Sustainable development of Iran's medicinal plant exports to the global value chain: a strategic analysis

Maryam Shariatzadeh [1], Masoud Bijani [1*] and Farzane Bahadori [2*]

[1] Department of Agricultural Extension and Education, College of Agriculture, Tarbiat Modares University (TMU), Tehran, Iran, [2] Agricultural Research, Education and Extension Organization (AREEO), Semnan, Iran

Introduction: Iran, with a wide variety of climates, is among the top 20 countries in the world in terms of medicinal plant production, yet it does not have a significant position among the top exporting countries of medicinal plants and related products. Therefore, this exploratory descriptive research was conducted with the aim of analyzing the strategic development for sustainable export of medicinal plants from Iran to the global value chain using the SWOT technique.

Methods: The study population consisted of three groups: experts in medicinal plants, managers and relevant experts in agricultural administrations, natural resources and watershed management, Agriculture and natural resources research and education center, as well as producers, traders, and managers in the field of medicinal plants, with 31 individuals selected purposefully as a sample using snowball sampling method.

Results and discussion: Based on the findings, 10 strengths, 25 weaknesses, 11 opportunities, and 16 threats were identified. The results indicated that the average weaknesses outweighed the strengths, and threats outweighed the opportunities. Therefore, the strategic quadrant of the SWOT matrix was placed on the WT (defensive strategies). Accordingly, some proposed strategies such as "Encouraging regional investment in the field of medicinal plant processing industries" and "Reforming and facilitating administrative bureaucracy to obtain necessary licenses for final product production" were suggested to play a more significant role in the development of medicinal plant production and processing. The findings of this study can be utilized by decision-makers and relevant policymakers in planning and for sustainable development of Iranian medicinal plant exports in the global value chain.

KEYWORDS

medicinal plants, sustainable export, SWOT technique, defensive strategies, sustainability indicators

1 Introduction

Medicinal plants in Iran are globally recognized as one of the most important medicinal resources due to their diverse variety and various medicinal properties. Iran is among the top 20 countries in the world in the production of medicinal plants (Mehrnia et al., 2021). However, Iran is not among the leading countries in the export of medicinal plants and related products. Table 1 illustrates the leading countries in the world in the export of medicinal plants. A comparison of Iran's potential in terms of richness and diversity of medicinal plants with some of the mentioned countries indicates challenges in entering

Iranian medicinal plants into the global value chain and, consequently, the country's economic development.

TABLE 1 The world's leading countries in the import and export of commodity group pharmaceutical plants, 2022.

