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Related Task:	Task 2.4 Production of dissemination materials (month 1 –36)
Author(s)	Deborah Pacetti
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Duration	36 months
Summary of Deliverable D2.9 – Collection of 12 Newsletters	Over its three years, SEAFENNEL4MED maintained a steady and engaging dialogue with its community through the publication of 12 newsletters, released every three months. This series became a cornerstone of the project's communication strategy, ensuring transparency, visibility, and active involvement of stakeholders and the wider public. Each newsletter offered more than simple updates: they told the evolving story of sea fennel. Early issues introduced the plant's history, cultural significance, and the project's vision, while subsequent editions highlighted scientific milestones such as the sampling of wild populations, the establishment of demo fields, germination trials, and the creation of food prototypes. Other newsletters focused on by-product valorization, socio-economic surveys, life cycle assessments, and dissemination at conferences and fairs, painting a comprehensive picture of the project's breadth. The newsletters also served as a platform to invite stakeholder participation, from expert Delphi surveys to consumer questionnaires, making readers feel part of the innovation process. Practical details, such as links to interactive maps, publications, recipes, and videos, encouraged further exploration and engagement. What made this series effective was its accessible style: combining scientific detail with visuals, photos, and storytelling. By mixing tradition (references to culinary heritage and biodiversity) with modern innovation (new foods, nutraceuticals, and eco-design solutions), the newsletters managed to capture attention across diverse audiences - from farmers and researchers to consumers and policymakers.

Versioning and Contribution History

Version	Date	Modified by	Modification reason
v1.0	30/10/2023	Deborah Pacetti	First version

v2.0

29/05/2025

Deborah Pacetti

Final version

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- NEWSLETTER#1
Sent 30_08_2022

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Let's start our activities!



Dear All,

Have you recently been to the sea?

Maybe you have noticed it among the salt-sprayed rocks near the seaside or growing gorgeous on the stunning sandy costs of the Mediterranean Sea. With green leaves and delicate yellow flowers, it's sea fennel (*Crithmum maritimum* L), also known as kritamo, from the ancient Greek word used for barley (krithmon), or St Peter's herb, Rock Samphire or simply Samphire from Saint Peter, the patron saint of fishermen, due to the ability of this halophyte to grow in rocky regions along the seacoast.

Mentioned by Shakespeare in his masterpiece King Lear "Half-way down, hangs one that gathers samphire; dreadful trade! " this highly aromatic species is highly appreciated and consumed since the Middle Ages for its carminative and diuretic properties as well as its unique sensory traits.

Delicious to eat, capturing the essence of the sea, resistant to high salinity environments with very low water and nutrient requirements, sea fennel is the absolute protagonist of the EU project SEAFENNEL4MED,

"Innovative sustainable organic sea fennel (*Crithmum maritimum* L.) - based cropping systems to boost agrobiodiversity, profitability, circularity, and resilience to climate changes in Mediterranean small farms"

To celebrate the start of the project funded under the PRIMA Call for Proposals 2022 -Section 2, a kick-off meeting was held on 15th June 2022 at the Botanic Garden "Selva di Gallignano", UNIVERSITÀ POLITECNICA DELLE MARCHE, Ancona (Italy).



Coordinated by UNIVERSITA' POLITECNICA DELLE MARCHE (Italy), the Consortium of partners includes CREA with its Food and Nutrition Research Center (Italy), the UNIVERSITY OF SPLIT and the INSTITUTE FOR ADRIATIC CROPS AND KARST RECLAMATION (Croatia), UNIVERSITÉ DE BRETAGNE OCCIDENTALE (France), INSTITUT NATIONAL DE RECHERCHE EN GÉNIE RURAL, EAUX ET FORÊTS (Tunisia) and, EGE UNIVERSITY (Turkey).

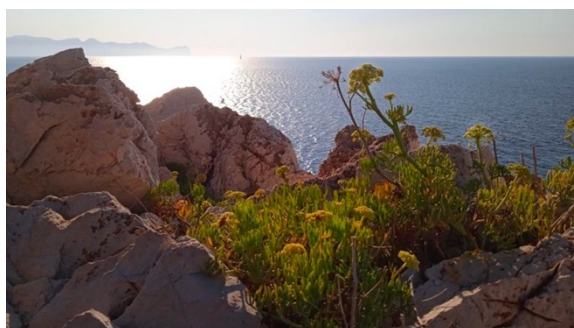
The project has a duration of 36 months - starting from 30th May 2022- and has received a total funding of 964.6 thousand euros.

The project objective deals with the introduction of Mediterranean sea fennel germplasm well adapted to climate change and Mediterranean conditions (e.g. water shortage, high salinity) for the development of new sustainable organic cropping systems, able to: (i) increase the resilience of the agro livelihood system based on agroecological principles that contribute to the zero-pollution ambition and ii) cope with limited resources and environmental constraints, with the final objectives of enhancing food production stability over time as well as increasing farmers' incomes.

Specific objectives of the project are:

- the selection of sea fennel ecotypes, well adapted to the Mediterranean climate;
- the introduction of sustainable farming systems for production of organic sea fennel crop in the Mediterranean;
- the development of new/improved high value products from the organic sea fennel crops;

- the valorization of sea fennel by-products for production of functional food ingredients/nutraceuticals/soil amendments;
- the demonstration of socio-economic benefits, environmental impacts and sustainability of the proposed innovations;
- the dissemination of sustainable sea fennel-based cropping solutions and products in the Mediterranean.



Our Botanists of SEAFENNEL4MED have just started the campaign for sampling and investigation of wild sea fennel populations spontaneously growing across the Mediterranean basin and Atlantic coastlines.

Do you want to be part of it?

Are you a farmer, a food industry, a food technologist, a consumer interested into the Project?

Don't miss this opportunity to keep updated!

Click the link below and visit the SEAFENNEL4MED web page!

Sea fennel, the essence of sustainability!

[Learn more about!](#)

- NEWSLETTER#2
Sent 30_11_2022

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1.The first objective!



Dear All

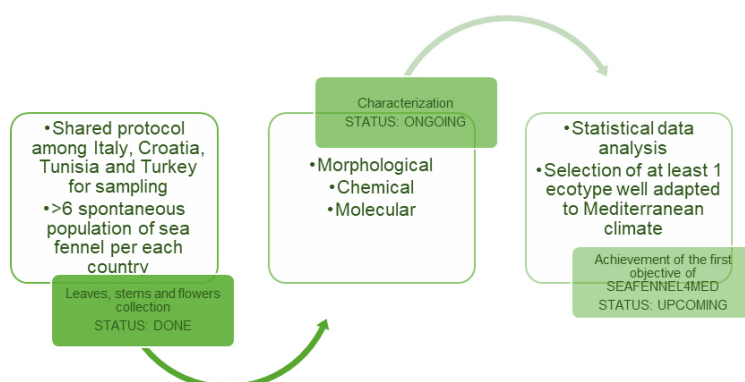
We are in autumn and the color of the Mediterranean costs are changing. Sea fennel is turning into seeds.

From August to October 2022, across the Mediterranean countries (Italy, Turkey, France and Tunisia) involved in the EU project SEAFENNEL4MED (<https://seafennel4med.com/>) botanists collected green leaves and delicate yellow flowers from wild populations of sea fennel (*Chritum maritimum*L), an halopythic herb (known as kritamo (from krithmon the ancient Greek word used for barley, St Peter's herb, Rock Samphire or simply Samphire, a corruption of St. Peter, the patron saint of fishermen), which grows in both rocky and sandy regions along the seacoast (see the photo gallery at the end of this newsletter...a pure joy to the eye!)

In the same months, sea fennel seeds from the wild populations have been stored and catalogued as well.

Hence, the first objective of the SEAFENNEL4MED project is the selection of wild sea fennel ecotypes well adapted to the Mediterranean climate, thus the first tasks include:

- sampling and morphological characterization of spontaneously growing sea fennel populations in Italy, Croatia, France, Tunisia, and Turkey
- chemical analysis of dried sea fennel aerial parts/seeds: carotenoids, tocopherols, vitamin C and phenolic compounds, fatty acids and essential oils.
- molecular analysis of sea fennel aerial parts
- elaboration of morphological, chemical, and genetic data for potential identification of different ecotypes



If you are receiving this SEAFENNEL4MED NEWSLETTER, it means that you are in the network to exchange knowledge. You are a stakeholder, and you are included in the stakeholder-platform of SEAFENNEL4MED.

We are communicating with you to ensure that:

- new R&D strategies and innovations are relevant to industry needs
- stakeholder's perspectives are considered in the development of the research programme
- you represent the interests of the target groups (e.g.: farmers, food industries, food business operators, agro-food processors retailers, endusers, researchers, public authorities, policy-makers, etc.)

STAKEHOLDERS SURVEY INVITATION

You are invited as a KEY STAKEHOLDER of SEAFENNEL4MED to participate to the first survey on a voluntary basis to help with the next objective of the project "the development of new/improved high value products from the organic sea fennel crops"

Don't miss this opportunity

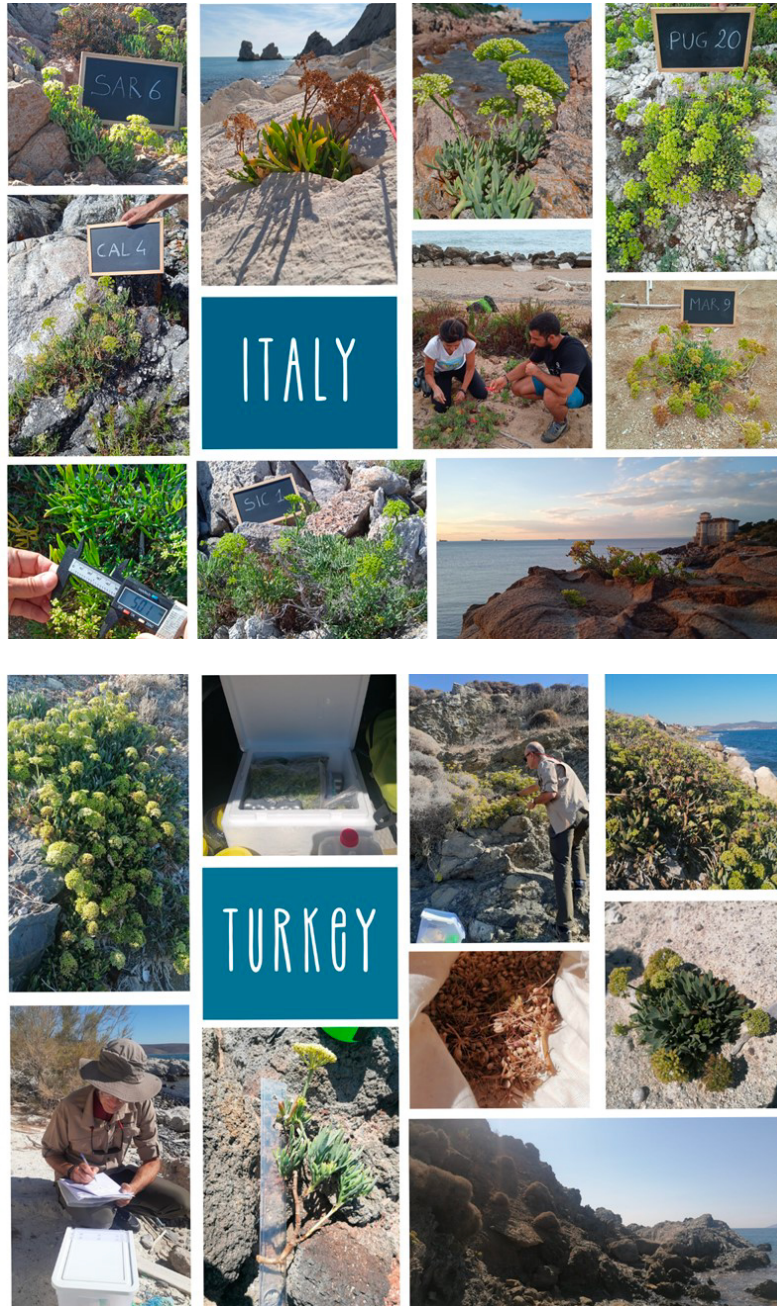
Design with us the new sea fennel foods!

