



A Study on Syrup of *Juniperus excelsa* Cones Grown in Türkiye

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

For beverage products, some analytical tests are conducted prior to packaging and distribution. However, physicochemical properties may affect product quality adversely in a number of ways. Liquids with high dissolved solids may impact inferior palatability and may induce an unfavorable physiological reaction in the transient consumer. In this study, it was to evaluate some certain physicochemical properties of syrup which was made from *Juniperus excelsa*'s berries collected from four different geographical locations managed by the Regional Directorate of Forestry authorities in Türkiye. Considerable physicochemical variations were found among *Juniperus excelsa*'s berry-based syrup products. The lowest value of pH: 5.46 was found with syrup prepared from Yalvaç-Isparta, (sample C), followed by pH: 5.75 from Hisarcık-Kütahya, (sample D), pH: 5.80 Ağlasun-Burdur (sample B), and pH: 6.32 Gazipaşa-Antalya (sample A), respectively. However,

syrup prepared from sample C showed the highest values of electrical conductivity (EC), total dissolved solids (TDS), sugar content (Brix), and also distinguished from the others by highest oxidation-reduction potential (ORP). It was found to be 3136.1 uS/cm for EC, 1568 ppm for TDS, 1.90 °Bx for Brix and 188.6 mV for ORP. However, the highest turbidity value of 67.6 NTU was found with sample D while the lowest with sample A (39 NTU). These values may be good criteria for the botanical origin of syrup and therefore, it may be used in syrups prepared from *Juniperus excelsa*'s berries.

Keywords: *Juniperus excelsa* berry; syrup; pH; EC; TDS; turbidity.

1. INTRODUCTION

Juniperus excelsa is a flowering plant belonging to the Cupressaceae family, which consists of more than 60 species [1,2]. However, except *Juniperus procera*, which is reported to be the only species of the genus that grows naturally in the southern hemisphere, the rest of them are naturally grown throughout the northern hemisphere of the world [2]. It has been reported that it could reach up to 20 meters in height with a trunk as large as 2.0 meters in diameter, while an evergreen shrub with a conical habit [1,3].

Juniperus excelsa is generally described as a very durable landscape plant whose growth habits vary from low growing to upright or spreading shrub to small tree. Due to it tolerates maritime exposure and is planted in a wide range of soil pH's, the landscape architect may find this tree useful as a compact evergreen conifer [4] while also very attractive to some birds and creatures. However, those can also be found in a wide range of shapes and sizes, while the needle color varies from blue to dark green [1-4]. In this regard, they can offer many uses in the landscape, from ground cover to specimen trees. Some of the common utilization of juniperus species for landscape applications are; screens, windbreaks, foundation plants, specimen plants, shrub borders and other diverse landscape designs. Moreover, junipers have also been suggested to be useful in landscapes in urban settings due to high tolerance to heat, and poor, dry soils [5-7]. Due to wide variations in physical appearances, they should be given preference in landscape plantings which are used as hedges or for other formal appearances.

However, the chemical constituents of a given plant are usually believed to be genetically determined and considerably influenced by the environment. These chemicals may have economic value, along with plant defense against fungus and insect attacks [4,5]. The chemical compounds of junipers have also been reported

to change due to interspecific differences [2, 4,5]. Numerous literature reports suggest that there are many variable effects on extractive content of plant species, including cones, flowers, wood or leaves even in the same species. Besides age, maturity, geographic locations, irrigation and seasonal factors are reported to be very effective on chemical composition of parts of a plant [4-9].