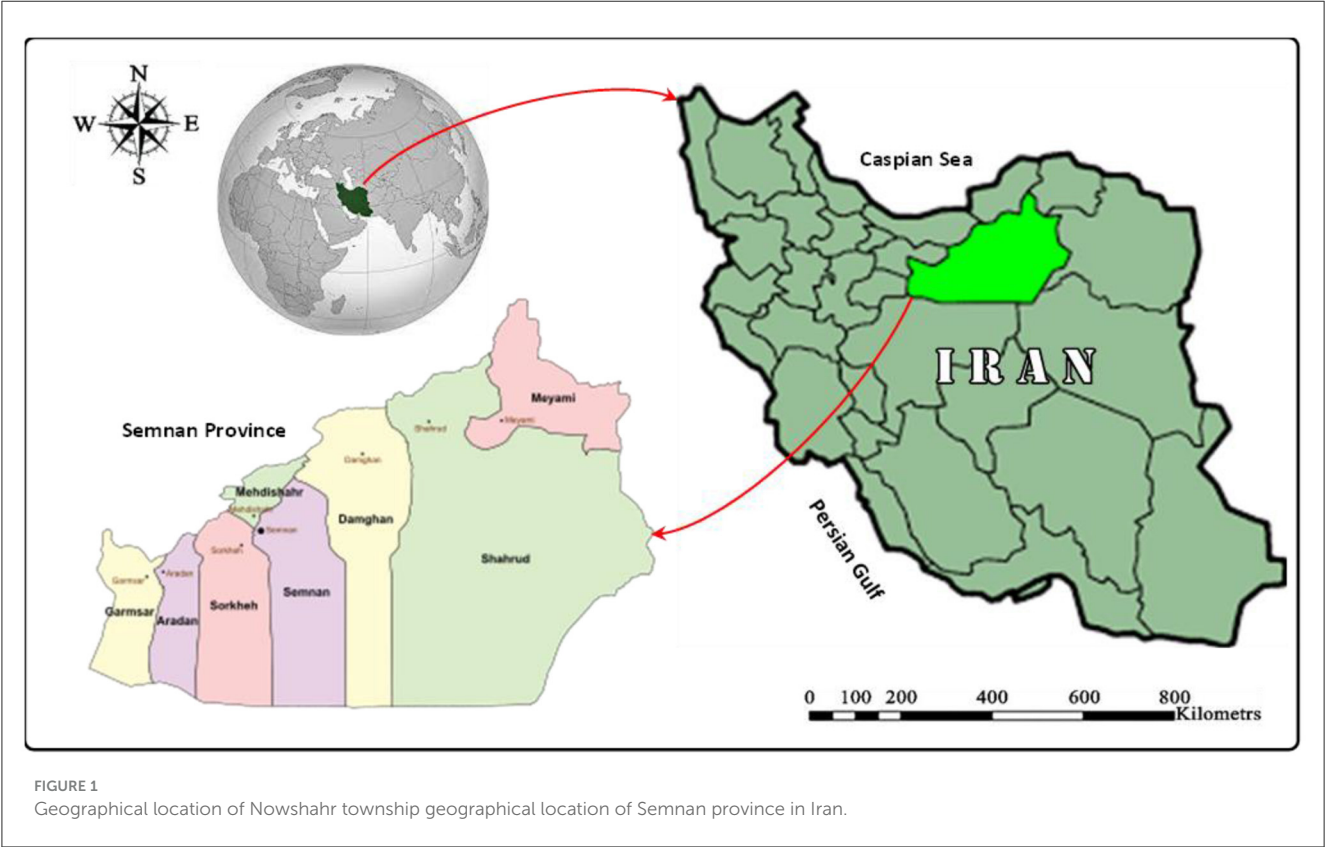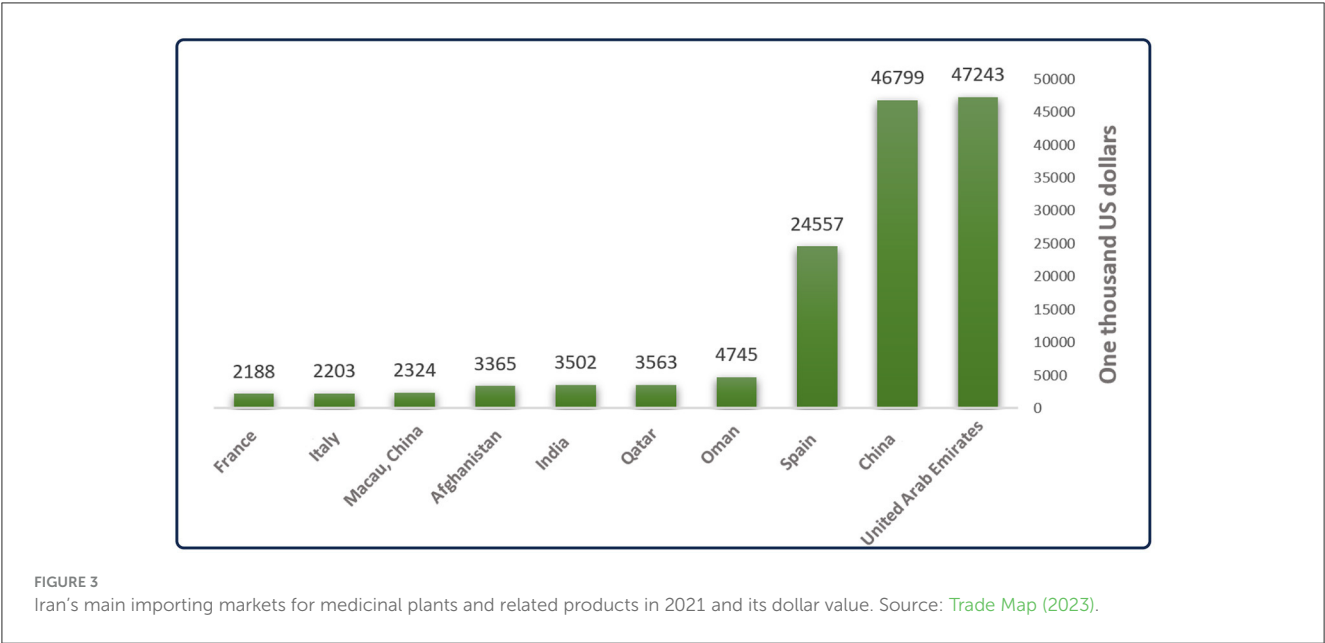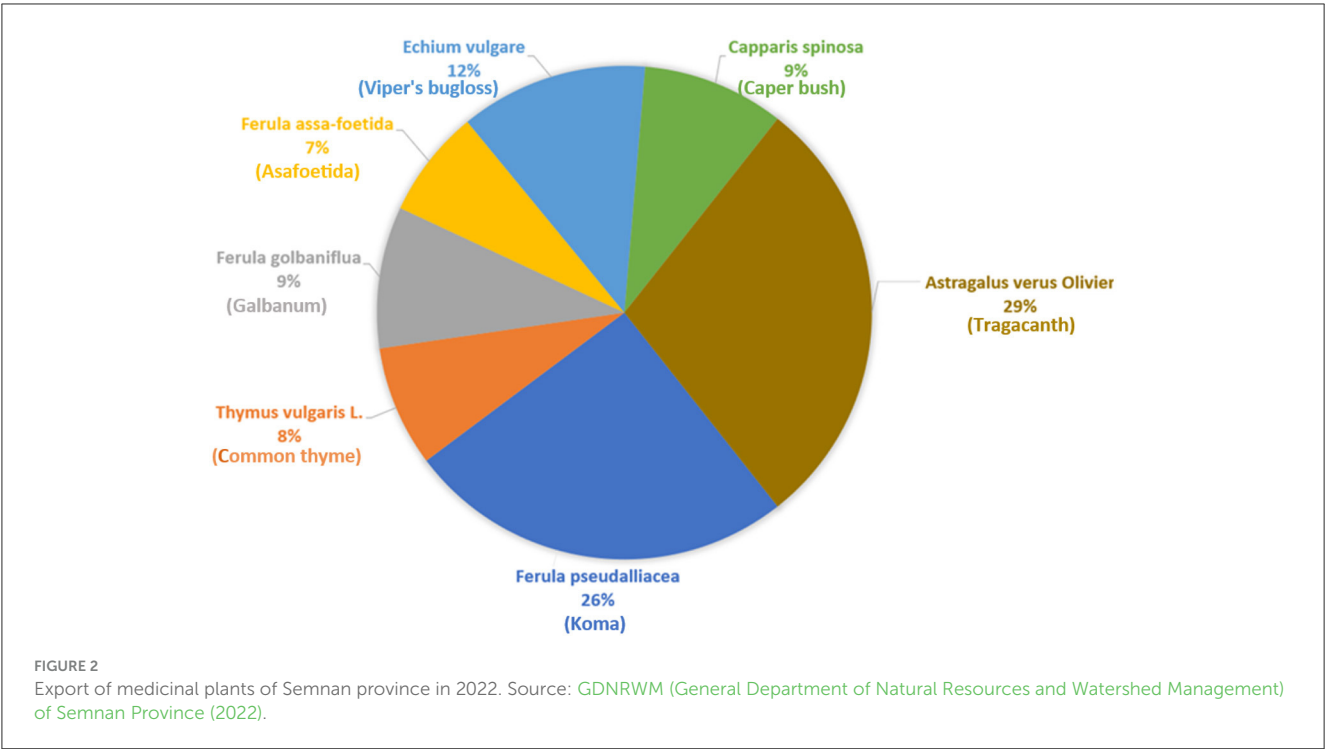| Country of import	Tonnes	Value (USSD)	Country of export	Tonnes	Value (USSD)
USA	157,347	420,066	India	35,686	98591,9
Germany	64,525	206,001	USA	31,136	707,884
Netherlands	101,389	182,127	France	9,029	438,444
Japan	69,490	155,350	Brazil	55,592	420,234
England	50,816	139,067	China	17,326	322,472
United Arabic Emirates	117,152	116,786	Germany	7,999	248,050
France	22,870	96,745	England	7,283	197,711
Canada	32,827	95,791	Italy	6,232	178,532
India	67,968	89,026	Mexico	Not available	177,963
Spain	Not available	88,519	Indonesia	5,908	172,873
Arabia	45,467	88,114	Netherlands	5,205	1,566,691
Belgium	19,167	71,427	Spain	6,787	156,547
The whole world		3,074,158	The whole world		5,567,251

Source: Trade Map (2023).

In Semnan province, Iran (Figure 1), annually three thousand tons of medicinal plants are harvested and utilized from rangelands. Approximately 50% of these plants are exported. Exported products such as *Ferula assa-foetida* (Asafoetida), *Ferula pseudalliacea* (Koma), *Zataria multiflora* (Shirazi Thyme), *Astragalus verus Olivier* (Tragacanth), *Ferula gummosa* (Galbanum), *Gundelia tournefortii* (Tumble Thistle), and *Terfezia boudieri Chatin* (Desert Truffle).

Figure 2 illustrates the export of medicinal plants from Semnan province in 2022 by product type. *Astragalus verus Olivier* had the highest export amount in 2022, while *Terfezia boudieri Chatin* had the lowest export volume among medicinal plants from the province.