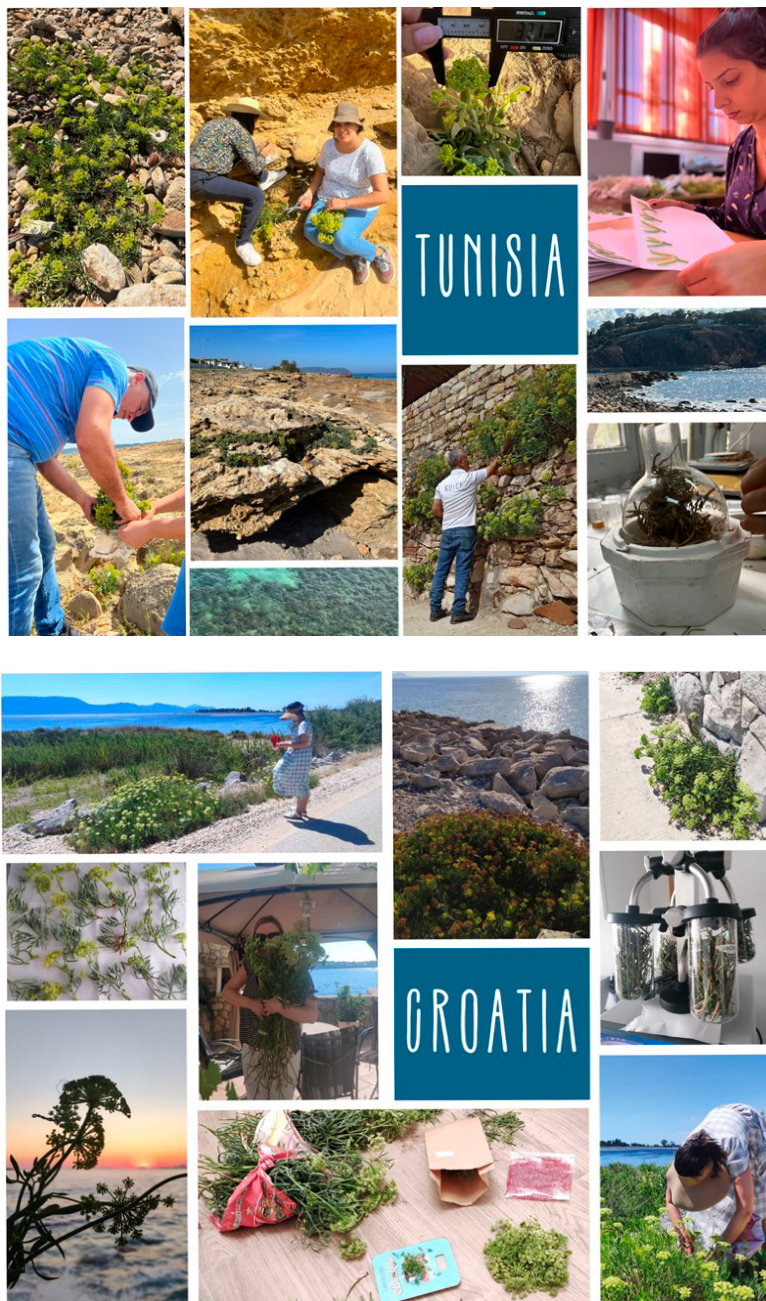
We will develop them for your needs!

Click the link below and fill the SEAFENNEL4MED first survey!

Languages available: ENGLISH, ITALIAN, ARABIC, FRENCH, TURKISH, CROATIAN

[STAKEHOLDER SURVEY INVITATION](#)







- NEWSLETTER#3
Sent 28_02_2023

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Dear All

have you ever wondered what's inside *C. maritimum*, commonly known as sea fennel, explaining its applications in manufacturing of functional foods and ingredients, nutraceuticals, cosmetics, and others?

The great potential of sea fennel relies on its high content in some bioactive compounds, exerting protective effects against oxidative stress and inflammation, in addition to a range of anti-inflammatory, anticancer, anti-aging, antibacterial, and antiviral activities.

These compounds include:

- phenolic compounds (e.g.: chlorogenic acids and rutin)

- essential oils (e.g.: sabinene, γ -terpinene, terpinene-4-ol, carvacrol, and thymol methyl ethers)
- fatty acids such (e.g.: linoleic and α -linolenic acids)
- essential amino acids
- vitamin C, E, A
- carotenoids
- minerals (e.g.: zinc, iron, magnesium, manganese, and copper)

The content of these bioactive composition varies according to:

- genotype
- habitats
- vegetative periods
- climate conditions nutrient
- deficiency
- salinity pest/predator attacks

An important objective of the SEAFENNEL4MED project (Work Package 6, Task 6.1) deals with the chemical and bioactive characterization of leaves and seeds collected from wild sea fennel populations sampled across the Mediterranean basin to select the best ecotype ever for production of functional foods and nutraceuticals.

The analysis for quantitative determination of carotenoids, tocopherols, vitamin C, phenolic compounds, fatty acids and essential oils are still ongoing in the food chemistry Labs of the Consortium Partners but the preliminary results collected onto the Croatian sea fennel populations have already been published in the renowned International Journal Plants, 2023, 12(1), 214; <https://doi.org/10.3390/plants12010214>



Article

Chemical Profiling of Sea Fennel (*Crithmum maritimum* L., Apiaceae) Essential Oils and Their Isolation Residual Waste-Waters

Olivera Politeo ^{1,*}, Marijana Popović ^{2,*}, Maja Veršić Bratinčević ², Kristina Kovačević ¹, Branimir Urljić ² and Ivana Generalić Mekinić ²

Briefly, the study aimed to investigate sea fennel essential oils (EOs) from different parts of sea fennel plants (flowers, leaves and stems) collected from Croatian wild populations and to

analysed the corresponding hydrodistillation by-products (residual water) to validate their potential use and application in different industries.

EOs were analyzed by gas chromatography coupled with mass spectrometry (GC-MS), while the phenolic profile of the residual water was analyzed by high-performance liquid chromatography (HPLC) and spectrophotometric methods.

The EO analysis confirmed the presence of 14 compounds, dominated by sabinene (from 42.55 to 51.47%) and limonene (from 36.28 to 43.58%), while among the 12 detected phenolics, chlorogenic acid and its isomers (cryptochlorogenic and neochlorogenic acid) were found in the highest concentrations.

Total phenolic, flavonoid and tannin contents were concentrated in the order flowers > leaves > stems. Although the sea fennel samples showed differences in chemical profiles, as a general rule, they were rich in bioactive compounds with relatively high amounts of key compounds with already proven good biological properties, especially in waste-water, thus indicating a great potential for re-use in accordance with green processing technology trends.

Sea fennel, the essence of sustainability!

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- NEWSLETTER#4
Sent 31_05_2023

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Dear All,

the sampling campaign of wild spontaneous sea fennel (*Crithmum maritimum* L.) populations planned in WP3 is finally over!

At https://www.google.com/maps/d/viewer?mid=1X_2nEZg8dw2dmdduyN6YHw5HN01cJTo&hl=it&usp=sharing you can now check out our interactive map to move into the sites where the sampled populations where located!

You might choose between 27 sites in 5 countries: Italy, France, Croatia, Tunisia, and Turkey all over the Mediterranean Sea.



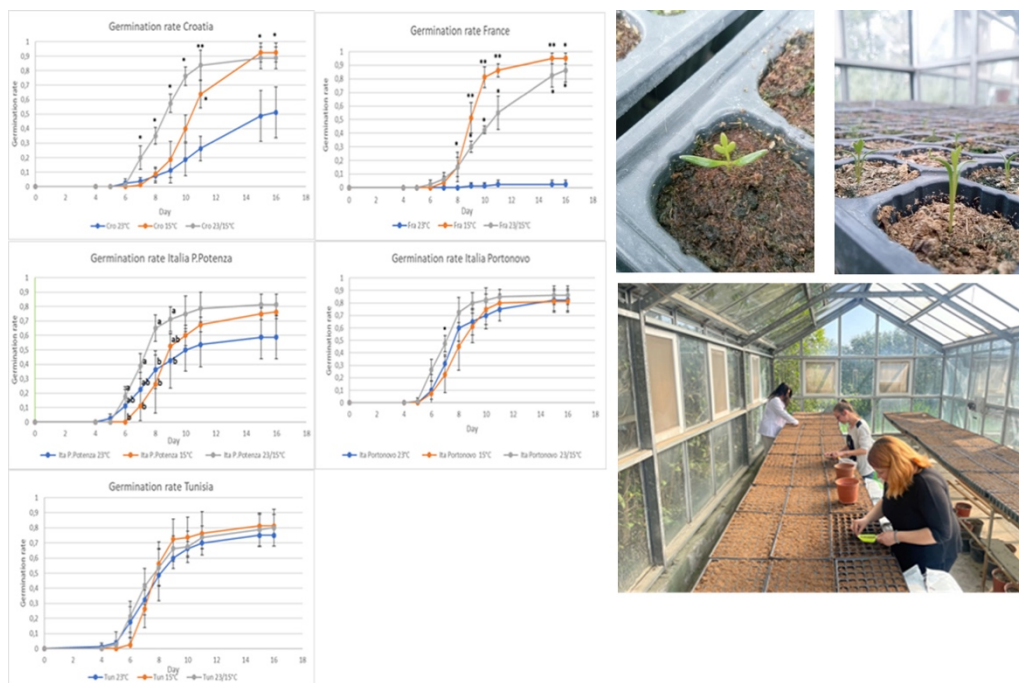
And now, let us present the most relevant outcomes achieved till today by the Consortium Partners! More than 50'000 seeds collected from the sampled wild sea fennel populations were catalogued and stored in the seed banks of the Consortium Partners.



Storing of sea fennel seeds

In parallel, leaves and flowering parts underwent chemical and genetic analyses aimed at identifying different ecotypes within the sampled populations.

Aliquots of seeds also underwent germination tests in either growth chamber or greenhouse, to evaluate the effect of different parameters (light, temperature) on the germination rate, which was attested for all the assayed populations at minimum 50%.



Results of germination tests of sea fennel seeds from different provenances

For WP4, seedlings are now ready for transplantation at the 4 demo fields set up by the Consortium Partners in Central Italy (Farm “Paccasassi del Conero” located in Camerano – Ancona – Italy 43_530 N, 13_550 E), Croatia (Institute for Adriatic Crops, Split), Tunisia (INRGREF site-Ariana-Tunisia 36.845610, 10.193484) and Turkey (Ege University, Faculty of Agriculture, Department of Field Crops, Bornova-Izmir/Turkey (38°27'06.0"N 27°13'31.9"E).

For WP5, the first 5 laboratory-scale prototypes of innovative foods produced with tender sea fennel leaves and stems from organic sea fennel crops have been produced in the last weeks, including:

- chili pure Harissa (traditional Tunisian dish) (A)
- orange jam added with sea fennel (B)
- noodles aromatized with sea fennel (C)
- kimchi-like preserve (D)
- sea fennel-based pickles (E)



Laboratory-scale prototypes of new sea fennel-based prototypes

Finally, regarding WP6, byproducts from the new sea fennel crop collected in Summer 2022 underwent extraction procedures for the obtaining of both essential oils and aqueous extracts with bioactive compounds following the procedure depicted below.



Preparation of freeze-dried extract from the by-products of the new crop of sea fennel.

More results and more foods are coming soon!
Sea fennel, the essence of sustainability!

- NEWSLETTER#5
Sent 31_08_2023

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Dear All,

maybe during your summer vacations you noticed some wild spontaneous populations of sea fennel (*Crithmum maritimum* L.) because it is widespread in the coastal areas of Southern and Western European countries, along the coasts of the Mediterranean Sea, North America, Central and Western Asia, growing spontaneously on cliffs, piers, gravel beaches, and rocky or sandy shores in the marine breeze!

