

Studies on the Plant Sterols and Triterpenes. III.¹⁾
Examination of Non-glycosidal Sterols
and Triterpenes in Crude Drugs²⁾

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The distribution of non-glycosidal sterols, triterpene alcohols, and triterpenic acids in 211 commercial crude drugs was examined by means of gas chromatography.

As reported in many papers sterols and triterpenes are found widely in a free state or as esters of various fatty acids, and as glycosides in many kinds and parts of plants.⁴⁾

Despite the most common occurrence in the crude drug, their functions have not been fully investigated. It has been said that the pharmacological activity of the crude drug might be due to the accumulative and cancellative action of each components,⁵⁾ and sterols and triterpenes could take part in the activities of a crude drug.⁶⁾ Lately some non-glycosidal sterol and triterpene have been found to have estrogenic,⁷⁾ antidiabetic activities,⁸⁾ and to be a biting-factor⁹⁾ or an insect hormone¹⁰⁾. Since Tsuda and his colleagues reported cholesterol in *Rhodoglossum pulcherrimum*¹¹⁾ it has been found in some kind of plants,¹²⁾ and by the extensive works of Bennett, Heftmann, and Tschesche the biogenetic conversion of cholesterol to

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steroidal alkaloids, sapogenins, and cardenolides has been shown in the plants of *Holarrhena*,¹³⁾ *Solanum*,¹⁴⁾ *Dioscorea*,¹⁵⁾ and *Digitalis*¹⁶⁾ genera.

An investigation of the distribution of non-glycosidal sterols, particularly cholesterol, and triterpenes in the plant kingdom is of considerable interest, and an examination of them in crude drugs was carried out.

The isolation and identification of a pure sterol or triterpene by the conventional procedures are tedious and sometimes inaccurate, but recently gas chromatographic techniques have been successfully developed for the rapid and accurate determination of closely resembling compounds.

In the previous work¹⁾ on the isolation of pure campesterol, stigmasterol, and β -sitosterol and the reinvestigation of so-called γ -sitosterol, it was proved by gas chromatography that γ -sitosterol was a mixture of campesterol and β -sitosterol.

In the present paper we describe the results of the gas chromatographic examination of the distribution of non-glycosidal sterols and triterpenes in 211 crude drugs of plant origin (Dicotyledoneae 162, Monocotyledoneae 49) which are mostly commercially available.

The experimental results are summarized in Table I.

As Bergmann had observed¹⁷⁾ most of all crude drugs contained sterols of stigmastane series, particularly β -sitosterol, in every parts of plant. A sterol of ergostane series, campesterol, widely occurred among Choripetalae, and less widely among Sympetalae, especially Campanulatae. The distribution of sterols, triterpenes, and the unknown components was more extensive in Dicotyledoneae than in Monocotyledoneae. In *Atractylodes*, *Digitalis*, *Scopolia*, *Paeonia*, and *Alisma spp.*, the distribution of same kinds of sterol and triterpene alcohol was observed irrespective of the habitat of the plant.

These results present a chemotaxonomical interest.

Sterols were accompanied by triterpene alcohols in about one half of the whole samples, and β -amyirin was widely recognized in Monocotyledoneae, while α -amyirin in Dicotyledoneae.

Triterpenic acids were rarely found in a free state or as an ester, while triterpene alcohols were frequently observed.

It is interesting that cholesterol was detected in the upper parts (leaves and stems) of some plants which were known to contain steroidal saponins.

This result is closely related with a consideration of Bennett and other investigators that cholesterol is one of the main precursors of a steroidal sapogenin and a steroidal alkaloid in plant.

Several unknown compounds which are considered to be monohydroxy sterols or triterpenes were detected in the genera of Compositae and Rosaceae.

Experimental

Sample—All samples were prepared as shown in Chart 1.

