



Research Paper

## Comparative data on the palynomorphological study of pollen grains of six Albania's honey plants of *Linum* genus

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**ABSTRACT:** Palynomorphological features of six plants of Linaceae family, collected in fresh conditions in some areas of our country (Albania), such as Elbasan (Ullishtë-Gurabardh), Krrabë-Elbasan, Librazhd-Rrajcë, Kukës-Krumë, Sarandë-Konispol and Shkodër, were analyzed based on the comparative methodology. Pollen grains of *Linum* genus, referring to the literature data [7], and the six plants studied: *capitatum*, *flavum*, *elegans*, *nodiflorum*, *hologynum* and *tenuifolium*, resulted to be three zonocolpate, isopolar, radiosymmetric with spheroidal shape in polar view and oval in equatorial one.

The exine sculpture varied from reticulate to granulate at the pollen grains of *elegans* specie, to clavate-echinate at the pollen grains of *capitatum* specie, to clavate-baculate at the pollen grains of *flavum* specie. The exine of pollen grains of *tenuifolium* specie varied from microechinate to baculate, while exine of *nodiflorum* and *hologynum* species varied from granulate to baculate.

Average dimensions (width and length) of pollen grains of the six plants of *Linum* genus were bigger at *Linum nodiflorum* and smaller at *flavum* and *tenuifolium* plant. The furrow length appeared with bigger values at *Linum nodiflorum* and with smaller ones at *Linum capitatum*, while the furrow width appeared bigger at *Linum flavum* and smaller at *Linum tenuifolium*. The mesocolpium was bigger at *Linum nodiflorum* and smaller at *Linum elegans*. The exine thickness appeared with bigger values at *Linum nodiflorum* and with smaller one at *Linum flavum*.

**KEYWORDS:** Pollen grains, mesocolpium, colpus, clavate, echinate, baculate, reticulate, *Linum* etc.

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### I. INTRODUCTION

In this study is given comparative data of six species of Linaceae family. The pollen grains of six studied plants were described from the point of view of morphopalynological features for the first time, giving contribution to palynological studies of Albania's plants.

Referred to the literature available [10], Linaceae family is represented by a genus (*Linum*) and this genus is represented by 19 species of which 6 species: *capitatum*, *flavum*, *nodiflorum*, *hologynum*, *elegans* and *tenuifolium* were studied for their comparative palynological features.

*Linum* L. genus is the main genus of Linaceae family with more than 180 species, which grow in subtropical and soft regions, especially in Mediterranean Basin. There may be around 37 species of *Linum* genus in Europe [7].

This study aims to provide:

- The comparative analysis of morphological features of pollen grains of *Linum* genus;
- The evidence of similarities and differences of palynological features of six species of *Linum* genus compared to *usitatissimum* specie, referred to available palynological literature of Albania [5].

### II. MATERIALS AND METHODS

The pollen grains of six honey plants of *Linum* genus were collected in fresh condition in some areas of our country such as Elbasan, Krrabë, Librazhd, Kukës, Sarandë and Shkodër. Morphological characteristics of pollen grains were studied by using three analytical methods as follows:

- Acetolysis of Erdtman method [3];
- Acetolysis of Avetisjan method [1];
- Basic fuchsin of Smoljaninova & Gollubkova method [12].

There were prepared 3 - 5 microscope slide by different methods and they were studied by the microscope "Motic". The microscopic photos of pollen grains of the plants studied with magnification X400 and X1000 taken by Pupuleku Blerina and Trokoliçi Klea and the photos of respective plants were presented as well.

### III. RESULTS AND DISCUSSION

#### 1. *Linum capitatum* Kit. Ex Schultes, Osterreichs Fl. ed. 2, 1:528 (1814)

Hemicyptophyte. Glabrous perennial plant. It was found in rocky slopes, mountains. Flowering: June-July. South-Eastern Europe [2, 10].

According to the type of aperture, pollen grains were tricolpate, monads and isopolar. In polar view, pollen grains had spheroidal shape whereas in equatorial, they had oval shape ( $P/E=1,01$ ).