You might also find it while reading masterpieces of international literature.....



But now, let's introduce you the most relevant outcomes to date achieved by our Consortium Partners, with a special focus on activities dealing with the assessment of the socio-economic

and environmental benefits of the proposed innovations, carried out with the work package (WP) 7 and 8, respectively.

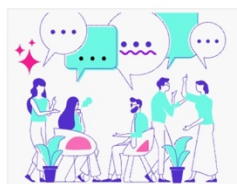
WP7 aimed to provide an evaluation of the socio-economic impact of sea fennel sustainable farming along the supply chain (farm to fork) in the context of a sustainable production approach. Within this WP, the consortium Partners started to identify the drivers and lock-ins for the development of sea-fennel products through a qualitative Delphi survey.

The first round of the Delphi expert survey was launched in June 2023 by UNIVERSITA' POLITECNICA DELLE MARCHE (UNIVPM, Italy) and UNIVERSITY OF EGE (UNIEGE, Greece).

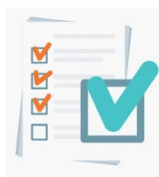
The survey aimed to collect expert opinions on the potential of sea fennel products in the Mediterranean region. To this end, an online questionnaire was prepared to open the subject and discover as wide a range of perspectives as possible. In total, 36 experts answered the questionnaire from all project countries with the help of the participating research teams. Analysis of the first round is continuing and soon the second round will start to allow experts to react to each other's assessment. The overall results of the Delphi survey will help to achieve a broad understanding of the constraints and lock-ins for the development of the market of sea-fennel products, the factors enabling this development as well as the potential socio-economic impacts on the value chain.



Which are the drivers and lock-ins of the market of sea fennel?



Group of experts involved in the Delphi first round questionnaire



Delphi first round questionnaire

For WP8, the main objective was the calculation of sustainability indices through the Life Cycle Assessment (LCA) method as defined by the ISO 14040 and ISO 14044 standards, using an updated SimaPro software application and associated LCA database. Different indices will be evaluated for the entire sea fennel supply chain including carbon footprint and water footprint.

To draft the sustainability assessment of:

- 1 Kg fresh sea fennel
- 1 Kg of packaged sea fennel preserve
- 1 g of sea fennel extracts

For each product (fresh sea fennel, packaged sea fennel preserve, and sea fennel extract), the team of agro-engineers working at UNIVPM has decided to consider the following aspects:

For fresh sea fennel:



- production of inputs used for sea fennel cultivation (fertilizers, plant protection products, seeds, seedlings);
- production of materials used for greenhouses, mulching, trays and substrates (peat or others);
- production of electricity and fuels used;
- production of auxiliary products used, if any;
- manufacturing of primary and secondary packaging, if applicable;

- transportation of inputs and materials to the cultivation field;
- amounts of inputs of energy and materials used for cultivation;
- direct emissions from sea fennel cultivation;
- preparation of the final product (before transportation);
- waste treatment of waste generated during manufacturing (e.g. mulching materials);
- production of agricultural machinery.
-

For sea fennel preserves LCA, the following aspects will be considered:



- Sea fennel cultivation
- Transportation from the field to the processing site
- Manufacturing of primary and secondary packaging, if applicable
- Transportation of inputs and materials (especially primary packaging) to the processing site
- Production of ingredients, preservatives, emulsifiers and additives used in the product,
- Production of auxiliary products used such as detergents for cleaning, refrigerating etc.
- Production of primary, secondary and tertiary packaging materials
- Amounts of inputs of energy (fuels, electricity) and materials (ingredients, preservatives, emulsifiers, additives) used for sea fennel preserves
- Cold chain operations
- Direct emissions from sea fennel processing
- Waste treatment of waste generated during processing and end-of-life packaging

For sea fennel extract:



- transportation of residues to the processing site;
- transportation of inputs and materials (if needed) to the processing site;
- amounts of inputs of energy (fuels, electricity) and materials used for extraction;
- direct emissions from processing;
- waste treatment of waste generated during processing.

More results about Delph survey round 2 and LCA assessments
are coming soon! Sea fennel, the essence of sustainability!

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- NEWSLETTER#6

Sent 10_01_2024

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Dear All,

the 2023 has just come to an end... Let's introduce you to the most relevant outcomes achieved by our Consortium Partners last year. Regarding WP1 (project coordination and management), the project general meeting n.3 took place on 22nd November 2023 at CREA - Centro di Ricerca Alimenti e Nutrizione (CREA-AN) to discuss and present the most relevant results after 18 months of project ongoing. The Principal Investigators (PI) and the research Team Members of the Partners of the SEAFENNEL4MED Consortium are presented in the photo below.

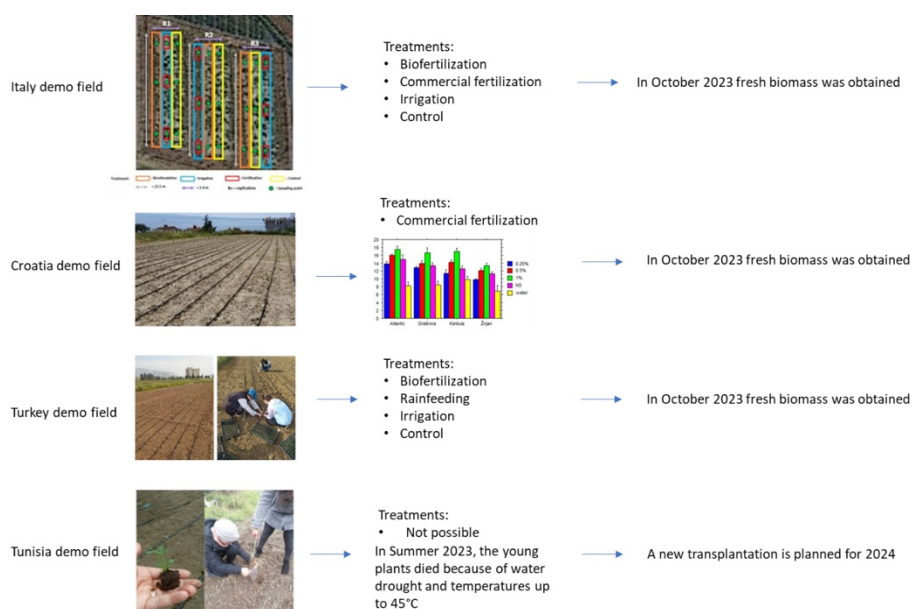


For WP2 (internal and external communication), the results to date achieved have been PRESENTED in:

- 6 scientific papers (check on our website)

- 6 conference proceedings
- 9 articles in divulgation journals/magazines
- 1 harvesting campaign of sea fennel
- 6 newsletters

Regarding WP3 (characterization of wild sea fennel populations) and WP4 (sustainable cultivation of organic sea fennel crops), the results of germination tests of seeds from spontaneous sea fennel populations under different conditions (16h/8h day/night photoperiod, daily temperatures: continuous 23°C, continuous 15°C, or 23°C/15°C alternance) suggest that the best conditions were 15°C for French seeds, 23°C/15°C alternance for Italian or Croatian provenances. In Spring 2023, seedlings were produced from seeds by all the Partners, except UNIVPM. Then, the available seedlings have been transplanted into the demo fields in all the countries involved in WP4, except for Italy, where this activity has been delayed to 2024. In Italy, onto 3-year-old sea fennel plants, field treatments were applied. The soil of the demo fields has been chemically characterized by almost all the involved partners.



In Croatia, further trials were also carried out to evaluate the effect of the pot volume on the biomass yield.



Regarding WP5 (manufacture of new sea fennel-based foods), the following prototypes of new fermented and unfermented food products were manufactured at laboratory scale using sea fennel as a key ingredient:

NEW FERMENTED SEA FENNEL FOODS

- Kimchi-like preserve (UNIVPM, ITALY)
- Pickled sea fennel (UNIVPM, ITALY)



NEW UNFERMENTED SEA FENNEL FOODS

- Dried spices (UNIVPM, ITALY- UNIST, CROATIA • Chili puree (Harissa) (INRGREF, TUNISIA) UNIEGE, TURKYE)



- Pickled sea fennel (UNIST, CROATIA)
- Jam aromatized with sea fennel (INRGREF, • Dalmatian patée (UNIST, CROATIA) TUNISIA)



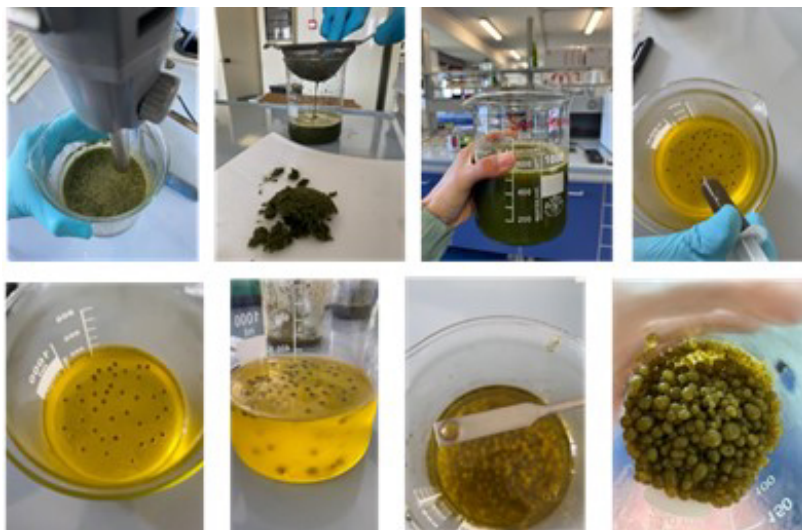
- Olive oils aromatized with sea fennel (UNIST, CROATIA)



- Extruded snacks (UNIEGE, TYRKYE)



For WP6 (valorization of waste from sea fennel crop), regarding the formulation of NEW FOOD INGREDIENTS, UNIVPM (Italy) explored the obtaining of water extracts from sea fennel to the production of seasoning edible capsules by spherification with sodium alginate (as pictured below).



In parallel, UNIST(Croatia) explored the production and analysis of essential oils.



Plant part	Target compounds	Detection method	Extraction method
Leaves	Phenolics EO components VOCs	HPLC-DAD GC-MS GC-MS	- Conventional extraction, Microwave-assisted extraction, Ultrasound-assisted extraction, Accelerated solvent extraction - Hydrodistillation, Microwave-assisted hydrodistillation - HS-SPME (Hydrolates)
Flower	Phenolics EO components/VOCs	HPLC-DAD GC-MS	Hydrodistillation (EOs, hydrolates, residual waste water)
Stems	Phenolics EO components/VOCs	HPLC-DAD GC-MS	Hydrodistillation (EOs, hydrolates, residual waste water)
Seeds	VOCs	GC-MS	HS-SPME

Regarding the formulation of NUTRACEUTICALS, the extracts (e.g. water and hydro-ethanolic extracts) obtained from sea fennel crop by-products were assayed by the partners involved for the following health-beneficial activities: (i) antioxidant activity; (ii) anti-tyrosinase activity; (iii), anti-elastase activity; (iv) anti-collagenase activity; (v) neuroprotection; (vi) anti-obesity activity; (vii) antidiabetic activity; (viii) anti-inflammatory activity (cytokine production by elicited cell lines).

