4 weeks of life remaining to form seed capsules and seeds. Additionally, plants try to form tubers for a second time through emergency shoots. For plant generation to continue, it is mandatory to replant the plant whose fresh tuber has been harvested.

Some unconscious collectors who illegally gather salep from nature sometimes remove the old tuber as well and add it to the product to increase the number of tubers they collect. Another mistake made by unconscious collectors is seeing replanting harvested plants as a waste of time and throwing plants on the ground. In other words, they take the useful part and abandon plants to death. This mistake leads to the extinction of salep species that would mature and release their seeds around, destruction of nature, and loss of biodiversity.

After harvest, obtained tubers are either stored as seed material or prepared for sale as commercial goods. Storage conditions are important for seed material. For commercial product tubers to be used in salep flour production, two different paths are followed after harvest. Some producers and collectors wash salep tubers and clean them of soil, then either sell them to buyers without further processing or process and dry them themselves for market supply. The mentioned processes are briefly summarized below.

10.1 Post-harvest Storage of Tubers to be Used as Seed Material

In their natural environments, new tubers that mature at the end of vegetation spend summer underground. In nature, tubers are found 5-

10 cm deep from the soil surface. Tubers stored at this depth during summer remain in a dormant state. It is thought that internal maturation occurs within the tuber during the dormant period for the next development process.

In case of cultivation, seed tubers need to be stored to prevent tuber losses. This is because field trips show that salep areas, especially near forests, are ravaged by wild boars. Some bird species are also known to collect salep tubers. Ultimately, tubers are a food source for many creatures in wildlife, and some losses may occur if left in the field.

Post-harvest washing is not done for seed tubers. Tubers should be stored with the small amount of soil on them. Cleaning soils remaining on tubers damages seed characteristics. It can also cause skin damage and decay.

Before storage, moisture in tubers should first be reduced by keeping them in a semi-shaded, ventilated environment for a few days. In a study conducted to determine the most suitable storage temperature with *Orchis sancta*, *Orchis anatolica*, and *Serapias vomeracea* species, control group representing room temperature was compared with 0, 5, and 10°C storage conditions. Tubers kept in zero-degree storage environment experienced serious vitality loss along with decay. At 5°C, maximum weight loss and shoot elongation were detected.

In a different study, it was observed that when *Anacamptis pyramidalis*, *Dactylorhiza romana*, and *Ophrys apifera* species were stored in a refrigerator at 4°C, the tubers rotted. Therefore, salep tubers to be kept as seed can be successfully stored throughout summer in ordinary storage conditions without any climate control. Similar to their natural environments, cool, dry, sunless environments are suitable areas for tuber storage. They should absolutely not be placed in refrigerators or cold storage.

10.2 Post-harvest Operations for Tubers Used as Salep Flour Raw Material

10.2.1 Washing

One of the most important operations to be performed on fresh tubers to obtain clean drugs is washing. Some collectors perform post-harvest operations themselves. These individuals manually wash salep tubers they collect daily in large containers like basins etc. (Figure 10.1). They boil them after stringing them and dry them hanging, thus offering them to the market as dry drugs.



Figure 10.1. Documentation of traditional post-harvest tuber washing process by local collector

However, many collectors and producers who grow salep through field agriculture market their products unwashed to buyers. Buyers purchase products brought to their businesses in districts after subjecting them to preliminary washing. The reason for preliminary washing is to clean fresh products from other residues. As mentioned in the harvest section, individuals who collect incorrectly and fraudulently add old tubers to their products to gain weight. Fresh tubers in water-filled containers sink to the bottom as they are full and heavy. Old tubers float on water due to their loosened and spongy structure. Thus, sorting is performed. Old tubers cannot be used as salep in any way because although they

swell by absorbing water during boiling, they dissolve and disappear during drying. In other words, when old tubers are processed and dried, only their shells remain.

Collectors who don't process their own products either market their products to merchants buying salep in district centers or sell their products by waiting for salep traders in public markets. These buyers also market the saleps they buy from collectors to processing facilities. There are around 20 salep processing facilities in Türkiye. When saleps collected from all over Türkiye reach these facilities, they are first taken to washing pools and washed with pressurized water, then taken to the boiling section.

10.2.2 Boiling

After tubers are washed and cleaned, boiling is performed. The boiling process applied to salep tubers is a brief boiling operation aimed at stopping vital activities, thus viability, in tubers. The temperature applied during boiling ensures the end of enzymatic activities in the tuber. Boiling time depends on the dry matter content of tubers. On average, 6-10 minutes of boiling is sufficient (Figure 10.2).



