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Summary of Deliverable D7.2 – Consumer Attitudes and Acceptance of Sea Fennel Products	Deliverable D7.2 sheds light on a critical aspect of sea fennel's future: how consumers perceive and accept this underutilized plant. A large-scale survey was conducted in five Mediterranean countries - Croatia, France, Italy, Tunisia, and Türkiye - collecting over 1,000 responses. Using the Theory of Planned Behaviour (TPB), the study explored how attitudes, peer influence, and perceived control shape people's willingness to buy sea fennel-based foods. The results highlight both challenges and opportunities. Awareness is still low: more than half of respondents had never heard of sea fennel, and tasting experience was rare outside Tunisia. Knowledge levels were uneven, with Tunisians showing the highest familiarity and French consumers the lowest. However, when consumers were informed about its qualities, perceptions were strikingly positive. Sea fennel was widely seen as natural, healthy, safe, and sustainable—attributes strongly aligned with current food trends. Fresh sea fennel emerged as the most attractive product, followed by pickles and powders. Yet, the study found that purchase intention depends not only on personal attitude but also heavily on peer pressure. In other words, people

are more likely to buy sea fennel if they perceive that family and friends approve of it. This underscores the importance of social networks, gastronomy influencers, and word-of-mouth in shaping demand.

Cross-country differences also emerged: consumers in Southern Mediterranean countries (Italy, Tunisia, Türkiye) expressed stronger intentions to buy compared to France and Croatia. Younger and urban consumers tended to be more open, while those who had already tasted sea fennel displayed significantly higher willingness to purchase.

Overall, the deliverable shows that while sea fennel is not yet mainstream, it has the potential to become one - provided that its story is communicated effectively. Campaigns should emphasize its Mediterranean identity, health benefits, and culinary versatility, while also creating opportunities for direct tasting and experiential marketing. By doing so, sea fennel can move from obscurity into everyday diets, turning curiosity into consistent consumer demand.

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1 Introduction

One of the most diverse collections of species in the world is found in the Mediterranean Basin. Over the centuries, many indigenous plants in the region were used by rural communities for both food and medicinal reasons (Petropoulos et al., 2018). Among them, sea fennel (*Crithmum maritimum* L.) has recently gained attention and been described as a "cash crop" due to its ability to grow well in the Mediterranean climate, its resistance to challenges associated with climate changes such as soil salinization, short-term water shortage, and its potential usability in food and non-food applications, offering an alternative source of employment in rural areas (Kraouia et al., 2023). However, sea fennel is a commercially underutilized crop as it is mostly grown and consumed locally (Renna, 2018). Therefore, we still do not know about general consumer attitudes toward this plant, which is crucial to explore for market development.

Sea fennel, also called rock samphire, marine samphire, crest marine, or marine fennel, is a salt-tolerant (halophyte) plant that is naturally grown in coastal areas. As it is widely found in the Mediterranean, it has been a part of traditional cuisine and folk medicine since ancient times. In addition to fresh consumption in salads, sea fennel stems and leaves are used in a variety of culinary applications, including pickles, sauces, spices, and condiments (Generalić Mekinić et al., 2024). Medicinal use of sea fennel is related to the tonic and depurative qualities of fresh leaves and the digestive and diuretic activities of its infusions (Atia et al., 2011; Cunsolo et al., 1993). It was also used by sailors in the past in foods due to its antiscorbutic properties (Cunsolo et al., 1993).

Sea fennel has been increasingly attracting the scientific community and potential uses of this promising plant have been acknowledged with various studies. Ascorbic acid, phenolic compounds, minerals, fatty acids, volatiles, and carotenoids are among the healthy and nutritional components that have been identified in sea fennel (e.g., Martins-Noguerol et al., 2022; Nartea et al., 2023; Özcan et al., 2019). In addition to food applications, several studies have suggested other possible usability of this valuable plant like a natural food colorant (Renna & Gonnella, 2012) or as an ingredient in food packaging (Gómez et al., 2023) and crop protection products (Renna, 2018).

Despite numerous promising research results, sea fennel still represents a niche market, and its consumption is limited to a few products at the local level. To promote the consumption of sea fennel products and to generate awareness regarding their benefits, it is important to focus on consumer research which is still missing in the literature. Currently, as reported by Custódio et al. (2021), most consumers are not familiar with salt-tolerant plants. Few studies included sea fennel in sensory analyses (e.g., Amoruso et al., 2022; Maoloni et al., 2021, 2022; Radman et al., 2023) and there is still a lack of data for a broader understanding of consumer behaviour toward sea fennel food products.

Considering the above context, the main objective of this project task was to explore consumer attitudes and acceptance of sea fennel-based food products in the Mediterranean. To this end, a cross-national survey was conducted in five countries, Croatia (HR), France (FR), Italy (IT), Tunisia (TN), and Turkey (TR). Data were collected on various attitudinal and behavioural constructs based on the Theory of Planned Behaviour model (TPB) as well as other background variables such as product awareness and knowledge, food-related lifestyle, gender, age, and education.

2 Material and Methods

2.1 Theoretical framework

Considering that sea fennel food products are a fairly new concept in the food market, a behavioural model leveraging the Theory of Planned Behaviour (TPB) was developed to measure the attitude and acceptance of consumers regarding sea fennel-based food products. According to the TPB (Ajzen, 1991), people's intentions to perform or not perform a behaviour can be used to predict their behaviour. The intentions are determined by attitudes (positive or negative evaluation of the individual performing the behaviour), subjective norms (the view of others on the individual's choices), and perceived behavioural control (the extent to which the individual perceives that the behaviour is under their control) (Figure 1).

In the food sector, the model has been applied to numerous studies to investigate the innovative food-related behaviours of consumers such as purchasing functional foods, eating insect-based foods, supplement use, use of genetically modified foods, dairy product intake, and organic product consumption (e.g., Menozzi et al., 2017; Metcalf et al., 2021; Naspetti et al., 2021; Patch et al., 2005).

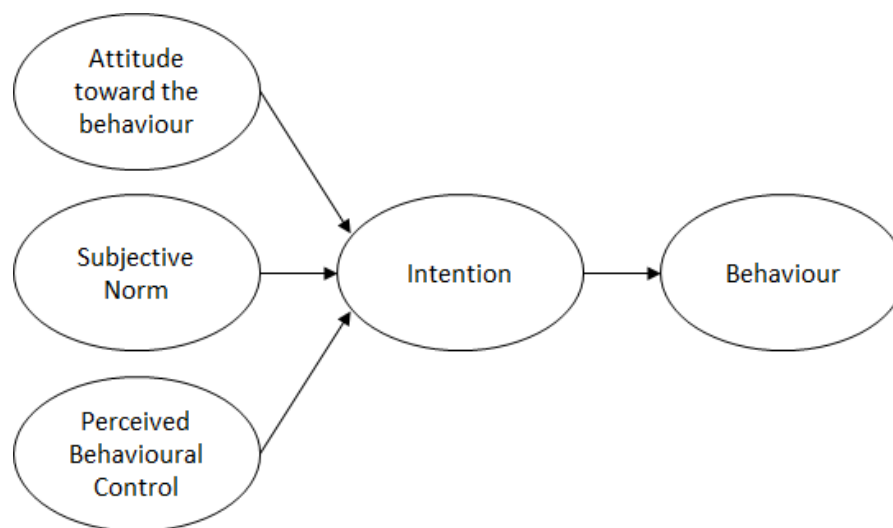


Figure 1 The original Theory of Planned Behaviour (TPB) model (Ajzen, 1991)

The core of the adapted model remains with the original constructs, attitude towards the behaviour, subjective norm, and perceived behaviour control (Figure 1). The theory was extended with additional constructs, positive and negative beliefs, background information related to sea fennel products (product awareness, objective and subjective product knowledge), and food-related lifestyle (FRL) including innovation, involvement, and responsibility (See Figure 2). Sociodemographic characteristics such as age, gender, employment status, family composition, and education were also considered to explore the variables' relationships.

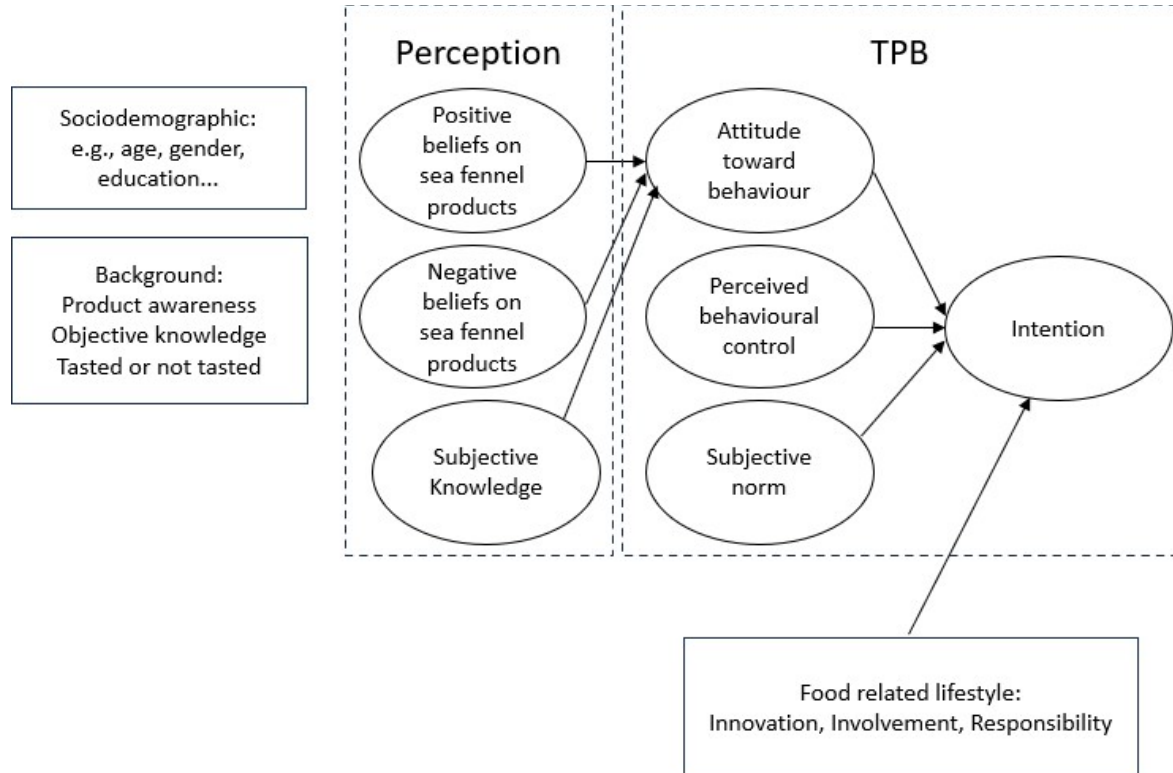


Figure 2 The behavioural intentions model used in the study

Based on this theoretical framework, the following hypotheses of consumer acceptance of sea fennel food products were formulated.

