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RESEARCH RESULTS REGARDING THE ANATOMY OF SOME MEDICINAL PLANTS OF *CUCURBITACEAE*

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Abstract

The Cucurbitaceae family is one of the most important plant families worldwide. It includes the largest number of well-known plants used for human food and medicinal purposes. Some of the important plants that have been studied are cultivated in Romania - Momordica charantia L., Cucumis metuliferus E. Mey. Ex Naud. and Luffa cylindrica (L.) Roem (syn L. aegyptiaca Mill.). We compared the stem anatomy of three representative Cucurbitaceae members. We found similarities in the arrangement and distribution of cells and tissues in the organs under investigation. The detailed anatomy of the three species is presented in this paper. Comparative anatomical studies of the three species, with variations in the number of tissues, is shown together for the first time. This study is, therefore, based on the principles that research anatomy has played a major role in the identification, characterization and delimitation of botanical taxonomic features.

Key words: *stem anatomy, Momordica charantia, Luffa cylindrica, Cucumis metuliferus.*

INTRODUCTION

The *Cucurbitaceae* family is one of the most important plant families worldwide. It includes the largest number of well-known plants used for human food and other purposes in different industries (pharmaceutical, cosmetics, etc.). Besides their economic usage, the plants belonging to this family are also known for their medicinal purposes, a fact which makes them important targets for the research in the domain of plants with significant medicinal potential.

The studies of *Momordica charanthia* demonstrated that this species has well adapted to our pedoclimatic conditions. It can be cultivated both in greenhouses and in open fields in warmer areas.

Moreover, this species supports various technological variants and can be ecologically cultivated with remarkable results.

It is known as the "green insuline", as it contains peptides that have similar molecules to insulin, alkaloids and glycosides that act together to lower blood sugar level (Lagunovschi-Luchian et al., 2017). *Momordica charantia* L. - Bitter melon is commonly used as an antidiabetic (Fang et al., 2011) and antihyperglycemic (Abascal et al., 2005; Kravinkel et al., 2006; Michael et al., 2006; Sharma, 1960, Sophowora, 1995), antioxidant (Sathishsekar, 2005), antiviral (Basch, 2003) in Asian and Latin American countries.

The popularity of *Momordica charantia* in various systems of traditional medicine for several aliments (antidiabetic, antihelminthic, contraceptive, dysmenorrhea, eczema, emmenagogue, antimalarial, galactagogue, abdominal pain, laxative, leprosy, leucorrhea, pneumonia, psoriasis, purgative, rheumatism, fever and scabies (Grover et al., 2004).

Also *Momordica charantia* is one of those plants with both edible and medical value and it was reported to exhibit anticancer activity (Ray et al., 2010; Fang et al. 2011, 2012; Chia – Jung-Li et al., 2012; Pitchakarn et al., 2011; Fang et al., 2012). Works based on the properties of medicinal plants were also made by Onaran and Bayan, 2016; Arslan, 2016; Grigore et al., 2016.

Luffa cylindrica (L.) Roem (syn *L. aegyptiaca* Mill.), commonly called sponge gourd, loofa, vegetable sponge fruit is used in the traditional medicine as an anthelmintic, carminative, laxative, depurative, emollient, expectorant,

and diuretic and lactagogue. It is useful in fever, syphilis, tumours, bronchitis and leprosy (Yoganandam, 2010). Its seeds have been used in the treatment of asthma, sinusitis and fever (Nagao, 1991). The seed oil is reported to be used for skin infections in the form of tincture (Partap, 2012). The leaf extract, which contains saponins, alkaloids, cardiac glycosides, has proved antibacterial to *Bacillus subtilis, Escherichia coli, Staphylococcus aureus* and *Salmonella typhi* (Muthumani et al., 2016; Velmurugan et al., 2011). Their immature fruits are eaten mainly as vegetables. The interest for the species of *Luffa* has grown considerably in Romania, further motivating the study presented in this paper. *Cucumis metuliferus* E. Mey. Ex Naud. - Kiwano containing 0 cholesterol but is rich in antioxidants and vitamins, kiwano slightly accelerates metabolism and stimulates the liver to lower cholesterol synthesis. Kiwano is a fruit that can be eaten by people who suffer from hypercholesterolemia (Omale et al., 2011). It is also used against cancer (Usman et al., 2015).

