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New distribution areas of Angelica tatianaeBordz and study of their coumarin derivatives

Husniya Mammadova Gara[1*] and Mashayeva Sevil Saleh[2]
[1]Department of Chemistry and Biology, Sumgait State University,Sumgait, Azerbaijan
[2]Azerbaijan National Academy of Sciences, Institute of Polymeric Materials, Sumgait, Azerbaijan

Abstract: The Angelica L. genus belongs to Umbelliferae family. *Angelica tatianae*is very rare in Azerbaijan. In Azerbaijan so far, there has been no research about phytochemistry of *A. tatianae*. In the present study, phytochemicals of the plant have been isolated and their structures have been elucidated. The roots of *Angelica tatianae* Bordz were extracted with 95% alcohol and the contents were extracted of a total of 3 individual substances by chromatography in a glass column filled with Al_2O_3, (1.$C_{13}H_{10}O_5$, m.p. 148.0°C; 2. $C_9H_6O_2$, m.p. 67.0-68.0 °C; 3. $C_{12}H_8O_4$, m.p. 145.0-146.0 °C).Based on chemical and spectral results (FTIR, ^{1}H NMR, ^{13}C NMR), the obtained substances were identified with isopimpinellin, coumarin, and xanthotoxin, respectively.

Keywords: *Angelica tatianae*, chromatography, coumarin, xanthotoxin, isopimpinellin.

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***Corresponding author. Email:** husniyamammadova63@gmail.com

INTRODUCTION

There are nearly 4500 kinds of plants in the flora of Azerbaijan. Among these plants, Apiaceae Lindl's family takes a special place. This family is represented in the world with 400 genders. Among the genders including this family, Angelica L. Gender attracts attention for its specific features. There are 115 types of this gender in the world (plant list 2013, 115), (plant list 2018, 116) (1).

There are more than 50 types of Angelica species in the Caucasus. In the floraof Azerbaijan, Angelica L. gender is represented with 3 types: *A.sachokiana*, *Angelica purpurascens* and *Angelica tatianae* Bordz (2,3). The first of them,*A. sachokiana*, is described in Azerbaijan (Ismailly, Nialdag, Kuzun village of Gusar region) (4, 5). It is encountered in the middle and upper mountain ranges of Greater Caucasus region on the rocks, on the banks of mountain rivers. The second *A. purpurascens* is the subalpine meadows plant of Nakhchivan and the Small Caucasus region) (6). The third type *A.tatianae* is encountered in the forest areas upper mountain ranges of the Small Caucasus region (Gadabay region). It is also encountered in the western part of the Greater Caucasus region (Zakhatala region) in upper mountain ranges. On our part, we found that in the small and medium range of the Lesser Caucasus (Gadabay region) is distributed in a limited range of forest areas.

A.tatianae is a rare species in the flora of Azerbaijan. This species is a remarkable perennial plan. The lifespan of the plant is 7 years. It is a monocarpous plant. It blooms in the last year, forms seeds and dies.

A.tatianae is a very valuable medicinal plant with 1-1,5m height and an empty stem. It passes to the blooming phase in July with white flowers. The length of the petals is about 1-2mm. The columns are short cone-shaped. The column is much longer than under columns and they are folded.The flowers turn whitish-yellow as they grow.

The length of the umbrellas consists of various, roughly 25-35 rays. The petals are white and are gathered in the umbrella flower group. The sizes of the edge and middle flowers are different. The grown seeds are wide oval-shaped, backbones are narrow, from sides are large winged, above is naked. The length of the seed is 10 mm; the width is 5-6mm and consists of ribs. The seed has a specific dark smell.

Picture 1-2. *A.tatianae flowering phase (July).*

The leaf limb is wide triangle-shaped, consists of 3 parts, it is feather-like, the length is about 30-40 cm, initial slices of a leaf are wide egg-shaped and the length is 20-25cm. The deep feather-like cut sharply pointed part is 6-8cm. The edges are unequal sharp cogged; the veinlet is short-hairy especially at the bottom part. Inside the stem is empty. It has a bitter taste.

