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CONTENTS

CHAPTER 1

On The Numerical Radius of Hardy-Steklov Operators in Lebesque Spaces

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1. INTRODUCTION

First, give a definition.

Definition [1,2]: Let X is a Banach space and $T \in B(H)$. The numerical range and numerical radius of T are denoted by as

$$W(T) := \{x^*(Tx): \ x \in S_x, \qquad x^* \in S_{x^*}, \qquad x^*(x) = 1\}$$

and

$$w(T) := \sup\{|\lambda|: \ \lambda \in W(T)\}$$

respectively.

Detailed information on numerical range and numerical radius can be found in [12,13].

In [2,5,14] the continuity properties of ratio numerical radius and ratio Crawford number functions, with respect to denominator of ratio numerical radius and Crawford number functions and p-numerical Radius function have been investigated.

In [1,3,6], some convergence properties of p-numerical radii, p-Crawford numbers sequences, (p,q)-numerical radii, (p,q)-Crawford numbers sequences and some spectral characteristics of the converging operator sequences have been investigated.

In [7], some estimates have been obtained by means of the number of differences between the operator norm of the analytic functions of the linear bounded Hilbert space operator and the numerical radius.

In [8], some estimates of this value were obtained using the difference numbers of powers of the associated Hilbert space operators.

In [9,10,15], some spectral characteristic numbers of direct sum of operators and the gaps between them have been investigated.

Operators related to the compatible gaps of coordinate operators have been identified in [11] by comparing the gaps between operator norm and the spectral and numerical radii of the tensor.

In this study, formulae are estimated for the numerical radius of the following Hardy-Steklov type operator

$$H_\varphi f(x) = \varphi(x)\int_0^x f(t)dt,\, f \in L^p(0,1),\, 1 < p < \infty,\, \varphi \in C[0,1],$$
$$H_\varphi: L^p(0,1) \to L^p(0,1)$$

have been investigated.

The source of inspiration for this study was an open problem in [4].

2. UPPER BOUND OF NUMERICAL RADIUS OF THE OPERATOR H_φ

First, prove the following result for the Hardy operator in $L^p(0,1)$, $1 < p < \infty$.

Theorem 2.1. For the norm of the Hardy operator

$$H_\varphi f(x) = x^n \int_0^x f(t)dt,\, n = 0,1,2,\ldots$$

$$H_\varphi: L^p(0,1) \to L^p(0,1)$$

is true

$$\|H_\varphi\| \le \left(\frac{1}{(1+n)p}\right)^{1/p}.$$

Proof. In this case, for any $f \in L^p(0,1)$ we have

$$\|H_\varphi f\|_p^p = \left\|x^n \int_0^x f(t)dt\right\|^p = \int_0^1 \left|x^n \int_0^x f(t)dt\right|^p dt$$

$$\le \int_0^1 \left(\int_0^x x^{nq} dt\right)^{p/q} \left(\int_0^x |f|^p(t)dt\right)dx$$

$$\le \int_0^1 x^{(1+nq)\frac{p}{q}} dx \left(\int_0^1 |f|^p(x)dx\right)$$

$$= \frac{q\|f\|_p^p}{p+q+npq} = \frac{q\|f\|_p^p}{(1+n)(p+q)} = \frac{q\|f\|_p^p}{(1+n)pq} = \frac{\|f\|_p^p}{p(1+n)},$$

where $1 < q < \infty$, $\frac{1}{p} + \frac{1}{q} = 1$.

From the last relation we see that

$$\|H_\varphi\| \le \left(\frac{1}{(1+n)p}\right)^{1/p},\, n = 0,1,2,\ldots$$

In the case, of $n = 0$, i.e., the case of the Volterra operator in $L^p(0,1)$ from the last inequality

$$\|H_\varphi\| \le \left(\frac{1}{(p}\right)^{1/p}$$

holds.

Theorem 2.2. For any $\varphi \in C[0,1]$,

$$\|H_\varphi\| \le \left(\int_0^1 x^{p/q} |\varphi|^p(x)dx\right)^{1/p}, 1 < p < \infty$$

is true.

Proof. In this case, for any $f \in L^p(0,1)$ we have

$$\|H_\varphi f\|_p^p = \int_0^1 \left|\varphi(x) \int_0^x f(t)dt\right|^p dx$$

$$= \int_0^1 \left|\int_0^x \varphi(x) f(t)dt\right|^p dx$$

$$\le \int_0^1 \left(\left(\int_0^x |\varphi|^q(x)dt\right)^{1/q} \left(\int_0^x |f|^p(t)dt\right)^{1/p}\right)^p dx$$

$$\le \int_0^1 \left(x|\varphi|^q(x)\right)^{p/q} dx \ \ \|f\|^p$$

$$= \int_0^1 x^{p/q} |\varphi|^p(x)dx$$

Hence

$$\|H_\varphi\| \le \left(\int_0^1 x^{p/q} |\varphi|^p(x)dx\right)^{1/p}.$$

Theorem 2.3.

(1) For $\varphi(x) = x^n$, $n = 0,1,2, \ldots$ is true $w(H_\varphi) \le \left(\frac{1}{(1+n)p}\right)^{1/p}$;

(2) For $\varphi = P$ is polynomial function $P(x) = \sum_{k=0}^m a_k x^k$, $0 \le x \le 1$ is true

$$w(H_\varphi) \le a\left(\frac{1}{p}\right)^{1/p} \sum_{k=0}^m \left(\frac{1}{1+k}\right)^{1/p},$$

where $a = \max\limits_{0 \le k \le m} |a_k|$.

(3) For $\varphi \in C[0,1]$ is true $w(H_\varphi) = \lim_{n\to\infty} w(P_n)$, where $P_n: [0,1] \to \mathbb{C}$ is a polynomial function sequences, such that (P_n) uniformly converges to the function φ in $[0,1]$.

Proof. First, note that if $F: L^p(0,1) \to \mathbb{C}$, $1 < p < \infty$, is any linear bounded functional, then there exists function $g_F \in L^q(0,1)$, $1 < q < \infty$, $\frac{1}{p} + \frac{1}{q} = 1$, such that for any $f \in L^p(0,1)$ the following holds

$$F(f) = \int_0^1 f(x) g_F(x) dx \text{ and } \|F\| = \|g_F\|_q.$$

(1) In this case, for any $f \in L^p(0,1)$, $\|f\|_p = 1$ and $F \in (L^p)^*(0,1)$, $\|F\| = 1$ we have

$$\left|F(H_\varphi(f))\right| = \left|\int_0^1 \left(x^n \int_0^x f(t)dt\right) g_F(x)dx\right|$$

$$\leq \left(\int_0^1 \left|x^n \int_0^x f(t)dt\right|^p dx\right)^{1/p} \left(\int_0^1 |g_F|^q(x)dx\right)^{1/q}$$

$$= \left(\int_0^1 \left|\int_0^x x^n f(t)dt\right|^p dx\right)^{1/p}$$

$$\leq \left(\int_0^1 \left(\left(\int_0^x x^{nq} dt\right)^{1/q} \left(\int_0^x |f|^p(t)dt\right)^{1/p}\right)^p dx\right)^{1/p}$$

$$\leq \left(\int_0^1 \left(\int_0^x x^{nq} dt\right)^{p/q}\right)^{1/p} \left(\int_0^1 |f|^p(t)dt\right)^{1/p}$$

$$= \left(\int_0^1 (x^{1+nq})^{p/q} dx\right)^{1/p}$$

$$= \left(\int_0^1 x^{\frac{(1+nq)p}{q}} dx\right)^{1/p}$$

$$= \left(\frac{1}{\frac{(1+nq)p}{q}+1}\right)^{1/p} = \left(\frac{q}{p+npq+q}\right)^{1/p}$$

$$= \left(\frac{q}{p+n(p+q)+q}\right)^{1/p}$$

$$= \left(\frac{q}{(1+n)(pq)}\right)^{1/p} = \left(\frac{1}{(1+n)p}\right)^{1/p} .$$

(2) Now assume that

$$\varphi(x) = P(x) = \sum_{k=0}^{m} a_k x^k,\ a_k \in \mathbb{C},\ k = 0,1,\dots,m,\ m = 0,1,2,\dots$$

In this case, from the subadditivity and absolute homogeneity properties of the numerical radius function it follows that

$$w(H_P) \le \sum_{k=0}^{m} |a_k| w\left(x^k \int_0^x f(t)dt\right)$$

$$\le \sum_{k=0}^{m} |a_k| \left(\frac{1}{(1+k)p}\right)^{1/p}$$

$$\le a \left(\frac{1}{p}\right)^{1/p} \sum_{k=0}^{m} \left(\frac{1}{1+k}\right)^{1/p},$$

where $a = \max_{0 \le k \le m} |a_k|$.

(3) If $\varphi \in C[0,1]$, then Weierstrass Approximation Theorem ([16]) states that there exist polynomial function sequences (P_n) on $[0,1]$, such that (P_n) uniformly converges to the function φ in the supremum metric. Then

$$\left\|\left(H_\varphi - H_{P_n}\right)f\right\|_p^p = \int_0^1 \left|H_\varphi f - H_{P_n} f\right|^p(x)dx$$

$$= \int_0^1 \left|\varphi(x) \int_0^x f(t)dt - P_n(x) \int_0^x f(t)dt\right|^p dx$$

$$= \int_0^1 |\varphi(x) - P_n(x)|^p \left|\int_0^x f(t)dt\right|^p dx$$

$$\le \sup_{0 \le x \le 1} {}^p|\varphi - P_n|(x) \int_0^1 \left(\int_0^x |f(t)|dt\right)^p dx$$

$$\le \|\varphi - P_n\|_C^p \int_0^1 \left(\left(\int_0^x 1^q dt\right)^{1/q} \left(\int_0^x |f|^p(t)dt\right)^{1/p}\right)^p dx$$

$$\le \|\varphi - P_n\|_C^p \left(\int_0^1 x^{p/q} dx\right) \left(\int_0^1 |f|^p(t)dt\right)$$

$$= \|\varphi - P_n\|_C^p \frac{q}{p+q} \|f\|_p^p$$

$$= \|\varphi - P_n\|_C^p \left(\frac{1}{p}\right) \|f\|_p^p ,$$

$1 < p < \infty$.

$$\left\|H_\varphi - H_{P_n}\right\| \le \left(\frac{1}{p}\right)^{1/p} \|\varphi - P_n\|_C,\ n \ge 1.$$

Consequently, the operator sequences $\left(H_{P_n}\right)$ converge to the operator H_φ in operator norm. From this and the theorem (see [16]) on the convergence of numerical radius sequences of uniformly converging operator sequences it is obtained that

$$w\left(H_\varphi\right) = \lim_{n\to\infty} w(H_{P_n}) \;.$$

Note that the last equality is not dependent on choosing polynomial sequences (P_n) that uniformly converges to the function $\varphi \in C[0,1]$.