The sustainable production of medicinal plants can contribute to preserving biodiversity, improving the quantitative and qualitative production, increasing employment opportunities and income generation, enhancing health, and improving the quality of life for individuals in rural and remote areas (Astutik et al., 2023). According to published statistics, Iranian medicinal plants are exported to more than 20 countries worldwide. Some of these countries include Iraq, Germany, India, China, Italy, United Arab Emirates, Egypt, Turkey, France, Japan, South Korea, Bahrain, Armenia, Qatar, Lebanon, Republic of Azerbaijan, Russia, Afghanistan, and Yemen (Karim et al., 2020). Figure 3 depicts the level of exports of Iranian medicinal plants to target countries in the year 2021.

In this regard, Iran needs to make more efforts and developments to improve the quality and increase production capacity, develop new markets, appropriate marketing, and

FIGURE 1
Geographical location of Nowshahr township geographical location of Semnan province in Iran.

FIGURE 2
Export of medicinal plants of Semnan province in 2022. Source: GDNRWM (General Department of Natural Resources and Watershed Management) of Semnan Province (2022).

FIGURE 3
Iran's main importing markets for medicinal plants and related products in 2021 and its dollar value. Source: Trade Map (2023).

optimize the use of natural resources and the environment to compete with other countries in the global market (Amiri et al., 2021). Therefore, this study examines the challenges of production and processing of medicinal plants in Semnan province to analyze a strategic development for sustainable export of medicinal plants of Iran to the global value chain. Challenges such as quality, safety, international standards, competition with other provinces producing medicinal plants are discussed and solutions are provided to address these challenges and develop the industry of medicinal plants. The novelty of this research, in addition to the geographical location (Semnan province), focuses on identifying

weaknesses and strengths, opportunities, and threats for providing a strategic analysis and sustainable development for the export of medicinal plants.

2 Theoretical background and literature review

Having comprehensive and reliable information about the distribution of medicinal plants allows for effective management, systematic planning, and economical exploitation of them. Success

in commercializing medicinal plant products requires a clear understanding of demand and production systems of medicinal plants along with their value chain. A value chain encompasses a full range of activities necessary for the utilization of a product from its source to the end user in a way that meets their needs, tastes, and preferences (Volenzo and Odiyo, 2020). In this regard, having international standards in the production and export of medicinal plants is of paramount importance, and failing to adhere to these standards may create difficulties for exporters (Vardian et al., 2021). To produce, process, and export medicinal plants and their derivatives to global markets, specific standards must be followed. The standards that need to be adhered to in the production and export of medicinal plants include:

- Good Manufacturing Practices (GMP), which involve compliance with issues such as quality management, production process management, human resource management, etc. (Karamipour Esfahani and Abedi, 2016).
- Good Agricultural Practices (GAP), which involve adherence to issues such as using healthy seeds, appropriate use of organic and chemical fertilizers, proper water uses and water resource management, weed control, pest and disease control, etc. (Karamipour Esfahani and Abedi, 2016).
- ISO 9001 standard for compliance with quality management standards and ISO 14001 standard for adherence to environmental issues in the production and export of medicinal plants to global markets [INSO (Iran National Standard Organization), 2023].
- Hazard Analysis Critical Control Point (HACCP) standard, which is used in the industry for ensuring safety and hygiene in the production and export of herbal products to global markets (Palash et al., 2021).
- Iranian National Standard (Medicinal plants, in general, do not have a mandatory national standard. However, non-carbonated herbal drinks and herbal distillates have national standards numbered 11077 and 10077) [INSO (Iran National Standard Organization), 2023].

In addition to the specific standards for the collection of plants from natural habitats, there are multiple factors that must be considered.

Despite Iran's suitable climate and abundant diversity of medicinal plants, being recognized as one of the important countries in the production of aromatic and medicinal plants, entering the global value chain of these plants and their by-products poses challenges for marketers and producers, including high diversity of medicinal plants, inadequate quality of products, and lack of customer identification (Vardian et al., 2021; Yang, 2024). A study conducted in Bangladesh in 2021 identified the barriers of the medicinal plants industry to enter the global value chain, including the lack of modern production techniques and business knowledge, financial backwardness of medicinal plant producing farmers, minimal educational and promotional support, and ultimately identified demand price and unstable market as challenges and introduced the strengths of the medicinal plants industry as land suitability, abundant inputs, and wide acceptance in society. Furthermore, low governmental and non-governmental support and low quality of inputs have been identified as threatening factors to the medicinal plants industry (Palash et al., 2021).

Given the issues mentioned, marketing in the herbal value chain is considered one of the key factors in the success of exporting these plants. Marketing involves various processes such as market research, product design, production, packaging, distribution, and sales (Alizadeh et al., 2023; Mostafayi Darmian et al., 2023). In developing countries, intermediaries dominate in the field of trade and marketing as local communities are not well organized (Volenzo and Odiyo, 2020). Therefore, marketing is one of the areas that is worthy of investigation and in need of enhancement for the sustainable production of medicinal plants in global value chains. In fact, one of the ways to reach global markets is to be familiar with the principles of marketing and branding (Tom et al., 2018). Through these methods, producers can introduce their products to customers worldwide and improve new markets by identifying customer needs (Karim et al., 2020). Thus, understanding the importance of marketing and using appropriate marketing methods can lead to a considerable improvement in the sales and exports of aromatic and medicinal plants in global markets (Rana et al., 2020).

Marketing and market orientation at the macro level in the pharmaceutical plants industry encompass processes carried out for the purpose of selling and developing the target market of pharmaceutical plant products in the international and domestic markets (Singh et al., 2022). These processes include market analysis, branding, advertising, market development, and marketing strategy determination (Karim et al., 2020). Based on numerous studies and marketing theories, the quality of marketing agricultural products with an emphasis on marketing pharmaceutical plants, including the commitment and inclination of senior managers toward marketing, has been identified as a foundational factor in marketing pharmaceutical plants (Alizadeh et al., 2023). Furthermore, skill development and market

TABLE 2 The statistical population of the panel of experts and the selected sample size.

Statistical population	Sampling method	Selected sample (n)
Subject matter experts	Purposive sampling (snowball method)	12
Executive managers and experts		9
Producers, traders and managers of transformation industries in the field of medicinal plants		10
Total		31

TABLE 3 SWOT matrix and how to determine strategies.

SWOT matrix		Internal factors[a]	
		Strengths (S)	Weaknesses (W)
External factors[b]	Opportunities (O)	Offensive strategy (SO)	Adaptive strategy (WO)
	Threats (T)	Conservative strategy (ST)	Defensive strategy (WT)

[a]Internal factors are the set of things that are in the organization's possession and have the ability to intervene in them.
[b]External factors are the set of things that are not under the control of the organization and there is no easy possibility to intervene in them.

understanding are factors that lead to the sustainable development of pharmaceutical plants production and globalization of pharmaceutical plants markets and the expansion of agricultural promotion in the pharmaceutical plants sector (Zhao et al., 2021; Alizadeh et al., 2023). In order to achieve these goals, the need for the provision of complementary strategies in marketing and market orientation at the macro level is felt in the policy-making domain in the pharmaceutical plants sector (Bekkers et al., 2020; Zhao et al., 2022).

