

PHARMACOGNOSTIC AND BIOLOGICAL EVALUATIONS OF *ZIZYPHUS LOTUS* (L.) LAM.
LEAVES AND STEMS, GROWING IN EGYPT.

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ABSTRACT

Pharmacognostical studies on *Zizyphus lotus* (L.) Lam; was carried out to identify and differentiate the plant organs. Phytochemical screening revealed that the plant rich with carbohydrates and/or glycosides, volatile substances, saponins, flavonoids, phenolics, steroids and/or triterpenes, and alkaloids and/or nitrogenous bases. The biological studies showed that 70% alcohol extract had promising antimicrobial activity. By examination of the LD₅₀ and analgesic effect after oral administration of various doses of extract 100, 200 and 300 mg/kg body weight, the LD₅₀ of 70% alcohol extract of *Zizyphus lotus* L. (Lam.) is 12.88 g/kg (mice) with confidence limit of 10.75 g/kg (mice) and 15.44 g/kg (mice). All tested extracts showed significant analgesic activity in all times of experiments except at 20 min. In conclusion, the tested extract can be used safely for analgesic purposes.

INTRODUCTION

In recent years the class of the naturally occurring compounds known as the cyclopeptide alkaloids and triterpenoid saponins gained increased appreciation because of their varied types of biological activity^(1,2). The presence of cyclopeptide alkaloids in the *Zizyphus* is of taxonomical significance⁽³⁾. In Egypt the genus *Zizyphus* is represented by two perennials *Zizyphus spina-Christi* (L.) Willd which is found in both wild and cultivated varieties in various localities of Egypt and *Zizyphus lotus* (L.) Lam. growing near Sallum valley⁽⁴⁾. Several parts of *Zizyphus* have been used by traditional and ancestral medicine, both in North Africa and Middle East, for the treatment of several pathologies including digestive disorders, weakness, liver complaints, obesity, urinary troubles, diabetes, skin infections, fever, diarrhea and insomnia⁽⁵⁻⁸⁾. The present study determined the macro- and micromorphology, phytochemical screening and Biological investigations of the stem and leaf of the plant.

Experimental

The plant *Zizyphus lotus* L. (Lam.) is an evergreen thorny shrub of about 1-3 meters height and forming thickets to 5 meters in diameters. The plant flowers from May to September and carries drupe edible fruits up to March annually.

Methods

1. Botanical study

Plant material

Samples of *Zizyphus lotus* L. (Lam.) leaves and stems were collected on March 2009 from shrubs growing in Sallum valley.

They were kindly identified by Dr. Nahid Al-Esnawy, professor of plant taxonomy, Faculty of Science, University of Cairo, Egypt.

Fresh samples of leaves and stems preserved in ethanol (70%) containing 5% glycerin were used for microscopical examination. Another plant sample was air dried in shadow and reduced to fine powder and kept for microscopical examination.

2. Phytochemical screening⁽⁹⁻¹³⁾

Phytochemical screening of *Zizyphus lotus* L. (Lam.) leaves and stems for the presence of carbohydrates (and /or glycosides), volatile

substances, saponins, flavonoids, phenolics, steroids (and /or triterpenes), and alkaloids (and /or nitrogenous bases).

3. Biological investigations

Alcohol (70%) extracts of *Zizyphus lotus* L. (Lam.) leaves and stems were freshly prepared, dried under reduced pressure. Albino mice, each weighting 18 - 22 g were used.

Determination of the lethal dose 50 (LD₅₀)⁽¹⁴⁻¹⁷⁾

30g of dried hydro-alcoholic extracts of *Zizyphus lotus* L. were emulsified separately by 2 ml tween 80 and completed to 50 ml with distilled water to obtain 60 % w/v suspensions of extracts in distilled water. Spearman and karper method was applied on mice and used for determination of LD₅₀.

Determination of the analgesic effect

The analgesic activity of hydroalcoholic extracts of *Zizyphus lotus* L. was determined by writhing Test and hot plate methods.

Preparation of test samples

1 gm of dried hydro-alcoholic extracts is emulsified by 2 ml tween 80 and is completed to 50 ml with distilled water to obtain 2 % w/v solutions of *Zizyphus lotus* L. Doses of 100, 200 and 300 mg/kg through giving 0.1, 0.2 and 0.3 ml per 20gm of mice body weight respectively.

Hot Plate Method⁽¹⁸⁻²¹⁾

The paws of mice are very sensitive to heat at temperatures which are not damaging the skin. The responses are jumping, withdrawal of the paws and licking of the paws.

Writhing Test^(22,23)

Pain was induced by injection of irritants 0.1ml of a 0.6% solution of acetic acid is injected intraperitoneally to mice. The animals react with a characteristic stretching behavior which is called writhing. In this test both central and peripheral analgesics are detected.

The formula for computing percent inhibition is: average writhes in the control group minus writhes in the drug group divided by writhes in the control group-times 100%.

Percentage reduction of the number of writhing (%)

$$= \left[\frac{(x - y)}{x} \right] \times 100$$

Where x was the mean of writhing of the control, and y was the mean of writhing of test or standard animals

Antimicrobial activities^(24, 25):

Antibacterial activity was investigated using agar well diffusion method. Mean zone of inhibition in mm \pm standard deviation beyond well diameter (6 mm) produced on a range clinically pathogenic microorganism using (20 mg/ml) concentration of tested sample. The activity of tested samples were studied against the *Staphylococcus aureus* (RCMB 010028) (The Regional Center for Mycology and Biotechnology strain), *Enterococcus faecalis* (RCMB 010068) and *Streptococcus pneumoniae* (RCMB 010010) (as Gram positive bacteria) while *Pseudomonas aeruginosa* (RCMB 010043), *Escherichia coli* (RCMB 010052), *Salmonella typhimurium* (RCMB 010072) (as Gram negative bacteria) and *Geotrichum candidum* (RCMB 05097), *Candida albicans* (RCMB 05031), *Aspergillus fumigatus* (RCMB 02568) (as fungi).

RESULTS

I. Botanical study of *Zizyphus lotus* L. (Lam.) growing in Egypt.

A. Macromorphology

Zizyphus lotus L. (Lam.) (photograph. 1) growing in Egypt, is a shrub reaching up to 3 meters in height. The leaves are alternate ovate to broadly elliptic, obtuse, crenulate, with minute gland at the top of each crenule with very sharp, one shorter and curved spiny stipules.