In fact, if there is another sequence (Q_n) that converges to the function φ, then

$$\|P_n - Q_n\|_C \le \|P_n - \varphi\|_C + \|Q_n - \varphi\|_C \xrightarrow[n\to\infty]{} 0$$

In this case, the subadditivity property of the numerical radius function it is implies that

$$\begin{aligned}|w(P_n) - w(Q_n)| &\le w(P_n - Q_n)\\ &\le \|P_n - Q_n\|_{L^p} \le \|P_n - Q_n\|_C \xrightarrow[n\to\infty]{} 0\end{aligned}$$

Then, in claim (3) of this theorem, the polynomial sequences (P_n) can be choosing in any way.

Example. Assume that

$$\varphi(x) = \sin x,\ 0 \le x \le 1,\ \varphi\colon [0,1] \to \mathbb{R}.$$

It is well known that the following polynomial sequences

$$P_n(x) = \sum_{k=1}^{n} (-1)^{k-1} \frac{x^{2k-1}}{(2k-1)!}\,,\ 0 \le x \le 1,\ n = 1,2,\ldots$$

Uniformly converges to the function φ in the supremum norm. Hence by Theorem 2.3 (2) we have

$$w(H_{P_n}) \le \left(\frac{1}{p}\right)^{1/p} \sum_{k=1}^{n} \frac{1}{(2k-1)!} \le \left(\frac{1}{p}\right)^{1/p} e$$

Consequently, by Theorem 2.3 (3) it is obtained that

$$w(H_\varphi) \le \left(\frac{1}{p}\right)^{1/p} e\;.$$

Theorem 2.4. If $\varphi \in L^p(0,1)$, $1 < p < \infty$, are true:

(1) $\left\|H_\varphi\right\| \le \left(\int_0^1 \left(x^{1/q}|\varphi(x)|\right)^p dx\right)^{1/p}$,

(2) $w(H_\varphi) \le \left(\int_0^1 \left(x^{p/q}|\varphi(x)|\right)^p dx\right)^{1/p}$.

Proof.

(1) In this case, for any $f \in L^p(0,1)$ are true

$$\|H_\varphi f\|_p^p = \int_0^1 \left|\varphi(x)\int_0^x f(t)dt\right|^p dx$$

$$\le \int_0^1 |\varphi|^p(x)\left(\int_0^x |f|(t)dt\right)^p dx$$

$$\le \int_0^1 |\varphi|^p(x)\left(\int_0^x 1^q dx\right)^{p/q}\left(\int_0^x |f|^p(x)dx\right)dx$$

$$\le \int_0^1 |\varphi|^p(x)x^{p/q}dx\ \|f\|_p^p$$

Then

$$\|H_\varphi\| \le \left(\int_0^1 \left(x^{1/q}|\varphi(x)|\right)^p dx\right)^{1/p}.$$

(2) For $f \in L^p(0,1)$, $\|f\|_p = 1$, it is obtained that

$$|F(H_\varphi f)| = \left|\int_0^1 \varphi(x)\int_0^x f(t)dt\, g_F(x)dx\right|$$

$$\le \int_0^1 \left|\varphi(x)\int_0^x f(t)dt\right||g_F(x)|dx$$

$$\le \left(\int_0^1 \left|\varphi(x)\int_0^x f(t)dt\right|^p dx\right)^{1/p}\left(\int_0^1 |g_F|^q(x)dx\right)^{1/q}$$

$$\le \left(\int_0^1 |\varphi|^p(x)\left(\int_0^x f(t)dt\right)^p dx\right)^{1/p}$$

$$\le \left(\int_0^1 |\varphi|^p(x)\left(\int_0^x dx\right)^{p/q}\left(\int_0^x |f|^p(x)dx\right)^{p/p}dx\right)^{1/p}$$

$$= \left(\int_0^1 x^{p/q}|\varphi|^p(x)dx\right)^{1/p}\ \|f\|_p$$

And from this we have

$$w(H_\varphi) \le \left(\int_0^1 \left(x^{p/q}|\varphi(x)|\right)^p dx\right)^{1/p}.$$

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CHAPTER 2

Investigation of Propanol-Water Mixture Using Two Types of TD-NMR Devices and Microwave Spectroscopy Technique

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1. INTRODUCTION

Propanol and other alcohols, as well as water combinations, are widely used in industrial applications. Alkyl chains containing less than four carbon atoms are the most commonly utilized alcohols, especially methanol, ethanol, 1-propanol (1pr), and 2-propanol (2pr). Their various physical and chemical characteristics dictate how they might be used to increase the effectiveness of industrial processes. The recommended 1-propanol and 2-propanol for utilization from these alcohols are both isomers of propanol, meaning they have distinct structures but the same chemical formula (C_3H_8O). Although the two compounds share an identical chemical formula, their physical and chemical characteristics are different due to the various positions of the hydroxyl group. 1-propanol is largely used as a solvent, whereas 2-propanol is used as a disinfectant and antiseptic. Alcohols are commonly utilized dissolved because they are readily soluble in room temperature water. However, their aqueous solutions do not exhibit micro-heterogeneities (aggregates of water or alcohol molecules), macroscopic phase separation, or local anisotropies (Pethes et al., 2021).

Alcohols' heterogeneity, which results from the development of alcohol-alcohol, water-water, or alcohol-water clusters, is a significant characteristic (Yoshida et al., 2006; Zhao & Xiao, 2012).

There are a variety of techniques used to detect and differentiate different liquid chemicals and their combinations (such as alcohol-water mixtures), which is crucial for industrial and safety situations. These include nuclear magnetic resonance (NMR) (Jora et al., 2017; Rameev et al., 2012), X-ray scattering (Takamuku et al., 2002), infrared (IR) (Parker et al., 2014), and molecular dynamics simulations (MDS) (Pothoczki et al., 2018), Microwave dielectric spectroscopy literature (J. Barthel, K. Bachuber, 1990; Li et al., 2014; Onimisi & Ikyumbur, 2016).

There are numerous subtypes of NMR among these techniques, including Time Domain NMR (TD-NMR), Earth's Magnetic Field NMR (EF-NMR), Solid State NMR (ss-NMR), Zero Field NMR, and High Field NMR (HF-NMR). High field (HF) NMR spectroscopy is a highly sensitive technique for examining chemical structures, but because it uses a superconducting magnet system, it needs a cryogenic environment. In this case, NMR spectroscopy is prohibitively costly and difficult to apply in practical applications. Because TD-NMR uses permanent magnet technology, no cryogenic system is required. It could be preferable for quality control and security applications because it is inexpensive, simple to use, and portable. The time-domain NMR (TD-NMR) approach measures sample relaxation times rather than the NMR spectrum (Balcı, 2020). The two primary parameters assessed by the TD-NMR approach are spin-spin (transverse, T_2) and spin-lattice (longitudinal, T_1) relaxation times. Different materials have varying relaxing durations. As a result, the T_1 and T_2 relaxation periods are crucial for efficient liquid screening and analysis (Malcolm H. Levitt et al., 2021). On the other hand, when many alcohols are involved in the discrimination process, relying solely on T_1 and T_2 relaxation time does not offer a rapid and accurate detection technique. As a result, more criteria and sophisticated measurement/analysis techniques are required to distinguish between various alcohols. An additional option is to use the microwave approach in conjunction with TD NMR relaxometry, which uses the dielectric permittivity constants real part ($\mathcal{E}_1$) and dielectric loss factor ($\mathcal{E}_2$).

The movement of electric dipoles as a result of being influenced by the electric field is the mechanism that results from the interaction of electromagnetic (EM) waves with the material and aids in EM absorption in microwave technology. This mechanism means that the electric polarization is expressed by the real component of the dielectric coefficient ($\mathcal{E}_1$), which measures the degree to which the electric dipoles are affected by the electric field, while the damping of the activated dipoles and consequently the energy loss is expressed by the imaginary component ($\mathcal{E}_2$) (Abea et al., 2021; Nelson & Trabelsi, 2009). Each material has distinct T_1 and T_2 relaxation times as well as $\mathcal{E}_1$ and $\mathcal{E}_2$, which affect the material's density, viscosity, bonding, and chemical structure (Bryan et al., 2005; Hindman et al., 1973; Lizhi et al., 2008; Ribose, 2000).

In this study, the relaxation times (T_1 and T_2) were measured using two distinct proton NMR instruments: 20MHz-0.5Tesla and 42MHz-1Tesla. Additionally, network analyzer and Dielectric Slimform Probe Kit were used to determine the dielectric parameters ($\mathcal{E}_1$ and $\mathcal{E}_2$) of the 1-propanol-water (1pw) and 2-propanol-water (2pw) mixtures.

2. MATERIAL and METHODS

1-propanol and 2-propanol have been supplied by Sigma-Aldrich® (%99). 1-propanol-water (1pw) and 2-propanol-water (2pw) combinations were prepared using deionized water (Milli-Q, 18.2 MΩ) with different molar fractions and stored at room temperature and the samples were kept stationary in the NMR device for 10 minutes before each measurement. We used two commercial instruments to measure relaxation times in a series of samples with different alcohol concentrations of alcohol-water mixtures (Figure 1 and Figure 2). These two devices are primarily comparable in that they assess T_1 and T_2 relaxation durations in a brief 1–10 minutes and are inexpensive, user-friendly, and portable. In addition, the Magritek Spinsolve TD-NMR device has a high resolution of 42MHz-1Tesla, while the Bruker Minispec device has a low resolution of 20MHz-0.5Tesla. The Magritek Spinsolve TD-NMR Device uses 5mm diameter NMR tubes, while the Bruker Minispec device uses 10mm diameter NMR tubes.

Figure 1. Bruker Minispec mq20 TD-NMR (20MHz-0.5Tesla)

Figure 2. Magritek Spinsolve NMR (42MHz-1Tesla)

The Agilent 85070E Dielectric Slim form Probe Kit and the Agilent Technologies E8364B PNA series network analyzer (Figure 3) were used to evaluate the dielectric constants $\mathcal{E}_1$ and $\mathcal{E}_2$. The liquid test fixture has been calibrated using purified water, 25 C air, and a 50 Ohm load terminal. Sample measurements have been made between 10 MHz and 20 GHz at 25 ^{o}C.