The distribution of plant cells and tissues such as sclerenchyma, vascular bundles and other anatomical features have been reported and utilized at different systematic levels for delimitation of taxa (Metcalfe and Chalk; 1979; Stace, 1980; Fahn, 1990; Agbagwa and Ndukwu, 2004). Comparative and systematic studies on the anatomy of the various vegetative organs (root, stem and leaf) of the species of the *Cucurbitaceae* family were carried out by Ikechukwu et al. 2004; Ajuru and Okoli, 2013; Okoli and Ndukwu, 1992; Okoli, 1984; Săvulescu and Hoza, 2010; Mohammed et al., 2015.

MATERIAL AND METHOD

The seed material originated from the Vegetable Growing Research Institute in Buzău, Romania.

The studies showed that this species has well adapted to our pedoclimatic conditions; it can be cultivated both in greenhouses and in open fields, in warmer areas.

The species in question supports various technological variants and can be ecologically cultivated with remarkable results (Lagunovschi-Luchian and Vânătoru, 2016; Viorica Lagunovschi-Luchian et al., 2017). Plants of *Momordica charantia* L., *Cucumis metuliferus* E. Mey. Ex Naud. and *Luffa cylindrica* (L.) Roem (syn *L. aegyptiaca* Mill.) were planted in the experimental field of the Botanical Garden of the University of Agronomical Sciences and Veterinary Medicine in Bucharest (USAMV-Bucharest) and in some private gardens in Bucharest, District 4. Stem cross-sections were manually performed for the three species using razor blades.

Thereafter the sections were clarified with chloral hydrate for 24 hours, then washed and stained with carmine alaunate and green iodine (Săvulescu and Hoza, 2011; Georgescu et al., 2015), except the *Luffa* stems.

Analyses and observations of these cross-sections were performed at the Center for the Study of Food and Agricultural Products Quality at USAMV-Bucharest.

Photos were taken and measurements were made using the Leica DM1000 LED, the Leica DFC295 Video Camera and the Leica S8 APO Stereo Microscope, as well as a Sony photo camera.

RESULTS AND DISCUSSIONS

Analysis of the *Momordica charantia* cross-section stem (Figure 1).

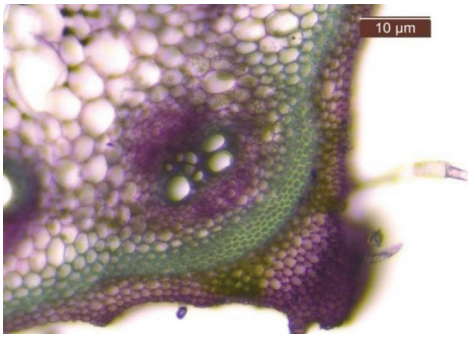

Figure 1. Stem cross-section - *Momordica charantia*

The cross-section has a polygonal shape with 5 angles, smooth cuticle, single layered epidermis with multicellular trichomes (Epidermis with trichome - Figure 2 and non-glandular trichomes - Figure 3, Figure 4, glandular and non-glandular trichomes Figure 5).

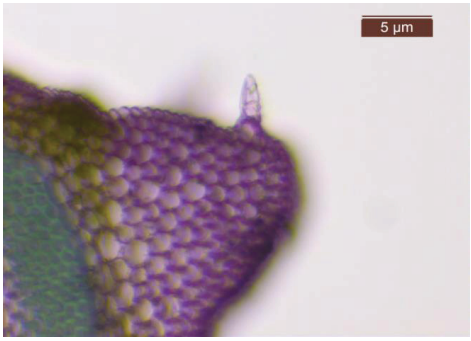

Figure 2. Epidermis with multicellular trichome

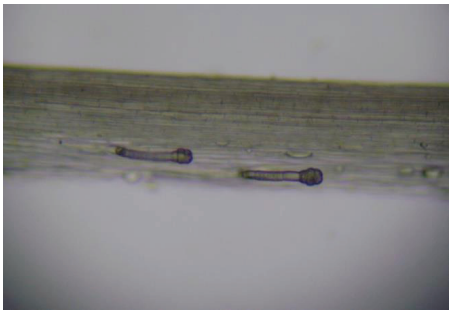

Figure 3. Glandular trichomes

Figure 4. Non - Glandular trichomes - *Momordica charantia*

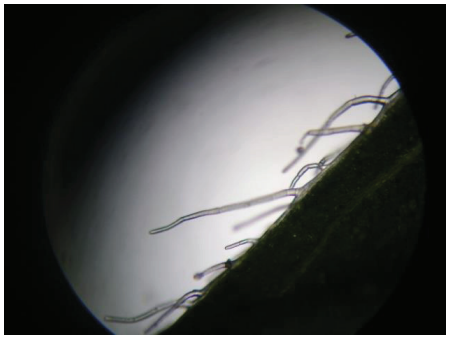

Figure 5. Glandular and non - glandular trichomes - *Momordica charantia*

The cortex contains a discontinuous collenchyma featuring 6-10 layers at the angles, 2-3 layers of parenchyma with chloroplasts, a pericycle with a 1-8 layered sclerenchyma. Ten bicollateral vascular bundles (Figure 6) are arranged in two rings. Those in the outer ring correspond to the ridges and those of the inner ring to the furrows. Each ring has five bundles with each bundle consisting of xylem (vessels, xylem parenchyma), two strips of cambium and two patches of phloem (sieve-tubes, companion cells and phloem parenchyma). Inter-fascicular cambium and fascicular cambium are not clear.