1- The leaf

The leaves (Figure 1) are simple, alternate, petiolate, ovate-oblong ovate, stipulate with two spiny stipules 0.2-0.7 cm long. The lamina is light green, ovate-oblong, with crenulate margin, obtuse apex and symmetric base. The venation is pinnate reticulate with 3-5 veins running from the base to the upper edge of the leaf lamina, measuring L 1-2.8 cm W 0.5-1.6 cm. The midrib is prominent on the lower surface.

The petiole is greenish-yellow in colour. Its length varies from 0.1-0.3 cm and is about 0.1 cm in diameter. The leaf is odour less and possesses astringent taste.

2- The stem

The old branches are cylindrical, hard and woody brownish grey with darker areas, rough with wrinkled cork and scattered ovoid lenticles. The young branches are yellowish green, longitudinally striated with internodes 1.5-3 cm, while long branches becoming shorter (0.7-1 cm) towards the end of the branch. Branching is sympodial (zigzag) and the phyllotaxis is of $\frac{1}{2}$ divergence. The

branches have a faint characteristic odour and slight astringent taste.

B. Micromorphology:

A. The leaf (Figure 2)

A. The lamina

A transverse section in the leaf consists of upper and lower epidermis enclosing an isobilateral mesophyll which is discontinuous in the midrib region. The midrib is less prominent on the lower surface and show straight on the upper one.

The epidermis: The upper and lower epidermis are tabular, polygonal cells, with thin straight anticlinal walls. They are covered with smooth cuticle.

The neural epidermis: cells of upper and lower are axillary elongated having straight anticlinal walls and covered with smooth cuticle.

Stomata of anomocytic type are sunken on both surface, being more frequent on the lower one and surrounded by 4-6 cells. Trichomes of non-glandular unicellular usually bent with swollen bases. The narrow lumen seems as discontinued at the basal region of the hair. They are concentrated on the lower surface of lamina near the veins.

The mesophyll is isobilateral, discontinuous in the midrib region and is formed of 4-5 rows on the upper surface and 1-2 rows on the lower surface of short columnar straight walled palisade cells and the spongy tissue consists of 2-3 rows of parenchymatous cells rounded and polygonal.

The midrib; the cortical tissue of the midrib and big veins consist of thin walled parenchymatous cells with 4 or 6 layers of collenchyma underlying both epidermis. Scattered cluster and prismatic of calcium oxalate and starch granules are present in the parenchyma beneath the vascular bundles. The rest of the cortical tissue is formed of polygonal or rounded, thick walled cellulosic parenchymatous cell with scattered secretion cells containing tannins on the lower layer.

The vascular tissue is formed of bicollateral vascular bundles with parenchymatous pericycle and separated by medullary rays. The phloem is formed of soft tissue in groups of sieve elements and parenchyma. The xylem formed of several radiating vessels. These rows of vessels are separated from one another by one to two rows of non lignified medullary rays. The xylem vessels and tracheides are lignified, showing spiral and annular thickening.

B. The Petiole: (Figure 6)

A transverse section of the petiole is more or less plano-convex in outline. It is formed of an epidermis followed by a wide parenchymatous cortex occupying about $\frac{2}{3}$ the diameter. Anomocytic stomata are present. Trichomes of non-glandular unicellular usually bent with swollen bases, similar to those present on the lamina.

The epidermis consists of tabular, polygonal cells, with thin straight anticlinal walls. They are covered with smooth cuticle.

The cortex and ground tissue consist of about 3-4 rows of collenchyma under the epidermis. They are followed by numerous thin walled parenchymatous cells. Numerous secretion cells, clusters of calcium oxalate and few minute starch granules are scattered through cortex.

The stele is formed of U- shaped bicollateral vascular bundle have upper and lower continuous arc of phloem surrounding a solid mass of xylem. The pericycle is parenchymatous and surrounds the vascular strand. The xylem elements are radially arranged and consist of lignified spiral and annular vessels. They are traversed by uniseriate or biseriate medullary rays with polygonal or slightly elongated, thin walled cells. The phloem is formed of sieve tissue and phloem parenchyma.

The Powdered Leaf

The powdered leaf is green to dark-green in colour, with aromatic odour, slight bitter taste, and characterised microscopically by the followings:

- 1- Fragments of upper and lower epidermis of the leaf which consist of polygonal cells with straight anticlinal walls, covered with thin smooth cuticle and containing anomocytic stomata.
- 2- Trichomes of non-glandular unicellular usually bent with swollen bases. The narrow lumen seems discontinued at the basal region of the hair.
- 3- Fragments of neural epidermis of the leaf which are polygonal or axially elongated, with straight anticlinal walls and thin smooth cuticle.
- 4- Fragments of epidermal cells of the petiole formed of polygonal cells with straight anticlinal walls and thin smooth cuticle.
- 5- Fragments of cortical tissue consisting of parenchyma cells, which contain clusters of calcium oxalate and minute starch granules, as well as collenchymatous cells.
- 6- Fragments of vessels with spiral and annular thickening.
- 7- Fragments of secretion cells either entire or broken.

The Stem: (Figure 4)

A transverse section in a young stem (green branches with diameter up to 2.5 mm) is nearly rounded in outline. It consists of an epidermis followed by parenchymatous cortex (about 1/10 of the diameter) which occasionally contains clusters crystals of calcium oxalate. The cortex is interrupted by secretion cell. The pericycle is consist of an almost continuous ring of pericyclic fibers; a narrow layer of phloem followed by a relative layer of xylem forming a continuous ring of collateral vascular bundles, and central parenchymatous pith.

The epidermal cells are polygonal, axially elongated with straight anticlinal walls and covered with thin smooth cuticle. Stomata are few of anomocytic type. Trichomes are absent.

The cortical tissue

The cortex is formed of 4-7 layers of thin-walled parenchymatous cells, interrupted by numerous secretion cells with tannin contents. The rest of the cortex is followed by 3-5 layers of radially elongated parenchymatous cells.

The pericycle is formed of 5-7 rows of fibres forming an almost continuous ring interrupted by small groups of parenchyma. The fibres are long with straight or undulating lignified walls, narrow or wide lumina and acute apices.

The vascular tissue is formed of a continuous ring of vascular tissue crossed by uniseriate medullary rays. The phloem is consisting of soft thin-walled elements formed of sieve tubes, companion cells and phloem parenchyma and have middle hard bast. The hard bast is formed of an almost continuous ring of phloem fibers. The fibres are lignified with straight walls, acute or blunt apices and wide or narrow lumina. The medullary rays are uniseriate or rarely biseriate and contain few small starch granules. The cambium consists of 4 or 5 rows of cambiform cells. The xylem is formed of lignified elements, the vessels are radially arranged, either solitary or in small groups and of spiral, annular and reticulate thickening, tracheids, fibers and wood parenchyma. The tracheids show pitted thickening. The wood parenchyma and medullary rays are rectangular, axillary elongated pitted cells with slight lignified pitted walls.

