DISCOVERING CONSUMER BEHAVIOR TOWARDS NON-WOOD FOREST PRODUCTS THROUGH DATA MINING METHODS: THE CASE OF TÜRKIYE

VERİ MADENCİLİĞİ YÖNTEMLERİYLE ODUN DIŞI ORMAN ÜRÜNLERİNE YÖNELİK TÜKETİCİ DAVRANIŞLARININ KEŞFİ: TÜRKİYE ÖRNEĞİ

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Özet

Odun dışı orman ürünleri; gıda, ilaç, kozmetik ve tarım gibi çeşitli sektörlerde kullanılan bitki ve hayvan kökenli ürünlerdir. Bu özelliklerinden dolayı, odun dışı orman ürünleri insan yaşamının vazgeçilmez bir bileşenidir. Bu nedenle, insanlar ile odun dışı orman ürünleri arasındaki ilişki araştırmaya değer bir konudur. Bu çalışma, tüketicilerin odun dışı orman ürünlerine yönelik bilgi düzeylerinin ve tutumlarının demografik özelliklere (cinsiyet, yaş, eğitim düzeyi, meslek, gelir ve medeni durum) göre farklılık gösterip göstermediğini belirlemeyi amaçlamaktadır. Araştırma örneklemi Türkiye'de ikamet eden tüketicilerden oluşmaktadır. 700 katılımcıya anket uygulanmış ve toplanan veriler SPSS istatistik programı kullanılarak analiz edilmiştir. Ayrıca, veri setleri arasındaki ilişkileri ilişkilendirme kuralları aracılığıyla ortaya koymak amacıyla önemli bir veri madenciliği yöntemi olan FP-Growth algoritması kullanılmıştır. Bu ilişkilendirme kurallarının belirlenmesinde RapidMiner yazılımı kullanılmıştır. Sonuçlar, demografik özelliklerin tüketici davranışlarının çok yönlü yapısına katkıda bulunduğunu ortaya koymaktadır. FP-Growth algoritmasına göre, cinsiyet en çok tercih edilen ürünü önemli ölçüde etkilemektedir. Ayrıca, bu ürünlere yönelik farkındalık düzeyinde eğitim düzeyi, medeni durum ve yaşa göre değişiklikler gözlemlenmiştir. Genel olarak, elde edilen bulgular, pazarlama stratejilerinin geliştirilmesine ve tüketici farkındalığını artırmaya yönelik girişimlere rehberlik edebilecek değerli bilgiler sunmaktadır.

Anahtar Kelimeler: Fp-Growth, Odun Dışı Orman Ürünleri, Tüketici, Veri Madenciliği, Birliktelik Kuralları

Abstract

Non-wood forest products are plant- and animal-based products used in various industries, such as food, pharmaceuticals, cosmetics, and agriculture. Due to these characteristics, non-wood forest products are an indispensable component of human life. Therefore, the relationship between humans and non-wood forest products is a topic that warrants investigation. This study aims to determine whether consumer knowledge levels and

attitudes toward non-wood forest products differ based on demographic characteristics (gender, age, education level, occupation, income, and marital status). The research sample consists of consumers residing in Türkiye. A survey was administered to 700 participants, and the collected data were analyzed using the SPSS statistical package. Additionally, the FP-Growth algorithm, a significant data mining method, was employed to uncover associations between data sets through association rules. RapidMiner software was used to identify these association rules. The results reveal that demographic characteristics contribute to the multifaceted nature of consumer behavior. According to the FP-Growth algorithm, gender significantly influences the most preferred product. Furthermore, variations in awareness of these products were observed based on education level, marital status, and age. Overall, the findings provide valuable insights that can guide the development of marketing strategies and initiatives to increase consumer awareness.

Keywords: Frequent Pattern (FP)-Growth; Non-Wood Forest Products; Consumer Behavior; Data Mining; Association Rules

Introduction

Throughout history, humans have gathered and utilized various plants and plant derivatives from forests to meet their needs for food, medicine, shelter, and other necessities. These usage patterns have evolved over time, becoming deeply integrated into societal cultures and, even national identities. Non-wood forest products (NWFPs), which contribute to rural, local, and national economies, hold significant importance not only as a reliable food source but also in facilitating the achievement of environmental goals by preserving biological diversity (Jones et al., 2004; Açıkgöz Altunel, 2011). NWFPs refer to various plant-based and animal-based products that grow in forested and open areas and provide benefits for humans and other living beings, either to meet their needs or for commercial income generation (Gedik, 2014). NWFPs are preferred due to their natural composition, absence of additives, delicious and aromatic properties, and their immune-boosting and protective effects. Ensuring that the production of NWFPs aligns with consumer demands in terms of variety, quantity, and form, along with accurately identifying the target audience, facilitates an efficient and sustainable process from production to marketing (Arslan, 2015).

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In terms of NWFPs and services, Turkey possesses substantial resource wealth. These products and services contribute positively to the national economy by supporting the development of rural populations, creating employment opportunities, increasing production, raising income levels, and influencing exports (Okumuş and Pak, 2025). NWFP production in Turkey has shown variations over time. Today, however, Turkey has become a global leader in the production of certain non-wood forest products, particularly thyme and bay leaves (Karik and Öztürk, 2009; Açıkgöz Altunel, 2011; Balcı and Köse 2023). The production of these products is regulated under the communiqué titled "Regulation No. 302 on the Inventory and Planning of Non-Wood Forest Products and Principles of Production and Sales." According to the provisions of this communiqué, not all NWFPs can be utilized. For a species to be eligible for use, it must not be classified as rare according to the Blanquet scale, and it must not be among those under strict protection as specified in international conventions to which Turkey is a party. Only selected species are included in annual production plans, and their production is carried out by cooperatives and forest villagers either through contractual agreements or based on unit pricing (Balcı and Köse 2023). Turkey exports NWFPs to a total of 113 countries worldwide. Among these, the United States accounts for 21% of total exports, followed by

Germany 14%, Italy 12%, France 9%, and Spain 5%. Approximately 60% of total NWFP exports are directed to these five countries, while the remaining 40% are distributed among other nations. Turkey imports NWFPs from 64 countries. In terms of imports, the Netherlands holds the largest share with 16%, followed by Italy 12%, China 11%, France 11% and Germany 10% (Sabra and Walter, 2001).