The seeds of the plant were planted in special conditions and vegetation was observed for 9 years. Sown seeds begin to ripen in the second year. Development is slow.

As a result of literature research, it is known that the phytochemistry of the plant A.tatianae has been little studied. In previous studies, the surface part (seeds) of the plant was used.

According to the literature in the fruit of Xanthogalum (Angelica) tatianae (Bordz.) Schischk., collected in the Gordzhomi region (Adjar ASSR) they had established the presence of 2.2% of lactones of the coumarin group consisting of a mixture of four substances: bergapten, isooxypeucedanin, bergaptol, b-sitosterol (A. I. Sokolo and G. K. Nikonov, 1969) (13,14).

The phytochemistry of *A. tatianae* has not been studied in Azerbaijan. We first obtained isopimpinellin, coumarin and xanthotoxin from the roots of the plant. Isopimpinellin and xanthotoxin derived from plant roots belong to the class of furanocoumarins (8,9,24, 25).

MATERIALS AND METHOD

A. tatianae was collected from the Gadabay region in July 2013 and was assigned to the Institute of Botany of the Azerbaijan National Academy of Sciences (compared to herbariums in the herbarium fund). On July 28, 2018, the plant was re-collected from a forest area at an altitude of 2000m above sea level and phytochemical studies were conducted.The bio-ecological features of the species have been studied by us. In addition, we studied the antimicrobial activity of *A. tatianae* and the repellent effect of the extract of *A. tatianae* on the mosquito *Culex pipiens molestus* (15-17).

Coumarins are widely spread in types of Apiaceae, especially in the genus Angelica L. (18-23).

Picture 3. Seeds of *A.tatianae*

Picture 4. Photo from the herbarium fund of the Institute of Botany (*A.tatianae*)

Picture 5. *A. tatianae* (root).

Picture 6. *A. tatianae* (surface part).

After the root of the plant was finely chopped and dried (120 g), it was extracted 3 times (each time for three days) in alcohol. Obtained the substance mixture (extract) (17g) was used. Thus, substance mixture was chromatographed in a glass column (h=100cm, d=3cm) that was filled with Al_2O_3. The mixture of substances we mean benzene + n-hexane (3: 1), chloroform + ethanol (4: 1), and other mixtures used in chromatography.

The volume of each fraction is 100 mL. Chromatography column was digitalized with n-hexane (46 fractions), n-hexane+benzene (42), benzene (20 fractions), benzene+chloroform (23 fractions), chloroform+benzene (20 fractions), chloroform (28 fractions), chloroform+alcohol (6 fractions). The individuality of the substances was determined by using a thin layer chromatography method (Silifol UV254, solvent-benzene+chloroform, 1:1), the melting temperature was defined on Boytius table. IG spectrums were recorded by the UR-20 spectrophotometer in Vaseline oil and the chemical structure of coumarin derivatives was defined on the base of the results obtained from the detection of NMR spectra.

RESULTS AND DISCUSSION

Three substances were extracted from chromatography of extracts from the root system of

A.tatianae. The structures of matter are determined chemically and spectrally.

The thin layer chromatography method was used to determine the individuality of the substances derived from the root of the plant, which has been identified as substances isopimpinellin, coumarin, xanthotoxin. All 3 substances were identified with based on the results of the detection of IR and NMR spectra (7).

Coumarin and its derivatives were obtained from the roots of the plant and identified (Table 1). As can be seen from the table, the roots of the studied plant contained the amount of coumarin derivatives - isopimpinellin (1.356%), xanthotoxin (1.809%) and coumarin (3.310%).

