



Deliverable title	D3.1 Dried sea fennel biomass (leaves, stems, flowers) from at least 5 Mediterranean and 3 Atlantic shoreline spontaneous sea fennel populations
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Summary of Deliverable D3.1 – Dried Sea Fennel Biomass from Mediterranean and Atlantic Populations	Sampling of wild sea fennel populations took place between summer and autumn 2022 and involved researchers from Italy, Croatia, France, Tunisia, and Türkiye. 31 wild populations were carefully selected to capture the diversity of habitats - from rocky sea cliffs in Sicily and Sardinia, to sandy beaches in the Adriatic, to the windswept shores of Brittany and the Aegean coast. For each site, 20 individual plants were sampled, and from each plant, leaves, umbels, and seeds were collected. The material was processed meticulously: portions were dried in silica gel for genetic analyses, while aerial parts (leaves, stems, flowers) were freeze-dried to preserve their biochemical properties. All samples were catalogued and stored under controlled conditions, ensuring long-term availability for future research. Beyond the technical details, the deliverable highlights the rich biodiversity of sea fennel and the remarkable adaptations of this halophyte to different environments - from granitic cliffs to limestone coasts and sandy soils. The associated vegetation recorded at each site also underlines the ecological context in which sea fennel thrives. This deliverable lays the foundation for the project's core scientific objectives: it provides the raw biological material needed for morphological, molecular, and chemical characterization, and ultimately for identifying the most promising ecotypes for cultivation and food innovation.

Versioning and Contribution History

Version	Date	Modified by	Modification reason
v1.0	20/11/2022	Abdelhamid Khaldi	First version
v2.0	30/11/2022	Abdelhamid Khaldi	Comments after peer reviewing process

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1. Sampling of spontaneous sea fennel populations

1.1 Italian sampling sites

Nine populations were sampled In Italy.



Sampling locations. SAR: "La Licciola beach" (OT); SIC "Capo Rama", Terrasini (PA); CAL: "Vasche di Cassiodoro" Copanello (CZ); PUG "Calalunga" Peschici (FG); TOS "Calafuria" (LI); MAR: "Porto Potenza Picena" (MC); CON "Due Sorelle" Sirolo (AN); LIG "Bergeggi" (SP); COR "Bussaglia" (Corsica, France).

Area of the sample	Abbreviation
Calabria	CAL
Marche, Conero regional park	CON
Marche, Porto Potenza Picena	MAR
Apulia	PUG
Sardinia	SAR
Sicily	SIC
Tuscany	TOS
Corsica	COR
Liguria	LIG

Details about the sampled populations are reported in the following table.

Location	CAL	CON	COR	LIG	MAR	PUG	SAR	SIC	TOS
Geographic latitude	38°45'33.13"N	43°32'56.82"N	42°16'49.00"N	44°24'23.42"N	43°20'42.71"N	41°56'48.22"N	41°13'56.78"N	38° 8'15.68"N	43°28'28.20"N
Geographic longitude	16°34'16.03"E	13°37'34.23"E	8°41'19.00"E	8°44'53.56"E	13°42'18.53"E	16° 3'34.26"E	9°16'23.16"E	13° 3'10.16"E	10°19'50.41"E
Exposure	E-SE	E-NE	W	NE	E	W-NW	E-NE	N-NW	SW
Soil	Granodiorite	Limestone	Granite	Dolomite	sand (quarz) plated on limestone rocks	limestone	granite	Dolomite	Sandstone
The proximity of the sea	5 m a.s.l.	4 m a.s.l.	5 m a.s.l.	10 m a.s.l.	0 m a.s.l.	5 m a.s.l.	0 m a.s.l.	26 m a.s.l.	15 m a.s.l.
Presence of other vegetation	Crithmo-Limonietum calabri	Reichardio maritimae-Brassicetum robertianae	Crithmo-Limonietum articulati	Crithmo-Limonietum	Echinophoro spinosae-Elymetum farcti	Crithmo-Limonietum diomedei	Crithmo-Limonietum contortiramei	Crithmo-Limonietum bocconeii	Crithmo-Limonietum multiflori

The first population was sampled on the 4th of August 2022, in Sicily, at the WWF reserve of Capo Rama near Palermo. The Sea Fennel population was located on a sea cliff made by dolomite rocks.