Figure 10.2. Boiling of salep tubers in cauldron

Early harvested tubers have high water content. Towards the end of flowering, tuber water content begins to decrease. Therefore, shorter boiling time is used for tubers harvested during 50% flowering period with high water content, while slightly longer boiling time is used for late-harvested tubers with decreased water content. The important aspect during the boiling stage is proper timing of the process. This is because overtime can cause tubers to burst and shells to tear and disperse. A proper boiling process is determined by checking tuber interior. In correctly boiled tubers, there should be no veining remaining inside the tuber. The person checking boiling takes a sample from the pot, cuts it in half to check if vein lines have disappeared, and adjusts boiling time.

Boiled tubers can be left to cool on their own. However, the heat inside them can cause shells to tear and tubers to disperse. Therefore, some processors place tubers in cold water pools for rapid cooling and cool tubers quickly. This process is called shocking.

10.2.3 Drying

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Almost all water inside wet tubers taken from the boiling pot and cooled needs to be removed. Ventilated and semi-shaded areas should be preferred during the drying stage. In practice, large enterprises perform drying by spreading on clean surfaces or using wire racks. Some producers who process their own collected tubers perform drying by stringing them on ropes for more careful handling. Drying time takes a few weeks depending on the region's temperature and humidity level.

Single tuber weight in salep tubers that have reached harvestable size is generally between 2-5 grams. This average weight varies according to species, which year's tuber the plant developed from, and growing environment. However, this generalization can be made for many species. A study conducted in Iran indicates that there are 304 ± 73 tubers in one kilogram of fresh tubers. The same research states that in one kilogram of dried ovoid tuber species there are 1117 ± 236 tubers, while in finger-shaped *Dactylorhiza* species there are 605 ± 219 tubers.

Harvest time is particularly an important factor affecting dry salep yield. Water content of tubers that continue to grow and accumulate substances until full flowering also changes periodically. As plant maturity progresses, tuber water content decreases. While approximately seven kilos of tubers harvested at the beginning of flowering yield one kilo of dry tubers, 5-6 kilograms of tubers collected at the end of flowering yield one kilo of dry tubers. Fresh salep buyers who know these characteristic direct collectors towards late harvest for their own profit. Even in pricing, early harvested tubers are priced lower due to high water content, while higher pricing is done for late harvest.

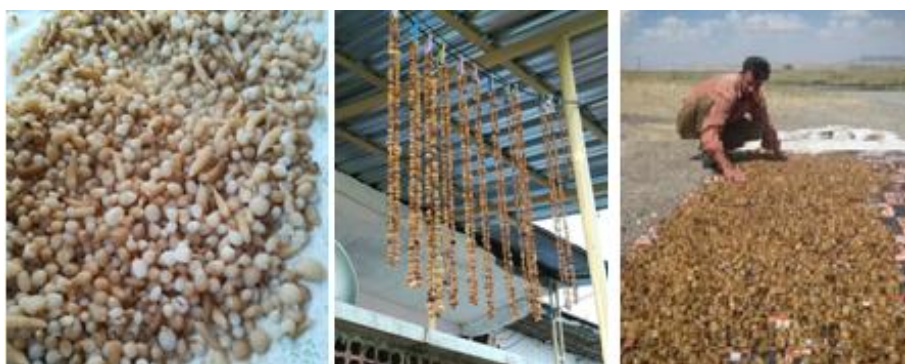


Figure 10.3. Drying of boiled tubers by spreading or stringing on rope

Another notable point regarding pricing is the separate evaluation of *Dactylorhiza* genera with palmate tuber structure. Species belonging to this genus have higher dry matter content and mucilage ratio and find buyers at 25-30% higher prices. Dried salep tubers are kept in a dry and cool area until grinding process. Salep flour has high water holding capacity and is quickly affected by ambient humidity. Therefore, grinding is only done when needed and in required amounts. Because tubers are extremely hard, grinding is done in special stone mills. Additionally, companies serving ice cream or hot beverages as end users prefer not to buy ground product to avoid adulteration; they need to see dried tubers and sense their color and smell. This is because salep flour is a product very easy to adulterate. Adulteration can be done by mixing grains and legume seeds like rice or chickpeas with salep during milling.

11 | SOME SPECIES FOUND IN THE TÜRKİYE

Türkiye has rich plant diversity due to its phytogeographical characteristics. This diversity is also reflected in the *Orchidaceae* family, and 24 genera belonging to this family have found the opportunity to spread within Türkiye's borders. Particularly tuber-producing orchids that produce salep are at the forefront worldwide in terms of diversity.

