

CHAPTER IV

RESULTS AND DATA

Crude drug randomization

1. Thian-tung-khao were randomly purchased. It was found that 8 kinds of Thian were available in a number of traditional drugstores. They are Thian Dam, Thian Dang, Thian Khaao, Thian Khaoplueak, Thian Taatakataen, Thian Yaowapanee, Thian Sattabut, and Thian Klethoi. Only one kind of Thian that is not available in the market is Thian Taakob.

2. Study of 5 samples of each kind of Thian obtained from 5 traditional drugstores was carried out. Comparisons of the morphology (Fig.1-8), TLC (Fig.9-16) and UV spectra (Fig.17-24) of each crude drug revealed that the 5 samples are all similar in these characters.

3. Information obtained from the above studies can be used to identify 7 kinds of Thian i.e. Thian Dam, Thian Dang, Thian Khaao, Thian Khaoplueak, Thian Taatakataen, Thian Yaowapanee, and Thian Klethoi.

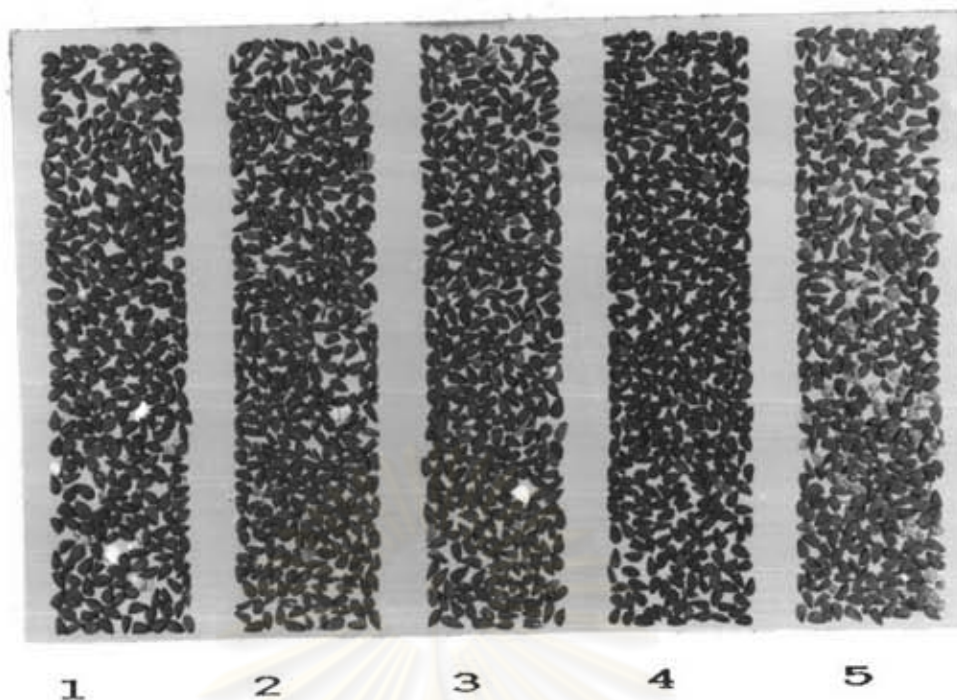


Fig.1 Morphology of the crude drugs of 5 samples of Thian Dam

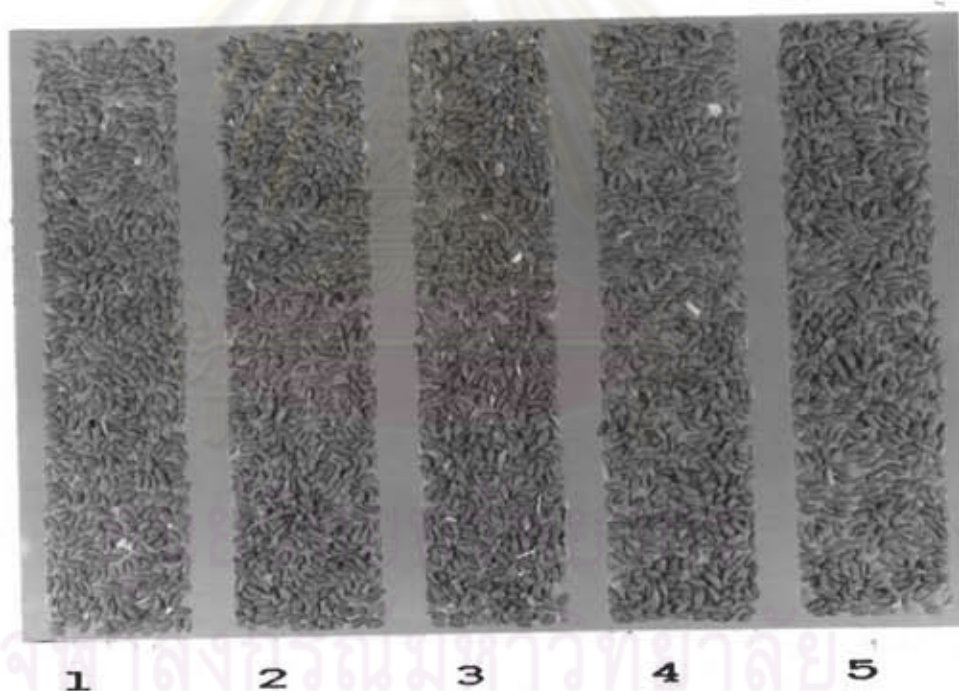


Fig.2 Morphology of the crude drugs of 5 samples of Thian Dang

1 = sample from Tai-an-chan

2 = sample from Vej-ja-pong

3 = sample from Bho-pra-dit

4 = sample from Choao-krom-peur

5 = sample from Ngun-heng-chan





1 2 3 4 5

Fig.3 Morphology of the crude drugs of 5 samples of Thian Khaao



1 2 3 4 5

Fig.4 Morphology of the crude drugs of 5 samples of Thian Khaoplueak

1 = sample from Tai-an-chan

2 = sample from Vej-ja-pong

3 = sample from Bho-pra-dit

4 = sample from Choao-krom-peur

5 = sample from Ngun-heng-chan

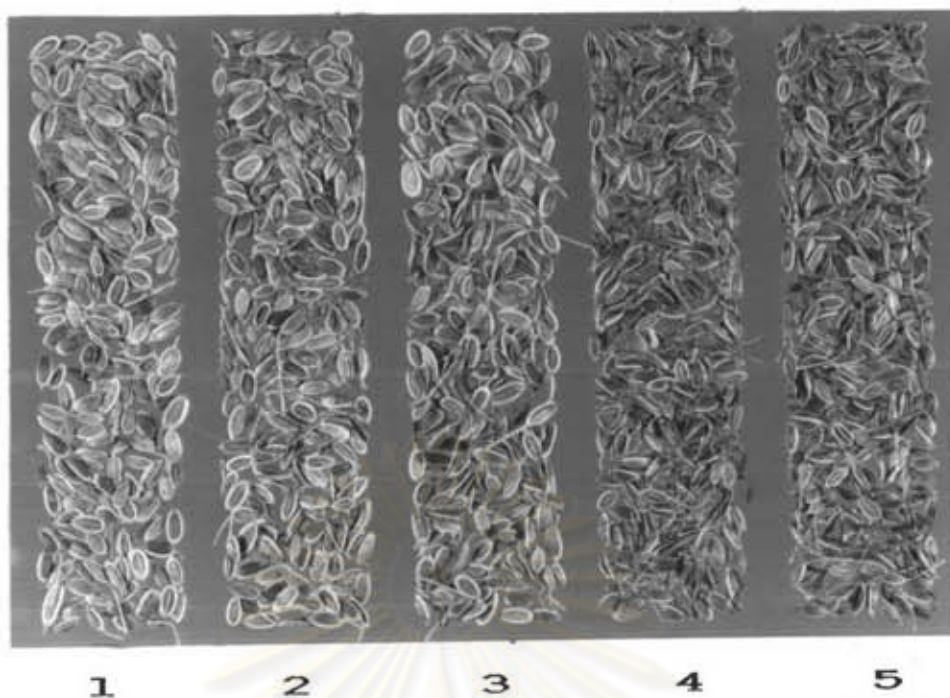


Fig.5 Morphology of the crude drugs of 5 samples of Thian Taatakataen

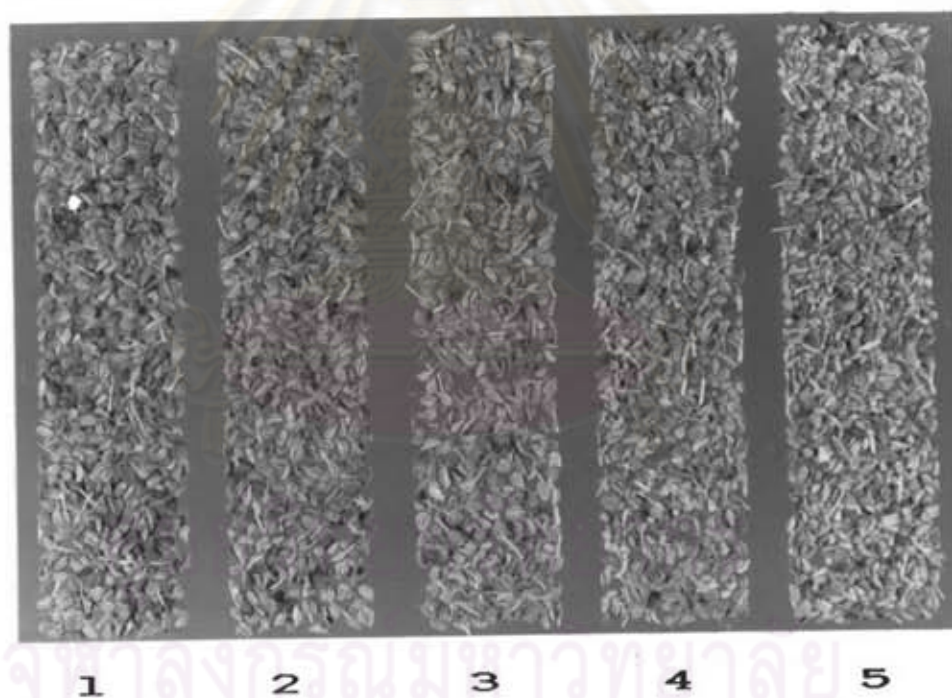


Fig.6 Morphology of the crude drugs of 5 samples of Thian Yaowapanee

1 = sample from Tai-an-chan

2 = sample from Vej-ja-pong

3 = sample from Bho-pra-dit

4 = sample from Choao-krom-peur

5 = sample from Ngun-heng-chan

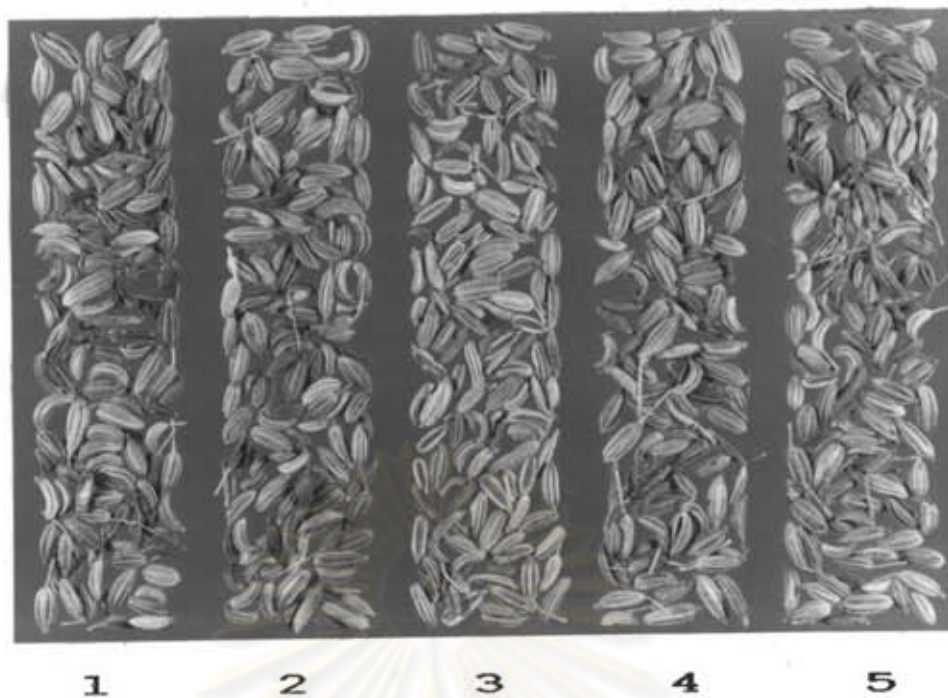


Fig.7 Morphology of the crude drugs of 5 samples of Thian Sattabut

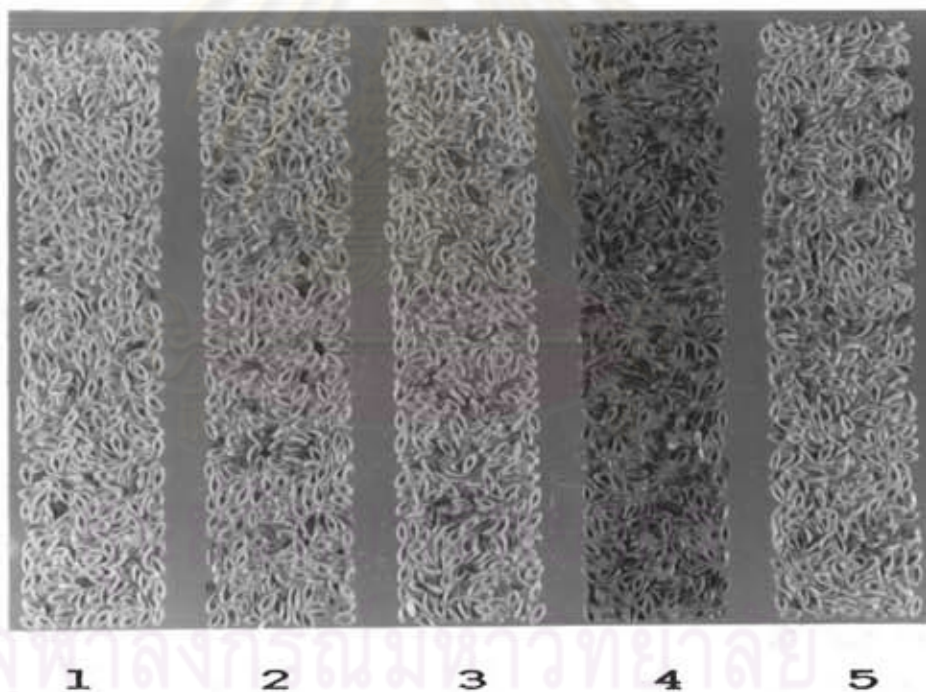


Fig.8 Morphology of the crude drugs of 5 samples of Thian Klethoi

1 = sample from Tai-an-chan

2 = sample from Vej-ja-pong

3 = sample from Bho-pra-dit

4 = sample from Choao-krom-peur

5 = sample from Ngun-heng-chan

5 = sample from Ngun-heng-chan

3 = sample from Bho-pra-dit 4 = sample from Chao-krom-peur

1 = sample from Tai-an-chan 2 = sample from Vej-ja-pong

Fig.10 TLC characters of the extracts of 5 samples of Thian Dang

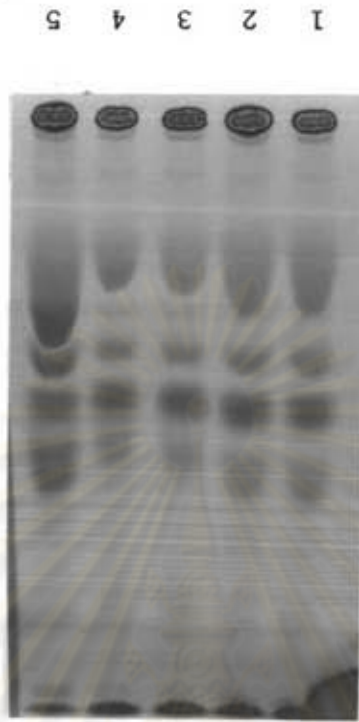
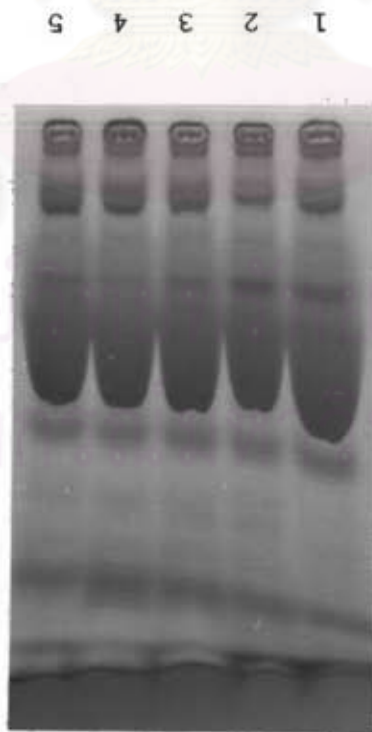


Fig.9 TLC characters of the extracts of 5 samples of Thian Dam



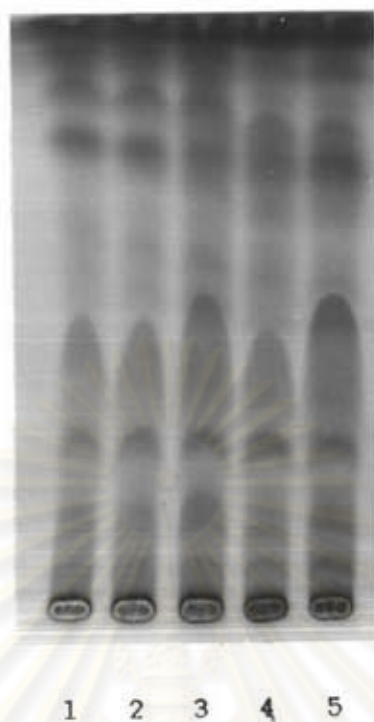


Fig.11 TLC characters of the extracts of 5 samples of Thian Khaao

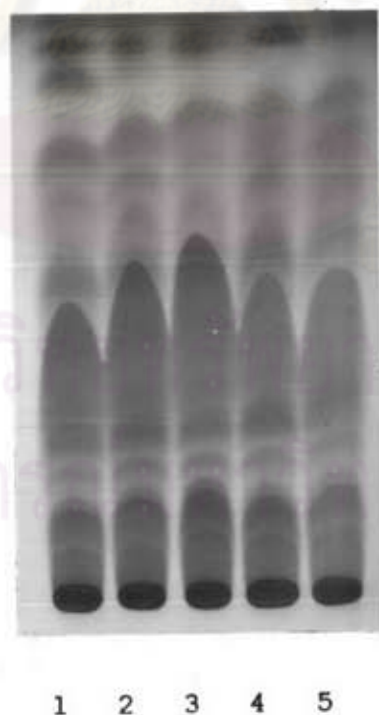
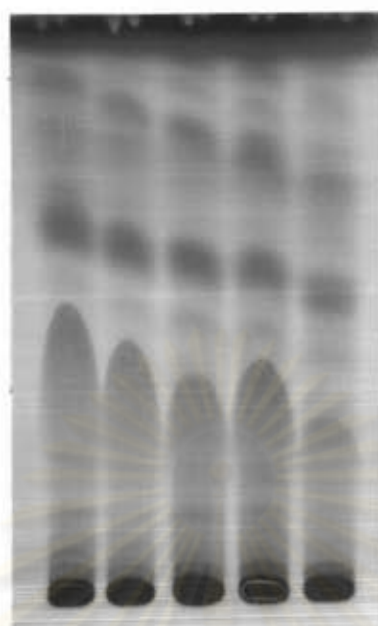


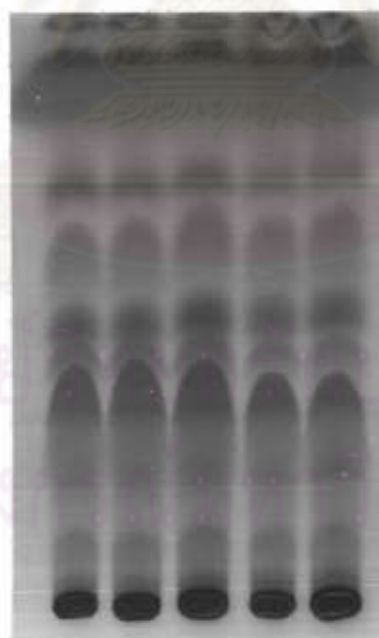
Fig.12 TLC characters of the extracts of 5 samples of Thian Khaoplueak

- | | |
|--------------------------------|---------------------------------|
| 1 = sample from Tai-an-chan | 2 = sample from Vej-ja-pong |
| 3 = sample from Bho-pra-dit | 4 = sample from Choao-krom-peur |
| 5 = sample from Ngun-heng-chan | |



1 2 3 4 5

Fig.13 TLC characters of the extracts of 5 samples of Thian Taatakataen



1 2 3 4 5

Fig.14 TLC characters of the extracts of 5 samples of Thian Yaowapanee

- | | |
|--------------------------------|---------------------------------|
| 1 = sample from Tai-an-chan | 2 = sample from Vej-ja-pong |
| 3 = sample from Bho-pra-dit | 4 = sample from Choao-krom-peur |
| 5 = sample from Ngun-heng-chan | |

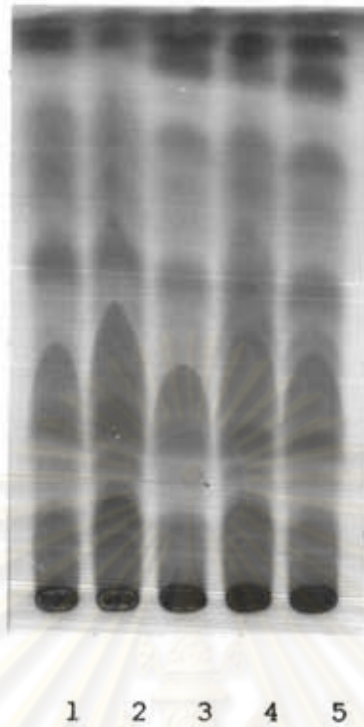


Fig.15 TLC characters of the extracts of 5 samples of Thian Sattabut

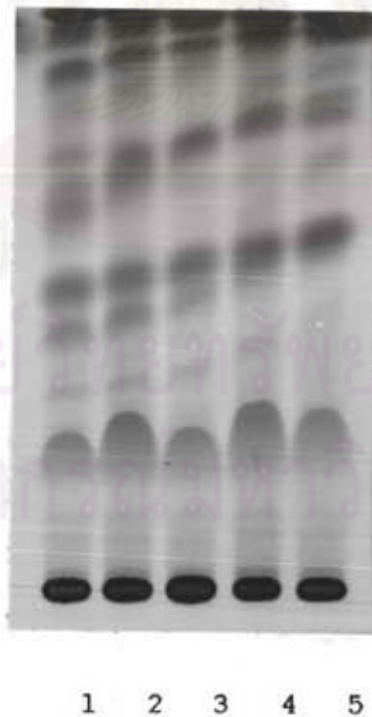
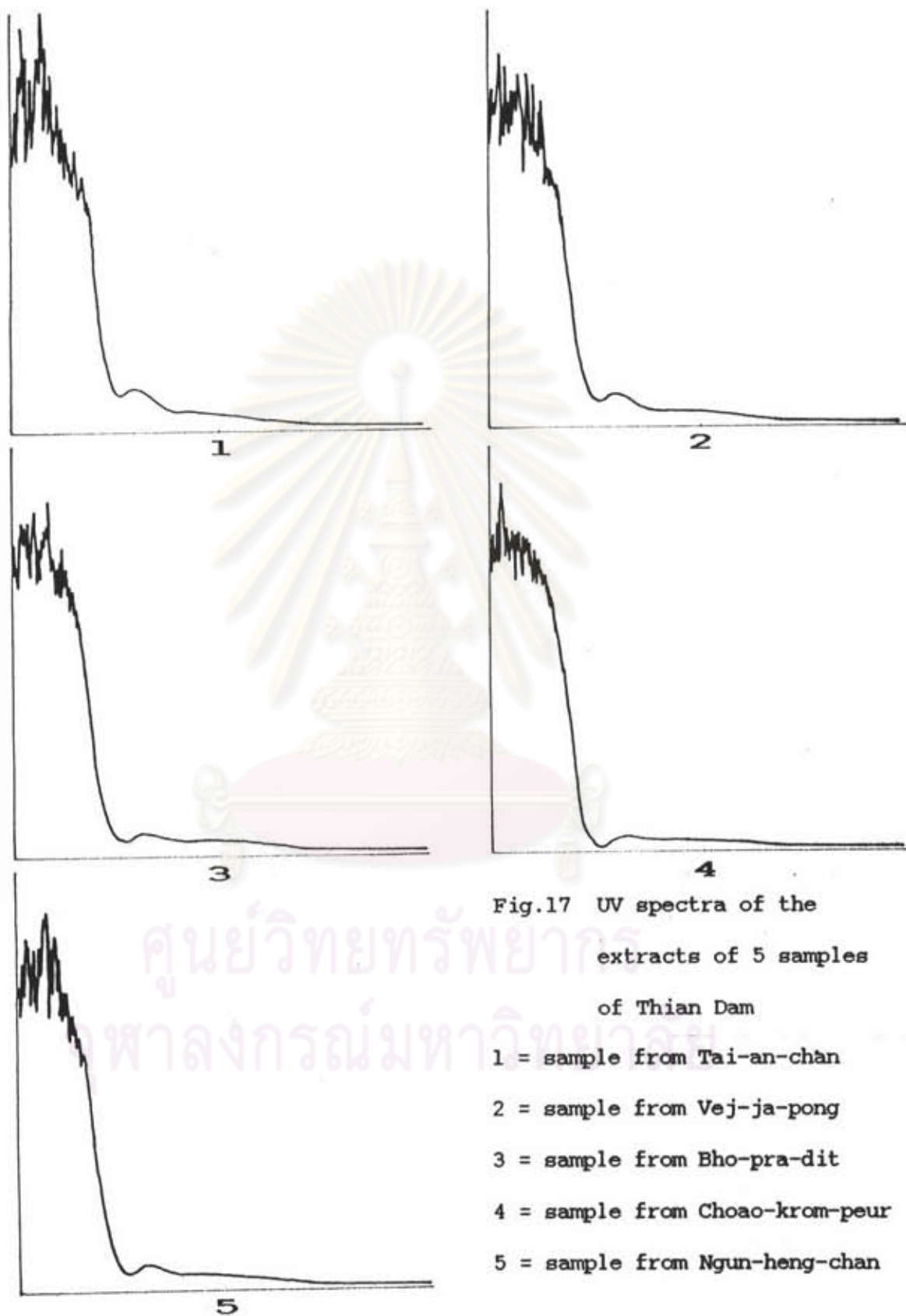
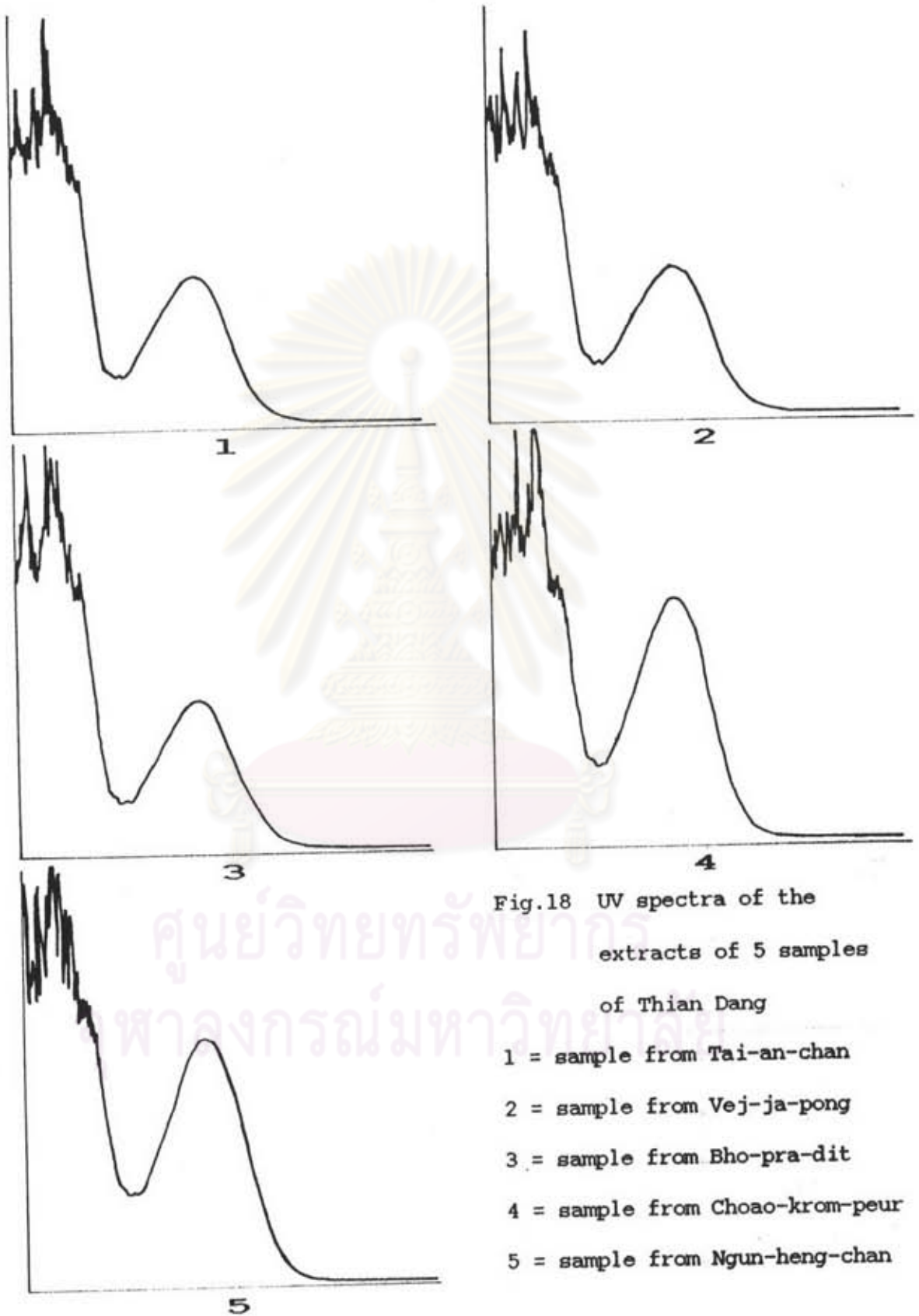
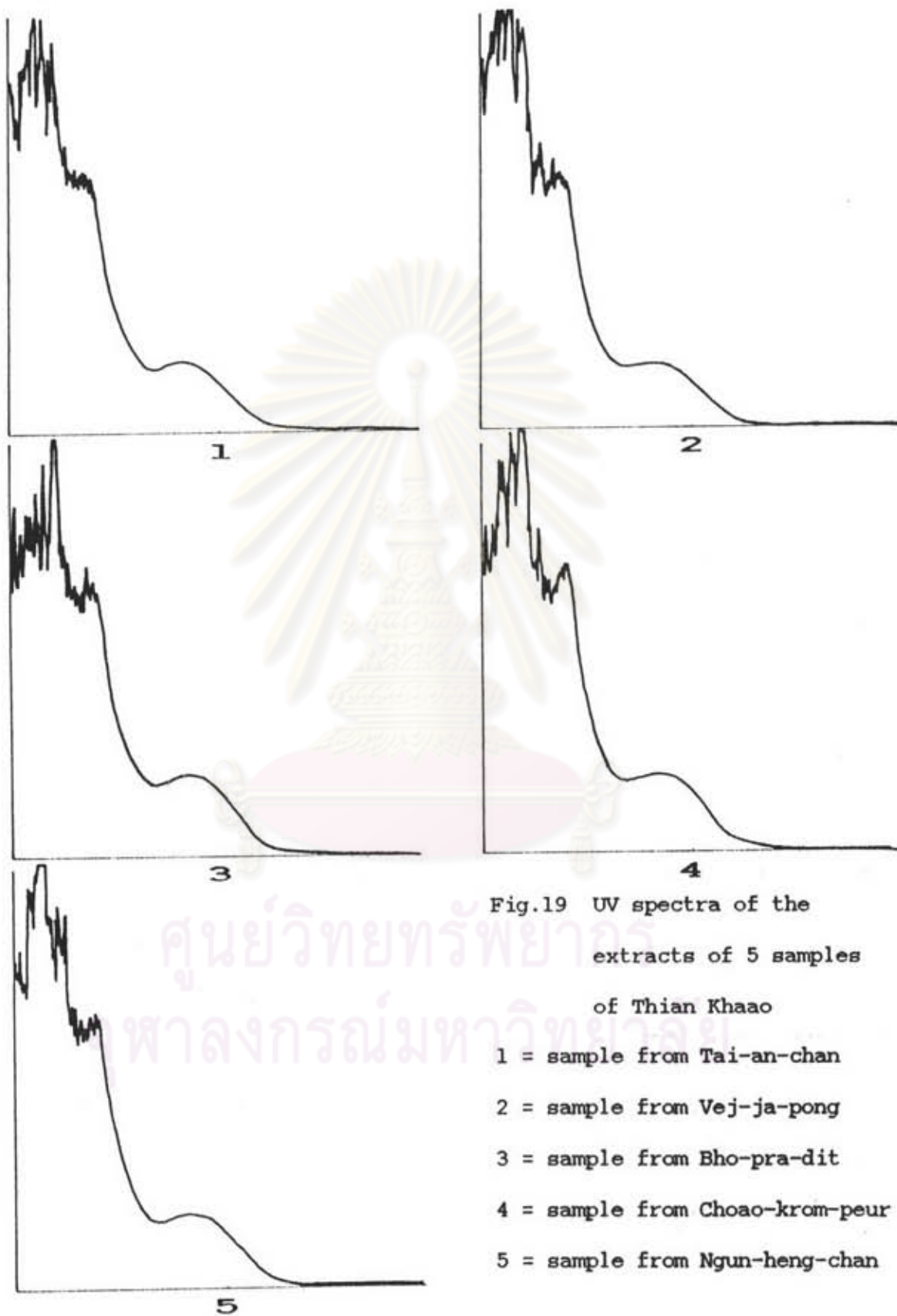
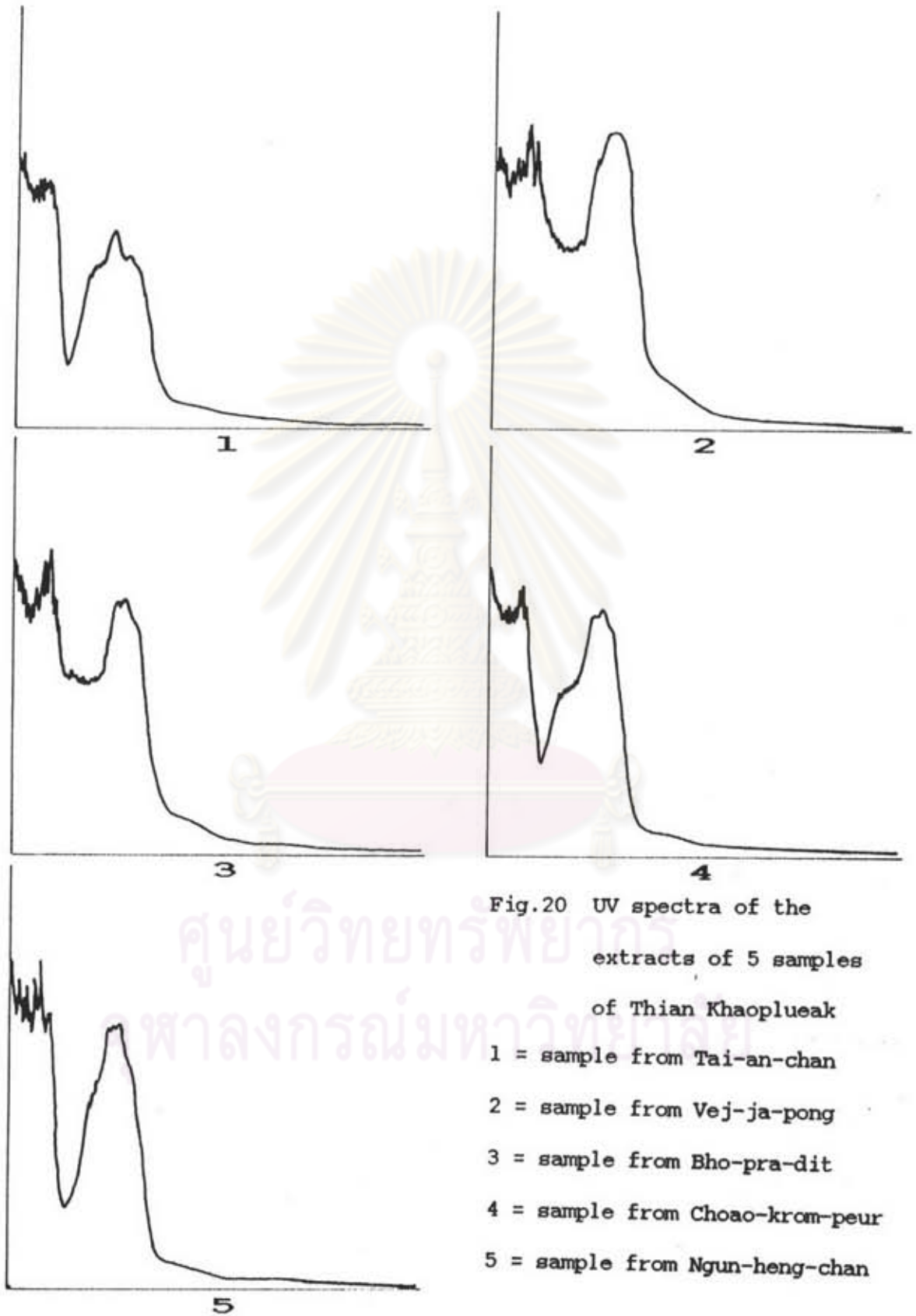