The sea cliff of Capo Rama Protected area



Sampling of the Sicilian population along the transect indicated by the red rope. In the foreground, the sampling sheet.

The second population was sampled in Sardinia at the locality named "Valle dell'Erica", more precisely at "La Licciola" beach, near Santa Teresa di Gallura (OT) on the 24th-25th of August 2022. The population occurs on a granite rock sea cliff.



The beach of "La licciola"



Sampling of the Sardinian population

The third population was sampled on the 31st of August-1st September 2022, in the Gargano Peninsula, near Peschici (FG), at the locality "Calalunga". The Sea Fennel population was on a limestone sea cliff.



The sea cliff of Calalunga (Peschici) where the third Italian population was sampled.



The sampling along the transect

The forth population was sampled on the 11th of September 2022, in Copanello (CZ) on the Ionian Sea. The population was located on a granodiorite sea cliff.



The site of the Calabria population sampling.



Sampling of a Sea Fennel plant.

The fifth population was sampled on a flat sand beach along the Adriatic coast, at Porto Potenza Picena (MC), on the 15th of September 2022.



The beach of Porto Potenza Picena with the sampling transect.



The sampling phases .

The sixth population was sampled on the 21th-22th of September 2022, in Tuscany, along the Tyrrhenian coast, at Calafuria, near Livorno. The Sea Fennel population was on a sea cliff made of sandstone.



The sea cliff in Calafuria (Livorno)



Some Sea Fennel plants sampled.

The seventh population was sampled on the 5th of October 2022, in the Marche Region, in the Natural Park of Conero (AN) on a limestone sea cliff.



The Due Sorelle bay (Sirolo), where the seventh Italian population was sampled.

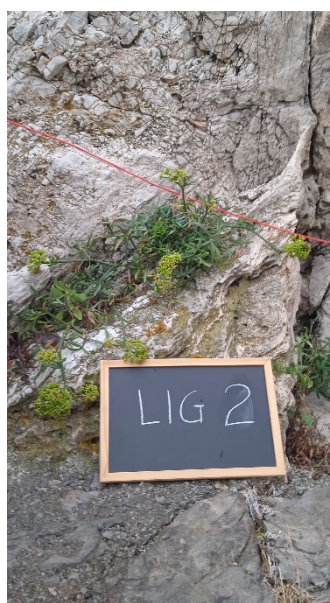


The sampling of some plants.

The eighth population was sampled on the 11th-12th of September 2023, in Liguria, along the Bergeggi coast (SV), on a dolomite cliff.



The dolomite cliff of Bergeggi



Some of the sampled plants

The ninth population was sampled on the 11th-12th of October 2023 in Corsica (France) at Bussaglia beach, on a granite cliff.



The granite cliff in Bussaglia (Corsica)



Some of the sampled plants

1.2 Croatian sites

Ten populations of Sea fennel were collected along the east Adriatic coast and islands of Croatia during the August 2022



Sampled Croatian populations: Krk , Senj, Pag , Šibenik , Split, Drašnice , Korčula , Pelješac , Neretva, Cavtat

Details about the sampled populations are reported in the following table.

Location	Krk	Senj	Pag	Šibenik	Split	Drašnice	Korčula	Pelješac	Neretva	Cavtat
Geographic latitude	45° 9'3.87" S	45° 3'20.96" S	44°29'4 9.74"S	43°43'4 2.09"S	43°30'2. 62"S	43°13'2 5.06"S	42°57'7. 80"S	42°49'0. 93"S	43° 1'13.47"S	42°35'1 3.29"S
Geographic longitude	14°31'5 9.04"I	14°52'1 2.82"I	14°54'5 8.19"I	15°50'6. 09"I	16°29'2 1.63"I	17° 6'28.94" I	17° 8'21.84" I	17°40'3 3.40"I	17°27'50.3 7"I	18°12'4 1.90"I
Exposure	N	S	N	S	S	S-W	N-E	S-W	S-W	N
Soil	lithic leptosol	lithic leptosol	lithic leptosol	lithic leptosol	artificial stone depositions	coluvium depositions	lithic leptosol	lithic leptosol	sandy and gravel depositions	lithic leptosol