Juniperus species are characterized by a high amount of essential oil in not only cones and needles, but also wood and seed. However, a number of researchers have already reported that the essential oil of *J. Excelsa*' berries is characterized by the presence of very high amounts of α -pinene, followed by cedrol, *L-verbenol* and *D-verbenol*, limonene as predominant components [1,3-5, 9-14]. There are many utilization methods for Juniper tree parts (i.e. cone, woods or leaf). In particular, wood is one of the well-known and desired sources for pencil manufacturing. A number of literature findings reported that juniper berry oil is commonly used by local people as folk medicine, and believed to be an antiseptic, analgesic and sedative and has been useful to cure tuberculosis, jaundice, and eczema, bronchitis, as well as for so many other healings [1,2, 5,7-14]. Along with these special chemical constituents and healing effects, in 2000, the first officially *Juniperus* berry harvested with quantity of 16.830 kg, was made by Isparta Regional Directorate of Forestry, then it has become important non-wood resource for Regional Directorates of Forestry [15].

The evaluation and understanding environmental interactions of plant extractives is a complex phenomenon and involves many variables. These make effective utilization of chemicals in valuable products a challenging topic. The vast literature reports have already presented on various *Juniper* species that certain chemicals from different parts have found to have healing effects on many human disorders (7-15). But the majority of these studies are usually focused on

chemical analysis quantitatively. To our knowledge, the literature data for comprehensive comparison of various characteristics of *Juniperus* syrup products are missing. However, no work has been found to investigate *Juniperus*'s berry syrup properties, which are commonly prepared and marketed as folk medicine by local entrepreneurs in Türkiye.

The aim of this study was to comparatively investigate general properties of samples of syrup made from *Juniperus* berry that were collected from four different locations, namely Regional Directorate of Forestry stands of Antalya, Burdur, Isparta and Kütahya in Türkiye. Selected properties, such as; pH, electrical conductivity (EC), total dissolved solids (TDS), oxidation-reduction potential (ORP), refraction index (Brix value), and cloudiness-haziness (Turbidity) were measured.

2. MATERIALS AND METHODS

The berries (cones) were collected from the *Juniper* stands of Gazipaşa-Antalya at 1683 m (sample A), Ağlasun-Burdur at 1360 m (sample B), Yalvaç-Isparta at 1584 m (Sample C), and Hisarcık- Kütahya at 1020 m (sample D) locations where managed by Regional Directorate of Forestry authorities. Berry samples were collected from healthy mature trees having bluish-black ripe berries in spring and May 2022. Trees were randomly selected in each location

and approximately 100 representative samples were collected from all sides of the crown.

The *Juniperus excelsa* berries are initially green, ripening to blue/ black in colour. Fig. 1 shows the general characteristics of geographic regions where berries were supplied and a geological map for collecting samples. The collected berries were manually cleaned from solid contaminants, then carefully washed with distilled water to remove dust and mud. The clean berries were stored in standard containers at 4.0 °C until analyzed. The experimental procedures were conducted in the botanic laboratory of the Forest engineering department, Faculty of Forestry, Isparta University of Applied Sciences-Türkiye.

In the syrup preparing procedure, 1.0 kg of contaminant free and washed/cleaned berries were put in a container and crushed until the oil/liquid mixture was presented. After pressing, the berries were mixed in 20 L. water and waited 30 minutes. After, it was cooked at constant heat. When this aqueous mixture had become boiled, 5 L. water was added, which was repeated two times. A total of 30 lt water and 1.0 kg crushed/pressed berries were used for 4.0 hours of cooking time. At the end, the syrup paste was screened and separated as solid and liquid. However, solid free screened liquid is further cooked for 2.0 hours. When the mixture has become a reddish/brownish color, the syrup preparation procedure ends and the syrup is poured into containers.