Substance 1. Composition of the element $C_{13}H_{10}O_5$, m.p. 148⌖C, **(Figure1).** In the IR spectrum, there are absorption peaks that characterize the carbonyl (1714 cm^{-1}) and double bonds (1600, 1649 cm^{-1}) of the lactone cycle. UV spectrum: λ_{max} 224 (logε 4.40), 241 (logε 4.16), 268 (logε 4.26), 312 nm (logε 4.11).Signals detected in the 1H NMR are as follows: δ 3,96 (s, 3H, OCH_3); 5,23 (s, 1H, H3); 5,99 (s, 1H, H13); 6,13 (s, 1H, H6); 6,80 (d, 1H, $J_{11,12}$= 8,1 Hz; H11), e 7,13 (dd, H1, $J_{12,11}$=8,1 Hz e $J_{12,8}$ =1,8Hz; H12), e 7,40 (d, 1H, $J_{8,12}$ =1,8Hz; H8). It is established that the substance obtained in item 1 generally refers to linear coumarin and identified as Isopimpinellin **(Table 1, A)** (8).

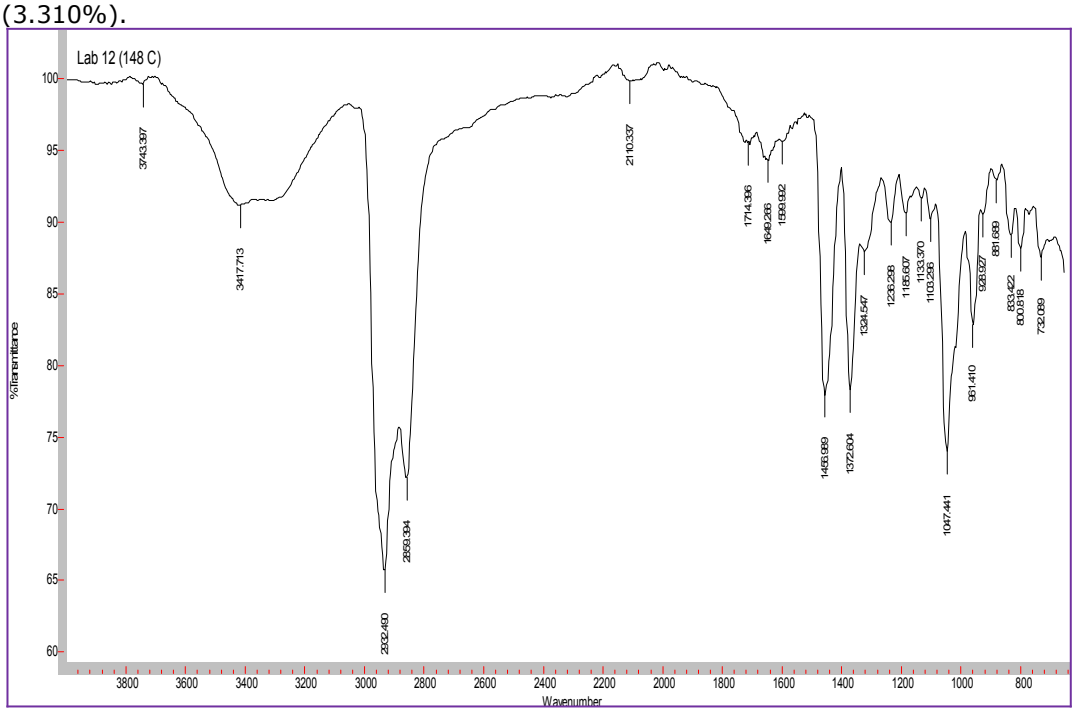


Figure 1. Composition of the element $C_{13}H_{10}O_5$, m.p. 148⌖C.

Substance 2.The crystalline substance was extracted from the 12–16 fraction fractionated by chloroform in the chromatographic column **(Figure 2).** After crystallizing with ethanol + water, the elemental composition of the substance is $C_9H_6O_2$. It was 67.0 - 68.0^{0}C. UV-spectrum: λ_{max} 275 (logε 3.9), 325 nm (logε 3.75) In the FTIR spectrum of the substance, the ν_{max} is 1723 (CO-δ-lactone cycle), and 1610 cm^{-1} (C = C benzene cycle) for double bonds. Signals detected in the ^{1}H NMR spectrum of the compound: δ: 7.65 (1H, d, J = 9.0 Hz H-4), 7.50 (2H, m, H-6, H7), 7.48 (1H, d, J = 8.5 Hz, H-8), 7.20 (1H, d, J = 8.5 Hz, H-5), 6.40 (1H, d, J = 9.4 Hz H-3).The obtained formula 2 proves that the structural formula of coumarin is the same as the structure formula were identified**(Table 1, B)**(8).