H1: The (positive/negative) attitude of consumers toward sea fennel is directly related to their intention (not) to buy sea fennel.

H2: The more that consumers have positive (H2a) or negative (H2b) perceptions toward sea fennel food products, the more favourable or unfavourable, respectively, their attitude toward sea fennel

H3: The attitude towards purchasing sea fennel is higher for consumers with higher product knowledge (objective and subjective).

H4: The more consumers perceive the influence of social and peer pressure to be favourable to sea fennel, the higher the consumer intention towards buying sea fennel food products.

H5: The more consumers perceive that the decision to purchase sea fennel is under their control, the higher the consumer intention towards buying sea fennel food products.

H6: The more the consumer is innovative, involved and responsible, the higher the consumer intention towards buying sea fennel food products.

2.2 Data collection

The data for the evaluation of the theoretical model were gathered through an online questionnaire distributed to consumers via Qualtrics online survey platform. The sub-contracted agency CINT

International has recruited consumers across five Mediterranean countries: Croatia (HR), France (FR), Italy (IT), Tunisia (TN), and Turkey (TR).

The questionnaire, reported in Annex 1, can be divided into five main sections considering the information collected:

The first section is a **screening segment** that aims to select eligible consumers. Accordingly, participants in the study were responsible for making household food purchases and, were not involved in any food-related professions, such as agriculture or food processing, nor did they work for a market research company. Additionally, questions regarding country of residence, age, and gender were included to ensure balanced representation from each country and guarantee that the age of all respondents was over 18 years.

The second section includes questions about **consumer awareness** of sea fennel. Participants were asked if they had ever heard about sea fennel, with dichotomous response options 'yes' or 'no'. Then, regardless of their previous knowledge, all the participants were provided a brief description of sea fennel to ensure a consistent information level among them. The information provided is given below:

*"Sea Fennel (*Chritum maritimum* L.) is a halophyte plant that grows spontaneously in rocky areas and salty soils along coastlines. In Mediterranean countries, sea fennel has several usage areas, such as culinary, medicine, and cosmetics, because of its nutrient and phytochemical contents, high nutritional value, and diuretic, digestive, and carminative properties. Traditionally, its leaves are consumed in salads, sauces, soups, and as fermented in vinegar or oil. The composition of sea fennel contains dietary fibre, protein, polyunsaturated fatty acids, minerals, vitamins (C, A, E), polyphenols, and essential oils. Bioactive compounds of sea fennel have functional properties such as antioxidant, antimicrobial, and anti-inflammatory activity.*

The third section focuses on **consumer knowledge** about sea fennel. Participants were presented with a multiple-choice question featuring images of fresh, pickled, and dry food images (see [Figure 3](#)) for the assessment of their objective knowledge. They were asked to identify the sea fennel among these options displayed in a randomized order.



Figure 3 Objective knowledge measurement question

Furthermore, the subjective knowledge question, which is important for understanding consumer preferences (Brucks, 1985; Park et al., 1994), was asked with a three-item construct. Participants rated their level of agreement on a five-point Likert scale verbally anchored from 'strongly disagree' to 'strongly agree' and at the mid-point with 'neither agree nor disagree' (See

Table 1).

Table 1 Subjective knowledge items

Construct	Definition	Item	Item wording
Subjective knowledge (Flynn & Goldsmith, 1999)	Perceived knowledge by the consumer about sea fennel	Sub_1	In comparison with an average person, I know a lot about sea fennel.
		Sub_2	People who know me, consider me an expert in the field of sea fennel.
		Sub_3	I know a lot about how to evaluate the quality of sea fennel products.

The fourth section consisted of **the constructs of the model** presented through itemised questions. Definitions of each construct, their references, and the corresponding scale items are given in Table

2. In this part of the survey, participants were first asked to indicate their opinion about sea fennel food products using a five-point bipolar interval scale that consisted of 10 positive versus 10 negative attributes (e.g., "unnatural" versus "natural") (Van der Stricht et al., 2024). This question allowed us to assess the consumers' perceptions of sea fennel food products through positive and negative beliefs. Next, participants were asked to respond to a 9-item question designed to evaluate the food-related lifestyle. The question included three constructs: innovation, involvement, and responsibility, with three items for each construct. Subsequently, questions of attitude toward sea fennel products (3 items), subjective norm (3 items), and perceived behavioural control (3 items) were presented.

Purchase intention was measured as a single-item variable. At the end of the section, participants were asked which of the three sea fennel products they would be most likely to purchase; sea fennel powder, pickled sea fennel, and fresh sea fennel.

All multi-item constructs were measured using a five-point Likert scale (from one 'strongly disagree', to five 'strongly agree'). Items were listed in a randomised order for each construct (Bredahl, 2001), and attention filters were added to check the quality of the responses.

Table 2 Definition of the multi-item constructs in the proposed model

Construct	Definition	Item	Item wording
Perception (Van der Stricht et al., 2024)	Positive or negative meanings associated with sea fennel (positive beliefs and negative beliefs)	<i>I believe that sea fennel food products are....</i> Pcp1 Traditional vs Modern Pcp2 Unsustainable vs sustainable Pcp3 Unhealthy vs healthy Pcp4 Unnatural vs natural Pcp5 Cheap vs expensive Pcp6 Unsafe vs safe Pcp7 Not tasty vs tasty Pcp8 Unpleasant vs pleasant Pcp9 Highly-processed vs low-processed Pcp10 Difficult to find vs easy to find	
Food-related lifestyle (Custódio et al., 2021)	What is meaningful to people when they engage in food-related activities	Innovation	FRL_1 I like to try recipes from different countries
			FRL_2 I like to try new foods that I have never tasted before
			FRL_3 I look for ways to prepare unusual meals
	Involvement		FRL_4 Eating and food is an important part of my social life
			FRL_5 Decisions on what to eat and drink are very important to me
			FRL_6 Eating and drinking are a continuous source of joy for me
	Responsibility		FRL_7 I try to choose food produced with minimal impact on the environment
			FRL_8 I am concerned about the conditions under which the food I buy is produced
			FRL_9 I try to choose food that is produced in a sustainable way
Attitude toward sea fennel products (Ajzen, 2005; Chen, 2008)	A positive or negative feeling associated with the sea fennel food products	Att1	Purchasing sea fennel food products is a good idea
		Att2	Purchasing sea fennel food products is pleasant
		Att3	Purchasing sea fennel food products is a wise choice
Subjective norm (Chen, 2008; Naspetti et al., 2021; Venkatesh et al., 2003)	Perception of relevant opinions on whether to purchase sea fennel products.	SN1	Most people who are important to me would approve of me buying sea fennel food products
		SN2	Most people who I value think that I should buy sea fennel food products if they were available in the shops

Construct	Definition	Item	Item wording
		SN3	My family would encourage me to buy sea fennel food products
Perceived behavioural control (PBC) (Bredahl, 2001; Chen, 2008)	Ease or difficulty of buying sea fennel food products	PBC_1	Whether I would buy sea fennel food products - if available for sale - is entirely up to me
		PBC_2	If sea fennel food products were available for sale nothing would deter me from buying them, if I wanted to
		PBC_3	I am confident that I am free to decide if buying or not sea fennel food products - if available for sale
Intention to buy (=perform behaviour) (Ajzen, 2005)	Intention to buy sea fennel food products	Int	If sea fennel food products were available in the shops, I would definitely buy them

The fifth section of the survey deals with **socioeconomic information** such as employment status, family composition, and education as well as age and gender, which were addressed in the screening section. Participants were requested to report their age as a continuous variable and to indicate the number of family members in each of the following categories: under 18 years old, between 18 and 64 years old, and over 64 years old. The categories for employment status included employed, unemployed, retired, and students or inactive population who are not currently looking for a job. The education levels were re-grouped into smaller categories following the International Standard Classification of Education (ISCED) (UNESCO, 2012) to facilitate a comparison between countries. In addition, participants were asked about their type of residence (urban, rural, semi- rural/semi-urban) and **whether they had ever tasted sea fennel**.

The questionnaire was initially developed in English and later translated into the relevant national languages with the help of project partners. Cross-checking, editing, and pre-testing were conducted before the survey was administered. The data was collected between August and September 2024. The questionnaire was sent to a panel of 3070 consumers, and after eligibility and consistency checks, 1031 consumer responses were retained.

2.3 Analysis

The Confirmatory Factor Analysis (CFA) and Structural Equation Modelling (SEM) were carried out using a robust maximum likelihood estimator (Hancock & Schoonen, 2015; Satorra & Bentler, 1994) via Mplus 8 (Muthén & Muthén, 2017). A post-hoc analysis was conducted to perform further model invariance tests finalised to latent means difference testing:

- across consumers with high or low knowledge of sea fennel
- across genders (male vs. female), age groups, and urban-rural residence
- across countries, and
- across the state of awareness and taste experience.

All descriptive analyses were carried out by using Stata version 18.

3 Results

3.1 Descriptive statistics

3.1.1 Socio-demographics

Socio-demographic data included information on gender, age, level of education, employment status, area of residence, and number of persons in the household.