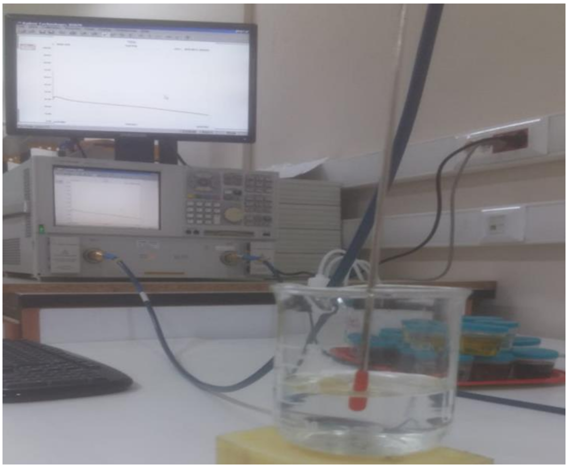

Figure 3. Agilent Network Analyzer (VNA) and Dielectric Kit.

3. RESULTS AND DISCUSSION

3.1.TD-NMR Properties of propanol-water mixtures

Two separate TD-NMR devices were utilized to assess T_1 and T_2 relaxation periods using inversion recovery (IR) and Carr-Purcell-Meiboom-Gill (CPMG) pulse sequence approaches, respectively. The number of scans for these commercial devices is represented by the measurement values of 4 and 2, respectively, for the CPMG (T_2) and IR (T_1) sequences. Inversion recovery (IR) is the most commonly used pulse sequence in which the spin-lattice relaxation time (T_1) is measured. One of the most used measurement sequences in TD-NMR devices for determining the spin-spin relaxation time (T_2) is the CPMG sequence (Carr-Purcell-Meiboom-Gill). This approach involves applying repeated 180-degree pulses following the first 90-degree pulse, and then adding up the signals to determine the spin-spin relaxation time (T_2). The relaxation curves for spin-lattice (T_1) and spin-spin (T_2) for each sample are presented in Figure 4. a and b. (only the Magritek Spinsolve NMR equipment spectra are displayed here).

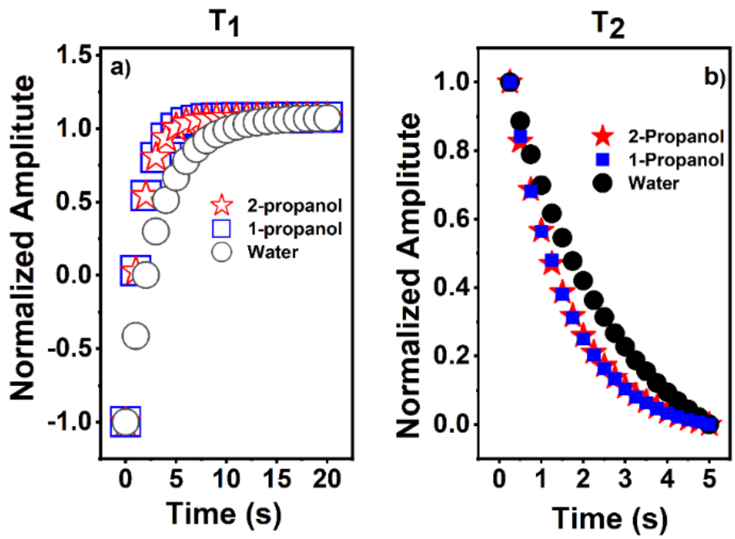

Figure 4. a. Spin-lattice (T_1) and **(b)** spin-spin (T_2) relaxation times spectra

The T_1 and T_2 values were determined by applying exponential fitting to each sample's relaxation time curve. The graphs of T_1 and T_2 for the pure liquids are displayed in Figure 5. a. b

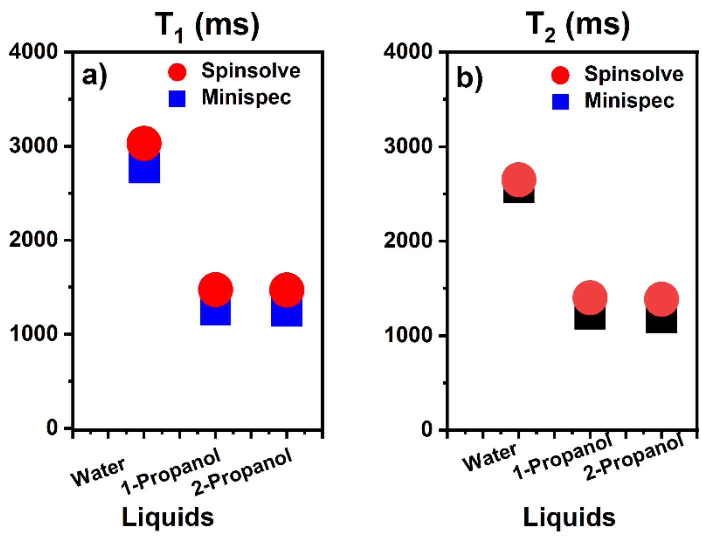

Figure 5. a. b Spin-lattice relaxation times for aqueous mixture

The graphs above show that T_1 and T_2 findings follow the same trend for both devices in identical chemical solutions. Analyzing these graphs shows that the T1 and T2 readings from the Bruker Minispec device are lower than those from the Magritek Spinsolve device. There are variations in the relaxation time values even if the two TD-NMR instruments display the same trend. The impact of magnetic field irregularity in the sample volume, a parameter unique to each TD-NMR device, may contribute to these variations. According to (Maraşlı et al., 2023), the Magritek Spinsolve device's inhomogeneity value was much superior to that of the Bruker Minispec TD NMR. This shows that when the magnetic field inhomogeneity is good, we have greater T_1 and T_2 values.

The graphs of T_1 and T_2 for the molar fractions of 1-propanol-water and 2-propanol-water mixtures are displayed in Figure 6 and Figure 7.

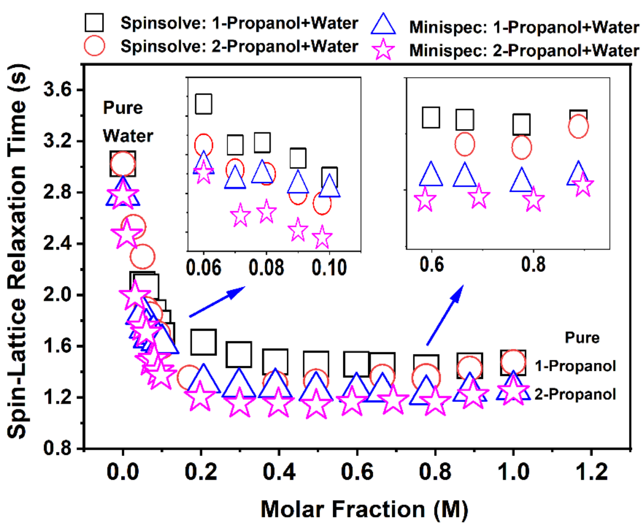

Figure 6. Spin-lattice relaxation times for aqueous mixture.

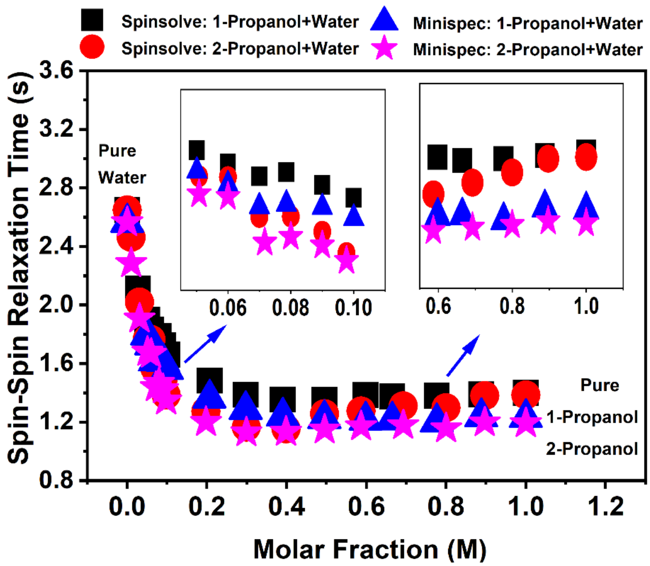

Figure 7. Spin-spin relaxation times for aqueous mixture.

The results show that as expected for liquids, the T_1 values are always slightly higher than the T_2 values for all substances. The energy transfer between spin-lattice for T_1 and spin-spin for T_2 is linked to the origin of relaxation times. It is anticipated that T_1 will be longer than T_2 since the distance between the spin-lattice is greater than the distance between the two spins. As a result, the measurements made in this investigation support the hypothesis (Ma et al., 2018). Similar patterns may be seen in the T_1 and T2 readings for 1-propanol-water and 2-propanol-water mixture concentrations. It is clear that both commercial devices produce results that are consistent with one another. As the figure shows, two inflection points appear at x_m = ~0.07 and ~0.7. While T_1 and T_2 values decrease up to 0.07 molar fraction, they increase and then decrease after this point. Special molar fractions (breaking or turnover) points in T_1 and T_2 values are indicated by arrows. These values translate to $x_{1pr} \approx$ 0.07 and $x_{2pr} \approx$ 0.07 in the molar percentages of 1-propanol-water and 2-propanol-water mixtures, respectively. These results are similar to other results in the literature (Jora et al., 2017; Takamuku et al., 2002; Yoshida et al., 2006). They also found this breaking point to be $x_{1pr}=x_{2pr}\approx 0.07$ and/or $x_{1pr}=x_{2pr} \approx 0.10$. This breaking point has to do with the shift in the alcohol-water clusters' transition structure. Additionally, it depends on the hydrogen connections between the water and alcohol molecules. This clumping effect affects water and molecules' translational and rotational motion.

Numerous study teams have investigated the alcohol-water system's hydrogen-bonding characteristics using a range of methodologies (Burikov et al., 2010; Matsugami et al., 2016; Takamuku et al., 2004; Yoshida et al., 2006). We used information from the literature to explain the observed concentration dependence. It is well known that even when pure water is liquid, its molecules prefer a tetrahedral arrangement, meaning that neighboring molecules are often oriented so that they form tetrahedral water clusters (in a near range) for a while. For instance, the number of hydrogen bonds does not change monotonically with the mole fraction but rather increases when x_{2pr} decreases. There are two inflection points at $x_{2pr} \approx 0.1$. and $x_{2pr} \approx 0.7$ as a result of this shift in the number of hydrogen bonds with the mole fraction. The quantity of hydrogen bonds gradually rises as x_{2pr} decreases in the range of 1 to 0.70, but it rapidly falls below 0.70. Ultimately, the number hits a plateau of $x_{2pr} \approx 0.1$. Propanol molecules prefer to form hydrogen bonds with water molecules over with themselves. This synchronicity implies that the 2-propanol-water mixtures' structure changed at $x_{2pr} \approx 0.1$ (Takamuku et al., 2002; Yoshida et al., 2006). Consequently, T_1 and T_2 values fall as molecular motions slow down.

