Nectar glands of *Passiflora* species growing in Absheron and relation with ants

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Abstract. The species *P. edulis*, *P. incarnata*, *P. ligularis* and *P. caerulea* belonging to the genus Passiflora L. of the *Passifloraceae* family were introduced in the experimental area of the Dendrology Institute, and bioecological characteristics were studied and it was determined that each of the species has extrafloral nectar glands. The presence of sugar in the exudate of the nectar glands was determined by the ACCU-Chek device, as a result *P.edulis*, *P.incarnata* species were rich in sugary substances. At the same time, the morphological arrangement and location of the nectar glands were very similar in both species. At the same time, in *Passiflora caerulea* L. it is completely different in size, shape and location. Thus, these glands are located at the edges of the divided parts of the pentalobed leaves and are very small in size. In the species of *P. ligularis* L., the leaf petiole is shorter than in other species, replaced by 3-4 pairs of trichomes 8-10 mm long, and ants were not found in this species due to the absence of sugar, which attracts ants. As, they usually have a protective nature.Among the studied species, *P. edulis* and *P. incarnata* have the closest relationships with ants. This has a positive effect on the protection of plants from diseases and pests.

1 Introduction

At the moment, monitoring environmental factors in the studied climate and the introduction of new species and varieties of flower crops are considered an urgent task in Absheron. Passionflower is a plant that is highly valued throughout the world as a valuable ornamental plant and also has therapeutic properties. Passionflower is a common representative tropical flora and belongs to the passionflower family, which has more 500 species. There are 350 species found in the tropical regions and rainforests of the South. In America there are 60 edible species [1].

Brazil has a large variety of these species. Two forms of edibles are recognized fruits are purple (*Passiflora edulis*) and yellow (*Passiflora ligularis*). Passionflower loves hot and humid climates. Mature forms have round, oblong yellow-green fruits. *Passiflora caerulea*

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is valuable as ornamental plant. *Passiflora incarnata* is a special type of plant. Makes a big difference modern herbal medicine is used as an anxiolytic agent [2, 3].

Passiflora is a perennial herbaceous or tree-like plant. It has a well-developed rhizome, the length is about 3-10 m. The stem spreads, has a smooth, round, leafy, woody shape from the base. The shapes of the leaves are simple, alternate, deeply tripartite, leathery, green above, grayish below and finely serrated at the edges. This plant clings to supports with tendrils. The flowers have an original, axillary, solitary, bisexual, large shape and pale lilac, oblong petals and several pistils. It has an edible fruit, juicy, berry-shaped, oval in shape. The seeds when ripe are yellow-orange with three nests, also the seeds are black and have an uneven surface. It blooms on the 50th day, and also bears fruit approximately on the 80-150th day after regrowth. The growing season is up to 210-280 days, from the second year of life it blooms and bears fruit, yellow-green in color.

Passionflower herb (*Passiflora incarnata* L) is used as a medicinal raw material, which is collected several times during the growing season: during the budding phase, as well as flowering and fruiting. This raw material is a mixture of pieces of crushed thin stems, leaves, flowers and unripe fruits. Flowers become discolored in dried raw materials. It has a bitter taste and a specific smell. The raw material should contain no more than 60% stems and no more than 8% immature fruit [4].

The formation of extrafloral nectar glands (EFNs) in species of the genus *Passiflora* L.is widely used as a diagnostic characteristic of species belonging to this genus [2, 10]. In species introduced on Absheron, these glands were observed on the leaf petiole (petiolate), in the leaf axil (laminar) and on flower buds. Petiolate extrafloral nectar glands (EFN) are the main feature when selecting species belonging to the genus *Passiflora* L.

Researcher in this study noted that extrafloral nectaries vary in size and shape. According to the literature, passiflora flowers have a protandric structure (the male reproductive organ is formed before the female) depending on their nature and are located singly in the leaf axils [5].

Extrafloral nectaries (EFNs) are morphologically diverse glands found in at least 90 families of angiosperms [6- 7]. EFNs produce sugar solutions that are attractive to ants and other nectar-feeding insects. Because ants are one of the most important predators small invertebrates [8].