As reported in [Table 3](#), we collected 1031 valid survey responses from five Mediterranean countries: CR (196), FR (225), IT (206), TN (204), and TR (200). Female respondents represent 53% of the sample. Among the age groups, the largest consumer segment was the '45-65' category (39%), followed by the '30-45' category (34%). The youngest group, aged '18-29', accounted for 16%, while the oldest group over '65' represented 12%.

Regarding the composition of family members, Tunisia has the highest average number of adults (mean 2.62 ± 1.25). In contrast, France has the lowest average of adults in the family (mean 1.36 ± 1.04 ; See

Most participants have a Bachelor's degree or higher, are employed, and live in urban areas (see [Table 3](#) for details).

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Table 3 Sociodemographic characteristics of the sample

Sociodemographic variables	Country					Total
	CR	FR	IT	TN	TR	
Total sample	196	225	206	204	200	1031
Gender in %						
Female	51	60	51	50	50	53
Male	49	40	49	50	50	47
Age group in %						
18-29 (%)	19	3	10	17	30	16
30-45 (%)	28	22	27	55	40	34
46-65 (%)	41	50	46	28	29	39
over 65 (%)	12	26	17	0	2	12
Education in %						
Lower secondary or below	1	6	4	7	3	4
Upper secondary	48	15	59	23	23	33
Bachelor's degree	31	38	18	42	64	38
Postgraduate	18	38	17	26	11	23
Other	2	4	2	1	0	2
Employment status in %						

Employed	65	53	61	76	71	65
Unemployed	12	6	13	8	7	9
Retired	17	37	21	5	12	19
Student/not looking for a job	6	4	4	12	11	7
Geographical area in %						
Urban	47	32	50	70	93	58
Intermediate	34	34	34	25	6	27
Rural	36	34	16	4	2	15
Household size in mean $\pm$ sd						
< 18 years old	0.60 $\pm$ 0.90	0.45 $\pm$ 0.89	0.44 $\pm$ 0.90	1.16 $\pm$ 1.04	1.09 $\pm$ 1.01	0.74 $\pm$ 1.00
18-64 years old	1.98 $\pm$ 1.13	1.36 $\pm$ 1.04	1.71 $\pm$ 1.09	2.62 $\pm$ 1.25	2.21 $\pm$ 0.96	2.20 $\pm$ 7.81
> 64 years old	0.45 $\pm$ 0.79	0.78 $\pm$ 4.62	0.46 $\pm$ 0.72	0.75 $\pm$ 0.86	0.21 $\pm$ 0.47	0.54 $\pm$ 2.26
Overall	1.01 $\pm$ 0.45	0.86 $\pm$ 1.54	0.87 $\pm$ 0.41	1.51 $\pm$ 0.62	1.17 $\pm$ 0.43	1.15 $\pm$ 2.70

3.1.2 Background about sea fennel

Concerning consumer awareness of sea fennel, 46% of the 1031 participants indicated that they had heard about sea fennel previously. The level of awareness varied on country bases as shown in Figure 4. Particularly, Tunisian respondents demonstrated the highest awareness with 79%, while the French participants showed the lowest, with 23% admitting that they had heard about sea fennel.

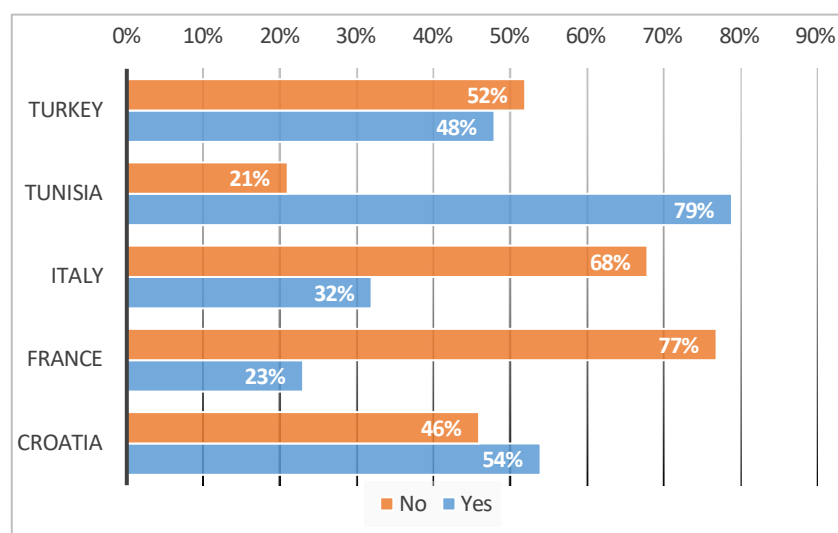


Figure 4 Distribution of respondents by country who are aware of sea fennel

The results of the awareness question are consistent with the results of the product-tasting question. As shown in Figure 5, Tunisian respondents have the highest score as 76% reported that they have tasted sea fennel before. They are followed by Turkish (37%), Croatian (28%), Italian (16%) and French (11%) participants.

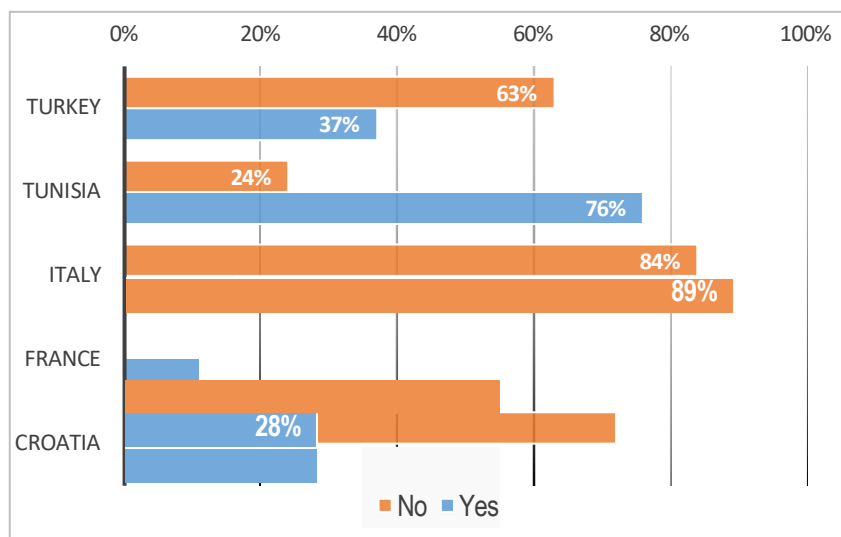


Figure 5 Distribution of respondents by country who tasted sea fennel

The objective and subjective knowledge questions were posed to all consumers, including those who said they had not heard of sea fennel considering that they had never heard the name but might have seen the plant with different names. According to the results, the fresh sea fennel image was the most recognized one among the respondents, 55% of 1031 participants selected the correct image. This was followed by the recognition of pickled sea fennel, with 35%, and sea fennel powder with 34%. The order of recognition of product images showed a similarity at the country level, as illustrated in Figure 6.

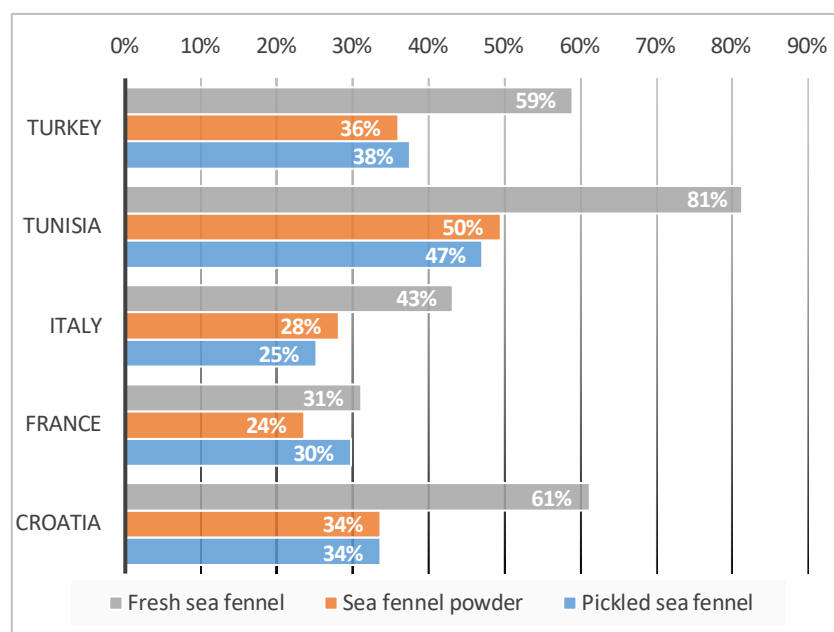


Figure 6 Distribution of respondents by country who recognized sea fennel product images

The distribution of ratings for the 'subjective knowledge' items in terms of level of agreement is shown in Figure 7. The figure presents the results of the entire sample of 1031 participants, for all three items of the construct. The option of 'strongly disagree' is the most selected category.

