

Accidental plant poisoning and identification of *Datura* seed

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Abstract

Recently an accidental plant poisoning occurred in Niigata. In order to identify the actual cause of poisoning, we analyzed the remaining sample, which caused the poisoning. Based on the patient's symptoms such as a dilatation of the pupil, thirst, and others, the poisoning was recognized as being caused by an anticholinergic substance. Furthermore, compressed-reniform shape and the buff color of the sample suggested the origin to be derived from the seeds of *Datura* (Solanaceae). The studies were carried out by comparing the external features and anatomical characteristics of the seeds with four comparative materials, namely *D. innoxia*, *D. metel*, *D. stramonium*, and *D. stramonium* f. *inermis*. These four materials could be distinguished from each other externally based on the differences in the color and texture, and anatomically by the structure of the sclerenchymatous epidermal cells. In conclusion, the poisoning was confirmed to be caused by an accidental intake of the seeds of *D. innoxia*.

Key words plant poisoning, *Datura* seed, *Datura innoxia*, plant anatomy, anticholinergic activities.

Abbreviations co, collenchyma; cot, cotyledon; ep-sc, sclerenchymatous epidermal cell(s); esp, endosperm; muc, mucilage; nuc, nucellus; p, parenchymatous cell; ph, phloem; rot, root; sd, seed coat; xy, xylem.

Introduction

The tendency of consuming more natural vegetables or medicinal herbs is growing, since many people have been paying more attention to the natural health care. On the other hand, the information about several natural herbs is insufficient or misunderstood, therefore, an accidental poisoning has been occurring frequently.

In 1997, a woman in Niigata was poisoned by taking a plant material obtained from her acquaintance. She felt thirsty, somnolence, and lapsed into delirium, which may be caused by some anticholinergic substances. From her symptoms described above and the careful observation on the remains of ingesta, she seemed to be poisoned by the compressed and reniform seeds of *Datura* plants of Solanaceae.¹⁾ In order to clarify the poisoning reason, as well as for a

quick reference of identification, a detailed study on *Datura* seeds were thought to be necessary.

For genus *Datura*, Satina *et al.*²⁾ proposed a taxonomic status, and it had been accepted for a long time. Recently, Huxley³⁾ rearranged the classification of this genus, and some of the species classified under synonymes. Timmerman⁴⁾ was the first to contribute to anatomical study on the seeds of *Datura*. However, with lack of clear and sufficient figures and the detailed analysis, it was not possible to apply literature results to this case. Hence, *Datura* seeds of four taxa were collected and a comparative morphological study was carried out in order to determine the cause of poisoning. And the identification of *Datura* seeds was confirmed by morphological and anatomical examination.

I. A case report :

A 78-year-old woman with clouding of conscious-

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ness was carried to the Niigata City General Hospital by an ambulance on Oct. 28, 1997. Dilatation of the pupil, thirst, somnolence, and delirium were observed. Her blood pressure was 161/92 mmHg and pulse rate 83 beats/min. The results of the examination of urine, cerebrospinal fluid, and blood were as follow; urine: CRP 0.2 mg/dl, Urobilinogen positive, relative density 1.011, yellow in color, and presence of crystalline phosphate salts, cerebrospinal fluid: cell counts 4, protein 48 mg/dl, saccharides 60 mg/dl, blood: PCO₂ 42.1 mmHg, PO₂ 72.4 mmHg, HCO₃⁻ 28.5 mEq/l, base-excess 4.7 mEq/l, total protein 5.9 g/dl, Na 135 mEq/l, Cl 102 mEq/l. Patient's clouding consciousness was recovered one day later, and no special sequel was observed.

II. Morphological analysis :

1. Materials: A portion of the unused seeds sample obtained from the patient is preserved in the Museum of Materia Medica, Toyama Medical and Pharmaceutical University (TMPW No.19081). This material is described as sample in the text. Comparative *Datura* seeds of four taxa viz. *D. innoxia*, *D. metel*, *D. stramonium* and *D. stramonium* f. *inermis*, are also kept in TMPW, as listed in appendix.
2. Methods: External observations of the materials are performed visually with a magnifier. Their anatomical structures were observed by taking on ordinary transection of the materials with the use of Optical Microscope (Olympus AH-3). Plant taxonomy and anatomical terms followed according to Huxley³⁾ and Timmerman,⁴⁾ respectively.