In Türkiye, it is known that all species belonging to 10 genera that produce tubers for salep raw material supply are used. It is not possible to give an exact number in terms of species count. This is because there are some contradictions in classification and naming. Various sources mention the presence of 38 species of salep orchids in Türkiye, while

some mention 90 and 120 species. There is even mention of more than two hundred salep orchids including natural hybrids.

Below, genera producing salep tubers in Türkiye are first listed. Following the alphabetically presented list, visual introduction of species commonly seen in the Central Black Sea Region covering Tokat, Amasya, Samsun, and Çorum provinces is aimed.

Genera producing salep tubers in Türkiye;

Genus: *Anacamptis*

Genus: *Barlia*

Genus: *Comperia*

Genus: *Dactylorhiza*

Genus: *Himantoglossum*

Genus: *Ophrys*

Genus: *Orchis*

Genus: *Platanthera*

Genus: *Serapias*

Genus: *Steveniella*

In the Central Black Sea region, all species except the salep orchid belonging to the *Barlia* genus have been encountered. In the *Comperia* genus, which has a single species, the mentioned *Comperia comperianum* is now called *Himantoglossum comperianum*.

Anacamptis pyramidalis

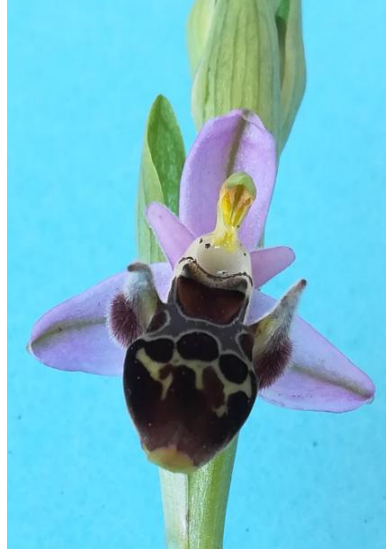


Local name: Meadow salep, pyramid, pointed salep.

A species commonly found in the Central Black Sea region. It exhibits wide adaptation from sea level to higher elevations. It occurs in open areas and forest clearings. The species demonstrates high dual and triple tuber formation rates with relatively large tuber morphology



Ophrys apifera



Local name: Bee orchid salep

This commonly occurring salep orchid species is characterized by its small stature and predominantly single new tuber formation. The tubers exhibit oval morphology with average fresh weight ranging from 3-5 grams. The species demonstrates widespread distribution in meadows and pastures, particularly in open areas, occurring across both coastal regions and medium elevations.

Ophrys sphegodes subsp. mammosa



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Local name: Black bee orchid salep

Ophrys mammosa is predominantly distributed along the Black Sea coastal belt, representing the earliest flowering species in the region. The species exhibits distribution primarily in meadows and pastureland habitats, with flowering initiation occurring in the latter half of March. While typically producing single new tubers, bi- and tri-tuber formation has been documented. Mature specimens with large tubers typically develop 8-10 flowers per inflorescence.

Dactylorhiza romana



Local name: Forked salep

The species derives its vernacular name from the characteristic bifurcated protrusions at the tuber base. Predominantly inhabits broad-leaved forest understory habitats, with flowering initiation occurring in late March. The species produces purple or white inflorescences and is distinguished by its high mucilage and dry matter content. Due to these superior chemical properties, it is harvested separately from other salep orchids and commands premium market value.

Orchis laxiflora



Local name: Water salep

The species predominantly occurs in coastal zones at near sea-level elevations. Distribution is characterized by presence in sandy and moisture-rich soil habitats.

Orchis tridendata



Local name: Round-headed salep

A species commonly distributed in open meadows and pastureland habitats. While predominantly characterized by single tuber formation, bilateral tuber development has been observed in specimens with larger tuber morphology.

Orchis punctulata



The species, typically encountered at elevations of 300 meters and above, is characterized by dimorphic flower coloration. It occurs predominantly in semi-shaded areas and sparse woodland habitats.

Orchis simia



Local name: Jinni orchid (Cinali)

The species predominantly occurs in inland areas away from sea level and semi-shaded habitats. Its distinctive floral morphology has led to vernacular appellations such as "jinni orchid" or "monkey orchid."

Orchis purpurea



Local name: Forest salep

This species, distinguished by its broad leaves and conspicuous inflorescences, consistently exhibits monotypic tuber formation. Notable is the progressive size increase in successive tuber generations, ranking among the few species characterized by large tuber morphology. Mature specimens have been documented with tuber masses ranging from 40-50 grams.