3.2 Dielectric Properties of propanol-water mixtures

The pure 1-propanol and 2-propanol dielectric constant (ε_1 and ε_2) spectra at 25 °C as a function of frequency from 10 MHz to 50 GHz are shown in Figure 8a-b, except water. The water's spectrum is displayed in the other figure with a mixture of the 1-propanol and 2-propanol combinations.

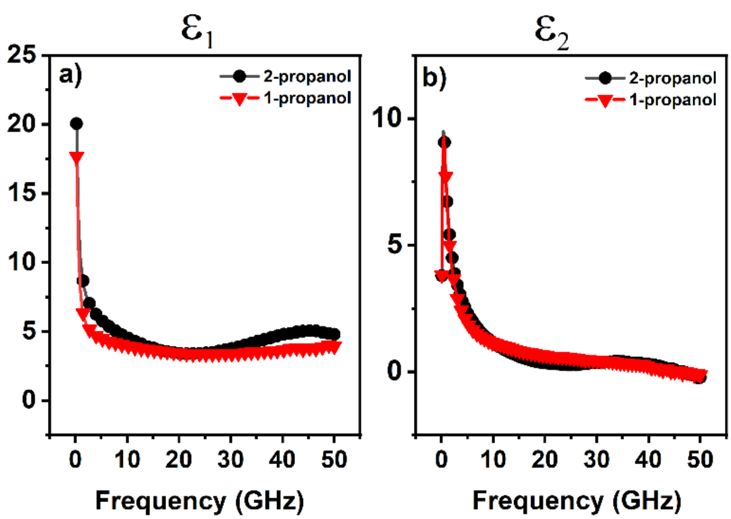

Figure 8.a-b Dielectric constant spectra for pure propanol

According to the dielectric constant $\mathcal{E}_1$ graphs plotted against frequency in gigahertz, the dielectric constants of 1-propanol and 2-propanol have higher values at low frequencies, then sharply decrease as frequency increases, and then remain nearly constant throughout the frequency range. However, as seen in these figures, the loss factor $\mathcal{E}_2$ was observed to be declining over time in both 1-propanol and 2-propanol. This behavior is consistent with the dielectric's typical behavior, as reported by (Onimisi & Ikyumbur, 2016). The spectra can be used to determine the dielectric constants directly. The gigahertz Dielectric Microwave Spectrum was used to determine the dielectric constants at 1 GHz ($\mathcal{E}_1$ and $\mathcal{E}_2$) for water, pure 1, and 2-propanol, which are 78.13- 9.96- 7.68 and 0.59-6.90-7.68, respectively. The measured dielectric constants ($\mathcal{E}_1$ and $\mathcal{E}_2$) were found to be in general agreement with values published in the literature (J. Barthel, K. Bachuber, 1990; Li et al., 2014; T.Sato, 2002). All four forms of polarization—space charge, dipole, ionic, and electronic polarization—may contribute to the greater values of $\mathcal{E}_1$ and $\mathcal{E}_2$ at lower frequencies (Khalil et al., 2014) . It has been noted that only the electronic and ionic polarizations participate at higher frequencies. As the frequency rises, the permanent dipoles' reaction diminishes and the charge carriers' (ions') contribution to the dielectric constant reduces, as seen by the dielectric constant $\mathcal{E}_1$ decreasing with increasing frequency (Graça et al., 2003).

The complex dielectric permittivity of a combination of water with 1-propanol and 2-propanol has been determined at 25 °C as a function of frequency from 10 MHz to 50 GHz and molar fraction x ($0 \leq x \leq 1$). The aqueous mixtures' dielectric constants (1 and 2) spectra, which vary from pure 1-propanol to pure water (molar fractions), are shown in Figure 9.a–b.

Since the dielectric spectra of 2-propanol-water mixtures follow the same pattern as those of 1-propanol, they are not displayed here.

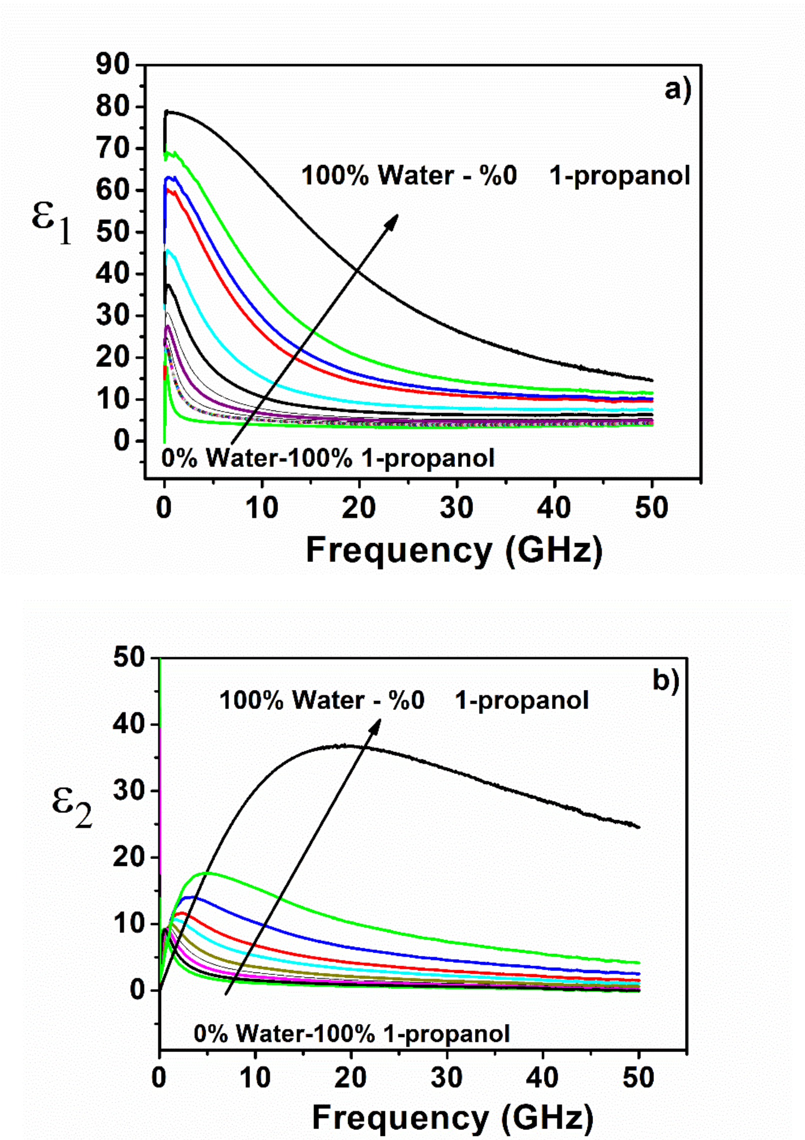

Figure 9. a-b. Real and imaginary parts of dielectric spectra of 1-propanol-water mixtures (at 25 °C)

Figure 10. a–b shows the dielectric constants (ε_1 and ε_2) that were determined by taking the average value of the measurements at 1 GHz.

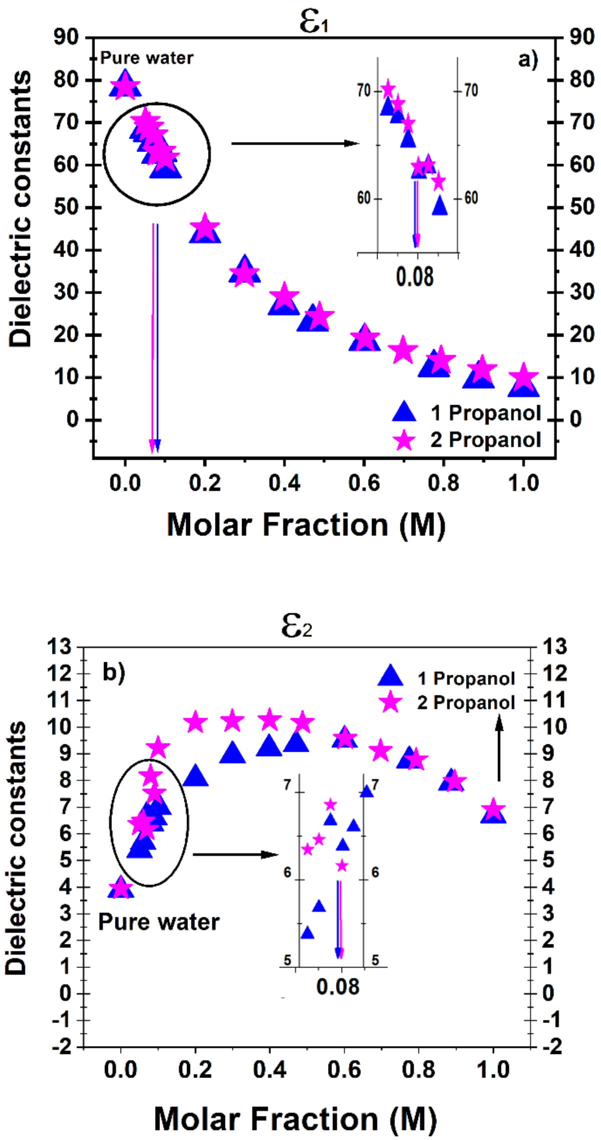

Figure 10.a–b Dielectric constants ($\mathcal{E}_1$ and $\mathcal{E}_2$) (at 1 GHz)

Similar patterns can be seen in the $\mathcal{E}_1$ and $\mathcal{E}_2$ values for different concentrations of 1-propanol-water and 2-propanol-water combinations. The figures show that when the concentrations of 1-propanol and 2-propanol rose, the dielectric constant values ($\mathcal{E}_1$) decreased for all of the examined aqueous solutions. Moreover, the findings indicate that the dielectric constant values ($\mathcal{E}_2$) increased for all of the aqueous solutions studied when the 1-propanol and 2-propanol concentrations grew.

