FRESH AND AIR-DRY BIOMASS OF OREGANO (*ORIGANUM VULGARE* L.) ACCESSIONS

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Abstract. *Oregano (Origanum vulgare L.) is a paramount medicinal plant in Europe. It is necessary to select the most productive accessions for cultivation. The aim of this research was to explore the fresh and air-dry biomass of oregano. The samples for experiment were selected from an ex situ collection of spice- and medicinal plants (latitude: N 56º39`47``; longitude: E 23º45`13``). It is a fundamental collection in Latvia, attached to the Latvia University of Agriculture, Laboratory of Cultivated Plants and Apilogy (Jelgava, Strazdu iela 1). In spring 2012, oregano accessions from this collection was propagated by cloning and grown in the field conditions. At this moment there are 44 accessions of oregano, planted in 4 rows, each accession in 10 repetitions. The accessions are in random order. In summer 2012-2014, stems had been cut, the data were recorded on fresh biomass. The samples had been dried at +26 ºC temperature, the data were recorded on air-dry biomass. The average fresh biomass per plant was 12.72 g in 2012, 127.50 g in 2013 and 195.08 g in 2014. The average air-dry biomass per plant was 5.11 g in 2012, 55.90 g in 2013, 77.96 g in 2014. The results showed that the variability between years and between accessions was significant ($p<0.05$), but the variability between plants of each accession was not significant ($p>0.05$).*

Key words: *oregano, fresh biomass, air-dry biomass.*

INTRODUCTION

Oregano (*Origanum vulgare* L.) is classified as medicinal, spice- and ornamental plant [1]. Oregano is used in production of essential oil, in medicine, perfumery, culinary, food and beverage production, aromatherapy, for attracting bees, in sauna switches composition, for bathing [2]. It blooms from June to the end of vegetation, from August it simultaneously produces fruit and seeds [3]. According to the Medicinal and Aromatic Plants Working Group of the European Cooperative Programme for the Plant Genetic Resources oregano is included in the List of "Priority Species" that are the paramount medicinal and aromatic plants in Europe. The general criteria for including oregano in this document were: actual economic use, current conservation status, endemism, restricted range, recent rate of decline, rarity, threat of genetic erosion, eco-geographical distinctiveness, biological characteristics and importance, cultural importance, high social demand, occurrence and frequency in current protected areas, status of protection, ethnical consideration, taxonomic or phyletic uniqueness or isolation, ecosystem role [2].

In Latvia only *Origanum vulgare* L. ssp. *vulgare* were found in nature. Research of Latvian folklore proved that oregano has been utilized in the folk medicine for thousands of years in the Baltic countries [4]. The wild use of oregano is one of the reasons why the wild populations are severely depleted in Latvia. It is necessary to cultivate oregano for keeping a biodiversity of Latvian nature and for meeting the needs of medicinal plant`s production.

Oregano is quite diverse species: it creates various, morphologically and chemically differentiated forms, which are related to the place of their occurrence [3]. Oregano lifespan is about 3-4 years, but many factors can influence the longevity: winter frost, disease, number of cuts [5]. It is important to use local genetic resources in agrocenosis as they are adapted to the Latvian agroecological conditions and possible stress situations in a specific environment [4].

By legislation, local genetic resources of spice- and medicinal plants are defined as local or foreign species that are grown and used in Latvia during long period of time. Cultivated species with their closely related or initial forms adapted to Latvian agroclimatic conditions are also ranked as local genetic resources [4]. These definitions are based on historical information, species` biological features and conservation capacity.

Oregano cultivation needs to get as rich and qualitative yield as possible. That is why local populations have to be explored with the aim to select the most productive accessions [6]. However, in practice Latvian

farmers don't pay their attention to the evaluation of optimal qualitative indices of cultivated medicinal and aromatic plants. In competition with foreign growers and producers it is necessary to evaluate the productivity of medicinal plants in agrocenosis.

The researches of genetic resources of spice- and medicinal plants are still innovative in Latvia. It is necessary to pay more attention to evaluation of quality of cultivated accessions, to their productivity, organoleptic and biochemical parameters, winter hardiness, resistance to diseases and pests, biotic stress susceptibility [7].

The aim of this research was to explore fresh and air-dry biomass of oregano accessions.