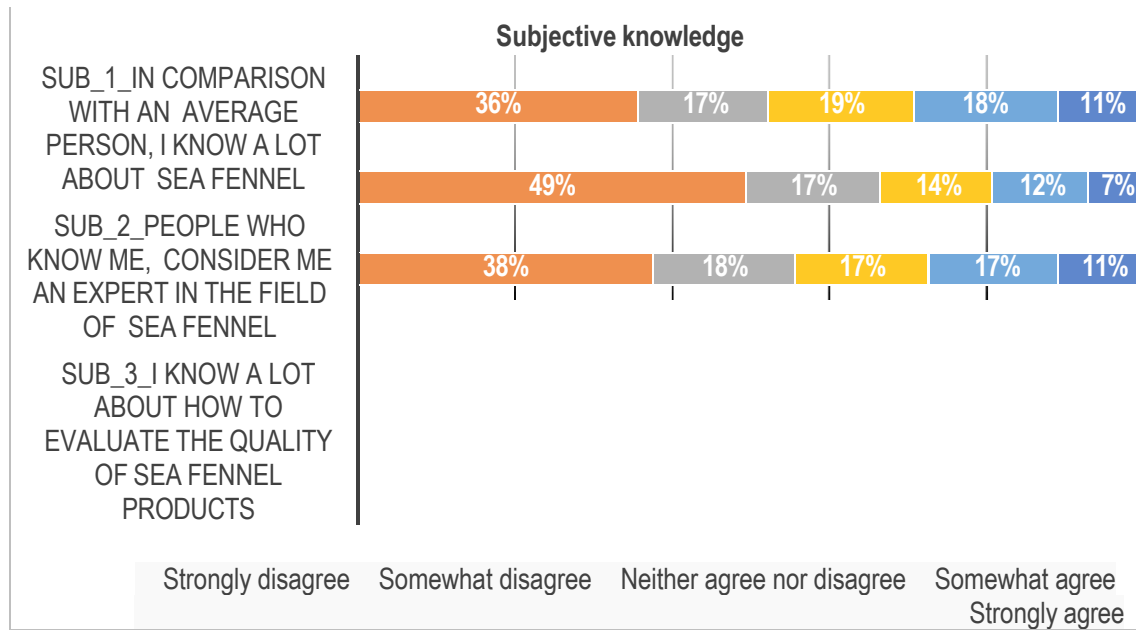


Figure 7 Distribution of subjective knowledge items ranking

The mean values of subjective knowledge responses are reported by country in Figure 8. Accordingly, all country scores are below the theoretical mean value (red line), except for Tunisia (3.75 ± 1.05).

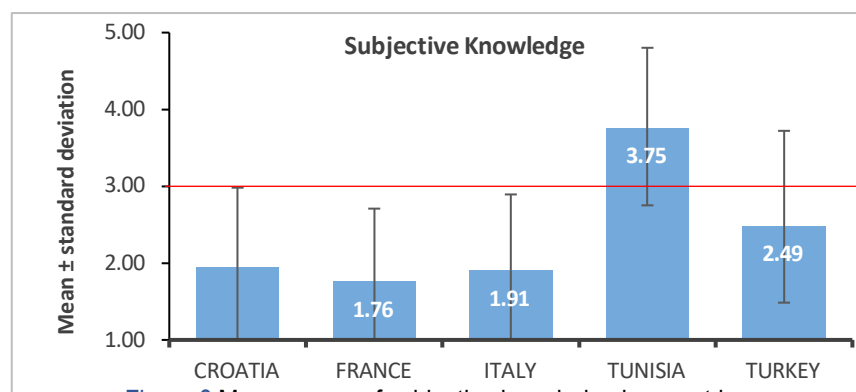


Figure 8 Mean scores of subjective knowledge by countries.

3.1.3 Multi-item constructs

Respondents perceived sea fennel food products as being low-processed, pleasant, tasty, safe, natural, healthy, and sustainable (See Figure 9). For the other attributes, the answers were rather neutral, e.g. respondents did not perceive sea fennel food products as either modern or traditional, cheap or expensive, and either difficult to find or easy to find. Particularly, 61% of the 1031 participants strongly agreed with the statement that sea fennel food products are 'natural' and 52% strongly agreed that they are 'healthy'. In contrast, only 18% strongly perceived that sea fennel food products



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are 'easy to find'.

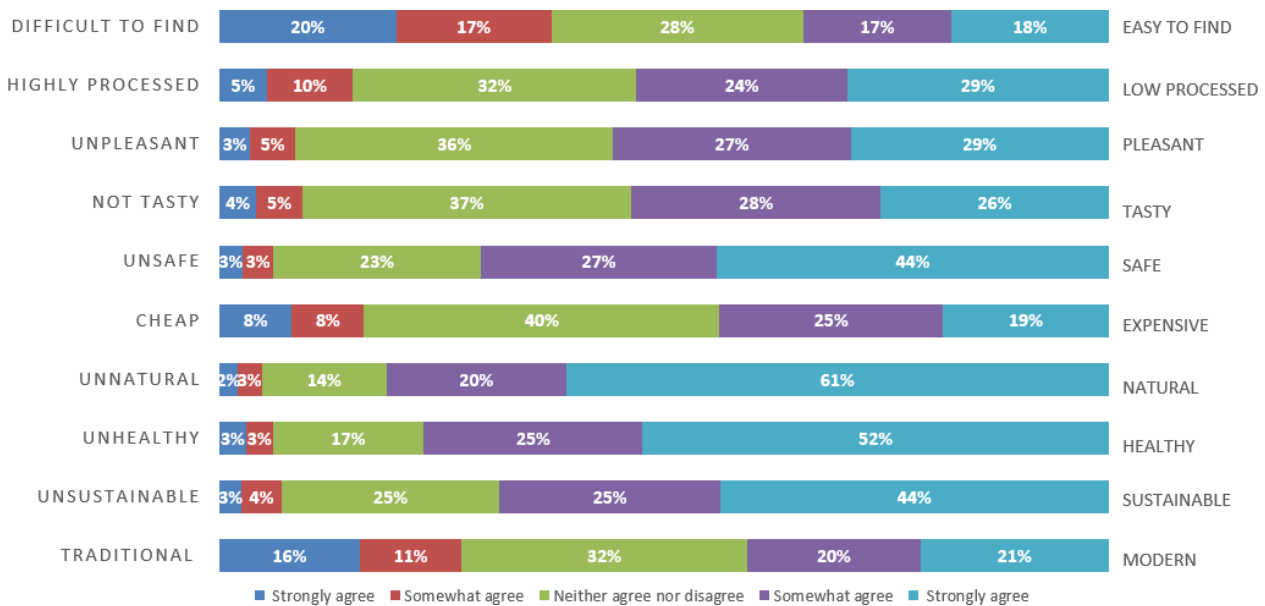


Figure 9 Distribution of respondents' attribute perception of sea fennel food products

Figure 10 illustrates the distribution of ratings for the FRL items. All items received a high level of agreement from respondents, with most ratings falling into 'somewhat agree' or 'strongly agree' categories. The mean values for each subconstruct of FRL were above the theoretical mean (Figure 11, red line). Particularly, the mean for participant's involvement is 4.11 (± 0.71), which is higher than the mean for responsibility at 3.91 (± 0.68) and innovation at 3.85 (± 0.81) (see Figure 11).

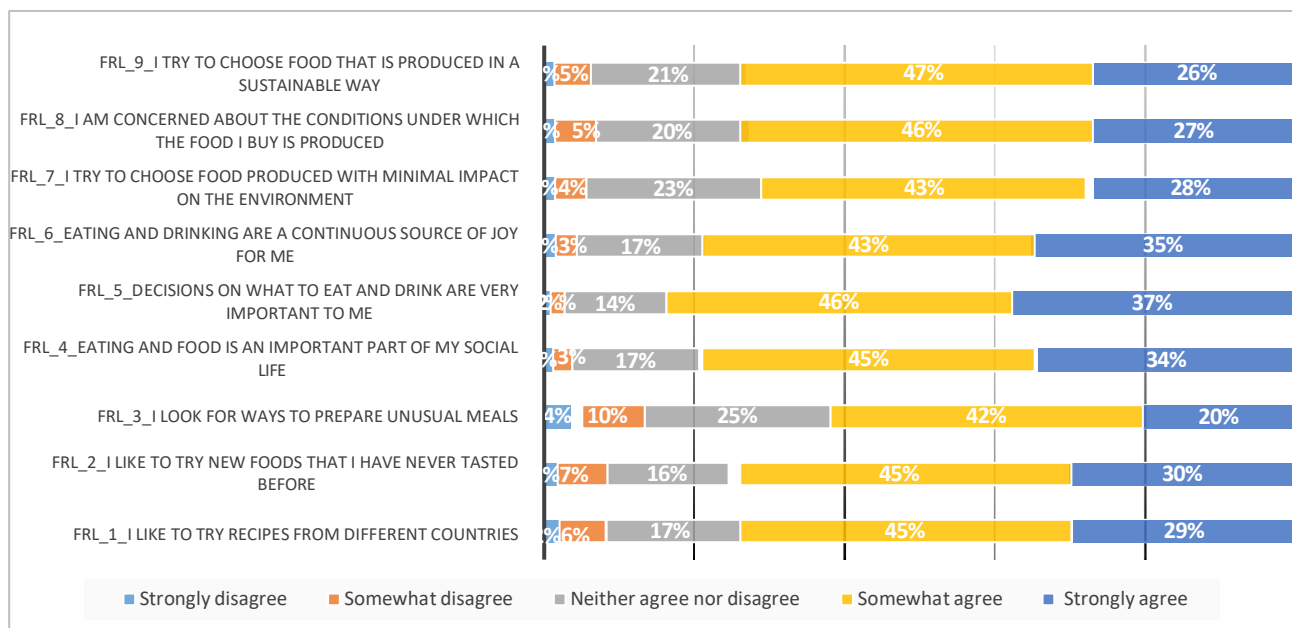


Figure 10 Distribution of Food-Related Lifestyle (FRL) items ranking

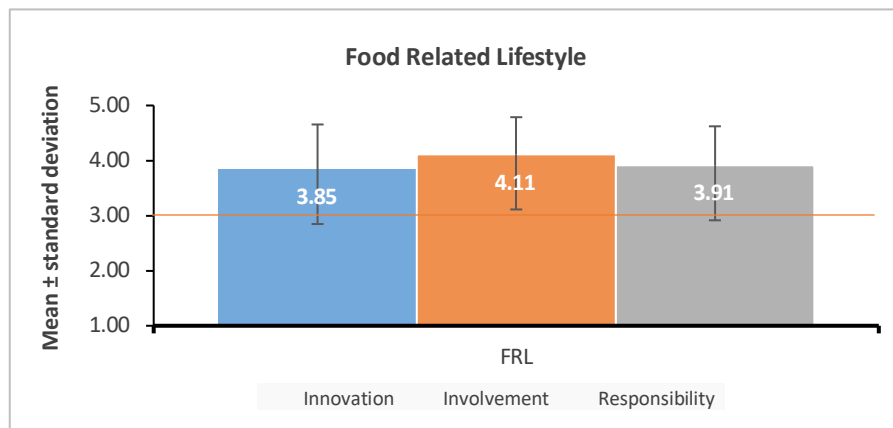


Figure 11 Mean scores of food-related lifestyle (innovation, involvement, and responsibility)

In country-based responses to FRL constructs, involvement received the highest rating score across all countries. While responsibility was ranked second in all countries, in Tunisia, innovation took second place instead (See Figure 12).

