c. Umbellulone apparently caused pulmonary circulation to be blocked.

d. Umbellulone causes vaso-dilation of the heart and large vessels.

e. The minimal lethal dose of umbellulone in dogs is about 0.178 cc. per Kg. of body weight, death being due to failure of the respiration followed in a few minutes by stoppage of the heart.

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FURTHER STUDIES ON PSYLLIUM SEED.*[1]

BY HEBER W. YOUNGKEN.

In an article entitled "Studies on Commercial Psyllium Seeds" which appeared in Vol. XXI, No. 12, pages 1265–1273 of the JOURNAL OF THE AMERICAN PHARMACEUTICAL ASSOCIATION, the writer discussed some earlier studies he had made on various commercial varieties of Psyllium. Since that time he has examined new lots of Psyllium seeds imported from Spain and France. He has also studied plants with mature fruit and seed bearing spikes from growers of commercial Psyllium seeds in France and Spain, and has compared these materials with authentic

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herbarium specimens in local herbaria and with standard descriptions of the species involved by Post (1), Reichenbach (6) and Hegi (2), thus enabling identification of the plants. Commercial seeds of *Plantago psyllium* L. and of *Plantago arenaria* Waldst. *et* Kit. [*P. ramosa* (Gilibert) Aschers] were planted in pots in a greenhouse and plants reared therefrom which compared favorably with descriptions of these species in the literature.

The seeds from a large number of recent commercial lots of Psyllium labeled French and Spanish Psyllium were also compared with seeds obtained from the fruits of the identified mature plants furnished by French and Spanish growers of Psyllium and the sources of four different kinds of seeds definitely established. It was found that most of the samples (in original packages with a Spanish label) labeled "Spanish Psyllium" were yielded by *Plantago psyllium* L., a few by *Plantago arenaria* Waldst. *et* Kit. and a number (with English labels) by *Plantago lanceolata* L., the last species being also the source of German Psyllium, also that most of the more recent "French Psyllium" samples were yielded by *Plantago arenaria*, a number by *Plantago psyllium* while occasional lots contained mixtures of *P. arenaria*, *P. psyllium* and *P. Cynops* or of *P. arenaria* and *P. Cynops*. It has also been ascertained that the seeds of *Plantago lanceolata L.*, previously described by the writer (4) are torrefied abroad and mixed with untorrefied seed of *Plantago arenaria* and offered in this combination to the American trade as French or Black Psyllium Seed.

Fig. 1.—*Plantago psyllium* L. Upper portion of leaf and flowering stem × 5/13.

Fig. 2.—*Plantago arenaria* W. *et* K. Terminal portions of leaf and flowering branches × 5/13.

A binocular dissection microscope was employed in the examination of the external morphology of the seeds. Cross sections were then made through the region of the cotyledons and raphe, mounted in glycerin and alcohol as well as in water and then studied under the compound microscope. The mucilage swelling factors were ascertained by the method outlined in a previous paper by the author (3).

From the studies made, the following descriptions are given for three authentic seeds of caulescent species of *Plantago* variously found in lots of French and Spanish Psyllium seeds.

PLANTAGO PSYLLIUM SEED.

The seeds examined were hemianatropous, silky to the touch, ovate to ovate elongate, larger at one extremity than the other, concavo-convex, light brown to chestnut brown, dark brown along the margin, very shining, mostly from 1.28 mm. to 2.72 mm. in length, rarely up to 3 mm., and from 0.6 to 1.12 mm. in breadth, the convex dorsal surface smooth, somewhat transparent and showing beneath the seed coat a light brown longitudinal area, representing the straight embryo, extending nearly the length of the seed, the hypocotyl being in the broader end and the cotyledons in the narrower end, the concave surface showing a large cavity, limited by the border which is raised as a cushion. The curved edge of the cushion forms a pointed, obtuse or right angle with the internal face of the cavity. In the center of the base of this cavity is an oval white scar representing the hilum. Occasionally, the raphe is present attached to one edge of the seed. A transverse fissure or groove is usually visible on the convex side and edges of most of the seeds. This is nearer the broader than the narrower extremity, and just over the point of union of hypocotyl and cotyledons. On the broader end of the seed may be seen the dark brown marks of the fusion of the seed coat at the end of the groove. The seeds are silky to the touch. 100 seeds weighed 0.072 Gm.