MATERIALS AND METHODS

Plant Material and Growing Conditions

The samples for experiment were selected from an *ex situ* collection of spice- and medicinal plants (latitude: N 56º39´47´´; longitude: E 23º45´13´´). It is a fundamental collection in Latvia, attached to the Latvia University of Agriculture, Laboratory of Cultivated Plants and Apilogy (Jelgava, Strazdu iela 1). There are 120 accessions of 13 species of spice- and medicinal plants in this collection.

In 2001-2006, thanks to various international projects, the genetic resources of oregano from different places of Latvia were added to this collection. The plants had been collected from nature using the modified method of Professor E. Muižarāja [4]. The main point of this method is the initial visual division of an area into squares and zigzag passing through these squares as well as the random gathering of samples. The oregano collection was planted in 2008 and reconstructed in 2009. In the process of selection of wild accessions, the latitude and longitude were registered; the topographic description of plants was made. All these data are registered in the system of Nordic Gene Bank.

The Draft Descriptor List *Origanum vulgare* L. was published in November 2011. After its methodology characters should be recorded on an average of minimum 10 plants per accession [8]. In spring 2012, 44 accessions was propagated by cloning and grown in the field conditions.

The soil at the trial site was strongly altered by cultivation loam with organic matter content of 2.7 g kg^{-1}, soil reaction was slightly acidic (pH_{KCl} 6.3), P content was 102 g kg^{-1} and K content was 207 g kg^{-1}. Plant care was provided for this collection.

It is proved that fresh and air-dry biomass was the largest in the phase of full blooming [3]. That is why in summer 2012-2014 stems of all accessions had been cut from the ground level to the tip of the plant at the stage of full flowering [8]. The data was recorded on fresh biomass. The samples had been dried at +26 ºC temperature in a special drying cabinet with ventilations. After 3 weeks the data was recorded on air-dry biomass.

Meteorological conditions

According to data of the Latvian Environment, Geology and Meteorology Centre, the average air temperature in 2012 was +6.1 ºC (0.2 degrees above long-term average observations). The quantity of rainfall was 832 mm (125% of normal). The average air temperature in winter was –3.4 ºC (0.5 degrees above long-term average observations). The spring average temperature was +6.1 ºC, the summer average temperature was +16.0 ºC. In vegetation period (from May to the end of September), the average temperature was 14.3 ºC and the total quantity of rainfall was about 373 mm. From 1 May to 7 July (before plant cutting), the average air temperature was 13.7 ºC, the total quantity of rainfall was 114.1 mm.

In 2013, the average air temperature was +7.0 ºC (1.1 degrees above long-term average observations). The quantity of rainfall was below normal (622 mm or 94% of normal). After a close-to-normal calendar winter of 2012-2013, spring of the year 2013 in Latvia was rich in weather contrasts. The spring average temperature was +4.3 ºC, the summer average temperature was +17.5 ºC. In vegetation period (from May to the end of September), the average temperature was 11.4 ºC and the total quantity of rainfall was 330 mm. From 1 May to 15 July (before plant cutting), the average air temperature was 16.6 ºC, the quantity of rainfall was 118.2 mm.

In 2014, the average air temperature was +7.4 ºC (1.5 degrees above long-term average observations). The quantity of rainfall was 725 mm (107% of normal). The spring was the warmest since 1924. The second part of June was significantly colder than normal – the third 10-day period was the coldest ever recorded (3.5 degrees below the 1961-1990 normal). The spring average temperature was +7.5 ºC, the summer average temperature was +16.9 ºC. In vegetation period (from May to the end of September), the average temperature

was 12.3 ºC and the total quantity of rainfall was 441.6 mm. From 1 May to 12 July (before plant cutting), the average air temperature was 14.1 ºC, the quantity of rainfall was 90.6 mm.
In scientific literature it was proved that during the vegetation period the influence of air temperature from +20 to +30 ºC and of the quantity of rainfall of about 600 mm on oregano yield is positive [9],[10]. In total, in 2012-2014 the meteorological conditions were not optimal for oregano cultivation and plant biomass creation.

RESULTS AND DISCUSSION

Cultivation is one of the solutions to the problem of over-exploitation in nature. Current guidelines for cultivation should be adapted and made available to Latvia [2]. It is proved that oregano accessions differ by morphology, biochemistry and genetics [7]. The biodiversity of oregano accessions might become a valuable potential for development of new beneficial products and income possibilities for farmers [2].
Oregano as a perennial plant is smaller in the first year of vegetation than in subsequent years [3]. The data of 2012-2014 years are important for evaluation of growth dynamics, plant development and productivity, cultivation planning and strategy, economical calculation. This research is important for successful and profitable oregano growing and production in Latvia.
The results showed that in 2012 the average fresh biomass was 12.72 g per plant (Table 1).