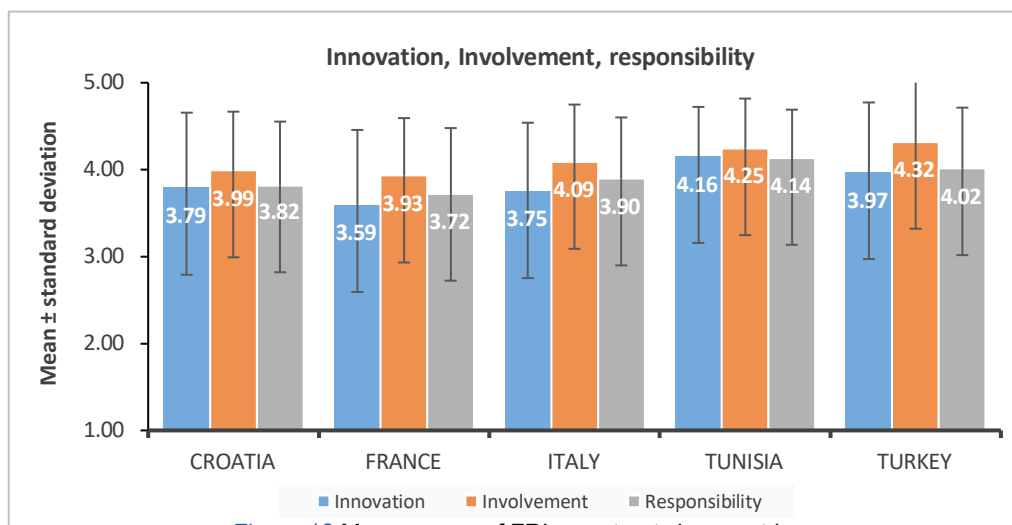


Figure 12 Mean scores of FRL constructs by countries

Descriptive statistics of the attitudes at the item level are given in Figure 13. Item ratings are mostly above the neutral response value of 'neither agree nor disagree'. Although the means vary by country, all ratings are above the theoretical mean (See Figure 14).

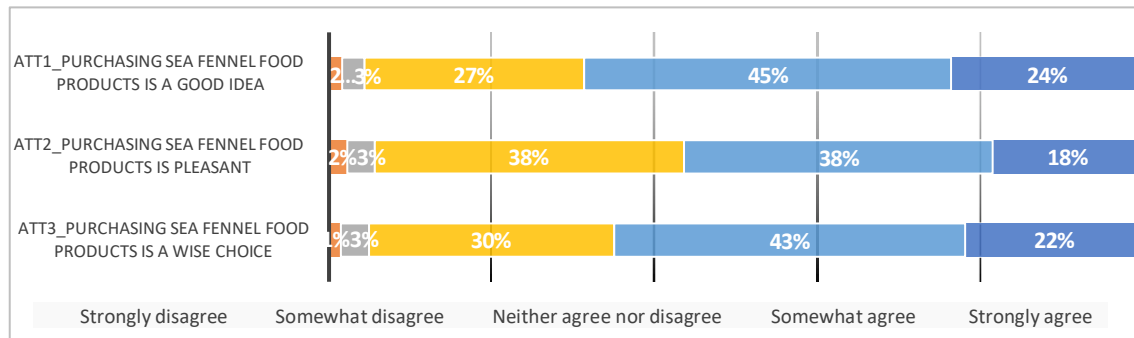


Figure 13 Distribution of attitude items ranking

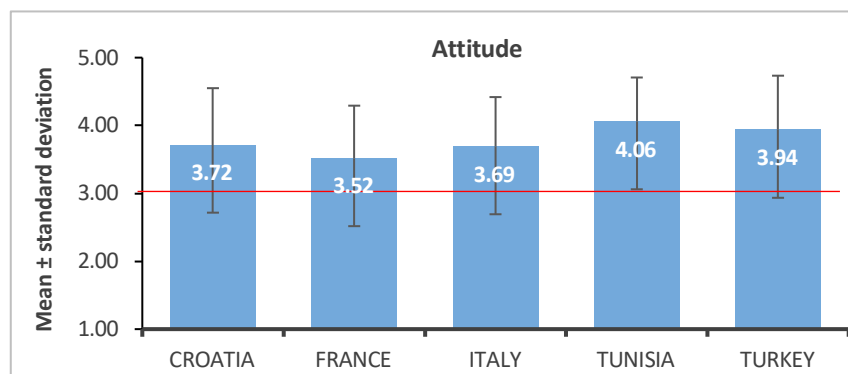


Figure 14 Mean scores of attitude by countries

Regarding the subjective norm, Figure 15 represents the distribution of the responses from all participants on an item base. The option of 'neither agree nor disagree' is the most frequently selected category. Notably, all countries, except France (mean 2.79 ± 1.03), have a mean value above the theoretical average. Tunisia has the highest mean score at 4.04 ± 0.75 (See Figure 16).

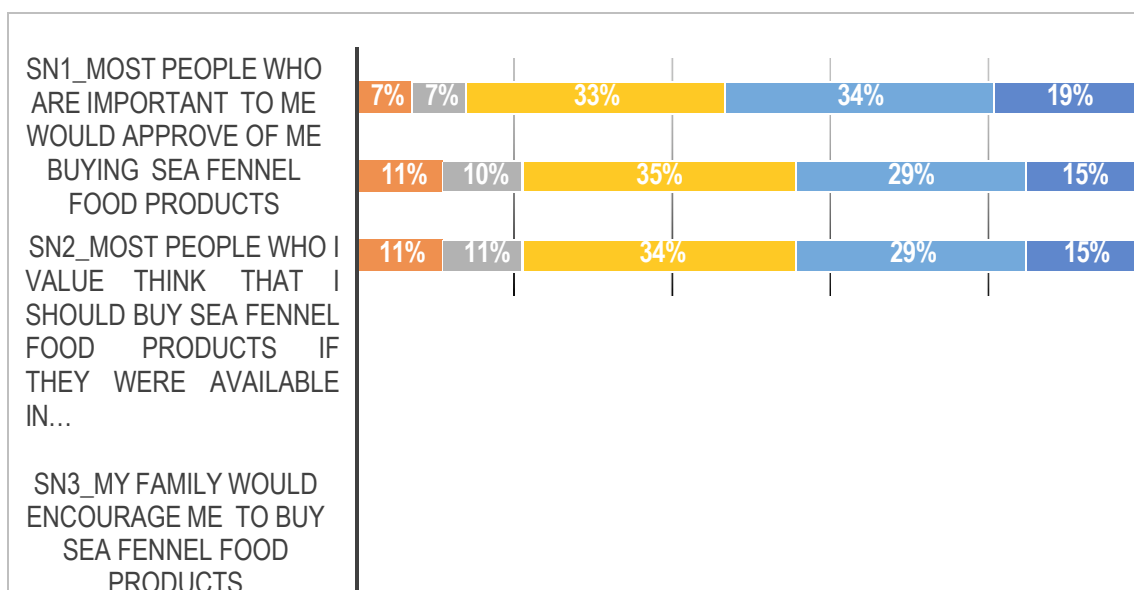




Figure 15 Distribution of subjective norm items ranking

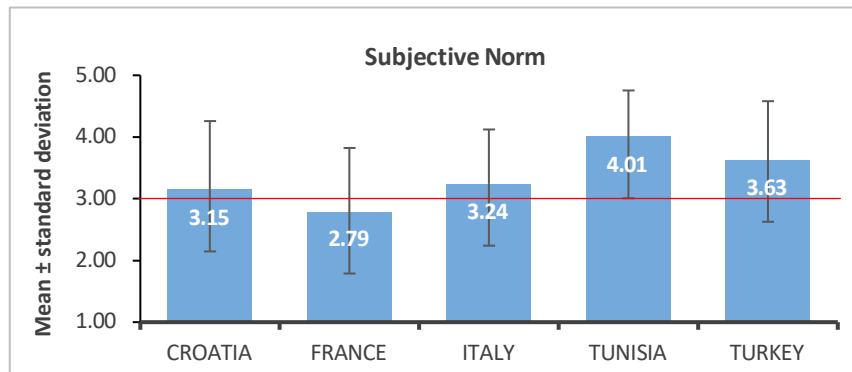


Figure 16 Mean scores of the subjective norm by countries

Respondents expressed a strong level of agreement with the behavioural items, as more than 75% of responses indicated 'somewhat agree' or 'strongly agree' as shown in Figure 17. Additionally, the mean values for all construct items are notably above the theoretical mean in all countries. Tunisia recorded the highest mean at 4.27 (± 0.5), followed by Croatia, Italy, Turkey, and France (See Figure 18).