Returning to Figure 10. a–b., the findings demonstrate that 2-propanol-water mixes consistently have larger ε_1 values than 1-propanol-water combinations. Almost the same turnover (breaking) point values are found in mixes of 1-propanol and 2-propanol with water. Special molar fractions are shown by arrows, which correspond to $x_{1pr}=x_{2pr}\approx 0.07$. ε_1 decreases with the increase of concentration toward turnover points. As alcohol fractions increase, ε_1 levels increase and eventually fall to pure alcohol liquid. ε_2 increases as the alcohol level rises until it reaches the breaking point, at which point it declines. After this breaking point, it increases slightly and then decreases again. Following measurements, the dielectric constant was compared to values recorded in the literature, demonstrating the accuracy of the results (Li et al., 2014; Mashimo et al., 1989; Perl et al., 1984). The microwave spectroscopy results are consistent with the literature results.

Dielectric constants have significant scientific and biological applications. The dielectric loss factor (2) indicates how much energy a material produces, while the dielectric constant (Ɛ1) indicates how much energy a substance can store. According to McSweeney, (1997) it has the ability to absorb energy and transform it into heat. Solubility, melting and boiling temperatures, and intermolecular interactions are examples of physical characteristics of compounds that are associated with their molecular polarity. The relationship between the polarity of the molecule and the dielectric constants is known. Furthermore, molecules with O-H bonds can also generate hydrogen bonds. London dispersion forces between molecules of alcohol can rise and even surpass as the alkyl chain lengthens. Numerous research groups have investigated the hydrogen-bonding properties of the alcohol-water system using a range of approaches (Burikov et al., 2010; Li et al., 2014; Matsugami et al., 2016; Pethes et al., 2021b; Takamuku et al., 2000). The number of hydrogen bonds grows modestly with decreasing x_{pr} in the range $0.7 \leq x_{pr} \leq 1$. At $0.1 < x_{pr} < 0.7$, the number climbs more steeply, and at $xpr \leq 0.1$, it converges to the value for bulk water (Takamuku et al., 2000, 2004). The aforementioned investigations show that at low alcohol concentrations, the tetrahedral structure of water predominates and that (isolated) alcohol molecules are encircled by water molecules (hydrophobic hydration creates huge cages). Alcohol molecules begin to agglomerate when alcohol concentration rises because the hydration shells overlap. Water clusters and 1-propanol chains are proposed to coexist inside the extended alcohol-water network in the medium concentration range (about 0.1 to

0.7 alcohol mole fraction). 1-propanol chains predominate at high alcohol concentrations; they have a structure like pure alcohol, while water molecules are scattered throughout the mixture (Pethes et al., 2021; Takamuku et al., 2004).

4. CONCLUSION

This study measured the spin-lattice and spin-spin relaxation times of 1-propanol and 2-propanol mixtures using two commercial TD-NMR devices. It has been observed that the results generated by various devices are consistent. The concentration dependency of relaxation times exhibits the same tendency for both kinds of alcohol. Furthermore, the Magritek Spinsolve NMR has longer T_1 and T_2 values than the Bruker Minispec instrument. The investigation indicates that x_m = ~0.07 and ~0.7 are the locations of two inflection points. The results from both commercial devices are evidently congruent with each other. Additionally, the microwave (MW) spectroscopy technique has been used in this study to analyze the dielectric characteristics (ε_1 and ε_2) of 1-propanol and 2–propanol–water mixtures. Regarding the relationship between concentration and dielectric characteristics, both forms of alcohol exhibited the same tendency. According to the microwave analysis, the inflection points are located at x_m = ~0.07, which is the same as the TD NMR.

In addition to TD-NMR, it is well known that microwave permittivity measurement-based detection is a great method for classifying and differentiating 1-propanol and 2-propanol.

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CHAPTER 3

History of the Medical and Aromatic Plants and their Economic Values

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Introduction

Our country with a vast variety of flora (the types of plants that grow in a region or country) reserves abundant medical and aromatic plants within its structure. Plants provide the necessary oxygen and nutrients for human beings to survive and protect human health. The use of plants for treatment has roots dating back to the history of humanity. Thousands of years ago, humans discovered the power of plants for treatment and have derived benefit from it to sustain a healthy way of living. Public medicines are the applications that have extended from the past to the present, resulting from long-term experience in Anatolia where public medical science

applications are widely encountered. Many types of medicines used in modern medical science are also derived from plants. The botanical fertility of our country is a result of its location at the intersection of three

phytogeographical regions, its role as a bridge between the floras of Southern Europe and Southwestern Asia, as well as being the center of origination and differentiation of many plant species and sections. However, this botanical fertility has not been adequately utilized. Laboratory research has been conducted since 1926 on the germicidal effects of plants on microorganisms as well as their major characteristics in terms of human health. According to WHO investigations, there are approximately 20,000 plants used for medicinal purposes.

As in the whole world, the use of plants existing in the natural flora for various public purposes such as treatment, food, tea, spice,paint, insecticide, veterinary cure, resin, glue, essential oil, beverage, and the cosmetic industry has been a part of our traditional culture for years. On the other hand, this existence is facing the danger of being lost due to contemporary urbanization. This study aims to review the history of the use of medical and aromatic plants and their economic value.

All animals, plants and humans in natureare the products of a balance. In mythology, plants have been regarded as the most valuable gift given by the gods to humans. All plants are at the service of humans, and the relationship between humans and plants has existed since the beginning of human existence (Gezgin, 2006). According to the archaeological findings dating back to ancient times,humans first benefited from plants toobtain food and solve health problems (Koçyiğit, 2005).

The remains of Neanderthal humans found during the excavations carried out between 1957-1961 in the Shanidar Cave in Northern Iraq, along with the items found in the grave, are considered the first data on the beginning of the plant-human relationship.

In this grave, which is thought to belong to a shaman and dates back to 60,000 years ago, the presence of plant species such as yarrow, canary grass, purple hyacinth, hollyhock, pasque flower and ephedra has been determined. In a society that began to bury their dead, these plants, which are thought to have been placed in the grave with the belief that the deceased would use them when they returned to life, may also be an indication that a distinction was beginning to be made between edible and medicinal plants. Because these plant species are still particularly important as medicinal plants today (Lewin, 2000;Heinrich et al., 2004).

As a result of the bond between humans and plants that has lasted for centuries, the field of ethnobotany, whose importance is recognized by the whole world today and serious research is being conducted, has emerged (Koçyiğit, 2005). The content of ethnobotanical knowledge, which has been acquired through trial and error and passed down from generation to generation over a long period of time, reflects very valuable information that has reached the present day. contributes significantly to the scientific evaluation of plants.

The term 'Phytotherapy', meaning 'treatment with medicinal plants', was first used by the French physician Henri Leclerc (1870-1955). The primary and secondary metabolites produced by plants are directly and indirectly the most fundamental

They are plant products. Plants convert the water, minerals, and certain elements they absorb from the soil into compounds that the human body can metabolize.

Carbohydrates, proteins, fats, vitamins and minerals are examples of basic nutrients. These are the main active substances formed in plant metabolism (e.g. essential oils (volatile oils, essences),alkaloids, tannins and bitter substances). They increase the body's defenses, support the functions of organs, and/or accelerate healing. Thus, they have a positive effect on the functions of certain tissues and organs in the organism. is collected and marketed. Medical and aromatic plants mainly Aegean, Marmara, Mediterranean,Throughout human history, many diseases(such as diabetes, jaundice, shortness of breath, etc.) have been and are being treated using plants. The World Health Organisaiton WHO reports that approximately 4 billion people worldwide

(80% of the world's population) initially try to address their health problems with

herbal drugs. Additionally, in developedcountries, approximately 25% of prescribed medicines contain plant-derived active ingredients (e.g. vincristine, reserpine,quinine, aspirin, etc.) (Farnsworth et al.,1985).Especially since the 1990s,the discovery of new uses for medicinal and aromatic plants, and the increasing demand for natural products, have been steadily increasing the usage volume of these

plants. It is estimated that the medical plants market currently has an annualvalue of approximately 60 billion dollars(Kumar, 2009).Türkiye is one of the leading countries inthe trade of medical and aromatic plantsthanks to its geographical location, climate and plant diversity, agricultural potential and wide area. This is Turkey; Settled in the developed countries, plant medicine, plant chemicals, food and additives, cosmetic and perfumery industries in the input of many plants that give the plant in the flora of the plants are due to the fact that the plants. Therefore, these plants are mostly from nature The East Black Sea and Southeastern Anatolia Regions are collected from. In order to adequately evaluate the sustainable production and market potential of medicinal and aromatic plants, these products need to be of the desired quantity and quality. The development of improved varieties that meet consumer and industrial demands, the determination of suitable ecological conditions, the timely collection of natural plants without harming nature, post-harvest processes and the determination of processing technology will increase the production and market opportunities of medicinal and aromatic plants (Bayram et al., 2010).

There are 3 varieties, including products (Van Overwalle, 2007). When talking about medicinal and aromatic plants, it covers a very large area in terms of plants, active ingredients and consumption areas. Although there is no standard classification system for this today, they are generally classified according to their families and the active ingredients they contain,

Definition and Scope It is not possible to fully define the definition of medicinal plants. Nowadays, the term 'medicinal'and'aromatic'plants are generally used together. Medicinal and aromatic plants are plants used as medicine to prevent diseases, maintain health or heal diseases. While medicinal plants are used in areas such as nutrition,cosmetics, body care, incense or religious ceremonies, aromatic plants are used to provide a pleasant aroma and taste (Anonymous, 2005). Aromatic plants also have a wide range of uses in the food, cosmetics and perfumery sectors.

The original material of herbal medicines is generally included in the group of medicinal plants. Herbal medicine is raw or processed substances derived from plants that have therapeutic properties or are beneficial to human health, containing one or more plant-derived components.They can be grouped according to their consumption and use, organs used and pharmacological effects. However, the most commonly used grouping is made according to the active ingredients. In order to use a plant in therapy, a pharmacope must be registered. Codexes are officialbooks prepared according to eachcountry's own needs, and to date, four sub -species of taxpayers (sub –speciescodexes in our country (1930, 1940, 1948, and 1974) have been prepared Ceylan,1995).a nd the number of herbaldrogs traded is 1,900 (WHO 1979). According to WHO's estimates, 80 % of the world's population and the African population Floristic Structure and Union of our country According to the Flora of Turkey Flora of Turkey and the East Aegean Islands, Turkey has a very rich flora with 1251 genus and more than 12,000 species and and varieties) of 174 family (Davis 1985,1988, Güner et al., 2000). 234 of these taxa are foreign -based and culture plant. The other species are the plants that show natural spread in our country (October et al., 1989, Erik and Tarıkahya, 2004).Approximately 12,000 of the whole European continent Considering that it has a plant taxon, it is seen that our country is rich in vegetation (October andArk. 2000). Our country isvery rich in terms of endemizm (which extends only in certain parts of the earth). While the total number of endemic taxa in all European countries is approximately 2750, the number of endemic species in our country is 2891. When we include 497 subtypes and 390 varieties that are endemic to this number, the total number of endemic taxa is more than 3750 (Güner et al., 2000).

