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# Studies on the variability of characters in a collection of costmary (*Tanacetum balsamita* L.) populations

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**Abstract** The costmary is a species with various medicinal uses, but little known in Romania. The study aimed at assessing variability and correlation between characters. The studied biological material consisted of 5 local populations collected in Western Romania. The studied morphological characters show moderate variability. We remarked the populations of Barzava with a large number of leaves, Barzava and Julita with a large number of flowers, Julita with large leaves, Grosii Noi with a high weight of leaves and flowers. There are significant correlations between the number of branches and the number of flowers, the weight of the stem and the weight of the leaves, between the number of leaves and the weight of the strain. The populations studied show satisfactory variability for processing in order to obtain new varieties.

**Key words**

*Tanacetum balsamita*, variability, correlations, morphological characters

The costmary (*Tanacetum balsamita* L. sin. *Chrysanthemum balsamita* L. Baill.) belongs to the category of important medicinal and aromatic plants, but less known in Romania. The costmary is a perennial plant, with the solitary strain, slightly pubescent, branched at the top. The basal leaves are long, with an oval elliptic leaf limb. The inflorescence is a capitulum. The flowers are hermaphrodite or bisexual [23, 26]. The fruits are achenes. The root is short, fibrous, thin and branched [7, 24]. The costmary is invasive and easy to cultivate. It can be grown in sunny areas, in dry soil, at a pH of 5-7.6. Under shading, flowering will be limited [8, 9]. The multiplication is done by bush splitting or by seeds [17, 18].

The costmary has Eurasian origins, and there are different habitats for this plant [27, 15]. The costmary is cultivated in some Asian countries and in Western Europe [4, 17]. This plant is present in the botanical gardens of European countries [24].

The costmary is rich in secondary metabolites which have various biological and therapeutic actions [1, 20]. Generally, these compounds are volatile oils or essential oils. The flavonoids of *T. balsamita* have been the subject of many studies [3]. The essential oils derived from leaves and flowers contain the most important active principles [10, 11, 18]. The composition in essential oils varies depending on genetic, geographic and climatologic factors [22]. Depending on the predominant terpenes of essential oils, four chemotypes were recorded for costmary [17]. The essential oil content of the leaves is between 0.31 - 1.25% [4]. The essential oil content of the organs in different growth phases may vary between 0.06 and 2.2% of the dry weight [14]. Other experiences show that the essential oil content of the costmary leaves, flowers and stems was 0.25, 0.15 and 0.05 respectively [13]. So far, 200 components have been identified in the costmary essential oil [10, 11]. A recent study reported, as major constituents of costmary essential, bornyl acetate, pinocarvone, camphor and terpineol [13]. To get quality essential oil, the plants are harvested at the beginning of the flowering period [6]. Other studies show the presence of carvone in a proportion of 52-57%, this being the most important component of volatile oil in Turkey and Spain [12].

Other studies have identified 29 components in costmary essential oil, but carvone and alpha-thujone are mentioned as the most important, both in leaves and flowers [4]. By analyzing the essential oil, 85 constituents were identified [6]. The volatile components of the aerial parts of *Tanacetum balsamita* comprise 21 components [19].

In Iran, the overground parts of *Tanacetum balsamita* ssp.*balsamita* were collected in the flowering stage. The essential oil obtained has high antimicrobial activity [26]. The essential oil of *Tanacetum balsamita* L. has been tested against pest insects as an alternative to synthetic insecticides [16, 26]. The costmary is used as seasoning for various types of food, cakes and drinks [4, 6]. The costmary leaves are used in various salads and soups [4]. For therapeutic purposes, this plant and its essential oil have been used as a hepatoprotector, antiallergic, tonic, sedative and cardiotonic [23]. There is also evidence of good antibacterial action [2]. It is also recommended for feeding chickens [21]. The costmary essential oil is synthesized and gets accumulated mostly in leaves; touching them causes a strong smell [27].

## Material and Method

The study aimed at assessing the variability of morphological characteristics of costmary (*Tanecetum balsamita* L.). The study was conducted under field conditions, in an experience based on the randomized block design. The biological material consisted of 5 costmary landraces which come from the West of Romania. Experimental data was collected by biometric measurements. We determined the main variability indices of characters and the coefficients of correlation between characters [5]. The data obtained were influenced by climatic conditions, the blossoming and the fruit formation were affected by drought. The comparison between populations was carried out reported to the experimental mean, because there are no homologous varieties of this species.