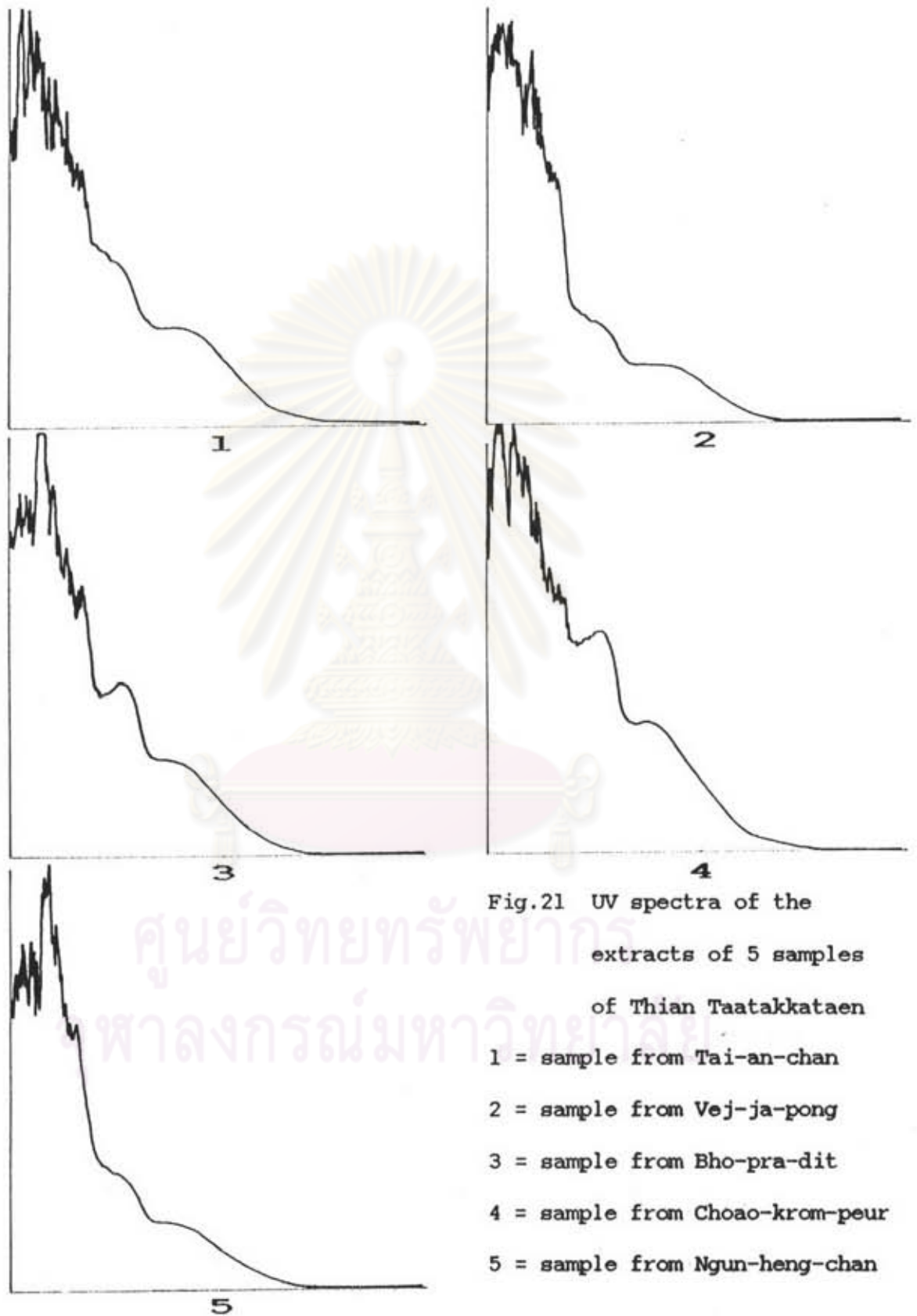
Fig.16 TLC characters of the extracts of 5 samples of Thian Klethoi
 1 = sample from Tai-an-chan 2 = sample from Vej-ja-pong
 3 = sample from Bho-pra-dit 4 = sample from Choao-krom-peur
 5 = sample from Ngun-heng-chan

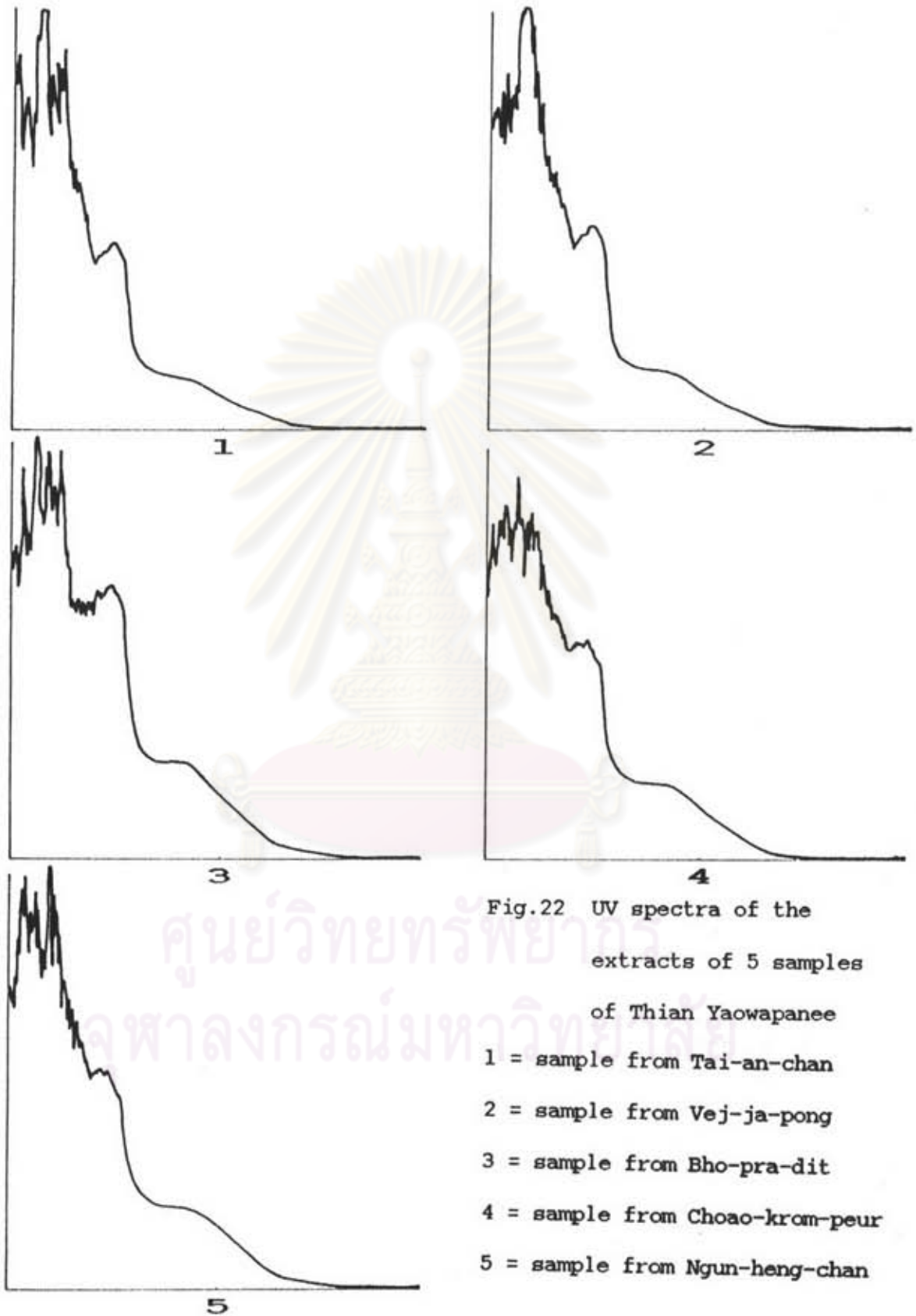


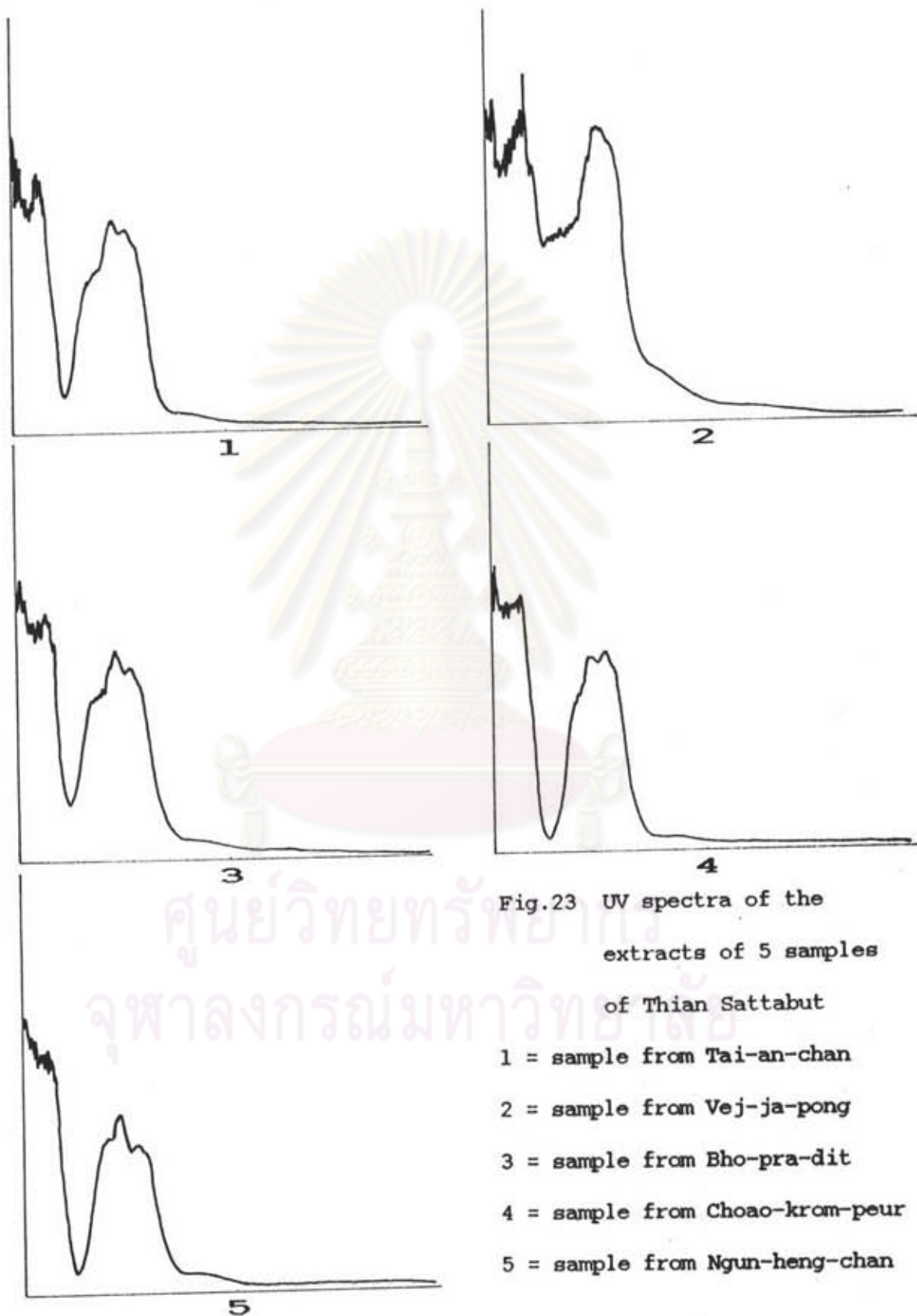


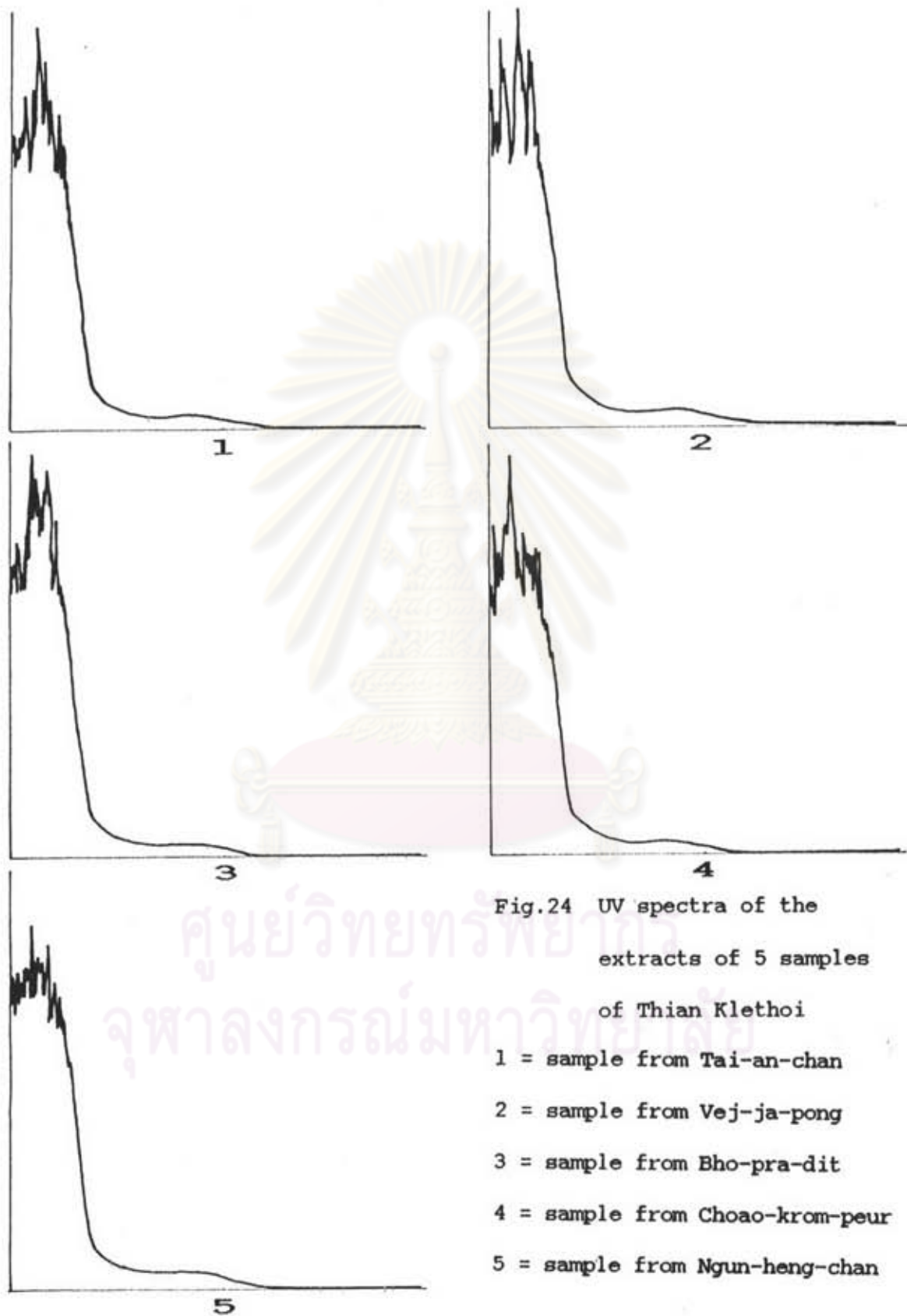












In case of Thian Sattabut, it was found that the morphology of crude drugs (Fig. 25), TLC (Fig. 26) and UV spectra (Fig.27) were similar to Thian Khaoplueak.

4. Random purchase of the other two kinds of Thian which are anise and caraway from supermarket. It was found that all 5 samples of each kind of Thian were similar in morphology of crude drugs (Fig.28-29), TLC (Fig.30-31) and UV spectra (Fig.32-33).

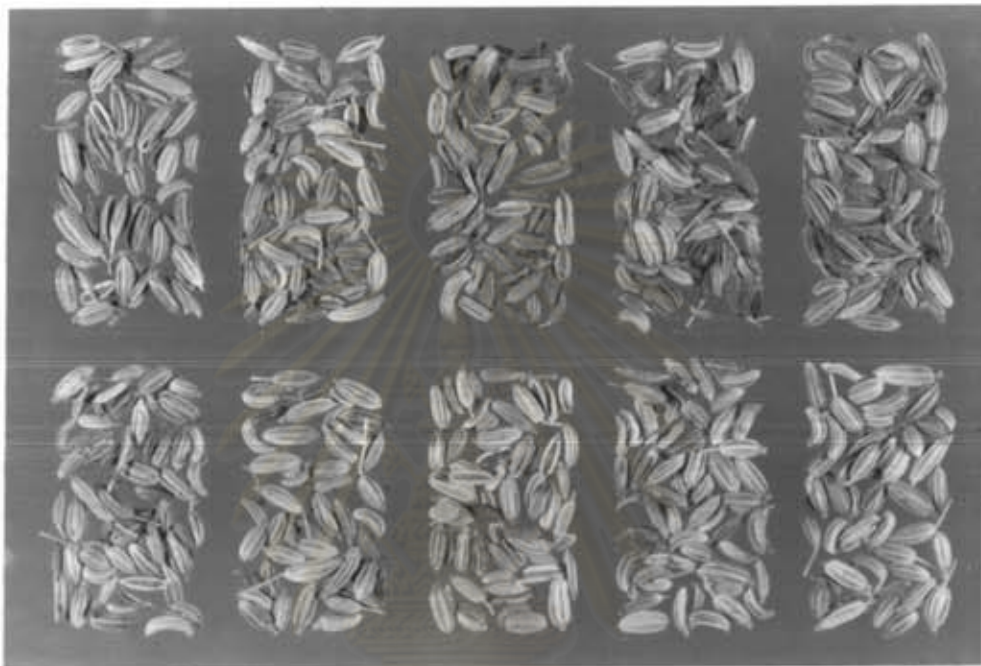
Plant Identification

1. From the planting of all 9 Thian, it was found that all kinds of Thian seeds can be germinated, however, their growing processes were incompleted, i.e. some of them will not flower or bear fruit; some were quickly drooped after flowering period. This was possibly due to the growing environment which was not suitable to the growth of these foreign plants.

2. Identification of plants were carried out by comparisons of the characters of stems, leaves, flowers, fruits, and seeds (or other available characters) of planted Thian with the characters of each Thian described in the "LITERATURE REVIEW" chapter under the "Description of plant" section.



Thian Khaoplueak



Thian Sattabut

1 2 3 4 5

Fig.25 Morphology of the crude drugs of 5 samples of Thian Khaoplueak and Thian Sattabut

- 1 = sample from Tai-an-chan 2 = sample from Vej-ja-pong
 3 = sample from Bho-pra-dit 4 = sample from Choao-krom-peur
 5 = sample from Ngun-heng-chan

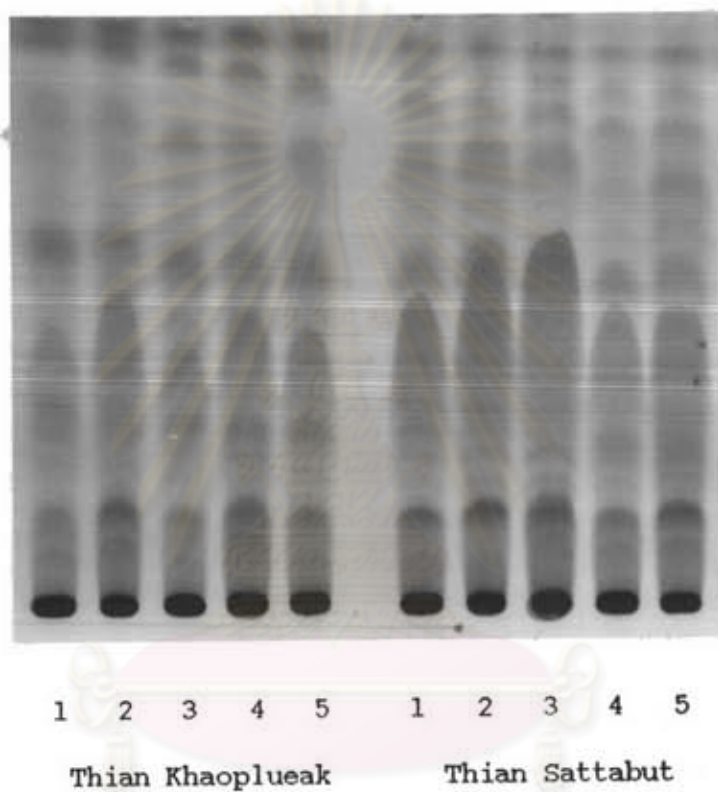


Fig.26 TLC characters of the extracts of 5 samples of Thian Khaoplueak and Thian Sattabut

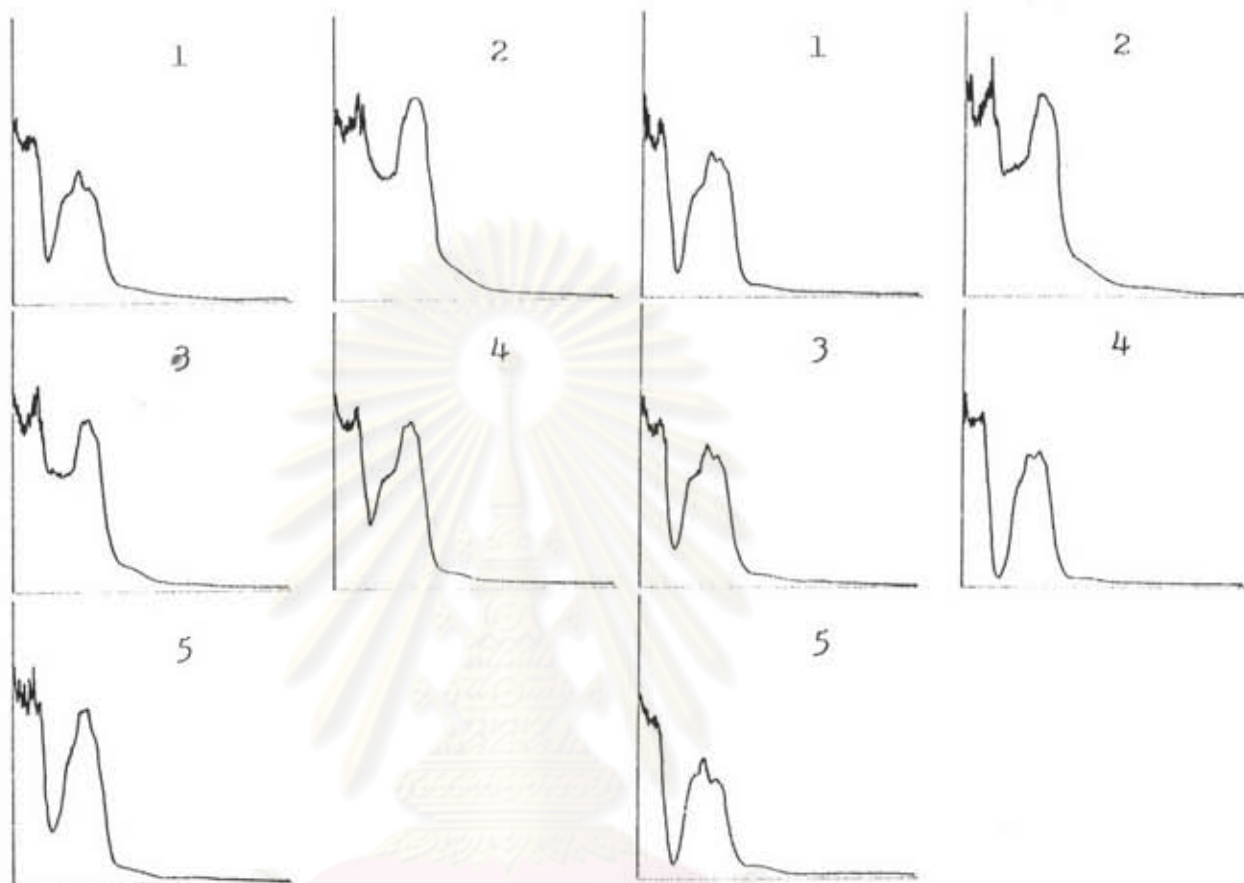
1 = sample from Tai-an-chan

2 = sample from Vej-ja-pong

3 = sample from Bho-pra-dit

4 = sample from Choao-krom-peur

5 = sample from Ngun-heng-chan



Thian Khaoplueak

Thian Sattabut

Fig.27 UV spectra of the extracts of 5 samples of Thian Khaoplueak and Thian Sattabut