Several studies have explored consumer attitudes toward NWFPs. Dündar (2019) examined the factors influencing consumer preferences for NWFPs in the Burdur province. The study determined that health was the primary factor in consumers' use of these products. In another study, Korkmaz and Fakir (2009) investigated the structure, consumption tendencies, and preferences of final consumers regarding plant-based NWFPs in the city center of Isparta. Consumers generally use these plants for health purposes and leisure. However, they lack knowledge regarding the appropriate dosage and potential side effects. Consumption primarily occurs in the form of infusions and decoctions, with a preference for using these plants in their naturally collected form. The study also found that family and close social circles play a crucial role in shaping consumption habits. In another study, Bilir (2017) examined public perception levels regarding NWFPs in the Kahramanmaraş province. The findings indicated that 20.6% of the survey participants had a low perception level, 77.5% had a moderate perception level, and 1.9% had a high perception level regarding NWFPs. Additionally, Akbulut and Özkan (2023) found in their study conducted in Northern Anatolia that, during the COVID-19 pandemic, herbalists' customers preferred products such as honey, salep, and olive oil rather than medicinal and aromatic plants. Cadar *et al* (2021) Based on consumers' perceptions, attitudes, and consumption habits, the study identified consumer segments that use medicinal and aromatic plant products for phytotherapeutic, cosmetic, and personal care purposes, and examined the potential correlations between the consumption of these products and the interest in a healthy lifestyle and sustainable behavior. The collected data were subjected to statistical analysis using the k-means clustering model, resulting in the emergence of two distinct clusters in both consumer groups: Cluster 1 "Curious" and Cluster 2 "Knowledgeable." The findings provide practical implications for product development and innovation processes tailored to consumer needs, while also contributing to a better understanding of the consumption behavior of medicinal and aromatic plant products. Güney's (2019) study examined the attitudes and behaviors of consumers toward medicinal and aromatic plants based on the characteristics of their demographic and socio-economic statuses, and identified distinct consumer groups. Data were collected via face-to-face surveys and analyzed using k-means clustering. The results indicated that aroma influenced the purchasing decisions across all groups. Furthermore, naturalness was found to be a common preference among all consumers. Lastly, the predominant modes of consumption for these plants were as infusions or in powdered form.

Data mining is the process of discovering hidden, useful, valuable, and comprehensible patterns, relationships, correlations, or trends within large and complex datasets that are difficult to detect using traditional methods. This process is carried out automatically or semi-automatically through various data analysis techniques and interdisciplinary approaches, with the aim of providing valuable insights for making accurate, effective, and knowledge-based decisions (Ganesh, 2002; Kuonen, 2004; Oğuzlar, 2004; Şentürk, 2006; Koyuncugil, 2007; Tüzüntürk, 2010). Data mining is a multidisciplinary field that integrates several technical areas, including database technology, statistics, artificial intelligence, machine learning, pattern

recognition, and data visualization. It is widely applied in various fields such as astronomy, biology, finance, marketing, insurance, and medicine (Özekes, 2003).

One of the earliest techniques used in data mining is association rules. An association rule is a method that supports future studies by identifying associative behaviors within historical data through analysis. In other words, association analysis aims to establish relationships between different variables. An example of an association rule is identifying relationships between products available in the market. Classic examples of association rules include market basket analysis and cross-selling programs. The FP-Growth algorithm, commonly used for association analysis, is widely applied in scientific research (Frawley et al., 1991; Agrawal et al., 1993; Özçakır and Çamurcu, 2007; Gadia and Bhowmick, 2015; Ahmed and Nath, 2021; Sözen et al., 2022).

In this study, the knowledge levels of consumers regarding NWFPs and their attitudes toward these products were examined to determine whether they differ based on demographic characteristics such as gender, age, education level, occupation, income, and marital status. Additionally, the relationships between the data were analyzed using the FP-Growth algorithm, one of the data mining methods."

Experimental

Material and Method
Data Collection Process

In this study, data mining methods were utilized to assess consumers' knowledge levels regarding NWFPs and to determine their attitudes toward these products. A survey method was employed to collect the necessary data. Ethical approval was obtained from Bartın University to utilize the survey method in this study. Additionally, an informed consent form was prepared to provide information to the participants and obtain their consent. This form stated that they could choose to answer the survey if they wished, their personal data would remain confidential, the researcher could exclude their responses if necessary, and they could withdraw from the survey at any time. The questionnaire consisted of four main sections. The first section included questions regarding the demographic characteristics of the respondents (gender, age, education level, occupation, income, marital status). The second section contained multiple-choice questions aimed at measuring consumers' knowledge levels about NWFPs. The third section focused on identifying which plant species consumers purchase most frequently. The fourth section comprised seven-point Likert scale questions designed to evaluate consumers' attitudes toward NWFPs.

The sample size was determined using a known sample size formula for a specific population, with a 99% confidence level and a 5% margin of error. Based on these criteria, the number of participants included in the study was set at 700.

Data Analysis

The SPSS software package was used to analyze the data. Descriptive statistics were applied to determine the frequency distribution of the demographic characteristics of the participants and the corresponding percentages. To assess consumers' knowledge levels based on demographic characteristics, identify the most frequently purchased NWFPs, and evaluate

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consumers' trust in and perceived importance of these products, Independent Samples t-tests, One-Way ANOVAs, and One-Way Kruskal-Wallis tests were employed. The Independent Samples t-test is typically used to compare the means of two independent groups, such as males and females. The ANOVA test is widely applied in scientific research to identify and compare statistical significance among different groups (Kaya, 2010; Kim, 2019; Kurt and Can, 2021; Ersen *et al.,* 2023). The Kruskal-Wallis test, on the other hand, is a non-parametric alternative to ANOVA and is used when data do not follow a normal distribution.