Some of these extracts were also assayed for the:

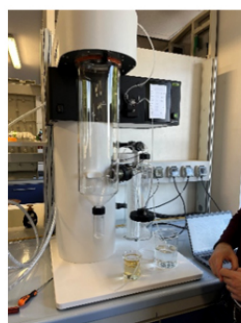
- manufacture of new spray-dried dietary supplement (for the sole water extract) (pictured below)



By-product



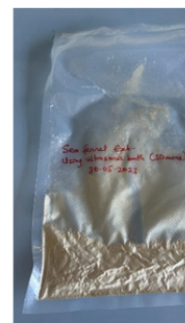
Extract



Spray-drying



Spray-dried extract + maltodextrin



- encapsulation of polar extract
- preparation of mucoadhesive oral films (oral strips)
- bio-enhancers evaluation

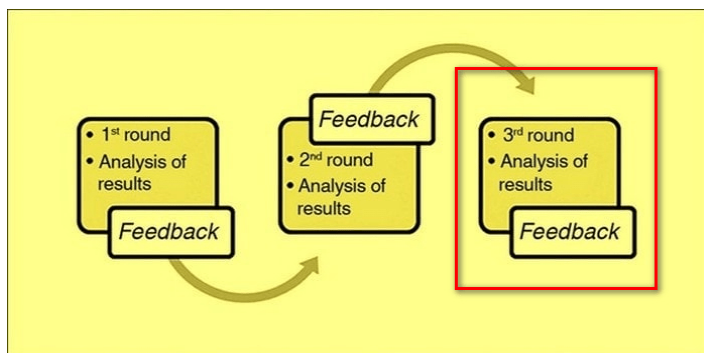
For WP7 (evaluation of economic sustainability), the first round of the Delphi expert survey was launched in June 2023. The questionnaire of the first round of Delphi was sent to 15 experts from Italy, 14 experts from France, 14 experts from Croatia, 15 experts from Turkey and 16 experts from Tunisia.

Finally, out of the total of 74 experts contacted, 48.65% returned the completed question form. 9 experts from Turkey, 6 experts from Croatia, 10 experts from Italy, 9 experts from Tunisia, 2 experts from France responded first round of the Delphi survey.

A total of 36 experts were surveyed. In the Delphi first round questionnaire: seven open-ended questions were asked.

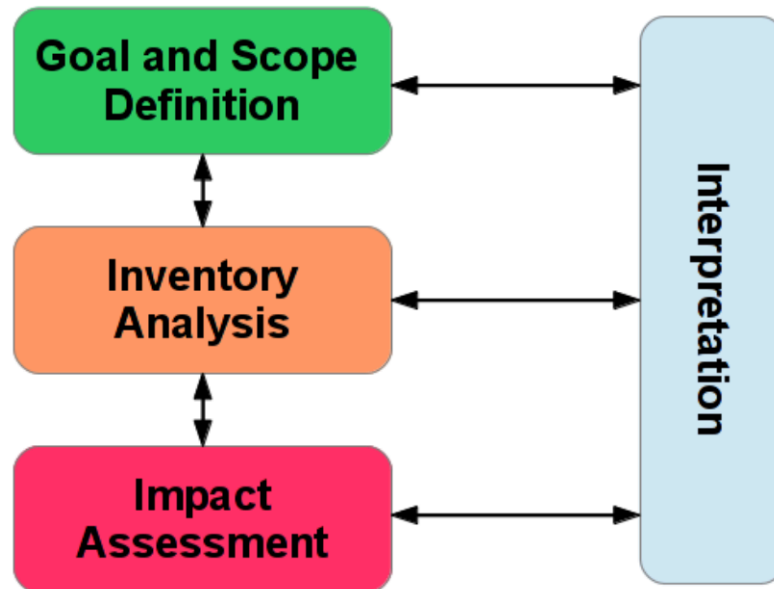
The data were collected via Qualtrics online survey website (Qualtrics software):

- Market research
- Customer satisfaction and loyalty
- Product and concept testing
- Employee evaluations
- Website feedback



Now, the study on the second round of the Delphi survey has started. Items were transformed into a structure that could be evaluated using a 5-point Likert-type scale. Currently, the second round Delphiexpert question form is finalized and started to be translated into each country's native language.

For WP8 (evaluation of environmental sustainability), for the environmental benefits of the proposed innovations, LCA interpretation is at its final step, LCA inventory analysis is ongoing while LCA definition of goal and scope has just started.



The preliminary results of the sustainability assessment of sea fennel open field production suggest that:

- Organic open-field cultivation of sea fennel has a relatively low environmental impact.
- The main contributing input (material) was the plastic mulch.
- Increasing plastic recycling rate can substantially reduce environmental impacts.
- Substitution with alternative mulches like soil biodegradable mulch may improve environmental performance. Other emerging environmental concerns, such as microplastic pollution are currently not included in the impact assessment models.



If you want to know more, ask us about specific topics! Sea fennel, the essence of sustainability!

We wish you a happy new year!!!



Follow us on our social network

- NEWSLETTER#7
Sent 07_06_2024

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Dear All,

the 2nd year of the project has just come to an end (30 May 2024).

Let's introduce you to the scientific papers and conference proceedings published by our Consortium Partners till now. Find useful information in our papers about:

- the morphological characterization of sea fennel wild populations
- vinegar to choose to produce vinegar-based sea fennel
- the best technique to dry sea fennel for producing novel spices
- the aroma definition of sea fennel -the best technique to isolate essential oils
- the extraction methods to produce aqueous, ethanolic and methanolic extracts
- the chemical characterization of sea fennel wild populations
- the chemical characterization of sea fennel by-products.

More is coming soon!

"A new agricultural plant for Azerbaijan: *Crithmum maritimum* L. (Apiaceae)" at the Republican Scientific-Practical Conference, dedicated to the 101st Birthday Anniversary of Nationwide Leader Heydar Aliyev, held in Ganja on May 14, 2024.



Azərbaycan Respublikası
Kənd Təsərrüfatı Nazirliyi
Azərbaycan Dövlət Aqrar Universiteti



Ümummilli Lider Heydər Əliyevin anadan olmasının
101-ci ildönümünə həsr edilmiş

“Ümumdünya Bitki Sağlamlığı Günü: Dayanıqlı Kənd Təsərrüfatında Bitki
Amili” mövzusunda

Respublika elmi-praktiki konfransın materialları

Gəncə, 14 may, 2024-cü il

Proceedings of the Republican Scientific-Practical Conference Dedicated to
the 101st Birthday Anniversary of Nationwide Leader Heydar Aliyev

“International Day of Plant Health: The Plant Factor in Sustainable
Agriculture”

Ganja, May 14, 2024

Материалы Республиканской научно-практической конференции,
посвященной 101-летию со дня рождения общенационального лидера
Гейдара Алиева

“Международный день охраны здоровья растений: растений фактор в
устойчивом сельском хозяйстве”

Ganja, 14 мая , 2024

DR. MIRZA GÖKGÖL INTERNATIONAL PLANT GENETIC RESOURCES SYMPOSIUM
İZMİR, TÜRKİYE, NOVEMBER 6-9, 2023

***Morphological Character Comparison of *Crithmum maritimum* L. (Apiaceae)
Populations with Different Substrate Characteristics in İzmir Province***

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Article

Vinegar-Preserved Sea Fennel: Chemistry, Color, Texture, Aroma, and Taste

Sanja Radman ¹, Petra Brzović ¹, Mira Radunić ^{2,3}, Ante Rako ⁴, Mladenka Šarolić ¹, Tonka Ninčević Runjić ², Branimir Urlić ⁴ and Ivana Generalić Mekinić ^{1,*}

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Article

Impact of Different Drying Methods on the Microbiota, Volatilome, Color, and Sensory Traits of Sea Fennel (*Crithmum maritimum* L.) Leaves

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CHARACTERIZATION OF THE AROMA OF ESSENTIAL OILS FROM SEA FENNEL (*Crithmum maritimum* L.) LEAVES AND CROP BY-PRODUCTS.



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INTRODUCTION

Sea fennel (*Crithmum maritimum* L.) is an aromatic plant that grows spontaneously in coastlines, especially in several Mediterranean countries. Sea fennel is a **halophyte plant** whose cultivation is attracting increasing interest in the context of the **halophyte agriculture** expansion, as diminishing freshwater resources put pressure on civilization to utilize the vast saline soils and aquifers.

A lot of traditional culinary uses of sea fennel leaves are reported in many European countries, mainly thanks to its peculiar sensory traits and to its essential oil. However, the application of essential oil extracted from this plant in the food sector has not yet been fully exploited. **Essential oils** may be obtained from sea fennel **edible leaves**, **flowers** as well as from **residual biomass** from crop cultivation cycle, such as damaged or discarded aerial parts, seeds, flowers and autumn mowing. At present, a detailed characterization of key odorants of sea fennel essential oil has not been given yet, whereas, few information is available about the chemical composition and sensory properties of the essential oil obtained from crop cultivation by-products. Thus, the aim of this study was to provide a preliminary characterization of the aroma of essential oils obtained from sea fennel leaves, flowers and residual biomass from crop cultivation cycle.



Article

Vinegar-Preserved Sea Fennel: Chemistry, Color, Texture, Aroma, and Taste

Sanja Radman ¹, Petra Brzović ¹, Mira Radunić ^{2,3}, Ante Rako ⁴, Mladenka Šarolić ¹, Tonka Ninčević Runjić ², Branimir Urlić ⁴ and Ivana Generalić Mekinić ^{1,*}

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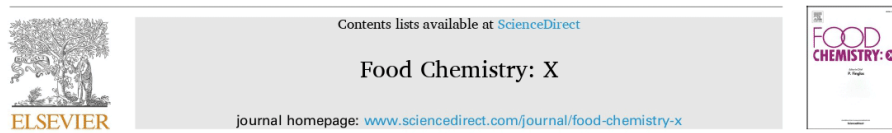


Sea fennel (*Crithmum maritimum* L.) leaves and flowers: Bioactive compounds, antioxidant activity and hypoglycaemic potential

Ancuta Nartea^a, Oghenetega Lois Orhotohwo^a, Benedetta Fanesi^a, Paolo Lucci^a, Monica Rosa Loizzo^b, Rosa Tundis^b, Lucia Aquilanti^a, Simona Casavecchia^a, Giacomo Quattrini^a, Deborah Pacetti^{a,*}

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The alphabet of sea fennel: Comprehensive phytochemical characterisation of Croatian populations of *Crithmum maritimum* L.

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Article

A Year in the Life of Sea Fennel: Annual Phytochemical Variations of Major Bioactive Secondary Metabolites

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Article

Volatiles from French and Croatian Sea Fennel Ecotypes: Chemical Profiles and the Antioxidant, Antimicrobial and Antiageing Activity of Essential Oils and Hydrolates

Olivera Politeo¹, Pavao Ćurlin¹, Petra Brzović², Killian Auzende³, Christian Magné^{3,*} and Ivana Generalić Mekinić^{2,*}

Article

Conventional vs. Microwave-Assisted Hydrodistillation: Influence on the Chemistry of Sea Fennel Essential Oil and Its By-Products

Olivera Politeo ^{1,*}, Marijana Popović ², Maja Veršić Bratinčević ², Petra Koceić ³, Tonka Ninčević Runjić ⁴ and Ivana Generalić Mekinić ^{3,*}



If you want to know more, visit our site! Sea fennel, the essence of sustainability!

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- NEWSLETTER#8
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Dear All

the 5th general meeting of the project SEAFENNEL4MED scheduled for 13rd December 2024 is approaching, but in the meanwhile to meet again, let's see some interesting results and achievements of the research activities presented at the 4th General Meeting held in Izmir (Smirne), Türkiye, on 24th May 2024!



Figure 1. Attendants at 4th General Meeting of SeaFennel4Med, in Izmir (Smirne), Türkiye, hosted by Ege University.

Regarding WP3 dealing with the morphometric and genetic characterization of Mediterranean wild sea fennel populations, chemical characterization has been completed, and several papers summarizing these results have been published (<https://seafennel4med.com/publications/>). Morphological data are under evaluation for the comparison of sea fennel wild populations in all Consortium countries (Tunisia, Italy, Türkiye, France and Croatia). From the preliminary comparisons of morphometric data, researchers found that the most different populations are those from Sicily, Calabria, Tuscany and Corsica Island (France).

About the populations of *C. maritimum* sampled Türkiye, the population growing on limestone bedrock (Figure 2) showed the lowest average values in terms of basic morphological characters. In the light of these data, it can be hypothesized that different substrates might provide advantages for the better development of different *C. maritimum* characters.