Fig. 3.—*Plantago Cynops* L. × 5/13.

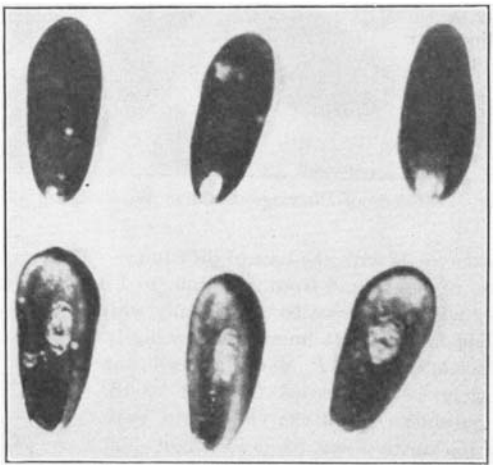

Fig. 4.—Seeds of *Plantago psyllium* L. × 10.

Upon soaking the seed in water, the seed coat swelled and the seed became enveloped with a transparent, colorless mucilage. When the swelling phenomenon is observed under the microscope, it is noted that the epidermal cells elongate and their outer and radial walls become transformed to mucilage. The mucilage swelling factor in 24 hours varied from 12 to 16, and in 48 hours was up to 35.

Histology.—Transverse sections of *P. psyllium* seed cut through the central region possess a reniform outline and present for examination a spermoderm, endosperm and embryo. The spermoderm shows (1) an outer epidermis of mucilaginous epidermal cells with more or less obliterated walls in glycerin mounts, the radial and inner walls of which swell and disintegrate to form a clear mucilage upon irrigation of the mount with water, (2) a pigment layer with brown amorphous content. Directly beneath the spermoderm lies the broad endosperm, composed of irregular shaped, thick-walled cells with walls of reserve cellulose and intercellular-air-spaces. The outer layer of this region consists of palisade cells which range from 15μ to 34μ, rarely

to about 40μ in height. The contents of these endosperm cells consist of aleurone grains and fixed oil.

The straight embryo lies in the center of the endosperm and consists of 2 elongated, plano-convex cotyledons and a cylindrical hypocotyl. The cells of the embryo contain aleurone grains of varying shape up to 8μ in diameter and fixed oil. Three plerome bundles extend through the mesophyll of each of the cotyledons.

Fig. 5.—Seeds of *Plantago arenaria* W. *et* K. × 9.

PLANTAGO ARENARIA SEEDS.

The seeds observed differed from those of *P. psyllium* by the following characters:

They were darker brown to maroon in color, ovate-oblong to elliptical, less shiny, often dull, and rough and reticulate on the outer surface, with a median transverse groove or fissure or dent more distinct and usually nearer an equal distance from the two extremities than in *P. psyllium* and *P. Cynops* seeds. The ventral or concave surface shows averagely a broader cavity than in *P. psyllium* seed and the edge forms a somewhat flattened cushion instead of a rounded one. Moreover, as François (5) has shown, this edge forms a sharp indented angle with the base of the cavity. The size of *P. arenaria* seeds ranged from 1.6 mm. to 3 mm. in length and from 0.96 mm. to 1.5 mm. in breadth. The hilum at the bottom of the cavity was pale brown to occasionally whitish. 100 seeds weighed 0.0842 Gm. Their mucilage swelling factor in 24 hours was averagely 8, whereas that of *P. psyllium* seed was averagely 14 and varied from 12 to 16. The palisade cells of the endosperm were from 15μ up to about 52.5μ in height.

PLANTAGO CYNOPS SEEDS.

This seed is larger than those of the other two species, ranging from 3 to 4 mm. in length and up to 2 mm. in breadth. It is ovate-oblong, enlarged at one extremity and strongly contracted at the other, dull brown to dull greenish brown, with a transverse depression nearer the broader than the narrower end. It is convex on the dorsal surface with a broad, deep concavity on the ventral surface which is open at the contracted end. The edges are curved into the cavity. A whitish hilum is found at the base of the ventral cavity. 100 seeds weighed 0.1649 Gm. The palisade cells of its endosperm were from 15μ to 48.75μ in length.