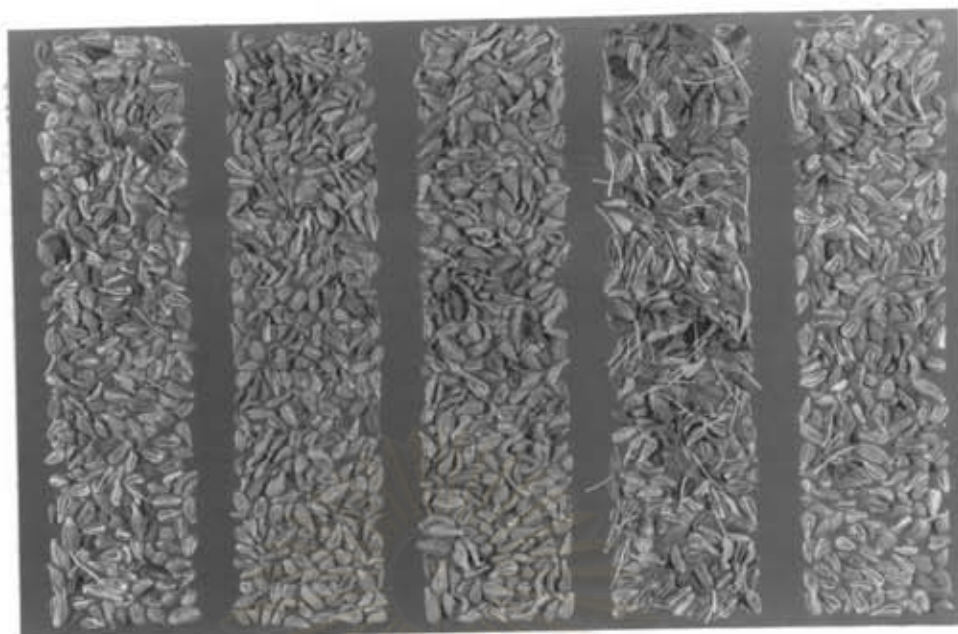
1 = sample from Tai-an-chan

2 = sample from Vej-ja-pong

3 = sample from Bho-pra-dit

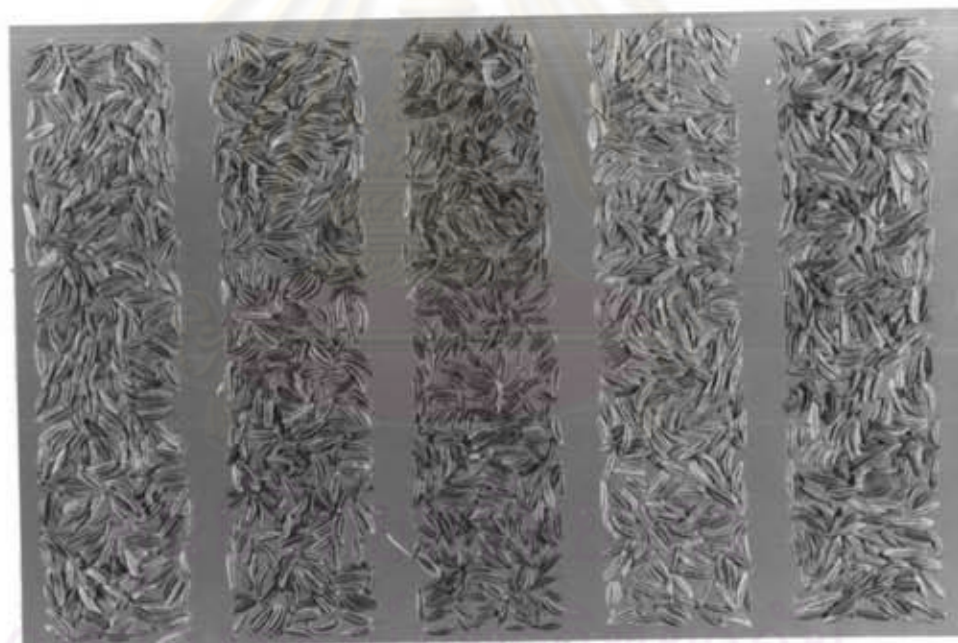
4 = sample from Choao-krom-peur

5 = sample from Ngun-heng-chan



1 2 3 4 5

Fig.28 Morphology of the crude drugs of 5 samples of anise seeds



1 2 3 4 5

Fig.29 Morphology of the crude drugs of 5 samples of caraway seeds

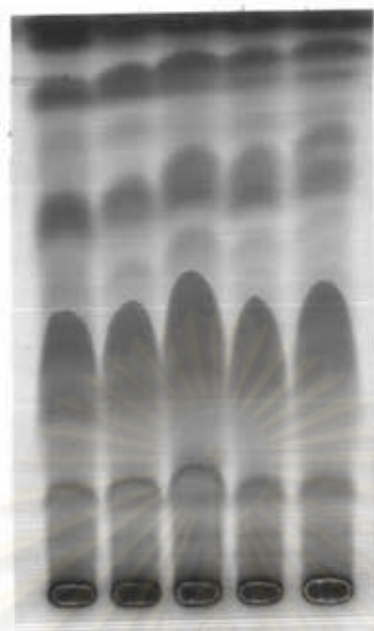
1 = sample from Central

2 = sample from Robinson

3 = sample from Foodland

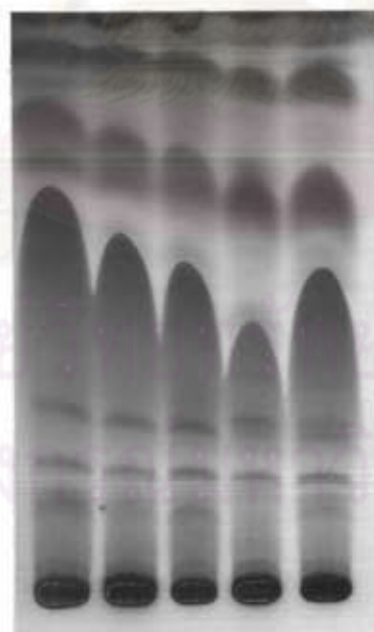
4 = sample from Banglampoo

5 = sample from Jusco



1 2 3 4 5

Fig.30 TLC characters of the extracts of 5 samples of anise seeds



1 2 3 4 5

Fig.31 TLC characters of the extracts of 5 samples of caraway seeds

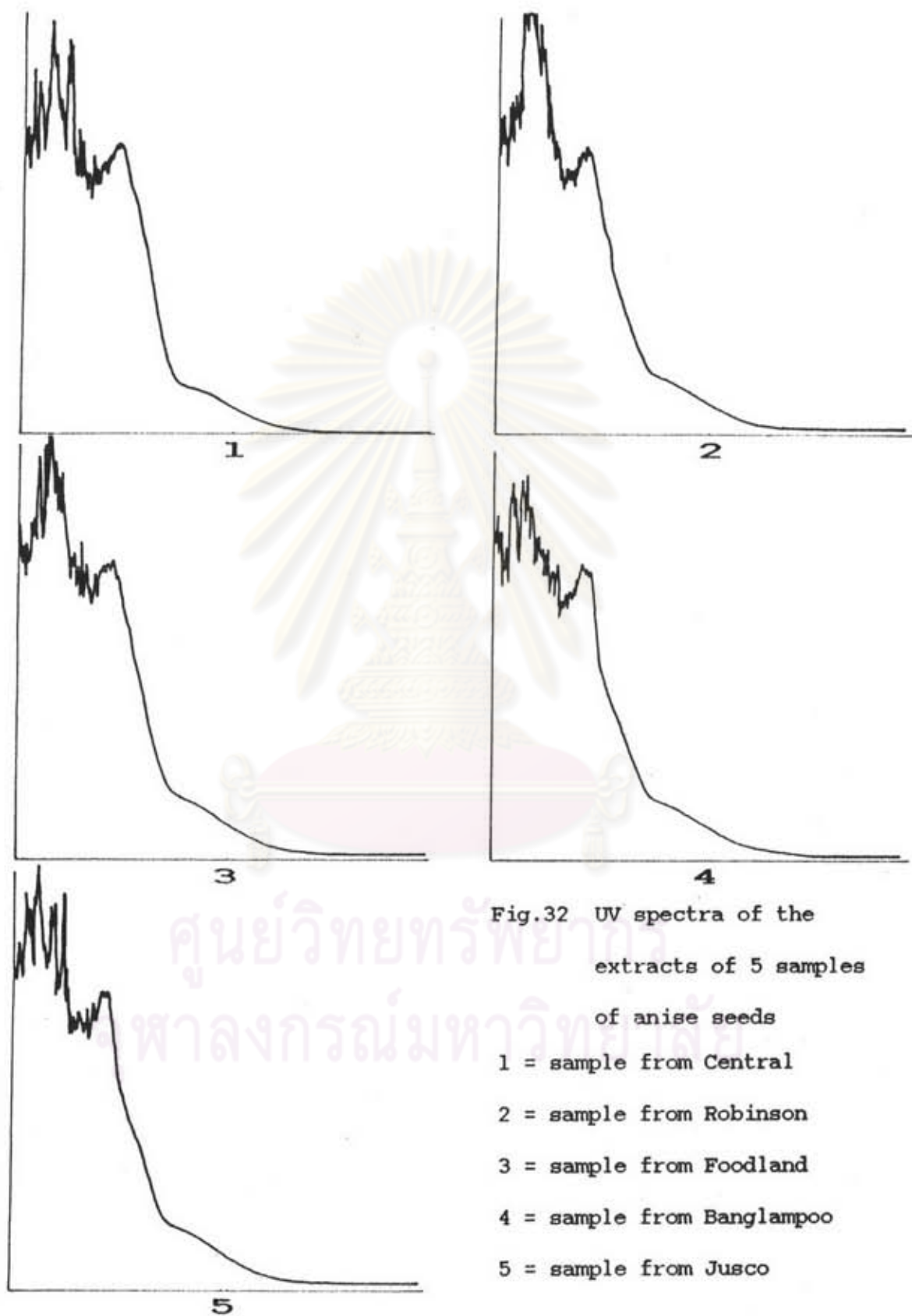
1 = sample from Central

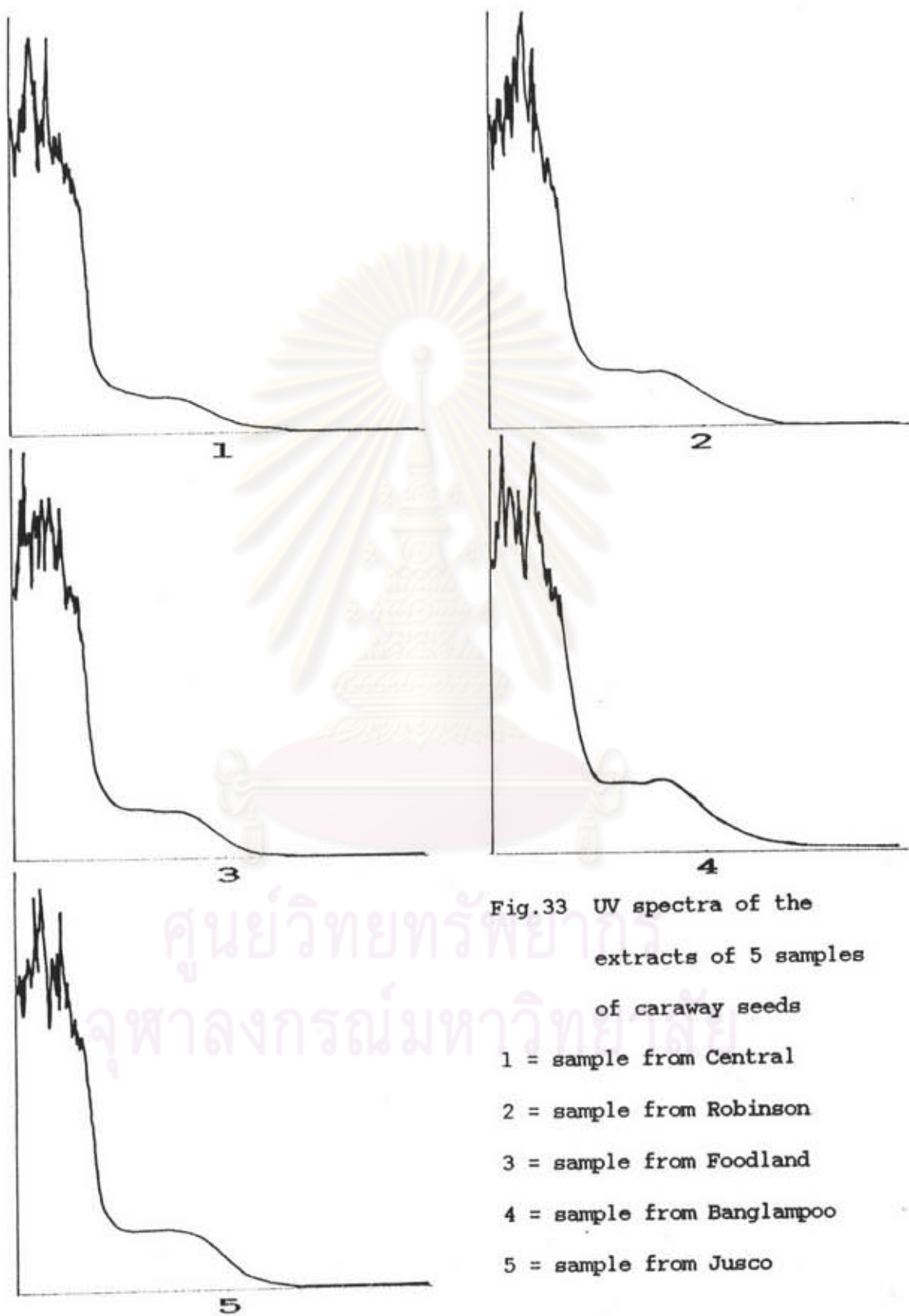
2 = sample from Robinson

3 = sample from Foodland

4 = sample from Banglampoo

5 = sample from Jusco





Each Thian can be identified as followed

1. Thian Dam	<i>Nigella sativa</i> Linn.	Ranunculaceae
2. Thian Dang	<i>Lepidium sativum</i> Linn.	Cruciferae
3. Thian Khaao	<i>Cuminum cyminum</i> Linn.	Umbelliferae
4. Thian Khaoplueak	<i>Foeniculum vulgare</i> Mill.	Umbelliferae
5. Thian Taatakataen	<i>Anethum graveolens</i> Linn.	Umbelliferae
6. Thian Yaowapanee	<i>Petroselinum crispum</i> (Mill.) Nyman	Umbelliferae
7. Thian Klethoi	<i>Plantago ovata</i> Forskal	Plantaginaceae
8. Anise	<i>Pimpinella anisum</i> Linn.	Umbelliferae
9. Caraway	<i>Carum carvi</i> Linn.	Umbelliferae

For anise, which is the seed of *Pimpinella anisum* Linn., its characters agreed well with a plant with Thai name "Thian Sattabut"⁽⁶⁾. Accordingly, caraway, the seed of *Carum carvi* Linn., is identical to "Thian Taakob"⁽⁶⁾.

The characters of the stems, leaves, flowers, and seeds of planted Thian will be described in details in the "Morphology of plant" section.

Specifications of Thian-tung-khao

The specification of each kind of Thian was investigated by using pharmacognostic, chromatographic and spectrophotometric methods. The results will be described separately in the following sections.

Thian Dam

Morphology of plant

Annual slender, erect, herbaceous, hairy. Leaves alternate, deltoid in general outline, 1-3 pinnately dissected into linear or capillary lobes. Flower large, simple, terminate or axillary, about 2 cm in diameter; sepals 5, petaloid, caducous, longer than petals, white; petals many, small, clawed, purplish with greenish nectar-pore; stamens numerous; carpels 2-4, connate below, diverging above into 2-4 styles; style long, beak-like, ovary superior. (Fig.34)

Description of crude drug

Seed ovoid to lanceolate, 3 or nearly 5 angled, 2.5-3.0 mm long, 1.4-1.8 mm wide. Externally black, coarsely reticulate, glabrous (Fig.35). Sectional surface filled with oily endosperm, embedded of 2 fleshy cotyledons.

Odourless, taste aromatic.



stem, leaves and flower



flower



flower



fruit

Fig.34 Morphology of the plant of Thian Dam



— 2 mm

Fig.35 Morphology of the crude drug of Thian Dam

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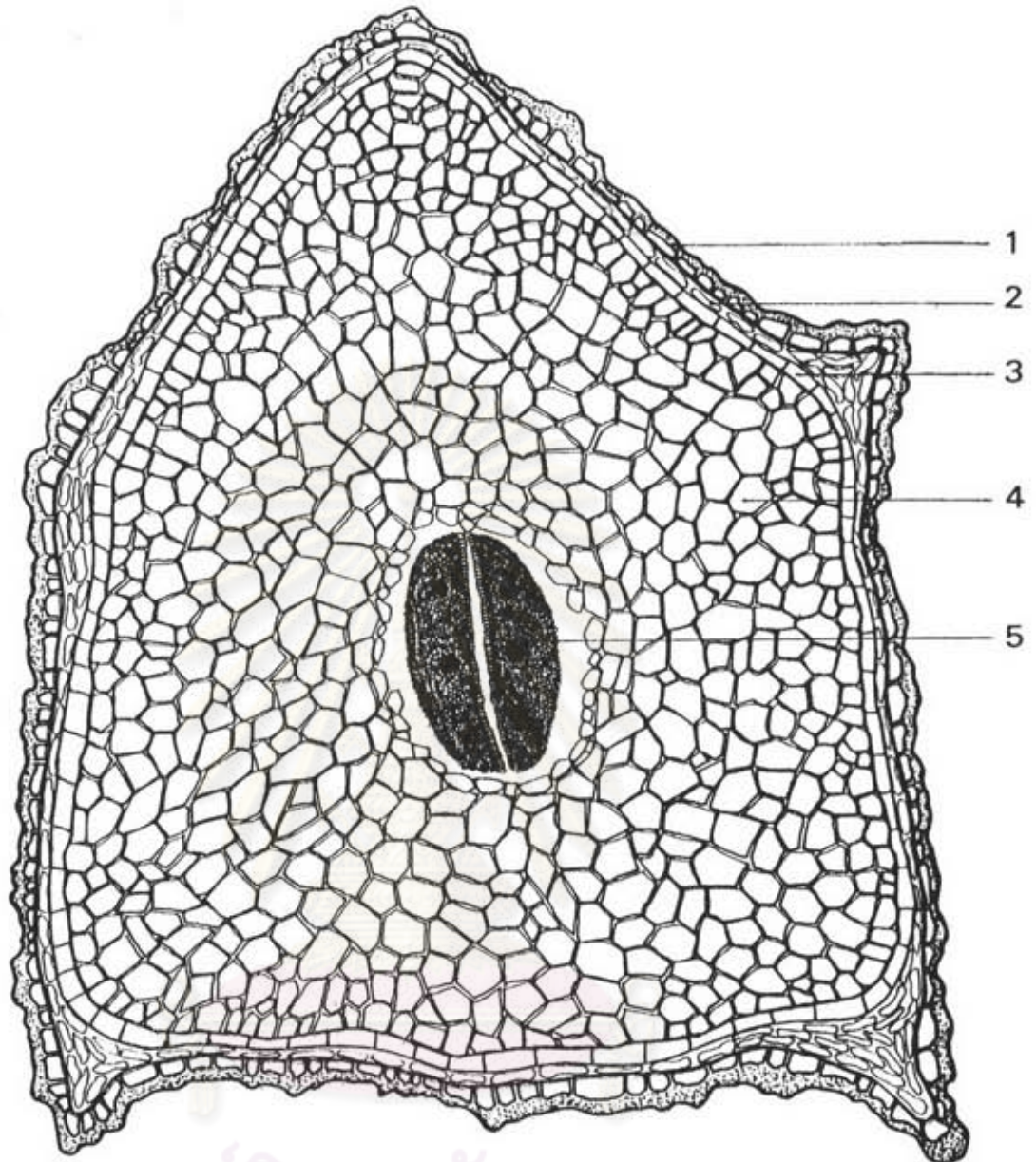
Microscopical characters

Histology

Transverse sections of Thian Dum cut through the cotyledon region show a nearly pentagonal outline, the following microscopical details are noted. (Fig.36)

1. Spermoderm, consisting of 3 kinds of epidermal layer. Outer epidermis, a layer of dark brown, sinuous thick-walled epidermal cells; cicatrices may be present. A layer of more or less collapse, brown, thin-walled cells. Inner epidermis, a layer of dark brown, tangentially-elongated cells.
2. Endosperm, consisting of thick-walled polygonal cells containing aleurone grains and oil globules.
3. Cotyledon, lies in the centre of the endosperm, consisting of thin-walled cells containing aleurone grains and oil globules.

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— 0.1 mm

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Fig.36 Transverse section of Thian Dam

- | | |
|---------------------|-----------------------------|
| 1 = outer epidermis | 2 = layer of collapsed cell |
| 3 = inner epidermis | 4 = endosperm |
| 5 = cotyledon | |

Powdered drug

Powdered drug of Thian Dum is black with white spot in colour. It has aromatic odour and taste. The microscopical characters are listed according to the frequency of tissues found as follows. (Fig.37)

1. Fragments of the outer epidermis in surface view, showing dark brown, thicken-walled polygonal cells.
2. Fragments of the inner epidermis in surface view, showing brown, striped, thicken double walled with pitted canal.
3. Fragments of cotyledon showing thick-walled cells containing oil globules and small aleurone grains, some cells are associated with inner epidermis.
4. Fragments of outer epidermis in sectional view, showing papillose wall.
5. Scattered of oil globules.
6. Scattered of aleurone grains, 5-15 microns in diameter.

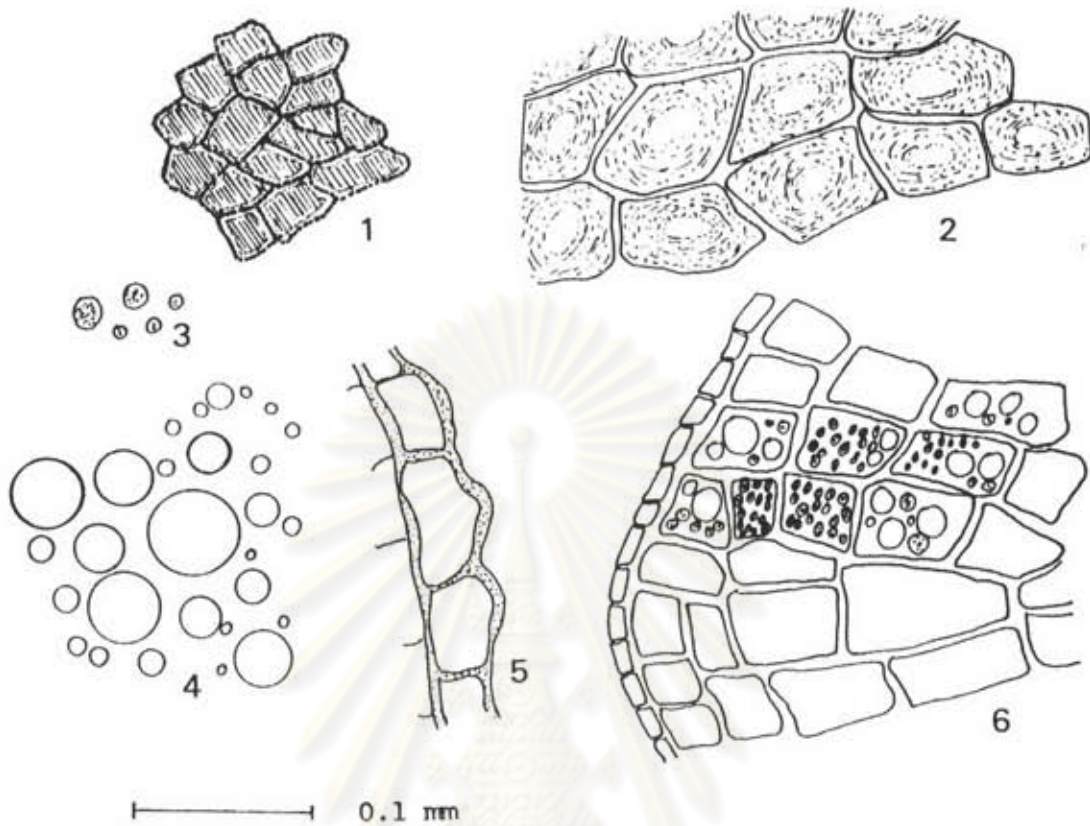


Fig.37 Microscopical character of powdered drug of Thian Dam

1 = inner epidermis in surface view

2 = outer epidermis in surface view

3 = aleurone grains

4 = oil globules

5 = outer epidermis in sectional view

6 = inner epidermis in sectional view associated with
endosperm containing oil globules and small aleurone
grains

Chromatographic characteristics

One-dimensional TLC

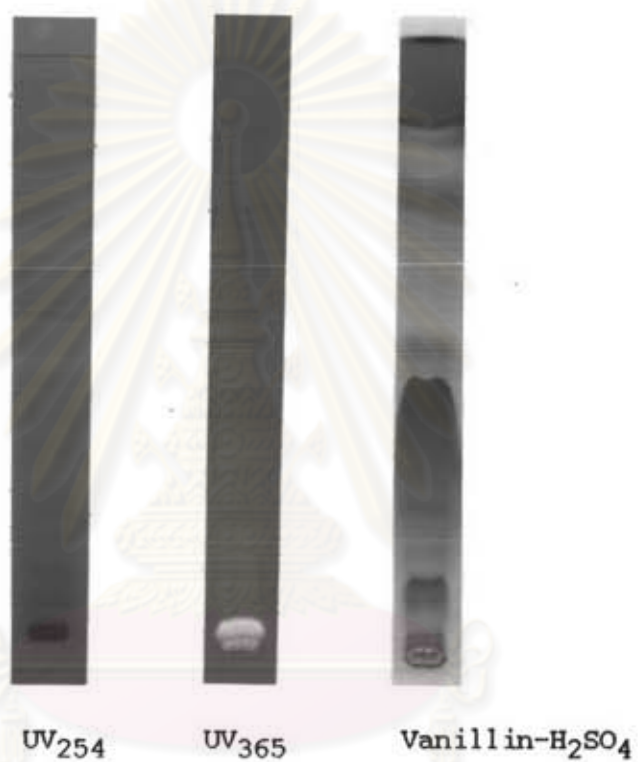


Fig.38 One-dimensional TLC characteristics of the extracts of
Thian Dam

Table 1 Rf value and color of one-dimensional TLC of Thian Dam

spot	Rf value	UV ₂₅₄	UV ₃₆₅	V-H ₂ SO ₄	L-B	Kedde	Dragendorff
1	0.04	-	lt.blue F	purple	-	-	-
2	0.07	-	-	purple	-	-	-
3	0.12	-	lt.blue	purple	-	-	-
4	0.25	-	lt.blue	lt.blue	-	-	-
5	0.32	-	lt.blue	purple	-	-	-
6	0.47	-	pink	blue	-	-	-
7	0.51	dark	pink	purple	-	-	-
8	0.60	-	lt.blue	purple	-	-	-
9	0.67	-	-	purple	-	-	-
10	0.78	dark	-	lt.blue	-	-	-
11	0.79	-	-	blue	-	-	-
12	0.86	dark	-	brown	-	-	-
13	0.95	-	-	rd.brown	-	-	-
14	0.99	dark	-	blue	-	-	-

lt.blue = light blue; F = fluorescent; rd.brown = reddish brown

Two-dimensional TLC

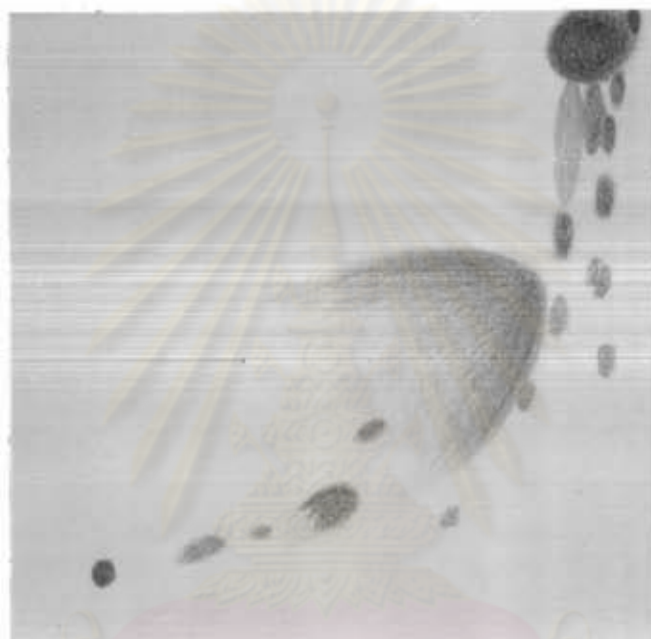


Fig.39 Two-dimensional TLC characteristics of the extracts of Thian Dam

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Table 2 Rf value and color of two-dimensional TLC of Thian Dam

spot	Rf value		color	spot	Rf value		color
	X	Y			X	Y	
1	0	0	brown	11	0.89	0.52	bl.purple
2*	0.18	0.04	purple	12*	0.86	0.53	yl.brown
3	0.28	0.07	lt.blue	13*	0.81	0.60	purple
4*	0.41	0.12	purple	14	0.89	0.67	purple
5*	0.61	0.10	yl.brown	15	0.83	0.78	lt.blue
6*	0.47	0.25	lt.blue	16	0.90	0.79	blue
7*	0.74	0.32	grey	17	0.87	0.82	blue
8	0.88	0.38	grey	18	0.91	0.86	brown
9*	0.81	0.47	lt.blue	19*	0.88	0.95	brown
10*	0.77	0.51	purple	20	0.93	0.99	blue

lt.blue = light blue; bl.purple = blueish purple;
yl.brown = yellowish brown

* spots which are clearly observed on the TLC plate

** spot numberings were arranged with reference to Y-axis

Ultraviolet spectroscopic characters

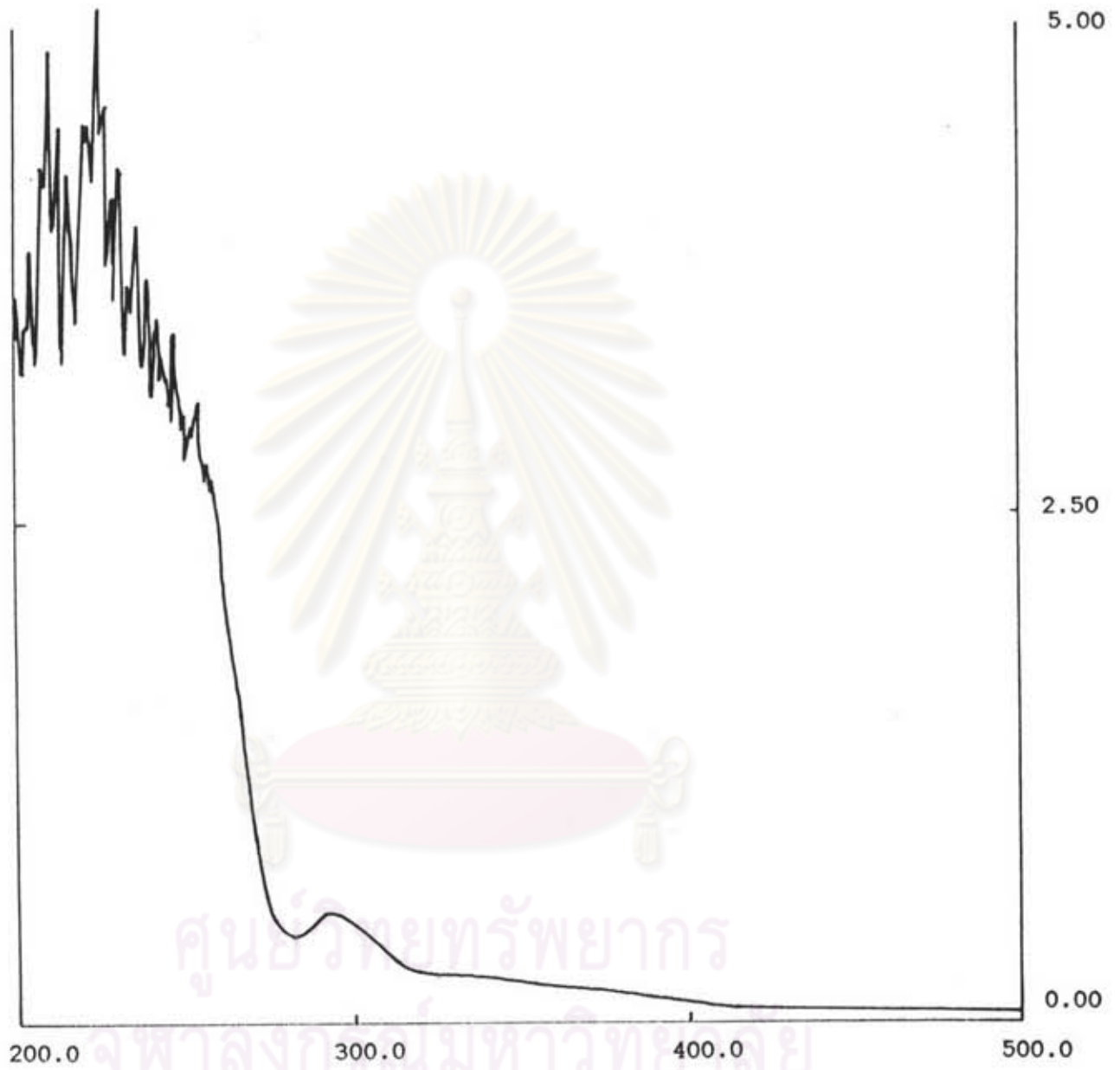


Fig.40 Ultraviolet spectrum of the extract of Thian Dam

Table 3 Ultraviolet absorptions of the extract of Thian Dam

peak	wavelength(nm)	absorption	peak	wavelength(nm)	absorption
1	294.8	0.53	11	225.2	4.59
2	253.6	3.11	12	223.2	5.11
3	246.8	3.45	13	220.0	4.50
4	242.4	3.33	14	216.4	3.71
5	241.2	3.53	15	215.2	3.97
6	238.0	3.72	16	211.6	4.50
7	235.2	4.00	17	208.4	4.88
8	232.8	3.70	18	206.4	4.28
9	229.6	4.29	19	203.6	3.87
10	227.6	4.14			

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Thian Dang

Morphology of plant

Annual slender, erect, herbaceous, usually branching, glabrous, glaucous. Leaves, basal and lower leaves petiolate, alternate, ovate in general outline, 1-2 pinnately dissected, with dentate, obovate lobes; upper leaves sessile, pinnatifid or entire, linear. Inflorescence dense, terminal, ebracteate raceme, elongating later. Flower small, 3-5 mm in diameter; sepal 4, petal 4, white to light purple, spatulate; stamens 6, 4 long and 2 short; style 1; ovary superior; carpels 2, united. Fruit silicula broadly elliptical, 5-6 mm long, 3-5 mm wide, angustiseptate, narrowly winged above, with a deep apical notch, 2-seeded. Seed obovate, about 1.5 mm long, red. (Fig.41)

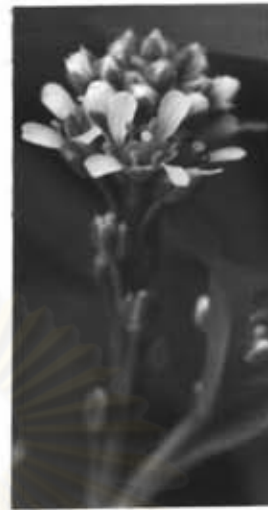
Description of crude drug

Seed ovoid, 2.5-2.8 mm long, 1.0-1.4 mm wide. Externally red, glabrous, smooth, with a short longitudinal groove on one side at the narrow end (Fig.42). Sectional surface filled with embryo which composed of incumbent position of 2 fleshy cotyledons and radicle. Seed coat swollen when moistened.