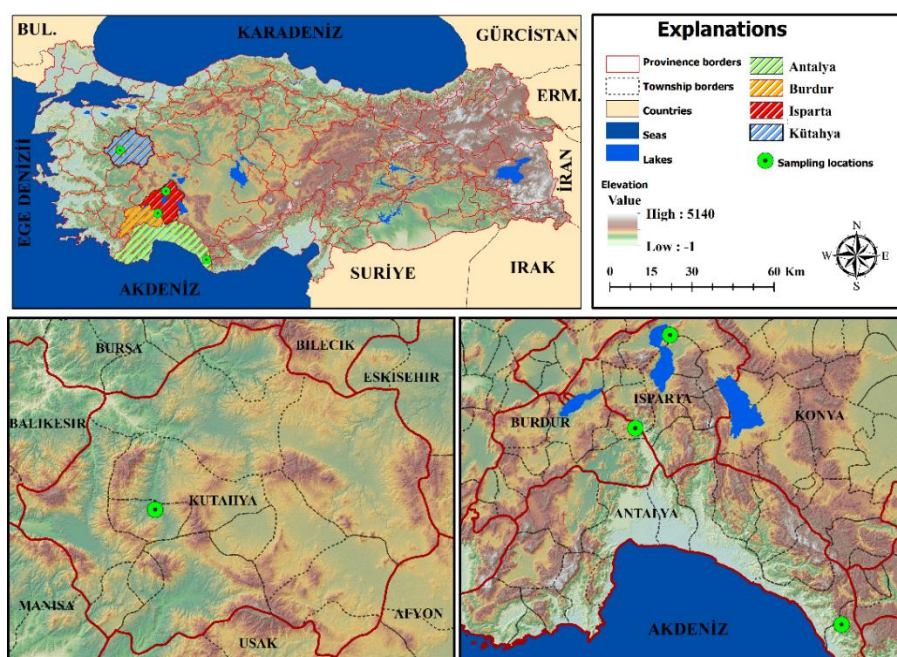


Fig. 1. Geological map of *Juniperus excelsa* berries supplied from

The general properties of *Juniperus excelsa*'s syrup was investigated. While very complex chemical constituents, it is not intend to chracterize and determine all chemical constituents instead of only basic appearance and cloudiness/haziness (turbidity) parameters measured. Therefore, four parameters, commonly accepted for determining liquid quality levels, have been selected. These were; pH, Total Dissolved Solids (TDS), Electrical Conductivity (EC), and Oxidation Reduction Potential (ORP) were examined. A multi-parameter instrument (Jinan Huiquan Electronic Co., Ltd, China) was used to measure these values. The cloudiness or haziness of syrup samples were determined by a turbidity meter (Hanna HI 93703, East Drive Woonsocket, RI, USA) according to the ISO 7027 International Standard.

A Palm Abbe model PA2021 digital refractometer (Solon, OH) was used for all experiments using syrup's Brix (°Bx) level. While the device supports automatic temperature compensation, all studies were conducted with the instrument and materials at ambient temperature.

An analysis of variance (ANOVA) was used for the statistical determination of physicochemical variations. All multiple comparisons were individually evaluated and significant differences among the average pH, EC, TDS, ORP, Turbidity and Brix values were determined. Duncan test was used to make comparison among board types for each property tested if the ANOVA found significant.

3. RESULTS AND DISCUSSION

The foods are varied in taste and also different and beautiful in presentation, color, and can be served with a beautiful appearance. There are not any coloring ingredients used during syrup preparation for *Juniperus excelsa*'s berries, while syrups appear to a reddish-brown color at ambient conditions, as shown in Fig. 2. However, geographical sampling of berries affects variation in appearance of color, particularly intensity.

Besides measuring the quality of water, which is used to indicate the presence of pathogens, bacteria, and other contaminants, it was suggested to measure colour intensity or cloudiness-haziness of a product using the turbidity method (16-19). Depending on the application, it is a colour-compensated angle scattered light measurement to ensure the quality of the product. It is also used by dairies and beverage industries for predicting quality assurance, cost and process optimization (16-17). In our study, the highest turbidity value of 67.6 NTU was found with D, followed by 55.9 NTU (C), 46.3 NTU (B), 39.0 NTU (A), respectively. It has well been proposed that the higher the turbidity, the greater the amount of scattered light. Although the visual appearance of a beverage is one of the most important acceptance criteria for consumers, while the prepared syrups may or may not look aesthetically pleasing, there is no clear evidence that the safety of the beverage has been compromised [16-19].