Orchis provincialis



Local name: Spotted salep

A distinctive species characterized by purple-derivative maculation patterns on both foliage and floral structures. This diminutive orchid taxon occasionally exhibits bi- or tri-tuber formation. Distribution is limited to forest margins and semi-shaded habitats, with relatively sparse population density.

Orchis pallens



Steveniella satyrioides



Local name: Single leaf

This unique taxon is distinguished within salep orchids by its reddish foliar pigmentation, a coloration that extends to both the flower stalk and inflorescence. The species is characterized by the development of a solitary mature leaf, hence its vernacular nomenclature. It exhibits diminutive habit with consistent monotypic tuber formation, producing characteristically small-sized tubers.

Orchis morio



The salep species occurring in high-altitude meadows and pastureland exhibits a dwarf habit with diminutive stature. Tubers are characteristically small, typically weighing between 2-3 grams.

Orchis papilionacea



Local name: Lion's mouth

The species, occurring in meadow and pastureland habitats, demonstrates primary adaptation to inland open areas distant from sea level.



Serapias vomeracea



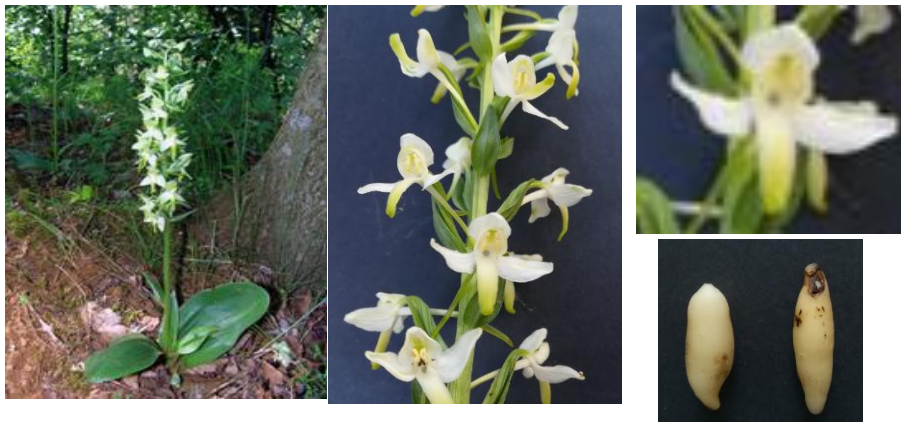
Local name: Horse hoof orchid

One of the most prevalent species, characterized by its capacity for multiple tuber formation (typically two or more). This characteristic renders it optimal for salep cultivation.

Under controlled agricultural conditions and optimal cultivation parameters, specimens have demonstrated the capacity to produce 4-5 tubers. This attribute positions the species as significant for the development of commercial salep agriculture.

The species exhibits widespread distribution throughout the country, predominantly at sea level and adjacent elevations. This distribution pattern suggests enhanced seed germination capability and survival rates compared to congeners.

Platanthera chlorantha



Local name: Princess

A rare taxon inhabiting forest understory environments, characterized by broad, fine-textured foliar morphology and distinctive white inflorescences. The species exhibits elongated, carrot-shaped tubers with diminutive dimensions.

Orchis coriophora



Local name: Sand salep

The species derives its vernacular nomenclature from its characteristic occurrence in coastal sandy habitats. It demonstrates potential for bi- or tri-tuber formation. Notable for its extended vegetative period, ranking among species with longest growth cycles, with anthesis occurring in late May.

Himantoglossum comperianum* - *Comperia comperianum



Local name: Bearded salep

A forest understory species characterized by broad foliar morphology and gracile habit. The taxon demonstrates sparse distribution patterns. Mature specimens exhibit significant tuber development, with fresh tuber mass reaching 30-40 grams.

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Dactylorhiza euxina



Local name: Fingered salep

The species demonstrates habitat preference for high-elevation zones and semi-shaded environments, particularly along riparian corridors. Additional occurrence in consistently mesic open areas. Notable for elevated dry matter content.

Himantoglossum caprinum



Local name: Snake tongue

A species occurring in high-altitude forest understory habitats, characterized by consistent monotypic tuber formation. Ranks among the few taxa exhibiting large tuber morphology, with documented specimens producing tubers exceeding avian egg dimensions.

Orchis palustris



The species predominantly occurs at high elevations and represents one of the less frequently encountered taxa.

***Himantoglossum robertianum-* (*Barlia robertiana*)**



It is one of the species seen in the Aegean-Mediterranean Regions.

