A PHARMACOGNOSTICAL STUDY OF THE FRUIT OF *PASTINACA SATIVA* L. CULTIVATED IN EGYPT

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Received September 23, 1955

Pastinaca sativa L. is a common dietetic plant, its roots being used as a vegetable. Nevertheless, it is mentioned by many authors as having photo-sensitising properties, causing dermatitis when applied locally. Inflammation had been noticed on the back of a student after being rubbed by a handful of *Pastinaca sativa* plant while sunbathing, and developing after a few hours into a large blistered surface[1]. Belringer[2] mentioned that wild parsnip (*P. sativa*) as well as cultivated parsnip appeared to be the plant most commonly associated with photo-sensitivity. He also found that the flowers, leaves and stalks when applied to the skin caused erythema in 24 hours and vesication in 48 to 72 hours, followed in a few days by desquamation and faint pigmentation. He mentioned that the active principle is found in both the aqueous and the ethanolic extracts of the plant. Kuské[3] investigated the photo-dynamic properties of a group of ketonic compounds known as furocumarins and found these substances when applied to the skin in sunlight produced erythema after 48 hours followed by prolonged pigmentation.

Van Urk[4] analysed the fruits of the plant and stated that they were free from any skin-irritating substance, contrary to Wittstein[5] who stated that they contained a volatile base and a substance which causes skin irritation. Abu-Shady claimed that they had similar dermatic irritation properties to those of *Ammi majus*[6] and advised the cultivation of the former plant in Egypt as a source of another drug for the treatment of leukodermia. All the studies mentioned in the literature deal mostly with the root[7–9], and with the exception of the cursory knowledge of the fruit nothing has been mentioned of any other organ of the plant, or about the nature of the substance causing the phyto-photo-dermatitis.

This work deals with the cultivation of the plant in Egypt, records detailed macro- and microscopy of the fruit, and refers to the principle or principles, causing the phyto-photo-determatitis.

Botanical Study and Cultivation of the Plant

Pastinaca sativa L. is a biennial small shrub, ½–1 metre to 1½ metres in height: it belongs to the family Umbelliferæ, Subfamily Apioidæ, Tribe Peucedenæ[10,11]. The plant has been grown successfully in Egypt by sowing the fruits in several localities in Cairo and Giza, the best time for sowing being in the late autumn for the fruit, and early spring for the vegetative crop (Fig. 1).

Macroscopical characters of the fruit (Fig. 2)

The Cremocarp is broadly elliptical, lenticular in shape, with thin wings on the lateral sides. It splits into two mericarps which are dorsiventrally

compressed, and measure from 5 to 8 mm. in length and 4 to 6 mm. in breadth; they are notched at apex and base and crowned by a small pyramidal stylopod, terminating with the remains of style and stigma. The basal portion of the fruit is thin and membranous, being an extension of the pericarp and continuous with the lateral wings. The dorsal side of the mericarp shows five prominent ridges, the two lateral ones extending outwards to form two thin lateral wings. The intercostal regions, separating the primary ridges, show brown bands indicating the position of vittae which run from the top, but do not reach the base of the fruit. The commisural side shows two broader similar bands but the vittae here run only to three-quarters the length of the fruit. The seed is albuminous and fills the whole loculus of the mericarp except for small cavities at the lateral sides and at the base. Odour is slight, becoming more distinct on crushing, the taste is slightly bitter but distinctly pungent.

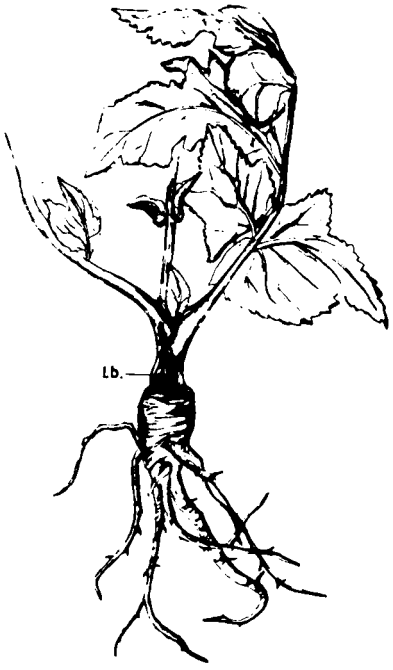

FIG. 1. Young plant of *Pastinaca sativa*, showing tuberous root and bases of radical leaves (l.b.) (× ¼).