Odourless, taste aromatic.



stem, leaves and inflorescence



inflorescence



fruit and seeds

Fig.41 Morphology of the plant of Thian Dang



— 2 mm

Fig.42 Morphology of the crude drug of Thian Dang

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Microscopical characters

Histology

Transverse sections of Thian Dang possesses a nearly ovate shape, the following microscopical details are noted.(Fig.43)

1. Spermoderm, consisting of 2 kinds of epidermal layer. Outer epidermis, a layer of mucilaginous reddish thick-walled epidermal cells. Inner epidermis, a layer of colorless rectangular cells.
2. Endodermis, filled with embryo which composed of incumbent position of 2 cotyledons and radicle.
3. Cotyledon, consisting of thin-walled cells containing aleurone grains and oil globules.
4. Radicle, consisting of rather thick-walled cells containing aleurone grains and oil globules.

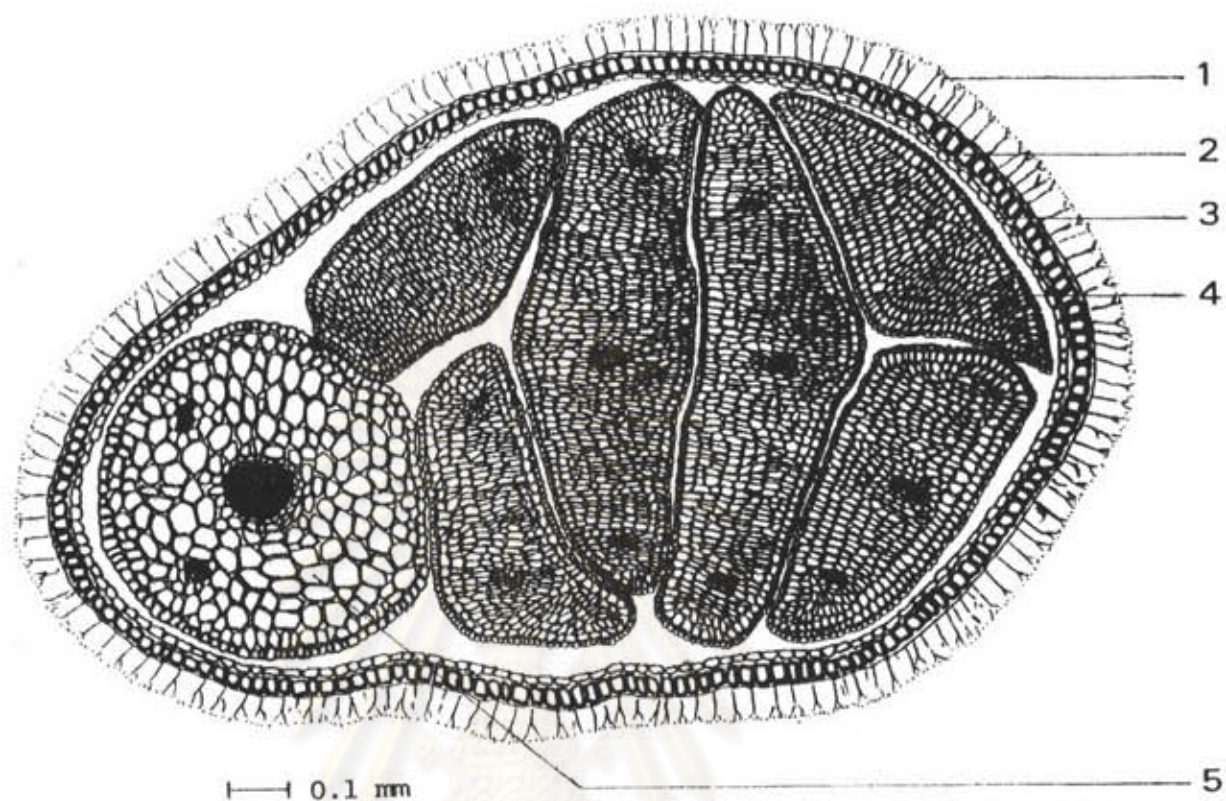


Fig.43 Transverse section of Thian Dang

- 1 = mucilage 2 = outer epidermis
 3 = inner epidermis 4 = cotyledon
 5 = radicle

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Powdered drug

Powdered drug of Thian Dang is reddish brown in colour. It has aromatic odour and taste. The microscopical characters are listed according to the frequency of tissues found as follows.(Fig.44)

1. Fragments of outer epidermis in surface view, showing brown, thicken double walled cells.
2. Fragments of outer epidermis in sectional view, showing brownish double walled cells, on radial, associated with mucilaginous layer on the outer part of the cells, some fragments attached to inner epidermis.
3. Fragments of outer epidermis in surface view, from above, showing colorless of nearly rounded mucilaginous layer.
4. Fragments of cotyledon showing thick-walled cells containing oil globules and aleurone grains, 2-5 microns in diameter.
5. Scattered of oil globules.

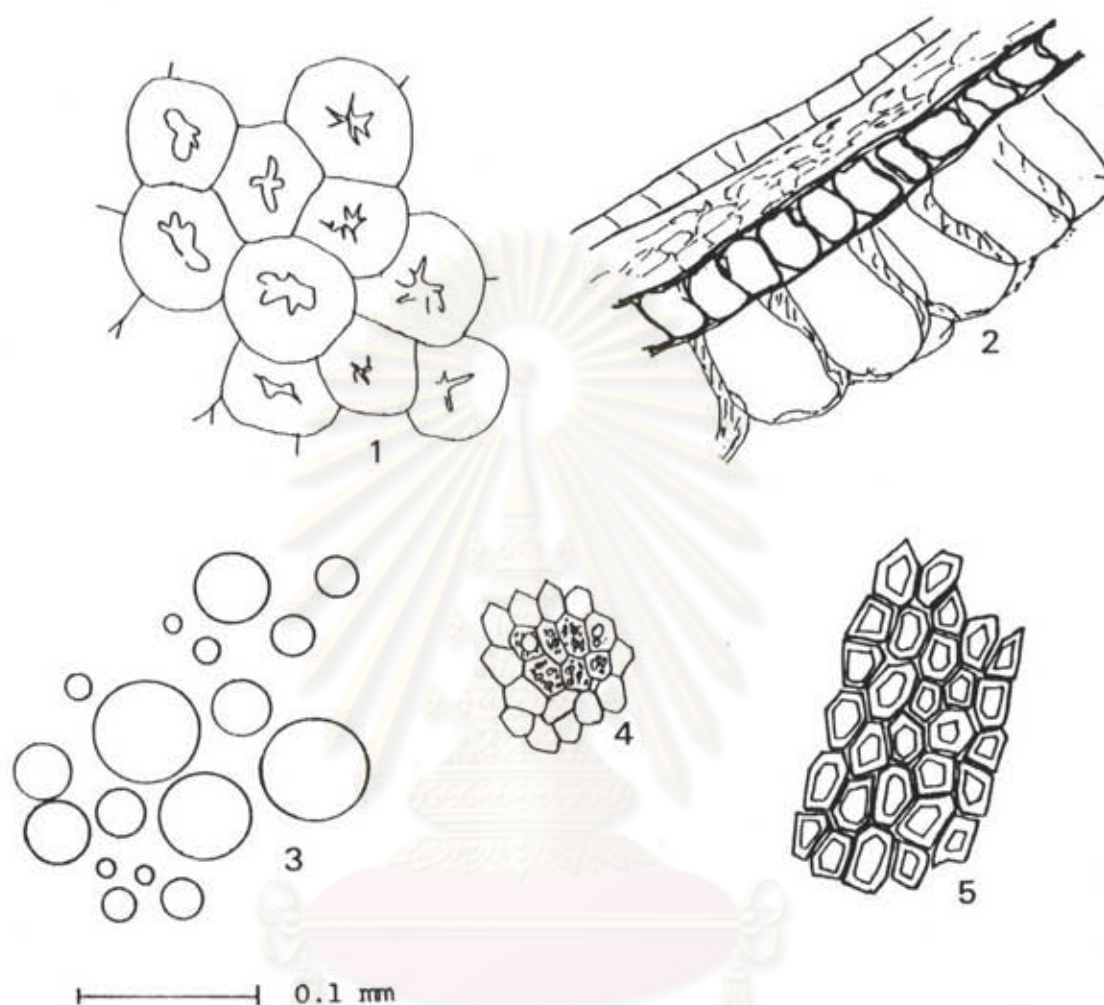


Fig.44 Microscopical character of powdered drug of Thian Dang

1 = mucilage in surface view from above

2 = outer epidermis and mucilage in sectional view
associated with inner epidermis

3 = oil globules

4 = cotyledon containing oil globules and small aleurone
grains

5 = outer epidermis in surface view

Chromatographic characteristics

One-dimensional TLC



Fig.45 One-dimensional TLC characteristics of the extracts of Thian Dang

Table 4 Rf value and color of one-dimensional TLC of Thian Dang

spot	Rf	UV ₂₅₄	UV ₃₆₅	V-H ₂ SO ₄	L-B	Kedde	Dragendorff
1	0.01	-	-	purple	-	-	-
2	0.04	-	-	purple	-	-	-
3	0.38	-	-	purple	-	-	-
4	0.54	-	-	purple	-	-	-
5	0.62	-	-	purple	-	-	-
6	0.73	-	-	purple	-	-	-
7	0.77	-	-	purple	-	-	-
8	0.92	-	-	brown	-	-	-

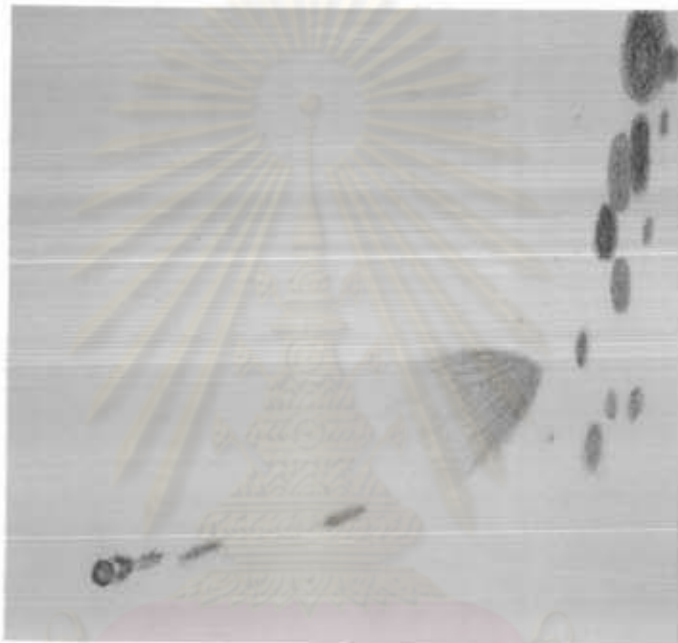
Two-dimensional TLC

Fig.46 Two-dimensional TLC characteristics of the extracts of
Thian Dang

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Table 5 Rf value and color of two-dimensional TLC of Thian Dang

spot	Rf value		color	spot	Rf value		color
	X	Y			X	Y	
1	0	0	brown	11*	0.88	0.54	lt. blue
2	0.04	0.01	purple	12*	0.85	0.62	purple
3	0.08	0.02	purple	13*	0.93	0.63	yl.brown
4	0.16	0.04	purple	14*	0.87	0.73	lt.blue
5	0.40	0.11	purple	15*	0.91	0.77	purple
6	0.84	0.24	lt.blue	16*	0.95	0.82	yl.brown
7	0.87	0.32	grey	17	0.92	0.95	brown
8	0.91	0.32	purple	18	0.96	0.93	lt.blue
9	0.74	0.38	purple	19	0.97	0.92	yl.brown
10	0.82	0.42	purple				

lt.blue = light blue; yl.brown = yellowish brown

* spots which are clearly observed on the TLC plate

** spot numberings were arranged with reference to Y-axis

Ultraviolet spectroscopic characters

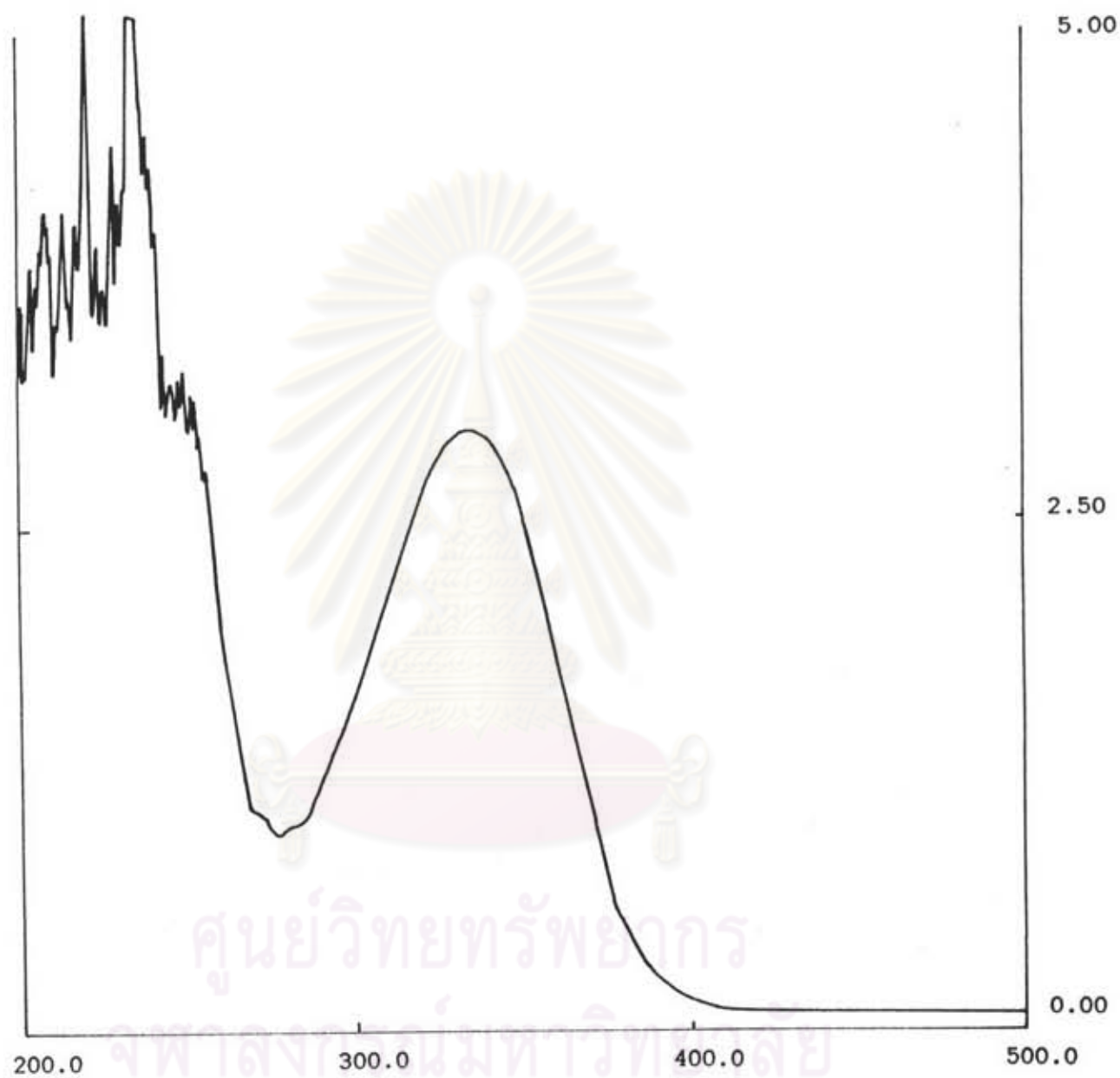


Fig.47 Ultraviolet spectrum of the extract of Thian Dang

Table 6 Ultraviolet absorptions of the extract of Thian Dang

peak	wavelength(nm)	absorption	peak	wavelength(nm)	absorption
1	333.6	3.00	12	229.2	4.14
2	280.0	0.98	13	227.6	4.43
3	253.2	2.99	14	225.2	3.70
4	250.8	3.18	15	223.2	3.90
5	248.8	3.30	16	219.6	5.09
6	247.2	3.25	17	216.8	4.04
7	244.8	3.24	18	214.4	3.64
8	242.8	3.38	19	212.8	4.10
9	240.4	3.98	20	207.2	4.09
10	238.8	4.32	21	203.2	3.81
11	232.8	5.80			

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Thian Khaao

Morphology of plant

Plant slender, erect, herbaceous, glabrous. Leaves ovate in general outline, ternately dissected; petioles sheathing. Flowers umbel, about 2 mm in diameter; sepal minute or wanting; petal 5, rose with a narrower inflexed apex; stamens 5; styles 2, short; stylopodium conic; ovary inferior. Carpophore 2-cleft to the base. Fruit oblong setulose and bristly about 3 mm long. (Fig.48)

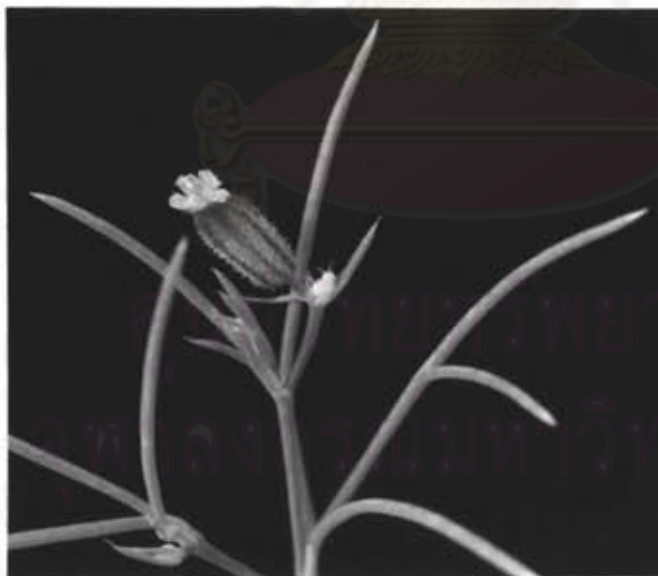
Description of Crude drug

Mericarp usually separated, narrowly elliptical but slightly curved, similar to caraway, 4.5-6.2 mm long, 1.3-2.0 mm wide, covered with tiny bristly hairs. Cremocarp oblong. Dorsal surface convex, brown, with 5 lighter-coloured filiform primary ribs, and at the summit with an acute conical stylopodium; secondary ribs occurred between each pair of primary ribs, covered with prominent bristles; commissural surface concave, brown (Fig.49). Sectional surface occurred 2 vittae on the commissural surface and 4 vittae on the dorsal surface between each two primary ribs; oily endosperm large, embedded of 2 fleshy cotyledons.

Odour and taste aromatic, characteristic.



stem, leaves and inflorescence



flower and fruit

Fig.48 Morphology of the plant of Thian Khaao



— 2 mm

Fig.49 Morphology of the crude drug of Thian Khaao

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Microscopical characters

Histology

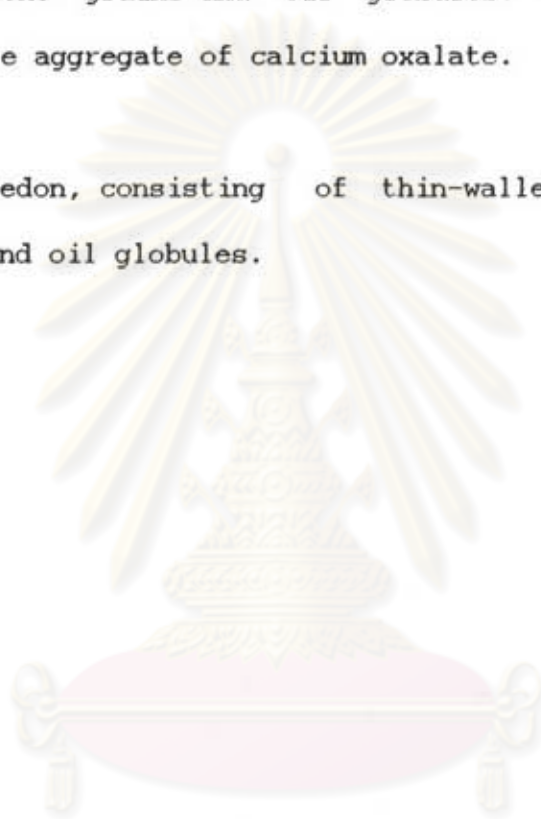
Transverse sections of Thian Khaao cut through the cotyledon region show a pentagonal outline, the following microscopical details are noted. (Fig.50)

1. Epicarp, covered with striated cuticle, consisting of a layer of sinuous walled epidermal cells and covering trichomes. Cicatrices may be present. Covering trichomes are multicellular, multiseriate, and rounded at the apex.
2. Mesocarp, consisting of several layers of more or less collapsed, tangentially-elongated parenchymatous cells. In each of the rib portions of this zone will be noted strengthened sclerenchymatous cells and a lignified fibrovascular bundle. On the dorsal side occurs 4 large vittae located between the vascular bundle; on the commissural side occurs 2 large vittae. Each vitta is elliptical, brown, and lined by small epithelial secretory cells.
3. Endocarp, composed of a layer of tangentially-elongated cells.
4. Spermoderm, consisting of a layer of brownish, tangentially-elongated cells which are closely united with the endocarp except where separated by a large area of collapsed thin-walled cells which

are defined in the region of the raphe along the commissural side. The center of the raphe located by lignified raphe bundle.

5. Endosperm, consisting of thick-walled polygonal cells containing aleurone grains and oil globules. Each aleurone grain contains a rosette aggregate of calcium oxalate.

6. Cotyledon, consisting of thin-walled cells containing aleurone grains and oil globules.



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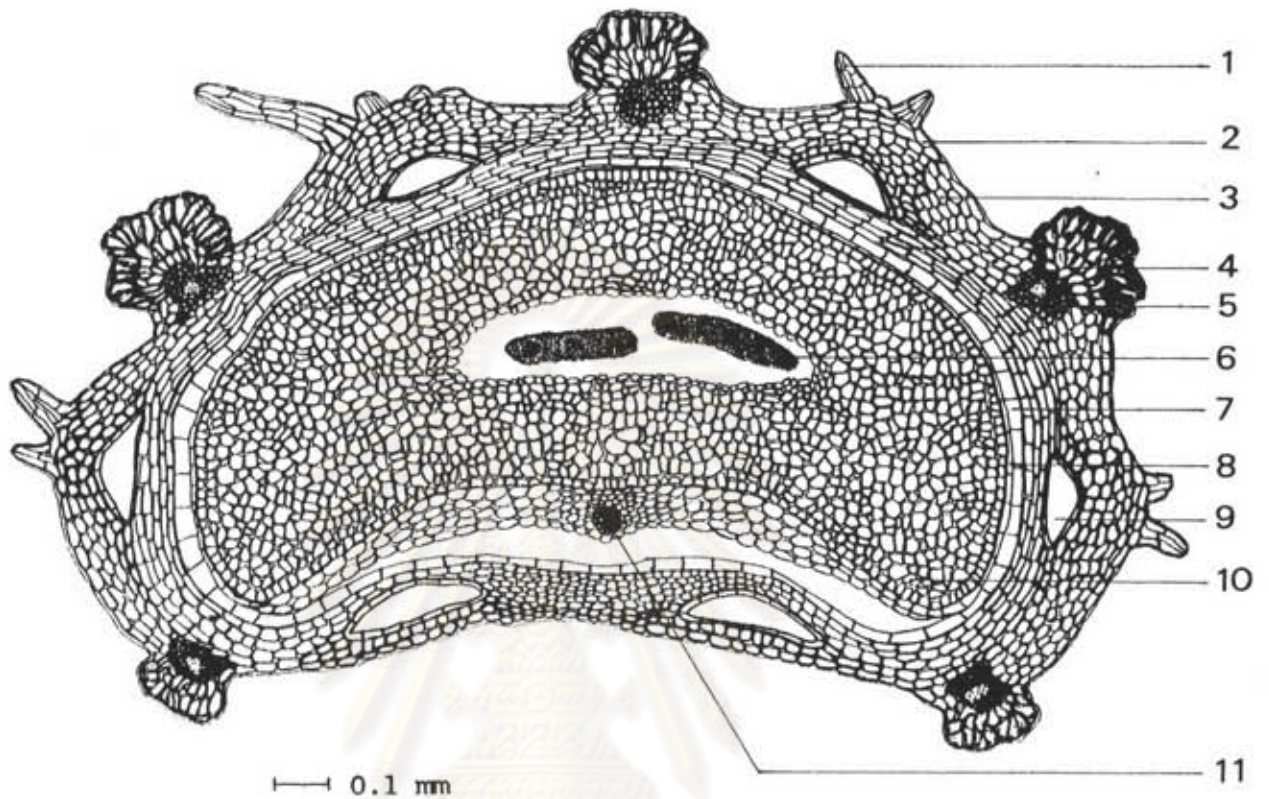


Fig.50 Transverse section of Thian Khaao

- | | |
|----------------------------|---------------------------|
| 1 = covering trichome | 2 = epicarp |
| 3 = parenchyma of mesocarp | 4 = sclerenchymatous cell |
| 5 = vascular bundle | 6 = cotyledon |
| 7 = endocarp | 8 = spermoderm |
| 9 = vittae | 10 = endosperm |
| 11 = raphe | |

Powdered drug

Powdered drug of Thian Khaao is yellowish brown in colour. It has aromatic characteristic odour and taste. The microscopical characters are listed according to the frequency of tissues found as follows.(Fig.51)

1. Fragments of epicarp in surface view, showing thin-walled polygonal cells covered with striated cuticle.
2. Fragments of epicarp in sectional view, showing epidermal cells attached to covering trichomes, multicellular, multiseriate and rounded at apex, up to 150 microns long, with striated cuticle.
3. Fragments of endocarps in surface view, showing thin-walled elongated rectangular cells with smooth surface.
4. Fragments of mesocarp showing thin-walled cells, some fragments attached to brownish epithelial cells of vitta.
5. Fragments of vitta in surface view showing brownish cells with transverse septum.
6. Fragments of lignified sclereids from sclerenchymatous tissue of the mesocarp, showing pitted thickening walled cells.

7. Fragments of lignified vessels showing spiral, scalariform and reticulate thickening walled cells.

8. Fragments of endosperm showing thick-walled polygonal cells containing oil globules and aleurone grains, about 10 microns in diameter, containing small rosette aggregate of calcium oxalate crystals.

9. Fragments of cotyledon showing thin-walled cells of palisade, mesophyll and vascular bundle.

10. Scattered of oil globules.



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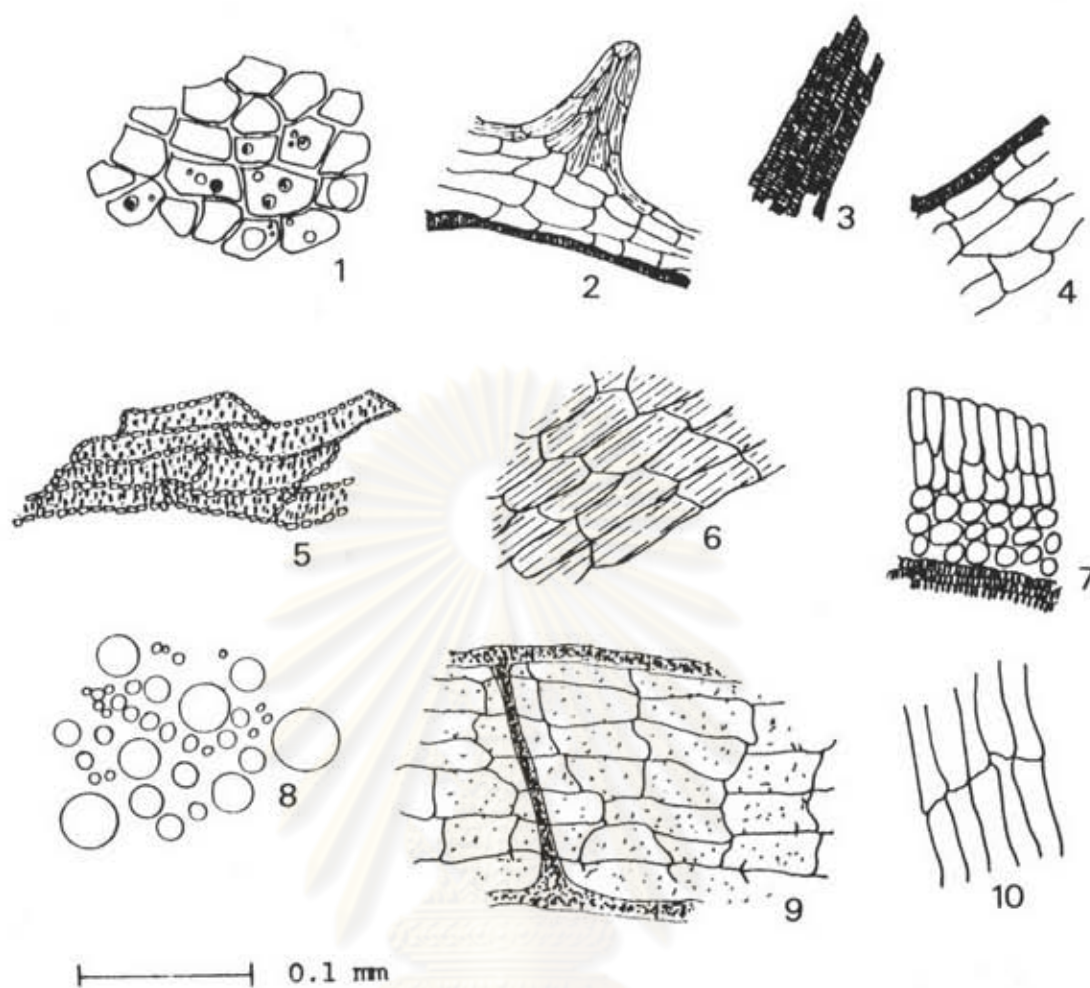


Fig.51 Microscopical character of powdered drug of Thian Khaao

- 1 = endosperm containing oil globules and aleurone grains with microcrystals
- 2 = epicarp and multicellular trichome in sectional view associated with mesocarp and vitta
- 3 = scalariform vessels
- 4 = mesocarp in sectional view associated with vitta
- 5 = sclereids
- 6 = epicarp in surface view
- 7 = cotyledon in sectional view
- 8 = oil globules
- 9 = vitta in surface view
- 10 = endocarp in surface view

Chromatographic characteristics

One-dimensional TLC



Fig.52 One-dimensional TLC characteristics of the extracts of Thian Khaao

Table 7 Rf value and color of one-dimensional TLC of Thian Khaao

spot	Rf	UV ₂₅₄	UV ₃₆₅	V-H ₂ SO ₄	L-B	Kedde	Dragendorff
	value						
1	0.07	-	purple	purple	-	-	-
2	0.15	-	lt.blue	purple	-	-	-
3	0.24		lt.blue	pink	-	-	-
4	0.26		pink	blue	-	-	-
5	0.38	-	lt.blue	grey	-	-	-
6	0.45	dark	pink	purple	-	-	-
7	0.57	-	lt.blue	purple	-	-	-
8	0.68	-	pink	purple	-	-	-
9	0.76	-	blue	green	-	-	-
10	0.78	dark	-	purple	-	-	-
11	0.86	-	-	purple	-	-	-
12	0.97	-	-	brown	-	-	-

lt.blue = light blue

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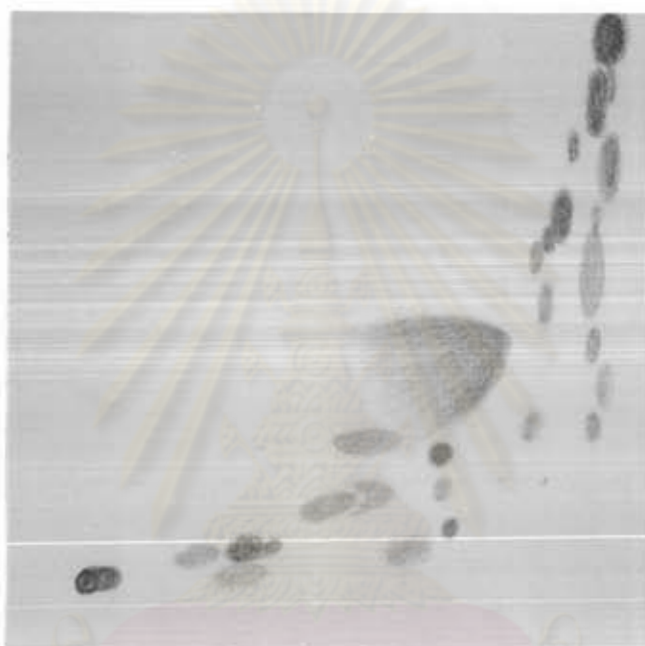
Two-dimensional TLC