In this study, the FP-Growth algorithm, one of the association rule mining techniques, was used to identify relationships in consumers' preferences for NWFPs. The FP-Growth method has been chosen because it provides better and more accurate results compared to other data mining techniques. It is also used in the analysis of large-scale datasets. The FP-Growth algorithm is one of the methods developed for association rule analysis and offers higher performance compared to other algorithms (Győrödi *et al.,* 2004; Han and Kamber, 2000; Erpolat, 2012). The FP-Growth algorithm is a widely used algorithm for analyzing correlations and patterns in large-scale datasets (Shohdy *et al.,* 2016). The RapidMiner software was used to conduct the FP-Growth analysis. In this program, operators were sequentially connected to form a process. Figure 1 presents the process designed to identify relationships in consumers' preferences for NWFPs based on the FP-Growth algorithm.
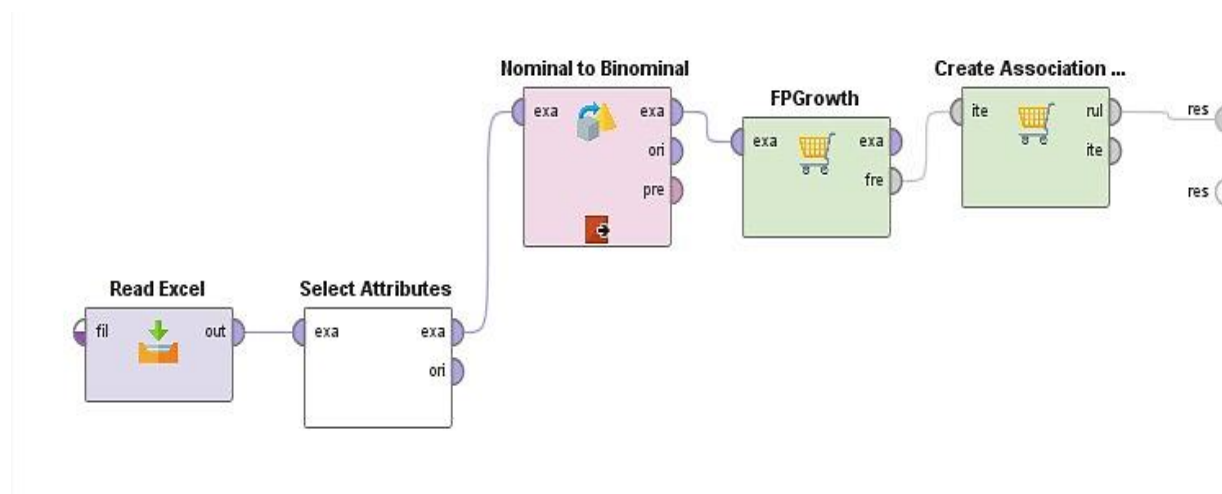

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Figure 1. The process designed to identify consumer relationships with NWFPs based on the FP-Growth algorithm.

After generating the process using the FP-Growth algorithm, association rules were derived from the data. The confidence measure was used to assess the accuracy of these rules. Confidence is defined as the probability of a variable x occurring together with variable y. In the context of FP-Growth association rule analysis, the data was imported into the RapidMiner software using the Read Excel operator. Subsequently, the Select Attributes operator was used to select the columns containing nominal data. The Nominal to Binominal operator was applied to convert the textual data into numerical values. The FP-Growth operator was then used to identify frequently occurring itemsets. Finally, in the Create Association Rules operator, the confidence interval was set to 70% or higher, and association rules were generated using the

results obtained from the FP-Growth operator. In the generated rules, similar and less interesting rules have been excluded to ensure that the study is easily understandable.

RESULTS AND DISCUSSION
Demographic Characteristics of the Participants

Among the survey participants, 50% were male and 50% were female. In terms of age distribution, 22.3% of the participants were between 18 - 25 years old, 31.1% were between 26 - 45 years old, 28.4% were between 46 - 64 years old, and 18.1% were 65 years and older. Regarding educational level, 19% of the participants had primary school education, 19.9% had middle school education, 19% had high school education, 36.6% had a university degree, 5.3% held a master's degree, and 0.3% had a doctoral degree, indicating a low proportion of participants with postgraduate education. In terms of occupation, 14% of the participants were students, 14% were public sector employees, 23.7% were private sector employees, 13.9% were self-employed, 13.9% were unemployed, and 20.6% were retired. Regarding income distribution, 38.4% of the participants had an income of 0 – 20000 TL, 17% had an income of 20001 – 35000 TL, 22.7% had an income of 35001 – 50000 TL, and 21.9% had an income of 50,001 TL and above. With respect to marital status, 34% of the participants were single, 40% were married, 8.9% were divorced, and 16.9% were widowed. The circular chart representing the demographic characteristics of the participants is presented in Figure 2.
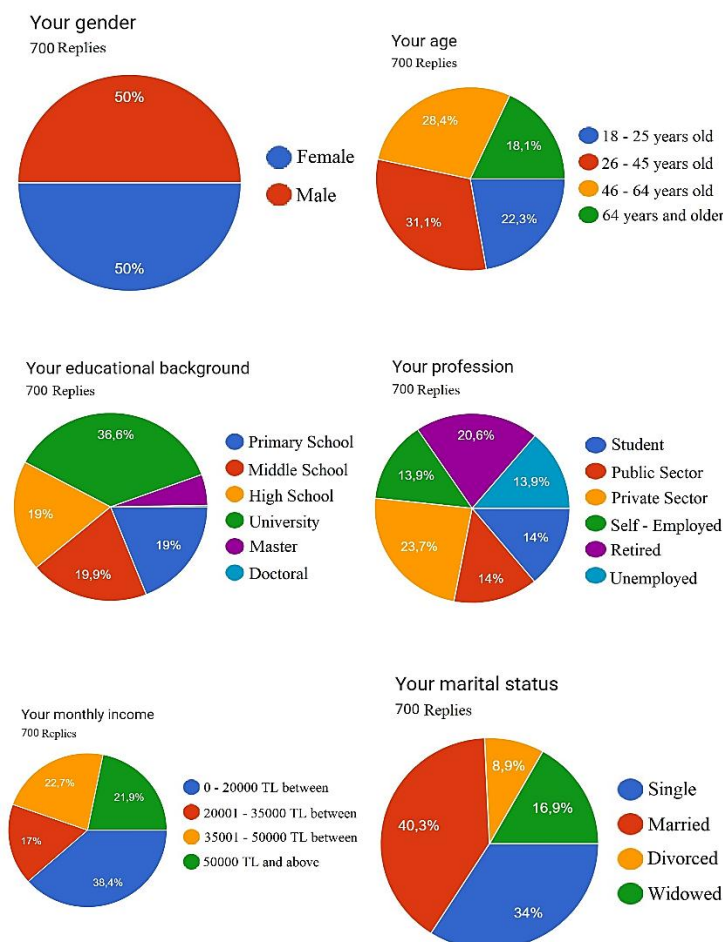
Figure 2. Circular chart of the demographic characteristics of the participants.

Table 1. Demographic Characteristics of the Participants

Demographic Characteristics		Frequency (f)	Percentage (%)
Gender	Female	350	50.0
	Male	350	50.0
Age	18 – 25 years old	156	22.3
	26 – 45 years old	218	31.1
	46 – 64 years old	199	28.4
	65 years and older	127	18.1
Educational Level	Primary School	133	19.0
	Middle School	139	19.9
	High School	133	19.0
	University	256	36.6
	Master	37	5.3
	Doctoral	2	0.3
Occupation	Students	98	14.0
	Public Sector	98	14.0
	Private Sector	166	23.7
	Self-Employed	97	13.9
	Retired	144	20.6
	Unemployed	97	13.9
Monthly Income	0 – 20000 TL between	269	38.4
	20000 – 35000 TL between	119	17.0
	35001 – 50000 TL between	159	22.7
	50001 TL and above	153	21.9
Marital Status	Single	238	34.0
	Married	282	40.0
	Divorced	62	8.9
	Widowed	118	16.9

Findings on the Differentiation of Consumers' Knowledge Levels and Attitudes in Terms of Demographic Characteristics

In analyzing the significance level of consumers' knowledge and attitudes regarding NWFPs in terms of demographic characteristics, an independent samples t-test was used to determine whether there were differences based on gender. A one-way ANOVA test was applied to examine differences based on age, income, and marital status. Additionally, as the

normality test for consumer attitudes fell outside the limits reported in the literature, a one-way Kruskal-Wallis test was used to assess differences based on education level and occupation. The results obtained from the independent samples t-test, one-way ANOVA test, and one-way Kruskal-Wallis test are presented in Tables 2–9.