Steveniella satyrioides



Local name: Single leaf

It is the only species among all salep orchid species with a reddish leaf color. The same color is predominant in the flower stalk and flowers. It also has a single developed leaf. For this reason, it is called single-leaf salep. It is small-bodied and always produces a single new tuber. The tubers are small in size.



Orchis palustris



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It is usually seen at high altitudes. It is not a very common species.

Ophrys lutea



It is one of the species seen in the Aegean-Mediterranean regions.
It is a small-bodied species.

REFERENCES

- Ar, E. 2000. Orkideler ve Türkiye’deki Mevcut Durum. *Derim*. 17 (3): 136-152
- Arabacı , O., M. Tutar, İ.İ. Özcan, N.G. Öğretmen, Ö. Yıldız. 2014. “Salep Orkidelerinden *Orchis sancta* L. Türünün Tarla Koşullar ında Hasat Zamanının Belirlenmesi”, II. Tıbbi Aromatik Bitkiler Sempozyumu Bildiriler Kitabı . 23-25 Eylül Yalova. s. 473-478.
- Arabacı , O., M.Tutar, İ. İ. Özcan, N.G. Öğretmen 2014. “Salep Orkidelerinde Farklı Kültürel Uygulamaların Etkisi”. II. Tıbbi Aromatik Bitkiler Sempozyumu Bildiriler Kitabı. 23-25 Eylül Yalova s.479-487.
- Arabacı , O., U. Tan, Ö. Yıldız, M. Tutar, 2017. Determination of Effect of Nitrogen Fertilization on Some Quality Properties of salep Orchid (*Orchis sancta* L.) Cultivated in Field Conditions in Turkey. *İnt. J. Sec. Metabolite*. 4:3 149-154.
- Arabacı , O., U. Tan, Ö. Yıldız, M. Tutar. 2017. Effect of Different Harvest Times on Some Quality Characteristics of Cultivated Sahlep orchid *Serapias vomeracea* (Burm.fill) Brig. *İnt. J. Sec. Metabolite*. 4:3 451-457.
- Arslan, N. 2012. Ülkemizde Cites Listesinde olan Bitki Türleri ve Salep. Türkiye II. Orkide ve Salep Çalıştay . 25-26 Nisan. s.45-54.
- Arslandkaya, H. 2012. Türkiye’deki Endemik Orkide Türlerinin Türkiye Biyoçeşitliliğinin Devamı açısından Önemi. Türkiye II. Orkide ve Salep Çalıştay . 25-26 Nisan. s.67-85.
- Atik, A.D., M.Öztekin, F.Erkoç. 2010. “Biyoçeşitlilik ve Türkiye’deki Endemik Bitkilere Örnekler”. Gazi Eğitim Fakültesi Dergisi, 30 (1), 219-240.
- Bektaş, E., M. Cüce, A. Sökmen. 2013. In vitro germination, protocorm formation, and plantlet development of *Orchis coriophora* (Orchidaceae), a naturally growing orchid species in Turkey. *Turkish J. of Botany*. 37:336-342.
- Bonte, F. V. Cakova, A. Lobstein. 2013. Medicinal Uses of Orchids in Europe. *Congres International d’Histoire de la Pharmacie*. Paris.
- Chandra L. De, P. Pathak, A.N. Rao, P.K. Rajeevan. 2015. Commercial Orchids. E Book. Managing Editor: Magdalena Golachowska. Published by DeGruyter Open Ltd, Warsaw/Berlin.
- Çağlayan, K., A. Özavcı , A. Eskalen. 1998. Doğu Akdeniz Bölgesinde Yaygın Olarak Yetişen Bazı Salep Orkidelerinin Embriyo Kültürü Kullanılarak İn Vitro Koşullarda Çoğaltımlar . *Tr. J. of Agriculture and Forestry*. 22: 187-191.
- Çalışkan, Ö., D. Kurt. H. Korkmaz. 2017. Studies on Samsun Salep Orchid Varieties. I. International Congress on Med. And Aromatic Plants. 10-12 May. Konya p : 69-74.
- Endersby, J. 2016. Orchid: A Cultural History. Royal Botanic Garden. Kew.
- Erzurumlu, Sandal, G., I. Doran. 2011. Türkiye’de Salep Orkideleri ve Salep Kültürü. *Hr. Ü. Z.F. Dergisi*. 15 (1) 29-34.