Synergistic strategies in marketing and market orientation in the herbal industry encompass actions that companies can take to enhance their performance in the market (Kala et al., 2006). Various studies have examined these strategies under different titles, summarily including:

- Collaborating with relevant companies: Manufacturers can collaborate with related companies in the herbal

industry to enhance their market performance. For instance, collaborations of manufacturers with distribution companies lead to a wider range of audiences with easier access for consumers (Heidarzade Rizi et al., 2015).
- Diversifying product development: In the herbal industry, focusing on essences and plant-based active ingredients meets the diverse needs of various audiences and increases market share for manufacturers (Zare Zardeini and Amiri Aghdaie, 2014; Afshar et al., 2022).
- Joint advertising: Joint advertising can be an appropriate operational solution to enhance the effectiveness of product offerings (Kala et al., 2006).
- Joint research and development: through collaboration between manufacturers and traders in research and development, products are aligned with market needs (Mintah et al., 2022).

TABLE 4 Descriptive statistics of the respondents ($n = 31$).

Variable	Level	Frequency	Percent	Cumulative percentage	M	SD	Mode	Min	Max
Gender	Male	23	74				Male		
	Female	8	26						
Age (year)	$X_i > 30$	2	6	6	39.71	6.67	38	28	61
	$30 \geq X_i > 45$	20	64	70					
	$45 \geq X_i > 60$	8	26	96					
	$60 \geq X_i$	1	4	100					
Work experience (year)	$X_i > 10$	12	38	38	15.68	9.3	8	1	30
	$10 \geq X_i > 20$	15	48	86					
	$20 \geq X_i$	4	14	100					
Scientific degree	Ph.D.	8	26	26			Master		
	Master	13	42	68					
	Bachelor's degree	8	26	94					
	Associate Degree and lower	2	6	100					
Field of study	Agricultural extension and education	2	6	6			Natural resource engineering and related fields		
	Horticultural engineering	9	29	35					
	Plant medicine engineering	4	14	47					
	Plant biology	6	19	77					
	Natural resource engineering and related fields	10	32	100					
Workplace	University	4	13	13			Private sector manufacturer and trader		
	Agricultural Research and Education Center	4	13	26					
	Jihad-e Agriculture Organization	4	13	39					
	General Department of Natural Resources and Watershed Management	4	13	52					
	Private sector manufacturer and trader	15	48	100					

M, mean; SD, standard deviation; Max, maximum; Min, minimum.

A literature review on the obstacles to entrepreneurship development in the field of medicinal plants and sustainable agriculture in developing countries, including Iran, reveals the existence of five barriers which are referred to as "educational-promotional," "economic," "supportive," "technical-management," and "infrastructural" barriers (Asl Roosta et al., 2017; Maleksaeidi and Memarbashi, 2023). The proposed solutions in this research can also assist companies producing products derived from medicinal plants to perform more successfully in domestic and international markets, thereby facilitating the growth and development of the medicinal plants industry in Iran.

3 Materials and methods

The current research is considered a qualitative study in terms of paradigm, a non-experimental study in terms of variable control, applied research in terms of objective, and a descriptive study in terms of data collection, which was carried out using the SWOT technique. The statistical population of this research included three groups: specialists in medicinal plants and related fields (as subject matter experts), managers and relevant experts in the Agricultural Jihad, Natural Resources, Watershed Management departments, and the Agriculture and Natural Resources Research and Education Center (as planners), as well as producers, traders, and managers in

TABLE 5 Descriptive analysis of the "strengths" extracted in the three phases of Delphi.

Component	Dimension	No.	Indicators	Phase 1	Phase 2		Phase 3				
				No. of repetitions	Agreement		M^b	SD^c	Relative importance[d]	Final coefficient[e]	Rank[f]
					Frequency	Percent[a]					
Strategic planning for the development of production and processing of medicinal	Strengths	S_1	The existence of medicinal plants with high and unique economic value	10	26	83	4	0.16	0.103	0.412	1
		S_2	Benefiting from skilled and specialized human resources in various scientific degrees	6	22	70	4	0.18	0.103	0.412	2
		S_3	Easy access to water, electricity and telephone infrastructure	13	26	83	4	0.2	0.103	0.412	3
		S_4	Strong genetic resources (ethnobotanical knowledge)	8	22	70	3.96	0.18	0.102	0.403	4
		S_5	Detailed familiarization and orientation of the employees of the medicinal plants department in line with the goals and mission of the relevant organizations and institutions	15	26	83	3.93	0.17	0.101	0.396	5
		S_6	Promoting the culture of innovation and technology creation through holding seminars and educational workshops	5	22	70	3.87	0.17	0.099	0.383	6
		S_7	The existence of many and reliable universities and research centers	6	27	87	3.87	0.21	0.099	0.383	7
		S_8	The existence of a suitable platform for conducting tests and providing laboratory, workshop, exhibition services	12	29	93	3.8	0.21	0.098	0.372	8
		S_9	High climatic diversity	9	23	74	3.7	0.19	0.096	0.355	9
		S_{10}	The existence of easy and cheap transportation infrastructure	8	24	77	3.7	0.19	0.096	0.355	9
	Total mean				3.83		1.000		1.122		

[a] The lowest percentage of acceptable agreement was 70%.
[b] The mean (M) was in the five-point Likert scale (1= completely disagree to 5= completely agree) according to the respondents.
[c] SD, Standard Deviation.
[d] Relative importance = Normal weight = Intensity ÷ Total intensity.
[e] Final coefficient = Intensity × Relative importance.
[f] In cases where the mean of the indicators was the same, the standard deviation was used as the rating criterion.

TABLE 6 Descriptive analysis of the "weakness" extracted in the three phases of Delphi.

