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Resource assessment and economic potential of bilberries (*Vaccinium myrtillus* and *Vaccinium uliginosum*) on Osogovo Mtn., R. Macedonia

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ABSTRACT

Bilberries in Macedonia represent significant natural resource that provides additional income for number of people. However, the systems for collection, licensing, control and monitoring are still not well developed in most of the Republic of Macedonia which puts pressure on natural habitats and wild species and leads to unsustainable use.

The aim of this paper is to assess the economic potential based on sustainable usage of bilberries (*Vaccinium myrtillus* – European bilberry and *Vaccinium uliginosum* – Bog bilberry) on Osogovo Mtn., north-east Macedonia by intensive field assessment of annual production of fruits and leaves along with chemical characterization of the leaves and analysis of the importance of bilberries for local population.

Field methods for assessment of surface of the heathlands and were based on remote sensing and ground truth data by using GIS; leaves and fruits production was estimated by standard transect square method; chemical characterization of the leaves was done by HPLC/DAD/ESI-MS^n.

The average production of dry leaves and fruits was 11.7 g m^{-2} and 213.2 g m^{-2}, respectively.

The total dry fruits biomass on Osogovo Mtn. in 2008 was estimated at 249.11 t (218.82 t in heathlands) from which 53% was European bilberry fruits. The total dry leaves biomass was estimated at 1459.4 t (927.1 t of European bilberry).

The total content of all phenolic compounds in freeze-dried extract of *V. myrtillus* was 36.53 mg g^{-1}. Phenolic acids (caffeic acid and its esters with quinic acid and glucose, or other hydroxycinammic acids such as *p*-coumaric, *p*-coumaroylquinic or feruloylquinic acid and corresponding *p*-coumaroyl glucoside) represented 36% of total phenolic compounds in the European bilberry leaves extract, followed by flavonols (60%) and catechin (4%).

Estimated economic income of sustainable use of fruits and leaves is 1.6 and 0.5 milion €, respectively. This amount can support 340 people with average Macedonian annual gross salary.

1. Introduction

Natural resources management depends on ecological knowledge of species and communities as well as socio-economic and cultural characteristics of a certain region. There is increasing demand for use of natural resources of medicinal and aromatic plants especially of wild berries by local inhabitants in the Republic of Macedonia. Collection of bilberries on Osogovo, Plakenska, Shara and Pelister mountains produces significant additional incomes for number of people. Besides the economic importance for local inhabitants, bilberries are used as a source of income for the administration of protected areas in the R. Macedonia as well as a tool for involving local communities in the protected areas' management. However, the system for collection, licensing, control and monitoring is still not well developed in R. Macedonia, with the exception of Pelister National Park (Petrova et al., 2009).

There are three species of bilberries in Macedonia (Micevski, 1998) and only two on Osogovo Mtn.: *Vaccinium myrtillus* L. (European bilberry) and *Vaccinium uliginosum* L. (Bog bilberry). They

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thrive in damp acid soils, damp woods and sandy and rocky soils, and covering vast areas (Karlsson, 1985; Altegrim and Sjöberg, 1996; Fernández-Calvo and Obeso, 2004).

People from Osogovo region use bilberry fruits for preparation of home-made juices and jams. In addition to fruits, the leaves of these species are also collected from nature as herbal raw material for domestic industry or exported abroad. European bilberry is most often used, while Bog bilberry has lower traditional use value. Parts used from the European bilberry are the leaves (*Myrtilli folium*) and the fruits (*Myrtilli fructus*). The harvest of the leaves begins from May to June, during the blooming period, and from July to August for the fruits. The material is usually collected by hand or by using special combs. Fruits are picked when they are completely ripe, they are air dried (the temperature should not exceed 40–50 °C). Leaves are collected young and dried in a shadow (Kulevanova and Stefkov, 2004). The leaves are primarily used as a folk remedy. Traditionally, they have been used for their astringent, tonic, anti-inflammatory, and antiseptic qualities. *Vaccinium* species have a legendary reputation as aid to diabetes; they are used for inducing menstruation, treatment of bladders stones, liver disorders; in syrups for coughs and lung ailments, intestinal conditions, typhoid fever, infections of the mouth, skin, and urinary tract infections, rheumatism. The dried berry tea is used as an astringent for diarrhea and dysentery, as a diuretic, cooling nutritive tonic, to prevent scurvy (vitamin C deficiency), and to stop bleeding. It is also used as an astringent and disinfectant mouthwash for mouth inflammations (Kulevanova and Stefkov, 2004). Nowadays, there is an increased interest for collection of bilberry leaves by some companies for production of plant extracts rich in chlorogenic acid.