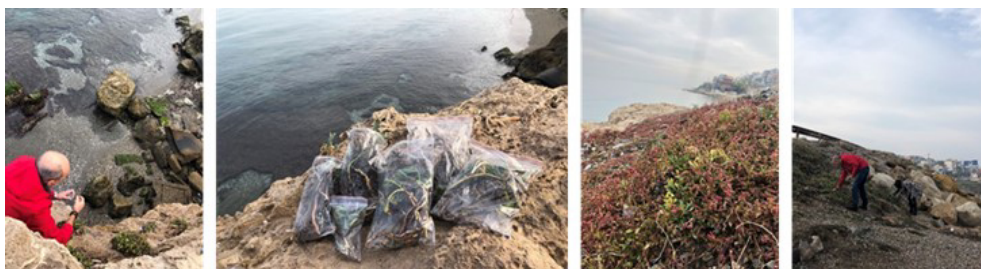


Figure 2. Urla population in Türkiye

For the Atlantic populations (sampled in Bretagne, France), little variations were observed between the 3 populations. Except for some items, individuals from Landunvez are taller, have more umbels and more branches (Figure 3).



Figure 3. Bretagne, France

Molecular analysis and DNA extraction of sea fennel aerial parts is going on (Figure 4)!



Figure 4. DNA extraction for molecular analysis

For WP4 dealing with the sustainable production of organic sea fennel crop in field, good results were obtained even with climatic challenges that our researcher faced.

Seedlings production was successful in: ITALY, TURKYIE, CROTIA, TUNISIA. Field transplanting was successful in CROTIA (Figure 5), ITALY (Figure 6), TURKYIE (Figure 7) and during summer 2024 the first harvest onto 1-year old crop was performed. TUNISIA cultivation failed due to high temperatures recorded, hence the cultivation will be renewed in the coming months. Based on this evidence, irrigation after planting as well as emergency irrigation during prolonged drought periods is a must!



Figure 5. Sea fennel crop production in Croatia



Figure 6. Sea fennel crop production in Italy



Figure 7. Sea fennel crop production in Türkiye

Biostimulation effects on *Crithmum maritimum* L. root development was investigated in controlled environments (see for more details the newly published paper : <https://journals.tubitak.gov.tr/agriculture/vol48/iss4/10/>). Biostimulants can be used in sustainable agriculture as they are regarded as inputs with minimal environmental impact. When applied to the root systems of certain plant species, microbial inoculants confer physiological and morphological benefits to the entire plant. The present study suggests the potential use of biostimulants during the nursery phases of sea fennel crop production. Check the publication on our website (www.seafennel4med.com) for more information.

For WP8, life cycle assessment of open field sea fennel production(Figure 9) was evaluated concluding that: (i) life cycle impacts are assessed for open-field sea fennel cultivation in Italy; (ii) cultivation does not require irrigation and agro-chemicals; (iii) the climate change score was 6.81E-02 kg CO₂ eq./kg fresh sea fennel; (iv) fossil-based plastic mulch is the major hotspot for climate change; (v) increasing the plastic recycling rate improves environmental performance.

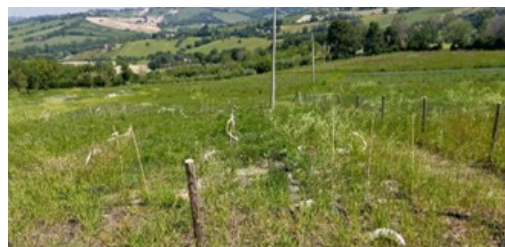
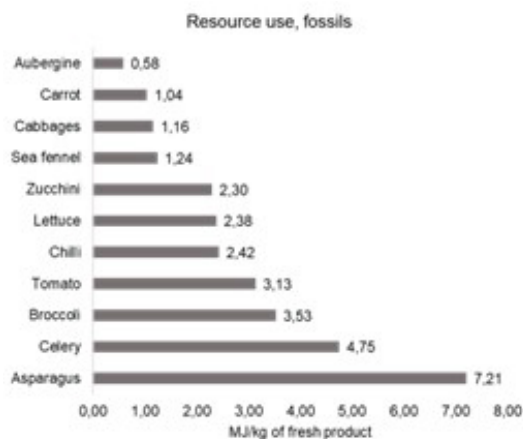


Figure 9. Open field cultivation of sea fennel





If you want to know more, visit our site!
Stay tuned for new foods (WP5), new foods ingredients (WP6)
and the socio-economic impact (WP7) of sea fennel-based
products!

Sea fennel, the essence of sustainability!

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- NEWSLETTER#9
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Dear All

Are you hungry? Are you ready to test the new sea fennel-based foods and to profit from the new business opportunities of Seafennel4Med results?

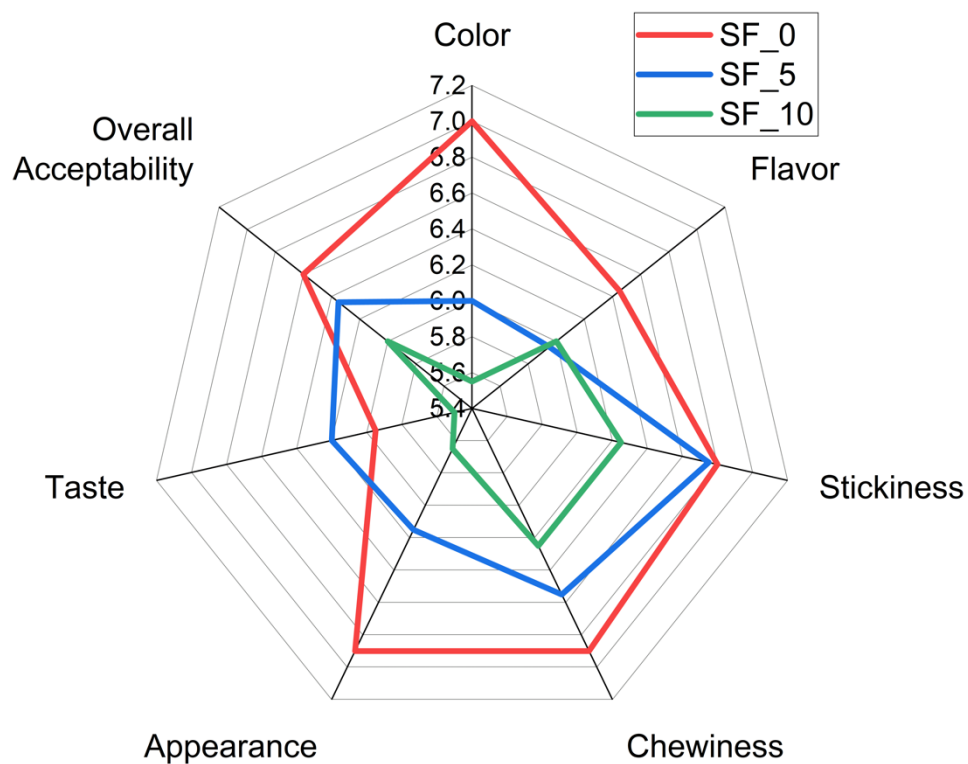
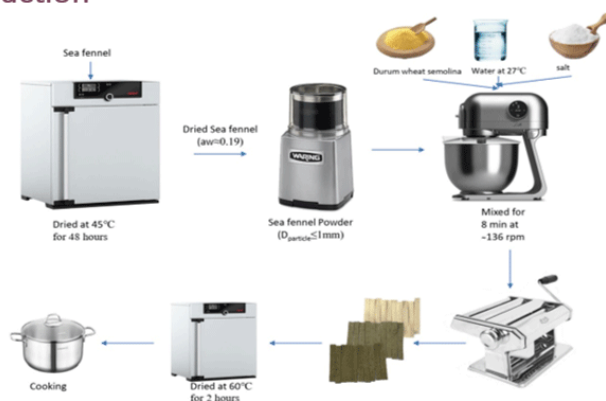
Let's see some interesting results and conclusions of the research activities carried out in the last weeks!

Dried spices formulated with blends of sea fennel and other Mediterranean aromatic herbs (sea fennel and rosemary, fennel, bay laurel). Food models- oxidative stability are on-going.



Hand-made pasta was developed with 5 and 10% of sea fennel powder.

Hand-made Pasta Production



Snacks obtained by extrusion from doughs made with sea fennel.

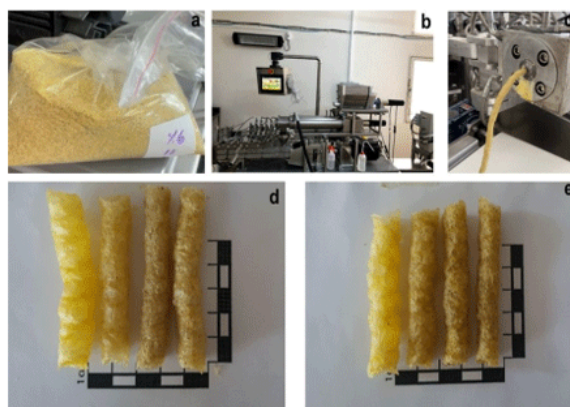
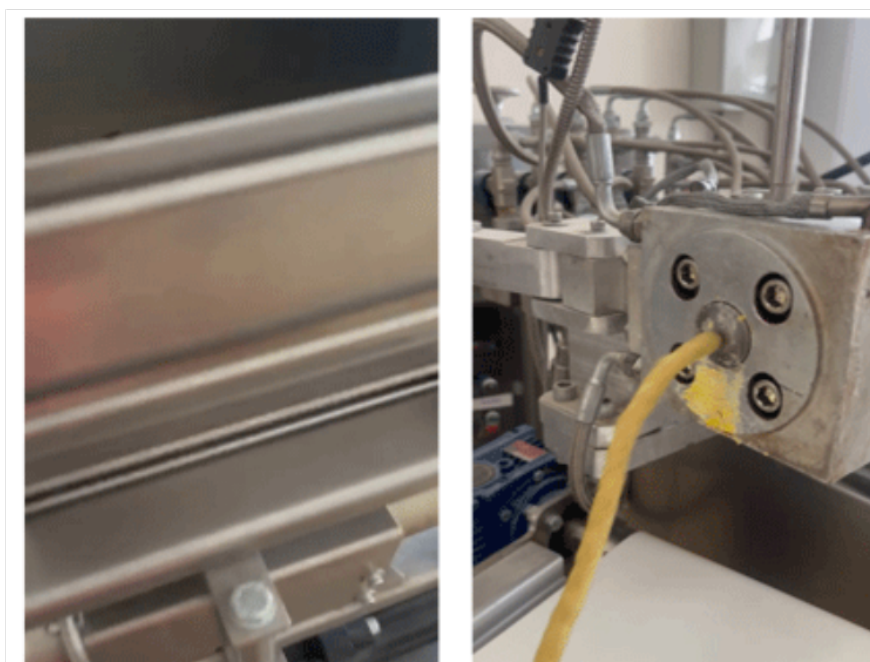


Figure 1. Processing steps of sea fennel added extruded snacks:

- a) composite flour ,
- b) extruder,
- c) exit of the die during extrusion process,
- d) the picture of extruded product with 16% moisture content with substitution of 0, 2, 4, and 6% sea fennel powder, respectively,
- e) the picture of extruded product with 18% moisture content with substitution of 0, 2, 4, and 6% sea fennel powder, respectively

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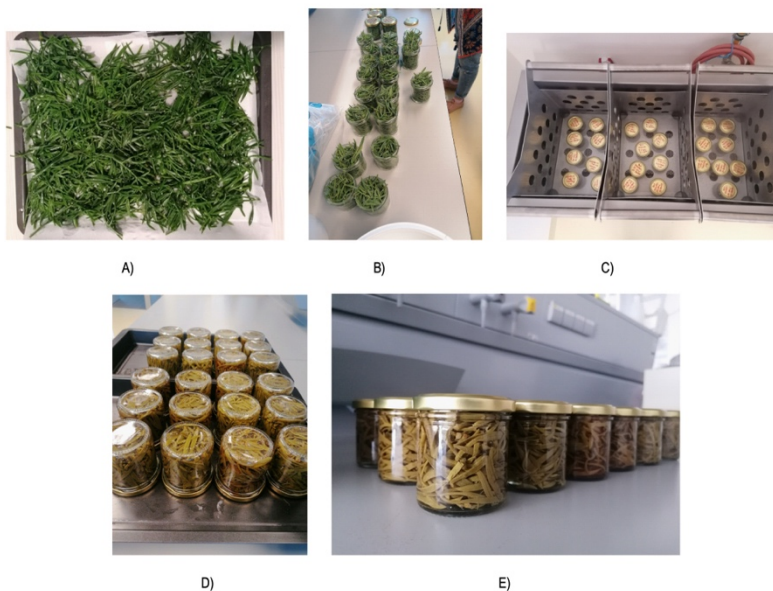


Molecular analysis and DNA extraction of sea fennel aerial parts is going on (Figure 4)!