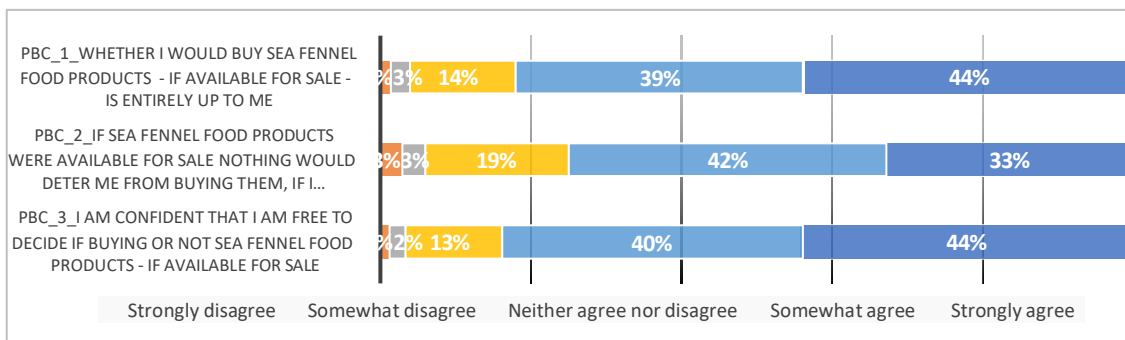


Figure 17 Distribution of perceived behavioural control items ranking

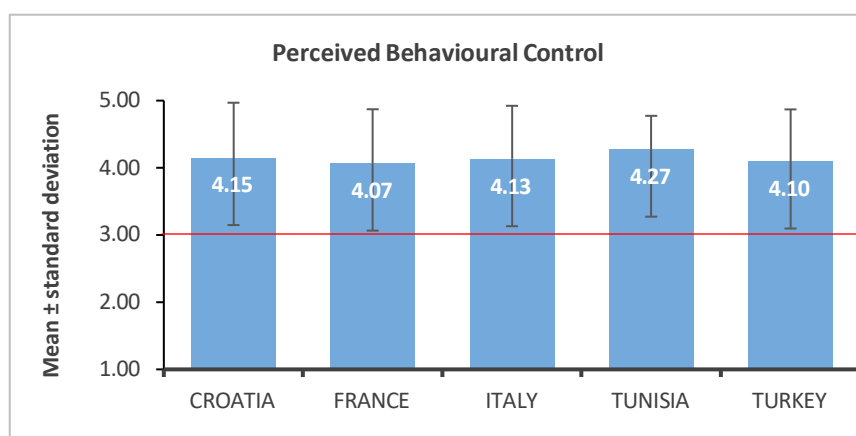


Figure 18 Mean scores of perceived behavioural control by countries

Figure 19 reports the respondent's intentions to buy sea fennel products. The category 'somewhat agree' is the most chosen, with 45 %, followed by 'strongly agree' with 24%.

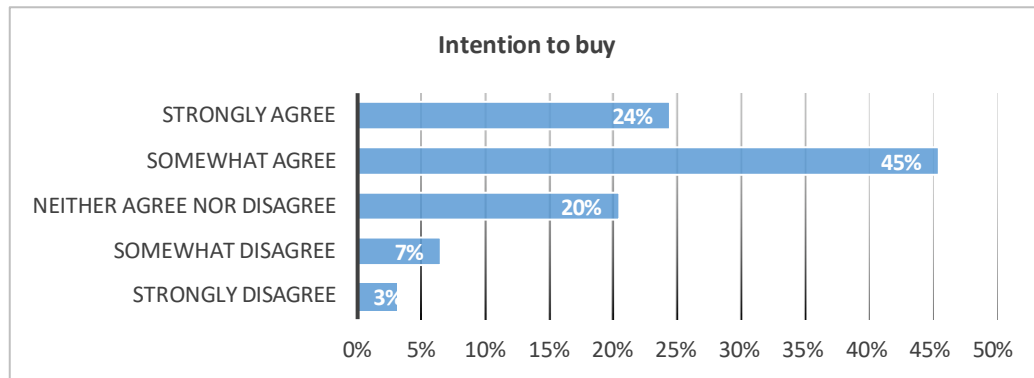


Figure 19 Distribution of intention to buy ratings of sea fennel food products

Regarding product base ratings, fresh sea fennel received the highest scores, with 40% of participants selecting 'somewhat agree' and 25% choosing 'strongly agree.' This was followed by pickled sea fennel, and finally, sea fennel powder (Figure 20).

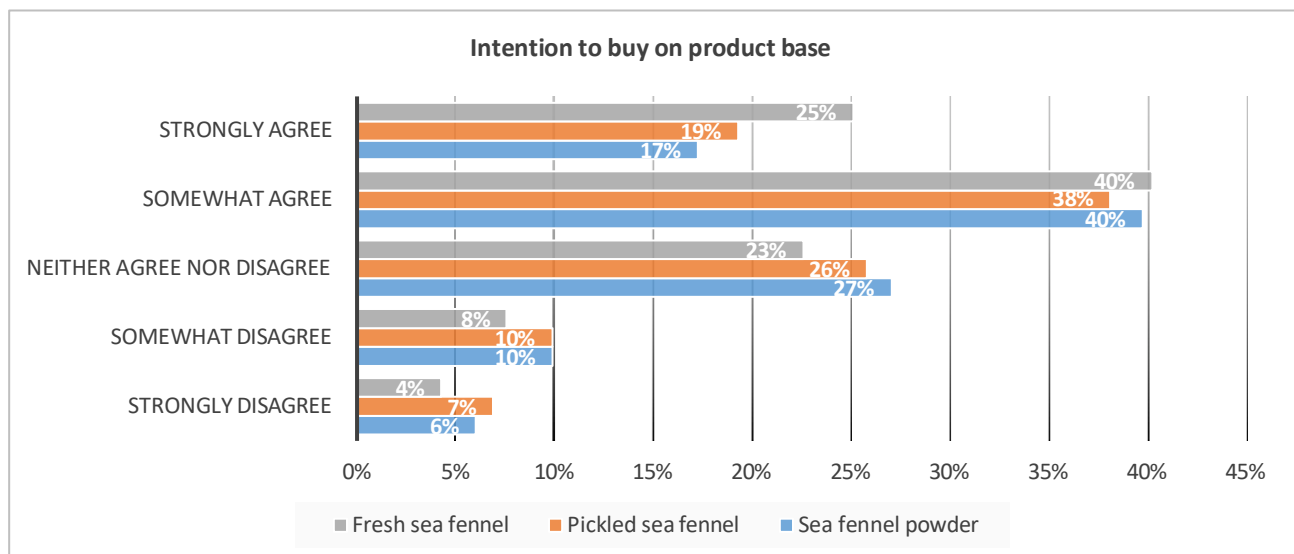


Figure 20 Distribution of intention to buy ratings on product base

In country-based responses for the intention to buy sea fennel food products, mean scores are above the theoretical value in all countries. While Tunisia recorded the highest intention to buy score with 4.28 ± 0.71 , France recorded the lowest with 3.79 ± 1.06 (Figure 21).

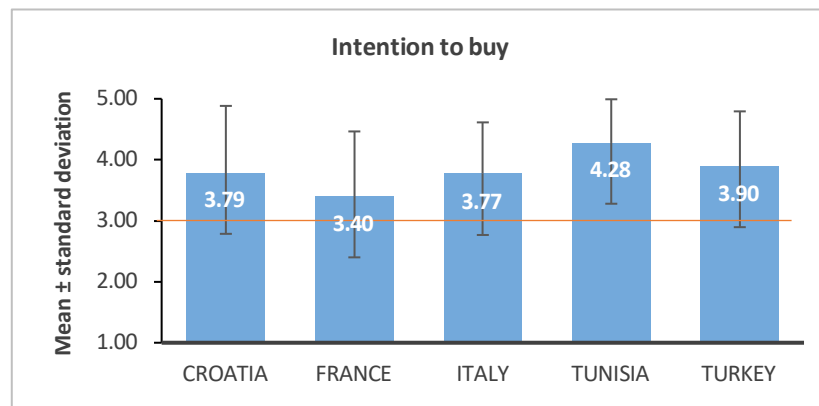


Figure 21 Mean scores of intention to buy by countries

Fresh sea fennel received the highest score in all countries except Turkey where pickled sea fennel had the highest mean value. See Figure 22 for details of the product-based intention to buy scores by country.

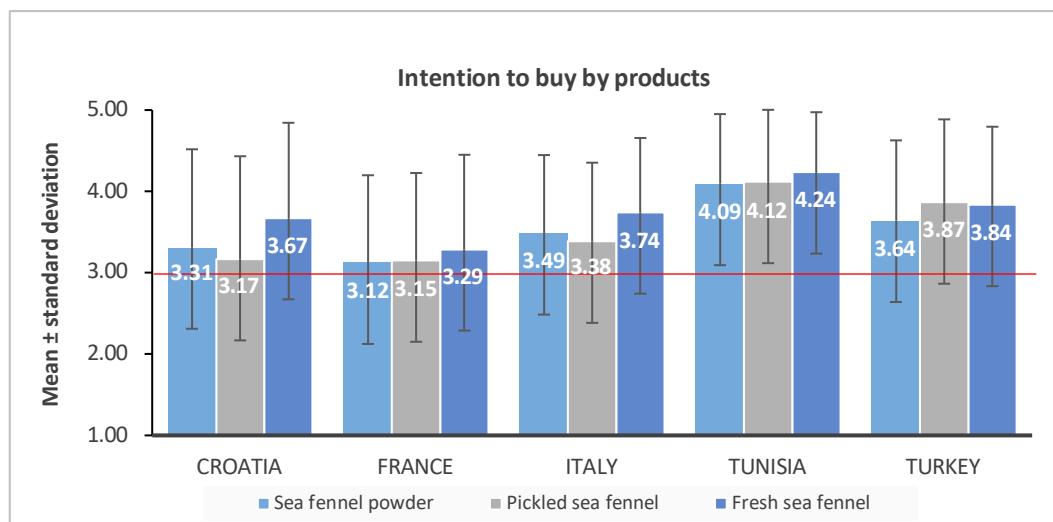


Figure 22 Mean scores of intention to buy by products and countries

3.2 Structural equation modelling (SEM) analysis

Confirmatory factor analysis was conducted to test the model validity on multi-item scales: Intention (measured on overall and product base intention); Attitude; Subjective Norm; Perceived Behavioural Control; Perception based on beliefs; and Food-Related Lifestyle. Descriptive statistics at the item level were reported in the previous chapter.

Robust maximum-likelihood estimation was used for the initial CFA models and the SEM model. The estimation of the SEM model resulted in confirming the theoretical model depicted in Figure 2.

All of the measurement statistics for the overall sample (pooled CFA model) are given in Table 4, while the statistics of the overall CFA and SEM models' fit are given in

Table 5. All constructs exhibit high reliability¹. All models were estimated using the algorithms implemented in Mplus version 8.11 (Muthén & Muthén, 2017).