Although the number of plants used medically in Turkey is not known, it is estimated that it is around 500; Approximately 200 medical and aromatic plants have export potential (Baytop, 1999; October et al. 2000; Aydin, 2004). According to the results of the research conducted by the World Health Period (WHO) 95% of the treatment methods utilized are based on medicinal plants (Başer, 1995). WHO has initiated the 'Traditional Medicine Strategies 2001–2005' program to promote the widespread use and standardization of traditional treatment methods in developing countries to support modern medicine (WHO, 1998). According to WHO data, 60-70% of doctors in Japan recommend traditional medicines to their patients (WHO, 2002). Chemical and pharmacological research has been conducted on only 15% of flowering plants (Başer, 1995). Considering all plant species on Earth, this extremely low percentage highlights that plants constitute a vast resource for use in various medicinal forms (Tarakçı, 2006). Considering all this information, it is seen that our country has a great potential for study in this area (Kendir and Güvenç, 2010).

The presence of 2000 transfers in Istanbul for 45 pharmacies in Istanbul is an evidence that determines the importance of herbal health in public health. One of the oldest prescription patterns known in history belongs to the Hittites. However, tablets and inscriptions from the Sumerians and Egypt can also contain information about healing plants. The presence of medical papyns of the ancient Egyptian period about Egyptian medicine and medicine The Historical Trade of Herbal Drugs in Anatolia Herbal medicines have been used since prehistoric times, through the periods of Mesopotamia, Ancient Egypt, Hittites, Greeks, Romans, Seljuks and Ottomans. Studies on folk medicine (medical folklore) were also conducted during the Republican era. It is known that the people of Anatolia have been using plants for treatment purposes since the Paleolithic age, and have been benefiting from plants for various purposes for approximately 50,000 years (Özbek, 2005).

During the Ottoman period, the drug needs of the people were met with mixtures prepared by physicians or herbalists. 1868 Our knowledge has been greatly expanded.The most important papyrus on medicines and treatments dates from the 15th Papyrus, which is estimated to have been written around 1550 BC, was found between the legs of a mummy in the tomb of El Assassaif in Thebes. It contains 77 plant, animal and mineral drugs and more than 800 prescriptions. The prescriptions most frequently mention wormwood,squill, juniper fruit, henbane, meadow saffron, mustard, castor oil, fig, gentian, flax seed, coriander, elder, pomegranate peel, wormwood, resin, aloe, onion, cinnamon, turpentine and grapes (Bayramoğlu and Toksoy, 2008). During the Mesopotamian civilization, the number of plant drugs used was around 250. Prescriptions from this period often contained drugs still used in medicine today, such as mandrake, henbane, ephedra, iris root, opium poppy, mustard, thyme, gum, oak apple, mint, pomegranate peel, fennel, saffron, and turpentine (Limet, 1978). In the Greek period, about 600 medicinal plants were known (Saber, 1982). This number rose to around 4,000 during the Arab-Persian civilization (Levey, 1973). By the early 19th century, the number of known medicinal plants had reached 13,000 (Baytop, 1999).

Anatolia, which is a bridge between Asia and Europe, has played an important role in the herbal medicine and spice trade for centuries. It is known that the trade of plants and plant parts used as medicinal active ingredients in Anatolia has been carried out since very ancient times (Özhatay et al., 1997). 6. century onwards, Istanbul has become the center of Spice and Drog trade. Drog and spices of the Far East (pepper, cloves, Küçükhistancevizi,Caucry, musk, sarısabır, cinnamon, ginger and others) came toAntakya, İskenderun or Trabzon ports and was transferred to Istanbul with ships. During the periods when pirates dominated the seas, transport was made from land and caravans (Baytop, 1990).During the Ottoman Empire period, Anatolia also maintained its importance in the transportation of spices and drugs. New roads and caravanserais were built and their protection was emphasized. The roads named'Royal Road' or 'Silk Road' connected the ports of Western Anatolia with the Eastern countries. However, sea transportation was always preferred. Eastern goods were brought to the ports of Trabzon or Iskenderun via caravans through Iran, and then transported to the ports of Genoa or Venice to be sent to European centers (Baytop, 1990).

It has been specified. At the end of the work, 97 colored plant pictures have been given,and all plants have been classified according to their therapeutic effects. In this work, Baytop stated that there are approximately 750,000-1,000,000 plant species in the world, about 20,000 of these plant species are used for medical purposes, and only about 500 out of the 9,000 plant species growing in Turkey are used in treatment.

In the 5-volume work De Materia Medica by Dioscorides, which can be considered the first pharmacopoeia, detailed information is provided on the use of 500 medicinal plants and the medicines prepared from these plants (Baytop, 1999). Many of these plants are species grown in Anatolia. Pedanius Dioscorides, a military physician, is considered the most famous expert on medicinal plants in ancient times and the first physician to provide comprehensive information on medicinal plants in Anatolia. Dioscorides'work includes the properties of about 1,000 natural substances (of plant, animal and mineral origin), about 4,750 medical uses of these substances, and about 350 medicinal effects. (Baydar, 2009). Baytop (1999), in his work'Healing with Plants in Turkey', first provided general information about the historical development of medicinal plants used for thousands of years, their names in various languages, cultivation, drug preparation, chemical compositions of medicinal plants, their effects and methods of use. In the main section, he provided information on the families, botanical characteristics, chemical compositions, local names, andusage of the medicinal plants used in Turkey.

It is reported. Only a very small part of them has been cultured. The number of plants recorded in the codices is around 140, but their production is carried out in very limited areas compared to other cultivated plants. The number of plantssold in herbal shops is around 300,and the export of 70-100 plants is carried out. When examining the developments in the production and use of medicinal and aromatic plants in the 20th century, the innovations brought by technology, social and political changes at the beginning of the century led to a rapid decrease in the use of plants as medicine. In the 1930s and 1940s, the synthesis of organic chemicals stimulated the production of synthetic drugs in addition to medicinal plants. The economic and social changes following the World War, as well as new definitions related to plants and treatments, led to a decrease in the use of plant extracts and plants in the Westernized countries that were modernized by industrial advances until the late 1970s (Craker and et al., 2003). processing of the product and buyers' demand for clean (free of physical and chemical residues), continuous (reliable and with a consistent level of active ingredients) and certified (identifiable origin and history) production More than 40% of the drugs listed at the beginning of the 20th century (mostly obtained without refining) were of plant origin, but this figure dropped to below 5% by the mid-1970s (Craker and Gardner, 2005). In the 1980s and 1990s, increased consumer awareness about health, increased interest in herbal medicines, especially in developed countries, and the trend towards organic and natural foods have brought medical and aromatic plants back to the agenda. This has led developed countries to seriously re-examine laws and regulations regarding herbal medicines (Başer, 1998). The end of the 1990s and the beginning of the 2000s saw concerns about the globalization of trade and the preservation of genetic diversity impacting the cultivation of medicinal plants. Quality standards for plant materials,

The demand for products has increased.The research on medicinal and aromatic plants initiated in the 1980s and 1990s has led to advancements in their production, the extraction of bioactive compounds, and the verification of medical applications (Khan and et al., 2005). In the world and in Turkey, the Economic Importance In the past decade, there has been a revival of interest and curiosity towards the use of traditional medicine globally. It is reported that traditional medicine accounts for approximately 40% of all health services in China, 71% of the population in Chile, and 40% of the population in Colombia use similar medical methods. In rural India, 65% of the population uses traditional medicine methods to meet their basic health service needs. In the research on the Public's Traditional Treatment Preference in Isparta Province, 68.0% were found to have used at least one traditional health practice during their lifetime (Öztürk et al., 2005).

The Customs Tariff Statistical Position (CTSP) numbers and order used in its schedules are also seen. There is no special system for classifying medicinal or aromatic plants. It is important that products are exported or imported with the correct CTSP number. Because, each Another reason for the increasing value of medicinal plants in recent years is the resistant strains that have developed due to the resistance of pathogens. Preparations made from medicinal plants have a multifaceted effect and are found to be effective against new strains. For this reason, there has been a return to herbal preparations in recent years. Malaria can be cited as an example. While synthetic preparations such as Atebrin are used in the treatment of malaria, quinine obtained from the chinchona tree growing in tropical regions is still of great importance (Ceylan, 1995). Therefore, it is impossible to draw definite boundaries between medicinal and aromatic plants. This situation affects exports. The restrictions, facilities, funds and quotas periodically made in the customs tariff of the product mean that the product is imported or exported with the correct GTIP number, which brings beneficial results for the buyer, the seller and the country. However, this may not be possible in every case. Because each product may not have a special GTIP number. In this case, the product is processed under the 'others'heading under the nearest category (Başer, 1997). The system accepted in Turkey is the 'Harmonized Commodity Description and Coding System' (HS) which is the form accepted in the European Union of the 'Customs Cooperation Council Nomenclature' (CCCN) (Başer, 1997,Lange, 2006). HS has been developed by the World Customs Organization (WCO) and is used in more than 177 countries and economies today (Lange, 2006).

Due to the large number of medicinal and aromatic plants involved in trade the wide variety of active ingredients obtained from them, a single grouping is not possible in trade statistics. The most healthy and reliable data on the world trade volume and value of medicinal and aromatic plants can be obtained from the UN Comtrade database in Geneva. World herbal drug trade has realized an average of $16.8 billion in exports and $18.6 billion in imports over the last five years. The most important plant species in termsof

production were; bulb-tuber, tea-coffee,spice,seasoning, root and other plant

groups. Among the countries importing medicinal and aromatic plants in the world, countries such as the USA, UK, Germany, France, Netherlands, China and India are also among the countries exporting many plants. On the other hand, the changing health understanding in developedcountries has also increased the use ofthis group of plants in terms of addingflavor to dishes as a result of reducingsalt and fat in meals (Binici, 2002). Collected from nature in Turkey, for domestic and foreign there are 347 species of traded0% of these are involved in foreign trade (Özhatay and Koyuncu, 1997).

Turkey carries out the foreign sales of medicinal and aromatic plants toapproximately 100 countries worldwide. It makes an important part of its foreign sales to the countries of North America,the EuropeanUnion, Latin America, the Far East and North Africa. Among thesecountries, the USA, Germany, Vietnam, the Netherlands, Poland, Brazil, Canada, Italy, Belgium, Greece, France and Japan are at the top of the list (Dagmar, 2002).Turkey's major exported medicinal drugs and spice plants are thyme, laurel leaf,cumin, anise, fennel seed, juniper bark, mahaleb, fenugreek, rosemary, licorice root, mint, sumac, sage and linden flower (Bayram et al., 2010).