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TABLE I. Composition of Non-Glycosidal Sterol and Triterpene in Crude Drug

Species	P	S	Neutral fraction ^{a)}											Acidic fraction ^{b)}					
			Y	1	2	3	4	5	6	7	8	9	10 ^{c)}	U	Y	11	12	13	U
Compositae																			
<i>Arctium lappa</i>	S	J	0.4	—	—	10	—	—	60	—	—	30	—	—	4.0	—	—	—	—
<i>Artemisia capillaris</i>	Fl	J	0.7	—	—	25	—	—	35	—	40	—	—	—	—	—	—	—	—
<i>A. maritima</i>	F	J	0.2	—	—	20	—	—	25	—	—	—	—	55(3.68) ^{d)}	—	—	—	—	—
<i>A. vulgaris</i> var. <i>indica</i>	F	J	0.9	25	—	20	—	—	25	—	—	30	—	—	—	—	—	—	—
<i>Aster tataricus</i>	R	J	0.7	—	—	+	—	—	5	—	—	10	—	30(3.46) 25(4.40) 30(5.20)	0.2	—	—	—	—
<i>Atractylodes ovata</i>	Rh	J	4.8	—	—	5	—	—	30	20	25	20	—	—	2.3	—	—	—	—
<i>A. spp.</i>	Rh	C	—	—	+	—	—	—	20	—	40	—	—	40(3.88)	1.3	—	—	—	—
<i>A. spp.</i>	Rh	K	4.5	—	—	5	—	—	35	30	—	30	—	—	—	—	—	—	—
<i>Chrysanthemum cinerariaefolium</i>	Fl	J	1.5	+	—	10	—	—	20	20	—	—	—	50(4.05)	0.1	—	—	—	—
<i>Helianthus annuus</i>	S	J	0.2	—	—	25	—	—	75	—	—	—	—	—	—	—	—	—	—
<i>Inula Helenium</i>	R	J	0.3	—	—	25	—	—	30	—	—	45	—	—	—	—	—	—	—
<i>Matricaria Chamomilla</i>	Fl	J	0.6	—	—	5	—	—	15	30	20	—	—	30(3.96)	0.5	—	—	—	—
<i>Saussurea lappa</i>	R	In	0.5	—	—	40	—	—	60	—	—	—	—	—	0.6	—	—	—	—
<i>Xanthium Strumarium</i>	S	J	0.5	—	—	55	—	—	45	—	—	—	—	—	—	—	—	—	—
Campanulaceae																			
<i>Platycodon grandiflorum</i>	R	J	0.2	—	—	15	—	—	35	—	—	15	—	35(3.86)	0.4	—	—	—	—
<i>P. grandiflorum</i>	R	C	0.2	—	—	—	—	—	—	—	—	—	45	55(4.40)	—	—	—	—	—
Cucurbitaceae																			
<i>Benincasa cerifera</i>	S	J	—	+	+	—	—	—	100	—	—	—	—	—	—	—	—	—	—
<i>B. cerifera</i>	S	C	—	—	15	15	—	—	70	—	—	—	—	—	2.5	—	—	—	—
<i>Trichosanthes Kirilowii</i> var. <i>japonica</i>	R	J	0.2	—	—	+	—	—	35	—	—	35	—	30(3.80)	—	—	—	—	—
<i>T. Kirilowii</i> var. <i>japonica</i>	S	J	—	—	+	—	—	—	60	—	—	40	—	—	11.7	—	—	—	—
Valerianaceae																			
<i>Valeriana officinalis</i> var. <i>latifolia</i>	Rh	J	—	—	20	—	—	—	80	—	—	—	—	—	0.6	—	—	—	—
Caprifoliaceae																			
<i>Sambucus Sieboldiana</i>	L	J	—	+	+	—	—	—	10	+	90	—	—	—	0.2	50	50	—	—
Rubiaceae																			
<i>Cinchona succirubra</i>	C	In	—	—	5	5	—	—	35	35	—	—	—	20(4.03)	—	—	—	—	—
<i>Morinda officinalis</i>	R	C	0.1	—	—	25	—	—	55	—	20	—	—	—	—	—	—	—	—
Plantaginaceae																			
<i>Plantago asiatica</i>	S	J	0.1	+	—	40	—	—	—	50	—	—	—	10(3.92)	0.3	—	—	—	—