Component	Dimension	No.	Indicators	Phase 1	Phase 2		Phase 3				
				No. of repetitions	Agreement		M^b	SD^c	Relative importance[d]	Final coefficient[e]	Rank[f]
					Frequency	Percent[a]					
Strategic planning for the development of production and processing of medicinal	Weakness	W_1	The lack of importance to the discussion of education and promotion in raising the awareness of the local people and the development of newly established and knowledge-based companies entering this field.	9	23	74	4.38	0.13	0.0421	0.18	1
		W_2	Lack of knowledge about the compounds in medicinal plants	8	24	77	4.35	0.13	0.0418	0.18	2
		W_3	Weakness in the processing and production of the final product from medicinal plants	6	27	87	4.29	0.13	0.0413	0.18	3
		W_4	Lack of support from the Ministry of Health	10	26	83	4.29	0.14	0.0413	0.18	4
		W_5	Lack of labor for harvesting and processing	6	22	70	4.29	0.15	0.0413	0.18	5
		W_6	Failure to comply with health issues and standards in the process of production, harvesting, processing and trade of medicinal plants has been emphasized as one of the important obstacles.	8	25	80	4.29	0.15	0.0413	0.18	5
		W_7	Indiscriminate harvesting of nature and destruction of natural resources by mines and...	7	29	93	4.25	0.13	0.0409	0.17	6
		W_8	Lack of sufficient knowledge about the method and principles of harvesting and the exact time of harvesting and processing	6	22	70	4.25	0.16	0.0409	0.17	7
		W_9	Lack of inter-departmental coordination in relevant ministries and agencies	12	30	96	4.25	0.16	0.0409	0.17	7
		W_{10}	Failure to guarantee the quantitative and qualitative stability of medicinal plants and their products	11	29	93	4.22	0.12	0.0406	0.17	8
		W_{11}	Dominance of traditional methods in industries and agriculture of the region	12	29	93	4.22	0.17	0.0406	0.17	9
		W_{12}	Absence and implementation of a codified program in the production and processing of medicinal plants	4	25	80	4.22	0.17	0.0406	0.17	9
		W_{13}	Smuggling and selling in bulk	15	26	83	4.19	0.15	0.0403	0.17	10
		W_{14}	Absence of health monitoring system of medicinal plants produced or collected	9	22	70	4.16	0.16	0.0400	0.17	11
		W_{15}	Lack of teamwork spirit among manufacturers and traders	11	24	77	4.16	0.18	0.0400	0.17	12

(Continued)

TABLE 6 (Continued)

Component	Dimension	No.	Indicators	Phase 1	Phase 2		Phase 3				
				No. of repetitions	Agreement		M^b	SD^c	Relative importance[d]	Final coefficient[e]	Rank[f]
					Frequency	Percent[a]					
		W_{16}	Cumbersome administrative structures for obtaining permits	8	22	70	4.16	0.19	0.0400	0.17	13
		W_{17}	Non-assignment of insurance to herbal medicines	6	26	83	4.12	0.17	0.0396	0.16	14
		W_{18}	Failure to observe isolation in cultivation	17	23	74	4.09	0.18	0.0393	0.16	15
		W_{19}	Non-flooding of habitats of medicinal plants with economic value and endangered	3	25	80	4.06	0.19	0.0390	0.16	16
		W_{20}	Low quality and lack of variety of processed products	9	29	93	4.06	0.2	0.0390	0.16	17
		W_{21}	The lack of financial credits and necessary support allocated to the producers of the sector	5	22	70	4.03	0.19	0.0387	0.16	18
		W_{22}	Reducing the quantity and quality of water and soil resources	10	26	83	4	0.17	0.0385	0.15	19
		W_{23}	Weakness of transformation industries and preservation of medicinal plant products	14	26	83	3.96	0.17	0.0381	0.15	20
		W_{24}	Lack of primary standard	11	27	87	3.87	0.21	0.0371	0.14	21
		W_{25}	Lack of motivation for farmers and ranchers to produce	6	23	74	3.83	0.18	0.0368	0.14	22
	Total mean					**4.15**		**1.0000**	**4.16**		

[a] The lowest percentage of acceptable agreement was 70%.

[b] The mean (M) was in the five-point Likert scale (1= completely disagree to 5= completely agree) according to the respondents.

[c] SD, Standard Deviation.

[d] Relative importance = Normal weight = Intensity ÷ Total intensity.

[e] Final coefficient = Intensity × Relative importance.

[f] In cases where the mean of the indicators was the same, the standard deviation was used as the rating criterion.

the pharmaceutical industry sector (as operational and executive agents), of which 31 individuals were purposefully and snowball-sampled (Table 2). It is worth noting that the sample size in a Delphi panel can range from 3 to 80 individuals. In most studies utilizing the Delphi technique, the number of participants ranges from 5 to 20 individuals (Hsu and Sandford, 2007).

The data collection instruments consisted of questionnaires and interviews. To achieve a consensus, the Delphi technique was employed in three rounds. The use of the Delphi technique is appropriate when the research goals involve exploration, prioritization, and obtaining new information in the studied area (Tohidimoghadam et al., 2023). In the first round, an open-ended questionnaire consisting of five questions regarding the problems and their implications in the production, processing, and export of aromatic and medicinal plants was presented. In the first round, 122 factors were extracted from the respondents' opinions. In the second round, the members of the expert panel expressed

their agreement or disagreement with the extracted items. After collecting the questionnaires and analyzing the responses using SPSS27 software, the items agreed upon by more than 70% of the respondents were retained, and the rest were removed (Tohidimoghadam et al., 2023; Mohammadi et al., 2024). The remaining items were used as the main items in the design of the third questionnaire. In the third stage, the items were categorized into four sections of strengths, weaknesses, opportunities, and threats and presented as 62 questions tailored to the respondents. These questions were designed in the form of a Likert scale (with options of 1 = very low, 2 = low, 3 = moderate, 4 = high, and 5 = very high), and the recipients were asked to express their level of agreement regarding the main factors affecting the production, processing, and export of medicinal plants. The face validity of the questionnaire at each stage was examined and confirmed by a panel of experts. As for the reliability of the questionnaire, in the Delphi method, when the size of the respondent

TABLE 7 Descriptive analysis of the "opportunities" extracted in the three phases of Delphi.

Component	Dimension	No.	Indicators	Phase 1	Phase 2		Phase 3				
				No. of repetitions	Agreement		M^b	SD^c	Relative importance[d]	Final coefficient[e]	Rank[f]
					Frequency	Percent[a]					
Strategic planning for the development of production and processing of medicinal	Opportunities	O_1	High investment opportunities in the field of production and processing of horticultural and agricultural products, medicinal plants, saffron, aquatics, etc.	8	22	70	4.19	0.14	0.0961	0.40	1
		O_2	The existence of many and reliable universities and research centers	9	23	74	4.06	0.2	0.0932	0.38	2
		O_3	Convenient access to neighboring countries (Iran's location between East and West)	20	29	93	4.03	0.18	0.0925	0.37	3
		O_4	The possibility of modifying and localizing medicinal plants	8	24	77	4	0.17	0.0917	0.37	4
		O_5	Existence of necessary legal emphasis in upstream documents (vision document, fifth development plan law)	17	22	70	4	0.19	0.0918	0.37	5
		O_6	Improving the view of managers in supporting the use of knowledge-based research results	6	27	87	3.93	0.17	0.0902	0.35	6
		O_7	The possibility of improving production productivity with basic and simple scientific training	12	29	93	3.93	0.17	0.0902	0.35	6
		O_8	Adaptable climate for the synthesis of more effective substances	10	26	83	3.9	0.18	0.0895	0.35	7
		O_9	The possibility of creating new and sustainable job opportunities	6	22	70	3.9	0.18	0.0895	0.35	7
		O_{10}	The possibility of using legal capacities and credit facilities available in the country to support knowledge-based companies that operate in the field of medicinal plants.	15	26	83	3.87	0.21	0.0888	0.34	8
		O_{11}	The presence of a wide market for the trade of medicinal plants	5	22	70	3.77	0.2	0.0865	0.33	9
		Total mean				**3.96**		**1.0000**	**3.96**		

[a]The lowest percentage of acceptable agreement was 70%.