- Farhoosh R., A. Riazi 2007. A Compositional Study on Two Currents types of Salep in Iran and Their Reolojical Properties as a Function of Concentration and Temperature. Food Hydrocolloids. 21: 660-666.
- Güner, A., T. Ekim, 2014. Resimli Türkiye Florası, cilt 1, NGBB Yayınları Flora Dizisi 2, Flora Araştırmaları Derneği ve Türkiye Bankası Kültür Yayınları, İstanbul.
- Güzel, N., 2014. “Doğadan Tüketiciye Türkiye’deki Salep Ticareti”. II. Orkide ve Salep Çalıştayı 25-26 Nisan Ege T.A.E. Yayın No: 153 İzmir. s.1-2.
- Gorbani, A., B. Gravendeel, S. Zarre, H. Boer. 2014. Illegal Wild Collection and International Trade of CITES Listed Terrestrial Orchid Tubers in Iran. Traffic Bulletin Vol.26 No.2 53-58.
- Hossain, M.M. 2011. Therapeutic orchids: traditional uses and recent advances — An overview. Fitoterapia. 82 102-140.
- Işın, Priscilla, M. 2008. "Salep, Spiced Winter Drink and Cure-All" ("Salep, Rahat-ı Can Sıhhatü'l-Ebdan Talim-i Nefayis"). 1. Uluslararası Tıp Tarihi Kongresi ve 10. Ulusal Tıp Tarihi Kong. Bildiri Kitabı. 20-24 Mayıs Konya.
- Jacobson, G. 2008. Morphogenesis of wild orchid *Dactylorhiza fuchsii* in tissue culture. Acta Univ. Latviensis. Biology. Vol: 745 17-23.
- Kara, Ö., O. Sevgi, H.B. Tecimen, I. Bolat. 2012. Bazı Salep Türlerine ait Toprak Özelliklerinin Karşılaştırılması. II. Salep Orkidesi Çalıştayı. S: 185-203.
- Karaman S., M.T.Yılmaz, M.F. Ertugay, M. Başlar, A. Kayacier 2012. Effect of ultrasound treatment on steady and dynamic shear properties of glucomannan based salep dispersions: Optimization of amplitude level sonication time and temperature using response surface methodology. Ultrasonics Sonochemistry, 19:928-938.
- Kasperek, M., U. Grim. 1999. European Trade in Turkish Salep with Special Reference to Germany. Economic Botany 53(4) pp 396-406.
- Kayıkçı, S., E. Oğur 2012. Hatay ilinde Yayılı Gösteren Bazı Orkide Türleri Üzerine Bir İnceleme. Anadolu, J. Of AARI 22(2): 1-12.
- Kevseroğlu, K., A. Uzun, V. Çalışkan, 2014. “Orta ve Doğu Karadeniz Bölgesi Doğal Florasında Belirlenen Tıbbi ve Aromatik Bitkiler”. II. Tıbbi Aromatik Bit. Sempozyumu Bildiriler Kitabı. 23-25 Eylül Yalova s. 108-117.
- Kreutz, C.A.J. 2002. “Türkiye’nin Orkideleri, Salep, Dondurma ve Katliam”. Yeşil Atlas, Sayı: 5, 98-109.
- Kreutz, C. A. J., A.H. Çolak, 2009. Türkiye Orkideleri. Botanik Özellikleri, Ekolojik İhtekleri, Doğal Yayılı Alanları, Ya am Tehditleri, Koruma Önlemleri. Rota Yayınları, 848 s, İstanbul.
- Kreziou, A., H. Boer, B. Gravendeel. 2015. Harvesting of salep orchids in northwestern Greece continues to threaten natural populations. Fauna and Flora International. Oryx, page 1-4. doi:10.1017/S0030605315000265.