The Pith consists of rounded to polygonal thin walled parenchymatous cells with moderately wide intercellular spaces, with scattered, resin cells. Cluster crystals of calcium oxalate are scattered through pith.

The old stem

A transverse section in the old stem shows differs from the young stem in the following:

- 1- The epidermis is replaced with several layers of cork cells which originate from the phellogen. The cork cells are yellowish-brown, suberised, polygonal with thick straight anticlinal walls.
- 2- The cortical parenchyma is narrower and has thicker walls.
- 3- Absence of secretion cells.
- 4- The presence of hard bast.

Powdered Stem

Powdered stem is greyish-green in colour, with slight aromatic odour and slight bitter taste. It is characterised microscopically by:

- 1- Fragments of epidermal cells from the young stems with polygonal axially elongated cells, straight anticlinal walls,

- thin smooth cuticle and show few anomocytic stomata.
- 2- Fragments of yellowish-brown cork cells, polygonal with thick suberised straight anticlinal walls.
 - 3- Fragments of parenchymatous tissues from the cortex, phloem and pith which contain prismatic and cluster crystals of calcium oxalate.
 - 4- Fragments of sclereids from the cortex occasionally pitted with unequal thickenings, narrow or wide lumina, in different sizes.
 - 5- Fragments of lignified fibres from the cortex with straight walls, acute or blunt apices and wide or narrow lumina.
 - 6- Fragments of lignified pericyclic and phloem fibres with straight or slightly wavy thick or thin walls, acute or blunt apices and narrow or wide lumina.
 - 7- Fragments of lignified spiral and annular vessels.
 - 8- Fragments of lignified pitted tracheids.
 - 9- Fragments of parenchyma cells from the pith containing clusters and prismatic crystal of calcium oxalate.

The spine: (Figure 7)

A transverse section in the spine is oval in outline, more convex on the lower side. It consists of an epidermis followed by continuous bundle of fibers and a ground tissue with scattered vascular

bundle. Cluster and prismatic crystals of calcium oxalate are scattered through center.

The epidermis cells are polygonal, tubular with straight anticlinal walls and covered with smooth cuticle.

The ground tissue is formed of 10-12 rows of non lignified fibres, followed by thin-walled cellulosic parenchymatous cells. The fibers have wide lumina, acute apices and vary in length.

The vascular bundle is closed concentric vascular bundle with phloem to out side and xylem to inner side.

2. Phytochemical screening

Phytochemical screening of *Zizyphus lotus* L. (Lam.) leaves and stems were revealed the presence of carbohydrates (and /or glycosides), volatile substances, saponins, flavonoids, phenolics, steroids (and /or triterpenes), and alkaloids (and /or nitrogenous bases).

3. Biological investigations

1. Determination of the lethal dose 50 (LD₅₀)

The experiments revealed that the LD₁₀₀ was 13.3 gm/kg while the LD₀ was 4 gm /kg, thus seven doses between these values were also registered.

The LD₅₀ of 70% alcohol extract of *Zizyphus lotus* L. (Lam.) is 12.88 g /kg (mice) with confidence limit of 10.75 g /kg (mice) and 15.44 g /kg (mice). From calculated data, the study revealed that, the 70% alcohol extracts could be safe.

2. Determination of the analgesic effect

a. Hot Plate Method

The analyzed data are recorded in Table 1 and represented in Figure 1.

Table (1): The effects of hydroalcoholic extracts of *Zizyphus lotus* L. (Lam.) leaves on hot plate reaction time in mice

Treatment	Mean Reaction Time (Seconds) ± SEM				% of increase in reaction time Respect to control (Percentage protection)				% relative activity to standard		
	Time of measures				Time of measures				Time of measures		
	20 min	60 min	90 min	120 min	20 min	60 min	90 min	120 min	60 min	90 min	120 min
Control	16.2±0.87	16.7±0.67	16.2±0.48	16.2±0.48	-	-	-	-	-	-	-
Standard Tramadol 10 mg/kg	16.6±0.33	19±1.03	29.2±1.08	29.7±0.76	2.4	13.8	82	83.3	-	-	-
<i>Zizyphus lotus</i> extract 100 mg/kg	16.7±0.67	18.3±0.56	17.7±0.92	20±0.77	3	9.5	9	23.5	68.8	11	28.2
<i>Zizyphus lotus</i> extract 200 mg/kg	17.5±0.42	18.8±0.31	23.5±0.85	28.3±1.63	8	12.6	45	74.7	91.3	54.9	89.7
<i>Zizyphus lotus</i> extract 300 mg/kg	17.8±0.48	19.3±0.42	24.1±1.17	27±1.18	9.8	15.6	66.7	66.7	113	81.3	80

The reaction of groups compared by one way analysis of variance (ANOVA) which revealed that: There is a significant difference between groups at P < 0.05.