The colpi had sharp ends, which did not go to the center of the pollen grains. Their exine appeared reticulate and clavate. The colpi length varied from 10,35 to 15,3 (12,27)  $\mu$ , while their width varied from 9 to 15,5 (11,58)  $\mu$ . Mesocolpium varied from 28,2 to 31,95 (30,66)  $\mu$ .

The exine appeared clavate and echinate and the cytoplasm appeared smooth. The length of the pollen grains varied from 41,55 to 49,65 (44,79)  $\mu$ , while their width varied from 40,35 to 46,5 (44,36)  $\mu$ .

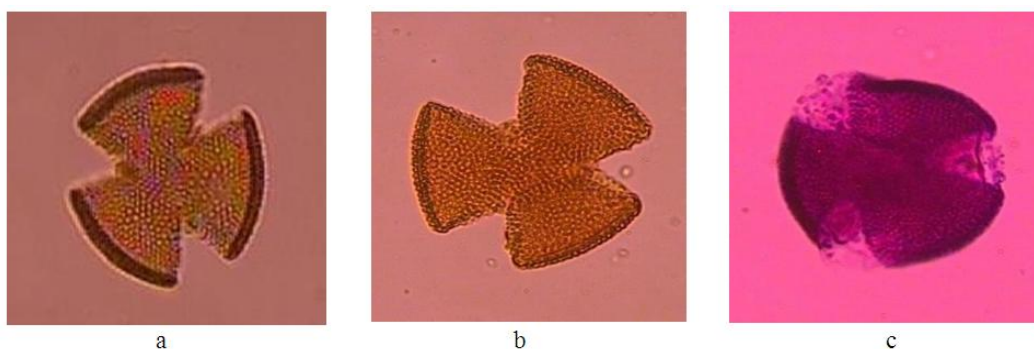


Figure 1: Pollen grains of *Linum capitatum* a: Equatorial position x400; b, c: Polar position x400

#### 2. *Linum flavum* Sp. Pl. 279 (1753)

Golden flax. Hemicyptophyte. Glabrous perennial plant. It was found in grassy lands. Flowering: June-July. South-Eastern Europe (Pontic) [2, 10].

According to the type of aperture, pollen grains were tricolpate, monads and isopolar. In polar view, pollen grains had spheroidal shape whereas in equatorial, they had oval shape ( $P/E=0,99$ ).

The colpi had sharp ends, which did not go to the center of the pollen grains, where the length exceeds the width. Their exine appeared reticulate and baculate. The colpi length varied from 9,6 to 20,85 (12,81)  $\mu$ , while their width varied from 9,6 to 15,45 (12,71)  $\mu$ . Mesocolpium varied from 26,25 to 31,65 (28,39)  $\mu$ .

The exine appeared clavate-baculate and its thickness varied from 1,8 to 2,7 (2,02)  $\mu$ . The cytoplasm was smooth. The length of the pollen grains varied from 38,25 to 44,1 (41,25)  $\mu$ , while their width varied from 37,65 to 44,85 (41,58)  $\mu$ .