- Korkmaz, H., A.Engin, 2001. "The Flora of the Boyabat (Sinop) Dam and It's Environs". Turkish Journal of Botany, 25: 397-435.
- Korkmaz, H., 2010. Önemli Bir Doğa Mirası: Kızılırmak Deltası-BİTKİLER. In Ö. Sağlam, U. İşler (Edit.). Önemli Bir Doğa Mirası: Kızılırmak Deltası, Doğa ve Yaban Hayatı Koruma Derneği Yayınları No: 1, Erol Ofset – Samsun.
- Korkmaz, H., Ü. Mumcu, H.G. Kutbay, S.Alkan. 2011. "Vascular flora of the Gölardı Wildlife Protection Area and Its Surroundings (Terme/Samsun, Turkey)". Phytologia Balcanica, 17 (3): 315 – 331.
- Kutbay, H.G., M. Kılınç, F.Karaer. 1995. "Nebyan Dağı (Samsun/Bafra) Florası". Tr. J. of Botany, 19: 345 -375.
- Mehra, S. 2014. Nutritional and genetic diversity in orchid mycorrhizal fungi from Caladenia species. RMIT University. School of Applied Sciences. College of Science Engineering and Health. Vol.1 436 s.
- Özen, F., M. Kılınç. 2002. "The Flora and Vegetation of Kunduz Forests (Vezirköprü / Samsun)". Tr. J. of Botany, 26: 371-393.
- Parlak, S., M. Tutar. 2012. Karaburun Yarımadasında en Fazla Sökümü Yapılan Salep Orkidelerinin Bazı Toprak Özellikleri. Türkiye II. Orkide ve Salep Çalı tayı S: 205-2012
- Parlak, S. 2016. Kültüre alınan *Anacamptis sancta* parsellerinde yabancı otlarla mücadelede kimyasal ve mekanik yöntemlerin etkinli inin belirlenmesi. Ormancılık Araştırma Dergisi. 2,A,:4, 126-1331.
- Parlak, S., M. Tutar, 2014. "*Anacamptis sancta* Salep Orkidesinde Yaprak Gübresi Uygulamasının Yumru İrilğine Etkisi". III. Uluslararası Odun Dışı Orman Ürünleri Sempozyumu. 8-10 Mayıs Kahramanmara s. 1-6.
- Rasmussen H.N. 1995. Terrestrial orchids from seed to mycotrophic plant. Cambridge, UK: Cambridge University Press.
- Rasmussen H.N. 2002 Recent developments in the study of orchid mycorrhiza. Plant and Soil 244: 149–163.
- Sandal, G. 2009. Doğu Akdeniz Bölgesi'nde Yetişen Orkideler ve yetiştirme Ortamı Nitelikleri ile Tehdit Faktörlerinin Araştırılması, Çukurova Üniversitesi. Fen Bilimleri Enstitüsü. Adana.
- Sandal, G., Z. Söğüt. 2010. Türkiye Orkideleri. (Salepler). Akdeniz Ün. Ziraat Fakültesi Dergisi. 23 (2): 109-116.
- Sevgi, E., E.Altunda , Ö. Kara, O. Sevgi, H.B. Tecimen, 2014. Çanakkale Biga'da *Serapias bergonii* E.G. CAMUS Türünün Toplum Yapısı ve Bireylerinin Morfolojik Özellikleri Arasındaki li kiler. II. Orkide ve Salep Çalı tayı Bildirileri. 25-26 Nisan Ege T.A.E. Yay.No: 153, 157-172, İzmir.
- Sezik E. 1967.Türkiye'nin Salepgilleri, Ticari Salep Çeşitleri ve Özellikle Muğla Salebi Üzerine Araştırmalar. Doktora Tezi. stanbul Üniversitesi Eczacılık Fakültesi, İstanbul.