<i>P. asiatica</i>	H	J	0.7	+	—	40	—	—	—	60	—	—	—	—	0.9	40	60	—	—
Gesneriaceae																			
<i>Conandron ramondioides</i>	F	J	—	—	15	15	—	—	70	—	—	—	—	—	0.8	—	—	—	—
Bignoniaceae																			
<i>Catalpa ovata</i>	Fr	J	0.1	—	—	25	—	—	75	—	—	—	—	—	2.2	—	—	—	—
Scrophulariaceae																			
<i>Digitalis purpurea</i>	F	J	0.9	+	—	35	—	—	35	—	30	—	—	—	1.0	—	—	—	—
<i>D. purpurea</i>	F	F	0.2	+	—	30	—	—	35	—	35	—	—	—	0.3	—	—	—	—
<i>Rehmannia spp.</i>	R	C	0.2	—	—	15	—	—	85	—	—	—	—	—	0.1	—	—	—	—
Solanaceae																			
<i>Datura Stramonium</i>	F	J	—	—	—	60	—	—	40	—	—	—	—	—	—	—	—	—	—
<i>Lycium chinense</i>	F	J	1.0	35	—	10	—	—	35	—	20	—	—	—	2.0	—	—	—	—
<i>L. chinense</i>	F	K	0.5	20	—	15	—	—	40	10	15	—	—	—	1.6	—	—	—	—
<i>L. chinense</i>	S	C	0.1	10	—	20	—	—	30	40	—	—	—	—	0.5	—	—	—	—
<i>L. chinense</i>	S	K	0.3	+	—	—	—	—	50	—	50	—	—	—	0.4	—	—	—	—
<i>Scopolia japonica</i>	Rh	J	0.2	+	25	—	—	—	75	—	—	—	—	—	1.1	—	—	—	—
<i>S. japonica</i>	Rh	K	0.2	+	25	—	—	—	75	—	—	—	—	—	0.6	—	—	—	—
Labiatae																			
<i>Clinopodium gracile</i>	H	J	—	—	5	10	—	—	80	—	—	—	—	—	—	—	—	—	—
<i>Leonurus sibiricus</i>	H	J	0.5	—	—	25	—	—	35	—	40	—	—	—	1.6	—	—	—	—
<i>Nepeta japonica</i>	H	J	—	—	20	—	—	—	50	—	30	—	—	—	8.0	45	55	—	—
<i>Perilla frutescens</i> var. <i>acuta</i>	F	J	1.0	—	10	—	—	—	20	20	30	20	—	—	0.5	40	60	—	—
<i>P. frutescens</i> var. <i>acuta</i>	S	J	0.4	—	20	—	—	—	—	55	—	—	—	25(3.70)	0.2	—	—	—	—
<i>Prunella vulgaris</i>	H	J	0.3	—	5	+	—	—	15	30	50	—	—	—	0.2	—	—	—	—
<i>Scutellaria baicalensis</i>	R	J	0.1	—	25	25	—	—	50	—	—	—	—	—	0.6	—	—	—	—
<i>S. baicalensis</i>	R	C	0.2	—	20	—	—	—	80	—	—	—	—	—	—	—	—	—	—
<i>Thymus vulgaris</i>	H	J	0.7	—	10	10	—	—	80	—	—	—	—	—	1.0	45	55	—	—
Boraginaceae																			
<i>Lithospermum erythrorhizon</i>	R	J	0.3	+	10	10	—	—	80	—	—	—	—	—	0.6	—	—	—	—
Convolvulaceae																			
<i>Cuscuta japonica</i>	S	J	0.3	+	20	15	—	—	40	—	—	—	—	25(3.96)	0.1	—	—	—	—
<i>C. chinensis</i>	S	C	0.2	+	+	30	—	—	40	+	—	—	—	30(3.96)	2.0	—	—	—	—
<i>Pharbitis Nil</i>	S	J	0.7	—	40	+	—	—	60	—	—	—	—	—	1.0	—	—	—	—
Gentianaceae																			
<i>Gentiana lutea</i>	R	E	—	—	—	5	—	—	—	—	95	—	—	—	—	—	—	—	—
<i>G. scabra</i> var. <i>Burgeri</i>	R	J	1.0	—	—	25	—	—	—	—	75	—	—	—	—	—	—	—	—
<i>G. scabra</i> var. <i>Burgeri</i>	R	K	—	—	—	20	—	—	80	—	—	—	—	—	1.4	—	—	—	—