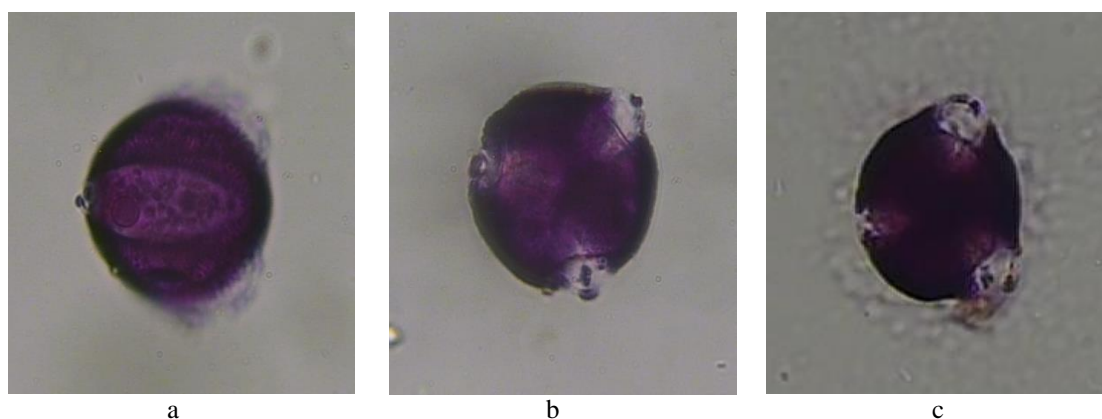


Figure 2: Pollen grains of *Linum flavum* a: Equatorial position x400; b, c: Polar position x400

**3. *Linum nodiflorum* Sp. Pl. 280 (1753)**

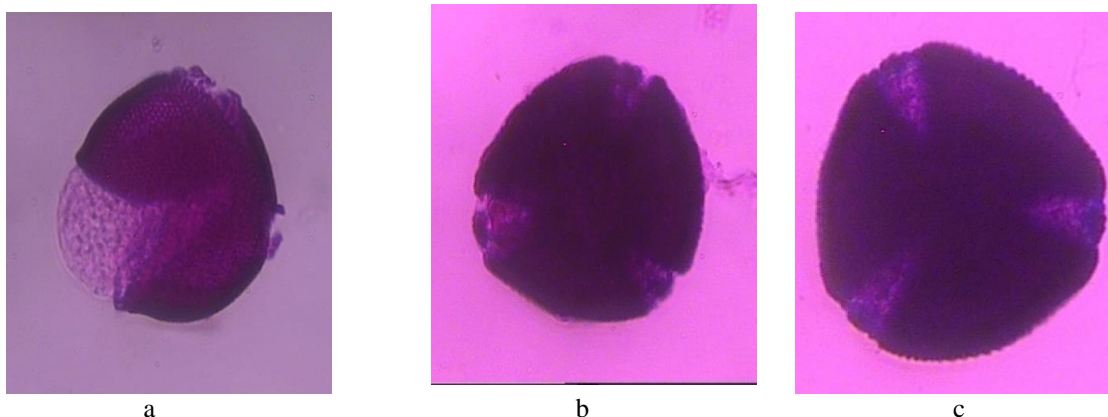
Hemicryptophyte. Inflorescence with flowers between nodes. Glabrous perennial plant. It was found in dry shores, grassy lands, olive groves ect. Flowering: May-July. Euri-Mediterranean [2, 10].

According to the type of aperture, pollen grains were tricolpate, monads and isopolar. In polar view, pollen grains had spheroidal shape whereas in equatorial, they had oval shape ( $P/E=0,99$ ).

The colpi had sharp ends, which did not go to the center of the pollen grains. Their exine appeared clavate and baculate. The colpi length varied from 8,7 to 21,6 (15,48)  $\mu$ , while their width varied from 6,75 to 16,65 (10,76)  $\mu$ . Mesocolpium varied from 32,4 to 44,55 (39,92)  $\mu$ .

The sculpture of exine varied from granulate to baculate and its thickness varied from 2,85 to 3,6 (3,12)  $\mu$ .

The cytoplasm appeared smooth. The length of the pollen grains varied from 45 to 60 (53,33)  $\mu$ , while their width varied from 44,85 to 59,85 (53,57)  $\mu$ .