Fig.53 Two-dimensional TLC characteristics of the extracts of
Thian Khaao

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Table 8 Rf value and color of two-dimensional TLC of Thian Khaao

spot	Rf value		color	spot	Rf value		color
	X	Y			X	Y	
1	0	0	brown	16	0.89	0.38	grey
2	0.04	0.01	purple	17*	0.78	0.45	purple
3*	0.27	0.02	purple	18	0.87	0.44	yellow
4	0.19	0.05	purple	19	0.79	0.51	purple
5	0.27	0.07	purple	20*	0.87	0.57	lt.blue
6*	0.31	0.07	lt.blue	21	0.77	0.60	lt.blue
7*	0.56	0.07	grey	22	0.93	0.63	pink
8	0.62	0.11	purple	23*	0.82	0.68	purple
9*	0.42	0.15	purple	24	0.87	0.67	orange
10	0.49	0.17	purple	25*	0.89	0.76	yellow,
11	0.61	0.18	grey				lt.blue
12*	0.61	0.24	red	26	0.83	0.78	blue
13*	0.49	0.26	lt.blue	27	0.88	0.86	blue
14	0.76	0.30	grey	28	0.90	0.91	yellow
15	0.87	0.30	yellow	29	0.96	0.97	brown

lt. blue = light blue

* spots which are clearly observed on the TLC plate

** spot numberings were arranged with reference to Y-axis

Ultraviolet spectroscopic characters

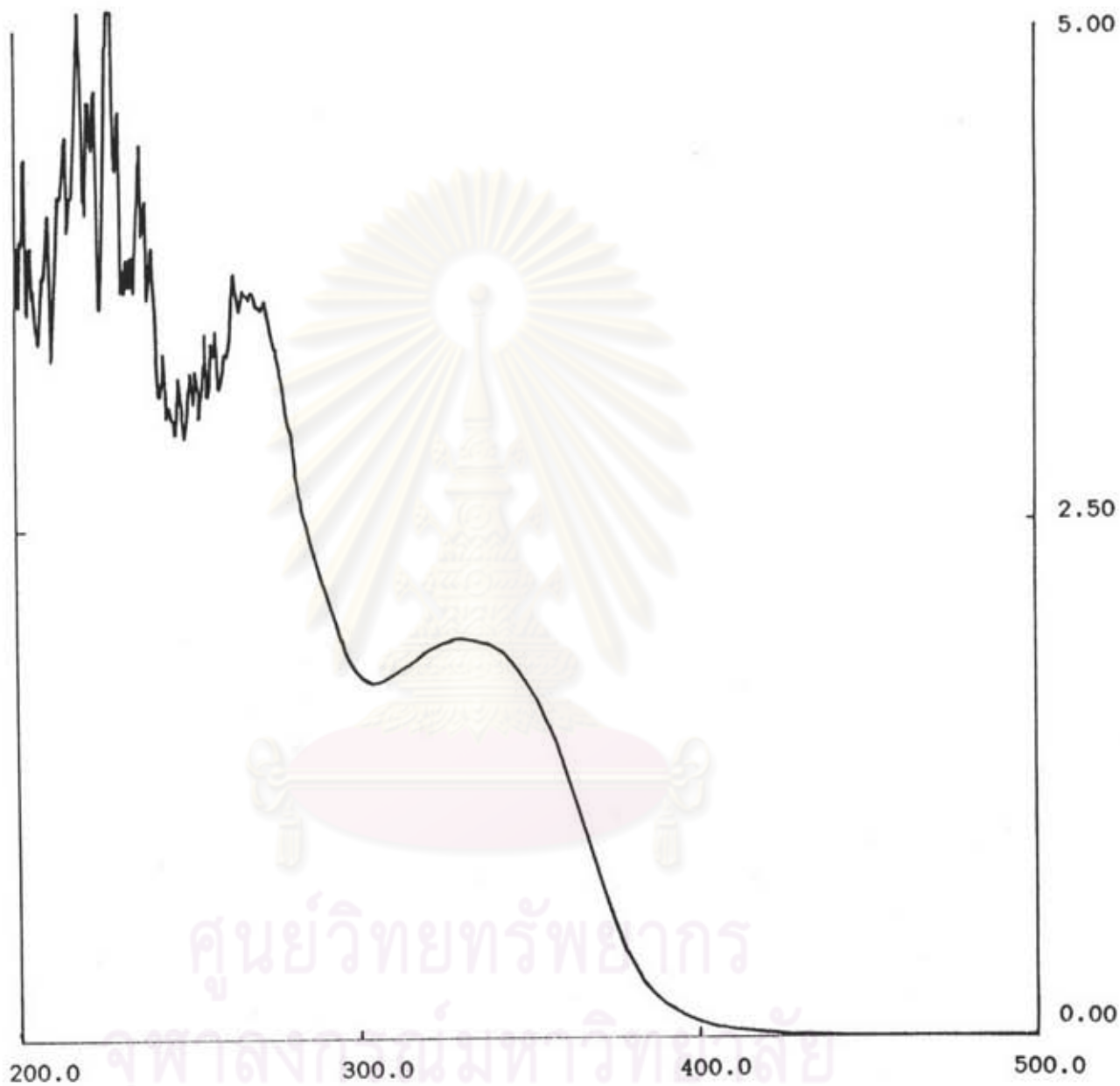


Fig.54 Ultraviolet spectrum of the extract of Thian Khaao

Table 9 Ultraviolet absorptions of the extract of Thian Khao

peak	wavelength(nm)	absorption	peak	wavelength(nm)	absorption
1	331.6	1.96	11	239.6	3.90
2	266.8	3.70	12	237.6	4.13
3	264.0	3.78	13	236.0	4.40
4	258.8	3.49	14	233.6	3.85
5	256.0	3.48	15	232.4	3.85
6	253.2	3.29	16	231.2	3.79
7	251.6	3.28	17	229.6	4.57
8	248.0	3.27	18	226.8	5.41
9	245.2	3.09	19	222.4	4.67
10	243.6	3.38	20	220.8	4.62

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Thian Khaoplueak

Morphology of plant

Plant slender, erect, herbaceous, caulescent, branching, glabrous. Leaves deltoid in general outline, 3-4 times pinnate with linear-filiform ultimate segments; petioles broad-sheathing. Inflorescence compound umbels; florets about 2 mm in diameter; sepals minute or wanting; petals 5, yellow with a narrower inflexed apex; stamens 5; styles 2, short; stylopodium conic; ovary inferior. (Fig.55)

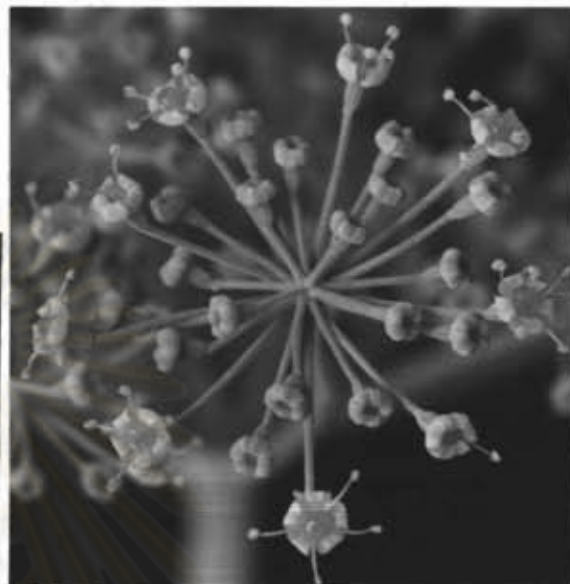
Description of crude drug

Cremocarp oblong. Mericarp seldom separated, each being elliptical, more or less concave, glabrous, 5.0-8.0 mm long, 2.0-2.5 mm wide. Dorsal surface convex, brown, with 5 prominent longitudinal ribs, and at the summit being a short stylopodium; commissural surface flat or slightly concave, brown, persistent of carpophore and pedicel (Fig.56). Sectional surface occurred 2 vittae on the commissural surface and 4 vittae on the dorsal surface between each two ribs; oily endosperm large, embedded of 2 fleshy cotyledons.

Odour and taste aromatic.



stem and leaves



inflorescence



fruits

Fig.55 Morphology of the plant of Thian Khaoplueak



— 2 mm

Fig.56 Morphology of the crude drug of Thian Khaoplueak

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Microscopical characters

Histology

Transverse sections of Thian Khaoplueak cut through the cotyledon region show a pentagonal outline, the following microscopical details are noted.(Fig.57)

1. Epicarp, covered with smooth cuticle, consisting of a layer of epidermal cells. In the commissural region occurs an attached carpophore, composing of lignified fibers.

2. Mesocarp, consisting of several layers of thin-walled parenchymatous cells. In each of the rib portions of this zone will be noted a lignified fibrovascular bundle, surrounding the bundle are reticulate porous thickened lignified parenchymatous cells. On the dorsal side occurs 4 large vittae located between the vascular bundles; on the commissural side occurs 2 large vittae. Each vitta is elliptical brown, and lined by small epithelial secretory cells.

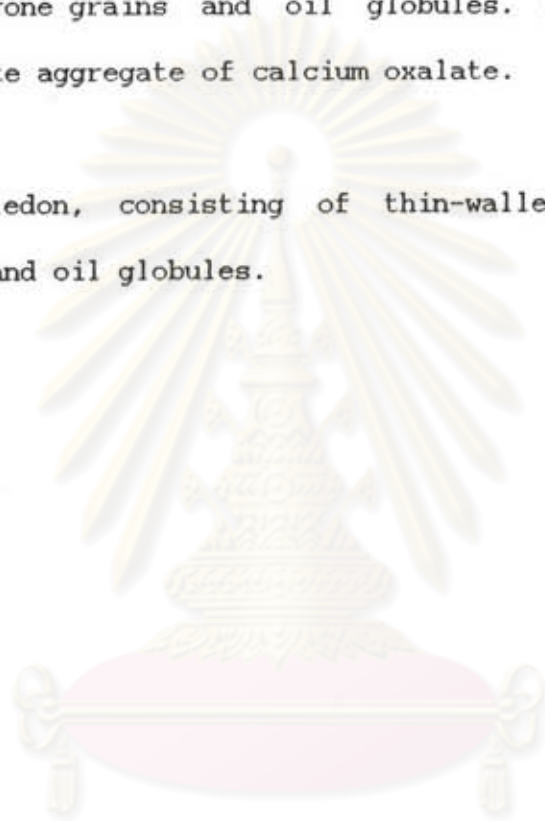
3. Endocarp, composed of a layer of tangentially-elongated cells.

4. Spermoderm, consisting of a layer of brownish, tangentially-elongated cells which are closely united with the endocarp except where separated by a large area of collapsed thin-walled cells which are defined in the region of the raphe along the

commissural side. The center of the raphe located by lignified raphe bundle.

5. Endosperm, consisting of thick-walled polygonal cells containing aleurone grains and oil globules. Each aleurone grain contains a rosette aggregate of calcium oxalate.

6. Cotyledon, consisting of thin-walled cells containing aleurone grains and oil globules.



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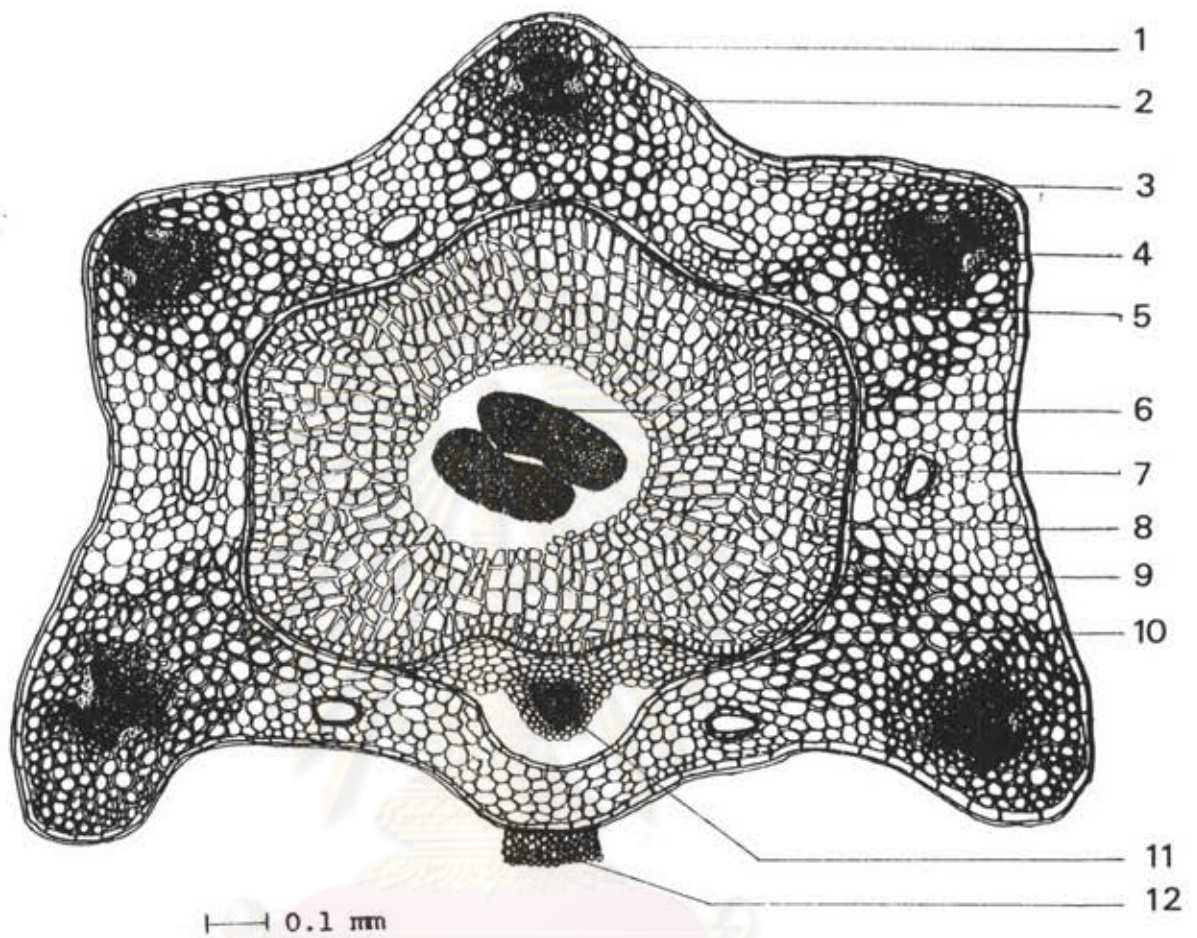


Fig.57 Transverse section of Thian Khaoplueak

- | | |
|----------------------------|---------------------|
| 1 = cuticle | 2 = epicarp |
| 3 = parenchyma of mesocarp | 4 = vascular bundle |
| 5 = porous parenchyma | 6 = cotyledon |
| 7 = vittae | 8 = endocarp |
| 9 = spermoderm | 10 = endosperm |
| 11 = raphe | 12 = carpophore |

Powdered drug

Powdered drug of Thian Khaoplueak is yellowish brown to greenish brown in colour. It has aromatic odour and taste. The microscopical characters are listed according to the frequency of tissues found as follows.(Fig.58)

1. Fragments of epicarp in surface view, showing thin-walled polygonal cells covered with smooth cuticle.
2. Fragments of endocarp in surface view, showing thin-walled cells with sinuous striped marked along the cells.
3. Fragments of mesocarp showing thin-walled cells, some fragments attached to brownish epithelial cells of vitta, some fragments attached to epicarp in sectional view.
4. Fragments of lignified parenchyma from sclerenchymatous tissue of the mesocarp, showing porous walled cells.
5. Fragments of lignified vessels showing scalariform and reticulate thickening walled cells.
6. Fragments of endosperm showing polygonal thick-walled cells containing oil globules and aleurone grains, about 10 microns in diameter, containing small rosette aggregate of calcium oxalate crystals.

7. Fragments of spermoderm in surface view, showing brownish elongated rectangular cells.

8. Scattered of oil globules.



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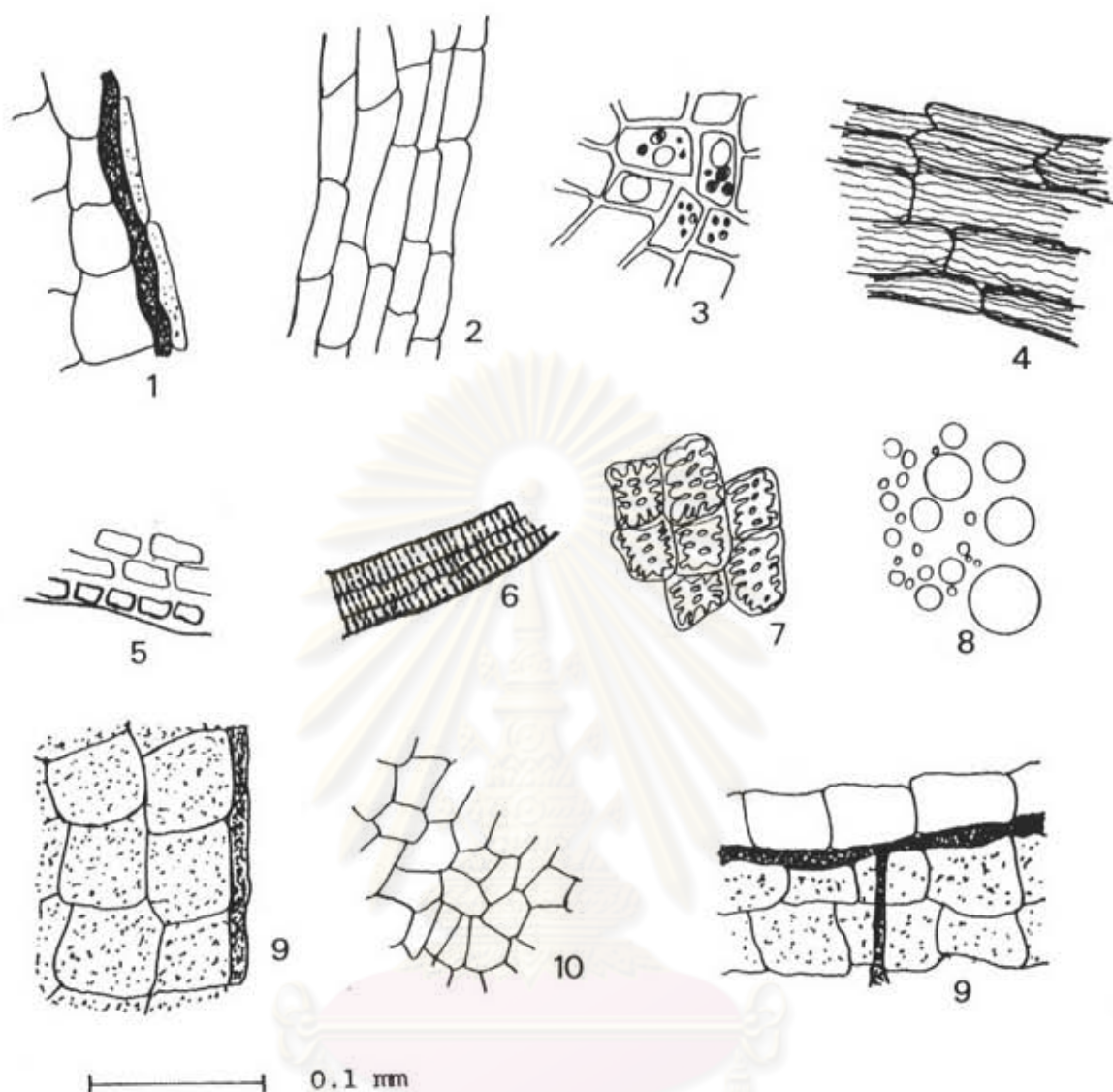


Fig.58 Microscopical character of powdered drug of Thian Khaoplueak

- | | |
|--|--|
| 1 = mesocarp in sectional view | 5 = epicarp associated with mesocarp in sectional view |
| 2 = spermoderm in surface view | 6 = reticulate vessels |
| 3 = endosperm containing oil globules and aleurone grains with microcrystals | 7 = porous parenchyma |
| 4 = endocarp in surface view | 8 = oil globules |
| | 9 = vitta in surface view |
| | 10 = epicarp in surface view |

Chromatographic characteristics

One-dimensional TLC

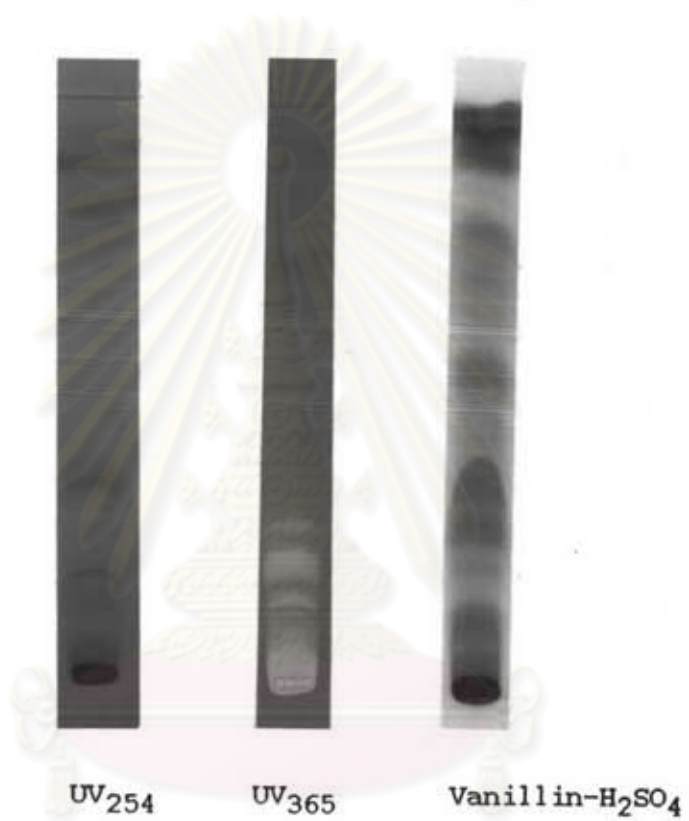


Fig.59 One-dimensional TLC characteristics of the extracts of Thian Khaoplueak

Table 10 Rf value and color of one-dimensional TLC of Thian Khaoplueak

spot	Rf	UV ₂₅₄	UV ₃₆₅	V-H ₂ SO ₄	L-B	Kedde	Dragendorff
	value						
1	0.14	-	pink F	purple	-	-	-
2	0.20	-	pink F	blue	-	-	-
3	0.22	dark	pink F	dk.purple	-	-	-
4	0.31	-	pink F	dk.purple	-	-	-
5	0.43	-	lt.blue	bl.purple	-	-	-
6	0.51	dark	-	purple	-	-	-
7	0.66	dark	-	purple	-	-	-
8	0.70	-	-	purple	-	-	-
9	0.75	-	pink	lt.blue	-	-	-
10	0.78	-	-	lt.blue	-	-	-
11	0.79	-	-	purple	-	-	-
12	0.84	-	-	purple	-	-	-
13	0.85	-	-	lt.blue	-	-	-
14	0.88	-	-	purple	-	-	-
15.	0.89	dark	-	purple	-	-	-
16.	0.97	dark	-	purple	-	-	-

lt.blue = light blue; F = fluorescent; dk.purple = dark purple;

bl.purple = bluish purple

Two-dimensional TLC

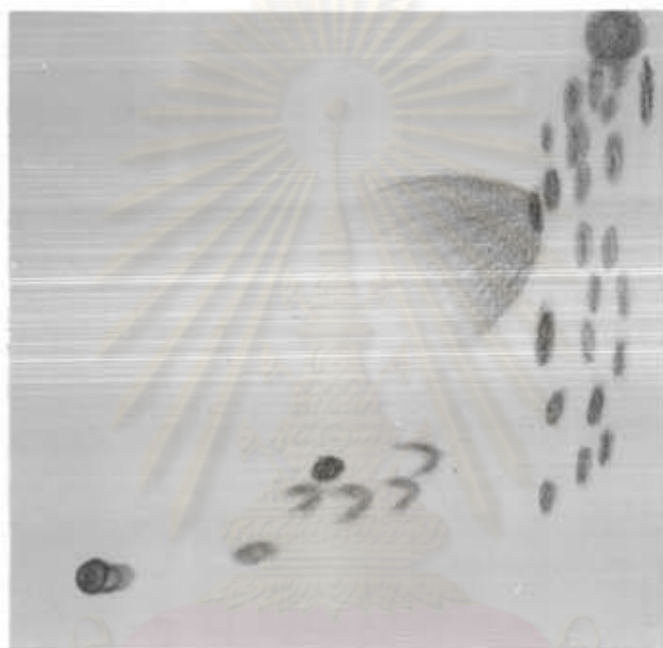


Fig.60 Two-dimensional TLC characteristics of the extracts of Thian Khaoplueak

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Table 11 Rf value and color of two-dimensional TLC of Thian Khaoplueak

spot	Rf value		color	spot	Rf value		color
	X	Y			X	Y	
1	0	0	brown	18	0.87	0.51	purple
2	0.05	0	purple	19	0.91	0.51	purple
3	0.07	0	grey	20	0.85	0.59	lt.blue
4	0.29	0.05	purple	21	0.89	0.59	lt.blue
5	0.37	0.15	purple	22*	0.76	0.66	purple
6	0.47	0.14	purple	23*	0.79	0.70	bl.purple
7	0.56	0.16	purple	24	0.85	0.71	lt.blue
8	0.80	0.15	rd.brown	25	0.89	0.75	lt.blue
9*	0.41	0.20	blue	26	0.84	0.78	lt.blue
10*	0.59	0.22	purple	27	0.79	0.79	yl.brown
11	0.85	0.20	rd.brown	28	0.89	0.84	yl.brown
12	0.89	0.24	rd.brown	29	0.83	0.85	lt.blue
13*	0.80	0.31	rd.brown	30	0.87	0.88	bl.purple
14*	0.87	0.31	rd.brown	31	0.90	0.89	yl.brown
15*	0.91	0.39	purple	32	0.95	0.88	brown
16	0.87	0.43	purple	33	0.91	0.97	purple,
17*	0.79	0.43	bl.purple				brown

rd.brown = reddish brown; bl.purple = bluish purple ;

lt.blue = light blue; yl.brown = yellowish brown

* spots which are clearly observed on the TLC plate

** spot numberings were arranged with reference to Y-axis

Ultraviolet spectroscopic characters

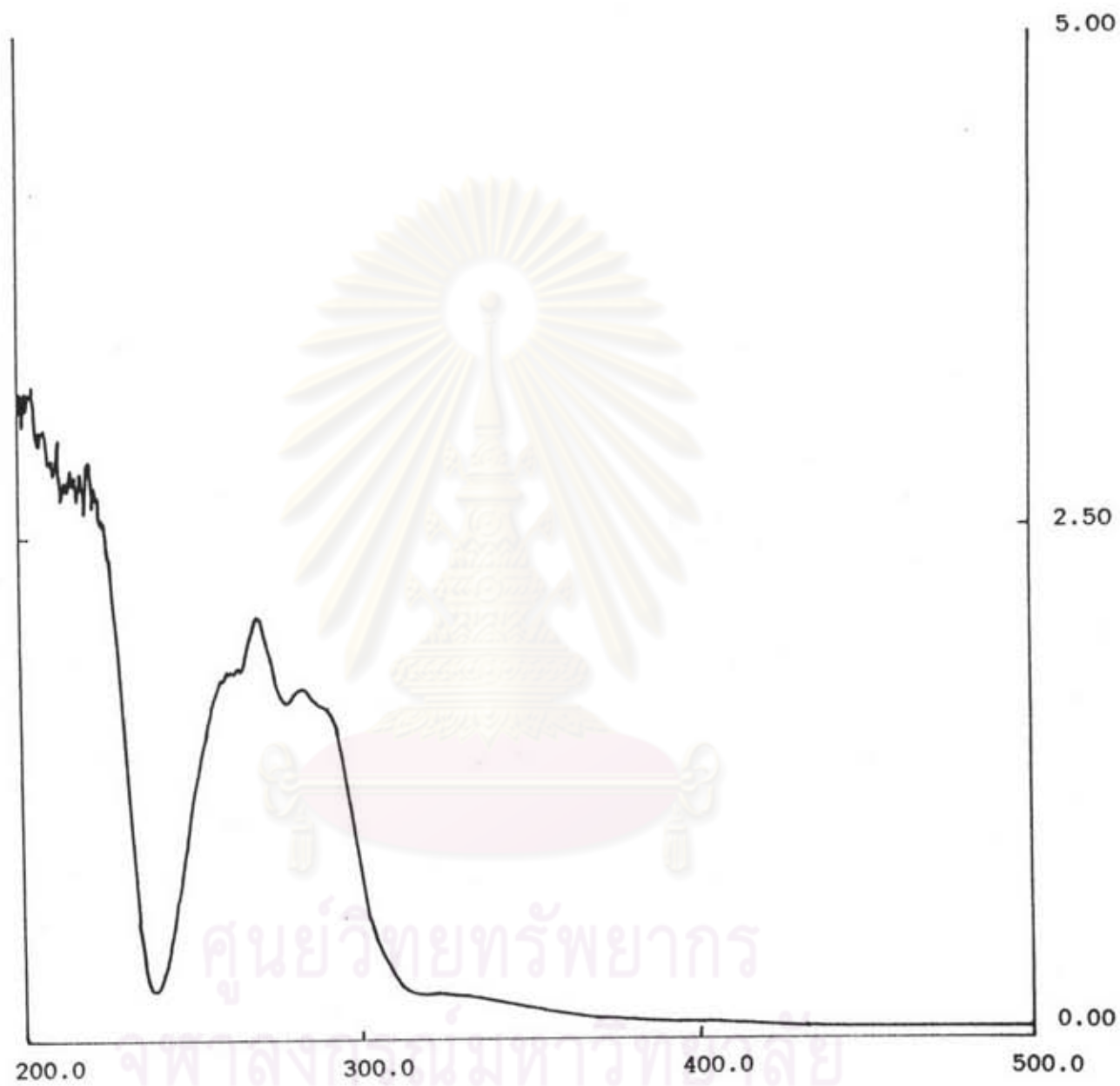


Fig.61 Ultraviolet spectrum of the extract of Thian Khaoplueak

Thian Taatakataen

Morphology of plant

Plant slender, erect, herbaceous, caulescent, branching, glabrous. Leaves deltoid in general outline, 3-4 times pinnate with linear-filiform ultimate segments; petioles broad-sheathing. Inflorescence compound umbels, terminal and lateral; florets about 2 mm in diameter; sepals minute or wanting; petals 5, yellow with a narrower inflexed apex; stamens 5; styles 2, short; stylopodium conic; ovary inferior. Carpophore 2-cleft to the base. Fruit ovoid, glabrous, flattened dorsally, with 3 distinct dorsal ridges and 2 pale coloured lateral ring, about 3 mm long, 2 mm broad. Seed flattened dorsally in cross section, the face plane. (Fig.62)

Description of crude drug

Cremocarp broadly ovoid, compressed laterally. Mericarp frequently separated, each being broadly compressed ovoid, glabrous, 4.0-6.2 mm long, 1.8-2.8 mm wide. Dorsal surface convex, dark brown, with 3 dorsal lighter-coloured longitudinal ribs, and 2 broader and longer lateral ribs which are yellowish and wing-like, and at the summit being a short conical stylopodium; commissural surface flat, brown, persisting of carpophore and pedicel (Fig.63). Sectional surface occurred 2 vittae on the commissural surface and 4 vittae on the dorsal surface between each two ribs; oily endosperm large, embedded of 2 fleshy cotyledons. Odour and taste aromatic.



stem, leaves and inflorescence



inflorescence



fruits

Fig.62 Morphology of the plant of Thian Taatakataen



|—| 2 mm

Fig.63 Morphology of the crude drug of Thian Taatakataen

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Microscopical characters

Histology

Transverse sections of *Thian Taatakataen* cut through the cotyledon region show a wing-like compressed orbicular outline, the following microscopical details are noted. (Fig.64)

1. Epicarp, covered with striated cuticle, consisting of a layer of slightly tangentially-elongated epidermal cells. In the commissural region occurs an attached carpophore, composing of lignified fibers.

2. Mesocarp, consisting of several layers of more or less collapsed, tangentially-elongated parenchymatous cells. In each of the rib portions of this zone will be noted a lignified fibrovascular bundle, surrounded by reticulate porous thickened lignified parenchymatous cells in the lateral ribs. On the dorsal side occurs 4 large vittae located between the vascular bundles; on the commissural side occurs 2 large vittae. Each vitta is elliptical, brown, and lined by small epithelial secretory cells.

3. Endocarp, composed of a layer of broad tangentially-elongated cells.

4. Spermoderm, consisting of a layer of brownish, tangentially-elongated cells which are closely united with the endocarp except where separated by a large area of collapsed thin-walled cells which are defined in the region of the raphe along the commissural side. The center of the raphe located by lignified raphe bundle.

5. Endosperm, consisting of thick-walled polygonal cells containing aleurone grains and oil globules. Each aleurone grain contains a rosette aggregate of calcium oxalate.