Microscopical Characters of the Fruit

Epicarp (Fig. 3, A, B and C). There is a single layer of subrectangular, or tangentially elongated cells on the ribs, measuring from 36 to 80μ in length, 15 to 36μ in width and 11 to 29μ in height, with straight or slightly wavy anticlinical walls, containing small prismatic or cluster crystals of calcium oxalate measuring from 3 to 8μ in diameter. Stomata are present. These are mostly of cruciferous type. Trichomes are few, warty, conical, unicellular and non-glandular, measuring from 14 to 40μ in length and 15 to 22μ in width at the base. The cuticle is distinctly striated.

Mesocarp (Fig. 4, A, B and C). This consists of an outer zone of several layers of parenchyma cells, and an inner sclerenchyma zone of several layers of lignified fibre cells crossing each other. Some of these cells are elongated, with pointed ends and narrow lumen; others have no pointed ends, but with thick pitted walls and measuring from 43 to 75μ in length and 5 to 15μ in width (Fig. 5, A, B, C and D). Vittae are found traversing the mesocarp in the inner region of the outer parenchymatous zone and are usually abutting on, or even embedded in, the fibrous layer. Vascular bundles run through the ribs (Fig. 4, A) and

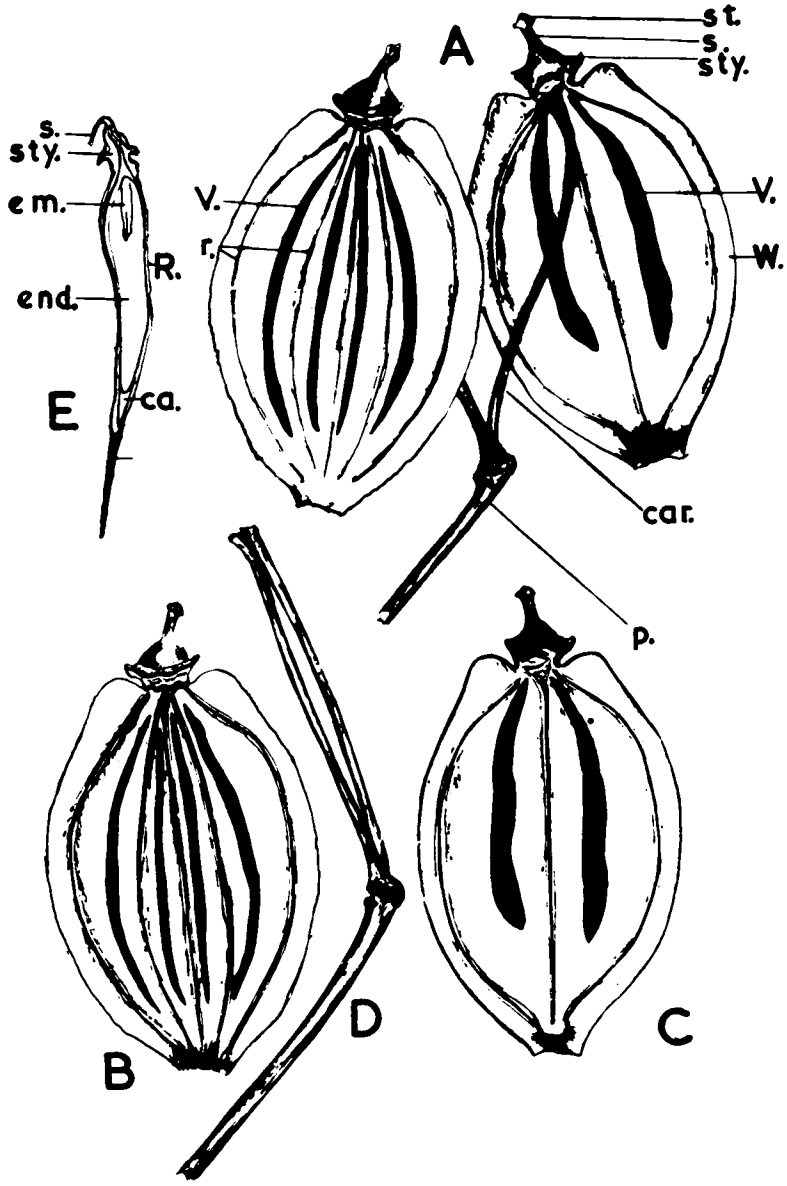

FIG. 2. Fruit of *Pastinaca sativa* L.: A., cremocarp splitting into 2 mericarps and attached to carpophore; B., mericarp from dorsal side; C., mericarp from commisural side; D., isolated carpophore attached to pedicel; E., M.L.S. in mericarp (all × 7); ca., cavity; car., carpophore; em., embryo; end., endosperm; p., pedicel; R., raphe; r., ridge; s., style; st., stigma; sty., stylopod; V., vitta; W., wing.

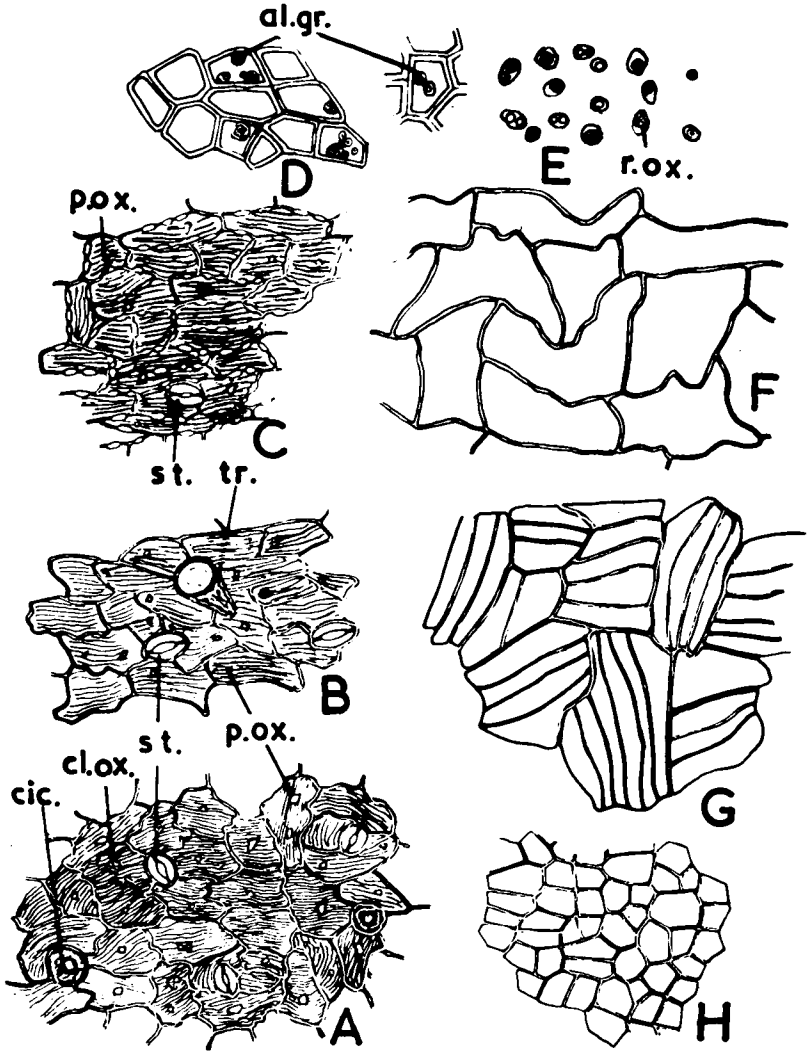

FIG. 3. A., Epicarp between the ridges; B. and C., epicarp on the ridges; D., endosperm cells; E., aleurone grains; F., endocarp; G., endocarp showing parquetry arrangement; H., seed-coat (all × 200); al.gr., aleurone grain; cic., cicatrix of hair; cl.ox., clusters of calcium oxalate; p.ox., prisms of calcium oxalate; r.ox., rosette of calcium oxalate; st., stoma; tr., trichome.