Table 4 Measurement properties for the multi-item constructs (overall sample)

Construct	Cronbach's alpha*	Composite reliability (rho)*	Average variance extracted (AVE)*
Knowledge (KNOW)	0.92	0.92	0.80
Perception (beliefs) (PB)	0.83	0.83	(0.45)
Perceived behavioural control (PBC)	0.80	0.76	0.51
Subjective norm (SN)	0.90	0.90	0.75
Attitude (Att)	0.88	0.88	0.70
Intention (Int)	0.84	0.84	0.57
Food-Related Lifestyle (FRL)	0.84	0.83	(0.36)

*Alpha should be above 0.70, Rho should be higher than 0.6, and AVE > 0.4. In brackets the values below the threshold

Table 5 CFA and SEM models' fit statistics

Model	Chi-Square	RMSEA	CFI	SRMR
		(90% C.I.)		
CFA	913.73 (df 407)	0.035 (0.032-0.038)	0.963	0.051
SEM	1492.91 (df 538)	0.042 (0.039-0.044)	0.934	0.062

Legend: RMSEA= Root Mean Square Error of Approximation; CFI=Comparative Fit Index; SRMR = Standardized Root Mean Square Residual

All models exhibit close fit. In both the CFA and the SEM models, all loadings were significant and above the 0.50 threshold.

Using the alignment method factor means were compared for the groups based on gender, age group (below and above 45 years old), urban dwelling (0/1), living in a Southern Mediterranean country (IT/TR/TN), university or higher education (0/1), awareness of sea fennel (0/1), objective knowledge of at least 2 forms of sea fennel products (0/1), experience (whether they had tasted it before or not). At the same time, the measurement invariance of the CFA structure was tested.

¹ After testing for reliability, we excluded the following items from the perception construct: availability, safety, sustainability and tradition, to improve the internal consistency of the construct.

Given the FREE alignment approach, as usually happens, was poorly identified, the FIXED approach was used with the group with the factor mean closest to zero as the reference group (factor mean = 0). As a rule of thumb, up to 20% of non-invariant parameters may be acceptable. For higher percentages, a Monte Carlo simulation is recommended to assess the validity of the results (Asparouhov & Muthén, 2014). In general, there was a small degree of (non-)invariance for most of the loadings and intercepts, showing that measurement invariance holds to a large extent. In all cases, only a few parameters were non-invariant, thus rejecting the hypothesis that the measurement model is non-invariant across groups (Coromina & Peral, 2020a).

Latent factor means are not estimated in absolute scores, but instead as an arbitrary adimensional factor mean, reflecting average differences in the level of attitude toward sea fennel products between groups. Since one group factor mean is set to zero, means values may also be interpreted as differences between any given group and the reference group.

In terms of **gender** differences, men exhibit a significantly more favourable attitude to sea fennel than women. However, this does not translate into higher purchase intentions by men. This is probably the result of men's less positive perception of the product and lower perceived behaviour control. Respondents **younger** than 45 years old exhibit significantly higher subjective knowledge, subjective norm, and food-related lifestyle scores than older respondents. **Urban** dwellers also exhibit significantly higher knowledge, better attitude, higher subjective norm, perceived behavioural control, and food-related lifestyle scores. However, perception and intention to buy are not significantly higher neither for the younger nor for the urban consumers. Respondents from **Southern Mediterranean** countries (IT, TR, TN) exhibit significantly higher latent means for all variables, except attitude, perception, and intention, meaning there are no big differences in the most relevant decision-making variables across the Mediterranean. Similarly, higher **objective knowledge** implies higher latent means for all variables except the two key ones: attitude and intention.

On the contrary, **higher awareness**, and – especially – previous experiences with the sea-fennel products (i.e., having **tasted** it), significantly increase all model constructs' scores: perception, knowledge, attitude, subjective norm, perceived behavioural control, food-related lifestyle and intention to buy.

The overall pooled SEM model is displayed in Figure 23. All coefficients are significant. Attitude depends largely on perception (beliefs) while itself is the second most relevant antecedent of behavioural intention together with the subjective norm. The difference is small, but it is interesting to note that – in the purchase of a complementary food such as sea fennel - for consumers the opinion of relevant others (SN) appears to be equally relevant than their own opinion (Attitude).

Perceived behavioural control as often in the SEM model related to food, appears to explain only a little above 20% of the final behavioural intention, followed by the food-related lifestyle that has a lower (but still significant) impact. Although purchasing sea fennel could be difficult if it is not usually available in local food stores, the evolving online marketplace renders almost any product at the willing consumer reach.

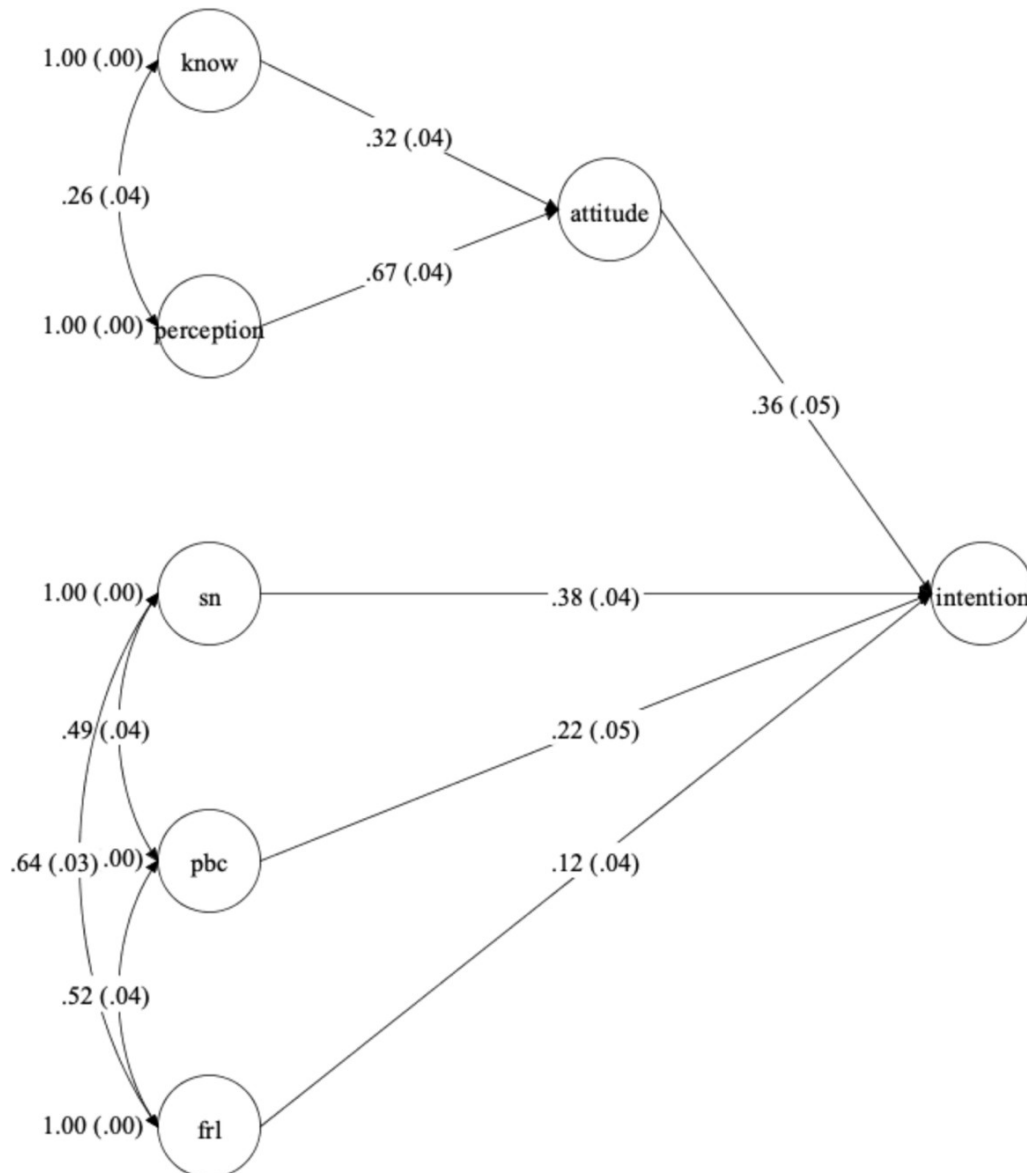


Figure 23. The estimated SEM model

All hypotheses have not been falsified. The model holds and is robust.

4 Conclusion

Despite being widely available in the Mediterranean region, sea fennel is a product with a low level of consumer awareness. In fact, more than half (54%) of consumers surveyed in the study stated that they had not heard of sea fennel. As a result, the tasting rates in countries other than Tunisia, as well, are less than 50%. Similarly, in all countries except Tunisia, the level of subjective knowledge is below average.

Given the low levels of awareness and knowledge of sea fennel across most of the Mediterranean countries studied, one of the main conclusions of this research is the need for further introduction of the plant to potential consumers.

According to the results, 35% of consumers "somewhat" or "strongly agree" that it is easy to find sea fennel food products, 53% that it is a low-processed product, 56% that it is a pleasant product, 54% that it is a tasty product, 71% that it is a safe product, 44% that it is an expensive product, 81% that it is a natural product, 77% that it is a healthy product, 69% that it is a sustainable product and 41% that it is a modern product.

These findings as well as the limited consumer awareness confirm the limited availability of sea fennel products in the consumer markets, which requires to be improved. On the other hand, consumers reveal considerably positive attitudes towards the natural, healthy, and sustainable characteristics of sea fennel, when they are given brief information on its properties. Therefore, these features could be underlined in promotional efforts. The results also put forward that sea fennel recipes could be further optimized.

It was determined that a significant portion of the consumers intend to purchase sea fennel primarily fresh. Ensuring the accessibility of fresh sea fennel in organic markets, local markets, and grocery stores is important in the mobilization of the market potential. At the same time, and since it is not a well-known product by consumers, different recipes should be developed in which fresh, pickled and powdered sea fennel can be used. Establishing tasting stands for these products in the markets where the product is sold is important in terms of increasing awareness.

The usage areas of this product should be increased in the health and cosmetics sector as well as in the food sector. Explaining the health benefits of this product by experts through radio, television, and social media is an important key point for the recognition of the product.