**Figure 3:** Pollen grains of *Linum nodiflorum* a: Equatorial position x400; b, c: Polar position x400

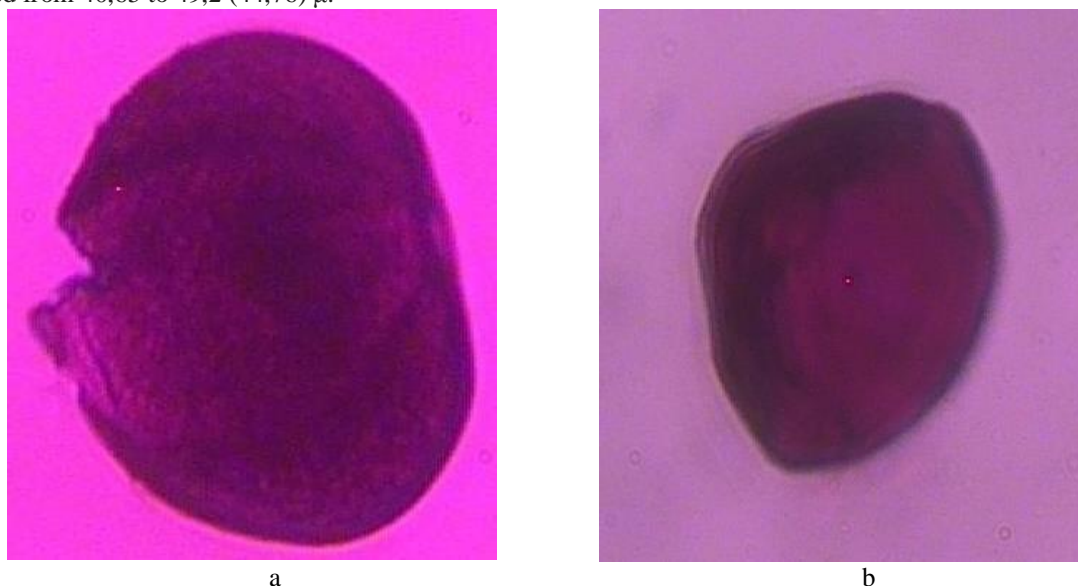
**4. *Linum hologynum* Reichenb., Fl. Germ. Excurs 833 (1832)**

Hemicryptophyte. Glabrous perennial plant. It was found in meadows of mountains areas. Flowering: May-July. Balkan [10].

According to the type of aperture, pollen grains were tricolpate, monads and isopolar. In polar view, pollen grains had spheroidal shape whereas in equatorial, they had oval shape ( $P/E=1,03$ ).

The colpi had sharp ends, which did not go to the center of the pollen grains. Their exine appeared baculate, where baculums were uniform, but too condensed. The colpi length varied from 10,65 to 15,3 (12,84)  $\mu$ , while their width varied from 3,3 to 16,35 (9,15)  $\mu$ . Mesocolpium varied from 25,65 to 37,95 (32,94)  $\mu$ .

The sculpture of exine varied from granulate to baculate and its thickness varied from 1,95 to 2,4 (2,22)  $\mu$ . The cytoplasm was granular. The length of the pollen grains varied from 39,15 to 48,75 (46,14)  $\mu$ , while their width varied from 40,65 to 49,2 (44,76)  $\mu$ .



**Figure 4:** Pollen grains of *Linum hologynum* a: Equatorial position x1000; b, c: Polar position x1000

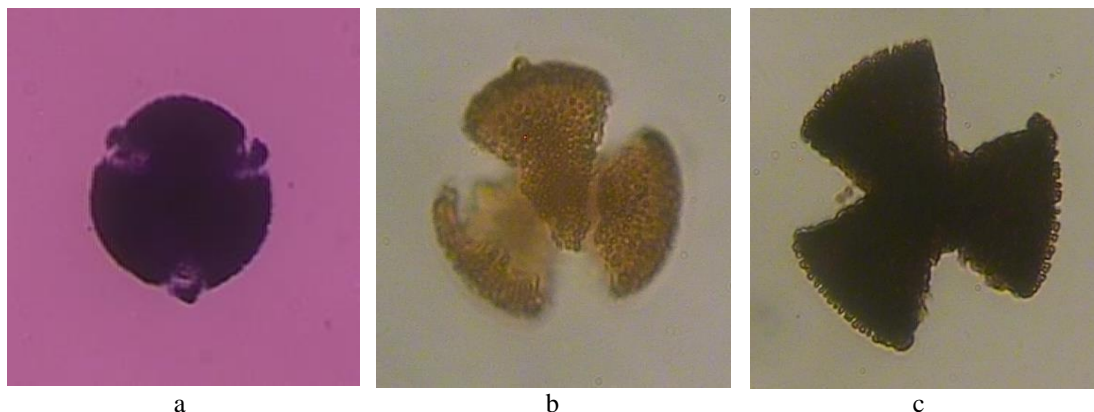
**5. *Linum elegans*** Spruner ex Boiss; Diagn. Pl. Or. Nov. 3(1): 90 (1853)