6. Cotyledon, consisting of thin-walled cells containing aleurone grains and oil globules.



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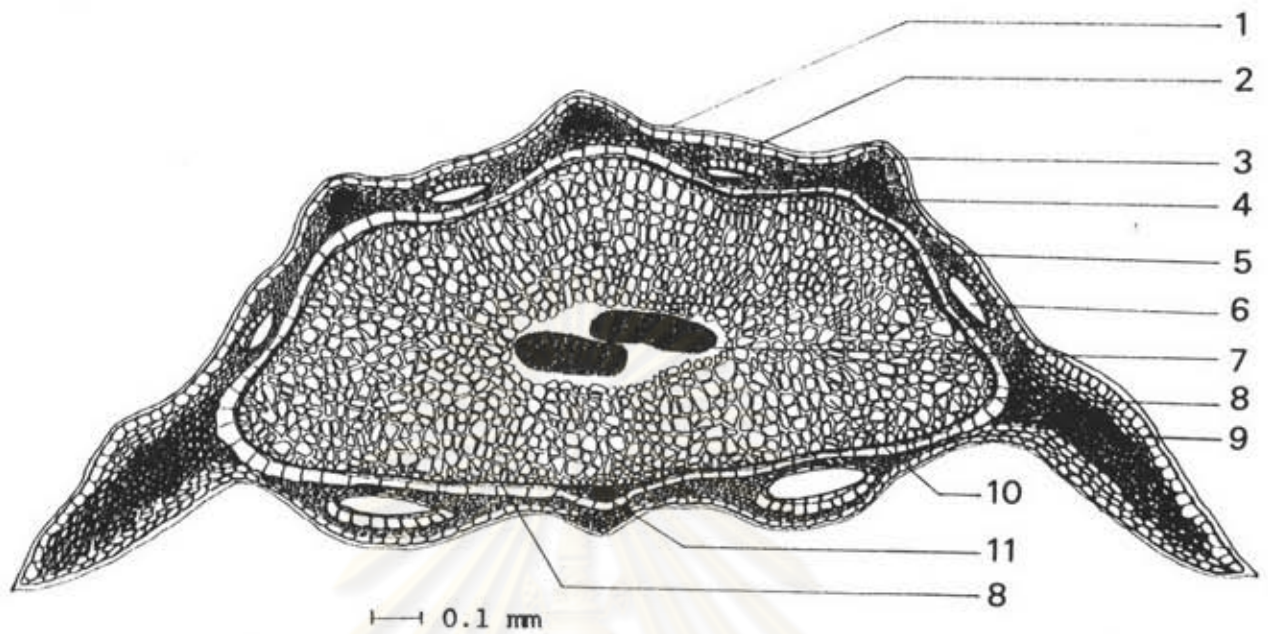


Fig.64 Transverse section of Thian Taatakataen

- | | |
|----------------------------|---------------------|
| 1 = cuticle | 2 = epicarp |
| 3 = parenchyma of mesocarp | 4 = vascular bundle |
| 5 = endocarp | 6 = vittae |
| 7 = cotyledon | 8 = spermoderm |
| 9 = porous parenchyma | 10 = endosperm |
| 11 = raphe | |

จุฬาลงกรณ์มหาวิทยาลัย

Powdered drug

Powdered drug of *Thian taatakataen* is brown in colour. It has aromatic odour and taste. The microscopical characters are listed according to the frequency of tissues found as follows. (Fig.65)

1. Fragments of epicarp in surface view, showing thin-walled polygonal cells covered with faintly striated cuticle.
2. Fragments of endocarp in surface view, showing thin-walled cells with sinuous striped marked along the cells.
3. Fragments of mesocarp showing thin-walled cells, some fragments attached to brownish epithelial cells of vitta, some fragments attached to epicarp in sectional view.
4. Fragments of lignified parenchymatous tissue of the mesocarp, showing reticulate porous walled cells.
5. Fragments of lignified vessels showing spiral, scalariform and reticulate thickening walled cells, some fragments associated with fiber elements, with or without septum and pitted canals in the wall of the cells.
6. Fragments of endosperm, showing polygonal thick-walled cell containing oil globule and aleurone grains, about 10 microns in diameter, containing small rosette aggregate of calcium oxalate

crystals.

7. Scattered of oil globules.



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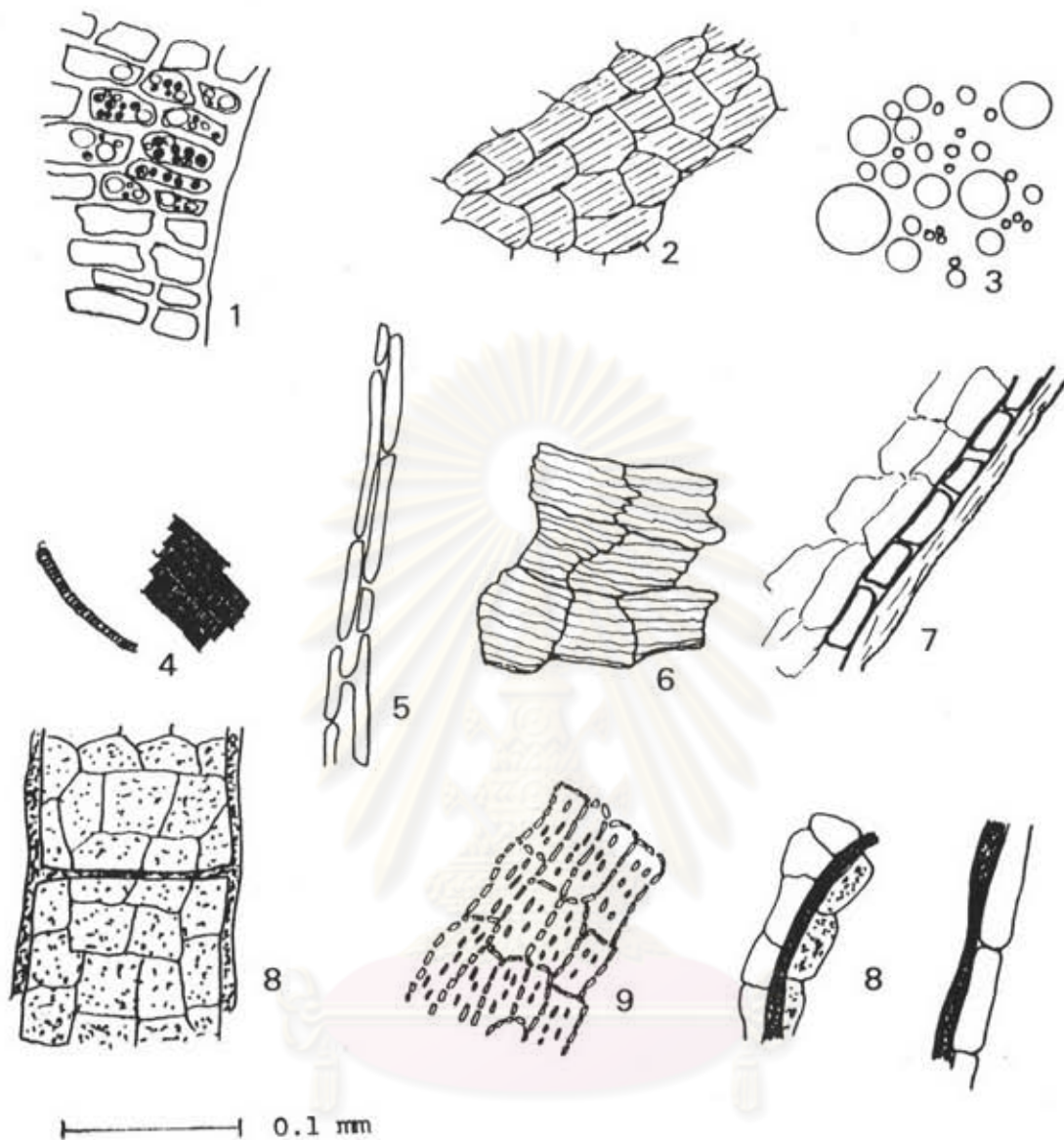


Fig.65 Microscopical character of powdered drug of Thian Taatakkataen

1 = endosperm containing oil
globules and aleurone grains
with microcrystals

2 = epicarp in surface view

3 = oil globules

4 = spiral and scalariform vessels

5 = fibro-sclereid with
transverse septum

6 = endocarp in surface view

7 = epicarp and mesocarp in
sectional view

8 = vitta

9 = porous parenchyma

Chromatographic characteristics**One-dimensional TLC**

Fig.66 One-dimensional TLC characteristics of the extracts of Thian Taatakataen

Table 13 Rf value and color of one-dimensional TLC of Thian Tatakkataen

spot	Rf	UV ₂₅₄	UV ₃₆₅	V-H ₂ SO ₄	L-B	Kedde	Dragendorff
	value						
1	0.03	-	pink F	purple	-	-	-
2	0.15	-	-	blue	-	-	-
3	0.18	-	blue	yellow	-	-	-
4	0.33	-	-	purple	-	-	-
5	0.51	-	pink	purple	-	-	-
6	0.58	-	pink F	purple	-	-	-
7	0.66	-	-	lt.blue	-	-	-
8	0.71	-	pink	lt.blue	-	-	-
9	0.78	-	lt.blue	purple	-	-	-
10	0.79	-	-	purple	-	-	-
11	0.88	dark	-	pink	-	-	-
12	0.93	dark	-	brown	-	-	-

F = fluorescent; lt.blue = light blue

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Two-dimensional TLC

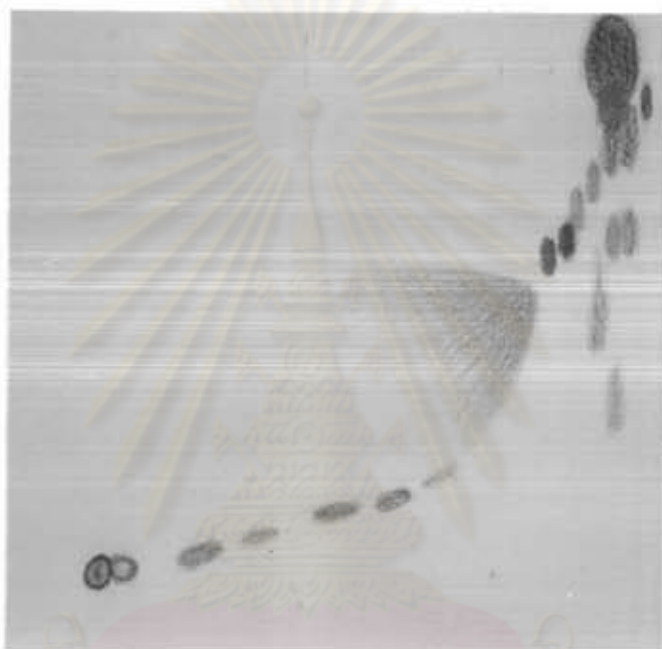


Fig.67 Two-dimensional TLC characteristics of the extracts of Thian Taatakkaen

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Table 14 Rf value and color of two-dimensional TLC of Thian Tatakataen

spot	Rf value		color	spot	Rf value		color
	X	Y			X	Y	
1	0	0	brown	12*	0.78	0.58	purple
2	0.04	0.01	blue	13*	0.81	0.60	blue
3*	0.19	0.03	purple	14*	0.89	0.62	purple
4	0.29	0.08	grey	15	0.92	0.62	grey
5	0.42	0.12	bl.purple	16	0.84	0.66	lt.blue
6	0.51	0.15	blue	17	0.86	0.71	lt.blue
7	0.59	0.18	yellow	18	0.89	0.78	blue
8	0.90	0.33	grey	19	0.92	0.79	blue
9	0.88	0.45	grey	20*	0.90	0.88	pink
10*	0.76	0.51	purple	21	0.95	0.88	brown
11	0.81	0.55	yellow	22	0.89	0.93	brown

bl.purple = bluish purple; lt.blue = light blue

* spots which are clearly observed on the TLC plate

** spot numberings were arranged with reference to Y-axis

Ultraviolet spectroscopic characters

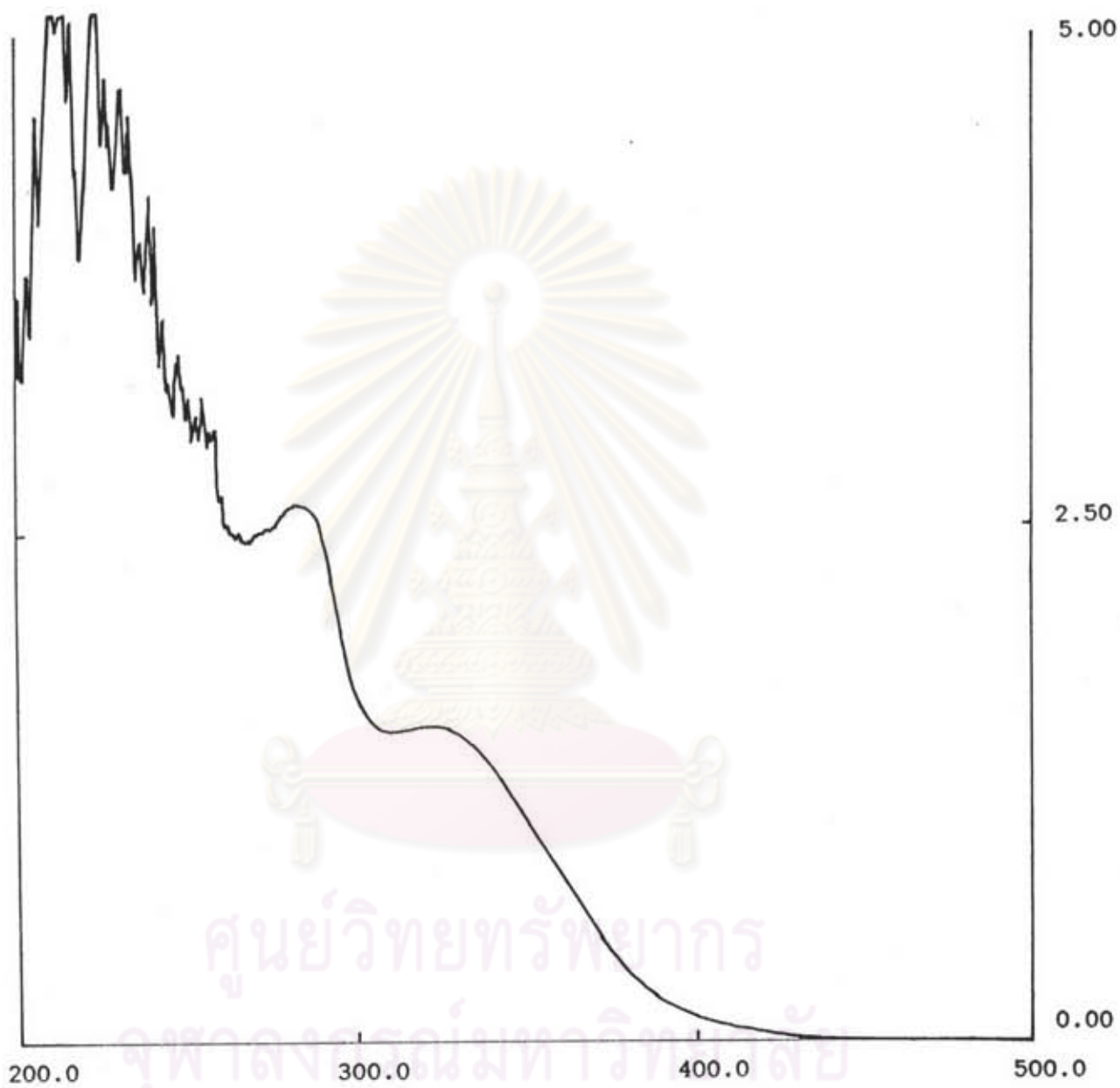


Fig.68 Ultraviolet spectrum of the extract of Thian Taatakataen

Table 15 Ultraviolet absorptions of the extract of Thian Taatakataen

peak	wavelength(nm)	absorption	peak	wavelength(nm)	absorption
1	320.0	1.50	12	229.2	4.72
2	282.8	2.62	13	226.0	4.54
3	254.0	3.18	14	224.8	4.77
4	252.4	3.07	15	222.0	5.16
5	250.0	3.17	16	216.0	4.32
6	247.2	3.39	17	214.4	5.04
7	242.4	3.58	18	212.0	5.30
8	240.0	4.05	19	208.4	5.39
9	238.0	4.19	20	204.0	4.58
10	235.6	3.95	21	202.0	3.77
11	232.0	4.59			

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Thian Yaowapanee

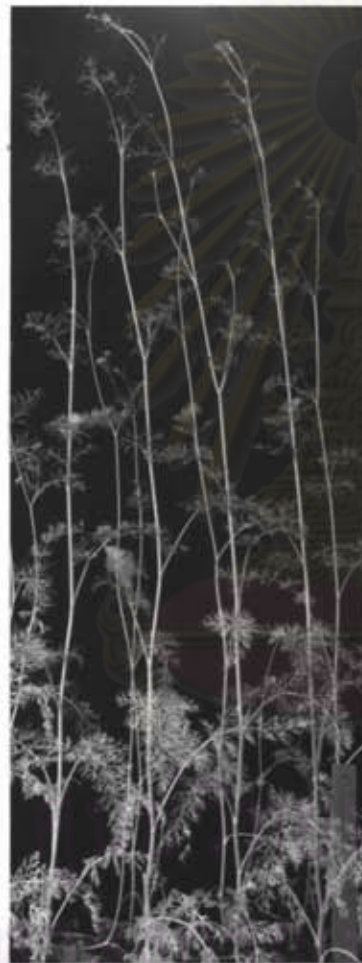
Morphology of plant

Plant slender, erect, herbaceous, caulescent, branching, glabrous. Leaves, deltoid in general outline, 2-3 pinnately dissected, the ultimate divisions ovate-lanceolate to linear; petioles sheathing. Inflorescence compound umbels: sepals minute or wanting; petals 5, greenish white with a narrower inflexed apex; stamens 5; styles 2, short; stylopodium low-conic; ovary inferior. (Fig.69)

Description of crude drug

Cremocarp broadly ovoid. Mericarp frequently separated, each being crescent shaped, 2.0-3.1 mm long, 1.0-1.4 mm wide. Dorsal surface convex, brown, with 5 lighter-coloured prominent longitudinal ribs alternating with roughened furrows, and at the summit being a short conical stylopodium; commissural surface concave, brown, persisting of carpophore and pedicel (Fig.70). Sectional surface occurred 2 vittae on the commissural surface and 4 vittae on the dorsal surface between each two ribs; oily endosperm large, embedded of 2 freshy cotyledons.

Odour and taste aromatic, characteristic.



stem and leaves



inflorescence

Fig.69 Morphology of the plant of Thian Yaowapanee



— 2 mm

Fig.70 Morphology of the crude drug of Thian Yaowapanee

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Microscopical characters

Histology

Transverse sections of Thian Yaowapanee cut through the cotyledon region show a pentagonal outline, the following microscopical details are noted.(Fig.71)

1. Epicarp, covered with striated cuticle, consisting of a layer of epidermal cells, numerous papillae and covering trichomes which are short, unicellular, non-glandular hairs with thick papillose walls. In the commissural region occurs an attached carpophore, composing of lignified fibers.

2. Mesocarp, consisting of several layers of more or less collapsed, tangentially-elongated parenchymatous cells. In each of the rib portions of this zone will be noted a lignified fibrovascular bundle. On the dorsal side occurs 4 large vittae located between the vascular bundles; on the commissural side occurs 2 large vittae. Each vitta is elliptical, brown, and lined by small epithelial secretory cells.

3. Endocarp, composed of a layer of tangentially-elongated cells.

4. Spermoderm, consisting of a layer of brownish, tangentially-elongated cells which are closely united with the

endocarp except where separated by a large area of collapsed thin-walled cells which are defined in the region of the raphe along the commissural side. The center of the raphe located by lignified raphe bundle.

5. Endosperm, consisting of thick-walled polygonal cells containing aleurone grains and oil globules. Each aleurone grain contains a rosette aggregate of calcium oxalate.

6. Cotyledon, consisting of thin-walled cells containing aleurone grains and oil globules.



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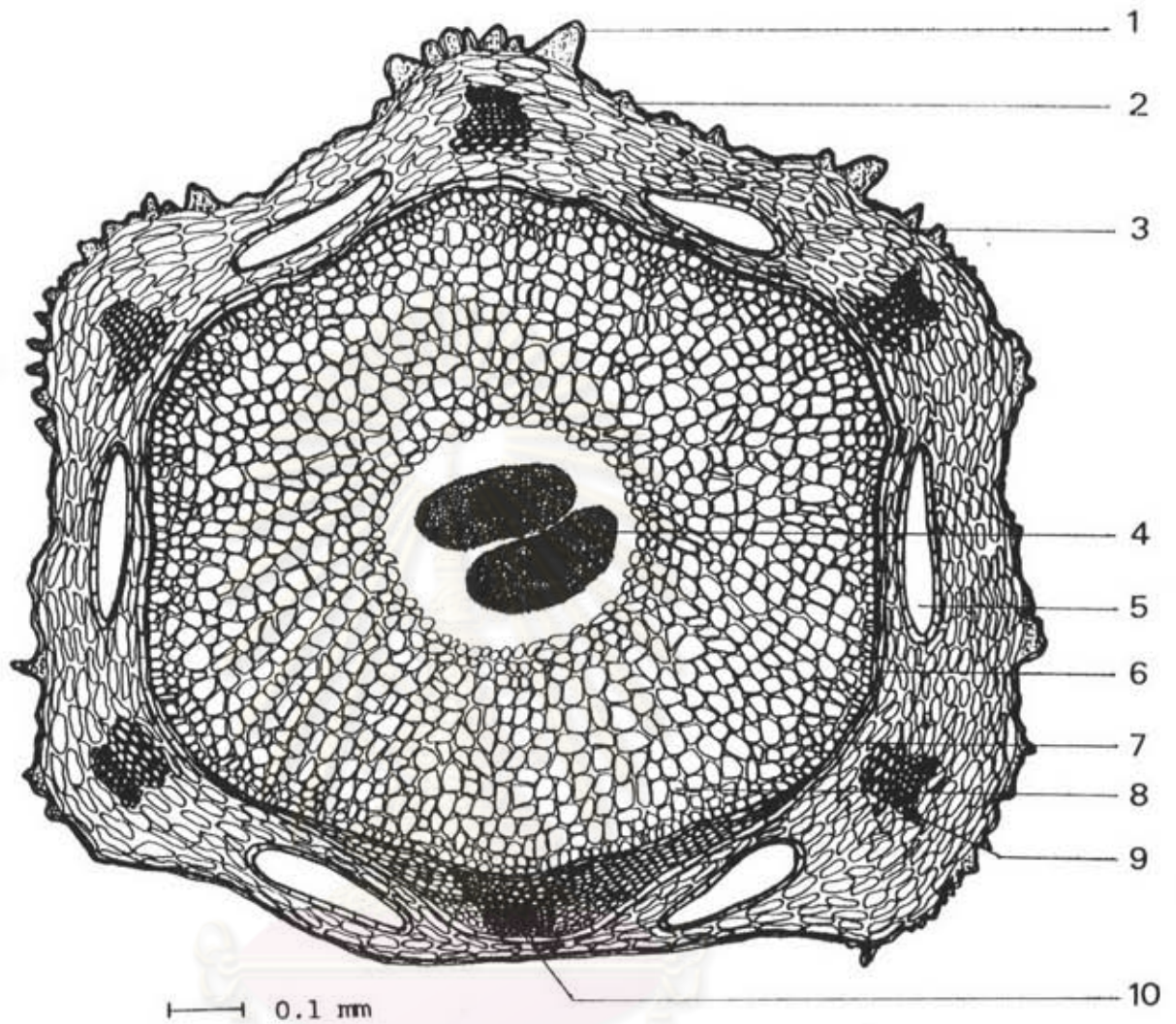


Fig.71 Transverse section of Thian Yaowapanee

- | | |
|----------------------------|---------------|
| 1 = covering trichome | 2 = epicarp |
| 3 = parenchyma of mesocarp | 4 = cotyledon |
| 5 = vittae | 6 = endocarp |
| 7 = spermoderm | 8 = endosperm |
| 9 = vascular bundle | 10 = raphe |

Powdered drug

Powdered drug of *Thian Yaowapanee* is brown in colour. It has aromatic odour and aromatic characteristic taste. The microscopical characters are listed according to the frequency of tissues found as follows. (Fig. 72)

1. Fragments of epicarp in surface view, showing thin-walled polygonal cells covered with striated cuticle.
2. Fragments of epicarp in sectional view, showing papillae or covering trichomes, unicellular, rounded at apex, up to 100 microns long, and covered with thick papillose walls, some trichome scattered from the epicarp.
3. Fragments of endocarp in surface view, showing thin-walled elongated rectangular cells with smooth surface.
4. Fragments of mesocarp showing thin-walled cells, some fragments attached to brownish epithelial cells of vitta.
5. Fragments of lignified parenchyma from sclerenchymatous tissue of the mesocarp, showing reticulate porous walled cells.
6. Fragments of lignified vessels, showing scalariform and reticulate thickening walled cells.

7. Fragments of endosperm, showing thick-walled polygonal cells containing oil globules and aleurone grains, about 10 microns in diameter, containing small rosette aggregate of calcium oxalate crystals.

8. Fragments of spermoderm in sectional view, showing brownish cells associated with endocarp.

9. Scattered of oil globules.



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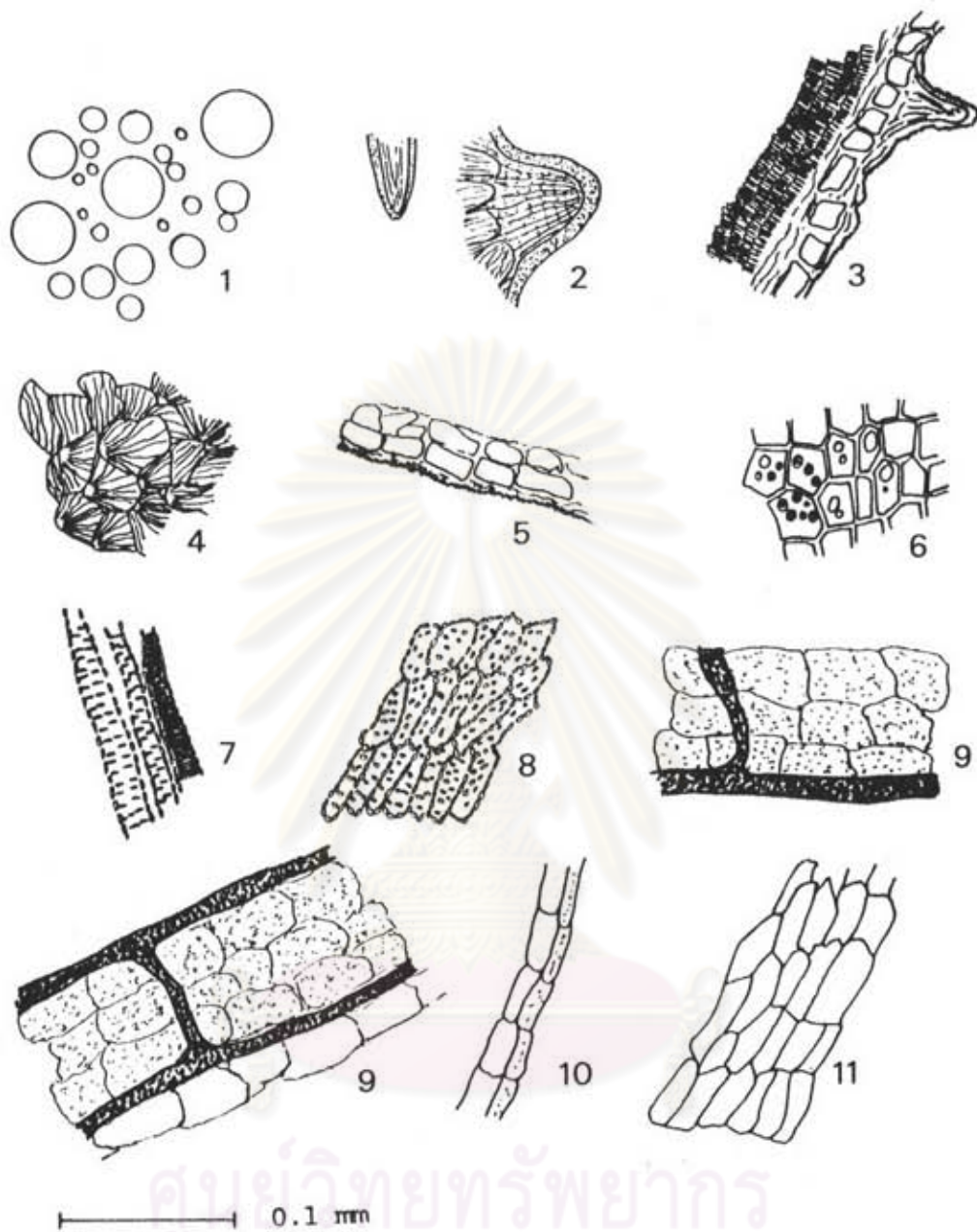


Fig.72 Microscopical character of powdered drug of Thian Yaowapanee

- | | |
|---|--|
| 1 = oil globules | 6 = endosperm containing oil globules and aleurone grains with microcrystals |
| 2 = unicellular trichome | 7 = scalariform and reticulate vessels |
| 3 = epicarp with unicellular trichome in sectional view associated with vascular bundle | 8 = porous parenchyma |
| 4 = epicarp in surface view | 9 = vitta in surface view |
| 5 = epicarp in sectional view | 10 = spermoderm and endocarp in sectional view |
| | 11 = endocarp in surface view |