appear in transverse section as triangular or rounded structures on the outer side of the fibrous layer. Each bundle shows small phloem patches either on the outer side, or on the lateral sides of the xylem. This exhibits a few slender, annular and spiral vessels. The two vascular bundles of the wings show phloem patches on both the outer and inner sides. The fibrous layer from the dorsal and ventral sides of the fruit passes into each wing as a single band of fibrous cells, and joins there with the vascular

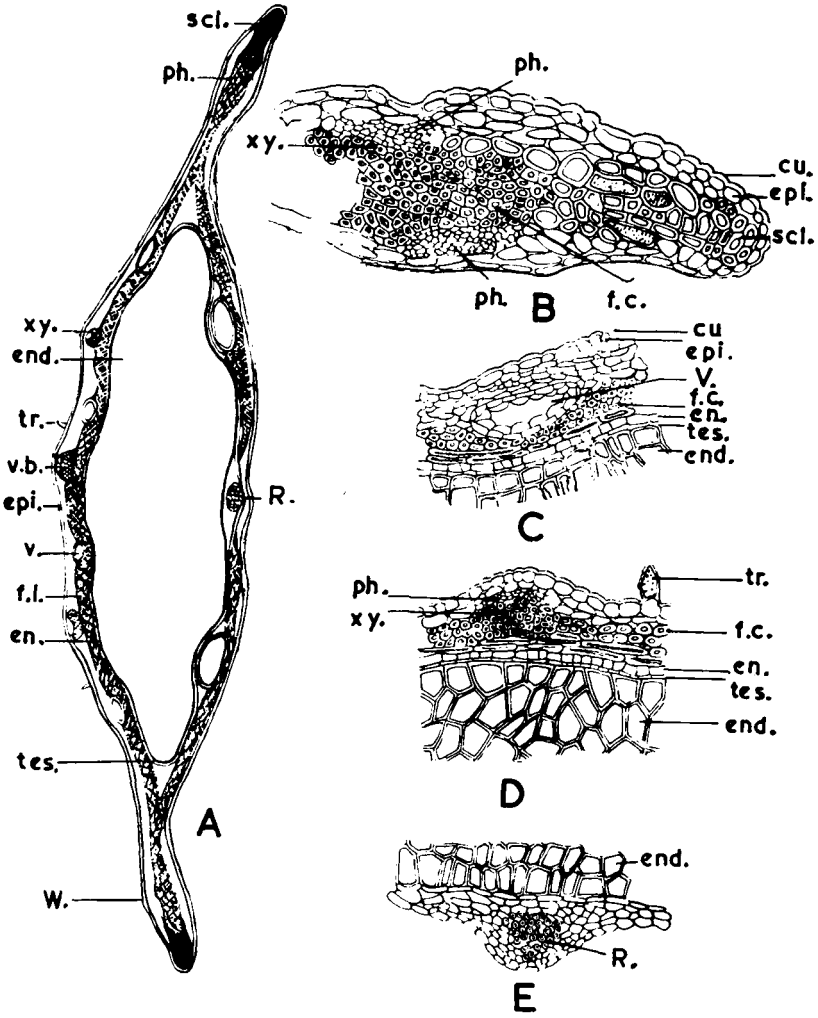

FIG. 4. A., Diagram of T.S. of mericarp (× 36); B., T.S. in wing of mericarp; C., same in region of dorsal vitta; D., same in one of ridges; E., in raphe (all × 120); cu., cuticle; en., endocarp; end., endosperm; epi., epicarp; f.c., fibrous cells; f.l., fibrous layer; ph., phloem; R., raphe; scl., sclereids; tes., testa; tr., trichome; V., vitta; v.b., vascular bundle; W., wing; xy., xylem.

bundle. The fibrous layer in the wing is thicker than in the other parts of fruit, and in addition to the fibrous cells, it shows sclereids and lignified, pitted, parenchymatous cells (Fig. 4, A and B).