- Sezik E., B. Özer 1983. Kastamonu Salebinin Menşei ve Kastamonu Civarının Orkideleri. TÜBİTAK Proje No: TBAG -424, Ankara.
- Sezik, E., 2002. Turkish Orchids and Salep. *Acta Pharmaceutica Turcica*, 44, 151-157.
- Sezik, E. 1984. Orkidelerimiz Türkiye'nin Orkideleri. Sandoz Kültür Yayınları. No: 6 166 s.
- Sezik E., T. Baykal. 1988. Maraş Salebinin Menşei ve Maraş Civarının Orkideleri, Tübitak Temel Bilimler Araştırma Grubu, Proje No:TBAG 664.
- Sezik, E., S. İşler, N.Güler, Ç. Orhan, M. Aybeke, G. Deniz, O. Üstün. 2007. Salep ve Orkidelerin Tahribi. Tübitak TBAG-Ç.SEK/23 (103T008) No'lu Proje Sonuç Raporu. Ankara.
- Swarts, N.D., K.W. Dixon. 2009. Terrestrial orchid conservation in the age of extinction. *Annals of Botany* 2104: 543-556.
- Şeker Süngü Ş., M.K. Akbulut, G. Şenel 2016. Labellum micromorphology of some orchid genera (Orchidaceae) distributed in the Black Sea region in Turkey. *Turkish J. of Botany*. 40:623-636.
- Şen M.A. 2016. Türkiye'nin Değişik Yörelerinden Toplanan Orkidelerden Elde Edilen Saleplerin Özelliklerinin Belirlenmesi ve Geleneksel Yöntemle Maraş Usulü Dondurma Yapımında Ürün Kalitesine Etkilerinin Araştırılması. Doktora Tezi 146s. NKÜnv. Fen Bil. Ens. Tekirdağ.
- Tamer, C.E., B. Karaman, O.U. Çopur. 2006. A Traditional Turkish Beverage: Salep. *Food Reviews International*. 22:43-50.
- Tekinşen KK, A. Güner 2009. Kahramanmaraş Yöresinde Yetişen Saleplerin Kimyasal Bileşiminin ve Bazı Fizikokimyasal Niteliklerinin Araştırılması. Selçuk Üniversitesi Bilimsel Araştırma Projeleri, Konya.
- Tekinşen K.K., A. Güner. 2010. Chemical composition and physicochemical properties of tubera salep produced from Orchidaceae spices. *Food Chemistry* 121, 468-47.
- Telcioğlu, A., A. Kayacı 2007. The Effect of Sweetener and Milk Type on the Reological Properties of Reduced calorie Salep Drink *Afr. J. Bio.* 6: 465;469.
- Tıgılı, E.H. 2015. Bucak (Burdur) Yöresinde Bazı Doğal Orkide Türlerinin Yayılış Alanları, Morfolojik ve Fenolojik Özellikleri. Süleyman Demirel Üniv.Fen B.Ens. Yük.Lis. Tezi. 184 s. Isparta.
- Topcuoğlu, B., Y. Kasap, M. Alpaslan, R. Yalçın. 1996. Kahramanmaraş yöresinde doğal florada yetişen salep bitkisinin bazı bitki besin maddesi içerikleri ile salep bitkisinin yetiştiği toprakların bazı fiziksel ve kimyasal özellikleri. *Tarım Bilimleri Dergisi*, 2(3):7-10.
- Tubives 2016. Türkiye Bitkileri Veri Servisi. <http://www.tubives.com/>
- Tutar, M., A.O.Sarı, A.Bilgiç, F.Çiçek. 2011.Salep Orkidelerinin Tarla Şartlarında Yetiştirilme Olanakları". IX.Tarla Bit. Kon. 12-15 Ey.Bursa. s.1235-1240.

- Tutar, M., F. Çiçek, A.O. Sarı, A. Bilgiç, Ö. Yıldız. 2012. Salep Orkidelerinin Tarla Şartlarında Yetiştirilmesi. Türkiye 2. Orkide ve Salep Çalıştay Bildiri Kitabı. 25-26 Nisan 2012. İzmir. S.301-315.
- Tutar, M., A.O. Sarı, S.Parlak, F. Çiçek. 2013a. Salep Orkidelerinde Vejetatif Üretim". XI. Ulusal Ekoloji ve Çevre Kongresi. 1-4 Ekim. Samsun. s. 88.
- Tutar, M., S. Parlak, A.O.Sarı, F. Çiçek. 2013b. Salep Orkidelerinde Tohumdan Üretimi". XI. Ulusal Ekoloji ve Çevre Kongresi. 1-4 Ekim. Samsun. s. 89.
- Tuzcu, A. 2007. Seyahatnamelerde Amasya. Amasya Bel. Kültür Yay. 396 s.
- URL <http://www.milliparklar.gov.tr/AnaSayfa/resimliHaber/13-08-19> KAÇAK SALEP BİTKİSİ TOPLAYANLARA CEZA.
- Uyanık, M., Ş.M. Kara, B.Gülbüz, Y. Özgen. 2013. Türkiye’de Bitki Çeşitliliği ve Endemizm. Ekoloji Sempozyumu. 2-4 Mayıs Tekirdağ.
- Vangjeli, J., B. Ruci, A. Mulaj, K. Paparisto, Xh. Qosja. 2000. Flora e Shquiperise. Vol. 4 (Flora of Albania 4). Akademia e Shkencave e Republikes se Shqiperise Tirane, 502pp.
- Warghat A.R., P.K. Bajpai, R.B. Srivastava, P. Chaurasia, R.S. Chauhan, H. Sood. 2014. In vitro protocorm development and mass multiplication of an endangered orchid, *Dac. hatagirea*. Turkish Journal of Botany. 38 737-746.
- Whigham D.F., J.H. Willems. 2003. Demographic studies and life-history strategies of temperate terrestrial orchids as a basis for conservation. Orchid conservation pp. 137-158.
- Yaman, K. 2013. 1920’ den Günümüze T.C. Resmi Gazete Arsivinde Salep ve Ticareti ile ilgili Yasal Düzenlemeler. Tarih Kültür ve Sanat Ara . Dergisi. Vol:2 No:1 172-180.

SALEP ORCHIDS OF TÜRKİYE

(Orchids Used for Salep Production)