[b]The mean (M) was in the five-point Likert scale (1= completely disagree to 5= completely agree) according to the respondents.

[c]SD, Standard Deviation.

[d]Relative importance = Normal weight = Intensity ÷ Total intensity.

[e]Final coefficient = Intensity × Relative importance.

[f]In cases where the mean of the indicators was the same, the standard deviation was used as the rating criterion.

group exceeds 13 experts, the reliability is estimated at over 80% (Drumm et al., 2022).

Following the collection of the questionnaires in the third phase, the gathered responses were analyzed using $SPSS_{27}$ software. The statistics utilized in this phase included mean, standard deviation, relative importance, and final coefficient. Ultimately,

the identified factors consisted of 10 strengths, 25 weaknesses, 11 opportunities, and 16 threats, which were analyzed in a SWOT matrix. In the third phase, the received responses were ranked, and the items with agreement levels below 70% were eliminated. 62 remaining items were classified on a 5-point Likert scale ranging from 1 (lowest level of agreement) to 5 (highest level of agreement)

TABLE 8 Descriptive analysis of the "threats" extracted in the three phases of Delphi.

Component	Dimension	No.	Indicators	Phase 1	Phase 2		Phase 3				
				No. of repetitions	Agreement		M^b	SD^c	Relative importance[d]	Final coefficient[e]	Rank[f]
					Frequency	Percent[a]					
Strategic planning for the development of production and processing of medicinal	Threats	T_1	Ignoring non-university elites and entrepreneurs without university degrees	8	24	77	4.36	0.12	0.065	0.29	1
		T_2	The high cost of purchasing laboratory equipment	12	25	80	4.33	0.14	0.065	0.28	2
		T_3	More profitability and less risk in brokerage instead of production	5	22	70	4.3	0.12	0.064	0.28	3
		T_4	Weak international communication with processing centers and pharmaceutical companies inside and outside the country	9	23	74	4.3	0.13	0.064	0.28	4
		T_5	Lack of knowledge base of agriculture in the country	6	27	87	4.27	0.12	0.064	0.27	5
		T_6	High risk of investment in the production sector	6	22	70	4.27	0.15	0.064	0.27	6
		T_7	Lack of economic stability in the field of business	15	26	83	4.21	0.14	0.063	0.27	7
		T_8	Cautious approach and reluctance of banks with risky investment category	12	29	93	4.21	0.16	0.063	0.27	8
		T_9	Lack of familiarity of producers in the agricultural sector with the process of commercialization, market issues, etc.	8	22	70	4.18	0.18	0.063	0.26	9
		T_{10}	The lack of desire and interest of the local people to preserve the pasture plant species	17	29	93	4.18	0.18	0.063	0.26	9
		T_{11}	Inability to access regional and global markets	21	30		4.12	0.17	0.062	0.25	10
		T_{12}	Lack of knowledge of local people about medicinal plants in the region	13	22	70	4.12	0.18	0.062	0.25	11
		T_{13}	Lack of risk-taking culture and challenging business start-up in the region	10	26	83	4	0.16	0.061	0.24	12
		T_{14}	Lack of sustainability of specialist forces	5	22	70	4	0.18	0.060	0.24	13
		T_{15}	The lack of awareness of mountaineers, tourism and ecotourism about the value of medicinal plants in the region and the country, which causes the unwanted destruction of plants.	11	24	77	3.96	0.19	0.059	0.24	14
		T_{16}	Failure to realize the minimum predicted and approved credit sources	7	27	87	3.87	0.17	0.058	0.22	15
		Total mean				**4.16**		**1.000**	**4.17**		

[a]The lowest percentage of acceptable agreement was 70%.

[b]The mean (M) was in the five-point Likert scale (1 = completely disagree to 5 = completely agree) according to the respondents.

[c]SD, Standard Deviation.

[d]Relative importance = Normal weight = Intensity ÷ Total intensity.

[e]Final coefficient = Intensity × Relative importance.

[f]In cases where the mean of the indicators was the same, the standard deviation was used as the rating criterion.

and were sent to 31 panel members, of which 23 questionnaires were returned (a return rate of 74%, which is acceptable for the third round).

The SWOT matrix serves as a framework to assist planners in identifying strategies to achieve goals. The term SWOT stands for the initials of the four words Strength (S), Weakness (W), Opportunity (O), and Threat (T) (Table 3). The logic behind this approach is that an effective strategy should maximize a system's strengths and opportunities while minimizing its weaknesses and threats. If applied correctly, this logic will yield very good results for selecting and designing an effective strategy (Fallah Haghighi et al., 2021). The SWOT matrix comprises four categories of strategies: offensive strategy (SO), conservative strategy (ST), adaptive strategy (WO), and defensive strategy (WT) (Table 3).

TABLE 9 Internal-external of the Strategic planning for the development of production and processing of medicinal plants in Semnan.

Internal factors		External factors	
Strengths (S)	Weaknesses (W)	Opportunities (O)	Threats (T)
3.83	4.15	3.96	4.16
SO offensive strategy	**WO adaptive strategy**	**ST conservative strategy**	**WT defensive strategy**
7.79	8.11	7.99	8.31

4 Results and discussion

4.1 Descriptive and demographic statistics of specialists

The respondents consisted of 74% male professionals and the remaining 26% were female. 48% were employed in the manufacturing sector and private companies, 39% were employed in government agencies, and 13% were university professors. Table 4 presents the other characteristics of the respondents.