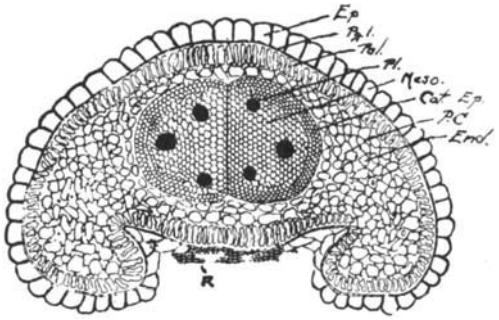

Fig. 6.—Transverse section of *Plantago arenaria* seed × 40.

Ep, epidermis and Pgl, pigment layer of seed coat; Pal, palisade layer of endosperm; End, inner region of endosperm which contains fixed oil and aleurone but no starch; PC, protoplasmic connections between inner endosperm cells; Cot. Ep., epidermis of cotyledon; Meso, mesophyll of cotyledon; Pl, plerome bundle; R, raphe.

The mucilage swelling factor of one lot taken after 24 hours was 1 and after 48 hours 1.5. The writer anticipates additional work on the mucilage swelling factor of this seed as more material becomes accessible.

CONCLUSIONS.

1. It is ascertained that good French and Spanish Psyllium Seeds of the current American market are yielded by *Plantago psyllium* and *Plantago arenaria*.

2. *Plantago psyllium* seed is superior to *Plantago arenaria* seed in mucilage swelling capacity.

3. Most of the French Psyllium seed is now yielded by *Plantago arenaria*, less by *P. psyllium* while occasional lots contain mixtures of *P. arenaria*, *P. psyllium* and, rarely, *P. Cynops*.

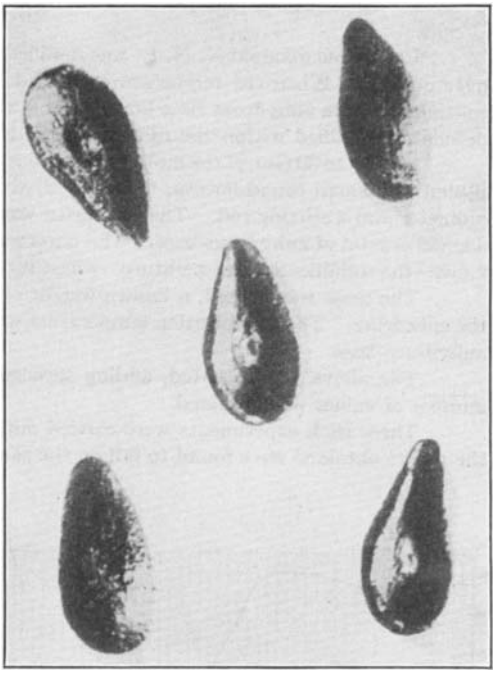

Fig. 7.—Seeds of *Plantago Cynops* L. × 6.5.

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CRYSTALLINE FORMS OF EPHEDRINE ALKALOID.*

BY E. E. MOORE AND D. L. TABERN.

Ephedrine alkaloid as it appears on the market was found to exist in two forms, one containing about 95 per cent of the alkaloid, and five per cent of water, while the other assays nearly 100 per cent. Although the former is crystalline, while the latter is usually an oil or a rock-like solid, assays of the latter indicated that the more nearly the composition approached the anhydrous, the higher the melting point.

Emde (1) reported an ephedrine hydrate containing about 10 per cent of water which would correspond to one mol. of water for each mol. of ephedrine. However, samples of hydrated ephedrine obtained from different manufacturers, or prepared by recrystallizing the alkaloid from water, were assayed in this laboratory and found always to contain about 5 per cent of water. This would correspond to a hemi-hydrate, rather than a hydrate.

The purpose of this work was to prove that the hemi-hydrate is the usual hydrate of ephedrine, to determine the melting point of anhydrous ephedrine, and to ascertain the effects of different amounts of water on this melting point.

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