continued

Oleaceae																			
<i>Forsythia suspensa</i>	Fr	J		-	+	+	-	-	5	5	-	40	-	50(4.50)	0.4	50	50	-	-
Ebenaceae																			
<i>Diospyros Kaki</i>	Ca	J	0.2	-	-	-	-	-	50	-	50	-	-	-	1.5	40	40	-	20(8.05)
Ericaceae																			
<i>Arctostaphylos Uva-Ursi</i>	F	E	2.0	-	-	-	-	-	+	30	-	70	-	-	2.7	25	75	-	-
<i>Vaccinium Vitis-Idaea</i>	F	J		-	-	-	-	-	+	30	30	20	-	20(3.96)					
Cornaceae																			
<i>Cornus officinalis</i>	Fr	J		-	-	20	-	-	40	40	-	-	-	-					
Umbelliferae																			
<i>Angelica dahurica</i>	R	J	0.2	-	-	30	-	-	35	-	35	-	-	-	0.9	-	-	-	-
<i>Angelica pubescens</i>	R	J		-	-	20	-	-	65	-	15	-	-	-					
<i>Bupleurum falcatum</i>	R	J	0.6	-	-	30	-	70	+	-	-	-	-	-	0.2	-	-	-	-
<i>B. spp.</i>	R	C	0.5	-	-	30	-	70	-	-	-	-	-	-	1.7	-	-	-	-
<i>Cnidium officinale</i>	R	J	0.2	10	-	10	-	-	80	-	-	-	-	-	1.5	-	-	-	-
<i>Glehnia littoralis</i>	R	J	0.6	-	-	45	-	-	55	-	-	-	-	-	2.5	-	-	-	-
<i>Ligusticum acutilobum</i>	R	J	0.3	-	5	15	-	-	80	-	-	-	-	-	1.2	-	-	-	-
<i>L. acutilobum</i> var. <i>Sugiyamae</i>	R	J	0.4	-	5	20	-	-	75	-	-	-	-	-	0.3	-	-	-	-
<i>Pseudanum decursivum</i>	R	J	0.2	-	-	30	-	-	40	-	30	-	-	-	1.2	-	-	-	-
<i>P. decursivum</i>	R	K	0.1	-	-	40	-	-	60	-	-	-	-	-	0.1	-	-	-	-
Araliaceae																			
<i>Acanthopanax Sieboldianum</i>	C	J		+	-	10	-	-	10	10	-	70	-	-	1.6	-	-	-	-
<i>Aralia cordata</i>	R	J	0.5	-	5	25	-	-	75	-	-	-	-	-					
<i>Panax japonicum</i>	Rh	J	0.1	-	+	-	-	-	35	-	-	-	-	65(3.70)	0.1	-	-	-	-
<i>Tetrapanax papyrifera</i>	Rh	J		-	-	30	-	-	35	-	35	-	-	-					
Oenotheraceae																			
<i>Oenothera Lamarckiana</i>	Rh	J	1.0	-	5	-	-	-	95	-	-	-	-	-					
<i>O. odorata</i>	Rh	J	1.0	-	5	-	-	-	95	-	-	-	-	-					
Combretaceae																			
<i>Quisqualis indica</i>	S	C		-	-	-	60	-	-	-	-	-	-	40(2.93)					
Punicaceae																			
<i>Punica Granatum</i>	C	J	0.3	-	-	-	-	-	75	-	-	-	-	25(2.34)	0.5	-	-	-	-
Passifloraceae																			
<i>Passiflora edulis</i>	S	J	0.3	-	-	65	-	-	35	-	-	-	-	-					
Guttiferae																			