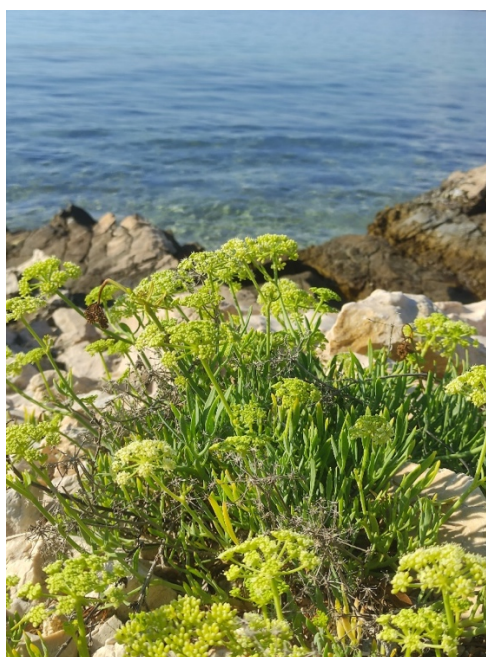
The proximity of the sea	closer than 10 m	closer than 10 m	closer than 10 m	closer than 10 m	closer than 10 m	closer than 10 m	closer than 10 m	closer than 10 m	closer than 10 m	closer than 10 m
Presence of other vegetation	No	Yes low grass	No	No	Yes (<i>Inula crithmoides</i>)	Yes (low grass)	No	No	Yes (brackish water tolerant plants)	No



The northernmost population was sampled on the island of Krk



Sampling of population Senj



Population Pag



Sampling of population Šibenik



Sampling of population Neretva



Sorting samples for storage in silica gel for molecular analyses and freeze drying for biochemical analyses (stems, flowers, leaves).

1.3 French sites

For the Breton provenances, 30 different plants were studied in October 2022 at Landunvez (Finistère), Plouha (Côtes d'Armor) and Primelin (Finistère) for their morphological characteristics, and 5 of them were brought back to the laboratory to study their chemical composition. A hundred seeds were then collected from these 3 sites to study their germination capacity.

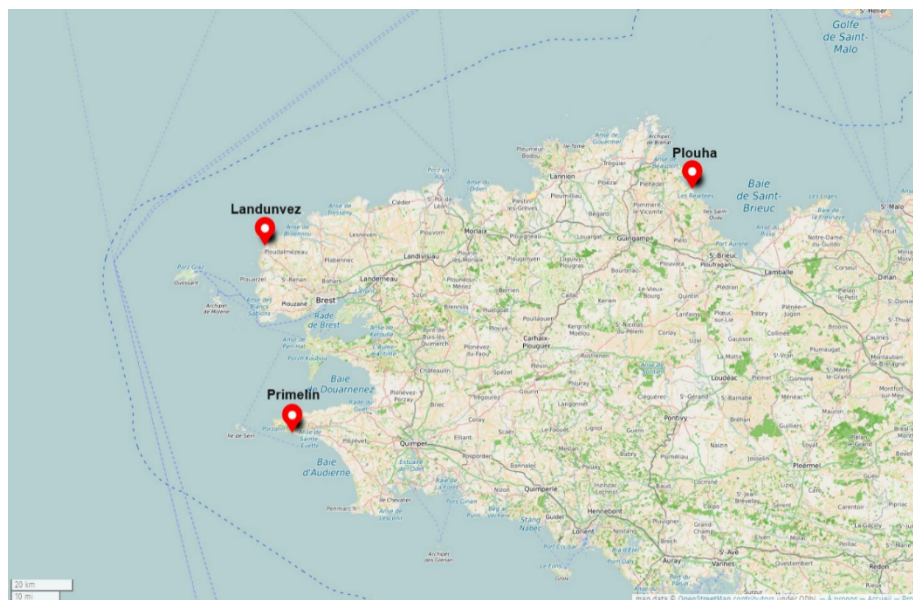
Plouha site is characterized by North-facing rocks along the Channel shoreline with temperate hyperoceanic climate (Coordinate: 48.6998N; -2.8938W);