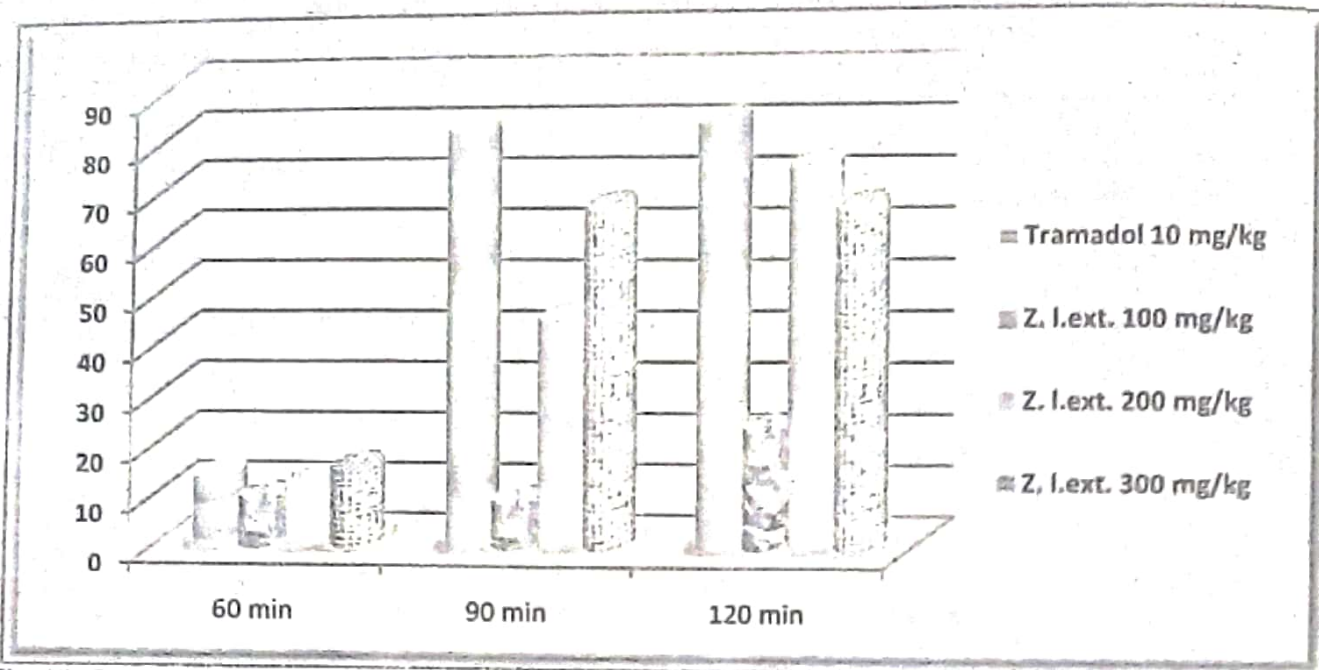


Fig. (1): Percentage of increase of hot plate reaction time by different extracts.

All tested extracts showed significant analgesic activities in all times of experiments except at 20 min. On the other hand the tested extract showed good analgesic activities after 90 and 120 min. of treatment.

a) **Writhing Test**

The analyzed data is recorded in Table 2 and represented in Figure 2.

Table (2): The effect of hydroalcoholic extracts of *Zizyphus lotus* L. on writhing test in mice

	Number of contractions	% inhibition	% relative activity to standard
Control	54.5±1.5	-	-
Diclofenac sodium 15 mg/kg	23.6±1.33	56.7 %	-
<i>Zizyphus lotus</i> extract 100 mg/kg	23.33±0.88	57.2 %	100.8 %
<i>Zizyphus lotus</i> extract 200 mg/kg	17.67±0.67	67.6 %	119.2 %
<i>Zizyphus lotus</i> extract 300 mg/kg	24.5±1.6	55%	97 %

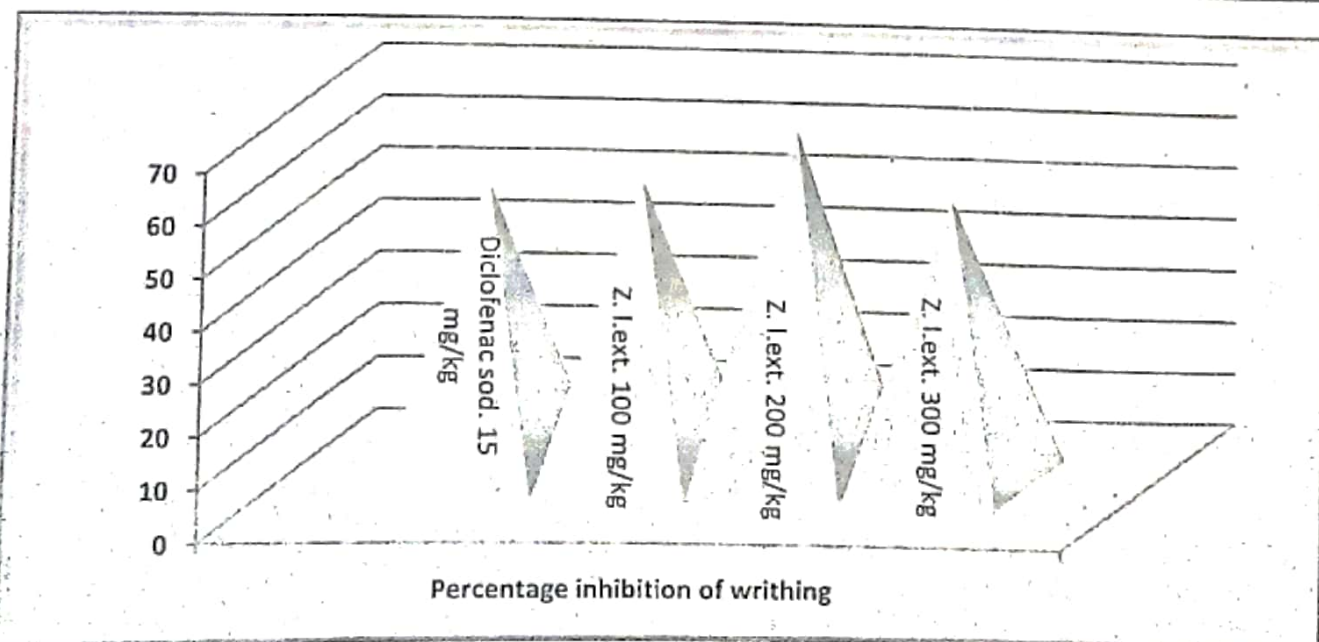


Fig. (2): Percentage of inhibition of writhing contractions by different extracts.

All tested extracts showed significant analgesic activities in comparing to standard.

1.1. Screening of Antimicrobial activity
 The analyzed data is recorded in Table 3 and represented in Figure 3. The results obtained with *Zizyphus lotus* L. the total extract (70% hydroalcoholic extract) showed antimicrobial activities to all tested organisms except *Pseudomonas aeruginosa*. Its percentage activity when compared to standard is as follows: *Staphylococcus aureus* (77

%), *Enterococcus faecalis* (97.5 %) and *Streptococcus pneumoniae* (86.5 %), *Escherichia coli* (91 %), *Salmonella typhimurium* (95 %) *Geotricum candidum* (71 %), *Candida albicans* (66 %), *Aspergillus fumigatus* (90%).
 The alcohol (70%) extract had higher antimicrobial activities to all tested organisms except *Pseudomonas aeruginosa*.

Table (3): Antimicrobial activities of alcoholic (70%) extract of *Zizyphus lotus* L.