Table 2. Independent Sample t-Test Result for Consumer Knowledge Level and Attitudes

	Gender	Mean	t	p
Consumer Knowledge Level – 1	Male	2.1400	0.993	0.321
	Female	2.1083		
Consumer Knowledge Level – 2	Male	1.8020	0.338	0.735
	Female	1.7883		
The most purchased product by consumers	Male	5.5629	6.456	0.001
	Female	4.0943		
The importance consumers attach to NWFPs	Male	4.5271	0.378	0.710
	Female	4.5007		
Consumers' trust in NWFPs	Male	5.1846	-.184	0.854
	Female	5.2017		

Upon examining the independent samples t-test results in Table 2, it was found that the mean score of the products purchased by consumers differed statistically significantly by gender (p<0.05). However, the mean scores for Consumer Knowledge Level-1 (questions with responses: "I know," "I partially know," "I don't know"), Consumer Knowledge Level-2 (questions with responses: "Yes," "No," "I don't know"), the importance consumers attach to NWFPs, and consumers' trust in NWFPs did not show statistically significant differences by gender (p>0.05).

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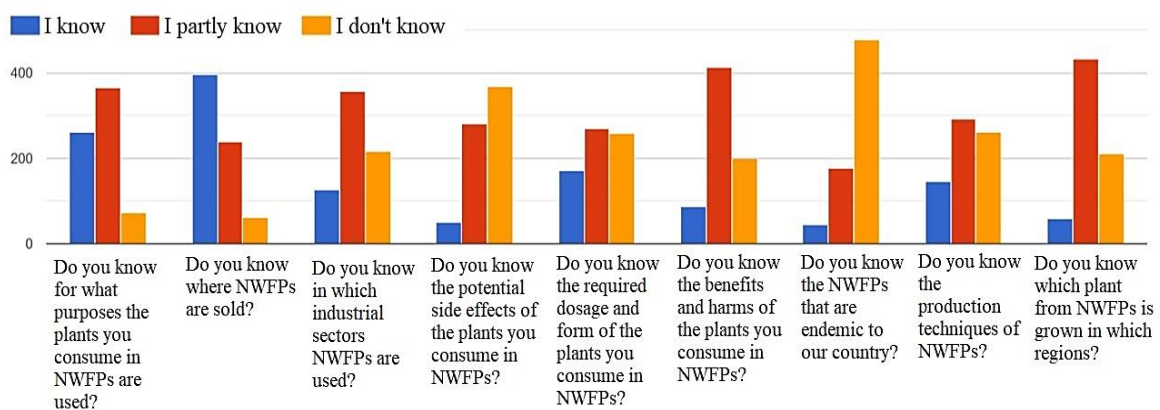I. GENERAL INFORMATION ON THE SURVEY ON NON-WOOD FOREST PRODUCT

Figure 3. Bar chart of responses to Consumer Knowledge Level-1 questions.

Table 3. Independent One-Way ANOVA Test Results for Consumer Knowledge Level-1

Variable		Mean	F	p
Age	18 – 25 years old	2.2756	10.460	.000
	26 – 45 years old	2.1035		
	46 – 64 years old	2.0313		

	65 years and older	2.1190		
Educational Level	Primary School	2.0869	5.108	.000
	Middle School	2.0943		
	High School	2.0418		
	University	2.2192		
	Master	2.0390		
	Doctoral	1.5556		
Occupation	Students	2.2234	1.822	.106
	Public Sector	2.0522		
	Private Sector	2.1345		
	Self-Employed	2.1317		
	Retired	2.0965		
	Unemployed	2.1123		
Monthly Income	0 – 20000 TL between	2.1776	2.553	.054
	20001 – 35000 TL between	2.1130		
	35001 – 50000 TL between	2.0727		
	50001 TL and above	2.0922		
Marital Status	Single	2.2442	12.228	.000
	Married	2.0240		
	Divorced	2.1290		
	Widowed	2.1186		

In Figure 3, the responses to the Consumer Knowledge Level - 1 questions (Do you know for what purposes the plants you consume in NWFPs are used? Do you know where NWFPs are sold? Do you know in which industrial sectors NWFPs are used? Do you know the potential side effects of the plants you consume in NWFPs? Do you know the required dosage and form of the plants you consume in NWFPs? Do you know the benefits and harms of the plants you consume in NWFPs? Do you know the NWFPs that are endemic to our country? Do you know the production techniques of NWFPs? Do you know which plant from NWFPs is grown in which regions?) are presented using a bar chart. Examining the results of the one-way ANOVA test in Table 3, it was found that the mean score of Consumer Knowledge Level-1 differed significantly based on age, education level, and marital status ($p < 0.05$). However, the mean score of Consumer Knowledge Level-1 did not show a statistically significant difference based on occupation and monthly income ($p > 0.05$).

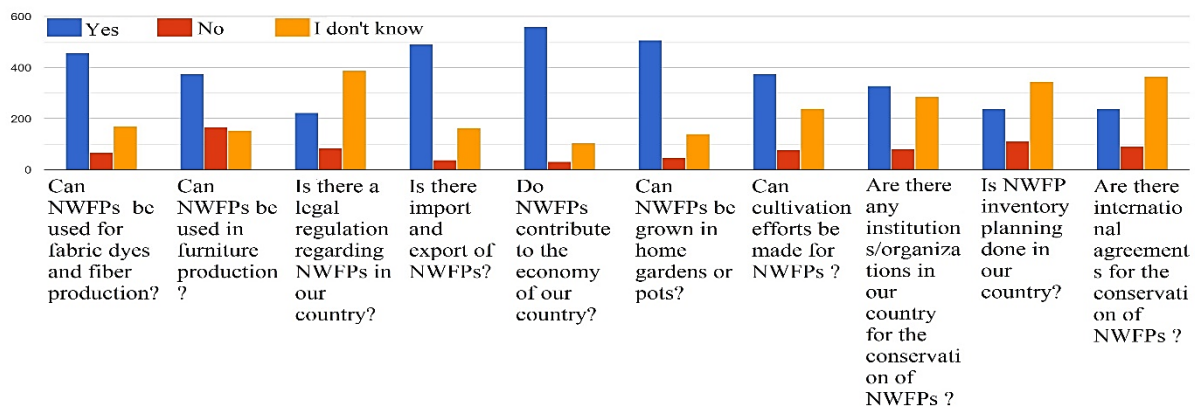ANSWER THE QUESTIONS AFTER THIS SECTION WITH YES, NO, OR I DON'T KNOW.