Table 1

Fresh biomass of oregano accessions in 2012, g per plant

Accession number	Interval
2, 28	Less than 6
3-5, 7, 10-12, 14-16, 20, 22, 24, 25, 29-35, 38-40, 42-45	6-12
1, 6, 9, 13, 18, 19, 21, 23, 27, 36	12-20
17, 41, 26, 37	More than 20

Only 4 accessions had the biomass over 20 g per plant. The majority of accessions had the biomass from 6 to 12 g per plant. The accession No. 37 had the highest biomass (27.46 g per plant). The accession No. 28 had the least biomass (4.76 g per plant). The data statistical analysis showed that the variability between accessions was significant ($p<0.05$), between plants of each accession it was non-significant ($p>0.05$).
In 2012, the average air-dry biomass was 5.11 g per plant. The data are presented in Table 2.

Table 2

Air-dry biomass of oregano accessions in 2012, g per plant

Accession number	Interval
7, 13, 14	Less than 3
6, 12, 16, 20, 40	3-4
1-5, 9, 10, 15, 18, 19, 24, 25, 28, 29, 30, 32-36, 38, 39, 42, 43, 45	4-6
21-23, 26, 31, 41, 44,	6-8
11, 17, 27, 37	More than 8

The accessions No. 11, 17, 27, 37 had the largest air-dry biomass (more than 8 g per plant), but the accessions No. 7, 13, 14 had the least air-dry biomass (less than 3 g per plant). The majority of accessions had the results from 4 to 6 g per plant. The accession No. 37 had the biggest result (10.37 g per plant). The accession No. 13 had the least result (2.77 g per plant). The variability between accessions was significant ($p<0.05$), but between plants of each accession it was non-significant ($p>0.05$).
The analysis of both tables showed that only the accession No. 37 had the largest fresh and air-dry biomass.
The results showed that in 2013 the average fresh biomass was 127.50 g per plant (Table 3).

Table 3

Fresh biomass of oregano accessions in 2013, g per plant

Accession number	Interval
4, 5, 25, 11, 21, 23, 24, 32, 38	Less than 50
2, 12, 15, 22, 25, 26, 29, 30, 33, 34, 36, 42	50-100
6, 16, 17, 20, 37, 40	100-150
10, 18, 19, 28, 39, 41, 44	150-200
1, 3, 7, 9, 13, 14, 27, 31, 35, 43, 45	More than 200

The largest fresh biomass (more than 200 g per plant) had 11 accessions, it was the least (less than 50 g per plant) for 9 accessions. The majority of accessions had the results from 50 to 200 g per plant. The accession No. 1 had the highest biomass (269.33 g per plant). The accession No. 23 had the least biomass (8.03 g per plant). The variability between accessions was significant ($p<0.05$), between plants of each accession it was non-significant ($p>0.05$).

In 2013, the average air-dry biomass was 55.15 g per plant. The data are presented in Table 4.

Table 4

Air-dry biomass of oregano accessions in 2013, g per plant

Accession number	Interval
2, 5, 6, 11, 21, 23, 24, 30, 32, 38	Less than 20
15, 17, 19, 20, 22, 25, 26, 28, 29, 33, 34, 36, 41, 42	20-50
9, 12, 13, 14, 16, 18, 27, 35, 37, 39, 40, 43 – 45	500-100
10	100-150
1, 7, 31	More than 150

The accessions No. 1, 7, 31 had the largest air-dry biomass (more than 150 g per plant), but 10 had the least air-dry biomass (less than 20 g per plant). The majority of accessions had the results from 20 to 100 g per plant. The accession No. 7 had the biggest result (194.07 g per plant). The accession No. 23 had the least result (3.51 g per plant). The variability between accessions was significant ($p<0.05$), but between plants of each accession it was non-significant ($p>0.05$).

The analysis of both tables showed that the accession No. 1, 7, 31 had the largest fresh and air-dry biomass.

The results showed that in 2014 the average fresh biomass was 195.08 g per plant (Table 5).