Microorganism	Extract	Standard
		Inhibition zone in mm
Gram positive bacteria		Ampicillin
<i>Staphylococcus aureus</i> (RCMB 010028)	21.8± 1.4	28.3± 0.1
<i>Enterococcus faecalis</i> (RCMB 010068)	19.8± 2.0	20.3± 0.3
<i>Streptococcus pneumoniae</i> (RCMB 010010)	20.6± 1.3	23.8± 0.2
Gram negative bacteria		Gentamicin
<i>Pseudomonas aeruginosa</i> (RCMB 010043)	No activity	18.2± 0.1
<i>Escherichia coli</i> (RCMB 010052)	18.6± 0.9	20.4± 0.6
<i>Salmonella typhimurium</i> (RCMB 010072)	22.6± 1.16	23.7± 0.7
Fungi		Amphotericin B
<i>Candida albicans</i> (RCMB 05031)	16.75± 1.0	25.4± 0.1
<i>Aspergillus fumigatus</i> (RCMB 02568)	21.43± 2.12	23.7± 0.1
<i>Geotricum candidum</i> (RCMB 05097)	20.42± 1.22	28.7± 0.2

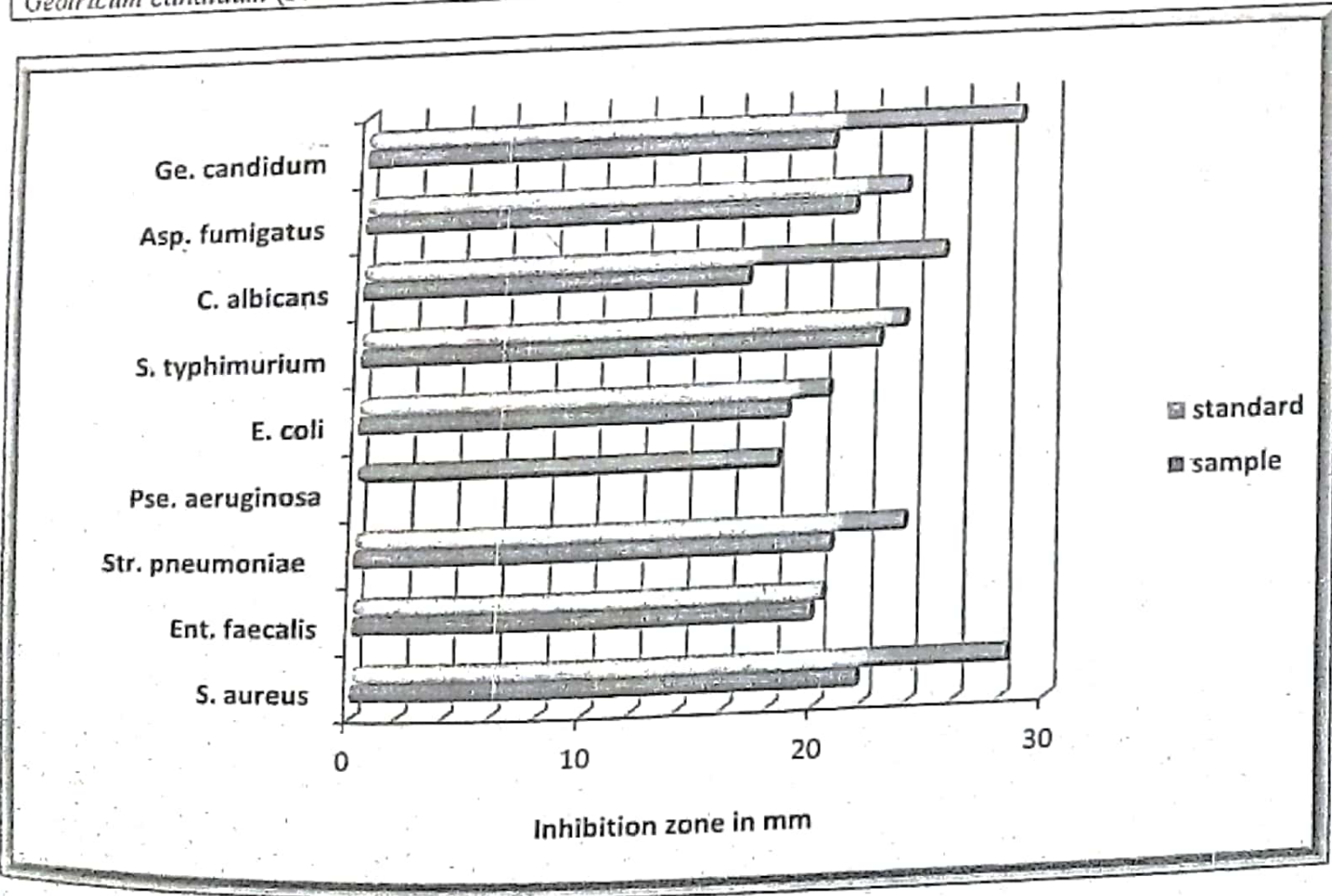


Fig. (3): Percentage of activity when compared to standard by extract.



Photograph (1): The shrub of *Zizyphus lotus* L. (Lam.)

Table (4): Microscopical measurements of the different elements of the organs under investigation in μ .

Item	Measurements		
	Length	Width	Height
Leaves			
Lamina			
Upper epidermis	14 - 20 - 37	20 - 22 - 24	60 - 63 - 68
Lower epidermis	13 - 19 - 34	10 - 12 - 13	23 - 23 - 35
Upper neural epidermis	40 - 51 - 68	17 - 19 - 21	33 - 35 - 37
Lower neural epidermis	25 - 36 - 57	14 - 16 - 18	19 - 20 - 22
Stomata	35 - 31 - 42	16 - 18 - 20	
Non- glandular trichomes	260 - 270 - 280	12 - 13 - 14	
Calcium oxalate			
Cluster		19 - 25 - 31	
Prism	14 - 15 - 16	8 - 9 - 10	
Palisade	24 - 32 - 36	5 - 6 - 8	
Vessel and vessel segments		16 - 18 - 23	
Secretion cell		55 - 75 - 78	
Petiole			
Epidermal cells	10 - 17 - 23	8 - 12 - 16	15 - 20 - 23
Stomata	11 - 18		
Non- glandular trichomes	250 - 265 - 275	11 - 12 - 13	
Calcium oxalate			
Cluster		14 - 28 - 38	
Vessels		11 - 16 - 23	
Secretion cell		62 - 85 - 110	
Young stem			
Epidermal cells	14 - 23 - 31	10 - 13 - 15	9 - 13 - 17
Stomata	21 - 23 - 25	13 - 14 - 15	
Calcium oxalate			
Cluster		20 - 27 - 33	
Prism	15 - 17 - 20	8 - 10 - 12	
Periicyclic fibres	286 - 475 - 670	5 - 8 - 16	
Vessels		10 - 14 - 18	
Tracheids	100 - 150 - 180	17 - 28 - 39	
Wood fibres	105 - 145 - 185	7 - 13 - 15	
Secretion cell		61 - 82 - 110	
Old stem			
Cork cells	34 - 45 - 50	17 - 20 - 23	7 - 9 - 11
Sclereid cells			