Chromatographic characteristics

One-dimensional TLC



Fig.73 One-dimensional TLC characteristics of the extracts of
Thian Yaowapanee

Table 16 Rf value and color of one-dimensional TLC of Thian Yaowapanee

spot	Rf value	UV ₂₅₄	UV ₃₆₅	V-H ₂ SO ₄	L-B	Kedde	Dragendorff
1	0.05	-	white	purple	-	-	-
2	0.07	-	-	purple	-	-	-
3	0.10	-	white	purple	-	-	-
4	0.40	-	lt.blue	purple	-	-	-
5	0.55	-	-	yellow	-	-	-
6	0.56	-	pink	purple	-	-	-
7	0.64	-	-	lt.green	-	-	-
8	0.73	-	-	purple	-	-	-
9	0.77	-	-	purple	-	-	-
10	0.84	-	-	pink	-	-	-
11	0.89	-	pink	blue	-	-	-
12	0.93	dark	-	brown	-	-	-

lt.blue = light blue; lt.green = light green

Two-dimensional TLC

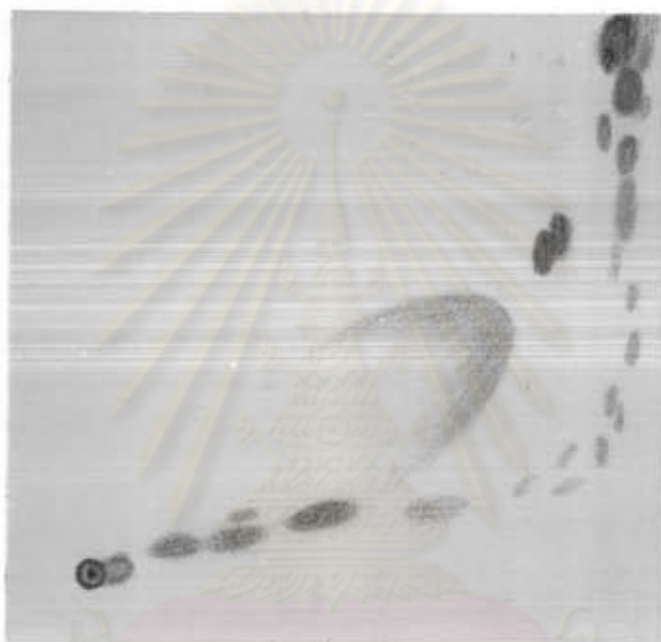


Fig.74 Two-dimensional TLC characteristics of the extracts of
Thian Yaowapanee

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Table 17 Rf value and color of two-dimensional TLC of Thian Yaowapanee

spot	Rf value		color	spot	Rf value		color
	X	Y			X	Y	
1	0	0	brown	15*	0.72	0.40	purple
2	0.05	0.01	purple	16	0.94	0.48	grey
3*	0.15	0.05	purple	17	0.91	0.55	yellow
4	0.24	0.07	purple	18*	0.80	0.56	purple
5	0.26	0.10	lt.blue	19*	0.82	0.59	deep blue
6*	0.41	0.10	purple	20	0.93	0.64	lt.green
7	0.61	0.12	yellow	21*	0.93	0.73	purple
8	0.76	0.15	grey	22	0.89	0.77	blue
9	0.84	0.16	grey	23	0.96	0.81	yellow
10	0.84	0.21	grey	24*	0.93	0.84	pink
11*	0.88	0.21	purple	25	0.90	0.89	deep blue
12	0.92	0.27	grey	26	0.92	0.93	brown
13	0.91	0.30	grey	27	0.96	0.93	yellow
14	0.95	0.39	grey				

lt.green = light green; lt.blue = light blue

* spots which are clearly observed on the TLC plate

** spot numberings were arranged with reference to Y-axis

Ultraviolet spectroscopic characters

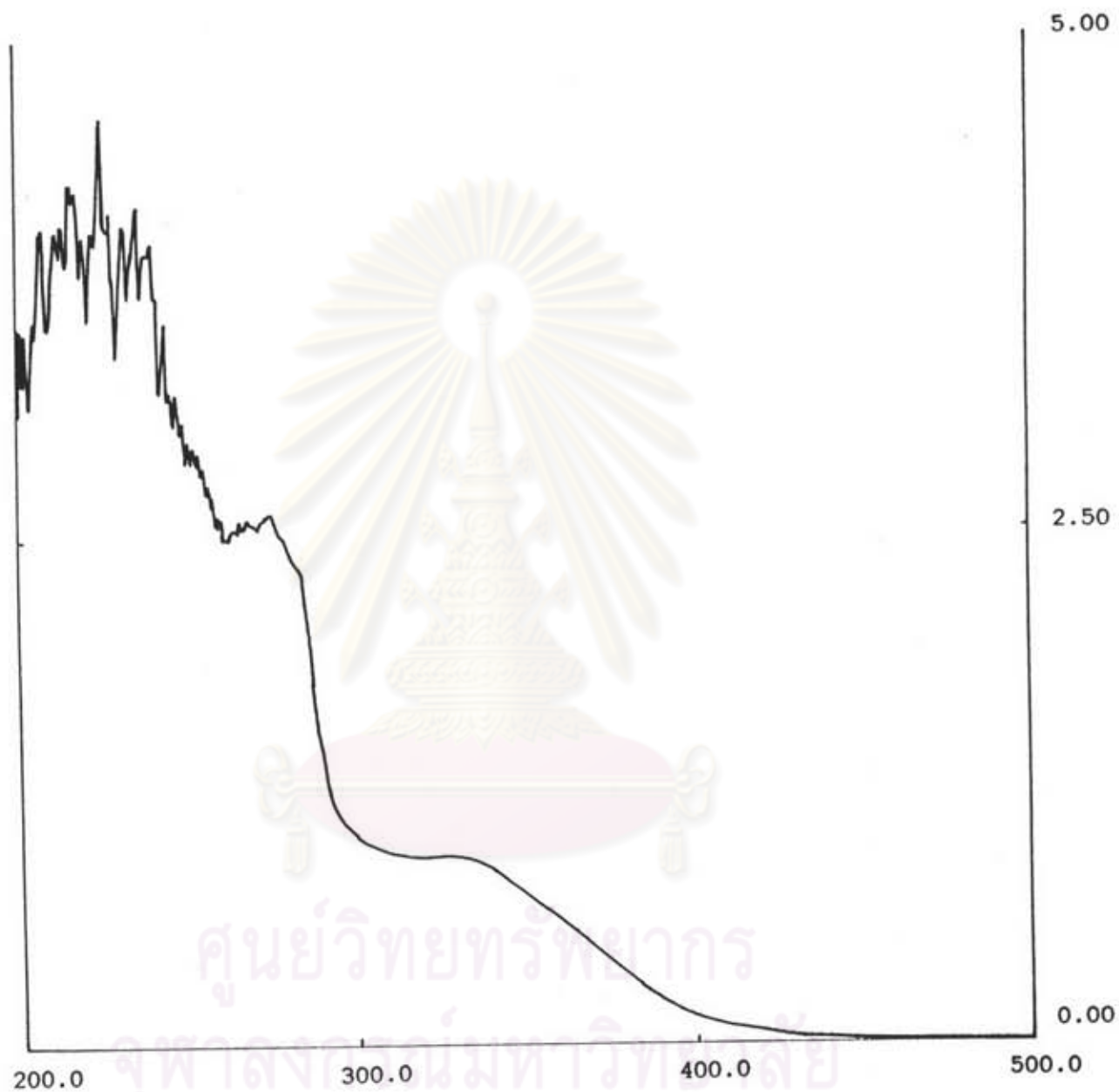


Fig.75 Ultraviolet spectrum of the extract of Thian Yaowapanee

Table 18 Ultraviolet absorptions of the extract of Thian Yaowapane

peak	wavelength(nm)	absorption	peak	wavelength(nm)	absorption
1	323.0	0.90	9	229.6	4.07
2	274.0	2.62	10	225.6	4.14
3	249.2	2.99	11	222.8	4.60
4	245.6	3.23	12	217.6	4.00
5	242.0	3.58	13	214.0	4.28
6	239.2	3.73	14	211.6	4.07
7	237.6	3.98	15	209.2	4.04
8	234.0	4.17	16	205.6	4.06

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Thian Sattabut**Morphology of plant**

Plant slender, herbaceous, caulescent. Basal leaves long-petiolate, membranaceous, pubescent, lamina broadly orbicular to reniform, margin regularly finely serrate or pinnately dissected. (Fig.76)

Description of crude drug

Cremocarp ovoid. Mericarp frequently separated, each being crescent shaped, slightly pubescent, 3.0-4.8 mm long, 1.4-2.0 mm wide. Dorsal surface convex, brown, with 5 longitudinal ribs and at the summit being a short conical stylopodium; commissural surface concave, brown, persisting of carpophore and pedicel (Fig.77). Sectional surface occurred many vittae along the seed coat; oily endosperm large, embedded of 2 freshy cotyledons.

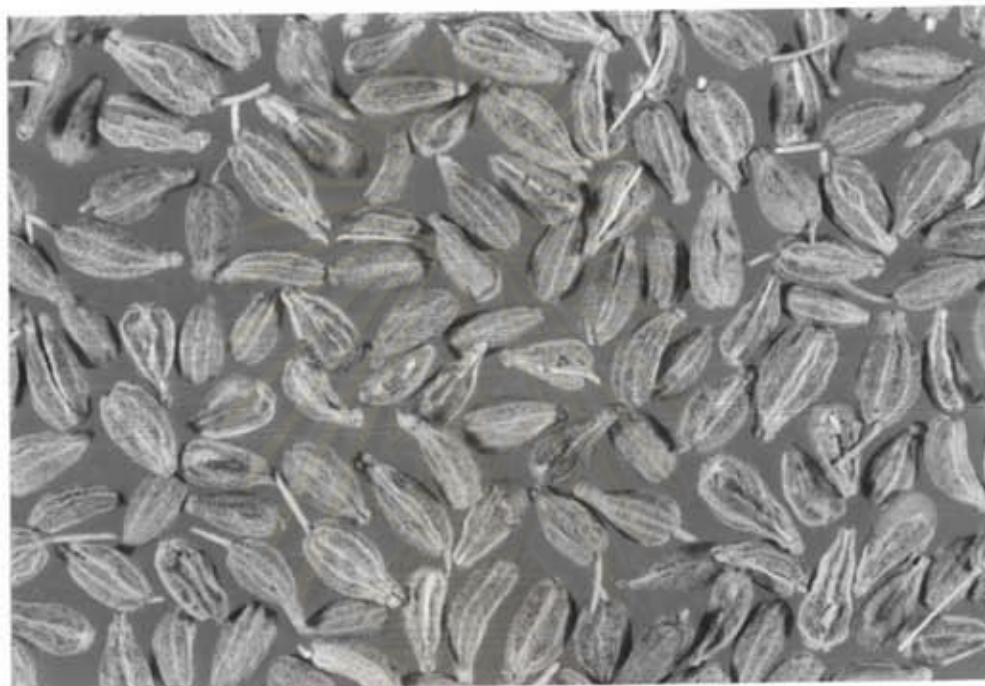
Odour and taste aromatic.



stem and leaves

Fig.76 Morphology of the plant of Thian Sattabut

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┆┆ 2 mm

Fig.77 Morphology of the crude drug of Thian Sattabut

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Microscopical characters

Histology

Transverse sections of *Thian Sattabut* cut through the cotyledon region show a reniform outline, the following microscopical details are noted. (Fig. 78)

1. Epicarp, covered with striated cuticle, consisting of a layer of epidermal cells having numerous papillae and short, unicellular, non-glandular hairs with thick papillose walls.

2. Mesocarp, consisting of 3-4 layers of tangentially-elongated parenchymatous cells. In the center of each of the rib portions occurs a small lignified fibrovascular bundle. On the dorsal side occurs 30-35 small vittae forming a line along the side; on the commissural side, 2 large vittae or with 2 to 8 small vittae are noted. Each vitta is elliptical, brown, and lined by small epithelial secretory cells.

3. Endocarp, consisting of a layer of tangentially-elongated thin-walled cells closely adherent to the seed coat, except near the middle line of the commissural side where the endocarp cells may have thick walled cells.

4. Spermoderm, consisting of a layer of brownish tangentially-elongated cells which are closely united with the endocarp except

where separated by a large area of collapsed thin-walled cells which are defined in the region of the raphe along the commissural side. The center of the raphe located by lignified raphe bundle.

5. Endosperm, consisting of thick-walled polygonal cells containing aleurone grains and oil globules. Each aleurone grain contains a rosette aggregate of calcium oxalate.

6. Cotyledon, consisting of thin-walled cells containing aleurone grains and oil globules.



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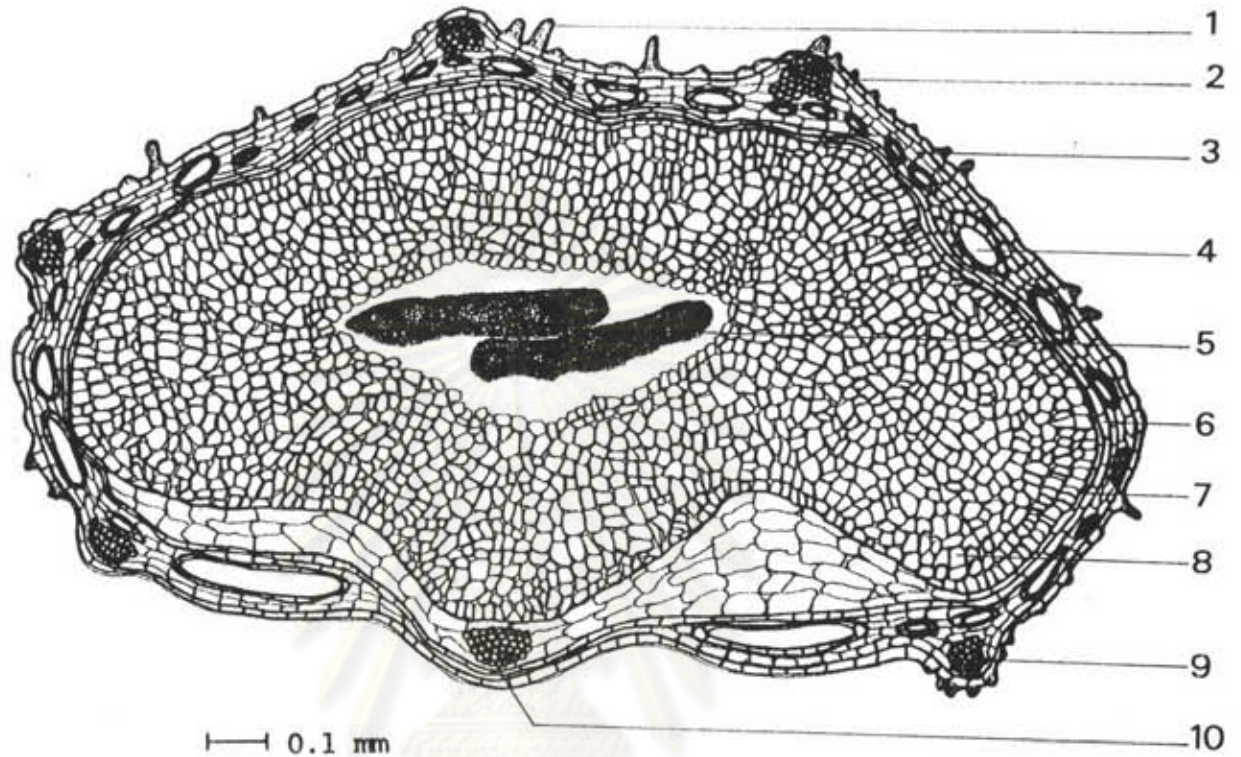


Fig.78 Transverse section of Thian Sattabut

- | | |
|----------------------------|---------------|
| 1 = covering trichome | 2 = epicarp |
| 3 = parenchyma of mesocarp | 4 = vittae |
| 5 = cotyledon | 6 = endocarp |
| 7 = spermoderm | 8 = endosperm |
| 9 = vascular bundle | 10 = raphe |

Powdered drug

Powdered drug of Thian Sattabut is yellowish brown in colour. It has aromatic odour and taste. The microscopical characters are listed according to the frequency of tissues found as follows. (Fig.79)

1. Fragments of epicarp in surface view, showing thin-walled polygonal cell covered with faintly striated cuticle.
2. Fragments of epicarp in sectional view, showing papillae or covering trichomes, unicellular with thick papillose walls, and rounded end, up to 200 microns long.
3. Fragments of endocarp in surface view, showing thin-walled elongated cells with smooth surface.
4. Fragments of vitta showing brownish epithelial cells and underlying endocarp in surface view.
5. Fragments of lignified sclereids from sclerenchymatous tissue of the mesocarp, showing pitted thickening walled cells.
6. Fragments of lignified vessels, showing spiral, scalariform and reticulate thickening walled cells.

7. Fragments of endosperm, showing thick-walled polygonal cell containing oil globules and aleurone grain, about 10 microns in diameter, containing small rosette aggregate of calcium oxalate crystals.

8. Scattered of covering trichomes showing thick papillose walls, usually unicellular, conical, slightly curved, occasionally the lumen is divided by single transverse septum.

9. Scattered of oil globules.



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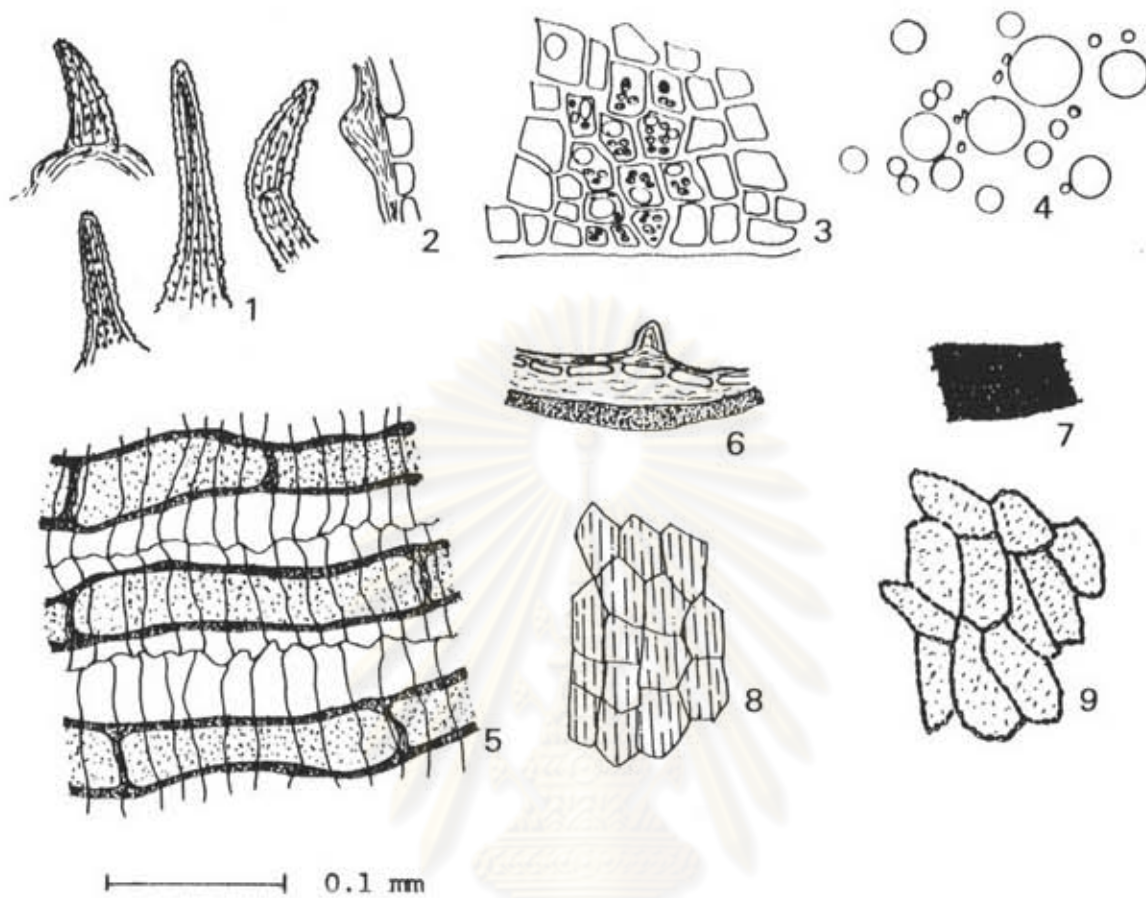


Fig.79 Microscopical character of powdered drug of Thian Sattabut

- 1 = covering trichomes
- 2 = epicarp in sectional view
- 3 = endosperm containing oil globules and aleurone grains with microcrystals
- 4 = oil globules
- 5 = vitta in surface view with underlying endocarp
- 6 = vitta in sectional view associated with epicarp and trichome
- 7 = scleriform vessels
- 8 = epicarp in surface view
- 9 = sclereids

Chromatographic characteristics

One-dimensional TLC

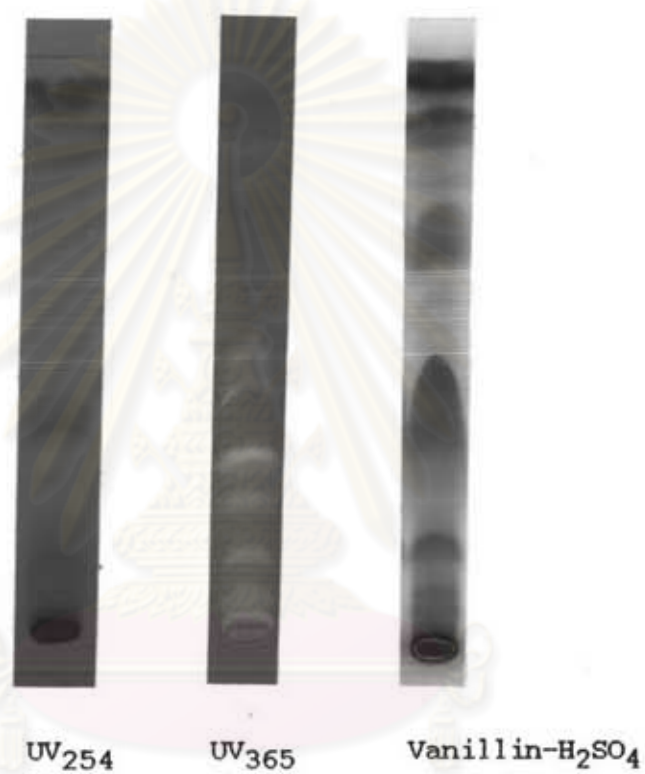


Fig.80 One-dimensional TLC characteristics of the extracts of Thian Sattabut

Table 19 Rf value and color of one-dimensional TLC of Thian Sattabut

spot	Rf	UV ₂₅₄	UV ₃₆₅	V-H ₂ SO ₄	L-B	Kedde	Dragendorff
	value						
1	0.04	-	lt.blue	purple	-	-	-
2	0.10	-	-	lt.blue	-	-	-
3	0.16	-	lt.blue	bl.purple	-	-	-
4	0.34	-	pink	rd.brown	-	-	-
5	0.38	-	lt.blue	bl.purple	-	-	-
6	0.48	-	lt.blue F	purple	-	-	-
7	0.51	dark	pink	purple	-	-	-
8	0.63	-	pink	purple	-	-	-
9	0.81	dark	lt.blue	purple	-	-	-
10	0.96	-	-	purple	-	-	-
11	0.98	dark	-	brown	-	-	-

lt.blue = light blue; F = fluorescent; bl.purple = bluish purple;
rd.brown = reddish brown



Two-dimensional TLC

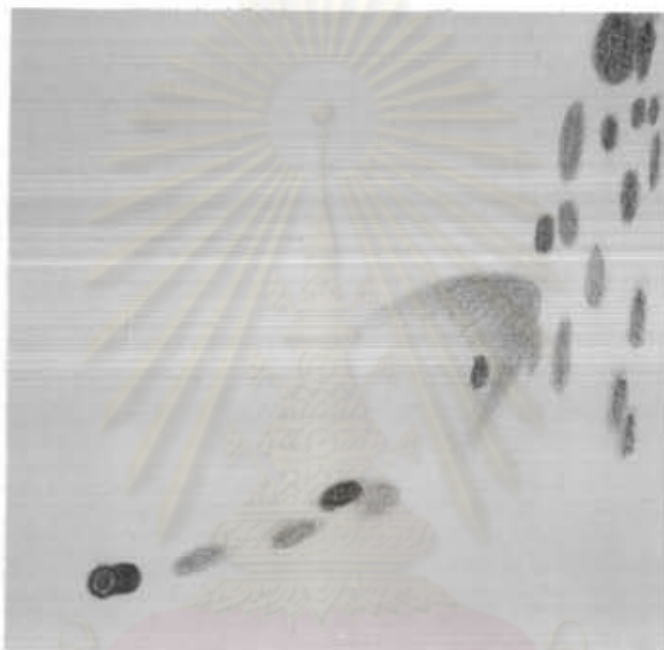


Fig.81 Two-dimensional TLC characteristics of the extracts of
Thian Sattabut

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Table 20 Rf value and color of two-dimensional TLC of Thian Sattabut

spot	Rf value		color	spot	Rf value		color
	X	Y			X	Y	
1	0	0	brown	14	0.89	0.55	lt.blue
2	0.05	0	blue	15*	0.76	0.63	purple
3	0.17	0.04	purple	16*	0.79	0.65	bl.purple
4	0.33	0.10	lt.blue	17*	0.89	0.68	yl.brown
5*	0.41	0.16	bl.purple	18	0.93	0.75	brown
6	0.47	0.16	lt.blue	19	0.80	0.79	lt.blue
7	0.89	0.27	rd.brown	20	0.87	0.81	purple
8*	0.88	0.34	rd.brown	21	0.91	0.85	yellow
9*	0.64	0.38	bl.purple	22	0.93	0.85	brown
10*	0.74	0.42	pink	23	0.88	0.98	brown
11*	0.79	0.41	blue	24	0.92	0.93	yellow
12*	0.91	0.48	rd.brown	25	0.92	0.96	purple
13*	0.72	0.51	purple	26	0.92	0.99	lt.blue

rd.brown = reddish brown; bl.purple = bluish purple ;
 lt.blue = light blue; yl.brown = yellowish brown

* spots which are clearly observed on the TLC plate

** spot numberings were arranged with reference to Y-axis

Ultraviolet spectroscopic characters

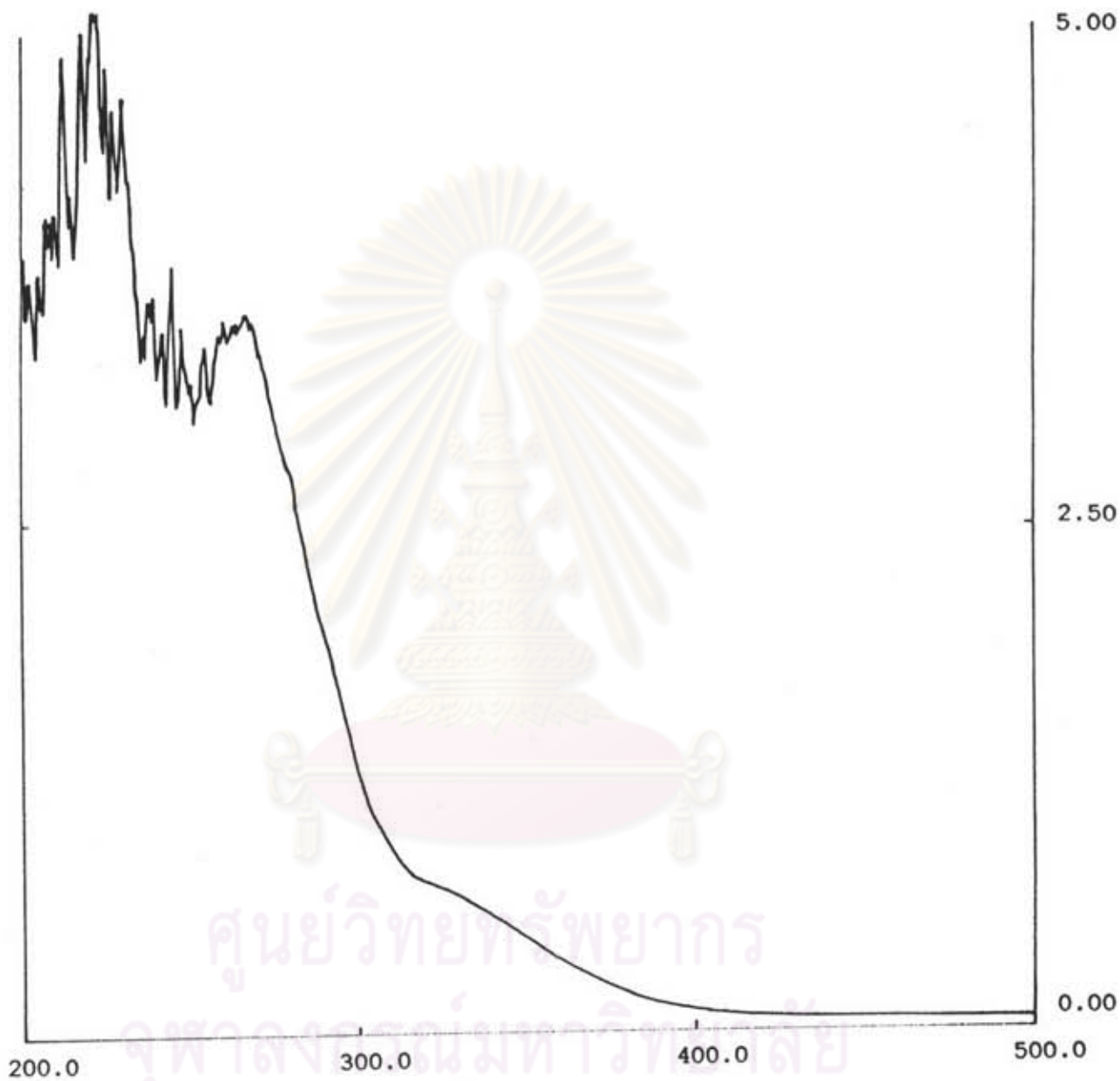


Fig.82 Ultraviolet spectrum of the extract of Thian Sattabut

Table 21 Ultraviolet absorptions of the extract of Thian Sattabut

peak	wavelength(nm)	absorption	peak	wavelength(nm)	absorption
1	274.0	3.51	12	232.0	4.66
2	268.8	3.57	13	229.2	4.60
3	258.0	3.35	14	227.2	4.81
4	262.4	3.54	15	223.6	5.12
5	256.8	3.40	16	220.0	4.98
6	250.0	3.52	17	216.4	4.18
7	246.8	3.80	18	214.4	4.85
8	244.4	3.49	19	211.6	4.09
9	241.2	3.65	20	210.4	4.04
10	238.4	3.47	21	209.2	4.05
11	233.6	4.25	22	206.8	3.78

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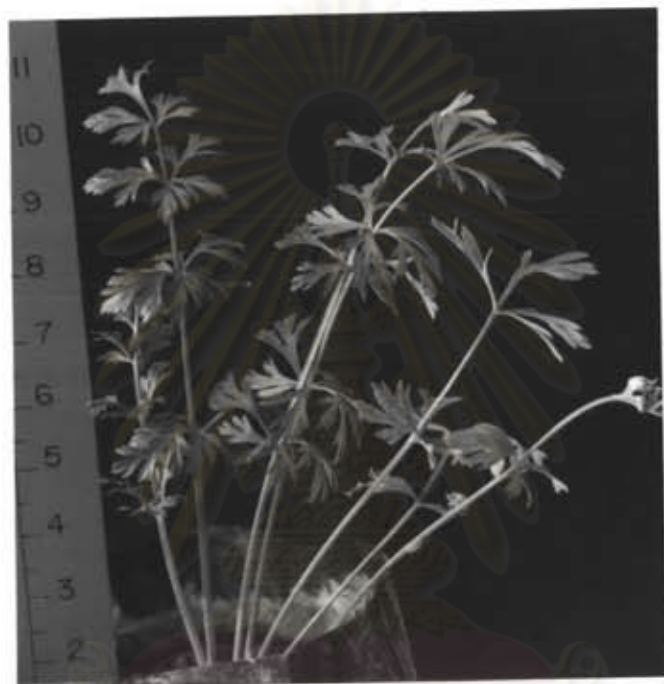
Thian Taakob**Morphology of plant**

Plant slender, herbaceous, caulescent, glabrous. Basal leaves petiolate, membranaceous, oblong to oval in general outline, 2-3 pinnately dissected, the ultimate divisions narrow to filiform, entire or toothed; petioles sheathing. (Fig.83)

Description of crude drug

Meri carp usually separated, narrowly elliptical but slightly curved, similar to cumin, 4.8-5.9 mm long, 1.0-1.4 mm wide, glabrous. Cremocarp oblong. Dorsal surface convex, dark brown, with 5 longitudinal ribs, and at the summit with a conical stylopodium; commissural surface concave, dark brown, persisting of carpophore (Fig.84). Sectional surface occurred 2 vittae on the commissural surface and 4 vittae on the dorsal surface between each two primary ribs; oily endosperm large, embedded of 2 freshy cotyledons.

Odour and taste aromatic, characteristic.



stem and leaves

Fig.83 Morphology of the plant of Thian Taakob

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— 2 mm

Fig.84 Morphology of the crude drug of Thian Taakob

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Microscopical characters

Histology

Transverse sections of Thian Taakob cut through the cotyledon region show a nearly equilaterally pentagonal outline, the following microscopical details are noted.(fig.85)

1. Epicarp, covered with striated cuticle, consisting of a layer of slightly tangentially-elongated epidermal cells.

2. Mesocarp, consisting of several layers of more or less collapsed, tangentially-elongated parenchymatous cells. In each of the rib portions of this zone will be noted a small vitta and beneath is a lignified fibrovascular bundle; On the dorsal side occurs 4 large vittae located between the vascular bundle; on the commissural side occurs 2 large vittae. Each vitta is elliptical, brown, and lined by small epithelial secretory cells.

3. Endocarp, composed of a layer of broad tangentially-elongated cells.

4. Spermoderm, consisting of a layer of somewhat collapsed brownish cells, which are closely united with the endocarp except where separated by a large area of collapsed thin-walled cells which are defined in the region of the raphe along the commissural side. The center of the raphe located by lignified raphe bundle.

5. Endosperm, consisting of thick-walled polygonal cells containing aleurone grains and oil globules. Each aleurone grain contains a rosette aggregate of calcium oxalate.