4.2 Strengths, weaknesses, threats and opportunities in the production, processing and export of medicinal plants

In order to achieve success in the global market, Iranian medicinal plant producing companies need to address challenges and employ appropriate strategies for their management, including technology development, standardization and quality control, proper advertising and marketing, expansion into new markets and access to global markets, as well as formulation of suitable marketing and sales strategies (Tom et al., 2018; Vardian et al., 2021; Padulosi et al., 2002). Based on this, through three Delphi phases, 10 strengths, 25 weaknesses, 11 opportunities, and 16 threats were identified. Descriptive statistics of the extracted items are presented in Tables 5–8.
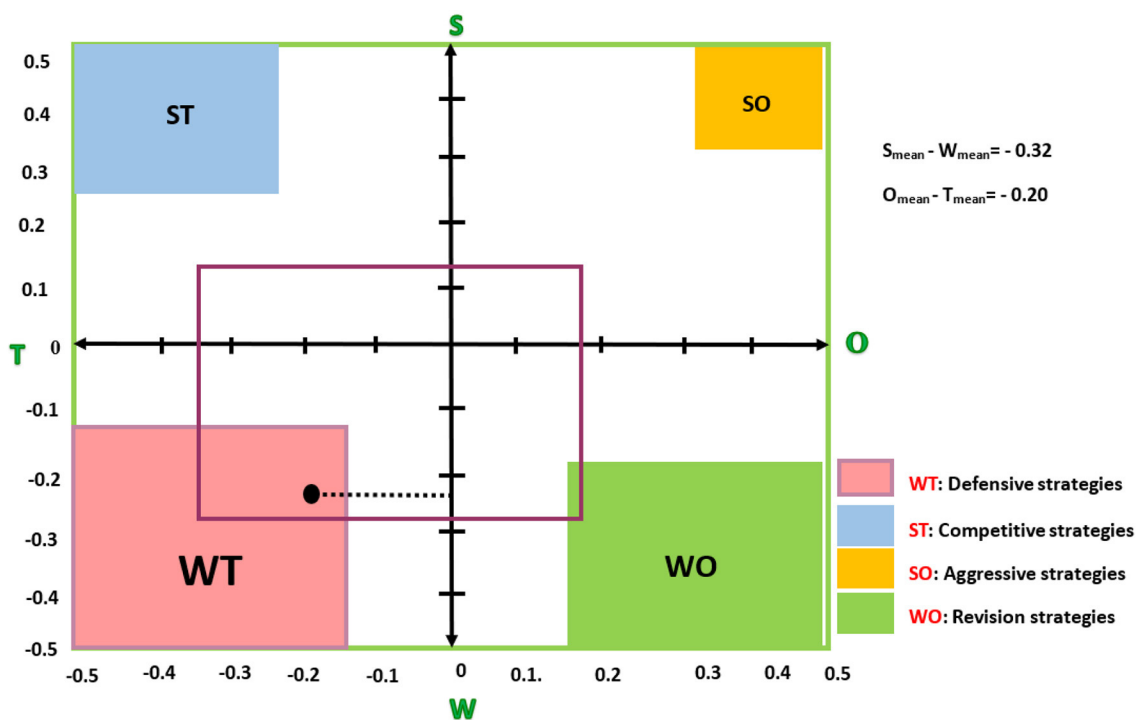

$S_{mean} - W_{mean} = -0.32$

$O_{mean} - T_{mean} = -0.20$

WT: Defensive strategies
ST: Competitive strategies
SO: Aggressive strategies
WO: Revision strategies

FIGURE 4
The scope of the strategic space for the development of production and processing of medicinal plants in Semnan province.

4.3 Strategic analysis and executive actions

The results presented in Tables 5–8 indicate the strengths, weaknesses, opportunities, and threats obtained from the perspectives of the respondents in this research. The overall average of strengths (3.83), weaknesses (4.15), opportunities (3.96), and threats (4.16) was calculated, revealing the superiority of weaknesses over strengths and threats over opportunities. Based on this, the internal and external differences in the SWOT matrix yield coordinates in the defensive strategic area (WT: weaknesses and threats) as shown in Table 9 and Figure 4.

Average strengths (S)–Average weaknesses (W) = 3.83–4.15 = −0.32.

Average opportunities (O)–Average threats (T) = 3.96–4.16 = −0.20.

Based on the strengths, weaknesses, opportunities, and threats identified, strategies were formulated using the SWOT matrix to advance the production, processing, and export of medicinal plants (Table 10).

The offensive strategies (SO) focus on sustainable development of the medicinal plants industry derived from combining internal strengths with external opportunities. These strategies aim to maximize environmental opportunities by leveraging the strengths of the existing system.

The defensive strategies (WO) are derived from combining internal weaknesses with environmental or external opportunities. These strategies aim to utilize potential advantages present in environmental opportunities to compensate for existing system weaknesses.

Competitive strategies (ST) are derived from combining internal strengths with environmental or external threats. These strategies are designed to maximize strengths to address threats effectively.

Defensive strategies (WT) are derived from combining internal weaknesses with environmental threats. They encompass strategies aimed at minimizing the damages resulting from threats and weaknesses (Puyt et al., 2023).

Based on the results of the SWOT matrix, some executive actions for sustainable development of the medicinal plants industry can be presented according to Table 11.

To enhance the understanding of the strategic development of Iran's medicinal plant exports, it is essential to draw comparisons with marketing chains in other leading countries in the medicinal plant sector. For instance, countries such as China, India, and Germany have established robust frameworks for the cultivation, processing, and export of medicinal plants, which can serve as valuable benchmarks for Iran (Mehrnia et al., 2021).

In China, the integration of traditional medicine with modern agricultural practices has led to a significant expansion of its medicinal plant exports. The Chinese government actively supports this sector through policies that promote research and development, quality control, and international marketing initiatives. As a result, China has successfully positioned itself as a global leader in the medicinal plant market, leveraging its vast biodiversity and traditional knowledge.

Similarly, India has a well-developed system for the cultivation and marketing of medicinal plants, supported by the National Medicinal Plants Board (NMPB). This board facilitates the sustainable harvesting of medicinal plants and promotes their export through various initiatives, including financial incentives for farmers and producers. India's approach emphasizes the importance of community participation and the preservation of indigenous knowledge, which has significantly contributed to its success in the global market (Karim et al., 2020).

TABLE 10 SWOT matrix for the development of production and processing of medicinal plants in Semnan.

	Strengths (S)	Weaknesses (W)
Opportunities (O)	**SO strategies (Offensive)** SO1: Additional research to increase the added value of priority plant species (S7, O7, O10) SO2: aligning research in scientific societies with the needs of the market (O10, S7, O11, O3) SO3: Identifying and investigating the potentials of the province in the field of rainfed cultivation of medicinal plants (S1, O8) SO4: Presentation and implementation of research projects in the field of valuable medicinal species of the province (S7, O7) SO5: Promoting the cultivation of medicinal plants among farmers (S6, O9, O11)	**WO strategies (Conservative)** WO1: Using new technologies in the preparation of medicinal plant products (W5, O2) WO2: Identifying the potential capacities of the region (W9, O9) WO3: Collection and cultivation of native and non-native varieties of medicinal plants suitable for the climate in botanical gardens in the province (W24, O1, O6, O9). WO4: Investigation and identification of medicinal plants resistant to environmental stresses (W2, O8) WO5: Reforming and facilitating the administrative bureaucracy to obtain the necessary permits for the production of the final product (O1, O5, W4, W6)
Threats (T)	**ST Strategies (Competitive)** ST1: Identifying and investigating the possibility of reviving rare natural medicinal plants (S1, T10, T12) ST2: Using local and appropriate scientific knowledge available in the province (T12, T5, S4) ST3: Designing and creating a pilot for the industrialization of laboratory findings (T5, S8) ST4: Application of cultivation and improvement methods and production of native seeds compatible with native plants of the region (S8, T3, T6)	**WT Strategies (Defensive)** WT1: Holding training courses for farmers, manufacturers and sellers of medicinal plants (W25, T5, T6) WT2: Identifying the target markets for the export of discovered native medicinal plants and their products inside and outside the country (T9, W12, W14) WT3: Investigating production potentials and the feasibility of exploiting and revitalizing plants producing by-products (W3, T4, T14) WT4: foundation and development of related industries in the region (T6, W4) WT5: Protecting genetic resources in nature and preventing the harvesting of endangered car plants (W7, T15) WT6: Creating a seed bank of medicinal plants for indigenous and compatible cultivars of the region (W6, W24, T10, T15) WT7: Cultivation and domestication of indigenous and exclusive species with added value (W2, W3, T5) WT8: Incentivizing investment within the province in the field of medicinal plant transformation industries (T1, T7, T9, W23, W25)

TABLE 11 Implementation measures based on SWOT matrix strategies.