## Results and Discussions

Regarding the characteristics of the stem, there were differences in average values between the populations studied. The length of the stem showed average values of 95.26 cm in the Tarnova population and 111.03 cm in Grosi Noi population. Stems with average values below 100 cm were observed only in the Tarnova population. The Julita and Barzava populations have very close average values. The variability within populations was small or moderate. The highest variability was shown by Bârzava population, and the lowest was reported in the Julita population (Table 1).

Several branches may be formed on the stem. The average number of branches in the five populations was 10.39, the extreme averages being of 14.25 branches (Bârzava population) and 7.66 branches (Tarnova population). A large number of branches was present in the Grosii Noi population. In all populations, the variability of this character is high, and the highest value of the coefficient of variability is present in the Nadas population (41,74). Comparing the average number of branches per stem with populations' average value, we may note that three populations have average values below the population average. Stems with more than 10 branches were present in the Barzava and Grosii Noi populations.

The number of leaves per stem is a very important character for productivity. There are very big differences between populations. The most leaves were found in the Bârzava population (176.00 leaves), and the fewest are in the Nadas population (115,80 leaves). The Julita and Grosii Noi populations also showed a big number of leaves. These populations are at the average or above the average of the studied populations. For this character, the most uniform population was Bârzava. In the other populations, the variability is high; the most non-uniform population is Nadas.

The number of flowers per stem is another character of great variability, both at intra-population and inter-population level. The average number of flowers per stem was between 70.83 flowers in the Tarnova population and 290.50 flowers in the Barzava population. More than 200 flowers on the stem also featured the Julita population. Below the experience average, we determined two populations. The individual variability within populations was high in all populations.

The data presented above reveals that there are morphological differences between the populations studied. A general conclusion is that the populations collected from the Southern side of the explored area show higher stems, more branched and with bigger numbers of leaves and flowers. The Bârzava population is remarkable, with branched stems, rich foliage and abundant flowering.

Table 1

**Results on stem elements in costmary**

| Population | Stem length (cm) | | | Number of branches | | | Leaf number/stem | | | Flowers number/stem | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $x \pm s_x$ | s% | % exp.av. | $x \pm s_x$ | s% | % exp.av | $x \pm s_x$ | s% | % Exp. av. | $x \pm s_x$ | s% | % exp.av. |
| Juliţa | 105.46 ±1,.7 | 7.23 | 100.40 | 9.93± 0.98 | 38.32 | 95.57 | 153.33 ±14.48 | 36.59 | 105.41 | 244.60± 26.97 | 42.71 | 131.03 |
| Tarnova | 95.26± 3.57 | 14.52 | 90.68 | 7.66±0.68 | 34.39 | 73.72 | 137.66 ±8.84 | 25.02 | 94.64 | 70.83± 9.31 | 50.94 | 37.94 |
| Nadas | 109.06 ±2.04 | 7.27 | 103.83 | 7.80± 0.84 | 41.74 | 75.07 | 115.80 ±13.85 | 46.32 | 115.80 | 128.80± 17.95 | 53.98 | 68.99 |
| Barzava | 104.25 ±9.78 | 18.77 | 99.25 | 14.25± 1.49 | 20.95 | 138.15 | 176.00 ±16.77 | 19.06 | 176.00 | 290.50± 64.06 | 44.10 | 155.62 |
| Grosii Noi | 111.16± 3.78 | 8.35 | 105.83 | 12.33± 1.08 | 21.55 | 118.67 | 144.50 ±13.18 | 22.34 | 144.50 | 198.66± 28.63 | 35.30 | 106.42 |
| Experiment average | 105.03 | | 100.00 | 10.39 | | 100.00 | 145.45 | | 100.00 | 186.67 | | 100.00 |

As foliage parameters, were determined the leaf sizes. In order to determine leaf sizes, we measured the basal leaves. The leaves have different sizes depending on the position on the stem. The dimensions decrease from the bottom to the top of the stem.