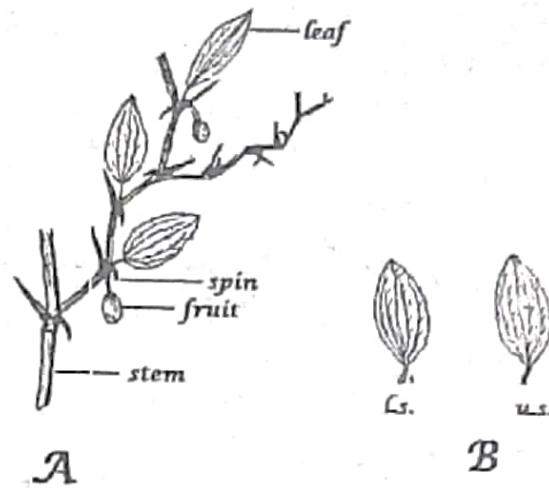


Fig. (4) : Macromorphology of *Zizyphus lotus* L. (Lam.)
 A. Fruiting branch (x 4), B. Leaves (x 3.5)

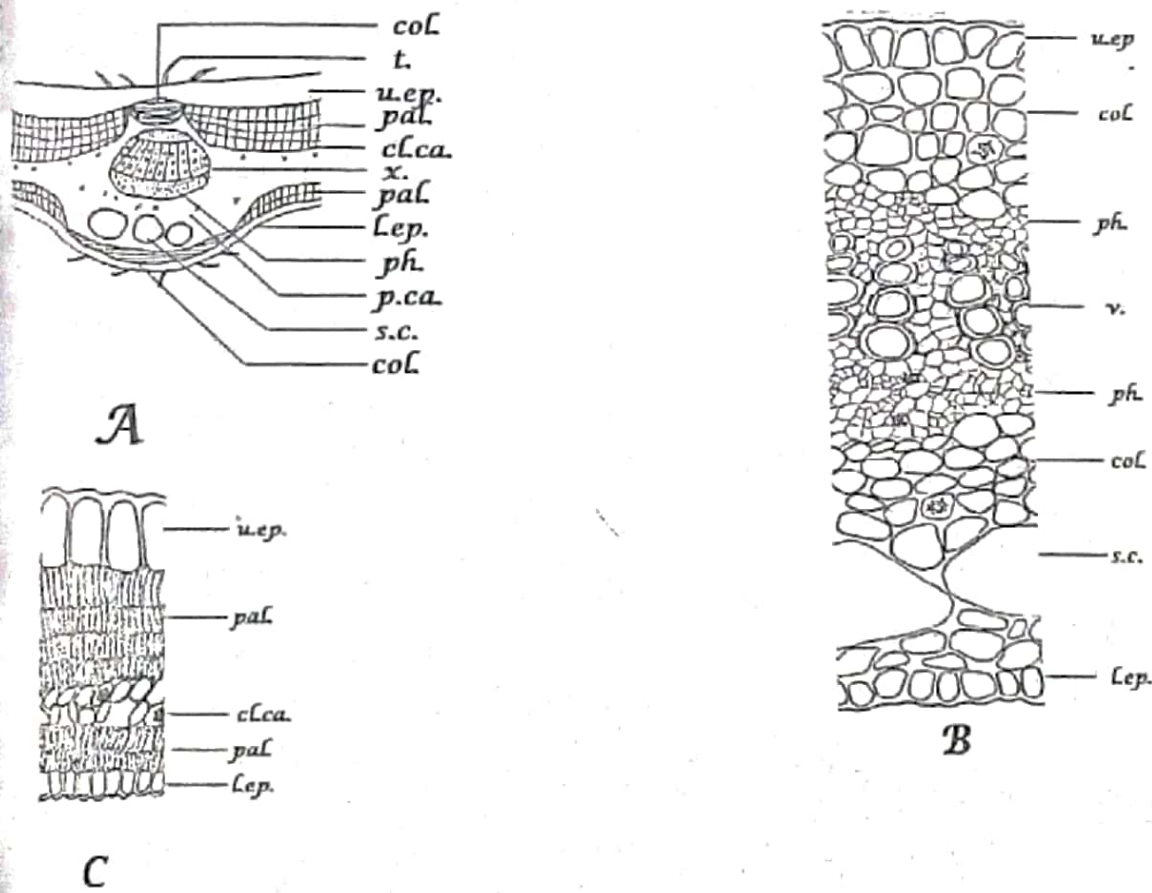


Fig. (5) : Micromorphology of the leaves of *Zizyphus lotus* L. (Lam.)

- A. Diagrammatic transverse section in the leaf (x 70)
 - B. Detailed transverse section in the midrib (x 285)
 - C. Diagrammatic transverse section in the lamina (x 220)
- u.ep., upper epidermis; l.ep., lower epidermis; t. trichome; f., fiber; col. collenchyma; pal. palisade; m.r., medullary ray; s.c., secretion cell; p.ca., prismatic calcium oxalate; cl.ca., cluster calcium oxalate; ph., phloem; v., vessel; x., xylem.