The bundles are separated by parenchymatic rays and the pith is parenchymatic, in the center of the cross-section.

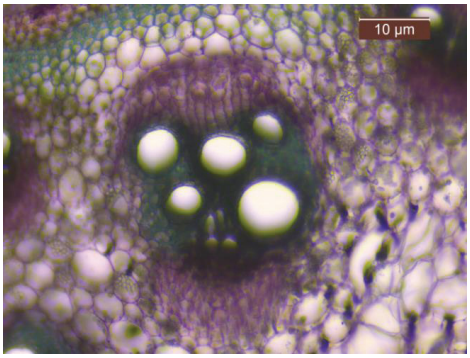

Figure 6 - Bicollateral vascular bundles – *Momordica charantia*.

Measurements in the *Momordica charantia* stem were made at the vascular bundle showing a diameter between 149.71 and 314.54 µm. The xylem diameter ranged between 12.46 µm and 38.1 µm. (Table 1).

Table 1. Measurements in the *Momordica charantia* stem

Vascular bundle size (µm)	Xylem vessel diameter (µm)
149.71	30.303
314.54	38.10
257.60	32.71
127.48	21.26
267.51	22.18
309.13	23.79
245.15	17.67
172.73	12,46
147.69	14.50
148.00	19.80

Analysis of the *Luffa cylindrica* stem cross-section

The cross-section has a polygonal contour. From the outside to the inside of the section the following tissues can be observed: the epidermis, the bark and the central cylinder (Figure 7).

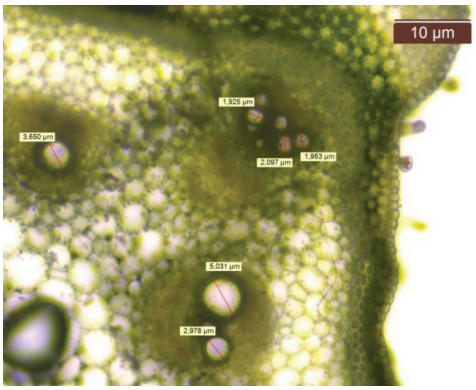

Figure 7 – Cross-section of a *Luffa cylindrica*

The epidermis is single layered, covered by cuticle and the pluricellular trichomes.

The cortex is differentiated into an angular collenchyma (just below the epidermis, 6-10 rows of cells in the ridges and only a few layers or none in the furrows), a 2-3 layered chlorenchyma (cells filled with choloplasts), a pericycle with 5 layers of sclerenchyma, a ground tissue wirh parenchyma cells and 10 vascular bundles, 5 vascular bundles in an outer ring and 5 in an inner ring.

The vascular bundles are bicollateral with xylem located centrally and phloem to the outside and inside of the xylem; the cambium is thin.

The xylem is made up of metaxylem and protoxylem vessels as well as wood fibres and xylem parenchyma.

The phloem consists of companion cells, parenchyma and sieve tubes.

Ten bicollateral primary vascular bundles are separated by parenchymatic rays. Pith is present and is made up of parenchimatous cells.

Table 2 shows the results of the measurements performed in *Luffa cylindrica*.

The size of the vascular bundles varied from 140.69 µm to 192.46 µm with the diameter of the xylem vessels ranging from 17.43 µm to 50.8 µm.

Table 2. Measurements in the *Luffa cylindrica* stem

Vascular bundle size (µm)	Xylem vessel diameter (µm)
158.41	50.80
171.99	48.90
151.68	36.03
181.34	36.03
162.38	28.10
192.46	24.27
166.78	20.79
140.69	21.18
179.45	28.10
184.02	17.43

Analysis of the *Cucumis metuliferus* stem cross-section – Kiwano.

The epidermis is single layered, covered by cuticle and the multicellular trichomes (Figure 8, Figure 9, Figure 10).