Species belonging to the genus Passiflora typically bloom during the day and at night. According to some scientists, night pollination of open passionflower flowers is carried out by bats [9, 10].

Currently, one of the important directions of bioecology is the study of the relationship between plants and insects. In the passiflora we studied, the flowers have a joint relationship with ants.

This connection is made through ecologically important extrafloral nectaries. According to the literature, extrafloral nectaries (EFN) are plant glands located outside the flowers, not involved in the pollination process, usually on the petiole of the leaf and producing special nectar connected with the veins of the leaf [11]. They are very diverse in size, mechanism and location. They can be found in all above-ground parts of the plant, including fruits and stems.

2 Materials and methods

Absheron is characterized by a dry subtropical climate. The average annual temperature in Institute Dendrology is about +12- 15˚C absolute minimum temperature in winter +2-4˚C, the maximum in summer is +36-38˚C; the transition of the average daily temperature above 4˚C occurs in the first and second ten days of March. A period with stable average daily air temperatures below 0˚ C is extremely rare. Precipitation amount up to 560mm .

These research works on introduced species were carried out at the experimental site of the Institute of Dendrology of the Republic of Azerbaijan. The Institute of Dendrology is located in the northeastern part of the Absheron Peninsula, in the village of Mardakan. The area of the institute is 12.5 hectares and is located at an altitude of 800 m above the sea level. Places near the sea are 80-85% limestone, sandy soil. The composition of the soil in elevated areas far from the sea is the mixture of medium sandy and heavy clay, the thickness reaches of 0.5-1.5 m.

Since flowering of Passiflora species occurs in the second year of the growing season, plant material was collected from biennial plants during the budding period. Based on visual observations, plant samples (leaves and flowers) of *Passiflora* L. of the genus *P.edulis*, *P.caerulea*, *P.incarnata* were collected and delivered to the plant ecology laboratory.

Fig. 1. Appearance under the microscope of extrafloral nectar glands of the species of *P.edulis* L.

An XSZ-N117A light microscope was used during the experiment. The remaining plants were dried and transferred to the Institute's herbarium fund. To determine the presence of glucose in the exudate of EFN glands, an ACCU-Chek device was used.

The use of the ACCU-Chek device in the determination of sugar in nectar glands increases the efficiency of research in this field and allows a more accurate understanding of the biological and ecological characteristics of plants.

The presence of sugars in the nectar glands of Passiflora species was determined using the ACCU-Chek device:

1. Nectar Collection: Nectar glands of plants are carefully collected for analysis, ensuring that the obtained samples are as clean and uncontaminated as possible.

2. Sample Preparation: Nectar is diluted to the required concentration for analysis in the ACCU-Chek device.

3. Using ACCU-Chek: A nectar sample is placed in the ACCU-Chek device. This device detects sugar levels quickly and accurately, and therefore provides accurate readings of sugar content in nectar.

4. Data Analysis: The obtained data are analyzed to determine the sugar concentration in the nectar glands. This provides important information about the nutritional value of nectar for pollinators.

This method is an effective method for measuring sugar in the nectar glands of plants.

3 Results and Discussion

To determine the presence of sugar in the secretion of passionflower leaf glands, a glucose test is used. In determining glucose, this glucostrip test showed that there is glucose in exudate petiole glands species P.edulis and P.incarnata. In the same time, structural features of the glands and presence of glucose in their secretions prove that it is truly a non-flower

nectar. Our study further confirms the opinion of scientists conducting research in this area [4-12].

Among the plants we studied in the study areas, both species were weakly infested with pests. It can be concluded that ants traveling for nectar attack the insects around the passion plants and protect them from pests.