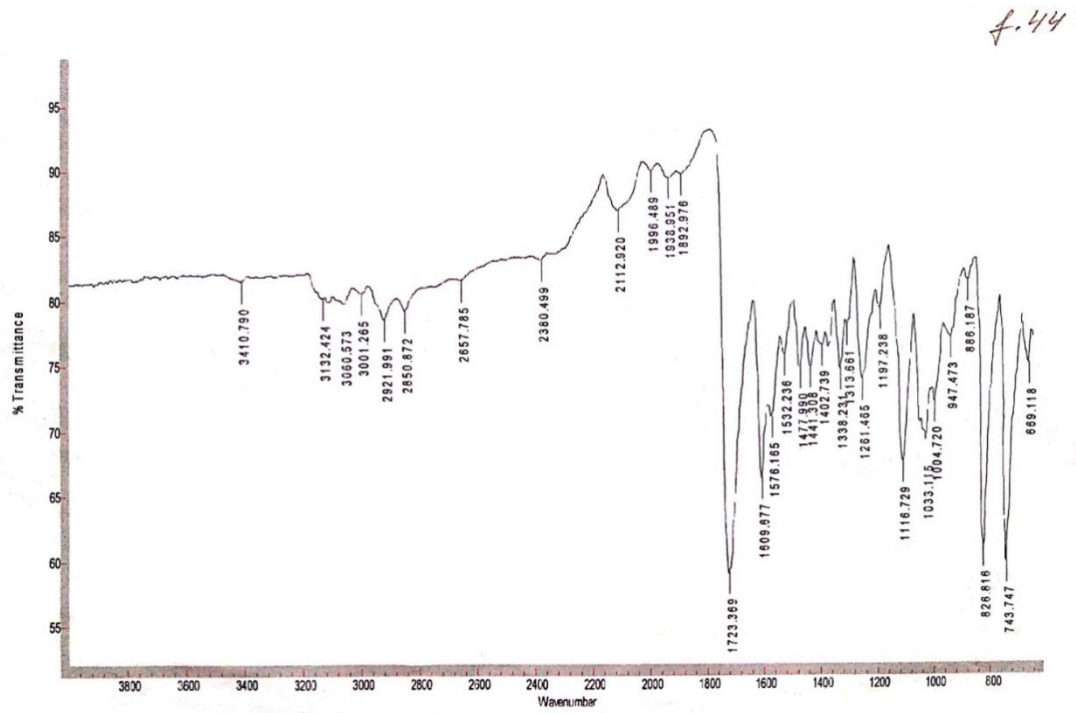


Figure 2. Composition of the element $C_9H_6O_2$, m.p.67.0 – 68.0 °C.

Substance 3. Composition of the element $C_{12}H_8O_4$ 145.0-146.0 °C **(Figure 3).** In the IR spectrum, the absorption peaks of the δ-lactone cycle C = O group (1726 cm^{-1}) and the double bonds of the aromatic system (1624, 1594, 1550 cm^{-1}) indicate that the compound belongs to the furocoumarin group. Signals detected in the ^1H NMR spectrum of matter: 7.73 (d, J = 9.65 Hz, 1H, CH =, H-4) , 7.60 (d. J = 2,00 Hz, 1H, CH =, H-3 ') 7.32 (s., 1H, CH =, H-5), 6.80 (d., J = 2,00 Hz, 1H, CH =, H-2 '), 6.30 (d., J = 9.65 Hz, H-3), and 3,4m singlet proves the presence of methoxy (–OCH_3) group in the molecule. The substance obtained was identified as xantotoxin**(Table 1, C)**(9).