Chamaephyta (Hemicryptophyta). It was found in rocky places of mountains areas. Flowering: May-July. Balkan [10].

According to the type of aperture, pollen grains were tricolpate, monads and isopolar. In polar view, pollen grains had spheroidal shape whereas in equatorial, they had oval shape ( $P/E=0,99$ ).

The colpi had sharp ends, which did not go to the center of the pollen grains. Their exine appeared reticulate and clavate. The colpi length varied from 9 to 16,05 (12,45)  $\mu$ , while their width varied from 8,55 to 19,05 (12,09)  $\mu$ . Mesocolpium varied from 15,6 to 34,8 (27,23)  $\mu$ .

The sculpture of exine varied from reticulate to granulate and its thickness varied from 2,7 to 3,15 (2,88)  $\mu$ . The cytoplasm appeared granular. The length of the pollen grains varied from 30,9 to 57,3 (44,55)  $\mu$ , while their width varied from 31,05 to 55,2 (44,7)  $\mu$ .



**Figure 5:** Pollen grains of *Linum elegans* a: Polar position x400; b, c: Polar position x1000

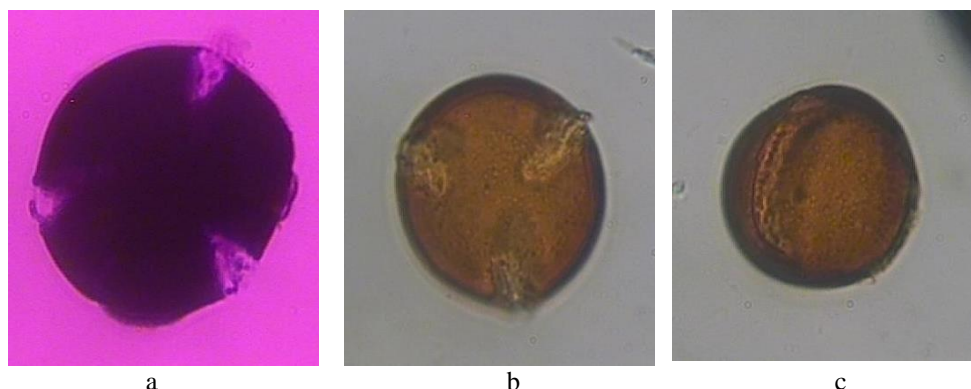
**6. *Linum tenuifolium*** L., Sp. Pl. 272 (1753)

Hemicryptophyte. It was found in grassy dry places and forests. Flowering: April- June. Steno-Mediterranean. Potentillo-Brachypodium pinnate [10].

According to the type of aperture, pollen grains were tricolpate, monads and isopolar. In polar view, pollen grains had spheroidal shape whereas in equatorial, they had oval shape ( $P/E=1,01$ ).

The colpi had sharp ends, which did not go to the center of the pollen grains. Their exine appeared echinate and baculate. The colpi length varied from 12,15 to 18,45 (14,51)  $\mu$ , while their width varied from 5,4 to 10,8 (7,52)  $\mu$ . Mesocolpium varied from 28,65 to 36,75 (32,48)  $\mu$ .

The sculpture of exine varied from microechinate to baculate and its thickness varied from 2,7 to 3,15 (2,91)  $\mu$ . The cytoplasm appeared smooth. The length of the pollen grains varied from 37,95 to 46,95 (41,82)  $\mu$ , while their width varied from 36,75 to 47,1 (41,39)  $\mu$ .