Table I The morphological characteristics of the sample and the seeds of *Datura* species.

	Sample*	<i>D. innoxia</i>	<i>D. metel</i>	<i>D. stramonium</i>	<i>D. stramonium</i> f. <i>inermis</i>
External Characteristics					
Color	buff	buff-light brown	light brown	pale brown-black	pale brown-black
Shape	reniform	reniform	ear-shaped, rarely reniform	reniform	reniform
Surface Texture	smooth	smooth	smooth	rough, netlike wrinkled	smooth, netlike wrinkled slightly
Diameter of					
Major Axis (mm)**	4.1-4.9	4.1-5.0	3.7-4.9	3.0-4.0	3.1-3.8
Minor Axis (mm)***	3.2-4.0	3.2-4.6	3.9-4.6	2.4-3.2	2.7-3.0
Thickness (mm)	1.1-1.5	1.1-1.7	1.1-1.5	1.2-1.6	1.4-1.7
Weight (mg)	10.0-16.0	12.0-19.0	12.0-16.0	4.2-9.8	6.1-8.9
Anatomical Characteristics					
Sclerenchymatous epidermis					
Shape at the abaxial side	undulate	undulate	undulate	round along with nucellus	round along with nucellus
Configuration at the apex of each cell	protrusions	protrusions	protrusions and flat plane	protrusions	protrusions
Color of cell wall	yellow	yellow	yellow	brown to dark brown	brown to dark brown
Diameter tangentially (μm)	90-92	60-110	60-86	49-120	55-100
Maximum Diameter (μm)	300-350	230-440	280-450	120-390	120-300
Nucellus Cells					
Tangential Diameter (μm)	10-62	8-60	10-68	11-70	17-51
Radial Diameter (μm)	13-21	8-32	11-44	9-21	12-16

*Sample refers the seed obtained from the patient by which she got poisoned.

**Major axis corresponds to the maximum length of the sample.

***Minor axis corresponds to the length of which is perpendicular to the Major's.

Results

1. Morphological characteristics of the sample (Table I):

External observation (Fig. 1) : The sample is buff in color, compressed and reniform in shape, and sulcated along its margin. Their texture is smooth. The diameter of the seeds is 4.1-4.9 mm×3.2-4.0 mm (in major axis and its perpendicular axis). The thickness is 1.1-1.5 mm, and the weight 10.0-16.0 mg. They do not show characteristic odor.

Anatomical structures (Figs. 2, 3) : Seed coat consists of epidermis and parenchyma. The epidermis outlines undulate at the abaxial side, and can also be recognized as the composition of sclerenchyma cells with hourglass shape. Each sclerenchymatous epidermal cell bears several protrusions at its apex, and is covered with mucilage substances. Cells of endosperm contain globoids generally as Timmerman⁴⁾ described. The structures mentioned above well agree with Timmerman's. Nucellus is single layer.

2. Detailed morphology of four references (Table I, Figs. 1-3)

Datura innoxia MILL. (Synonym³⁾ of *Datura*

meteloides DC.) : External observation (Fig. 1) : Seeds are buff to light brown in color, compressed and reniform in shape, and sulcated along its margin. Surface texture is smooth. The diameter of the seeds is 4.1-5.0 mm×3.2-4.6 mm. The thickness is 1.1-1.7 mm, and the weight 12.0-19.0 mg.

Anatomical structures (Figs. 2-3) : The epidermis outlines undulate at the abaxial side, and is composed by sclerenchymatous epidermal cells with hourglass shape. Each cell is found with several protrusions at the apex. The nucellus is observed beneath the seed coat, but rarely obliterated. Cells of endosperm contain globoids, which are negative to iodine-starch test and soluble to dilute acetic acid.