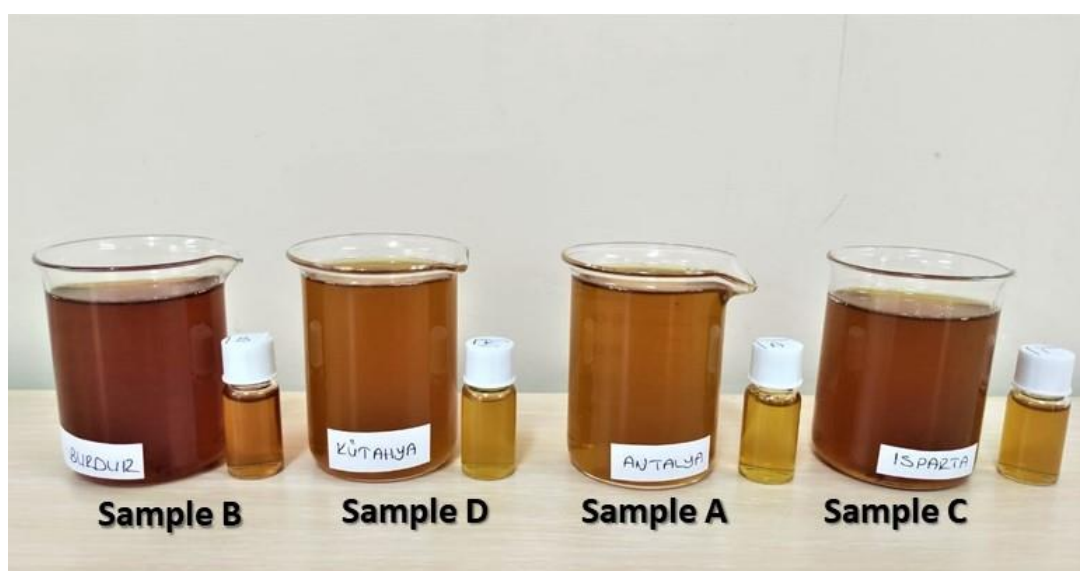


Fig. 2. The general apperance of syrups prepared from *Juniperus excelsa*'s berries

The parameters of pH, EC, TDS, ORP have already been reported to be useful methods for determining certain characteristics of foods [20-25]. These parameters were recently included in the international standards replacing the determination of ash content for honey [22]. In these regards, the selected average physicochemical results are presented in Table 1, comparatively. In four syrup samples, the highest values of EC, TDS, ORP and Brix were found to be in sample C with lowest pH value. These measured results may be used to distinguish between geographic sampling locations of *Juniperus excelsa's* berries.

The pH and/or acidity of a food are generally used to determine processing requirements and the applicability of *Good Manufacturing Process* (GMP) regulations which require a quality approach to manufacturing, enabling companies to minimize or eliminate instances of contamination, mixups, and errors [24]. However, methods and conditions for determining the pH and acidity of foods are also summarized in 21 CFR (Code of Federal Regulations) 114.90 in USA [25]. A considerable pH variation exists between syrup varieties, where are the lowest pH value of 5.46 was found with C, followed by D (pH: 5.75), A (pH: 5.80) and B (pH: 6.32), respectively. According to USDA regulations [24-25], all pH values are found to be in acceptable level in edible in their normal and natural state.

Electrical conductivity (EC) is a physicochemical measurement of the dissolved material in an aqueous (nutrient) solution, which relates to the ability of the material to conduct electrical current through it (21-22). The EC values of syrup samples tested in our study are also listed in Table 1. The EC of C is rather high (3136.1 uS/cm), means that it contains higher amount of minerals. It appears to no relationship between sampling elevations and syrup types. It was measured 1042 uS/cm for D, 1058 uS/cm for A, 1235 uS/cm for B, in that order. The EC may be a good criterion for the botanical origin of syrup and therefore it may be used in routine syrup control.