The length of petiole presented similar average values for all populations. The maximum value was 5.36 cm in the population of Julita, and the minimum value was 3.50 cm for the Tarnova population. The other populations showed average values between 4 and 5 cm. Compared to the average of experience, three of the populations showed lower average values. The variability within populations was high, with the exception of the Grosii Noi population, in which the variability was moderate (Table 2).

Regarding the length of the basal leaf, the populations are very similar. The minimum value was recorded in the Tarnova population (11.06 cm), and the maximum value was in the Julita population (12.56 cm). Long leaves were also found in the Grosii Noi population. Compared to the average of experience, three populations showed lower average values. The basal leaves are fairly uniform, the variability coefficients having low values. Only the Tarnova and Grosii Noi populations showed moderate variability, the other three populations showing reduced variability for this character.

The width of the leaf is a more uniform character. The calculated average values are very close. The average values ranged from 5.16 cm in the Grosii Noi population and 5.92 cm in the Julita population. Compared to the average of experience, only the Julita population presented a superior average; in the other populations, the averages were inferior. The variability of this character, according to the correlation coefficient, was moderate for all populations.

The data above reveals that the leaf sizes are similar in all populations. The most uniform character is the width of the leaves, being followed by their length. We may observe that the Julita population has the longest and the widest leaves.

Table 2

**Results on costmary leaf elements**

| Population | Petiole length (cm) | | | Basal leaf length (cm) | | | Basal leaf width (cm) | | |
|---|---|---|---|---|---|---|---|---|---|
| | $x \pm s_x$ | $s_{\%}$ | % exp.av. | $x \pm s_x$ | $s_{\%}$ | % exp.av. | $x \pm s_x$ | $s_{\%}$ | % exp.av. |
| Julita | 5.36±0.31 | 22.40 | 120.72 | 12.56±0.29 | 107.35 | 0.86 | 5.92±0.16 | 109.02 | 0.49 |
| Tarnova | 3.50±0.32 | 35.81 | 78.82 | 11.06±0.50 | 94.52 | -0.64 | 5.40±0.16 | 99.44 | -0.03 |
| Nadas | 4.33±0.42 | 37.93 | 97.52 | 11.22±0.25 | 95.89 | -0.48 | 5.31±0.22 | 97.79 | -0.12 |
| Barzava | 4.75±0.47 | 20.15 | 106.98 | 11.45±0.40 | 97.86 | -0.25 | 5.37±0.40 | 98.89 | -0.06 |
| Grosii Noi | 4.28±0.30 | 17.49 | 96.39 | 12.21±0.62 | 104.35 | 0.51 | 5.16±0.25 | 95.02 | -0.27 |
| Experiment average | 4.44 | | 100.00 | 11.70 | 100.00 | | 5.43 | | 100.00 |

The main parts of the plant: stem, fruit and flowers, were separated and weighed.

The weight of the strains is dependent on their length. The biggest weight was represented by the stems of the Grosii Noi population (22.40 g) and the lowest value was present in the Julita population (18.93 cm).Only two of the populations had the average higher than the average of the poor four populations being over 50. This may be due to the fact that the flowering was uneven. Atpulation. The variability of this character was high within populations, higher values of the coefficients of variability being present in the populations of Tarnova, Nadas and Bârzava (Table 3).

The leaf mass presented similar average values for all populations. Three of the populations had average values of about 27 g. The minimal mean value was for the Nadas population (22.39 g), and the maximum in the Grosii Noi population (27.93 g). Deviations from the average of experience are reduced. The variability of the character is great, but the Nadas population is remarkable with a coefficient of variation of 51,49.

The mass of the flowers was determined, an element without relevance because blooming was very late. At the time of determination, most inflorescences were immature. For these reasons, we did not determine the size of the inflorescences, but only the number of flowers. This is why the weight of the inflorescences has very varied mean values, the differences between populations being very high. The highest average of 6.48 g was determined in the Barzava populations, this being the earliest. The minimum value was only 0.79 g for the Tarnova population. The variability of this character was very high within populations, the coefficients of variability presenting high values, f the time the measurements were made, the plants were in different phases of development.