Figure 4. Bar chart of responses to Consumer Knowledge Level-2 questions.

Table 4. Independent One-Way ANOVA Test Results for Consumer Knowledge Level-2

Variable		Mean	F	p
Age	18 – 25 years old	1.9372	5.123	.002
	26 – 45 years old	1.7771		
	46 – 64 years old	1.7246		
	65 years and older	1.7622		
Educational Level	Primary School	1.7842	2.888	.014
	Middle School	1.7353		
	High School	1.7376		
	University	1.8813		
	Master	1.7081		
	Doctoral	1.1000		
Occupation	Students	1.8000	3.562	.003
	Public Sector	1.6439		
	Private Sector	1.8880		
	Self-Employed	1.7660		
	Retired	1.7431		
	Unemployed	1.8907		
Monthly Income	0 – 20000 TL between	1.8045	.471	.702
	20000 – 35000 TL between	1.8294		
	35001 – 50000 TL between	1.7560		
	50001 TL and above	1.7928		
Marital Status	Single	1.9008	6.151	.000
	Married	1.7018		
	Divorced	1.8290		
	Widowed	1.7873		

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In Figure 4, the responses to the Consumer Knowledge Level - 2 questions (Can NWFPs be used for fabric dyes and fiber production?, Can NWFPs be used in furniture production?, Is there a legal regulation regarding NWFPs in our country?, Is there import and export of

NWFPs?, Do NWFPs contribute to the economy of our country?, Can NWFPs be grown in home gardens or pots?, Can cultivation efforts be made for NWFPs?, Are there any institutions/organizations in our country for the conservation of NWFPs?, Is NWFP inventory planning done in our country?, Are there international agreements for the conservation of NWFPs ?) are presented using a bar chart. Examining the results of the one-way ANOVA test in Table 4, it was found that the mean score of Consumer Knowledge Level-2 differed significantly based on age, occupation, and marital status (p<0.05). However, the mean score of Consumer Knowledge Level-2 did not show a statistically significant difference based on education level and monthly income (p>0.05).
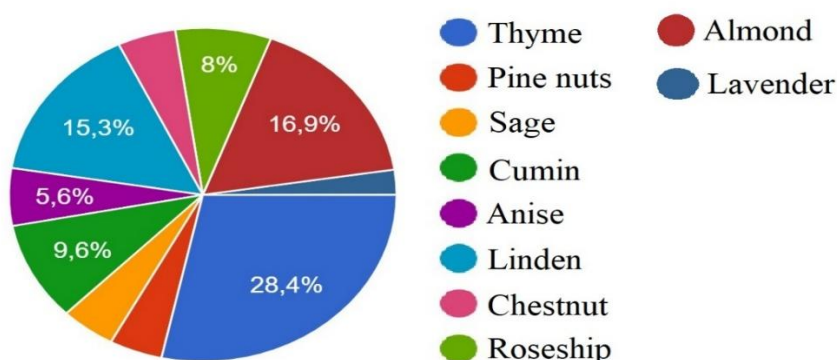

Figure 5. Circular chart of responses to the question about the most purchased product by consumers.

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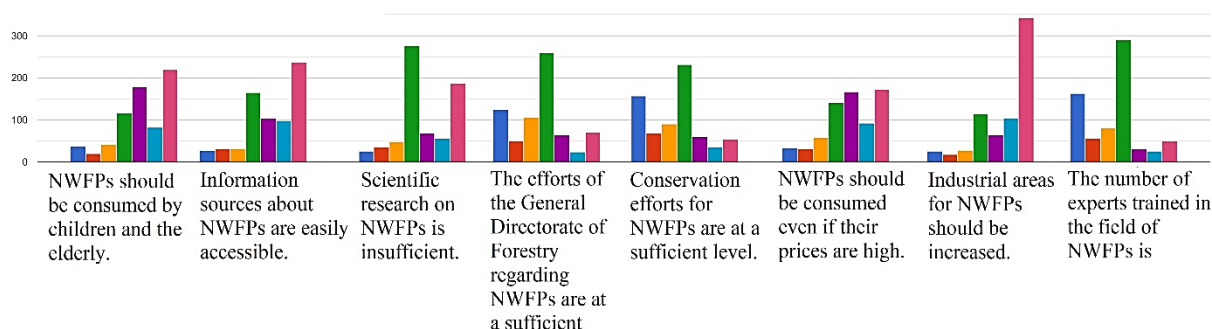Table 5. Independent One-Way ANOVA Test Results for Most Purchased Product by Consumers

Variable		Mean	F	p
Age	18 – 25 years old	4.4359	1.628	.182
	26 – 45 years old	4.7523		
	46 – 64 years old	5.1407		
	65 years and older	4.9528		
Educational Level	Primary School	4.7368	3.522	.004
	Middle School	5.4029		
	High School	5.3459		
	University	4.3320		
	Master	4.4324		
	Doctoral	7.5000		
Occupation	Students	4.7959	5.524	.000
	Public Sector	5.6531		
	Private Sector	4.0843		
	Self-Employed	5.7320		
	Retired	4.8333		
	Unemployed	4.3918		

Monthly Income	0 – 20000 TL between	4.4015	2.995	.030
	20000 – 35000 TL between	4.9496		
	35001 – 50000 TL between	5.2327		
	50001 TL and above	5.0654		
Marital Status	Single	4.6261	3.701	.012
	Married	4.6454		
	Divorced	5.9516		
	Widowed	5.0847		

In Figure 5, the responses to the question regarding the most purchased product by consumers are presented using a circular chart. Examining the results of the one-way ANOVA test in Table 5, it was found that the mean score of Most Purchased Product by Consumers differed significantly based on educational level and occupation ($p<0.05$). However, the mean score of Most Purchased Product by Consumers did not show a statistically significant difference based on age, monthly income, marital status ($p>0.05$).

III. SURVEY ON THE IMPORTANCE OF NON-WOOD FOREST PRODUCTS Please indicate the statements given below by marking them between 1 and 7 on the scale shown to you. 1. Strongly disagree 2. Strongly disagree 3. Slightly disagree 4. Undecided 5. Slightly agree 6. Strongly agree 7. Strongly agree

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Figure 6. Bar chart of responses regarding the importance consumers place on NWFPs.