According to a study conducted by the World Health Organization based on thepharmacopoeias of 91 countries and some publications on medicinal plants, the total number of medicinal plants used fortherapeutic purposes is around 20,000(Penso, 1983).50% of the medicinal and aromatic plants traded in the world are used in the food industry, 25% in the cosmetics industry and 25% in the pharmaceutical industry.Although the world herbal drug trade isestimated to be at the level of 10-13 billion dollars, our country, despite its rich flora, unfortunately, only receives a share ofapproximately 5-60 million dollars fromthis market. This is also due to the fact that we mostly export medicinal andaromatic plants as raw, unprocessed.

Mass production, which industrializationhas brought to our world, has shown a development in favor of synthetic andsemi-synthetic drugs in the pharmaceutical industry, so the use of herbal products in this sector was on a downward trend. In recent years, the serious side effects of the use of synthetic drugs and the medical and economic problems they have caused have again made plant-based treatment popular (Özbek, 2005). The process of returning to nature began with such a need, the demand

Medical and Aromatic Plants

Production and Trade in the

World and Turkey

The herbal medicine and cosmeticsindustry has rapidly become a growingsector, especially in developed countries,due to the demand it creates. In 1980, theherbal medicine market in the USA was $8billion. This value reached $18 billion in1985. In Japan, the sales of prescriptionherbal medicines were $2.6 billion in 1983.This value constituted 15-20% of all prescription drug sales in Japan that year. The same value accounted for 25% of theprescription drug market in the USA, and 35-40% in Germany (Başer, 1990).

In our country, medicinal and aromaticplants are obtained from wild collection and partially from cultivation. Between2004-2008, it is reported that an average of$7.5 million worth of medicinal and aromatic plants were imported in Turkey(Bayram et al., 2010). Despite the large imports, wild collection still plays an important role in the trade of medicinal and aromatic plants in Europe. The price ofmaterial obtained from natural plants is generally lower than that of cultivatedones. Wild collection is particularlyprominent in Albania, Turkey, Hungary andvSpain. The total volume of plant material collected from the wild in Europe annually is not less than 20,000-30,000 tons(Anonymous, 1998).

In our country, the collections from natureare sold a) at the estimated price inaccordance with Article 37 of the ForestLaw: Production programs such as resin,sılacagil oil, pine root with pine cone andboxwood are produced by the buyersthrough pre-production sales of seedlings and trees with and without soil, or b) at thetariff price: Any forest products that are not included in the production program and do not require special production techniques, are sold.

According to the priorities of Article 40 of the Law, products such as bay eaves,thyme, flower bulbs, sumac, linden, andcarob are sold to forest illagers and cooperatives (Anonymous, 2004). e continuous and unconscious removal of plants from nature causes thev deterioration of natural vegetation, theextinction of rare and endemic plantspecies, and an increase in the erosion,which is a very important problem in ourcountry (Özhatay and Atay, 1997).

The world markets and the pharmaceutical industry demand'standard'products with high active ingredient content and quality. Nowadays, it is not possible to supply sufficient standard and high-qualityvproducts from the collection of natural plants in Turkey, and these plants need to be regularly cultivated and improved to chieve the desired qualities.

Generally, raw drugs are being exported, and active ingredients are mostly imported. It is also important for our country's economy to start the production of those active ingredients that can be produced under our country's conditions from these imported effective substances. Thus, in Turkey, medicinal and aromatic plants are not only as raw drugs,

Production through cultivation It is now understood that the 'Nature andSpecies Conservation' laws cannot beeffectively implemented unless alternativesto plant collection from nature aredeveloped. The alternative to plantcollection from nature is the cultivation andfarming of these plants. Among the cultivated plants in our country are cumin, anise, thyme, mint, red pepper, fennel,poppy, fenugreek, black cumin, and mustard. Some of the cultivated plants occupy a very large area. However,compared to European countries, muchfewer plant species are cultivated. In someEuropean countries, this number rangesfrom 50-100, and in some, it exceeds 100.Except for opium alkaloids and rose oilThe production of extracts and essential oils obtained from them can create added value. The herbal medicine market in developed countries has an annual growth rate of approximately 10%. In the cultivation of medicinal and aromatic plants,like other plants, 'Good Agricultural Practices' need to be considered. These include: soil, plant material, sowing/planting, disease, pest and weed control (biological control is recommended),fertilization, mechanization, irrigation, hygiene conditions to prevent any contamination of tools and equipment, personnel, product harvesting, quality, drying, packaging and marketing stages; these should be selected and implemented in a way thatconsiders the characteristics of the plants to achieve the highest yield and quality,contain active ingredients that meetstandards, and avoid any contamination or pollution harmful to human health (Bayram et al., 2010).Kütahya, Mersin, Muğla and Yalova provinces are among the top in terms of plant diversity, while Adana is known for itsrosemary,

Organic production

Interest and demand for organic plants and herbs are increasing every day. According to five-year data covering 2003-2007 in Turkey, the average organic production area is 147,589 hectares, of which 1,977 hectares is for medicinal plants. The share of medicinal plants in the total area is 1.3%. The average organic production volume for the same period is 308,014 tons. Within the total production, medicinal and aromatic plant production is 12,928 tons, with a share of 4.5%. Depending on the year, medicinal and aromatic plants such as sage, anise, thyme, carob,rosemary and fennel are organically produced for both the domestic and export markets. In Turkey, in 2008,thyme stood out with 1,682.41 tons, fennel with 1,243.39 tons, and rosemary with 500.67 tons in organic medicinal and aromatic plant production. Medicinal and aromatic plants are organically produced in nearly 20 provinces in our country. Antalya,Aydın, Çanakkale, Izmir, Antalya,Aydın and Đzmir thyme,Afyon anise and cumin, Denizli caper, Isparta rose and thyme, Manisa caper, Muğla sage are prominent in production. There is no study on the production of organic seeds (seeds, cuttings, etc.) for the organic production of medicinal and aromatic plants in our country. Recently, the volatile oils or active substances of medicinal plants have been used to preserve animal feeds and increase quality and digestibility (Bayram et al., 2010).

It is recognized and the infusion obtained from them is consumed as a hot drink. This kind of use is quite widespread in the mountain villages of Western and Southern Anatolia as well as in the cities (Özhatay, 1997; Bulut, 2005).

The areas of use of plants a- Food and spice There is an important history of plant gathering for nutritional purposes in our country. The people meet their needs by collecting themselves from the surrounding mountains and forests. This tradition continues in rural areas. The aboveground parts or roots of many wild plants are used as vegetables. They are consumed raw or cooked, as well as dried, pickled or in the form of pickles. Although the existence of the'herb culture' is known in parallel with the rich plant cover in the Aegean and Black Sea regions of our country, it cannot be said that this culture has been very well researched (Yıldırımlı, 2004; Baytop, 1994; Tarakçı, 2006; Bulut, 2005). However, insome regions (especially in Western and Southern Anatolia), plants used as vegetables are brought to local marketsand put up for sale when the season comes (Bulut, 2005). The use of wild plants as aromatic and flavoring is also quite common. Some plants (various species of the genera Allium, Origanum, Mentha, Thymus) are used to add flavor and aroma to dishes. The leaves or flower heads of some species (especially Salvia and Sideritis species) are known as 'sage', 'mountain tea','highland tea'under various names For medical purposes Plants have been used for medicalpurposes in the treatment of various diseases and enteritis for centuries (Essawi and Srour, 2000; Özer et al., 2001). Essential oils, being complex mixtures with different components, also differ in their biological effects. While their effects vary depending on the active substances, many essential oils have antimicrobial, carminative, choleretic, sedative, diuretic, antispasmodic effects (Maksimović et al., 2005). It has been stated that green tea extract has more than 60%, and pepper, carrot and spinach extracts have 40-60% antimutagenic effect (Bunkova and et al., 2005). However, essential oils also have some side effects (Şarer, 1991; Leal-Cardoso and Fonteles, 1999). Garlic, cinnamon, curry, mustard, basil, ginger and some other plants are reported to have antimicrobial properties (Marinoand et al., 1999). In addition, the essential oil of aromatic plants, most of which belong to the Labiatae family, has been shown to have antimicrobial activity (Elgayyar and et al., 2001). For example, the essential oil of basil, bay, clove, thyme and rosemary has been found to have bactericidal activity against L. monocytogenes and other pathogens (O'Gara et al., 2000). People use these plants by collecting them from nature or buying them, for various purposes and in different ways (Baytop,1999). Chinese garlic and Chinese cinnamon have been found to reduce the number of Escherichia coli and otherbacteria during storage of meat, milk and fruit juices (Mau et al., 2001; Alzoreky and Nakahara, 2003; Akgül et al., 1989), and hey have stated that peppermint, cumin, fennel and bay essential oils inhibit Escherichia coli, Staphylococcus aureus,Pseudomonas aeruginosa, Proteus vulgaris, Bacillus subtilis. Yarnell andAbascal (2004) reported to eliminate resilience and also in the treatment of malaria disease Cinchona spp, Artemisia annua, Artemisia absinthium, Artemisia vulgaris, Cochlospermum Planchonii, Cochlospermum Tinktorium, Jatropha Curcas, Gossypium Hirsutum EuPHORBIA LATERIFLORA Khaya Grandifolia proposed to use plants. Acevedo et al. (2005) stated thatLepechinia Caulescens showed anti-Vibrio Cholerae activity. Helicobacter Pylori is agram negative, spiral -shaped, microaerophilic bacteria that colonized in the gastric mucosa (Warren, 1983). It is one of the most important pathogensresponsible for gastroduodenal diseases in people. The use of antibiotics in thedestruction of H. Pylori, who developed gastroduodenal diseases, led to rapid resistance to these antibiotics. Therefore, when the effect of some volatile oils called in vitro and in vivo is investigated; In vitro, it was found that when the fats were used in 1 %concentration, H. Pylori completely inhibited the proliferation. For example, Cymbopogon Citratus (Lemongrass) and Lippia Citriodora (Lemon Verbena) volatile oils have been found to have a bactericidal effect against H. Pylori at 0.01 % concentration. In the vivo studies carried out in mice,the density of H. Pylori in the stomach of the mice treated with lemon grass was a significant decrease in compared to non -treated. A new and safe anti-H can be used to prevent resistance to H. Pylori with a bouquet. It has been suggested that Pylori may be agent (Ohno et al., 2003). Leal-Cardoso and Fonteles the effects of volatile oils on muscle contraction. Şar (1988) determined in a study that 35 folk medicines consisting of 41 drugs in the Central Anatolia Region were used for the treatment of hemorrhoids, 36 of which were of plant origin and 5 were of animal origin (1999)They have conducted extensive research on the antimicrobial effects of the volatile oils of plants. In the study, they examined the pharmacological and therapeutic effects of volatile oils, and particularly noted Ilisulu (1992) provided basic information in his publication 'Medicinal and Spice Plants' on the alphabetical introduction, characteristics, utilization, active ingredients, drugs, economic value, distribution areas and agricultural opportunities of medicinal, spice and recreational plants that are important forthe national economy, public health and nutrition, as well as industry.