Landunvez site is characterized by West-facing rocks and weathered rocks along the Atlantic shoreline with temperate hyperoceanic climate (Coordinate : 48.5434N; -4.7497W);

Primelin site is characterized by South-facing rocks and weathered rocks along the Atlantic shoreline with temperate hyperoceanic climate (Coordinate: 48.0260N; -4.6294W).

The French sampled populations are listed in the table below, where information about the locations are added.

Location	Plouha	Landunvez	Primelin
Geographic latitude	48° 40' 35.40" N	48° 31' 59.88" N	48° 1' 35.04" N
Geographic longitude	-2° 55' 42.31" W	4° 43' 32.16" W	4° 36' 36" W
Exposure	N-W	N-W	N-W
Soil	granite rock sea cliff	granite rock sea cliff	granite rock sea cliff
The proximity of the sea	closer than 10 m	closer than 10 m	closer than 10 m
Presence of other vegetation	Yes low grass	Yes low grass	Yes low grass



French sites where sea fennel plants were sampled in Brittany (Landunvez left, Plouha center, Primelin right).

1.4 Tunisian sites

Tunisian wild sea fennel populations were sampled from 5 different sites (Bizerte, Tabarka, Monastir, Béja (Cap Negro) and Nabeul (Haouaria)).

The associated plants were: *Lavandula stoechum*, *Limonium carolinianum*, *Distichlis spicata*, *Lycium carolinianum*, *Jaumea carnosa*, *Batis maritima*, *Glocium flavum*, and *Carpobrotus edulis*.



Tunisian sampling sites. Bizerte (BIZ), Tabarka (TAB), Monastir (MON), Cap Negro (CN), Haouaria (HA).

Details about the sampled populations are reported in the following table.

Location	Bizerte	Tabarka	Monastir	Cap Negro	Haouaria
Geographic latitude (N)	37.25265	36.95951	35.78414	37.10278	37.05143
Geographic longitude (E)	9.94500	8.75302	10.83414	8.98423	10.94242
Exposure	N	NW	E	N	NE
Soil	Sandy soil	sandy and silty soil	lithic leptosol	lithic leptosol	lithic leptosol
The proximity of the sea	closer than 10 m	closer than 10 m	closer than 10 m	closer than 10 m	closer than 10 m
Presence of other vegetation	Yes	Yes	Yes	No	Yes

The first population was sampled on the 20th of September 2022, in Bizerte located in North Tunisia. The Sea fennel population was located on a sea cliff made of sandstone.



The sampling of Sea Fennel in Bizerte location

The second population was collected on the 23th of September 2022, in Tabarka located in North-West Tunisia, on a limestone sea cliff.



The sampling site of Tabarka

The third population was sampled on the 26th of September 2022, in Monastir located in Center Tunisia. The Sea fennel population was located on a limestone sea cliff.



The third sampling site of Monastir

The 4 population was sampled on the 28th of September 2022, in Cap Negro (Béja) located in North-West Tunisia. The Sea fennel population was located on a rocky wall.



