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LETTER TO THE EDITOR

Potential Reuse of Extracts from *Ulmus pumila L.* Wood

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In this paper through the detection and analysis of the extract of *Ulmus pumila L.* wood, it is found that it contains a large number of effective active ingredients for use in medicine, food, cosmetics, industry, etc. And it lays a theoretical foundation for the future development and utilization of high value-added products of *Ulmus pumila L.* wood extracts.

I Introduction

Ulmus pumila L. is a very common plant in northern China and it is a species of the genus Ulmaceae. In recent years, scholars at home and abroad have found through their in-depth study of it that *Ulmus pumila L.* extract contains many active ingredients, and it exerts good effects in terms of anti-inflammatory, anti-bacterial, and anti-cancer effects. And it has a strong antioxidant activity (Sun et al. 2010, Cho et al. 2018). Its antioxidant capacity may be attributed to the content of phenols and flavonoids, and selenated *Ulmus pumila L.* pectin polysaccharide (SE-PPU) has stronger antioxidant activity (Lee et al. 2017). Therefore, it has potential as a natural antioxidant in foods and medicines (Cho et al. 2016, Ko et al. 2015). It has been found that *Ulmus pumila L.* exhibits high anti-antagonistic activity against bacteria-Bacillus thuringiensis, microscopic fungi-Mucor circinelloides and Metschnikowia pulcherrima. And therefore utilizes the plant pathogenic microorganisms can be used to create biocides for them and have a role in antifungal diseases (Turaliyeva et al. 2014). In addition, the methanol extract of it exerts an effective anti-inflammatory effect on mouse macrophages and mouse skin (Ghosh et al. 2013). *Ulmus pumila L.* water extract can significantly inhibit Shay, aspirin and indomethacin induced rat ulcers (Lim et al. 2013). Its active extract can also effectively reduce lipogenesis by controlling cell cycle progression and downregulating the expression of adipogenic genes (Ghosh et al. 2012). Not only that, the ethanol extract of it also has a certain cytotoxic activity (Wang et al. 2012). Acetone extract in *Ulmus pumila L.* cortex has potent anti-proliferative activity against human non-small cell lung cancer (A549) and human colon cancer cells (SNU-C4) in a dose-dependent manner (In and Dong 2016). Therefore, *Ulmus pumila L.* has potential development value in anti-cancer.

Based on previous studies, it has been found that *Ulmus pumila L.* extract contains a large number of ingredients that can be applied to biomedicine, especially in the fields of anti-oxidation, anti-inflammatory, anti-bacterial, anti-cancer, etc. Therefore, in order to further study the active ingredients of *Ulmus pumila L.* wood extracts, We extracted *Ulmus pumila L.* wood with three organic solvents (ethanol, methanol, ethanol/benzene), and carried out

FT-IR and GC-MS detection and analysis (Fuentes Rivas et al. 2017, Wang et al. 2018). It is expected to find more effective active ingredients that can be applied to other fields, and providing a theoretical basis for deeper and more comprehensive development and utilization in the future (Marselis et al. 2017).

II Material and Methods

Experimental Materials

Ulmus pumila L. wood were mechanically pulverized into powder (FW-200). The powder was divided into three portions of about 15-20 g each. The powders were then thermostatically extracted for 4 hours in a 300 ml water bath that contained ethanol, methanol, ethanol/benzene (1:1). We named three kinds of extractives as A1, A2, and A3 samples, which were extracted by ethanol, methanol, and ethanol/benzene (1:1), respectively.

Experimental Methods

FT-IR Analysis

The FT-IR spectra of the samples were measured on a FT-IR spectrophotometer (IR100) with KBr discs that contained 1.00 % of the finely ground sample (Peng et al. 2017, Bolotova et al. 2018; Lam et al, 2019).

GC-MS Analysis

The analysis was performed on a 7890B-5977A GC-MS. Column HP-5MS (30 m×250 μm× 0.25 μm). An elastic quartz capillary column was used, the carrier gas was high purity helium, with a flow rate of 1.0 mL/min, and a split ratio of 20:1. The temperature program of the GC initiated at 50°C, rose to 250°C at a rate of 8 °C/min, and finally rose to 300°C at a rate of 5 °C/min. The MS program scan mass ranged between 30 amu-600 amu, with an ionization voltage of 70 eV, and an ionization current of 150 μA electron ionization (EI). The ion source and the quadrupole temperature were set at 230°C and 150°C (Huang et al. 2015, Xie et al. 2018, Gary et al. 2017, Peng et al. 2016).

III Results and Discussion

Analysis of FT-IR

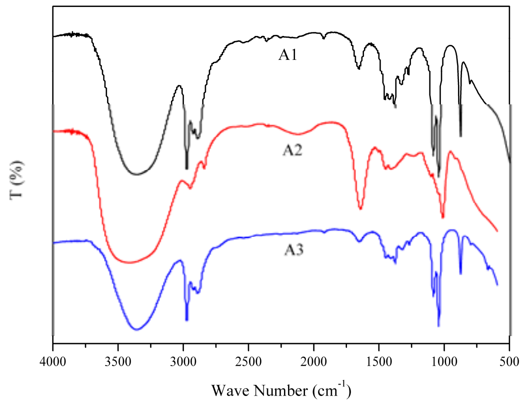

Figure 1 A1, A2, and A3 FT-IR spectra.