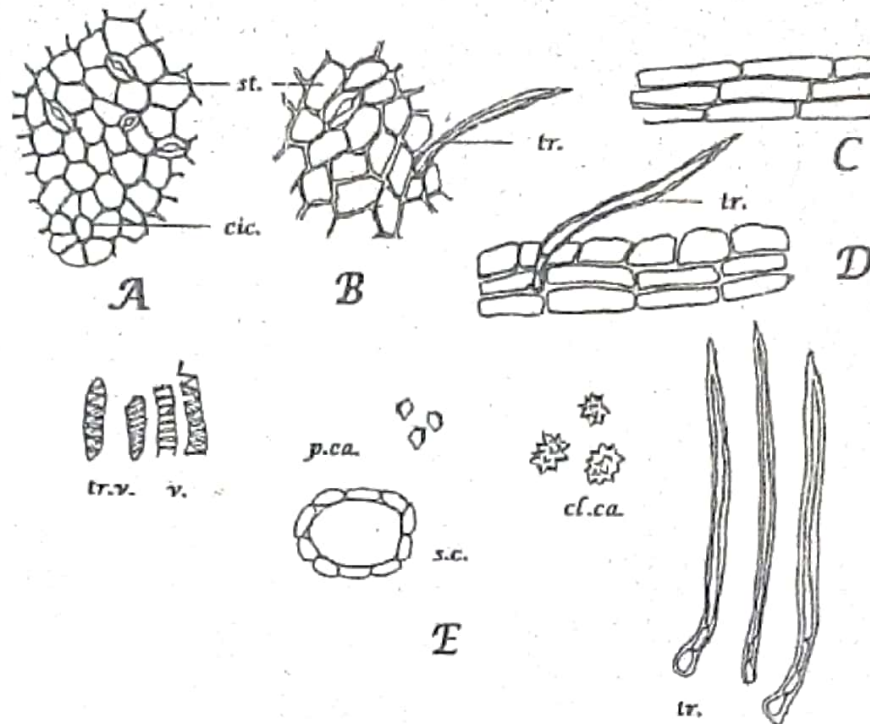


Fig. (6): Micromorphology of the epidermis and powder leaf of *Zizyphus lotus* L. (Lam.)

- A. Surface preparation of Upper epidermis (x 150)
- B. Surface preparation of Lower epidermis (x 150)
- C. Upper neural epidermis (x 150)
- D. Lower neural epidermis (x 150)
- E. Powdered leaf (x 250)

cic., cicatrix; t. trichome; s., stomata; s.c., secretion cell; p.ca., prismatic calcium oxalate; cl.ca., cluster calcium oxalate; v., vessel; tr.v., tr vessel.

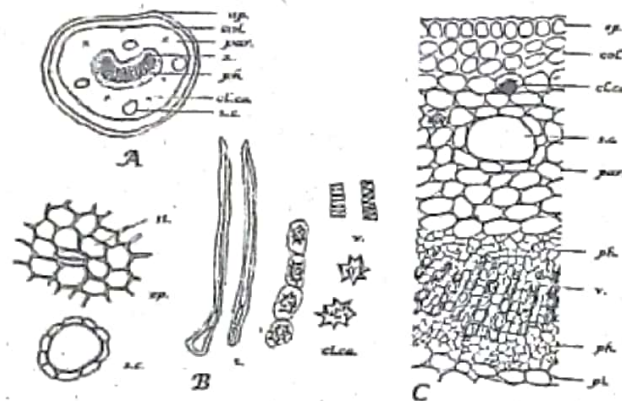


Fig. (7): Petiole of *Zizyphus lotus* L. (Lam.)

- A) Diagrammatic transverse section (x 70)
- B) Detailed transverse section (x 340)
- C) Surface preparation (x 340)
- D) Isolated elements (x 400)

ca.ox., calcium oxalate; cam., cambium; ck., cork; cl.ca.ox., cluster calcium oxalate; ep., epidermis; f., fiber; s.c., secretion cell; p.ca.ox., prismatic calcium oxalate; v., vessel. X., xylem.

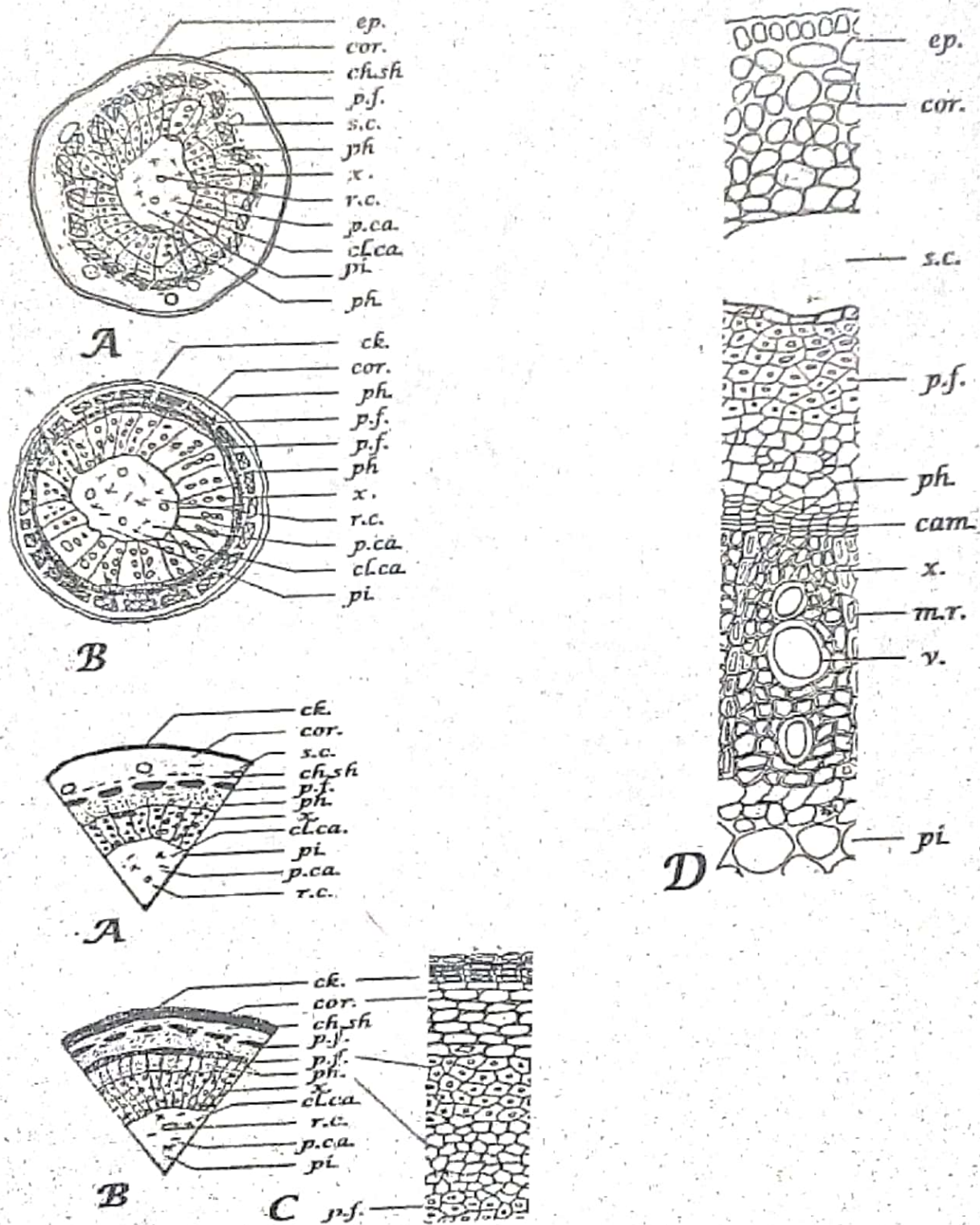


Fig. (8): Micromorphology of the Stem of *Zizyphus lotus* L. (Lam.).