**Figure 6:** Pollen grains of *Linum tenuifolium* a, b: Polar position x400; c: Equatorial position x400

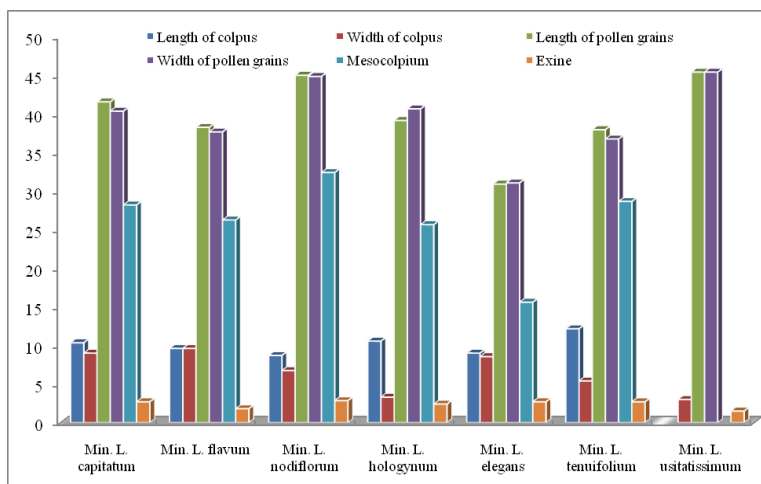
**Table 1.** Dimensions of six studied *Linum* pollen grains compared to pollen grains of *usitatissimum* specie

Palynological features	Length of colpus	Width of colpus	Length of pollen grains	Width of pollen grains	Mesocolpium	Thickness of exine
Minimum <i>L. capitatum</i>	10,35	9	41,55	40,35	28,2	2,7
Average <i>L. capitatum</i>	12,27	11,58	44,79	44,36	30,66	2,82
Maximum <i>L. capitatum</i>	15,3	15,15	49,65	46,5	31,95	3
Minimum <i>L. flavum</i>	9,6	9,6	38,25	37,65	26,25	1,8
Average <i>L. flavum</i>	12,81	12,71	41,25	41,58	28,39	2,02
Maximum <i>L. flavum</i>	20,85	15,45	44,1	44,85	31,65	2,7
Minimum <i>L.nodiflorum</i>	8,7	6,75	45	44,85	32,4	2,85
Average <i>L. nodiflorum</i>	15,48	10,76	53,33	53,57	39,92	3,12
Maximum <i>L.nodiflorum</i>	21,6	16,65	60	59,85	44,55	3,6
Minimum <i>L. hologynum</i>	10,56	3,3	39,15	40,65	25,65	2,4
Average <i>L. hologynum</i>	12,84	9,15	46,14	44,76	32,94	2,22
Maximum <i>L. hologynum</i>	15,3	16,35	48,75	49,2	37,95	1,95
Minimum <i>L. elegans</i>	9	8,55	30,9	31,05	15,6	2,7
Average <i>L. elegans</i>	12,45	12,09	44,55	44,7	27,23	2,88
Maximum <i>L. elegans</i>	16,05	19,05	57,3	55,2	34,8	3,15
Minimum <i>L. tenuifolium</i>	12,15	5,4	37,95	36,75	28,65	2,7
Average <i>L. tenuifolium</i>	14,51	7,52	41,82	41,36	32,48	2,91
Maximum <i>L. tenuifolium</i>	18,45	10,8	46,95	47,1	36,75	3,15
Minimum <i>L. usitatissimum</i>	-	3	45,4	45,4	-	1,5
Average <i>L. tenuifolium</i>	14,51	7,52	41,82	41,39	32,48	2,91
Maximum <i>L. usitatissimum</i>	-	4	52,5	52,5	-	5

From the comparative palynomorphological study of six plants of *Linum* genus, we noticed that the main similarity between them was the fact that the pollen grains were tricolpate, monads and isopolar. In polar view, pollen grains had spheroidal shape whereas in equatorial one, they had oval shape. The colpi had sharp ends, which did not go to the center of the pollen grains, except for *usitatissimum* specie, where the colpi went to the center of the pollen grains.