For fermented foods, kimchi prototypes are prepared with sea fennel sprouts.



Pickled sea fennel, developed using 3 different types of vinegar (apple-cider, red wine, alcoholic vinegar) in different proportions and added with 3% salt and 2% sugar.



Processing steps of vinegar preserved sea fennel: A) plant material preparation, B), filling jars, C) pasteurization, D) cooling, E) final products

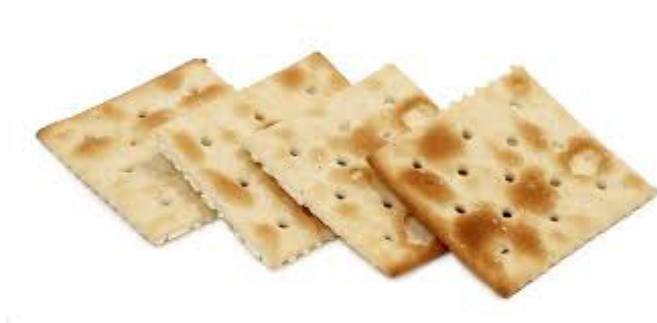
In Chili puree formulation sea fennel was used as salt replacer. The formulation of chili puree was made based on a popular traditional Tunisian recipe. The main ingredients used were dried pepper (50%), garlic (35%), mixture of salt, coriander, and caraway (15%).



In Orange jam sea fennel was used as preservative at different percentages and no problem was encountered during the formulation. Sea fennel was incorporated as a powder at different doses (0.5%, 1%, 1.5% and 2%) with the aim of assessing the effect of sea fennel on the stability and the taste of the orange jam. Analyses of stability, expiry date and microbiological analyses were carried out.



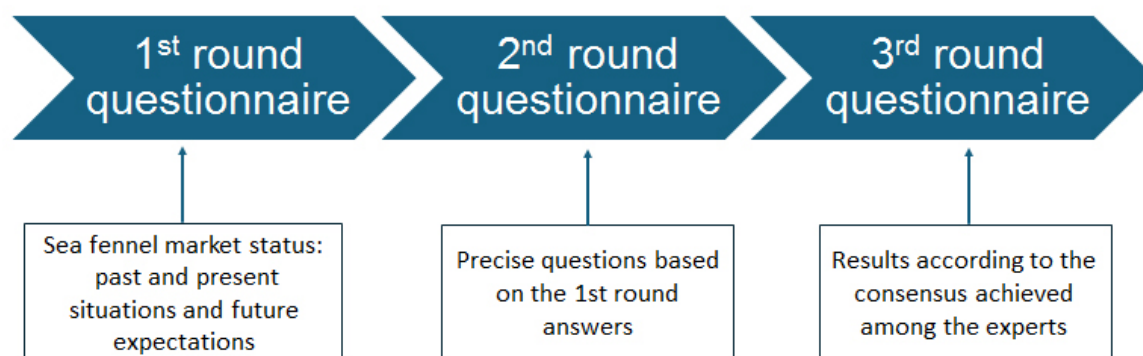
Salted biscuits produced with dried sea fennel powder.



And now, the results and activities dealing with the evaluation of consumer attitudes and acceptance towards sea-fennel-based food products and new business models.

The expert survey is concluded. The Delphi survey conducted to understand drivers and lock-ins of the sea fennel product market in the Mediterranean Region was concluded with the participation of around 30 experts from all the Consortium countries. The results of Delphi showed that in all countries representing the Mediterranean Region, the sea fennel market is not developed yet. Consumers do not know about sea fennel; therefore, the demand is limited. There are only a few processors working and investing in sea fennel products. However, the tendency to consume natural and local products can be an advantage to introduce this plant to the consumers.

Three-phase Delphi study with the experts from partner countries: **Croatia, France, Italy, Turkey, and Tunisia**. The experts represent different value chain actors such as farmer associations, producers, and traders as well as researchers.



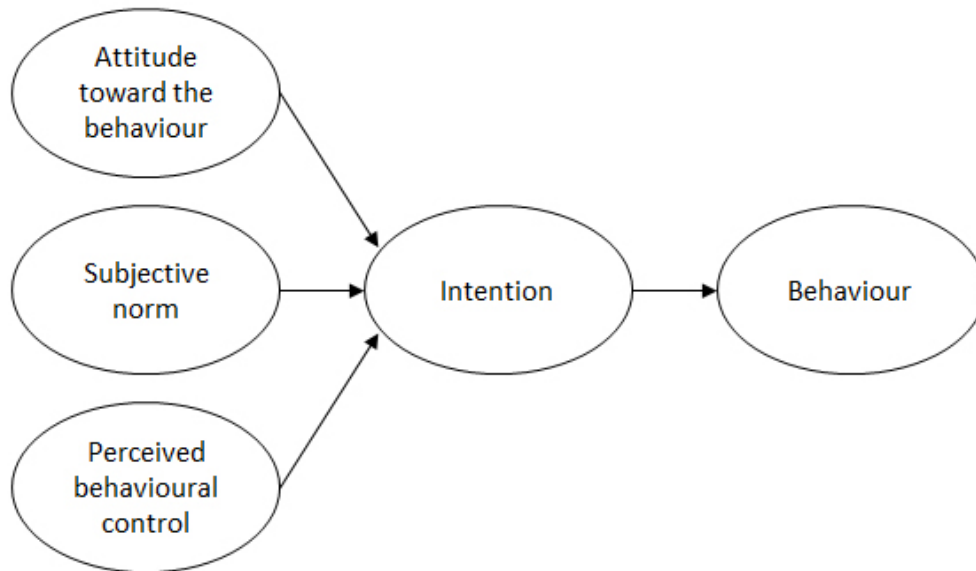
The steps of the Delphi method used in the project

The actions that are suggested for market development are;

- promotions of the sea fennel products,
- development of favorable agricultural and rural policies,
- focus on more research and development activities, and
- strong cooperation among the stakeholders.

Respecting the natural environment and the characteristics of sea fennel, and promoting its sustainable cultivation are crucial for market development.

A consumer survey was conducted in five countries, Croatia, France, Italy, Tunisia, and Turkey, with the participation of 1042 consumers in total. The aim was to explore consumer attitudes and acceptance of sea-fennel-based food products. The core of the survey is based on the Theory of Planned Behaviour Model (Ajzen, 1985). Accordingly, the intentions of people to perform or not to perform a behavior can be used to predict their behavior.



The original Theory of Planned Behaviour (TPB) model

The questionnaire was developed in English and translated into the relevant national languages of the Consortium partners. The data were collected from mid-August to mid-September 2023 on the Qualtrics platform in cooperation with a third party Cint International. Data collected is analyzed by using structural equation modeling (SEM) to investigate the drivers influencing the behavioral intentions and the level of acceptance of sea fennel products by consumers. The results will be published soon.

Alternative business models for the development of the sea fennel supply chain were also evaluated. For this task, a participatory approach will be used by involving the stakeholder's platform in an online workshop. Osterwalder's business model canvas (BMC) approach will be taken as a guideline to conceptualize and analyze inputs provided by the stakeholders.



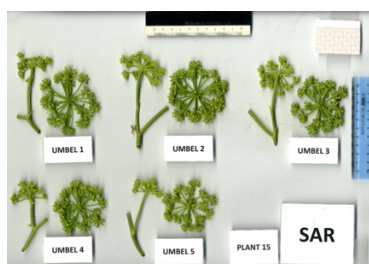
Dear All,

The 5th general meeting of the SEAFENNEL4MED project took place in Brest on December 13, 2024. We are excited to share some interesting results from the project!



Figure 1. Attendants at 5th General Meeting of SeaFennel4Med, in Brest, France, hosted by UNIBRE.

Regarding WP3 – The morphological characterization of wild sea fennel populations in all Consortium countries (Tunisia, Italy, Türkiye, France, and Croatia) has been completed, and statistical data analysis is ongoing.



Scanned umbels and leaves of wild sea fennel populations on a 600dpi scanner.

The chemical characterization of carotenoids, tocopherols, phenolic compounds, fatty acids, and volatile organic compounds has yielded significant findings.

- **Fatty Acid Composition:** Different parts of the sea fennel plant (leaves, flowers, and seeds) have distinct fat compositions:
 - Flowers are rich in polyunsaturated fatty acids, particularly omega-6.
 - Leaves contain high levels of omega-3, known for their anti-inflammatory properties, cardiovascular benefits, and support for brain function.
 - Seeds exhibit a high content of monounsaturated fatty acids, which contribute to heart health and cholesterol regulation.
- **Antioxidant Properties:**
 - The most abundant carotenoid in all tested samples was xanthophyll lutein, followed by β -carotene and neoxanthin.
 - Sea fennel samples from the Croatian Adriatic coast contained α -, β -, and γ -tocopherol isomers, with alpha-tocopherol concentrations significantly higher in leaves than in flowers.
- **Volatile Profile:**

- 42 volatile organic compounds (VOCs) were identified in the flowers and leaves using HS-SPME analysis.
- Some populations (MAR, CON, and APU) exhibited over 90% monoterpene hydrocarbons in their volatile fraction, while others displayed a more balanced profile with a significant presence of oxygenated monoterpenes.

Regarding WP4, (Sustainable production of sea fennel crop in demo field), to optimize sea fennel cultivation in organic farms, the following guidelines are recommended:

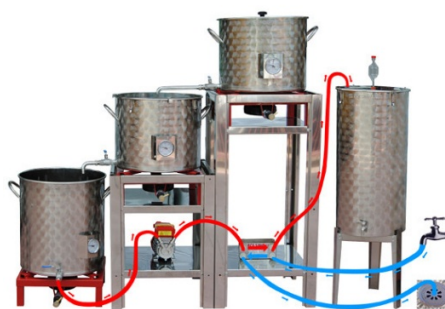
- **Soil Preparation:** Traditional ploughing (40 cm) or two-layer tillage (20 cm) followed by harrowing to prepare a suitable seedbed for transplanting.
- **Mulching:** Use of biodegradable mulch to retain soil moisture and suppress weeds.
- **Seedling & Transplanting:** Seeds are sown in greenhouses at 20°C in biodegradable pots with a topsoil-peat mix (50:50). Seedlings are transplanted in February-March at 0.45m x 0.45m spacing.
- **Weed Control:** Manual weeding ensures environmental sustainability without chemical inputs.
- **Fertilization:** Application of biostimulants and biofertilizers, aligned with organic farming regulations, enhances root growth, biomass production, and chlorophyll levels.
- **Irrigation:** Though drought-tolerant, emergency irrigation is essential in prolonged dry spells.
- **Harvesting:** Edible biomass should be harvested before flower buds open for optimal quality.

With these sustainable practices, organic sea fennel cultivation can thrive, supporting both environmental and economic sustainability in the Mediterranean region.

Regarding WP5, Sea fennel adds distinctive herbal notes to the beer, offering a new taste experience for craft beer enthusiasts. Enhancing flavor complexity and potential health benefits, this innovation fits in with the growing trend of botanical-based and sustainable beverages!