Unlike flower nectars, extrafloral nectars formed outside the flowers. During our visual observations at the experimental site, the amount of extrafloral nectar increases, and the number of ants also rapidly increases with the appearance of new buds in the leaf axils of *P.edulis* L., *P.incarnata* L. and *P .caerulea* L. flowers. At this time, the size of the petiolar glands in the new leaf petioles formed in young shoots also swells relatively. At this time, a large number of swallows crawling along the branches of the plant do not harm the leaves of the plant, they only wander to obtain nectar and secrete acid to ward off approaching insects and pests. In this way, the plant is protected from attacks by insects and pests. When fruits begin to form, the number of ants walking on the plants decreases and disappears. Since *P. edulis*, introduced for the first time, produces flowers and fruits in Absheron twice a year, this process is repeated in the budding phase.

Fig. 2. Extrafloral nectar glands on a flower bud of *Passiflora edulis* L. with an ant.

In Passiflora caerulea L., extrafloral nectaries (EFN) are relatively poorly developed compared to the studied species. Thus EFN in Passiflora caerulea L. is not located on the flower buds of the species, but only on the edges of leaf lobules and on leaf petioles. In Passiflora ligularis L., petiolar nectar glands were replaced by serrated trichomes in the study area. During the studies, no ants were found on these species.

EFN begins to swell when the buds are just forming, and nectar production increases and reaches a peak in the first days of flowering. At this time, the number of ants is constantly increasing. (Fig. 2.)

Fig. 3. Ants feeding by the petiolar nectars of the species of *Passiflora incarnata* L.

In *Passiflora* species, in the second year of growing season, plant growth accelerates and increases in width and length. At this time, a flower bud develops from the leaf axil on the newly formed axils. From this time on, ants begin to appear. When the buds are formed, extrafloral nectar glands are clearly visible on them. In *Passiflora incarnata* L. and *Passiflora edulis* L. this is more pronounced (Fig.3.).

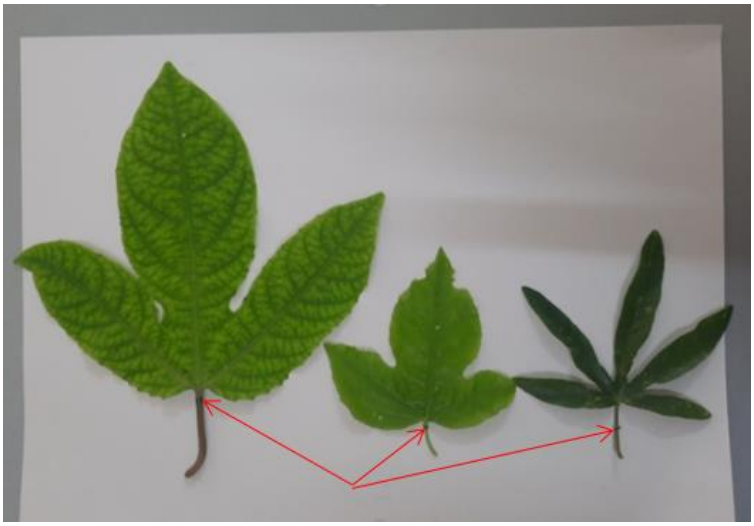

Fig. 4. Extrafloral nectar glands on the leaf stem of *P. edulis*, *P. incarnata*, *P. caerulea*.

The most attractive features of the plant are its flowers and the unique crown of each species [13-14]. The flowers are very beautiful to look at, fragrant, perfect and bisexual (hermaphroditic), 6-7 cm wide, androgenophore used for reproduction, 5 corolla leaves and silvery sepals, 5 stamens (anthers) and 2 rows of purple crowns at the base. tops [15]. The main plant pigments are carotenoids (reddish and orange-yellow), anthocyanins (red, blue and purple) and chlorophylls (green). Because the pollen in the pistil of passionflower flowers is thick and sticky, wind plays no role in pollination, but bees play a very important role (Fig.4).