Bozdoğangil (1996) determined that there are 224 genera and 1012 species ofmedicinal and various purpose plants naturally found in the Çukurova Region. He stated that 244 plants are used as medicine, as well as 26 for dye, 16 as insecticides, 43 as vegetables, 8 for animal diseases, 32 for their volatile and fixed oils,and 14 for their resins and gums.Tuzlacı and Erol (1999), in a study theyconducted, found that 66 species of plantsare used as folk medicine in the region,mostly as analgesics, diuretics, litholytics,carminatives, for ulcers, hemorrhoids,rheumatism, and cold treatment. Yucel andTulukluoglu (2000) researched the plants used as folk medicine in the Gediz (Kutahya) area, and identified 11 local uses from 9 species in 6 families; 4 for respiratory system diseases (sinusitis, cough, cold), 3 for digestive system diseases (bloating, abdominal pain, inflammation), 2 for circulatory system diseases (vascular occlusion), 1 for diabetes, 1 for malaria, and 1 as a sedative. Şimşek et al. (2002) investigated the purposes of using edible wild plants thatare frequently consumed among the public in Anatolia. They conducted the study on2,246 people living in 14 provinces, districts and villages of Anatolia. In thestudy, they obtained information through face-to-face surveys by interviewing source persons. Regarding the use of theplant for treatment purposes, it addresses how the plant part is prepared (decoction, infusion, poultice or ointment, dried or fresh) gathered by questioning what effect they were used to obtain in the form of a form.They have prepared herbarium materials by properly collecting the determined wild plants that are consumed, and made their scientific designation.

Ertuğ (2004) researched the plants used in folk medicine in the Bodrum region, and determined the use in treatment of a total of 116 plants, 92 of which are natural and 24 cultivated, among more than 350 useful plants. Gürsoy and Gürsoy (2004) investigated the plants commonly used among the public for the treatment of dental and gum-related diseases in Anatolia, their forms of use and botanical properties. Although some plants have proven their therapeutic efficacy, they stated that there are also many herbal medicines found to be ineffective in clinical studies, despite their widespread useamong the public. In this study, they identified that approximately 20 different plants are used together or separately for the purposes of toothache, dental abscess, tooth decay, gum bleeding, gum inflammation and teeth whitening, using the local terms. In the studies conducted using herbal extracts in the field of dentistry, they stated that mouthwash forms are generally used and successful results have been obtained.They predicted that it would be more appropriate to investigate the accuracy of these localprescriptions through randomized controlled studies, rather than rejecting the benefits that can be obtained from the plants used for generations in Turkey, and to use the successful results in the production of new preparations.

They have determined the usage areas of 40 species of 32 families. Gürhan and Ezer (2004), in the study of Hemorrhoids in the study of hemorrhoids in the study of hemorrhoid complaints used as folk medicine plants Latin and localnames, families, used parts, usage methods, used Malyer et al. (2004) investigated some plants and usage characteristics sold in Tekirdağ and surrounding transfers. It has the most use

Regions are given. They found that there are 84 breeds of 46 families used in the treatment of hemorrhoids in our country. It is noteworthy that some of these plants have similar activities with drugs used in the treatment of hemorrhoids. Medical used in the treatment of some diseases and disorders

Plants:

Kidney Diseases: Altınotu (non -dead flower), ponytail, separato.

Sexual reluctance: Demirdikeni,cardamom, licorice, saffron, ginger.

Indigestion: anise,dill, havlican,cardamom, cumin, daisy, fennel, newborn,

ginger.

Hemorrhoids: Civanperçemi, rosehip,thuja, sultanotu, ginger.Constipation: Linen, fennel, cinema,cinema, sizeliot seed.

Heart Disorders: Hawthorn, oxot.

Prevention of cancer:Nettle, red pepper, mistletoe.

Liver disorders:Artichoke, chicory, Wolf's claw, milk thistle,

turmeric.

Menopause: Yarrow, sage, anise,

chamomile, cinnamon.

Nausea and pain: Valerian, mint, ginger.

Prostate enlargement: Valerian, greentea, turmeric, nettle root.

Rheumatic pains: Anise, horsetail,

rosemary, clove, thyme, lavender, lemonbalm, chamomile.

Gallbladder Disorders:Dandelion, yarrow, chicory, wormwood,

turmeric.Colds, chills and cough: Juniper,marshmallow,echinacea, linden, clove,licorice root, mint, eucalyptus, chamomile,ginger.

Stress, depression, and anxiety:Anise, St. John's wort, lavender, lemon

balm, chamomile, fennel, hops.

Forgetfulness and memory weakness:Sage, rosemary, cardamom, green tea,ginger.

Sleep Disorders: Anise, marigold, catnip,lemon balm, chamomile, fennel, hops.

Fatigue: Sage, rosemary, licorice root,

cardamom, thyme, rose hips, ginger.

High Cholesterol: Rosemary, thyme, rose hips, grape seed, green tea, ginger.

High Sugar: Kudretnarı, mahlep,

cinnamon, myrtle.

Weight Loss Tea: Rosemary, cherry stems, corn silk,fennel, sinemaki, ginger, turmeric, green tea (Baydar, 2009).

In terms of quality and standardization of medicinal and aromatic plants, whether for domestic consumption or for export, certain aspects need to be known. These include the correct botanical name, source country or region, harvest time, sensory tests (organoleptic tests for color and odor), macroscopic (shape, size, surface character, texture, fracture that can be done with the naked eye or with an authentic sample), microscopic (parenchyma, collenchyma, fungus, leaf epidermis, calcium oxalate, starch, protein, fat or comparison with authenticmaterials), chemical (investigation of the presence of secondary metabolites such as alkaloids, cardiac glycosides) and chromatographic (especially Thin Layer Chromatography, TLC) tests (Bayram et al., 2010).

These standards should be expanded and brought in line with the current conditions (Bayram et al., 2010). In recent years, the European Pharmacopoeia (EP), the World Health Organization (WHO),the European Scientific It is necessary to determine the qualitystandards by conducting qualityassessments of medicinal and aromaticplants with various applications. Qualitystandards are becoming increasinglyimportant nowadays. In addition to basictests, specific research is also carried out(Phillipson, 1993).The Turkish Standards Institute has somestudies on certain medicinal and aromaticplants. However, these are not sufficientand cover certain plants.Herbal Medicine Cooperative (ESCOP) andsimilar organizations have begun publishing monographs on herbal drugs.WHO is preparing a long series ofmonographs on the most widely used medicinal plants. 28 monographs are expected to be published soon. 26 monographs are in the preparation stage. In Germany, the German Federal Health Agency has set up a panel of experts called 'Commission E' to evaluate the safety of herbal medicines.

Elderly patients who have to take a large amount of medication alongside are subject to drug interactions Side Effects of Plants and Herbal Products with Drugs The side effects of plants and potential drug interactions when usedtogether are not fully known. It is emphasized that attention should be paidto potential drug interactions and side effects when using plants and herbal products for treatment and prevention of any disease (Cupp, 1999). It is stated that substances in some foods and spices consumed daily with antibiotics interact and cause undesirable side effects and reduce effectiveness (Anonymous, 2002). Especially with the increase in the use of unlicensed, unqualified, ineffective and unreliable, improperly labeled andunstandardized drugs, mostly sold over-the-counter, the frequency of scientific publications to draw attention to side effects has increased significantly,especially in the USA and Europe. The use of herbal medicines in pregnant women and breastfeeding mothers is undesirable. Also, the use of these products in infants and children should be avoided. Because the physiology of children is different fromadults, their metabolic enzyme systems are not fully developed, and dose dy weightso they can easily reag to doses.

is the group that requires the most scrutiny in this respect (Gürün, 2004). Many medicinal plants (such as chamomile, sage, mint, lemongrass) are used as medicine in almost every home to treat minor ailments without the need for a doctor's recommendation. Uncontrolled and improper use often results in situations that are harmful to health. In this respect, for the treatment of important diseases, it is absolutely necessary to rely on the recommendation and treatment of a doctor (Özer et al., 2001).

Plant species should be cultivated and their natural cultivation should be adopted. To increase their share in foreign trade, their diversity should be increased and all the requirements for producing quality products that meet the desired standards in the world should be met. herbalistiofesiotnhe indiowthy do it,

Conclusions and Recommendations

The following recommendations have been developed to ensure that medicinal and aromatic plants contribute more effectivelyto the country's economy and to enable our

country,which has a rich flora in terms of plant diversity, to make more efficient useof these resources;It is seen as an obligation to implement all kinds of legal regulations necessary for the protection, sustainability and evaluation of the diversity of medicinal and aromatic plants. A completelist of natural plants traded omestically and internationally, together with collectors, intermediaries, exporting companies and relevant government agencies, should be prepared and a database should be created.

Companies exporting plants, relevant official institutions, and plant collectors should be trained on this issue. It is absolutely necessary to establish the institutional infrastructure that will provide the seedlings needed by growers who want to cultivate medicinal and aromatic plants today.

Especially those with high economic value Laws that clearly reveal the requirements, limits, and official institutions/organizations that should be bound must be prepared and implemented. - There is no regular statistical data onmedicinal and aromatic plants. This makes it difficult to produce, taking into account the supply-demand relationship. Therefore, data banks should be established whereinformation on plants can be collected and accessed.

- Including medicinal and aromatic plants in the plant production pattern as alternative products will help the development of agriculture of these plants. - Incentive premiums can be given for high-quality and naturally collected products and cultivated plants.

- It would be beneficial to establish aninterdisciplinary committee where information can be obtained on thepriorities regarding medicinal and aromatic plants, which ones need to be cultured, the supply-demand situation in the world market, and prices.

- The standards of the medicinal and aromatic plants used should be prepared as soon as possible, their number should be diversified and their contribution to the tneonmtinsuldldbeinpcariedatsoeh.eir use in human health, research should be done on this,and unconscious use should be prevented.

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