Total solid determination, either dissolved or retained in foods, is one of the most often used tests in quality control. As mentioned above, a number of chemical constituents are reported by numerous scientists, that *Juniperus* berries have components of essential oils, flavonoids, and many other extractives [5-14]. The TDS of the

syrups was found to range from 522.0 ppm (D) to 1568 ppm (C). Statistically (with 95% confidence), there are no significant differences in TDS between samples of A and D while there are significant differences between samples B and C (Table 1).

Oxidation reduction potential (ORP) is a numerical index, measured in millivolts (mV) and can either be above zero (oxidizing conditions-lose electrons) or below zero (reducing conditions- gain electrons), which is typically measured to determine the oxidizing or reducing potential of a water sample [26]. The measurements exposed that sample C not only showed the highest values of EC, TDS and Brix of syrups, but also distinguished from the other samples by the highest ORP value as well. The highest ORP value of 188.6 mV was found for sample C, followed by 160.6 mV (sample A), 155.8 mV (sample B) and 154 mV (sample D), in that order. Statistically (with 95% confidence), there are no significant differences in ORP between samples of A, B and D while there are significant differences between samples C (Table 1). But it is important to note that all syrup samples show lower ORP values than drinkable water quality levels, while ORP level for clean and/or drinkable water should be lower than 500 mV [27].

The Degrees Brix ($^{\circ}$ Bx) is traditionally used in various food industries (i.e., alcohol, soft drink, fruit juice and honey, so on.). Because many consumers usually assess food or beverage quality of flavor or sweetness, it is an important subject criterion. It has already well documented that there is a direct correlation between a food's Brix value and its taste, quality, potential sugar content, and nutritional density [28-30]. In our study, it was observed that samples A, B and C showed very small variations in Brix value (A: 0.40-, B: 0.50- and C: 0.60 $^{\circ}$ Bx) while sample C had the highest value (1.90 $^{\circ}$ Bx) among four samples, though still statistically-significant difference in comparison with all samples ($p < 0.05$). One may conclude that syrups prepared from *J. Excelsa* berries are sensitive to sampling regions (Table 1).

However the turbidity values of samples found to be lowest for sample A (39 NTU), followed by sample B (46.3 NTU), sample C (55.9 NTU) and sample D (67.6 NTU), in that order.

In order to evaluate pH level effects on physicochemical properties of *Juniperus*

excelca's berry syrups, the measured values were plotted against pH values. (Fig. 3). It appears to pH of samples has not closely correlated with other measured values of; EC (Fig.3A), TDS (Fig. 3B), ORP (Fig. 3C) turbidity (Fig. 3D) and Brix (Fig. 3E).

impact on measured properties, the pH, EC, TDS, ORP, Turbidity and Brix values were plotted against sample collecting elevations (Fig. 4). It appears to sample collecting elevations inversely related with pH (Fig. 4A) while EC (Fig.4B), TDS (Fig. 4B) and ORP (Fig. 4D) values have somehow related but no any correlation with turbidity (Fig. 4E) and Brix (Fig. 4F).

When Fig. 3 carefully evaluated, other properties appear to correlated each other rather than pH. In this case, for evaluating sampling elevations

Table 1. The general characteristics of syrups

Samples	pH	EC (uS/cm)	TDS (ppm)	ORP (mV)	°Brix
A	5.80 ^a (0.09)	1058.8 ^a (13.1)	532.0 ^a (10.7)	160.6 ^a (6.9)	0.40 ^a (0.16)
B	6.32 ^b (0.04)	1235.8 ^b (40.7)	618.6 ^b (21.7)	155.8 ^a (5.4)	0.60 ^b (0.11)
C	5.49 ^c (0.04)	3136.1 ^c (8.9)	1568 ^c (8.4)	188.6 ^b (3.6)	1.90 ^c (0.22)
D	5.75 ^a (0.11)	1042.2 ^a (33.4)	522.0 ^a (16.8)	154.0 ^a (13.5)	0.50 ^{ab} (0.16)