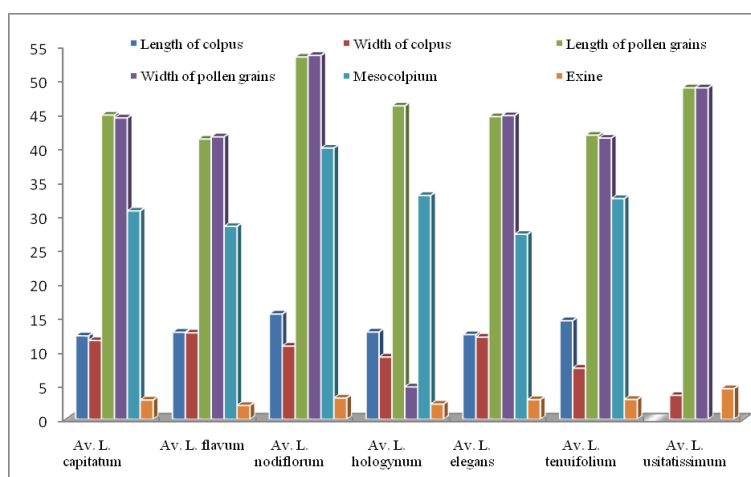
In addition to the similarities, we noticed the differences in the:

1. Exine sculpture, which varied from reticulate-granulate at the pollen grains of *elegans* specie to clavate echinate at the pollen grains of *capitatum* specie and clavate-baculate at the pollen grains of *flavum* specie. The exine of pollen grains of *tenuifolium* specie varied from microechinate to baculate, while at *nodiflorum* and *hologynum* species the exine varied from granulate to baculate.
2. Cytoplasm, which appeared smooth in *capitatum*, *flavum*, *nodiflorum* and *tenuifolium* species and granular only in *hologynum*, *elegans* and *usitatissimum* species.



**Chart 1:** Minimum dimensions of six studied *Linum* pollen grains compared to pollen grains of *usitatissimum* specie

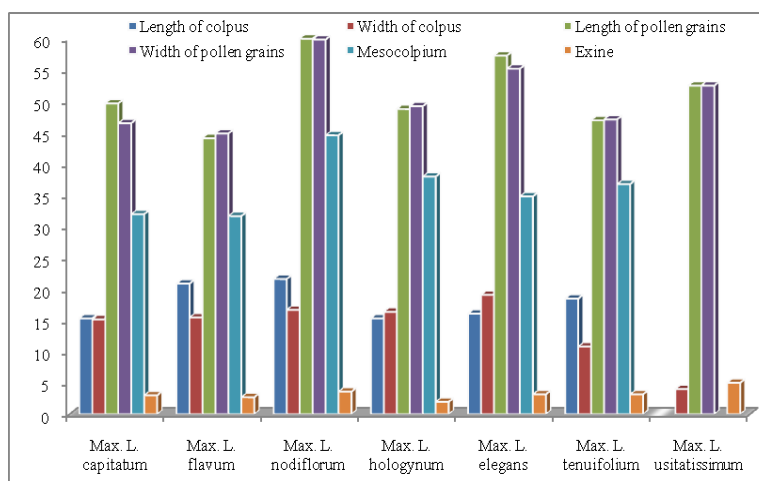
The minimum dimensions of pollen grains of six species of *Linum* genus, as shown in the chart 1, were smaller for the pollen grains of *Linum elegans* and bigger for the pollen grains of *Linum usitatissimum*, regarding to the length and width of pollen grains, referred to the available literature [4, 6, 8, 9, 11]. The length of colpus appeared to have higher values for pollen grains of *Linum tenuifolium* and lower values for pollen grains of *Linum nodiflorum*, while the width of colpi appeared with higher values for pollen grains of *flavum* specie and with lower ones for *usitatissimum* specie. Mesocolpium appeared with higher values for pollen grains of *Linum nodiflorum* and lower ones for pollen grains of *Linum elegans*, while *nodiflorum* specie had thicker exine and *usitatissimum* specie had thinner one.