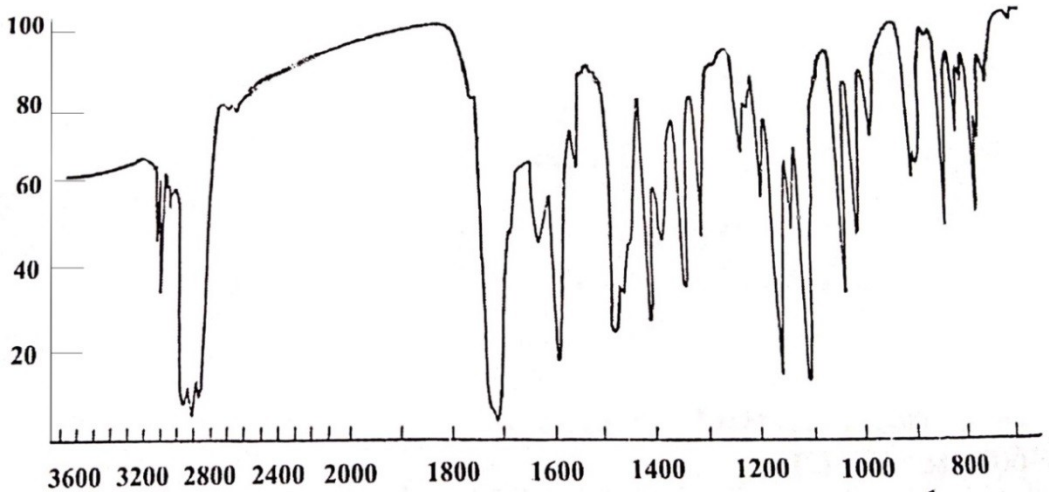
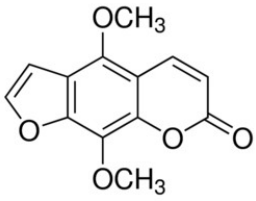
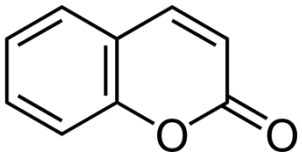
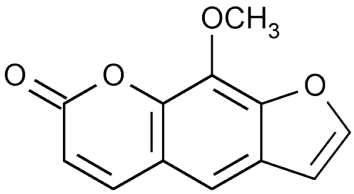


Figure 3. Composition of the element $C_{12}H_8O_4$, 145.0-146.0 °C.

Table 1. *Angelica tatianae* Bordz. chemical composition of the species.

Coumarin	Amount, %
 **A.** Isopimpinellin, $C_{13}H_{10}O_5$	1.356
 **B.**Coumarin, $C_9H_6O_2$	3.310
 **C.**Xanthotoxin, $C_{12}H_8O_4$	1.809

Isopimpinellin possibly inhibits 7,12-dimethylbenz(a)anthracene, which is the initiator of skin tumors. Evidence has also been reported that links these compounds to the inhibition of breast cancers. Isopimpinellin has inhibitory activity against the enzyme adenine phosphoribosyltransferase (APRT) from Leishmania, a tropical parasite causing endemic disease in poor countries (10).

The coumarins are of great attention due to their therapeutic property. Their physiological, bacteriostatic and anti-tumor activity marks coumarins as novel ones for therapeutic applications. Several researchers have reported the clinical applications of coumarins and their derivatives in the treatment of several diseases. Several studies have proven multiple potential roles of coumarins which include disease spread and prevention, growth modulation, antioxidant and anti-tumor effects (12).

Xanthoxin belongs to the group of medicines called psoralens. It is used along with ultraviolet light (found in sunlight and some special lamps) in a treatment called PUVA to treat vitiligo, a disease in which skin color is lost, and psoriasis, a skin condition associated with red and scaly patches (11). Xanthoxin is also used with ultraviolet light in the treatment of white blood cells. This treatment is called photopheresis and is used to treat the skin problems associated with mycosis fungoides, which is a type of lymphoma.

Isopimpinellin, coumarin, and xanthotoxin were first extracted from the substances investigated in the root of the Angelica tatianae plant; need further research and investigations to find out new areas of application.

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