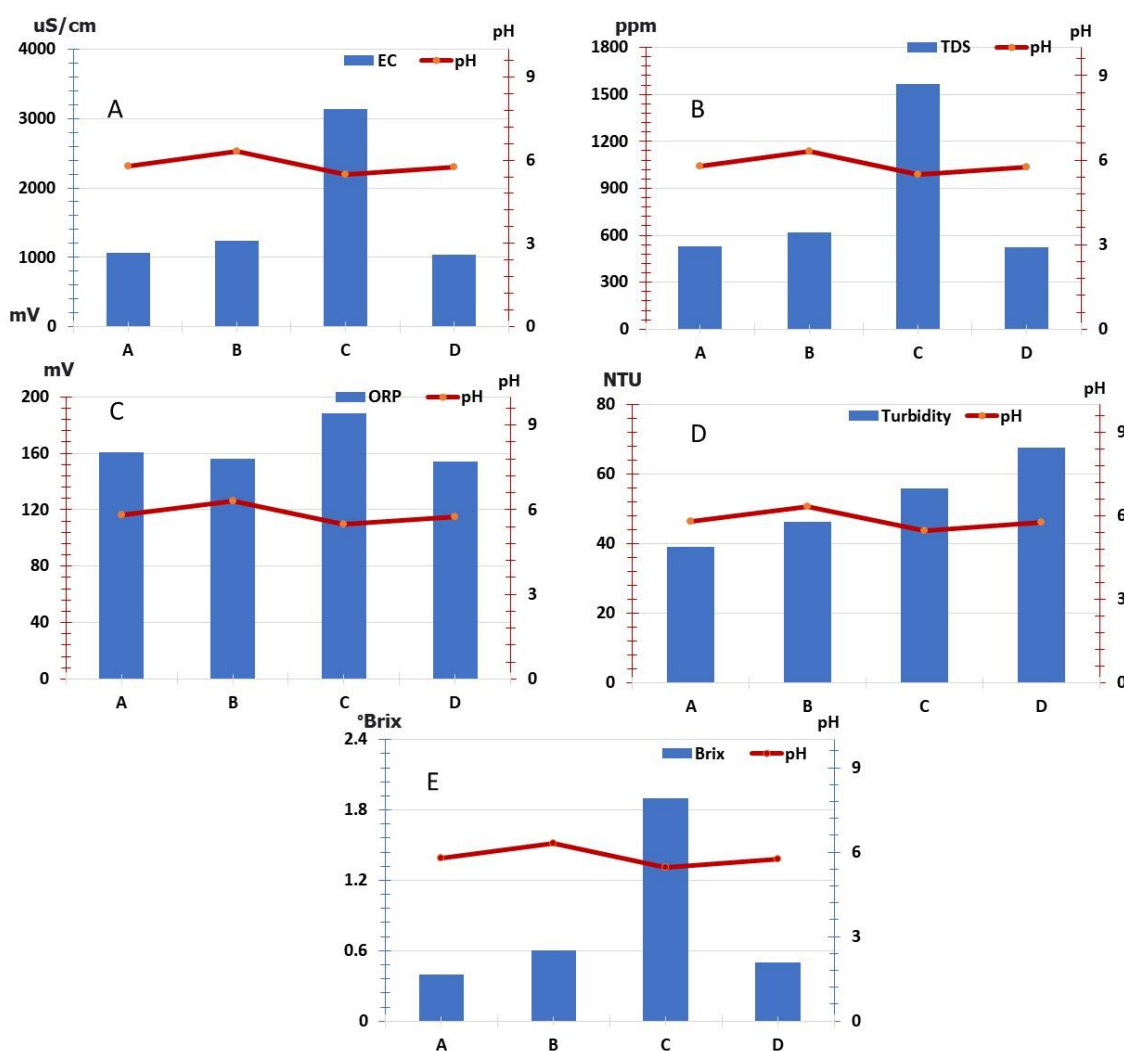


Fig. 3. The effects of pH on physicochemical properties of syrups