**Chart 2:** Average dimensions of six studied *Linum* pollen grains compared to pollen grains of *usitatissimum* specie

The average dimensions of pollen grains of six species of *Linum* genus, as shown in the chart 2, had higher values for the pollen grains of *Linum nodiflorum* and lower values for the pollen grains of *Linum flavum* and *Linum tenuifolium*, regarding to the length and the width of pollen grains. The length of colpus appeared to have higher values for pollen grains of *Linum nodiflorum* and lower values for pollen grains of *Linum capitatum*, while the width of colpi appeared with higher values for pollen grains of *flavum* specie and with

lower ones for *usitatissimum* specie. Mesocolpium appeared with higher values for pollen grains of *Linum nodiflorum* and lower ones for pollen grains of *Linum elegans*, while *usitatissimum* specie had thicker exine and *flavum* specie had thinner one.



**Chart 3:** Maximum dimensions of six studied *Linum* pollen grains compared to pollen grains of *usitatissimum* specie

The maximum dimensions of pollen grains of six species of *Linum* genus, as shown in the chart 3, had higher values for the pollen grains of *Linum nodiflorum* and lower values for the pollen grains of *Linum flavum*, regarding to the length and width of pollen grains. The length of colpus appeared to have higher values for pollen grains of *Linum nodiflorum* and lower values for pollen grains of *Linum capitatum* and *Linum hologynum*, while the width of colpi appeared with higher values for pollen grains of *elegans* specie and with lower ones for *usitatissimum* specie. Mesocolpium appeared with higher values for pollen grains of *Linum nodiflorum* and lower ones for pollen grains of *Linum flavum*, while *usitatissimum* specie had thicker exine and *hologynum* specie had thinner one.

#### IV. CONCLUSIONS

The six plants studied: *capitatum*, *flavum*, *elegans*, *nodiflorum*, *hologynum* and *tenuifolium*, resulted to be three zonocolpate.

The palynomorphological study of six plants of *Linum* genus showed that there were many similarities in their palynological features, according to the literature sources, such as:

1. Aperture, which appeared tricolpate in the pollen grains of plants of *Linum* genus;
2. Colpi, which had sharp ends, and did not go up to the center of the pollen grains;
3. Polarity, where all pollen grains were radiosymmetric isopolar;
4. Shape of pollen grains which spheroidal in polar view and oval in equatorial one.

There were some differences between them in terms of the structure of exine and cytoplasm and the dimensions of pollen grains. They were as follows:

1. Exine sculpture, which varied from reticulate-granulate at the pollen grains of *elegans* specie to clavate-echinate at the pollen grains of *capitatum* specie and clavate-baculate at the pollen grains of *flavum* specie. The exine of pollen grains of *tenuifolium* specie varied from microechinate to baculate, while at *nodiflorum* and *hologynum* species the exine varied from granulate to baculate.
2. Cytoplasm, which appeared smooth in *capitatum*, *flavum*, *nodiflorum* and *tenuifolium* species and granular only in *hologynum*, *elegans* and *usitatissimum* species.
3. Regarding to length and width of pollen grains of six plants of *Linum* genus, the minimum dimensions were at *Linum elegans*, whereas the maximum dimensions noticed at *Linum nodiflorum*. In average dimensions, the furrow length appeared with bigger values at *Linum nodiflorum* and with smaller ones at *Linum capitatum*, while the furrow width appeared bigger at *Linum flavum* and smaller at *Linum tenuifolium*. The mesocolpium was bigger at *Linum nodiflorum* and smaller at *Linum elegans*. The exine thickness appeared with bigger values at *Linum nodiflorum* and with smaller one at *Linum flavum*.

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