No.	Action plans	Strategy	Institution responsible for cooperation
1	Coherent and planned cultivation of medicinal plants that can be planted and prioritized in Semnan province, such as cumin and thyme. Also, promoting the cultivation of drought-resistant species.	WO3, WO4, WT7	Jihad-e Agriculture Organization, General Department of Natural Resources and Watershed Management
2	Holding national and international scientific and specialized conferences and exhibitions according to the scientific capacity of the province.	SO2, WO1, WT2	Agricultural and Natural Resources Research Center, Universities
3	Implementation of the land improvement program to maintain and develop habitats and preserve the plant's genetic reserve.	WT5, WT3, ST4, SO3	General Department of Natural Resources and Watershed Management, Organization of Environment
4	In the processing of medicinal plants, the use of different technologies such as solvent extraction, extraction using a high pressure process, nano technology, and the use of thermal processing methods such as microwave drying and hot air drying instead of raw sales.	WO1, SO1, SO5	Chamber of Commerce, Industries and Mines Organization, Agricultural and Natural Resources Research Center
5	In the field of medicinal plant cultivation, he used technologies such as hydroponic cultivation, greenhouse cultivation, and cultivation under environmental control. In the field of herbal medicine processing, various technologies such as molecular technology and combined technology can be used.	ST1, ST4, SO4, WT6, WO3	Jihad-e Agriculture Organization
6	Creating facilitation and educational incentives to motivate producers and processing industries to enter the field of medicinal plants.	WT1, WT4, WT8, WO2, SO5	Provincial Government, Banks Management and Planning Organization
7	Creating a platform for research activities in universities and scientific research centers of the province, mainly supporting research projects and theses to improve and promote the planting of native species.	SO1, SO4, ST2, ST3	Agricultural and Natural Resources Research Center, Universities, Provincial Government
8	Continuous training and promotion to train skilled workers in the field of production and processing of medicinal plants.	WT1, WT4, ST2, SO5	Jihad-e Agriculture Organization, Agriculture and natural resources research and education center
9	Pursuing the provision of equipment and facilities for the processing of products in order to prevent the sale of raw plants at low prices.	ST3, SO2, SO1, WO1, WT3	Jihad-e Agriculture Organization, Provincial Government
10	Holding regular meetings of the strategic committee of medicinal plants with legislative and governing bodies to facilitate investment.	WO2, WO5, WT3, WT4	Agricultural and Natural Resources Research Center, Jihad-e Agriculture Organization, Department of Industry and Mining, Organization of industrial companies
11	Obtaining a memorandum of understanding with universities and research centers in the province to create a local seed bank and improve the existing cultivars.	WT6, WT7, ST1, SO4, WO4	Jihad-e Agriculture Organization, Agricultural and Natural Resources Research Center and Universities
12	The participation of producers and traders in the province in scientific and commercial events of countries such as Germany, which is the largest importer of medicinal plants.	WT2, SO2, WO2	Jihad-e Agriculture Organization, Agricultural engineering system, Department of Industry and Mining

In contrast, Germany's medicinal plant sector is characterized by stringent quality standards and a strong emphasis on research and innovation. The country has established a comprehensive regulatory framework that ensures the safety and efficacy of medicinal products derived from plants. This focus on quality has enabled German companies to command higher prices in international markets, highlighting the importance of quality assurance in the marketing chain (Amiri et al., 2021).

By examining these international examples, it becomes evident that Iran can benefit from adopting similar strategies tailored to its unique context. For instance, fostering public-private partnerships, investing in research and development, and enhancing quality control measures could significantly improve the competitiveness of Iranian medicinal plants in the global market. Furthermore, understanding the dynamics of marketing chains in these countries can provide insights into best practices that could be adapted

to strengthen Iran's position in the global value chain of medicinal plants.

5 Conclusion

Given the position and value of production and processing of medicinal plants in the domestic economy as well as non-oil exports, and the climatic diversity of Semnan province for the cultivation and production of medicinal plants, the present study aimed to identify the strengths, weaknesses, opportunities, and threats in the sustainable development of production and processing of medicinal plants in Semnan province using the SWOT method, and to provide appropriate strategies for each of the challenges. Based on the research data, 10 strengths, 25 weaknesses, 11 opportunities, and 16 threats were identified. According to the findings, the strengths and opportunities can

be considered as advantages, while weaknesses and threats as constraints in the development and export of medicinal plants in Semnan province. Based on the research findings, considering that exports have not been carried out within a coherent and systematic marketing strategy, it is necessary to prioritize the target markets for medicinal plants and their related products, and to determine the strategy for developing the export of desired products in order to provide practical strategies for exporters and commercial planners of the province. Ultimately, a long-term strategy for industrial development in the field of medicinal plant processing and production of secondary products is recommended.

This research, like any other research, has its limitations. The present study was conducted qualitatively using the SWOT technique. Although the strategic results and proposed executive actions are useful, valuable results can be obtained in future research by using quantitative methods and other diverse techniques focusing on different target audiences, especially consumers of medicinal plants.

Ultimately, based on the findings, the following policy recommendations can be made:

- Encouraging regional investment in the field of medicinal plant processing industries and
- Reforming and facilitating administrative bureaucracy for obtaining necessary licenses for final product production.
- Furthermore, the following recommendations can serve as a starting point for future research.
- Analyzing the effects of regional investment incentives on the development of medicinal plant exports.
- Assessing the potential global markets for Iranian medicinal plant exports and
- Analyzing methods to improve quality and international standards in the production and processing of medicinal plants.

In conclusion, emphasizing the sustainability of Iran's medicinal plant industry is crucial for its long-term viability and global competitiveness. Key indicators such as the preservation of biodiversity and the economic value of these plants must be prioritized in strategic planning. By fostering sustainable practices that protect native ecosystems and promote the responsible harvesting of medicinal plants, we can ensure that economic benefits do not come at the expense of environmental integrity. This holistic approach will not only enhance the resilience of the industry but also contribute to the preservation of Iran's rich botanical heritage, ultimately positioning the country as a leader in the global medicinal plant market.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

Ethics statement

Ethical approval was not required for the studies involving humans because this study employed the Delphi technique with subject experts, who provided their consent before participating in interviews. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and institutional requirements because this study employed the Delphi technique with subject experts, who provided their consent before participating in interviews.

Author contributions

MS: Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Writing – original draft. MB: Conceptualization, Data curation, Methodology, Project administration, Software, Supervision, Validation, Visualization, Writing – review & editing. FB: Conceptualization, Project administration, Resources, Supervision, Validation, Visualization, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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