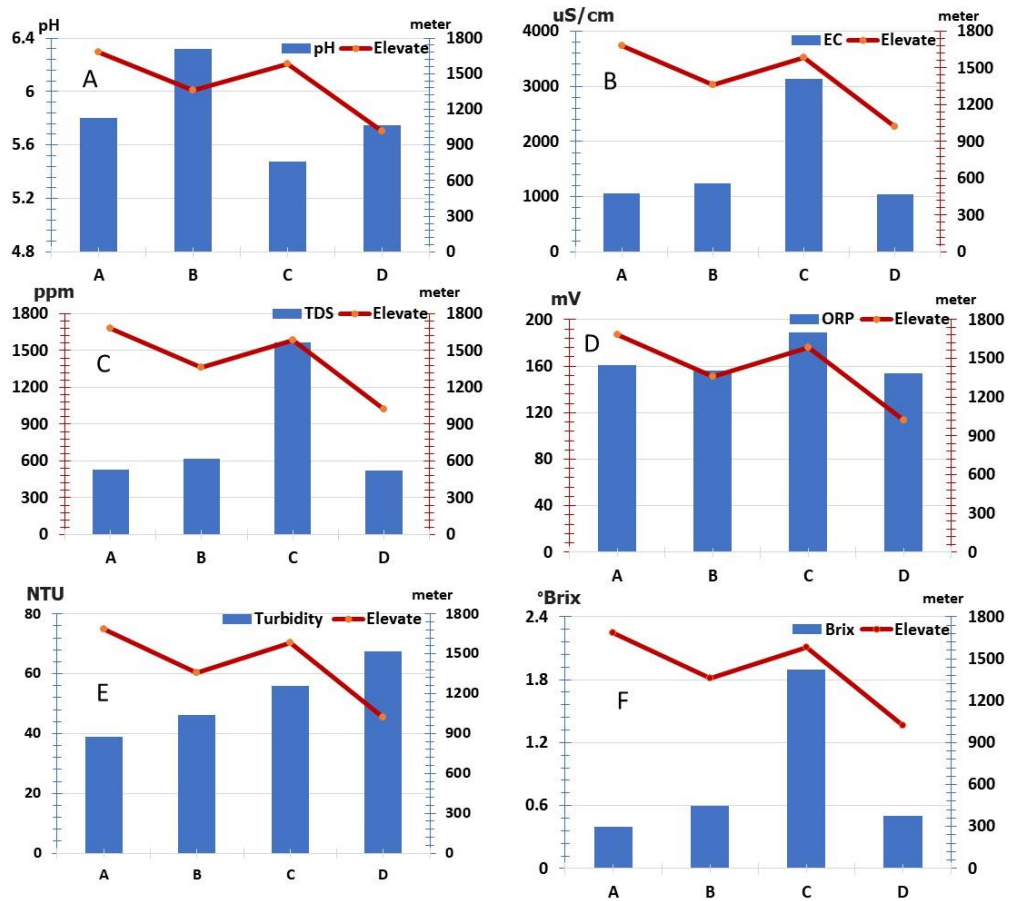


Fig. 4. The effects of sampling elevations on physicochemical properties of syrups