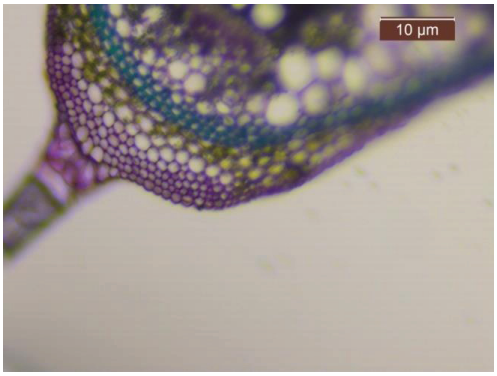

Figure 8 – Epidermis and multicellular trichome - *Cucumis metuliferus*

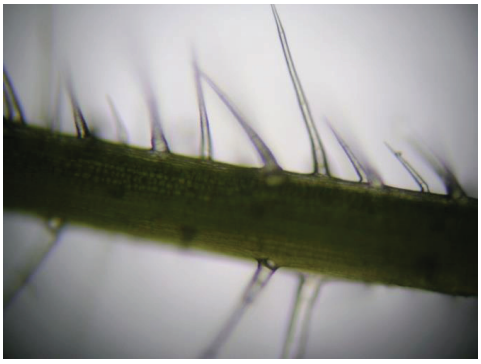

Figure 9 –Non-glandular trichomes - *Cucumis metuliferus*

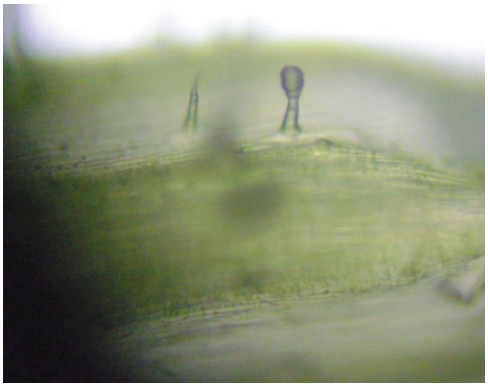

Figure 10 – Glandular and non-glandular trichomes - *Cucumis metuliferus*

The cortex is differentiated into the following tissues: an angular collenchyma, located just below the epidermis and made up of 4-8 rows of cells in the ridges and fewer layers or none in the furrows; a 2-3 layered chlorenchyma having cells filled with chloroplasts; a pericycle with 3 layers of sclerenchyma, a ground tissue with parenchyma cells and 10 vascular bundles, of which 5 vascular bundles on an outer ring and 5 on an inner ring.

The vascular bundle is bicollateral, with central xylem and phloem to the outside and inside of the xylem; the cambium is thin.

The xylem is made up of metaxylem and protoxylem vessels as well as wood fibres and xylem parenchyma.

The phloem consists of companion cells, parenchyma and sieve tubes.

Pith is present and is constituted of parenchymatous cells (Figure 11).

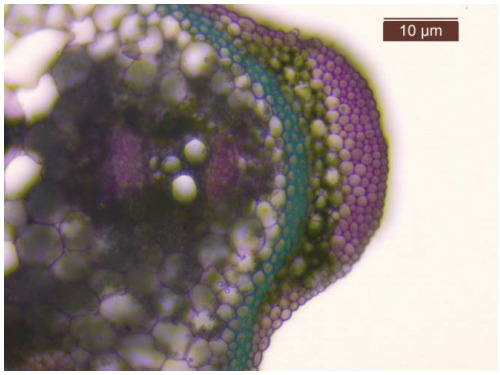

Figure 11 – Cross-section of a *Cucumis metuliferus* - stem sector

Table 3 - Measurements in the *Cucumis metuliferus* stem

Vascular bundle size (µm)	Xylem vessel diameter (µm)
287.35	34.04
211.38	30.20
148.73	32.00
228.31	57.71
150.11	28.10
274.30	15.59
322.80	12.87
287.30	25.10
272.20	24.26
215.20	14.53

Table 3 shows the results of the measurements performed on the vascular bundles and xylem of *Cucumis metuliferus*. The size of the vascular bundles varied from 148.73 µm to 322.80 µm, with the diameter of the xylem vessels ranging from 12.87 µm to 57.71 µm.

CONCLUSIONS

Similarities and differences were observed in the distribution, differentiation and number of cell layers and tissues in the stem cross-sections of *Momordica charantia*, *Luffa cylindrica* and *Cucumis metuliferus*.

At the same time, there are differences with regard to the size of the vascular bundles and xylem vessels in the three species analyzed.

The diagnostic features of all the species analyzed include the presence of bicollateral vascular bundles and also the existence of the siphonostele.

The stem of *Cucumis metuliferus* was studied for the first time anatomically.

The studied stems feature typical anatomical properties of a climbing dicotyledon plant.

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