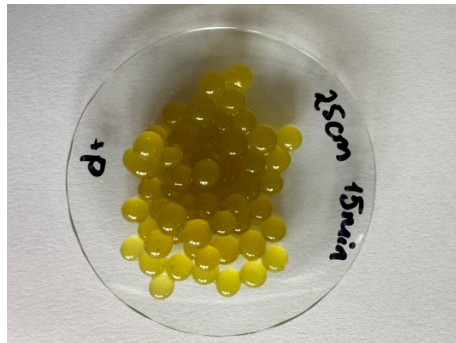


a) Sea fennel extract enriched beer samples



b) Pilot brewing plant

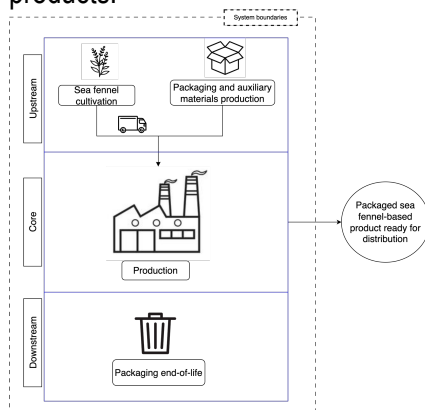
For WP6 (valorization of sea fennel by product), regarding the formulation of FUNCTIONAL FOOD INGREDIENTS AND NUTRACEUTICALS, UNIVPM (Italy) explored the obtaining of ethanol:water extract from sea fennel to the production of seasoning edible capsules by spherification with sodium alginate (as pictured below). Best capsule formulation was identified according to the encapsulation efficiency (%) of phenolic compounds.



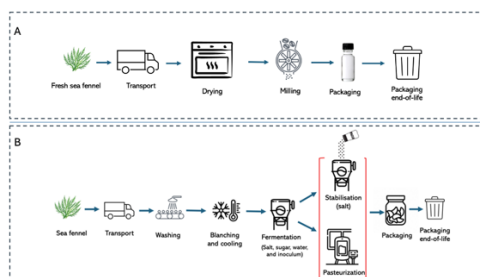
Regarding WP7, A recent study across Italy, France, Croatia, Tunisia, and Turkiye examined consumer awareness and acceptance of sea fennel products. Findings revealed **low awareness**, with 54% of respondents unfamiliar with sea fennel. However, when informed, consumers viewed it **positively**—81% recognized it as **natural**, 77% as **healthy**, and 69% as **sustainable**.

To boost demand, strategies should focus on **increasing availability**, **developing diverse product options**, and **enhancing marketing efforts** through tastings, expert endorsements, and social media campaigns. Peer influence plays a crucial role in purchase decisions, emphasizing the need for **word-of-mouth promotion** and **consumer engagement**.

Regarding WP8 (Sustainability assessment of new sea fennel-based foods/food ingredients), once the new organic crops became available, they were processed to produce pilot-scale prototypes of new sustainable foods or food ingredients. These prototypes were subsequently subjected to various tests to assess their nutritional, sensory, and functional properties. The Life Cycle Assessment (LCA) of these new sea fennel foods is focused on the abovementioned trials because the scale is the same as the commercial situation, and the environmental sustainability indicators are more consistent and comparable to other studies on similar products.



The system boundary considered for the new sea fennel-based products.



System boundaries and production stages for sea fennel spice (A) and fermented pickled sea fennel (B).

A Life Cycle Assessment (LCA) of **sea fennel spice and fermented pickles** highlighted key environmental impacts. **Glass packaging** was the largest contributor, but using refillable glass with lightweight plastic sachets reduced impact by **44%**. Switching to **solar energy** lowered energy use by **11%**, though with resource trade-offs.

For pickles, **pasteurization** reduced refrigeration needs, improving sustainability for transport but increasing water use—highlighting the need for **water efficiency**. Packaging tweaks, like **lighter lids**, also improved environmental performance. These findings guide the **eco-design of sustainable sea fennel products**.

NEW PUBLICATION ALERT!

We are delighted to announce that a new book chapter is now available and accessible for free on our website: seafennel4med.com in publications section.



Chapter

Adaptation of the Chasmophyte *Crithmum maritimum* to High-Salinity Conditions

Ivica Blažević, Azra Đulović, Franko Burčul, Josip Tomaš,
Petra Brzović, Sanja Radman, Olivera Politeo
and Ivana Generalić Mekinić

Overview of the Book Chapter:

Halophytes, naturally salt-tolerant plants, possess unique characteristics allowing them to thrive in high-salinity environments. This review examines the salt tolerance mechanisms of *Crithmum maritimum* L. (sea fennel), highlighting strategies such as:

- Accumulation of osmolytes (proline and glycine betaine) to maintain cellular stability under saline conditions.
- Enhanced antioxidant enzyme activity (superoxide dismutase, catalase, peroxidase) to mitigate oxidative stress.

- Presence of secondary metabolites (phenolic acids, flavonoids, and carotenoids) that improve resilience and stability.
- Alterations in fatty acid composition, including increased linoleic acid, which enhances membrane stability.
- Variability in essential oil composition under salt stress, demonstrating its potential in nutraceutical and agricultural applications.

These findings reinforce the importance of sea fennel in saline agriculture, offering sustainable solutions for food security and resilience in salt-affected soils.

UPCOMING FINAL MEETING!

We are pleased to announce that the **6th and final SEAFENNEL4MED meeting** will take place at the **University of Split, Croatia on April 10-11, 2025**. We look forward to sharing the latest updates with you following this event!

If you want to know more, visit our site!
Stay tuned for publications, video, sea fennel recipes and meetings.

Sea fennel, the essence of sustainability!

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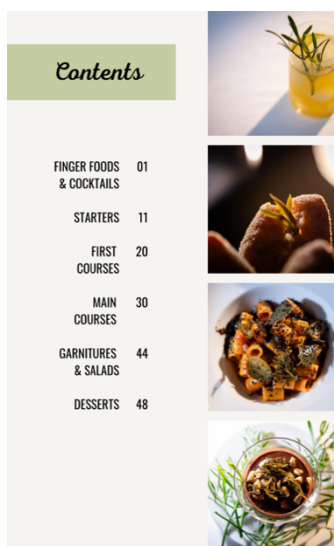


Exciting News!

We're thrilled to announce the release of our new **Sea fennel cookbook**, a delightful journey through the flavors of **Italy, Turkiye, Tunisia, and Croatia**, all starring the versatile sea fennel! 🌿



This



book



features a variety of traditional and innovative dishes from each country, celebrating the unique taste and health benefits of sea fennel in every bite. The complete version will soon be on store shelves, but a short version is accessible online (seafennel4med.com)!

Get ready to explore these vibrant, mouth-watering recipes and bring a touch of Mediterranean magic to your kitchen!

If you want to know more, visit our site!
Stay tuned for publications, video, sea fennel recipes and meetings.
Sea fennel, the essence of sustainability!

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Dear All,

The **6th General and final meeting** of the SEAFENNEL4MED project took place in **Split, Croatia**, on **April 10, 2025**, hosted by **UNIST**.



Attendants at the 6th General Meeting of SeaFennel4Med, Split, Croatia

This final meeting brought together all our project partners to present the outcomes of each work package carried out throughout the project. In most cases, our work even exceeded the initial expectations — reaching more than 100%! Here's a closer look at our achievements:

For WP2 (internal and external communication), the results to date achieved by each project partner have been presented through:

	 UNIVPM	 CREA-AN	 UNIST + IACKR	 UNIBRE	 INGREF	 UNIEGE	TOTAL
Press releases	1		3		5	2	11
Publication in divulgation journal/magazine	7		4				11
Open access publication in international peer-reviewed journal	7	1	11	2	1		22
Contribution at national/international conferences	9	3	12			4	28
Attended event/exhibition	2		7		1		10
Video	3						3
Workshop	1	1	1	1	1	1	6
Interview			2		2		4

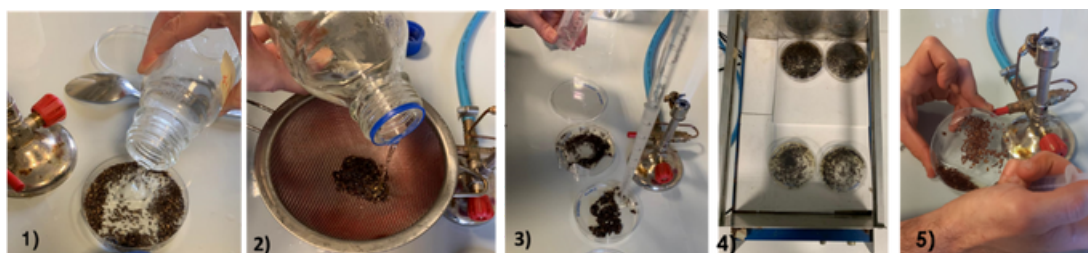
WP3: Morphological & Genetic Characterization

Sea fennel populations were studied across **Tunisia, Italy, Türkiye, France, and Croatia**, focusing on:

- **Morphological variation** – influenced by coastal environment (cliffs, volcanic rock, beaches) and substrate (granite, limestone, dolomite).
- **Genetic diversity** – shaped by geographical isolation and environmental stressors (temperature, salinity, soil).
- **Chemical composition** – variation in bioactives (phenolics, essential oils, vitamins, fatty acids) linked to genotype, habitat, climate, and biotic/abiotic stresses.

Regarding WP4, Seedlings were successfully cultivated and transplanted into **demo fields**.

•



Procedure for bacterization of sea fennel seeds

Biostimulant effect on sea fennel spontaneous ecotypes was studied and the variables were measured in controlled environments such as:

1. Incubator
2. Greenhouse
3. Open field

Biostimulant increased:

Root weight (+85%), diameter (+25%), and length (+128%) in the incubator

Root weight (+66%), diameter (+25%), and length (+75%) in the greenhouse

In the open field, BS boosted biomass (+93%) and SPAD values (+44%), indicating a more favourable nutritional status.

Fresh biomass harvested from new **organic sea fennel crops** during the 2023 and 2024 growing seasons showed promising results, especially with the use of biological fertilizers. Analysis of the **edible aerial parts** from three different sea fennel populations revealed a **19% increase in average biomass** in plots treated with a biostimulant. Plants in these plots yielded an average of **191 grams per plant**, compared to **160 grams per plant** in the untreated control plots. These findings underscore the effectiveness of biostimulant application in enhancing yield and sustainability in sea fennel cultivation.



Harvesting of sea fennel

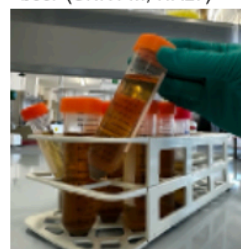
Regarding WP5, the following prototypes of new fermented and unfermented food products were manufactured at laboratory scale using sea fennel as a key ingredient:

NEW FERMENTED SEA FENNEL FOODS

- Kimchi-like preserve (UNIVPM, ITALY)
- Pickled sea fennel (UNIVPM, UNIST)



- Sea fennel extract enriched beer (UNIVPM, ITALY)



NEW UNFERMENTED SEA FENNEL FOODS

- Dried spices (UNIVPM, ITALY- UNIST, CROATIA • Chili puree (Harissa) (INRGREF, TUNISIA) UNIEGE, TURKIYE)
- Hand made pasta (UNIEGE, TURKIYE)



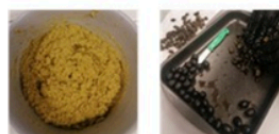
- Noodles with sea fennel (UNIEGE, TURKIYE)
- Jam aromatized with sea fennel (INRGREF, TUNISIA)
- Dalmatian patée (UNIST, CROATIA)



- Olive oils aromatized with sea fennel (UNIST, CROATIA)



- Extruded snacks(UNIEGE, TYRKIYE)

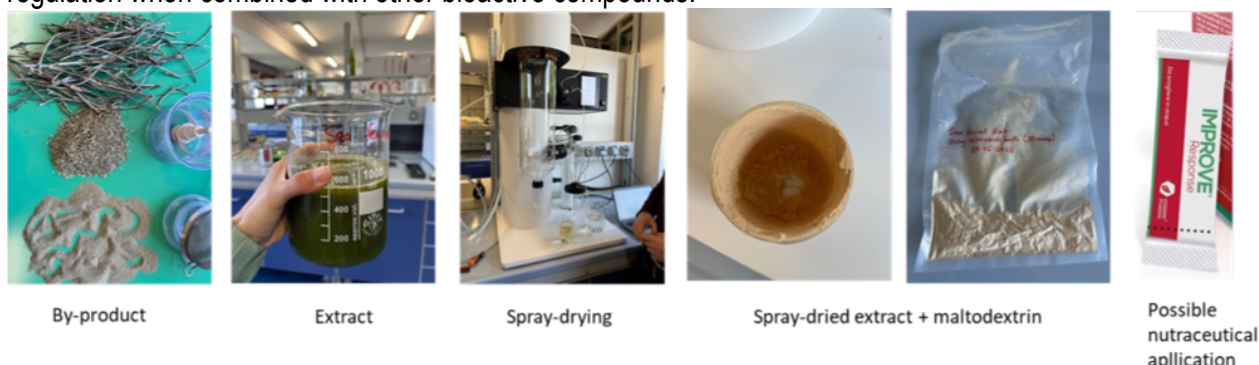


Products made with sea fennel are presented on 6th general meeting, UNIST, Croatia

As part of WP6 – Valorization of Sea Fennel By-products – the SeaFennel4Med project partners have made significant strides in developing innovative applications for sea fennel by-products across multiple industries.