A) Diagrammatic transverse section in young stem (x 45)

B) Diagrammatic transverse section in old stem (x 15)

C) Part of the detailed sector of the old stem showing differences from the young stem. (x 94)

D) Detailed transverse section in young stem (x 410)

cam., cambium; ck., cork; cl.ca., cluster calcium oxalate; p.ca., prismatic calcium oxalate; ep., epidermis; f., fiber; m.r., medullary ray; s.c., secretion cell; r.c., resin-cell; p.f., pericyclic fibre; ph.f., phloem fiber; pi., pith; v., vessel; x., xylem.

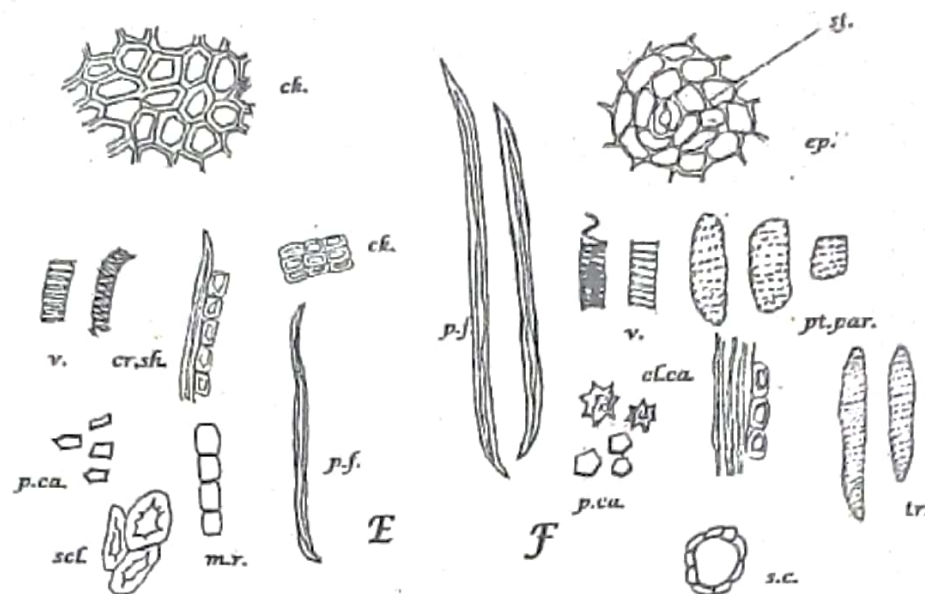


Fig. (9): Micromorphology of the epidermis and powder of the stem

- | | |
|--------------------------------------|---------|
| A) Cork of old stem | (x 615) |
| B) Surface preparation of young stem | (x 170) |
| C) Isolated elements of old stem | (x 250) |
| D) Isolated elements of young stem | (x 350) |

ck., cork; cl.ca., cluster calcium oxalate; p.ca., prismatic calcium oxalate; ep., epidermis; s.c., secretion cell; p.f., pericyclic fibre; ph.f., phloem fiber; v., vessel; x.

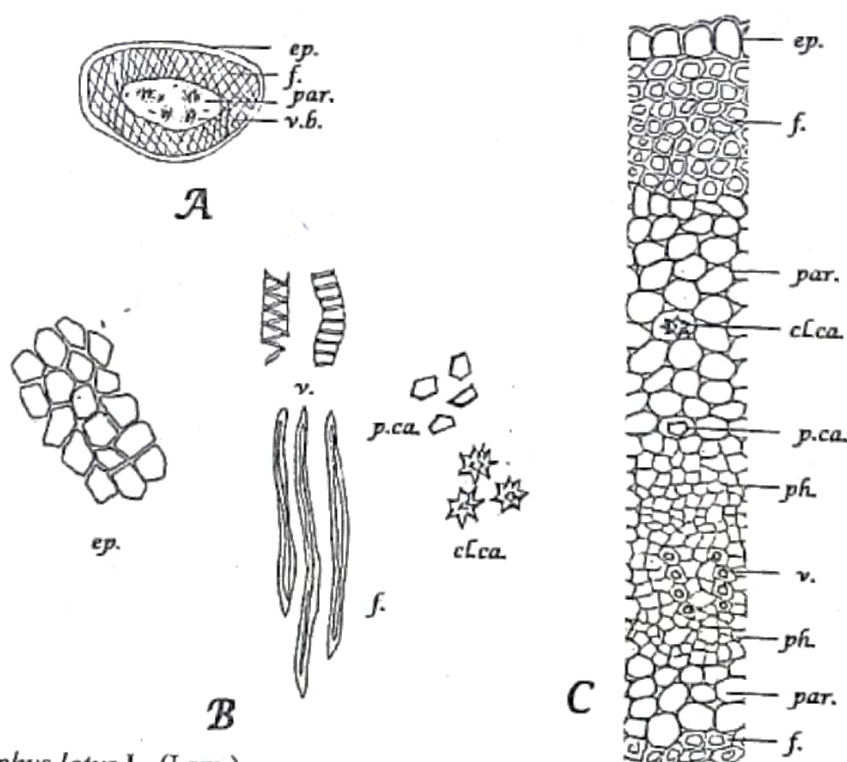


Fig. (10): Spine of *Zizyphus lotus* L. (Lam.)

- | | |
|------------------------------------|---------|
| A) Diagrammatic transverse section | (x 32) |
| B) Detailed transverse section | (x 270) |
| C) Surface preparation | (x 190) |
| D) Isolated elements | (x 470) |

ca.ox., calcium oxalate; p.ca.ox.; prismatic calcium oxalate; cl.ca.ox., cluster calcium oxalate; ep., epidermis; f., fiber; v., vessel. v.b., vascular bundle.

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دراسة عقاقيرية وبيولوجية لأوراق وسيقان نبات السدر البرى النامي في مصر

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يشمل هذا البحث وصف تفصيلي للصفات العيانية والمجهريّة لأوراق وسيقان نبات السدر البرى النامي في مصر وذلك ليسهل التعرف على هذه الأجزاء سواء كانت صحيحة أو على هيئة مسحوق . كما انه تم عمل مسح كميائي وبيولوجي للخالصة الكحولية.