D. metel L. : External observation: Seeds are light brown in color, compressed and ear-shaped or rarely reniform in shape, and sulcated along its margin. Surface texture is smooth. The diameter of the seeds is 3.7-4.9 mm×3.9-4.6 mm.

Anatomical structures: The epidermis outlines undulate at the abaxial side in the same manner as *D. innoxia*. Some of the cell walls of sclerenchymatous epidermal cells are flat at the apex, while the others are found with protrusions as observed in *D. innoxia*.

D. stramonium L. (Synonym³⁾ of *D. tatula* L.) :

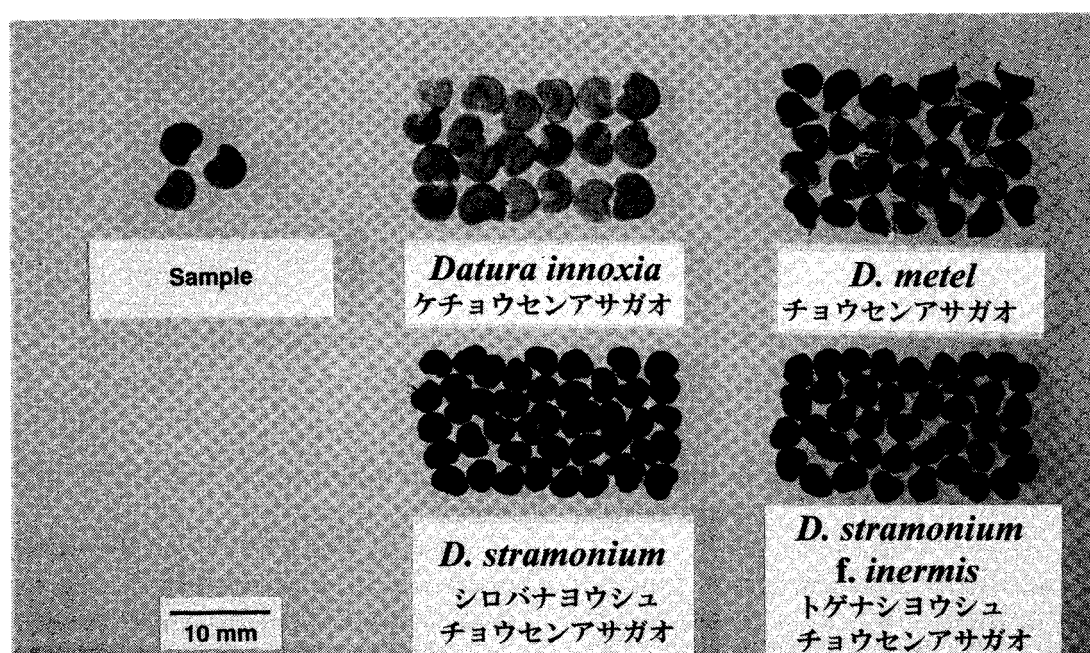


Fig. 1 Photographs of the sample and the seeds of *Datura* species.