Table 6. Independent One-Way ANOVA Test Results for the Importance Consumers Attach to NWFPs

Variable		Mean	F	p
Age	18 – 25 years old	4.2075	11.877	.000
	26 – 45 years old	4.4386		
	46 – 64 years old	4.6558		
	65 years and older	4.7972		
Monthly Income	0 – 20000 TL between	4.4368	1.510	.211
	20000 – 35000 TL between	4.4716		
	35001 – 50000 TL between	4.5841		
	50001 TL and above	4.6095		
Marital Status	Single	4.2479	10.670	.000
	Married	4.6671		

Divorced	4.5020	
Widowed	4.6907	

In Fig. 6, the responses to the Likert survey scale regarding the importance consumers place on NWFPs (NWFPs should be consumed by children and the elderly, Information sources about NWFPs are easily accessible, Scientific research on NWFPs is insufficient, The efforts of the General Directorate of Forestry regarding NWFPs are at a sufficient level, Conservation efforts for NWFPs are at a sufficient level, NWFPs should be consumed even if their prices are high, Industrial areas for NWFPs should be increased, The number of experts trained in the field of NWFPs is sufficient) are presented using a bar chart. Examining the results of the one-way ANOVA test in Table 6, it was found that the mean score of Importance Consumers Attach to NWFPs differed significantly based on age and marital status (p<0.05). However, the mean score of Importance Consumers Attach to NWFPs did not show a statistically significant difference based on monthly income (p>0.05).
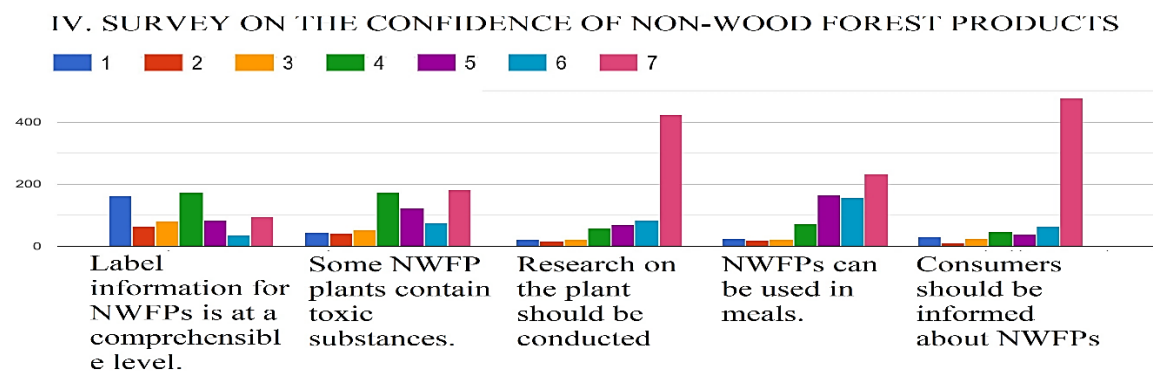

Figure 7. Bar chart of responses regarding consumers' trust in NWFPs.

Table 7. Independent One-Way ANOVA Test Results for Consumers' Trust in NWFPs

Variable		Mean	F	p
Age	18 – 25 years old	4.8641	6.802	.000
	26 – 45 years old	5.1459		
	46 – 64 years old	5.3357		
	65 years and older	5.4551		
Educational Level	Primary School	5.5805	5.103	.000
	Middle School	5.3424		
	High School	5.1218		
	University	4.9656		
	Master	5.0811		
	Doctoral	5.0000		
Monthly Income	0 – 20000 TL between	5.1286	.589	.622
	20000 – 35000 TL between	5.2437		
	35001 – 50000 TL between	5.2805		
	50001 TL and above	5.1765		
	Single	4.9193		
	Married	5.3667		

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Marital Status	Divorced	5.1774	6.506	.000
	Widowed	5.3390		

In Figure 7, the responses to the Likert survey scale regarding consumers' trust in NWFPs (Label information for NWFPs is at a comprehensible level, Some NWFP plants contain toxic substances, Research on the plant should be conducted before consuming an NWFP, NWFPs can be used in meals, Consumers should be informed about NWFPs by experts) are presented using a bar chart. Examining the results of the one-way ANOVA test in Table 7, it was found that the mean score of Consumers' Trust in NWFPs differed significantly based on age, educational level and marital status ($p<0.05$). However, the mean score of Consumers' Trust in NWFPs did not show a statistically significant difference based on monthly income ($p>0.05$).

Table 8. Independent One-Way Kruskal-Wallis Test Results for the Importance Consumers Attach to NWFPs

Variable		Mean	p
Educational Level	Primary School	411.91	.001
	Middle School	387.56	
	High School	356.77	
	University	297.78	
	Master	327.08	
	Doctoral	455.25	
Occupation	Students	310.28	.001
	Public Sector	393.99	
	Private Sector	316.60	
	Self-Employed	320.69	
	Retired	401.00	
	Unemployed	360.05	

Examining the results of the one-way Kruskal-Wallis test in Table 8, it was found that the mean score of the Importance Consumers Attach to NWFPs differed significantly based on educational level and occupation ($p<0.05$).

Table 9. Independent One-Way Kruskal-Wallis Test Results for Consumers' Trust in NWFPs

Variable		Mean	p
Occupation	Students	312.79	.097
	Public Sector	364.51	
	Private Sector	338.21	
	Self-Employed	331.55	
	Retired	378.26	
	Unemployed	373.22	

Examining the results of the one-way Kruskal-Wallis test in Table 9, it was found that the mean score of Consumers' Trust in NWFPs did not show a statistically significant difference based on occupation ($p>0.05$).

Findings Related to the FP-Growth Algorithm

The relationship between consumers' knowledge levels and attitudes toward NWFPs and their demographic characteristics was analyzed using the FP-Growth algorithm. The FP-Growth algorithm is a data mining method that identifies relationships between frequently repeated items within large datasets. In the FP-Growth algorithm, confidence measures the accuracy of an association rule. The findings of the study reveal significant relationships between participants' demographic characteristics and their knowledge levels and attitudes as consumers. Below is a list of association rules ranked according to their confidence level.