During our studies, in populations of *Passiflora edulis* L. at our experimental site, despite the absence of pollinators (insects and birds), pollination and fruit formation still occur. Insects and ants walking on plants collect nectar; they are not pollinators [16]. The results

obtained showed that the phenological development of plants, depending on their genotype, directly or indirectly reveals their biological characteristics and biorhythms, reflects changes environmental factors. The phenological phases of passionflower species under the conditions of Absheron demonstrate different degrees of adaptation of species to new conditions. In this case, the compilation of a local "phenological calendar", taking into account the phenological rhythm of the species under conditions of introduction, is of particular importance. Thus, seasonal environmental environmental factors play an important role in the life of a plant, influencing biological rhythms, growth and development, flowering, fruit ripening, leaf fall, etc.

As a result of a comparative analysis of the studied species, different forms of extrafloral secretory glands were identified.

When conducting research on the biological characteristics of the flowering of passionflower species introduced in the conditions of Absheron, the study of the biological characteristics of plants is of great importance.

Fig. 5. Extrafloral nectar glands on a flower bud of *Passiflora incarnata* L. with ant.

The most interesting area of plant ecology is studying the relationships between plants and insects. In some species of Passiflora introduced and studied on Absheron, flowers are in a symbiotic relationship with ants, and these relationships are especially widespread in some species of the genus *Passiflora* L. of the *Passiflorasceae* family (Fig.5).

Nutrient nectar is produced by extrafloral nectaries at the base of leaves and flower buds. According to the literature, extrafloral nectaries (EFN) are plant glands located outside flowers, not involved in the pollination process, usually on the leaf petiole and producing special nectar that is connected to the leaf veins [11- 17]. EFNs are found in the vegetative and reproductive parts of many plant species, primarily angiosperms [18- 19-20]. They are very diverse in size, mechanism and location. They can be found in all above-ground parts of the plant, including fruits and stems.

Extrafloral nectars consist of carbohydrates and amino acids, proteins and lipids. Unlike floral nectars, extrafloral nectars, produced outside the flower, usually have a protective function and are constantly in demand by honeybees and ants because they are sweet glands.

Because the amount of extrafloral nectar increases while the flowers of *Passiflora edulis* L. and *Passiflora incarnata* L. are still forming new buds, the number of ants also increases rapidly. At this time, they do not harm the leaves of the plant, they only wander to obtain

nectar, and to scare away approaching insects and pests they secrete formic acid, forcing them to flee. In this way, the passionflower plant is protected from attacks by insects and pests.

In *Passiflora caerulea* L., extrafloral nectaries (EFN) are relatively poorly developed compared to the studied species. Thus, in the species *Passiflora caerulea* L. is not located on flower buds, but only along the edges of the leaf axils and on the leaf petioles.

When the buds are just forming, the EFN begins to swell, and in the first days of flowering, nectar production increases and reaches its peak. At this time, the number of ants is constantly increasing.

4 Conclusion

When studying the bioecological characteristics of the species *P. edulis*, *P. incarnata*, *P. ligularis*, *P. caerulea* belonging to the genus *Passiflora* L. of the *Passifloraceae* family, studied at the experimental site of the Institute of Dendrology, during observation, it was determined that the extrafloral nectar glands of P. edulis and P. incarnata species are similar in appearance and location. At the same time, the nectar glands on the edges of the leaves and flowers of both species are rich in sugars. In *Passiflora caerulea* it is completely different in size, shape and location. Thus, these glands are located at the edges of the divided part of the pentalobed leaves and are very small in size. The leaf stem of *P. ligularis* species is shorter than that of other species. In the species *Passiflora ligularis*, only 3-4 pairs of opposite trichomes are replaced on the leaf stem, and ants are not found, since they do not contain sugar that attracts ants. Also, among the studied species, no morphological changes in leaves were observed in *P. ligularis*.

Authors' contribution

Methodology, Vusala Badalova, Zumrud Mammadova, Saleh Maharramov, Khayala Alibeyli: Investigation, Vusala Badalova, Zumrud Mammadova,: Writing – Original Draft Preparation, Saleh Maharramov, Khayala Alibeyli: Writing – Review & Editing, Vusala Badalova, Zumrud Mammadova: Project Administration, Vusala Badalova, Zumrud Mammadova: Funding Acquisition, Vusala Badalova.

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