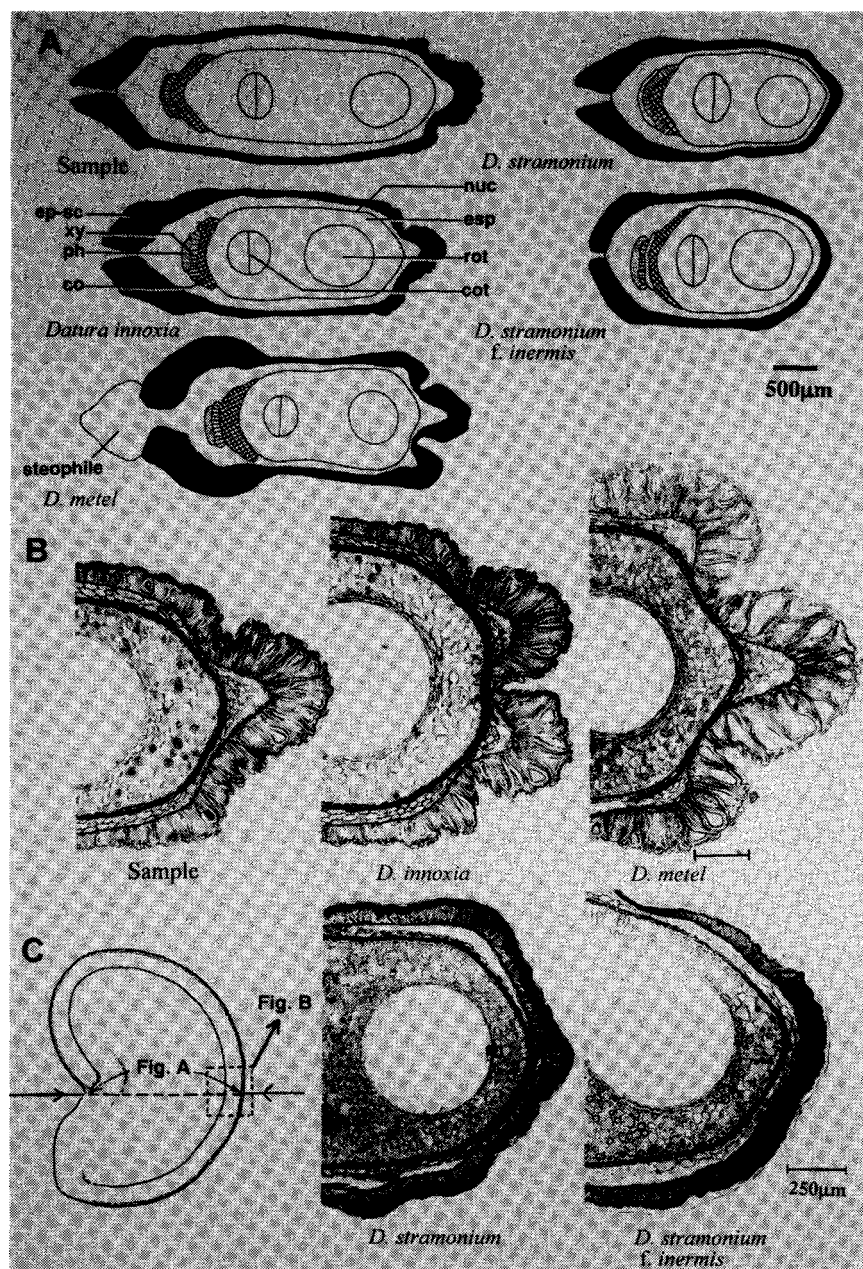


Fig. 2 Diagrammatic illustrations of the transections (A) and the photographs of abaxial side (B) of the sample and the seeds of the *Datura* species.

A line on the figure (C) corresponds to the cutting parts of these materials of (A) and (B).

External observation : Seeds are pale brown to black in color, flattened and reniform in shape. Surface texture is rough with netlike wrinkles.

D. stramonium L.f. *inermis* (JUSS.) HUPKA : External observation : The external morphology of the seeds is very similar to those of *D. stramonium*, especially regarding the color and shape. Surface

texture is smooth rarely with slightly netlike wrinkles.

The anatomical characteristics of the tissues mentioned above agreed with Timmerman,⁴⁾ especially in the shape of undulating epidermis and protrusions in the epidermal cell. However, in our result, the sclerenchymatous epidermal cells were often found to