Endocarp (Fig. 3, F and G). This is a single layer of polygonal, elongated cells with nearly straight or sinuate walls; measuring from 72 to 144μ in length, 36 to 80μ in width and 11 to 15μ in height; most of the cells are divided by parallel partitions, exhibiting parquetry arrangement. The endocarpal cells appear in transverse section as long narrow rectangular cells, showing occasional thin partitions.

Seed-Coat (Fig. 3, H). A single layer of small polygonal, isodiametric cells, with brownish walls, measuring from 11 to 36μ in length, 9 to 25μ in width and 4 to 7μ in height. In transverse section, it appears to be

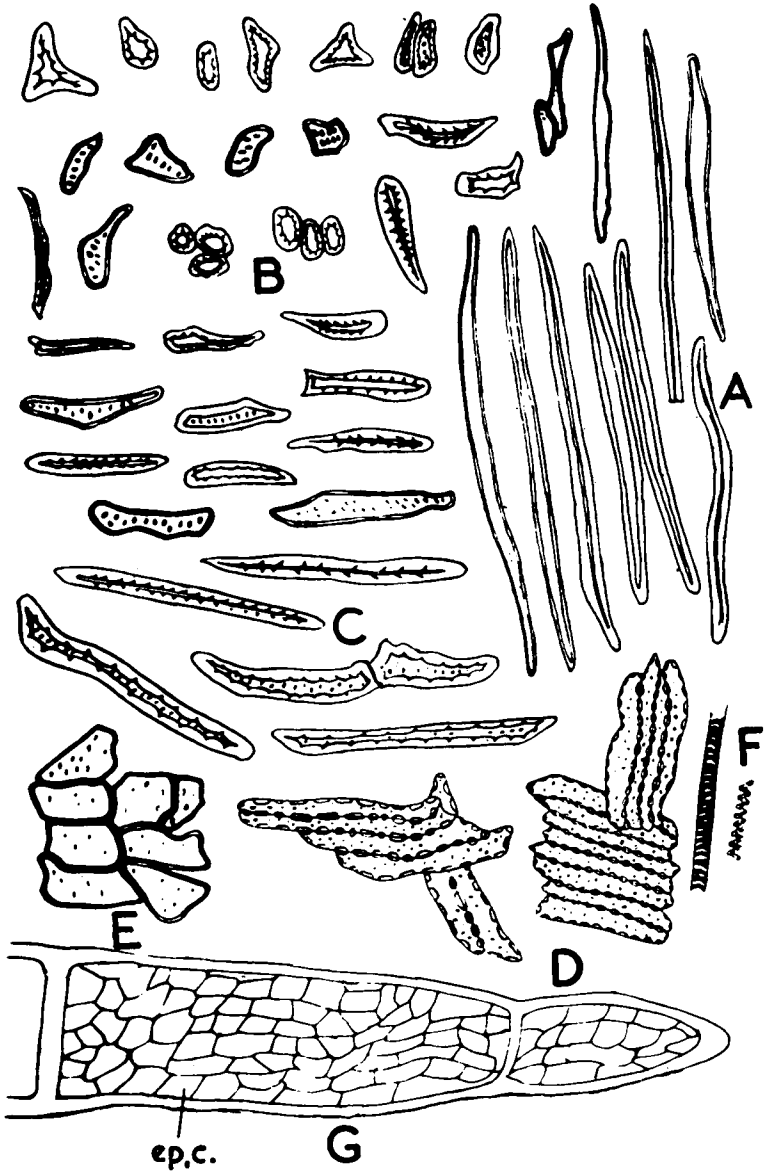

FIG. 5. Isolated elements from mesocarp of fruit; A., elongated fibrous cells with pointed ends; B., sclereids from wing; C., fibrous cells with non-pointed ends and thick pitted walls; D., fibrous cells crossing each other; E., lignified pitted parenchymatous cells from wing; F., vessels; G., part from the top of a vitta (all × 220); ep.c., epithelial cell.

formed of narrow rectangular cells, which are collapsed in many places; the seed-coat widens in the region of the raphe, where a slender vascular bundle is found.