Sampling and morphological characterization of Cap Negro Population

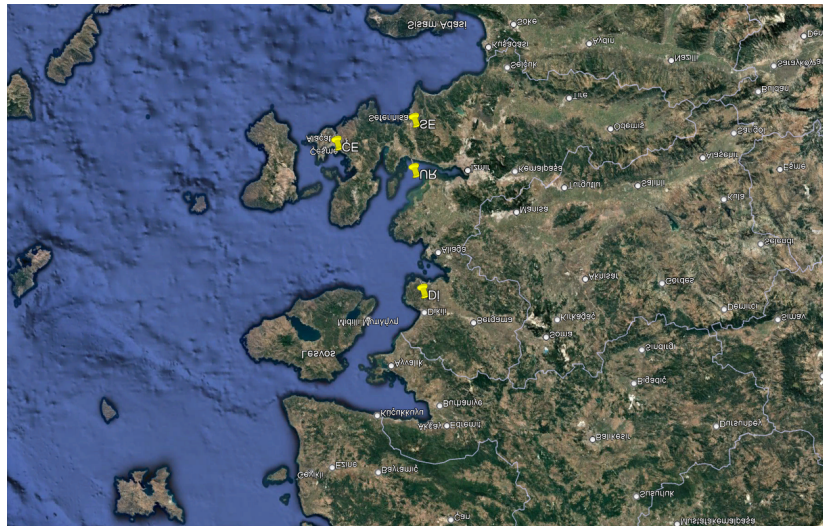
The fifth and the last population was sampled on the 29th of September 2022, in Haouaria (Nabeul) located in North-Est Tunisia. The sea fennel population was on a sea cliff made of sandstone.



The sampling site of Haouaria

1.5 Turkish sites

Starting from the Northern region of İzmir, the coastal areas were scanned with the mapping method, and 4 different populations were selected for sampling, taking care to have different geological substrates. Sample areas are within the boundaries of Çandarlı (Locality 1), Urla (Locality 2), Çeşme (Locality 3), and Seferihisar (Locality 4). GPS data of each sampling area was recorded. Samples were taken from 20 individuals from each population, paying attention to the fact that there was a distance of 5 meters between individuals. Samples from different individuals in each population were taken into separate kit bags to prevent cross contamination. Mature seeds were also sampled, cataloged and stored at +4°C and -20°C. The aerial parts of the sampled individuals were dried in silica gel (as the whole plant and plant parts: leaves, stems, flowers).



Turkish sampling sites: Dikili (Dİ) , Urla (UR), Çeşme (ÇE), Seferihisar (SE)



Collection of samples and transfer into silica gel



After the measurements made in the field, the samples were taken into ziplock bags and then brought to the laboratory in an icebox.

Details about the sampled Turkish populations are reported in the following table.

Location	Dikili	Urla	Çeşme	Seferihisar
Geographic latitude	38°55'13.51"N	38°22'3.90"N	38°14'28.14"N	38° 8'14.62"N
Geographic longitude	26°52'47.30"E	26°49'46.50"E	26°22'36.62"E	26°49'48.24"E
Exposure	East	North	South	West
Soil	Andesite rocks formed from extrusive igneous magmatic rocks	Limestone (calcareous rock) on the parent rock	Volcanic tuff/tuffite rocks	Sedimentary sandstone-shale mixed rock
The proximity of the sea	closer than 10 m	closer than 10 m	closer than 10 m	closer than 10 m
Presence of other vegetation	<i>Salsola kali</i> L.	<i>Anthemis tomentosa</i> L. <i>Glacium flavum</i> Crantz, <i>Salsola kali</i> L. <i>Atriplex hastata</i> Geners.	<i>Limonium gmelini</i> (Willd.) Kuntze, <i>Salsola kali</i> L. ,	<i>Glacium flavum</i> Crantz, <i>Centaurea spinosa</i> L. , <i>Salsola kali</i> L., <i>Carlina corymbosa</i> L., <i>Limonium gmelini</i> (Willd.) Kuntze, <i>Trifolium uniflorum</i> L. <i>Malcolmia flexuosa</i> (Sm.) Sm.

2. Lyophilization/drying of sampled sea fennel

About 50 gr of leaves have been collected from each sampled population for molecular analyses, put into separate bags to avoid cross contamination and dried in silica gel. Aerial parts of sampled sea fennel individuals (as whole plants and plant sections: leaves, stems, flowers) have been subjected to freeze-drying when opportune. The dried material has been kept in sealed bags at room temperature for long term storage prior to further analysis.