Table 3

**Results on the weight of plant parts in costmary**

| Population | Stem weight (g) | | | Leaf weight (g) | | | Flower weight (g) | | |
|---|---|---|---|---|---|---|---|---|---|
| | $x \pm s_x$ | $s_{\%}$ | % exp.av. | $x \pm s_x$ | $s_{\%}$ | % exp.av. | $x \pm s_x$ | $s_{\%}$ | % exp.av. |
| Juliţa | 18,93±1,56 | 32,09 | 84.50 | 27,28± 2,03 | 28,91 | 105.16 | 4,95±0,54 | 42,47 | 141.02 |
| Tarnova | 20,34±2,31 | 44,00 | 90.80 | 24,91± 1,95 | 30,31 | 96.02 | 0,79±0,12 | 61,59 | 22.50 |
| Nadaş | 20,20±2,37 | 45,55 | 90.17 | 22,39± 2,97 | 51,49 | 86.31 | 2,19±0,36 | 64,25 | 62.39 |
| Barzava | 25,92±5,21 | 40,27 | 115.71 | 27,22± 3,58 | 26,31 | 104.93 | 6,48±1,65 | 51,06 | 184.61 |
| Grosii Noi | 26,64±2,78 | 25,61 | 118.92 | 27,93± 3,59 | 31,52 | 107.67 | 3,17±0,65 | 50,66 | 90.31 |
| Experience average | 22,40 | | 100.00 | 25,94 | | 100.00 | 3,51 | | 100.00 |

For the links between the studied characters, we calculated the correlation coefficients. Their values are different. For some links, the values certify very tight links. The closest relationship exists between the number of flowers and their mass (0.946). Most linkages between characters are positive. Another close relationship exists between the number and the mass of the leaves (0.861). There is a strong dependence between the number of branching and the number of flowers, the stem weight and the leaves weight, but also between the leaves number and the stem weight. The negative values are few and small, so it can not be said that there are negative correlations between the studied character. This is very important for the selection process, because, with the selection for one character, another character will be improved.

Table 4

**Values of correlation coefficients for linkages between characters in costmary**

| Character | Branch number | Leaf number | Petiole lenght | Leaf lenght | Leaf width | Flower number | Stem weight | Leaves weight | Flowers weight |
|---|---|---|---|---|---|---|---|---|---|
| Stem length | 0.399* | 0.101 | 0.246 | 0.315 | 0.211 | 0.366 | 0.475* | 0.289 | 0.364 |
| Branche number | | 0.687*** | 0.326 | -0.026 | 0.247 | 0.767*** | 0.767*** | 0.699*** | 0.674*** |
| Leaf number | | | -0.146 | 0.222 | 0.464* | 0.552** | 0.737*** | 0.861*** | 0.508** |
| Petiole lenght | | | | 0.176 | 0.164 | 0.233 | -0.181 | -0.196 | 0.294 |
| Leaf lenght | | | | | 0.519** | 0.395* | 0.219 | 0.350 | 0.397* |
| Leaf width | | | | | | 0.398* | 0.337 | 0.453* | 0.380 |
| Flower number | | | | | | | 0.508** | 0.549** | 0.946*** |
| Stem weight | | | | | | | | 0.851*** | 0.424* |
| Leaf weight | | | | | | | | | 0.456* |

r5% =0.381; r1%= 0.487; r0.1%= 0.597

## Conclusions

As regards the characteristics of the strain, we observed that the longest stems were present in the Grosii Noi population, but most of the ramifications were in the Barzava population. The number of leaves per stem is a very important character for productivity. Most of the leaves were found in the Barzava population, and the fewest are found in the Nadas population. The number of flowers on stem fluctuated sharply from one population to another. The most flowers were reported in the Barzava and Julita populations. The Barzava population is remarkable with branched stems, rich foliage and abundant flowering. The leaf sizes are similar in all populations. The Julita population is noted as having longer and wider leaves. Concerning the weight of different parts of plants, it was observed that the largest weight was represented by the strains and leaves of the Gross New population.

Between some characters, there are very close links. The strongest dependencies are between the number of flowers and their weight, and between the number and weight of the leaves. There is also a close dependence between the number of branches and the number of flowers, between the weight of the strain and the weight of the leaves, but also between the number of leaves and the weight of the stem.

There are morphological differences between the studied populations that can be used in the selection process in order to create a variety, the costmary being a plant for which there are not any homologated varieties in Romania.

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