Extract

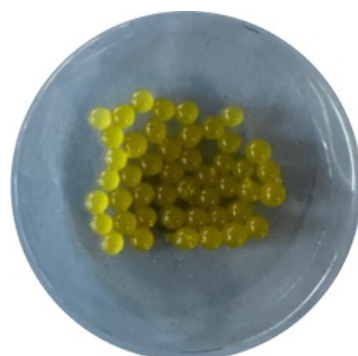
Encapsulation of aqueous sea fennel extract via spray-drying achieved an impressive **85% encapsulation efficiency**, indicating strong potential for applications in oxidative stress reduction and blood sugar regulation when combined with other bioactive compounds.



Croatian researchers investigated various extraction methods and found that a **1:1 ethanol–water mixture** was the most effective solvent for extracting phenolic compounds. Furthermore, **microwave-assisted extraction** showed the highest yield of phenolics, making it a preferred method for bioactive recovery.

Edible capsules

Innovative edible capsules enriched with sea fennel by-product extract were also formulated, showcasing promising results for functional food development with total phenols encapsulation efficiency of maximum 92%.



Edible capsule enriched with sea fennel by product extract

Animal Feed Applications

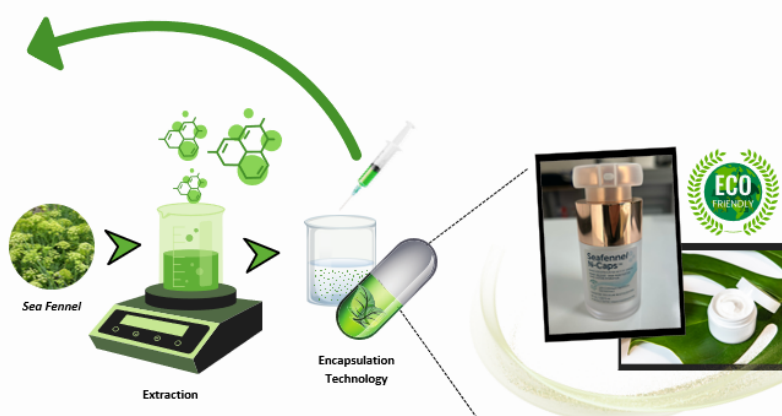
Under the task of integrating sea fennel by-products into animal feed formulations, Tunisian partners reported that rabbit feed pellets enriched with sea fennel showed high palatability and voluntary intake. Interestingly, while commercial pellets led to faster early growth, feed with higher sea fennel content resulted in better long-term weight gain, demonstrating a delayed but effective nutritional impact.



Dermatocosmetic and UV Protection Applications

Turkish partners conducted studies on the **Sun Protection Factor (SPF)** and UV-blocking activity of sea fennel extract. They confirmed that **phenolic compounds** in the extract contribute to its antioxidant and UV-absorbing properties. These findings support the use of sea fennel extract in **sunscreens, moisturizers, and other dermatocosmetic products**.

Additionally, Turkish researchers prepared **sea fennel extract-loaded zein nanoparticles** using the **antisolvent precipitation method**, identifying optimal candidates for further cosmetic product development.



Preparation and application of Sea Fennel (SF) extract-loaded zein nanoparticles via the antisolvent precipitation method.

Pharmacological Properties

French researchers explored the **anti-aging, anti-diabetic, anti-inflammatory, and neuroprotective properties** of sea fennel extract, producing very promising results that may pave the way for future pharmaceutical or nutraceutical innovations.

Essential Oils and Food Innovation

Croatian partners also extracted and analyzed **essential oils** from sea fennel by-products. Meanwhile, Tunisian researchers tested the incorporation of these oils in **jelly candy production**. Results revealed that **low concentrations (0.05%)** of essential oil enhanced consumer satisfaction, while **higher doses** were found to be less palatable.



Jelly candies enriched by EO from sea fennel by-product

As part of Task 6.3 Composting sea fennel biomass, composting trials were carried out using sea fennel biomass combined with other organic materials in compost bins. Two treatment mixtures were tested:

- **Treatment 1:** 50% sea fennel + 15% tomato residues + 35% pruned material
- **Treatment 2:** 30% sea fennel + 20% tomato residues + 50% pruned material

After six months of composting, the mature composts were collected, sieved, and prepared for further analysis. Initial evaluations showed that the water holding capacity of both composts was comparable to that of commercial peat-based substrates, indicating strong potential for horticultural applications.

In addition, compost tea was prepared using a 10:1 water-to-compost ratio, aerated for 24, 48, or 72 hours. Analysis of the compost tea revealed that both the sea fennel content and the aeration time significantly influenced potassium (K) and magnesium (Mg) concentrations. No significant differences were observed for other nutrients.

These findings support the potential of sea fennel biomass as a valuable component in sustainable composting and plant nutrition strategies.



Compost prepared in IACKR, Croatia

In Task 6.4 Preparation and Analysis of Essential Oils from Sea Fennel Crop By-products, essential oils (EOs) were extracted from sea fennel crop by-products using microwave hydrodistillation (MHD), with a focus on seasonal variation in composition and yield.

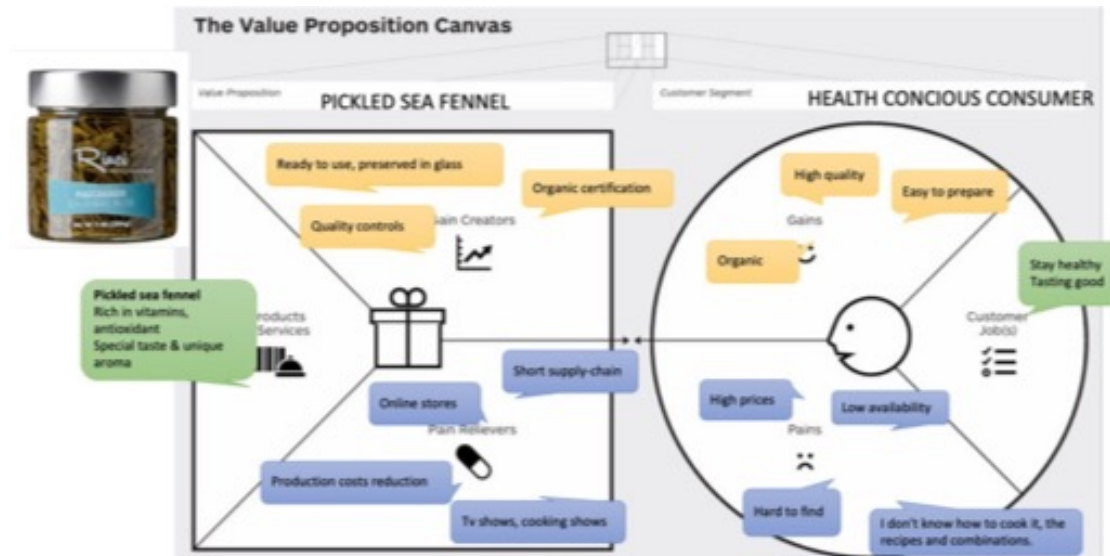
The analysis revealed that **limonene** was the dominant compound in all samples, with the highest concentration observed in **August (84.53%)** and the lowest in **January (58.74%)**. A strong positive correlation was found between limonene levels and average ambient temperatures, highlighting the influence of environmental conditions on EO composition.

Germacrene B, the only sesquiterpene identified, was present only in trace amounts or not at all during the period from **May to October**, suggesting seasonal limitations in its accumulation.

Microwave hydrodistillation proved particularly effective, producing essential oils with **higher yields of both limonene and sabinene** compared to conventional methods. These results support the value of sea fennel by-products as a potential source of high-quality essential oils for various applications.

Regarding WP7, a multi-country study revealed:

- **54%** had never heard of sea fennel.
- After introduction, **81%** saw it as natural, **77%** as healthy, **69%** as sustainable.

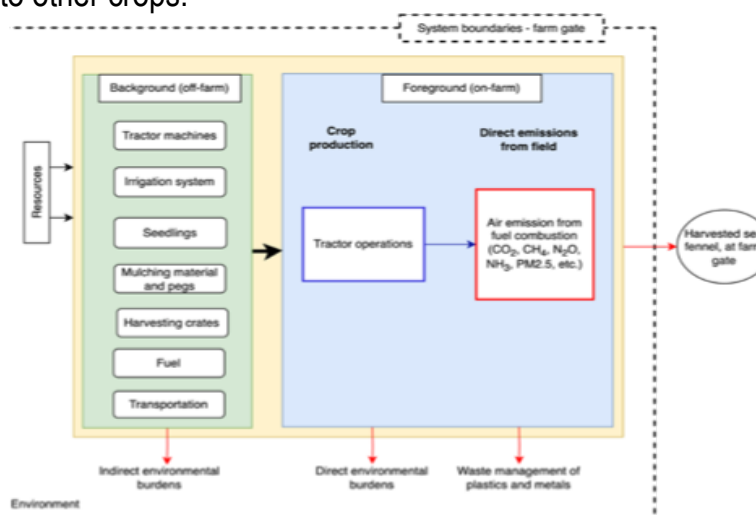


To increase demand, strategies should focus on:

1. Making sea fennel more available
2. Creating a variety of products
3. Improving marketing through tastings, expert recommendations, and social media.

Word-of-mouth and engaging consumers is a key.

Regarding WP8 (Sustainability assessment of new sea fennel-based foods/food ingredients), Life Cycle Assessment (LCA) indicated that sea fennel cultivation has a low environmental footprint compared to other crops.



LCA of sea fennel **spice, fermented pickles and capsules** as a functional food ingredient highlighted key environmental impacts.

- For spices, glass packaging was the largest contributor, but using refillable glass with lightweight plastic sachets reduced impact by 44%. Switching to solar energy lowered energy use by 11%, though with resource trade-offs.

- For pickles, pasteurization reduced refrigeration needs, improving sustainability for transport but increasing water use—highlighting the need for water efficiency. Packaging tweaks, like lighter lids, also improved environmental performance.
- For capsule produced at lab-scale, energy consumption was the largest contributor. Use more efficient process and switching to renewable energy to improve environmental performance.

These findings guide the eco-design of sustainable sea fennel products.

A Bittersweet Goodbye...

This marks the final newsletter of the SEAFENNEL4MED project — a journey that brought together science, sustainability, and passion for innovation. We were happy to share this wonderful experience with all of you!

We truly hope our paths will cross again in the near future!

Sea fennel, the essence of sustainability!

Newsletter are available at this link <https://seafennel4med.com/newsletter/>