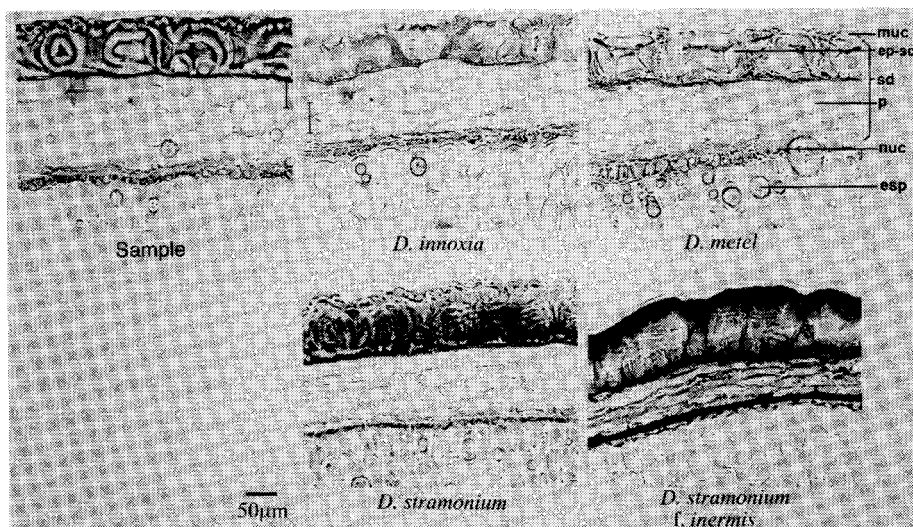


Fig. 3 Photographs of the transections of the sample and the seeds of *Datura* species.

be flat at the apex in *D. metel*.

Depending on these characteristics, the 4 taxa of *Datura* species could be classified by the color, texture, and by the shape and structure of the epidermis and its cells.

3. Identification and Result

The key for identification is shown in Table II. According to this key, the sample was distinguished by the external buff color, smooth texture on the

surface (Table II, 1), shape of the undulating outline of the epidermis, and presence of the protrusions at the apex of sclerenchymatous epidermal cell (Table II, 2). Depending on these characteristics, the sample was identified as the seeds of *D. innoxia*.

Discussion

Datura species are well-known medicinal plants

Table II Key for identification of the seeds of *Datura* species

<Macroscopics>

1. Buff to light brown in color, reniform to ear-shaped in shape,
Texture smooth—(1)*..... *D. innoxia*, *D. metel*
1. Pale brown to black in color, reniform in shape.
 2. Texture rough, netlike wrinkled obviously.
..... *D. stramonium*
 2. Texture smooth, netlike wrinkled slightly.
..... *D. stramonium* f. *inermis*

<Microscopics>

3. Epidermis outlined round along with the shape of nucellus, and contains brown pigments.....*D. stramonium*, *D. stramonium* f. *inermis*
3. Epidermis outlined undulate especially at the abaxial side. Colored pigments does not appeared
 4. Sclerenchymatous epidermal cell always bears protrusions on the apex.—(2)*
..... *D. innoxia*
 4. Sclerenchymatous epidermal cell bears protrusions and flat plane on the apex.
..... *D. metel*

*Numbers in the parenthesis correspond to the contents of the text in the identification and result.

that found in the temperate regions all over the world.^{2,3)} In spite of its medicinal uses, they may cause a fatal accident in the case of an overdose usually taken as a natural vegetables due to the misunderstanding. Their leaves and seeds have been used for mydriatics or spasmolytics, due to anticholinergic activity of the chemical constituents, such as scopolamine (hyoscine) or hyoscyamine.

Regarding its toxicity and narcotic effects, the production of *Datura* and related drugs should be governed by the law. In spite of such harmful effect, it is easy to obtain both seeds and whole plants, because they grow wild and are often cultivated for flowers. Recently, the aerial part or the seed of *Datura* is used as a kind of "Legal Drug", and is traded openly. Therefore, such troubles like this case seem to be expected.

Although chemical constituents in the plants responsible for poisoning can be analyzed, it may be difficult to identify the species that is attributed to immediate cause. In such a case, the anatomical identification, which we have been applying to prove the botanical origin of crude drugs, may be worthy and necessary to clarify the poisoning cause, especially from the small amounts of samples. The alkaloid content²⁾ and its ratio between scopolamine and hyoscyamine^{2,5,6)} in the *Datura* seeds are seemed to be varied inter- and infra-specifically, therefore, the anatomical determination can contribute for the correct identification of the species.

Datura seeds are macroscopically distinguished from each other by the differences in the features of their surface, such as the color or texture, and further confirmed microscopically by the appearance of the undulating epidermis and the configuration of sclerenchymatous epidermal cells at the apex (Table II). Consequently, the poisoning was proven to be caused by an accidental intake of *D. innoxia* seeds.