38128. Can cultivation efforts be carried out for NWFPs? = Yes Age = 18-25 YEARS OLD ==> Marital status = SINGLE <confidence:(1)>

1369. Do you know the purposes for which the NWFPs you consume are used? = I partially know Education level = UNIVERSITY Age = 18-25 YEARS OLD ==> Marital status = SINGLE <confidence:(1)>

1368. Do you know the benefits and harms of the NWFPs you consume? = I partially know Education level = UNIVERSITY Age = 18-25 YEARS OLD ==> Marital status = SINGLE <confidence:(1)>

1367. Do you know which regions certain NWFPs are grown in? = I partially know Education level = UNIVERSITY Age = 18-25 YEARS OLD ==> Marital status = SINGLE <confidence:(1)>

1364. Do you know in which industrial sectors NWFPs are used? = I partially know Age = 18-25 YEARS OLD ==> Marital status = SINGLE <confidence:(1)>

338777. Is inventory planning for NWFPs carried out in our country? = I do not know Education level = UNIVERSITY Age = 18-25 YEARS OLD ==> Marital status = SINGLE <confidence:(0.99)>

1343. Do you know the possible side effects of the NWFPs you consume? = I do not know Education level = UNIVERSITY Age = 18-25 YEARS OLD ==> Marital status = SINGLE <confidence:(0.98)>

1352. Do you know the production techniques of NWFPs? = I do not know Education level = UNIVERSITY Age = 18-25 YEARS OLD ==> Marital status = SINGLE <confidence:(0.98)>

1355. Do you know the required dosage and form of the NWFPs you consume? = I do not know Education level = UNIVERSITY Age = 18-25 YEARS OLD ==> Marital status = SINGLE <confidence:(0.98)>

1358. Do you know the endemic NWFPs found in our country? = I do not know Education level = UNIVERSITY Age = 18-25 YEARS OLD ==> Marital status = SINGLE <confidence:(0.98)>

34907. Do NWFPs contribute to the economy of our country? = Yes Is there import and export activity for NWFPs? = Yes Can cultivation efforts be carried out for NWFPs? = Yes Is inventory planning for NWFPs carried out in our country? = Yes ==> Can NWFPs be grown in home gardens or pots? = Yes <confidence:(0.96)>

1322. Do you know which regions certain NWFPs are grown in? = I partially know Do you know in which industrial sectors NWFPs are used? = I partially know Do you know the possible side effects of the NWFPs you consume? = I partially know Do you know the required dosage and form of the NWFPs you consume? = I partially know ==> Do you know the benefits and harms of the NWFPs you consume? = I partially know <confidence:(0.96)>

1311. Do you know the required dosage and form of the NWFPs you consume? = I do not know Marital status = SINGLE Do you know which regions certain NWFPs are grown in? = I do not know ==> Do you know the production techniques of NWFPs? = I do not know <confidence:(0.94)>

30858. Do NWFPs contribute to the economy of our country? = Yes Can NWFPs be used in furniture production? = Yes Are there international agreements for the protection of NWFPs? = Yes Is there legal regulation regarding NWFPs in our country? = Yes ==> Can NWFPs be used in fabric dyes and fiber production? = Yes Are there institutions/organizations for the protection of NWFPs in our country? = Yes <confidence:(0.92)>

29376. Do NWFPs contribute to the economy of our country? = Yes Can cultivation efforts be carried out for NWFPs? = Yes Are there institutions/organizations for the protection of NWFPs in our country? = Yes Marital status = MARRIED Are there international agreements for the protection of NWFPs? = Yes ==> Is there import and export activity for NWFPs? = Yes Is inventory planning for NWFPs carried out in our country? = Yes <confidence:(0.90)>

1217. Do you know the purposes for which the NWFPs you consume are used? = I partially know Monthly income = 0-20000 TRY Marital status = SINGLE ==> Education level = UNIVERSITY <confidence:(0.90)>

26907. Marital status = MARRIED Monthly income = 0-20000 TRY ==> Can NWFPs be grown in home gardens or pots? = Yes <confidence:(0.88)>

25140. Is there legal regulation regarding NWFPs in our country? = I do not know Marital status = SINGLE ==> Education level = UNIVERSITY <confidence:(0.87)>

1127. Do you know which regions certain NWFPs are grown in? ==> I do not know Do you know the production techniques of NWFPs? = I do not know <confidence:(0.87)>

24157. Gender = MALE Are there institutions/organizations for the protection of NWFPs in our country? = I do not know ==> Is inventory planning for NWFPs carried out in our country? = I do not know <confidence:(0.86)>

1054. Occupation = RETIRED Marital status = WIDOWER (DECEASED SPOUSE) ==> Do you know the endemic NWFPs found in our country? = I do not know <confidence:(0.86)>

54. Marital status = SINGLE Which non-wood forest product do you purchase the most? = Thyme ==> Education level = UNIVERSITY <confidence:(0.86)>

1019. Do you know the endemic NWFPs found in our country? = I do not know Do you know the possible side effects of the NWFPs you consume? = I do not know Occupation = RETIRED ==> Age = 65 AND ABOVE <confidence:(0.85)>

20256. Occupation = RETIRED Age = 65 AND ABOVE ==> Do NWFPs contribute to the economy of our country? = Yes Can NWFPs be grown in home gardens or pots? = Yes <confidence:(0.83)>

20386. Is inventory planning for NWFPs carried out in our country? ==> I do not know Are there international agreements for the protection of NWFPs? = I do not know <confidence:(0.83)>

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868. Gender = MALE Do you know the required dosage and form of the NWFPs you consume? = I do not know ==> Do you know the possible side effects of the NWFPs you consume? = I do not know <confidence:(0.82)>

17477. Gender = FEMALE ==> Do NWFPs contribute to the economy of our country? = Yes <confidence:(0.81)>

728. Do you know where NWFPs are sold? = I partially know ==> Do you know the purposes for which the NWFPs you consume are used? = I partially know <confidence:(0.80)>

26. Which non-wood forest product do you purchase the most? = Almond ==> Gender = MALE <confidence:(0.79)>

13151. Can NWFPs be used in fabric dyes and fiber production? = Yes

Can cultivation efforts be carried out for NWFPs? = Yes Marital status = SINGLE ==> Education level = UNIVERSITY <confidence:(0.78)>

11562. Gender = FEMALE, Age = 46-64 ==> Can NWFPs be grown in home gardens or pots? = Yes <confidence:(0.77)>

11516. Marital status = SINGLE Occupation = STUDENT ==> Can NWFPs be used in fabric dyes and fiber production? = Yes Monthly income = 0-20000 TRY <confidence:(0.77)>

578. Do you know the possible side effects of the NWFPs you consume? = I do not know, Education level = UNIVERSITY ==> Marital status = SINGLE <confidence:(0.77)>

454. Education level = UNIVERSITY Do you know where NWFPs are sold? = I partially know ==> Marital status = SINGLE <confidence:(0.76)>

19. Education level = MALE Which non-wood forest product do you purchase the most? = Thyme ==> Marital status = SINGLE <confidence:(0.75)>