6. Cotyledon, consisting of thin-walled cells containing aleurone grains and oil globules.



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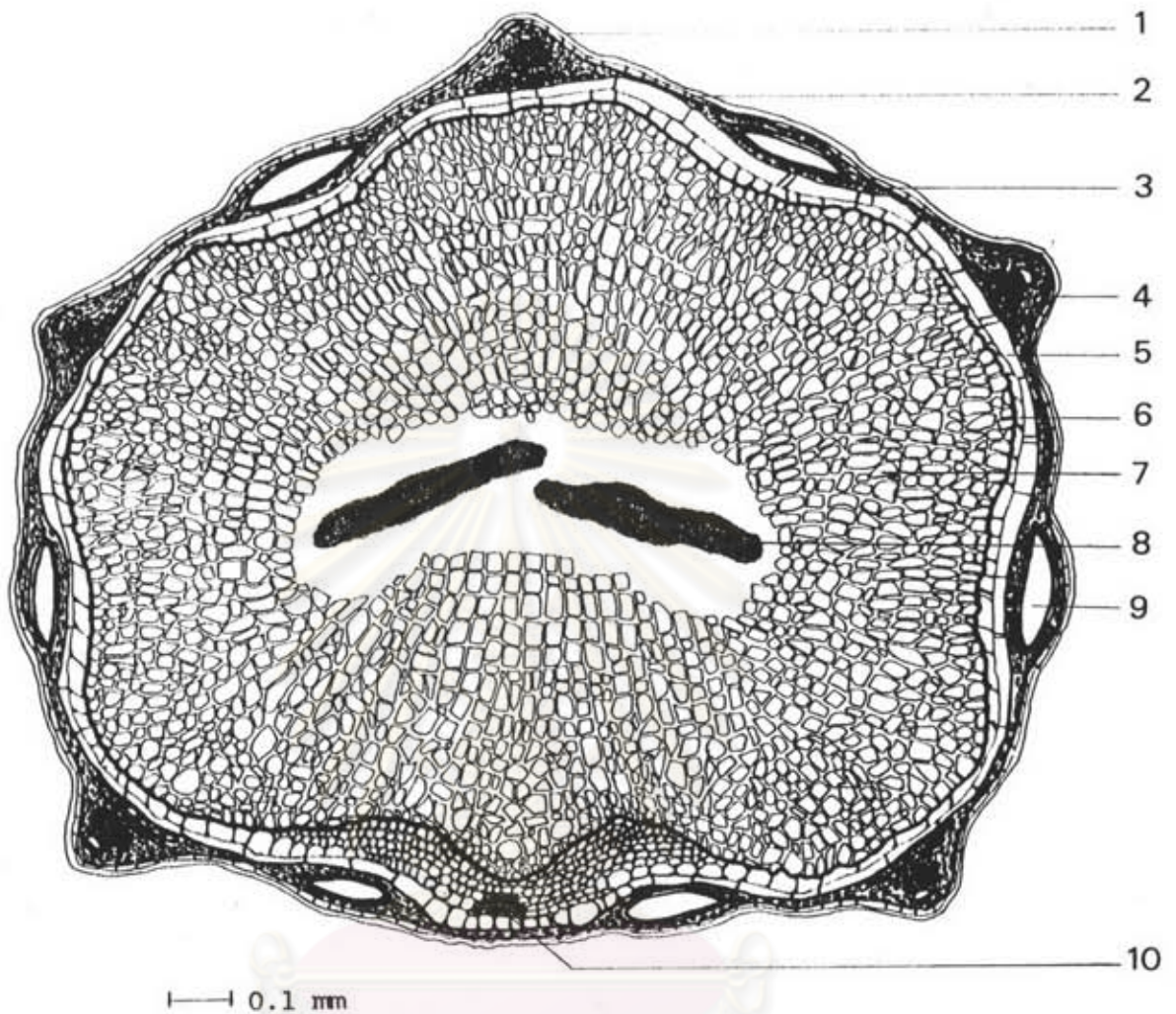


Fig.85 Transverse section of Thian Taakob

- | | |
|----------------------------|---------------------|
| 1 = cuticle | 2 = epicarp |
| 3 = parenchyma of mesocarp | 4 = vascular bundle |
| 5 = endocarp | 6 = spermoderm |
| 7 = endosperm | 8 = cotyledon |
| 9 = vittae | 10 = raphe |

Powdered drug

Powdered drug of Thian Taakob is brown in colour. It has aromatic odour and aromatic characteristic taste. The microscopical characters are listed according to the frequency of tissues found as follows.(Fig.86)

1. Fragments of epicarp in surface view, showing thin-walled polygonal cells covered with faintly striated cuticle.
2. Fragments of endocarp in surface view, showing thin-walled elongated polygonal cells with smooth surface.
3. Fragments of mesocarp showing thin-walled cells, some fragments attached to brownish epithelial cells of vitta, occasionally attached to endocarp in sectional view.
4. Fragments of lignified sclereids from sclerenchymatous tissue of the mesocarp, showing pitted thickening walled cells.
5. Fragments of lignified vessels, showing scalariform and reticulate thickening walled cells.
6. Fragments of endosperm showing thick-walled polygonal cells containing oil globules and aleurone grains, about 10 microns in diameter, containing small rosette aggregate of calcium oxalate crystals.

7. Scattered of oil globules.



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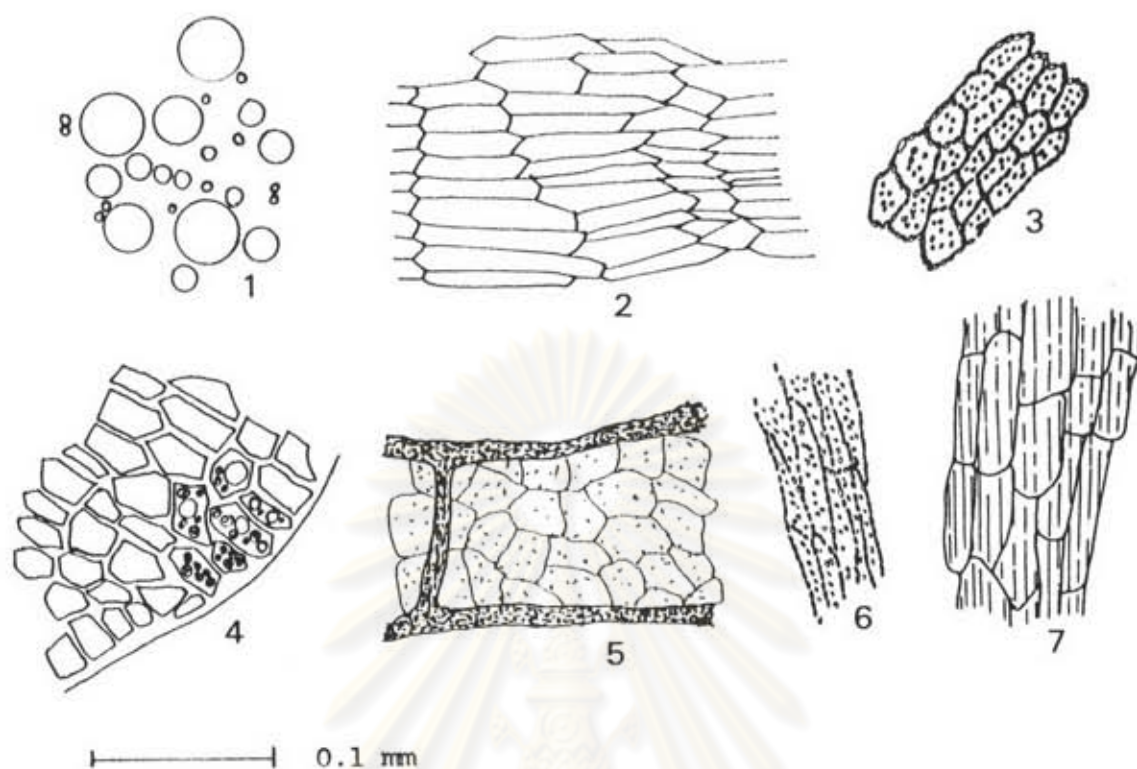


Fig.86 Microscopical character of powdered drug of Thian Taakob

- 1 = oil globules
- 2 = endocarp in surface view
- 3 = sclereids
- 4 = endosperm containing oil globules and aleurone grains
with microcrystals
- 5 = vitta in surface view
- 6 = reticulate vessel
- 7 = epicarp in surface view

Chromatographic characteristics

One-dimensional TLC



Fig.87 One-dimensional TLC characteristics of the extracts of Thian Taakob

Table 22 Rf value and color of one-dimensional TLC of Thian Taakob

spot	Rf	UV ₂₅₄	UV ₃₆₅	V-H ₂ SO ₄	L-B	Kedde	Dragendorff
	value						
1	0.05	-	lt.blue	purple	-	-	-
2	0.10	-	-	purple	-	-	-
3	0.13	-	-	blue	-	-	-
4	0.18	-	-	blue	-	-	-
5	0.27	-	-	blue	-	-	-
6	0.49	-	-	purple	-	-	-
7	0.61	-	-	purple	-	-	-
8	0.72	-	-	lt.blue	-	-	-
9	0.77	-	-	purple	-	-	-
10	0.93	dark	-	pink	-	-	-
11	0.99	-	-	rd.brown	-	-	-

lt.blue = light blue; rd.brown = reddish brown

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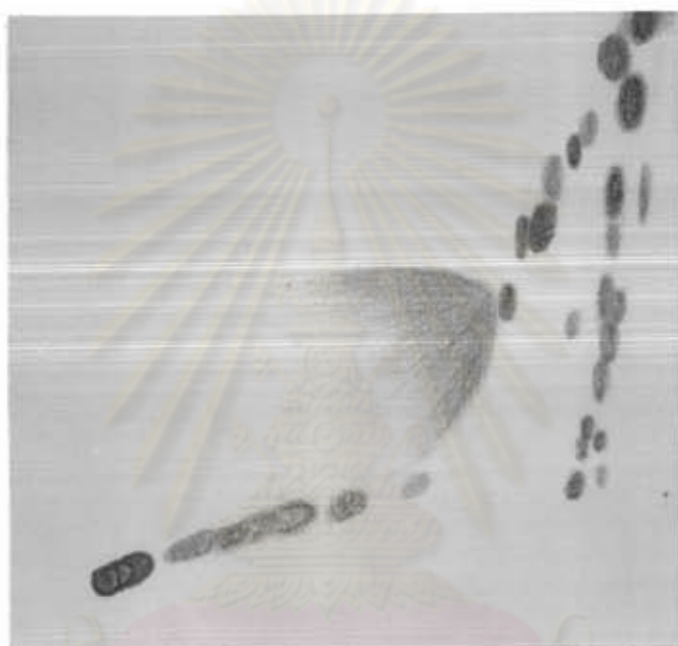
Two-dimensional TLC

Fig.88 Two-dimensional TLC characteristics of the extracts of
Thian Taakob

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Table 23 Rf value and color of two-dimensional TLC of Thian Taakob

spot	Rf value		color	spot	Rf value		color
	X	Y			X	Y	
1	0	0	brown	18	0.81	0.46	purple
2*	0.04	0.01	deep blue	19*	0.65	0.49	purple
3	0.07	0.03	blue	20	0.69	0.50	purple
4*	0.13	0.05	purple	21	0.87	0.51	purple
5	0.17	0.07	blue	22	0.89	0.49	purple
6	0.22	0.08	blue	23	0.72	0.61	purple
7*	0.27	0.10	purple	24	0.87	0.61	blue
8	0.27	0.12	blue	25*	0.76	0.64	deep blue
9*	0.43	0.13	blue	26*	0.88	0.69	rd.purple
10*	0.53	0.18	lt.blue	27	0.93	0.69	purple
11*	0.81	0.18	blue	28	0.77	0.72	lt.blue
12	0.85	0.19	lt.blue	29*	0.81	0.77	purple
13	0.82	0.24	yl.brown	30	0.84	0.81	lt.blue
14	0.85	0.26	purple	31	0.91	0.85	rd.purple
15*	0.83	0.27	blue	32*	0.88	0.93	pink
16	0.85	0.36	purple	33	0.93	0.99	brown,
17	0.87	0.43	purple				lt.blue

lt.blue = light blue; yl.brown = yellowish brown;

rd.purple = reddish purple

* spots which are clearly observed on the TLC plate

** spot numberings were arranged with reference to Y-axis

Ultraviolet spectroscopic characters

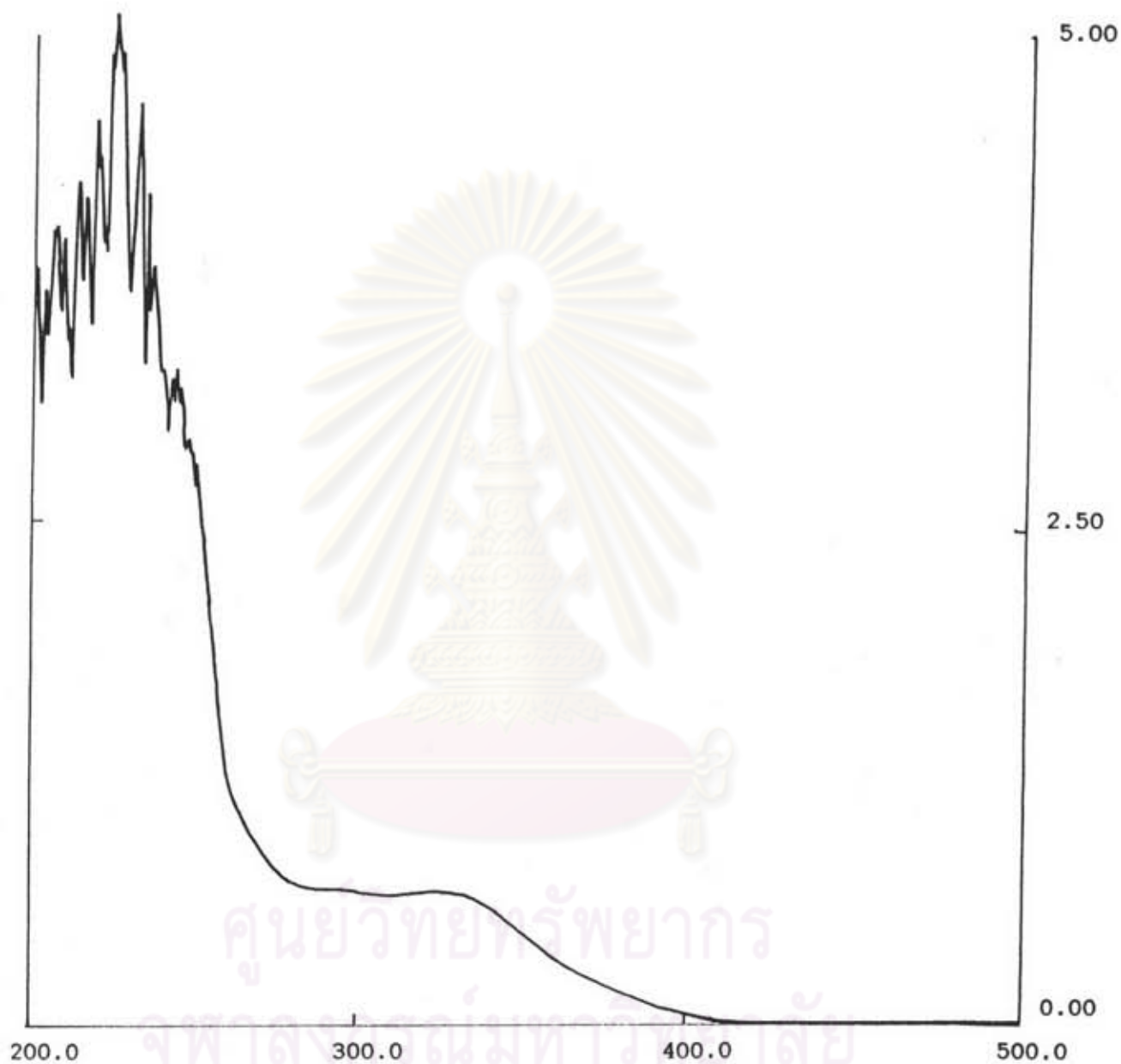


Fig.89 Ultraviolet spectrum of the extract of Thian Taakob

Table 24 Ultraviolet absorptions of the extract of Thian Taakob

peak	wavelength(nm)	absorption	peak	wavelength(nm)	absorption
1	318.0	0.67	10	220.4	4.55
2	251.2	2.83	11	217.6	4.18
3	244.8	3.30	12	214.8	4.25
4	243.6	3.25	13	212.4	3.50
5	238.0	3.82	14	210.8	3.97
6	236.0	4.19	15	208.4	4.02
7	233.6	4.64	16	205.2	3.70
8	226.4	5.08	17	202.4	3.82
9	223.2	4.00			

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Thian Klethoi**Morphology of plant**

Annual, stemless, thickly villous. Leaves radical, linear, acuminate at apex, entire. Spike spicate. Flower small; sepals 4, imbricate in bud, persistent; corolla salver-shaped, scarious, 4-lobed, imbricate in bud; stamens 4, inserted on the corolla-tube; anthers large; ovary superior. (Fig.90)

Description of crude drug

Seed ovoid to elliptic, peltate, glabrous, brown, 2.2-3.1 mm long, 1.1-1.7 mm wide. Dorsal surface convex, glossy, transparent, exhibiting a longitudinal reddish brown area extending nearly the length of the seed and representing the embryo lying beneath the seed coat; ventral surface being a deep excavation, in the center of reddish brown base of which is an oval white hilum (Fig.91). Sectional surface filled with oily endosperm, embedded of 2 freshy cotyledons.

Odourless, taste mucilagenous.



stem, leaves and inflorescence



inflorescence

Fig.90 Morphology of the plant of Thian Klethoi



— 2 mm

Fig.91 Morphology of the crude drug of Thian Klethoi

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Microscopical characters

Histology

Transverse sections of Thian Klethoi cut through the cotyledon region show a reniform outline, the following microscopical details are noted. (Fig.92)

1. Spermoderm, consisting of 2 kinds of epidermal layer. Outer epidermis, a layer of mucilaginous colorless epidermal cells with more or less obliterated walls. Inner epidermis, a layer of brownish tangentially-elongated cells.

2. Endosperm, consisting of thick-walled polygonal cells containing aleurone grains and oil globules.

3. Cotyledon, lies in the center of the endosperm and consists of 2 elongated plano-convex cotyledons, consisting of thin-walled cells containing aleurone grains and oil globules.

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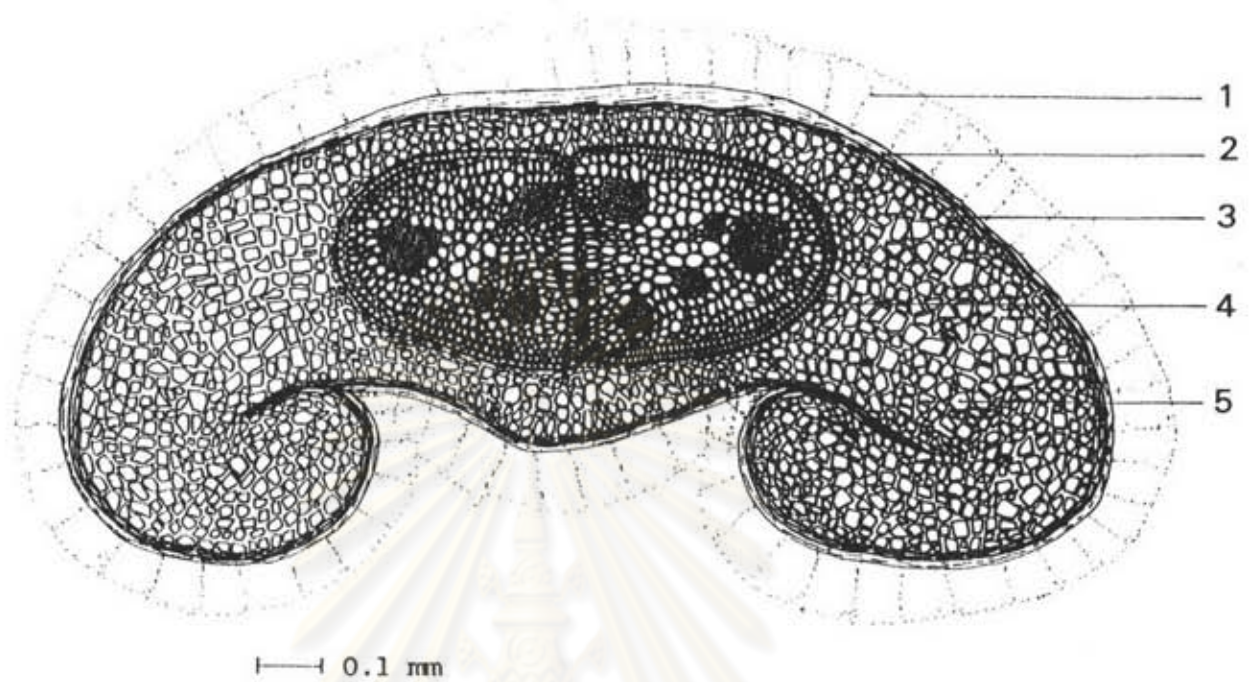


Fig.92 Transverse section of Thian Klethoi

- 1 = mucilage 2 = outer epidermis
 3 = inner epidermis 4 = cotyledon
 5 = endosperm

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Powdered drug

Powdered drug of Thian Klethoi is brown in colour. It has aromatic odour and mucilaginous taste. The microscopical characters are listed according to the frequency of tissues found as follows. (Fig.93)

1. Fragments of outer epidermis in surface view, showing colourless thick-walled cells, the cells swelled rapidly in aqueous mounts and appeared polygonal to slightly rounded when view from above.
2. Fragments of inner epidermis in surface view, showing brownish thick-walled polygonal cells.
3. Fragments of outer epidermis in sectional view showing mucilage layer on the outer part of the cells.
4. Fragments of endosperm showing thick-walled cells, containing oil globules and aleurone grains, 2-5 microns in diameter.
5. Fragments of cotyledon showing thin-walled cells associated with vascular bundle.
6. Scattered of oil globules.

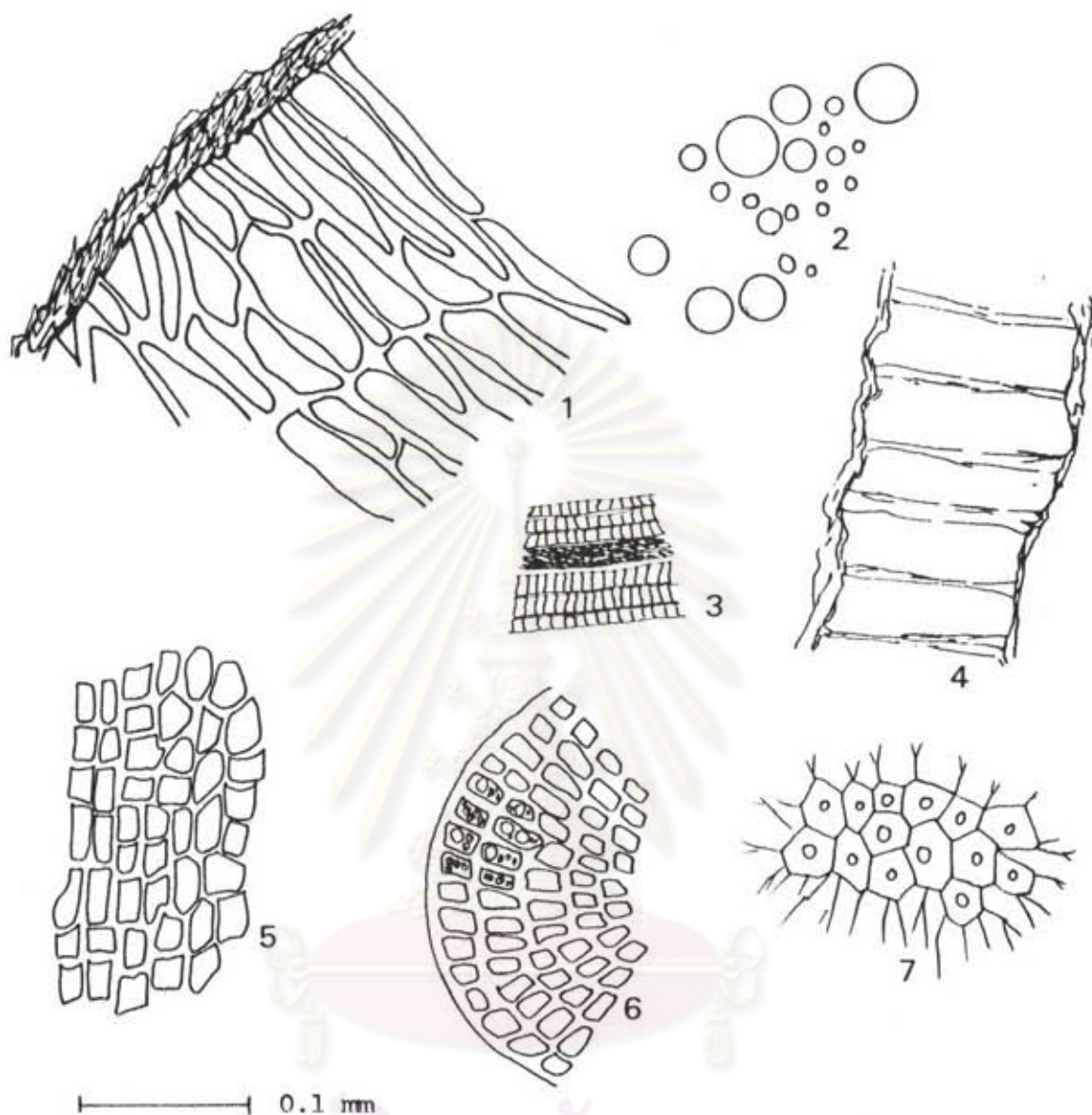


Fig.93 Microscopical character of powdered drug of Thian Klethoi

- 1 = outer epidermis in surface view
- 2 = oil globules
- 3 = cotyledon with vascular bundle
- 4 = outer epidermis in sectional view
- 5 = inner epidermis in surface view
- 6 = endosperm containing oil globules and small
aleurone grains
- 7 = mucilage in surface view from above

Chromatographic characteristics

One-dimensional TLC



Fig.94 One-dimensional TLC characteristics of the extracts of Thian Klethoi

Table 25 Rf value and color of one-dimensional TLC of Thian Klethoi

spot	Rf value	UV ₂₅₄	UV ₃₆₅	V-H ₂ SO ₄	L-B	Kedde	Dragendorff
1	0.00	-	-	purple	-	-	-
2	0.03	-	-	purple	-	-	-
3	0.10	-	-	yellow	-	-	-
4	0.29	-	-	purple	-	-	-
5	0.32	-	-	gr.yellow	-	-	-
6	0.48	-	-	gr.yellow	-	-	-
7	0.62	-	-	purple	-	-	-
8	0.63	-	-	yellow	-	-	-
9	0.75	-	-	purple	-	-	-
10	0.82	-	-	yellow	-	-	-
11	0.94	-	-	purple	-	-	-
12	0.96	-	-	yellow	-	-	-
13	0.99	-	-	yl.brown	-	-	-

gr.yellow = greenish yellow; yl.brown = yellowish brown



Two-dimensional TLC

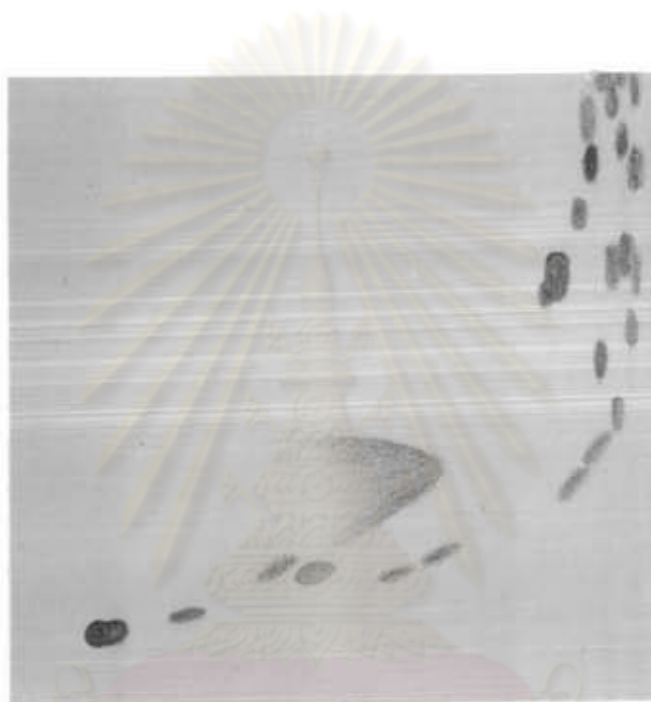


Fig.95 Two-dimensional TLC characteristics of the extracts of
Thian Klethoi

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Table 26 Rf value and color of two-dimensional TLC of Thian Klethoi

spot	Rf value		color	spot	Rf value		color
	X	Y			X	Y	
1	0	0	brown	14	0.78	0.60	blue
2	0.04	0	purple	15*	0.81	0.62	purple
3*	0.17	0.03	bl.purple	16	0.91	0.64	lt.blue
4	0.31	0.10	yellow	17	0.95	0.63	yellow
5	0.39	0.10	lt.blue	18*	0.95	0.66	gr.yellow
6	0.53	0.10	gr.yellow	19	0.85	0.75	lt.blue
7	0.59	0.14	gr.yellow	20	0.95	0.82	yellow
8	0.84	0.26	gr.yellow	21*	0.88	0.84	blue
9*	0.59	0.29	purple	22*	0.93	0.87	purple
10	0.88	0.32	gr.yellow	23	0.87	0.92	lt.blue
11	0.92	0.38	gr.yellow	24	0.91	0.94	purple
12*	0.89	0.48	yellow	25*	0.92	0.99	yellow
13	0.95	0.53	lt.blue	26	0.95	0.96	yellow

bl.purple = bluish purple; lt.blue = light blue;
gr.yellow = greenish yellow

* spots which are clearly observed on the TLC plate

** spot numberings were arranged with reference to Y-axis

Ultraviolet spectroscopic characters

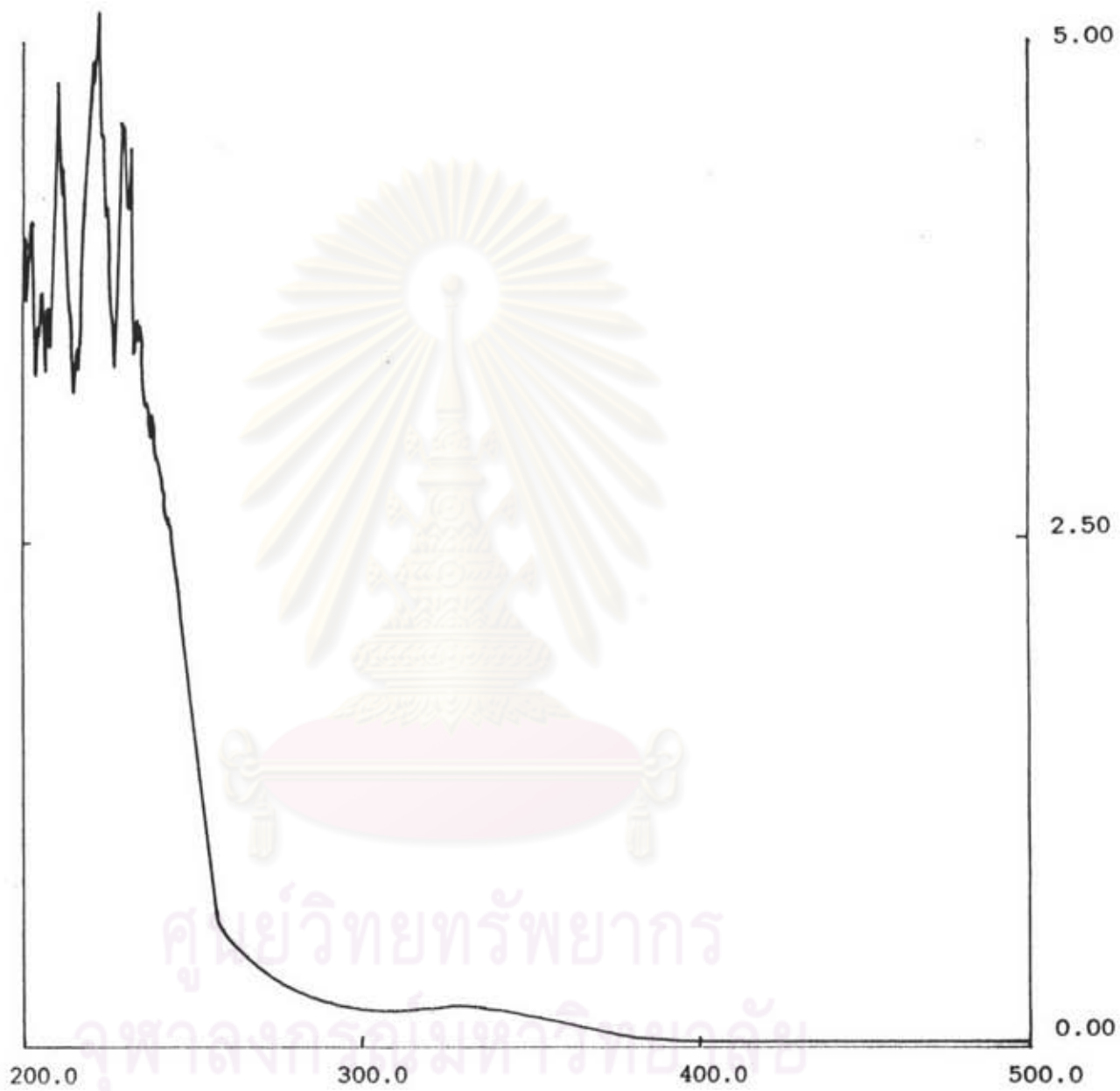


Fig.96 Ultraviolet spectrum of the extract of Thian Klethoi

Table 27 Ultraviolet absorptions of the extract of Thian Klethoi

peak	wavelength(nm)	absorption	peak	wavelength(nm)	absorption
1	330.0	0.20	9	220.8	4.83
2	241.2	2.89	10	216.4	3.42
3	234.4	3.56	11	211.6	4.31
4	232.4	4.41	12	210.0	4.74
5	229.6	4.55	13	207.2	3.61
6	225.2	4.14	14	205.2	3.69
7	224.0	4.48	15	202.0	4.05
8	222.0	5.29			

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