As shown in Figure 1 above, there is an obvious broad absorption peak near 3300 cm^{-1}, which is the stretching vibration of the O-H bond in the association state. Combined with a strong absorption peak near 1000 cm^{-1}, basically, hydroxyl-containing compounds such as alcohols or phenols can be identified. The absorption peak at 2950 cm^{-1} is a saturated C-H stretching vibration. The 1900-1500 cm^{-1} is a double bond stretching vibration area. A2 near 1640 cm^{-1} has a strong characteristic peak, which is the stretching vibration of the C=O bond, and it can be judged that there are carbonyl-containing compounds such as ketones, aldehydes, and acids. However, A1 and A3 have very weak absorption peaks near 1650-1670 cm^{-1}, which is the C=C stretching vibration of olefins. The asymmetric and symmetric stretching vibrations of the C-O-C group produce two strong absorption peaks at 1030 cm^{-1}. At 1645-1450 cm^{-1}, there is an overlapping peak, which may be caused by the vibration of the aromatic ring. Therefore, it can be judged that there is an aromatic ring.

In short, the infrared absorption peak of the *Ulmus pumila L.* extract is mainly concentrated in the range of 3000-2750 cm^{-1} and 1750-750 cm^{-1}. Alcohols, phenols, aldehydes, ketones, olefins, and aromatic compounds may be present.

Analysis of GC-MS

The results of GC-MS analysis showed that 31 peaks were detected in A1, where 13 chemical constituents were identified. The results showed that the content of the substances were as follows: Dodecanoic acid, 3-hydroxy-(1.01%), 5,6,7,8,9,10-Hexahydro-9-methyl-spiro[2H-1,3-benzoxazine-4, 1'-cyclohexane]-2-thione (1.75%), Ethyl iso-allocholate (0.41%), .beta.-Sitosterol (0.29%), Octasiloxane, 1,1,3,3,5,5,7,7,9,9,11,11,13,13,15,15-hexadecamethyl- (17.78%).

The GC-MS analysis showed that 70 peaks were detected in A2, where 31 chemical constituents were identified. The results showed that the content of the substances were as follows: Dihydroxyacetone (5.49%), Maltol (8.70%), 4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl- (5.48%), DL-Arabinose (3.39%), 5-Hydroxymethylfurfural (12.97%), Isosorbide Dinitrate (4.34%).

The results of GC-MS analysis showed that 57 peaks were detected in A3, where 25 chemical constituents were identified. The results showed that the content of the substances were as follows: DL-Arabinose (3.26%), 1-Hexanol, 2-ethyl- (26.06%), D-Alanine, N-propargyloxycarbonyl-, isohexyl ester (5.20%), 4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl- (4.65%), 5-Hydroxymethyl furfural (14.04%), Melezitose (3.07%).

The results demonstrate that the compounds identified were classified as alkane, phenols, alcohols, acids, esters, carbohydrate, ketones, aldehydes, and aromatic compounds.

Analysis of Function

Through the GC-MS analysis of three extract samples of *Ulmus pumila L.* wood. We found some useful active substances. 1-Hexanol, 2-ethyl- is used in the production of plasticizers, defoamers, dispersants, mineralizers, and petroleum additives. It is also used in printing and dyeing, paints, and films (Tsoukleris et al. 2005). 5-Hydroxymethylfurfural is used for the detection of metabolites of glucose infusion. It has anti-ischemic and anti-oxidative effects and has protective effects on liver damage and vascular endothelial cells (Niu et al. 2018, Li et al. 2011). Isosorbide Dinitrate is a fast-acting, long-acting nitrate anti-angina drug with the same effects as nitroglycerin. It is mainly used for the prophylaxis before heart attack and can also be used to relieve symptoms. In addition, there has been a significant improvement in blood pressure control after treatment with Isosorbide Dinitrate for use as a disease modifying agent in the treatment of kidney disease (Strong et al. 2018). At the same time, Isosorbide-Dinitrate also plays an important role in the treatment of reduced heart rate ejection fraction (HFrEF) (Nyolczas et al. 2018). Melezitose monoesters with long-chain fatty acids (C-16 to C-18) are promising surfactants for pharmaceutical applications and can be used instead of current commercial nonionic polyoxyethylene surfactants for parenteral formulations (Carvalho et al. 2015). The chemical constituents of *Ulmus pumila L.* wood extract are mainly alcohols, aldehydes, ketones, acids, esters, and carbohydrates. It containing a large number of active ingredients, widely used in medicine, food, cosmetics, industry and other fields. In-depth study of the chemical composition of *Ulmus pumila L.* wood extract has an important role in the study of the comprehensive utilization of it.

IV Conclusions

The FT-IR results showed that the infrared absorption peak of the *Ulmus pumila L.* wood extract is mainly concentrated in the range of 3000-2750 cm^{-1} and 1750-750 cm^{-1}. Alcohols, phenols, aldehydes, ketones, olefins, and aromatic compounds may be present.

The GC-MS test detected 31 peaks in the *Ulmus pumila L.* wood ethanol extract, where 13 chemical constituents were identified. It methanol extract had 70 peaks, where 31 compounds were identified. It ethanol/benzene (1:1) extract had 57 peaks, where 25 compounds were identified.

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