Moreover, a request and its response for this identification study were made through the Internet mailing list of Poison-Net.⁷⁾ Although the communication through the net may involve the illegal obtaining, abuse, misunderstanding of the information and other problems, it can be useful for the specialist who is concerned in the emergency and critical care medicine, legal medicine, forensic chemistry, and related

disciplines. Such information is also meaningful in the viewpoint of health and medical information regarding natural poison and medicine.

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和文抄録

新潟で中毒事故が発生した。この中毒の真の原因を明らかにするため、我々は患者が摂取した残りの食物試料を分析した。患者の諸症状、即ち、瞳孔散大、口渇等から、この中毒は抗コリン性物質により引き起こされたものと考えられた。また、患者が摂取した残りの試料は、扁平かつ腎臓形で黄土色を呈していたことから、ナス科 *Datura* 属の種子が原因と考えられた。

そこで、比較材料4種即ち、*D. innoxia*, *D. metel*, *D. stramonium*, *D. stramonium* f. *inermis* とともに、組織形態を含む比較形態学的研究を行った。これら4分類群 (taxa) の種子は外部形態的には色と質感、内部形態的には表皮の構造の違いによって区別しえた。結論として、この中毒は *D. innoxia* の種子の誤摂取によって引き起こされたものと確証した。

References

- 1) Ishikawa, S.: "Seeds/Fruits of Japan," (ed. by the Ishikawa S.), Publishing committee of Shigeo Ishikawa's encyclopedia, Tokyo, p. 202, 1994.
- 2) Avery, A. G., Satina, S., and Rietsena, J.: "Blakeslee: The Genus *Datura*," (Ed. by Verdoorn, F.), The Ronald Press Company, New York, pp. 16-47, 1959.
- 3) Huxley, A., Griffiths, M., and Levy, M.: "Dictionary of Gardening," Vol. 2, The Macmillan Press Ltd., London, pp.19-20, 1992.
- 4) Timmerman, H. A.: *Stramonium* and other species of *Datura*: A comparative study of their seeds. *Pharm. J.*, **118**, 742-746, 1927.
- 5) Vitale, A. A., Acher, A., Pomilio, A. B.: Alkaloids of *Datura ferox* from Argentina. *J. of Ethnopharmacology*, **49**, 81-89, 1995.
- 6) Hiraoka, N., Tashimo, K., Kinoshita, C., and Hiro'oka, M.: Genotypes and alkaloid contents of *Datura metel* varieties. *Biol.*

Pharm. Bull., **19**, 1086-1089, 1996.

7) URI <http://maple-www2.med.hiroshima-u.ac.jp/>

Appendix : The list of seeds of *Datura* species and their specimen number and the place of collection are shown. All seeds studies in the present paper were mature. (The specimen numbers with the asterisks correspond to their specimen with synonyms.)

Datura innoxia MILL. (synonyms of *Datura meteloides* DC.*) : N. Fushimi et S. Yamaji 569, 567*; Medicinal Plant Garden, Takeda Chemical Industries Ltd., Kyoto(abbreviated to **Tak** in the following, collector), S. Yamaji et H. Fujino 18901*, Medicinal

Plant Garden, Toyama Medical and Pharmaceutical University, Toyama (abbreviated to **Toy** in the following) ; Medicinal Plant Garden, Faculty of Pharmaceutical Sciences, Hokuriku University, Kanazawa (abbreviated to **Hok** as in the following), T. Tomimori *s.n.* ; *D. metel* L. : N. Fushimi 571 (Tak), S. Yamaji et Fujino 18902 (Toy), *D. stramonium* L. (synonyms of *Datura tatula* L.**): N. Fushimi et S. Yamaji 566, 570** (Tak) ; T. Tomimori *s.n.* (Hok) ; M. Kubo *s.n.*, Faculty of Pharmaceutical Sciences, Kinki University, Higashi-Osaka ; *D. stramonium* L.f. *inermis* (JUSS.) HUPKA. : N. Fushimi et S. Yamaji 568 (Tak).