Sometimes, decisions on exploitation of natural resources must be made regardless the quality of scientific information since management agencies often desire immediate answers to management questions (McPherson and DeStefano, 2003). Furthermore, applied ecology has to take into account current management practices and changes in the future. Osogovo case illustrates such a situation very well: there is an initiative to establish protected area on Osogovo Mtn. and it is obvious that sound management goals and practices should be defined and implemented in response to the increased demand for collection of bilberries.

The main goal of this paper is to assess the economic potential based on sustainable usage of bilberries on Osogovo Mtn., north-east Macedonia. This assessment is based on intensive field estimation of bilberries' natural resources (annual production of fruits and leaves) and analysis of the importance of bilberries for local population. The importance of European bilberries is supplemented by chemical analyses of leaves, whilst the chemical composition of fruits of European bilberry from Macedonia is already known (Gavrilova et al., 2011).

2. Materials and methods

2.1. Study area

Osogovo Mtn. is situated in the north-east part of the Republic of Macedonia. The border between Macedonia and Bulgaria passes through Osogovo Mtn.

The region has low population density with ~50 inhabitants per squared km (12 in rural areas). There are about 70 settlements, from which 4 are small towns with total of ~52,000 inhabitants (11,900 in rural areas). The average number of members per household is 3.5 (2 in rural areas). The total number of households is 15,880. About 28% are employed, 22.5% are unemployed and the rest of 49.5% are children or old people (SSO, 2004).

Habitats in the treeless zone of Osogovo Mtn. are not very diverse. Heathlands (above 1500 m) are the most important habitat type for bilberries. They are dominated by the *Vaccinium* species, *Bruckenthalia spiculifolia* and *Chamaecytisus absinthoides*. Bog bilberry occupies more exposed sites (crests of the mountain, steep slopes with shallow soil) while European bilberry dominates lower and more humid sites in the source areas of mountain brooks. High-mountain pastures grow on higher altitudes than heathlands and they dominate over heath in the zones above 2000–2100 m. Bilberries are scarce in the pastures. Bogs in the high-altitude zone of Osogovo Mtn. have almost no importance for bilberries. Bilberries can be found in the forests in a narrow belt along the timber line, as well.

The area above 1650 m is characterized by subalpine climate. The lower belt (1300–1650 m) is under continental-mountainous climate. The average annual air temperature at altitude of 700 m is 10 °C and it drops to 6 °C at 1400 m and 2 °C at 2000 m

The soils in the subalpine and alpine zone have developed over silicate substrate. The dominant are rendzinas, especially in the heathlands and alpine (high-mountain) pastures.

2.2. Investigation of bilberries production (fruits and leaves)

The assessment of the bilberry production on Osogovo Mtn. was done by means of quantitative investigation on several random localities. As a result, an estimate was made for the bilberry mass per area and coverage.

2.2.1. Field survey of bilberries production

Field survey was conducted during the summer in 2008 (07–12.07.2008), before the harvesting period. Line-transect method with collecting squares was used in order to estimate the bilberry production on different localities, altitudes, expositions and habitats. A 75 m long string was stretched at sites, almost always from lower to higher altitude. The sampling squares had surface of 0.25 m^2 (0.5 × 0.5 m). They were placed at every 3 m. Thus, in total, 15 sampling points were placed along one string. In total, 40 transects and 600 samplings were analyzed.

The fruits, separately for the two bilberry species, from the squared sampling surfaces were collected and counted carefully. The fruits were collected in small plastic containers. Leaves were also collected in every second square of five transects. The mass of fruits of both bilberry species was measured in August 2008. Fruits were collected from five localities and their mass was measured.

The altitudinal range of transects was 1640–2070 m. The greatest number of transects were positioned in heathlands (few of them with significant participation of *Bruckenthalia*).

The coverage of bilberries was also recorded during the field research and grouped into three categories (I < 20%; II: 20–60%; III: 60–100%).

2.2.2. GIS mapping

Estimation of the bilberry cover on Osogovo Mtn. was done by remote sensing in GIS (ArcGis 9.2) based on:

- Ground truth data on bilberry species presence and bilberry coverage (collected during the field work in 2008).
- Google Earth Images – 3-band images (red, green, blue) with varying quality of resolution.
- Satellite Images – ALOS – Recent satellite images with 4 bands (red, green, blue and infrared) with 10 × 10 m resolution.
- Ortophoto Images – Grayscale images produced from aerial photos taken in the period of July–August 2004, by the State Authority for Geodetic Works of Macedonia, with resolution of 0.5 m.
- Topography vector data – Digitized 10 m topolines (isolines), acquired from the State Authority for Geodetic Works of Macedonia.