7542. Is there legal regulation regarding NWFPs in our country? = Yes ==> Can NWFPs be used in fabric dyes and fiber production? = Yes Can cultivation efforts be carried out for NWFPs? = Yes <confidence:(0.74)>

313. Gender = FEMALE, Marital status = MARRIED ==> Do you know which regions certain NWFPs are grown in? = I partially know <confidence:(0.74)>

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307. Do you know the possible side effects of the NWFPs you consume? = I partially know ==> Do you know which regions certain NWFPs are grown in? = I partially know <confidence:(0.74)>

52621. Can NWFPs be grown in home gardens or pots? = Yes Do you know the benefits and harms of the NWFPs you consume? = I partially know Do you know the endemic NWFPs found in our country? = I partially know ==> Do NWFPs contribute to the economy of our country? = Yes Can NWFPs be used in fabric dyes and fiber production? = Yes <confidence:(0.73)>

52617. Do you know where NWFPs are sold? = Yes Can NWFPs be used in furniture production? = Yes Marital status = MARRIED ==> Are there institutions/organizations for the protection of NWFPs in our country? = Yes <confidence:(0.73)>

Discussion

In this study, notable findings have been obtained through the analysis of association rules identified using the FP-Growth algorithm. Upon examining Rule 38128, it is observed that individuals aged 18-25 who answered "yes" to the question of whether afforestation efforts could be undertaken for NWFPs have a marital status of "single," with a 100% confidence rate. According to Rule 1343, individuals aged 18-25 with a university education who responded "I don't know" to the question of whether they are aware of the potential side effects of consumed NWFPs are also single, with a 98% confidence rate. Rule 1217 indicates that individuals with a monthly income of 0-2000 TL, who are single, and who have partial knowledge of the

purposes for which NWFPs are used, have a university education, with a 90% confidence rate. According to Rule 57, individuals who are male and responded "I don't know" to the question of whether there are institutions/organizations in the country responsible for protecting NWFPs also answered "I don't know" when asked whether inventory planning for these products is conducted in the country, with an 86% confidence rate. Rule 54 shows that individuals who are single and purchase thyme most frequently have a university-level education, with an 86% confidence rate. According to Rule 26, males are the primary consumers of almonds, with a 79% confidence rate.

When analyzing these rules, Rule 38128 oung individuals aged between 18 and 25 not only demonstrate environmental awareness but are also more open to innovations and topics such as sustainability. Therefore, it can be inferred that they show greater interest in NWFPs. Based on Rule 1343 and Rule 1217, while university education enhances individuals' capacity to acquire knowledge, being "partially informed" or "uninformed" on specific topics such as NWFPs may be attributed to a lack of comprehensive curriculum coverage in this area, which could limit their level of knowledge. Similarly, Rule 57 suggests that the insufficient inclusion of such specific topics in educational programs may restrict individuals' understanding in this domain. According to Rule 54, individuals with a university-level education may possess greater knowledge about the health benefits of thyme, which may explain their increased attention to its consumption. Furthermore, Rule 26 indicates that almonds, due to their rich nutritional profile, contribute to bone and muscle development, regulate heart rate, and support the nervous and immune systems. These health benefits, particularly those related to muscle and bone development, may lead men to prefer almond consumption. Additionally, as a tasty and convenient snack, almonds might be favored by men for practical and sensory reasons.

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A review of the literature reveals that the use of herbal products is widespread among university students and general consumers, and many consumers trust these products (Sucaklı *et al.,* 2014; Neelkanth *et al.,* 2015; Öztürk and Filiz, 2024). A study emphasized that herbal products/medications are generally harmless; however, side effects have been observed, albeit rarely. Based on this, it was highlighted that the scientific basis of these products should be questioned, and consumers should be made more aware of this issue (Sakinah, 2023; Öztürk and Filiz, 2024). In another study in the literature, it was emphasized that the General Directorate of Forestry's (OGM) inventory studies on NWFPs should be finalized and that cooperation between OGM and forest villagers in production and marketing activities is necessary to promote rural development (Komut, 2019). Looking at previous studies, the use of thyme is generally widespread, and one study found that it is among the most purchased products. The majority of participants in the study were reported to have an educational level of high school and university (Kızıloğlu *et al.,* 2017). Essential oils in almonds may facilitate oxygen delivery to skeletal muscle by enhancing mitochondrial biogenesis and oxygen efficiency, while also reducing ammonia release, thereby improving the training effect on exercise (Yi *et al.,* 2014). In another study, it is stated that to enhance the sustainable management and economic contribution of NWFPs, it is necessary to integrate them into management plans, conduct comprehensive inventory and research studies, increase the income levels of villagers, assign expert personnel, establish an Research and Development (R&D) unit, ensure the accuracy of statistical information in international trade, carry out national and international promotional activities, regulate ownership and utilization rights, form a supreme

council comprising representatives from all sector stakeholders, record traditional knowledge, and accurately calculate the value of NWFPs in national accounts (Açıkgöz Altunel, 2011). In a separate study, some of the significant constraints identified for the direct marketing of NWFPs, which are collected from vast forest areas, include the difficulty of inventorying these products, lack of communication with collectors, intermediaries, and other marketing channel participants, irregular product utilization, lack of supervision, and insufficient training (Göksu and Adanacıoğlu, 2018).

Based on the rules, it can be stated that awareness of these products is influenced by factors such as educational status, marital status, and age. Additionally, the FP-Growth algorithm can be used to identify relationships between consumers' knowledge levels and attitudes toward non-timber forest products. These findings indicate that consumer behavior has a multidimensional structure, with demographic factors playing a significant role in shaping this structure. The research results can contribute to the development of consumer-oriented marketing strategies and aid in planning efforts to increase awareness of NWFPs. In this context, to enhance the sustainable development of NWFPs, it is necessary to integrate crucial information about these products into educational curricula, organize seminars and workshops in relevant universities and other educational institutions, provide informative content on the benefits and usage areas of these products at consumer supply points, effectively utilize digital marketing tools, encourage cultivation efforts, increase product diversity and emphasize innovation, adopt sustainable production methods, implement supportive legal regulations for the sector, provide incentives to producers and entrepreneurs, and support research and development activities. Furthermore, in order to enhance the studies on non-wood forest products, similar research can be conducted in different countries. With the opportunities provided by technology, comparative analyses of these products can be conducted using various data mining techniques, contributing to the research. Additionally, studies can be carried out on other factors such as cultural and psychological aspects that influence consumer preferences. Based on the diversity of non-wood forest products, research can also be conducted to investigate which needs consumers aim to fulfill when choosing these products.

Acknowledgments

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