Market segmentation, targeting, and positioning strategies should be developed to reveal possible trends towards sea fennel. It is possible to develop different marketing strategies since consumers in each country have different personal characteristics such as education, age, employment status, geographical origin, and their levels of awareness and knowledge of this product, attitudes, purchasing intentions, and behaviours.

The SEM results show that if the product is not previously known or experienced there will be hardly a relevant purchase intention.

Besides, purchase intention highly depends on attitude, but – most importantly - on peer pressure, so the perceptions of others are also significant.

This again shows the importance of better communicating the product benefits, increasing product awareness and knowledge beyond the current niche, while possibly organizing testing events and using word-of-mouth and social (media) networks to increase purchase intentions and, consequently, behaviour.

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Annex 1. Consumer Survey

INTRODUCTION

Dear Participant,

You are invited to participate in a survey that is conducted by the Università Politecnica delle Marche (Italy) and Ege University (Turkey). Before you decide and continue to participate, it is important that you fully understand why this research is being done, what it will involve, and what the possible consequences are. Please, read the information below carefully and then decide whether you wish to participate or not.

This online survey is conducted as part of the PRIMA research project [SeaFennel4Med](#) to explore consumer attitudes and acceptance of sea-fennel-based food products. The information that you provide us with will contribute considerably to new scientific knowledge on consumer's perceptions of innovative products in the Mediterranean Area.

In the survey, you will be asked to fill out a survey that includes multiple-choice and open questions. It will take approximately 15 minutes.

Participation in this survey is completely voluntary. If you decide not to participate there will not be any negative consequences. Please be aware that if you decide to participate, you may stop participating at any time.

As your contribution consists of filling out a short questionnaire online we have not identified any serious risk or discomfort for you during your participation in the survey. There is no evidence that screens damage eyes, but long periods of working at a computer screen can cause discomfort.

Computer vision syndrome (CVS) or other computer-related injuries may occur if you stare at a computer screen and use your desktop, laptop, smartphone or other similar device incorrectly. You must ensure the size of text and images on the screen are the right size for you and take regular breaks. In case you experience discomfort, please stop participating in the survey.

The personal information collected will be kept completely confidential and will be used for research purposes only. Please click [HERE](#) to learn about the confidentiality of the research records or data. The D3A-SIMAU research group of UNIVPM will maintain the confidentiality of the research data as described in below.

In case of questions or observations on the survey, you can always contact the data protection and research responsible using the following contact details:

1. IDENTITY AND CONTACT DETAILS OF THE DATA CONTROLLER

The rector of Università Politecnica delle Marche (legal representative), Piazza Roma n. 22,
60121 ANCONA, Tel. 071.2201,
E-mail: info@univpm.it, PEC: protocollo@pec.univpm.it.

2. CONTACT DETAILS OF THE DATA PROTECTION OFFICER Tel.:

071.2203002,
E-mail: rpd@univpm.it, PEC: rpd@pec.univpm.it DATA
PROTECTION OFFICER
Attorney Massimiliano Galeazzi, Morolabs S.r.l.

RESEARCH RESPONSIBLE

Prof. Raffaele Zanolì,
Department of Agricultural, Food and Environmental Sciences,
Università Politecnica delle Marche, E-mail: neurolab@agrecon.univpm.it Thank you in advance
for your participation!

Consent

By clicking "I agree" below, you confirm that:

1. you are at least 18 years of age
2. you received and read the information of the processing of personal data
3. you give your consent to the processing of your personal data for the pursuit of the research purpose referred to in point 3.2, pursuant to art. 6 co.1, letter a) and art. 9, par.2, letter a), EU Reg. n.2016/679.
4. you grant permission to the storage and processing of personal data for other scientific or statistical purposes as illustrated in the information.

You understand that your participation is fully voluntary, and that you are able to withdraw from this research at any time, and without any reason.

- ☐ I Agree
- ☐ I Do Not Agree

Below you are presented with some country flags.

Which of the following refers to the flag of the country you reside in?

Images of country flags

In which country are you resident?

- ☐ Croatia
- ☐ France
- ☐ Italy
- ☐ Tunisia
- ☐ Türkiye
- ☐ Other

Please indicate your biological sex at birth:

- ☐ Female
- ☐ Male
- ☐ I don't want to answer

Within your household, who is generally responsible for the food shopping?

- ☐ Me
- ☐ Me and another person together
- ☐ Another person

Are you or is someone else in your household employed in any of the following professions? Multiple answers can be selected.

- ☐ Agriculture (farmer or grower)
- ☐ Food industry/ food processing
- ☐ Food wholesale or retail
- ☐ Market research companies
- ☐ Food Science or Agricultural Research Institute/University
- ☐ None of the above

Please indicate your age.

Have you ever heard about sea fennel?

Latin name: *Crithmum maritimum* L.

Local names (English): Rock Samphire, Samphire, St. Peter's herb

- ☐ No
- ☐ Yes

Sea fennel info

Sea Fennel (*Crithmum maritimum* L.) is a halophyte plant that grows spontaneously in rocky areas and salty soils along coastlines. In Mediterranean countries, sea fennel has several usage areas, such as culinary, medicine, and cosmetics, because of its nutrient and phytochemical contents, high nutritional value, diuretic, digestive and carminative properties. Traditionally, its leaves are consumed in salads, sauces, soups and as fermented in vinegar or oil. The composition of sea fennel contains dietary fibre, protein, polyunsaturated fatty acids, minerals, vitamins (C, A, E), polyphenols and essential oils.

Bioactive compounds of sea fennel have functional properties such as antioxidant, antimicrobial and anti-inflammatory activity.

Please indicate the extent to which you agree or disagree with the following statements:

	Strongly disagree	Some what disagree	Neither agree nor disagree	Some what agree	Strongly agree
In comparison with an average person, I know a lot about sea fennel	☐	☐	☐	☐	☐

People who know me, consider me an expert in the field of sea fennel

0 0 0 0 0

I know a lot about how to evaluate the quality of sea fennel products

0 0 0 0 0

Please select the images that you recognise as sea fennel.



0



0



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Please indicate your opinion about sea fennel food products on the scale below:

"I believe that sea fennel food products are ..."

	Neutral						
Traditional	☐	☐	☐	☐	☐	☐	Modern
Unsustainable	☐	☐	☐	☐	☐	☐	Sustainable
Unhealthy	☐	☐	☐	☐	☐	☐	Healthy
Unnatural	☐	☐	☐	☐	☐	☐	Natural
Cheap	☐	☐	☐	☐	☐	☐	Expensive
Unsafe	☐	☐	☐	☐	☐	☐	Safe

Not tasty Unpleasant	0	0	0	0	0	Tasty Pleasant
Highly processed	0	0	0	0	0	Unprocessed
Difficult to find	0	0	0	0	0	Easy to find
	0	0	0	0	0	

Please indicate how much you agree or disagree with the following statements.

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Purchasing sea fennel food products is a good idea	☐	☐	☐	☐	☐
Purchasing sea fennel food products is pleasant	☐	☐	☐	☐	☐
Purchasing sea fennel food products is a wise choice	☐	☐	☐	☐	☐

Please indicate how much you agree or disagree with the following statements.

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I like to try recipes from different countries I like to try new foods that I have never tasted before	☐	☐	☐	☐	☐
I look for ways to prepare unusual meals Eating and food is an important part of my social life	☐	☐	☐	☐	☐
Decisions on what to eat and drink are very important for me	☐	☐	☐	☐	☐
and drinking are a continuous source I try to choose of joy for me	☐	☐	☐	☐	☐
food produced with minimal impact on the environment	☐	☐	☐	☐	☐

This is an attention filter: please select Somewhat agree	0	0	0	0	0
I am concerned about the conditions under which the food I buy is produced	0	0	0	0	0
I try to choose food that is produced in a sustainable way	0	0	0	0	0

Please indicate how much you agree or disagree with the following statements.

	Strongl y disagre e	Somew hat disagre e	Neither agree nor disagre e	Somew hat agree	Strongl y agree
Most people who are important to me would approve of me buying sea fennel food products	○	○	0	0	0
Most people who I value think that I should buy sea fennel food products if they were available in the shops	○	○	0	0	0
My family would encourage me to buy sea fennel food products	○	○	0	0	0

Please indicate how much you agree or disagree with the following statements.

	Strongl y disagre e	Somew hat disagre e	Neither agree nor disagre e	Somew hat agree	Strongl y agree
Whether I would buy sea fennel food products - if available for sale - is entirely up to me	○	○	0	0	0
If sea fennel food products were available for sale nothing would deter me from buying them, if I wanted to	○	○	0	0	0
I am confident that I am free to decide if buying or not sea fennel food products - if available for sale	○	○	0	0	0

All things considered, if sea fennel food products were available in the shops, I would definitely buy them.

- ☐ Extremely Unlikely
- ☐ Somewhat Unlikely
- ☐ Neither Likely nor Unlikely
- ☐ Somewhat Likely
- ☐ Extremely Likely

If sea fennel products are available in the shops, which of the following sea fennel products are you most likely to purchase?

	Extremely unlikely	Somewhat unlikely	Neither likely nor unlikely	Somewhat likely	Extremely likely
Sea fennel powder	☐	☐	☐	☐	☐
Pickled sea fennel	☐	☐	☐	☐	☐
Fresh sea fennel	☐	☐	☐	☐	☐

Tasted Have you ever tasted sea fennel or sea fennel based products?

- ☐ Yes
- ☐ No

What is the highest level of education that you achieved?

- ☐ Lower secondary education or below
- ☐ Upper secondary and equivalents
- ☐ Bachelor's degree or equivalent level
- ☐ Postgraduate with master or doctoral degree
- ☐ Other (please specify): _____

What is your employment status?

- ☐ Employed
- ☐ Unemployed
- ☐ Retired
- ☐ Student or not currently looking for a job

In which type of area do you live?

- ☐ Urban (>50.000 inhabitants)

- Intermediate (5.000 – 50.000 inhabitants)
- Rural (<5.000 inhabitants)

How many persons live in your household, including yourself? (Type zero "0" if there is no one in the specified group)

- Younger than 18 years old _____
- 18-64 years old _____
- Older than 64 years old _____