Endosperm (Fig. 4, A and D). This is formed of polygonal, isodiametric cells, with thick cellulosic walls; measuring from 6 to 16μ in diameter, and containing fixed oil, and several oval or rounded aleurone grains. These contain distinct micro-rosette crystals of calcium oxalate (Fig. 3, E), 3 to 10μ in diameter. These are mostly larger than those found in other umbelliferous fruits.

POWDER

The powder of Pastinaca fruit, is pale yellowish-brown, with distinct characteristic terebinthinate odour and a slightly bitter, very pungent taste. It is characterised microscopically by:

1. Fragments of epicarpal cells, with striated cuticle and showing occasional small calcium oxalate crystals, cruciferous stomata and non-glandular, warty, unicellular, conical trichomes or their scars.
2. Lignified, elongated, fibrous cells from the mesocarp (Fig. 5); some having pointed ends and thick walls, others with non-pointed ends and thick pitted walls, crossing each other.
3. Sclerenchymatous isodiametric cells in groups or isolated from the wing of the fruit.
4. Fragments of brown vittae, generally adhering to fibrous cells.
5. A few annular and spiral small vessels.
6. Endocarpal cells, mostly showing parquetry arrangement.
7. Endosperm cells with polygonal outlines and thick cellulosic walls; and containing aleurone grains with micro-rosette crystals of calcium oxalate.

CHEMICAL STUDY

Both Klein[12] and Van Urk[4] have stated that the fruit contains an ethereal oil which contains butyric acid, acetyl ester and yields also methanol by steam distillation. Klein[12] attributed the skin irritation to a non-volatile alkaloid, pastinacin. But the present work shows that:

(i) The sublimate of the fruits of *Pastinaca sativa* L. is free of crystals, and gives a purplish-brown colour with concentrated sulphuric acid;

(ii) The fruit yields 12 per cent. ash and 0·9 per cent. acid-insoluble ash;

(iii) The decoction is clear when hot, but it becomes turbid on cooling and gives positive tests for reducing sugar, unsaturated compounds, and catechol tannin;

(iv) The fruits, when successively extracted with light petroleum, ether, chloroform and ethanol, yield 12·68; 1·78; 13·61 and 7·36 per cent. of dried extracts respectively calculated with reference to the air dried fruits;

(v) Three crystalline constituents were isolated, and were found in the following percentages: xanthotoxin 0·1 per cent., imperatorin 0·17 per cent. and bergapten 0·38 per cent.; the fruits containing in addition about 9·9 per cent. of fixed oil, as well as resinous substance, colouring

matter and chlorophyll. Light petroleum is the best solvent for the extraction of these principles from the fruit because their isolation from the ethanolic extract is much more tedious and lengthy with more extractive and colouring matter.

The crystalline constituents when investigated reacted similarly to those listed by Fahmy and Abu-Shady[6] who also isolated xanthotoxin (ammoidin), imperatorin (ammidin) and bergapten (majudin) from the fruits of *Ammi majus* in the following percentages: 0·5, 0·3 and 0·02 respectively.

These constituents are used in the treatment of leucodermia[13]. As the fruits of *Pastinaca sativa* were found to contain the same constituents but in different percentages, viz. 0·1, 0·17 and 0·38 respectively, and the leaves were found to contain only xanthotoxin[14] in the percentage of 0·08 (*cf.* those of *A. majus* which are totally free of these crystalline constituents[15]) the fruits and leaves of *P. sativa* can be used as a substitute for *A. majus*. They could be used also as a source for the preparation of these active constituents; particularly bergapten, of which the fruits contain about twenty times the quantity found in *A. majus*.

Summary

1. The macro- and microscopical characters of the fruit of *Pastinaca sativa* L. are described.

2. The fruit was found to contain xanthotoxin 0·1 per cent., imperatorin 0·17 per cent., bergapten 0·38 per cent., about 10 per cent. of fixed oil, a resinous substance, colouring matter and chlorophyll.

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