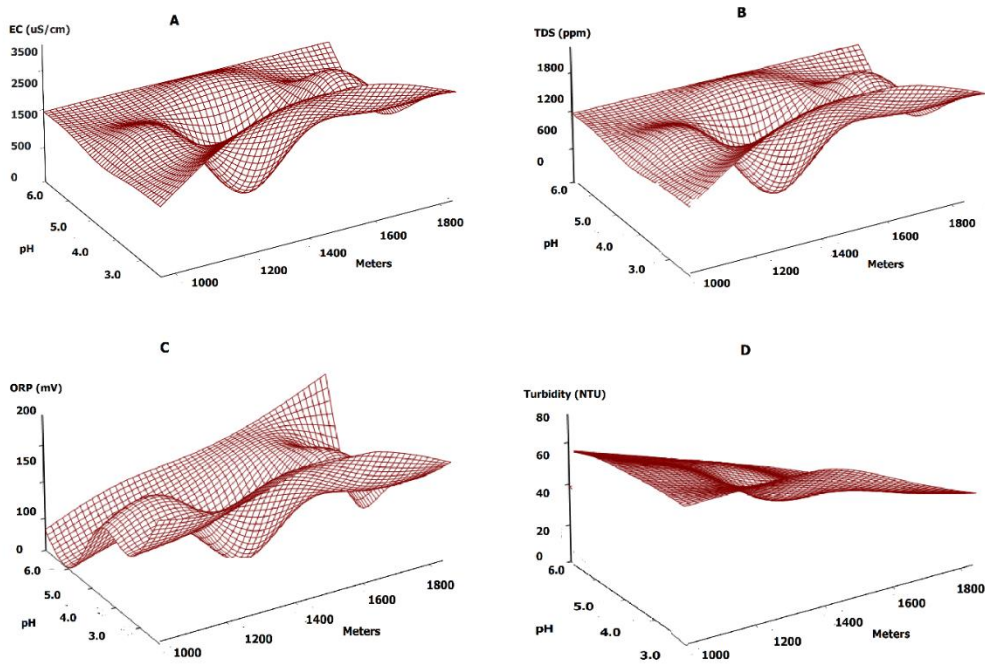


Fig. 5. Combine effects of pH and sampling elevations on physicochemical properties of syrups

The findings in Table 1 and Fig. 3 and 4 also suggest that different mechanisms may control the increased or decreased measured properties. In this case, further investigation which combined the effects of sample collecting elevation and pH were plotted against EC (Fig. 5A), on TDS (Fig. 5B), on ORP (Fig. 5C) and on Turbidity (Fig. 5D), respectively. The dependence of EC, TDS and ORP (Fig. 5A-C) on sampling geographic locations (elevations) and pH shows that those physicochemical properties have a somehow similar trend, shows only a narrow range of changes showing initially (at 1020 m; sample D), then but very sharp decreasing (at 1360 m; sample B), then again marginally changes for sample A (at 1584 m) and C (at 1683 m). However, a considerably different trend was observed with turbulence and it is usually decreasing as sample collection elevation and pH values increase (Fig. 5D). The plot shapes in Fig. 5 clearly suggest that all sample collection locations apparently bring an effect of changing these values. Hence, the different geographic locations should control either an increase or decrease in physicochemical properties of syrups from *J. Excelsa* berries. This could be expected, considering vast literature information have been reported on geographical conditions effects on chemical and botanical properties of plants while similar literature findings on juniperus species. Therefore, it is reasonable to suggest that the ripening time of *J. Excelsa* berries could be considered for producing more homogenous products from this species.

4. CONCLUSIONS

Some plants have become important sources for alternative medicine, with cost-effective ways of various healings. However, many herbaceous and woody plants have been used in combination with other elements to make folk remedies. Although different parts of plants (i.e., leaves, cones, fruits, flowers) have gained increasing attention and are widely utilized, there are still some concerns, particularly due to the 'growing locations' effects on properties. Therefore, a special attention should be taken to the use of medicine from plants. The experimental results found in this study clearly suggest a syrup product prepared from the same plant species but from different geographical locations could show different physicochemical properties. But in detail, many phenomenological properties were reported for plant substrates and the quantification of all those is very complicated and need further investigation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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