Table 5

Fresh biomass of oregano accessions in 2014, g per plant

Accession number	Interval
4, 12, 23	Less than 50
2, 11, 14, 15, 21, 24, 32, 36, 38, 42	50-100
16, 17, 19, 22, 25, 26, 30, 32, 34, 37, 44	100-200
6, 10, 20, 29, 40, 45	200-300
1, 3, 5, 7, 9, 13, 18, 27, 28, 31, 35, 39, 41, 43	More than 300

The largest fresh biomass (more than 300 g per plant) had 14 accessions, it was the least (less than 50 g per plant) for 3 accessions. The majority of accessions had the results from 50 to 200 g per plant. The accession No. 31 had the biggest result (495.10 g per plant). The accession No. 23 had the least result (12.61 g per plant). The variability between accessions was significant ($p<0.05$), between plants of each accession it was non-significant ($p>0.05$).

In 2014, the average air-dry biomass was 77.96 g per plant (Table 6).

Table 6

Air-dry biomass of oregano accessions in 2014, g per plant

Accession number	Interval
4, 23	Less than 10
11, 12, 14, 15, 19, 21, 22, 24, 25, 32, 34, 36, 38, 42	10-50
1, 2, 6, 16, 17, 18, 20, 26, 30, 33, 35, 44, 45	50-100
3, 7, 10, 27, 28, 29, 37, 39, 40, 41, 43	100-150
5, 9, 13, 31	150-200

The accessions No. 5, 9, 13, 31 had the largest air-dry biomass (more than 150 g per plant), but 2 accessions had the least air-dry biomass (less than 10 g per plant). The majority of accessions had the results from 10 to 150 g per plant. The accession No. 7 had the highest air-dry biomass (194.07 g per plant). The accession No. 23 had the least air-dry biomass (4.51 g per plant). The variability between accessions was significant ($p<0.05$), but between plants of each accession it was non-significant ($p>0.05$).

The analysis of both tables showed that the accession No. 5, 9, 13, 31 had the largest fresh and air-dry biomass. The data statistical analysis showed that the variability between years was significant ($p<0.05$).

The research of fresh and air-dry biomass is still innovative in our country. At this moment there are no published results of local researchers about this topic in the scientific literature. The only research on biomass had been made in 2011 in the Laboratory of Cultivated Plants and Apilogy, using oregano accessions from the *ex situ* collection in 3 repetitions. The biomass had been explored on oregano accessions that were 4 year`s old. The received data was not published, but they could be used as an orienteer for future studies. The average fresh biomass was 115.31 g per plant. It is necessary to explore the dynamic of biomass in future. It is possible that 4-year-old plants` weight is not maximal and it could be influenced by process of aging of accessions.

In Poland, the average fresh biomass of 1-year-old oregano was 168.1 g per plant, but the average dry biomass was 55.0 g per plant. The average fresh biomass of 2-year-old oregano was 181.9 g per plant, but the average dry biomass was 55.2 g per plant [3]. These results are higher than results that are presented in this research. However, in Italy the average fresh biomass of 1-year-old oregano varies from 116 g per plant [5] to 1269.0 g per plant [11].

By Marzi, the photoperiod influences the growth and the floral differentiation: plants grown under conditions from 12 to 16 light-hours per day enter the full floral differentiation stage around the sixtieth and the ninetieth day of cultivation respectively, plants grown under conditions less than 12-hour daylength are more vigorous with a larger leaf area and a greater plant total dry weight [5]. Azizi et al. found out that the deficiency of water in the soil caused the reduction of oregano plant weight [12]. These statements can be checked for Latvian oregano in the future.

By Marzi, oregano losses of biomass are often encountered after the second mowing in autumn, whenever cuts have been made very close to the ground and frost was experienced [5]. The criteria of right cutting of Latvian oregano should be created.

By Marzi, highest yields are those obtained in the second year with two cuts: in June-July or at the end of October [5]. The practical experience showed that agrometeorological conditions don`t allow to have two identical cuts of oregano per year in Latvia. The exact time of general cut depends on accession`s biology. Usually it starts at the end of June and finishes in August. It is possible to make the 2nd cut in September, but the economical profit is quite minimal.

CONCLUSIONS

The variability of biomass between years and between accessions is significant, but the variability between plants of each accession is not significant.

The previous recommendation is to cultivate the accessions No. 5, 9, 13, 31 in agrocenosis as the most productive.

The dynamics of biomass should be researched. It is necessary to make recommendations for farmers about the optimal parameters of cutting.

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