<i>Hypericum erectum</i>	H	J	1.0	-	-	35	-	-	65	-	-	-	-	-	1.1	-	-	-	-
Rhamnaceae																			
<i>Rhamnus japonica</i>	S	J	0.7	-	5	10	-	-	85	-	-	-	-	-	6.5	-	-	-	-
<i>R. purshiana</i>	C	J	0.4	-	-	20	-	-	80	-	-	-	-	-	1.1	-	-	-	-
<i>Zizyphus vulgaris</i> var. <i>inermis</i>	S	J		-	-	20	-	-	80	-	-	-	-	-		100	-	-	-
<i>Z. jujuba</i>	S	C		-	-	10	-	-	30	-	-	-	-	60(3.60)					
Sapindaceae																			
<i>Sapindus Mukurossi</i>	Fr	J		-	-	10	-	-	50	-	-	-	-	40(3.15)					
Celastraceae																			
<i>Euonymus japonica</i>	C	J	0.2	-	-	5	-	-	95	-	-	-	-	-					
Euphorbiaceae																			
<i>Mallotus japonicus</i>	C	J	0.3	-	-	10	-	-	40	-	50	-	-	-	0.1	-	-	-	100(4.35)
<i>Ricinus communis</i>	S	J	1.7	-	-	15	-	-	30	-	55	-	-	-					
Polygalaceae																			
<i>Polygala Senega</i>	R	NA	0.6	+	+	+	-	-	100	-	-	-	-	-	0.5	-	-	-	-
<i>P. Senega</i> var. <i>latifolia</i>	R	J	0.1	+	+	+	-	-	30	30	30	10	-	-	2.2	-	-	-	-
<i>P. tenuifolia</i>	R	J	0.5	-	+	+	-	-	55	+	45	+	-	-	1.9	-	-	-	100(6.20)
Meliaceae																			
<i>Melia Azedarach</i> var. <i>japonica</i>	C	J	0.4	-	5	10	-	-	20	20	-	25	-	20(4.30)	0.6	-	-	-	-
Simaroubaceae																			
<i>Picrasma aitanthoides</i>	L	J	0.1	-	-	45	-	-	55	-	-	-	-	-	0.1	-	-	-	-
Rutaceae																			
<i>Citrus Aurantium</i>	P	J	0.1	-	20	20	-	-	50	-	10	-	-	-	0.1	-	-	-	-
<i>C. Unshiu</i>	P	J	0.1	-	25	-	-	-	40	-	35	-	-	-					
<i>Phellodendron amurense</i>	C	J	0.7	-	40	-	-	-	60	-	-	-	-	-					
<i>Xanthoxylum piperitum</i>	Fr	J	1.3	-	20	-	-	-	50	-	-	-	-	30(3.64)	6.0	-	-	-	-
Zygophyllaceae																			
<i>Tribulus terrestris</i>	Fr	J	0.2	+	10	10	-	-	80	-	-	-	-	-					
Linaceae																			
<i>Linum usitatissimum</i>	S	J		-	-	20	-	-	30	-	30	20	-	-					
Geraniaceae																			
<i>Geranium nepalense</i>	H	J	0.2	-	-	30	-	-	70	-	-	-	-	-	0.4	-	-	-	-
Leguminosae																			
<i>Albizia Julibrissin</i>	C	J	0.4	-	-	-	-	-	40	-	40	-	-	20(3.85)	4.8	-	-	-	-
<i>Astragalus membranaceus</i>	R	K		-	-	10	-	-	45	-	-	45	-	-	0.7	-	-	-	100(4.27)
<i>A. spp.</i>	R	J		-	-	10	-	-	60	15	15	-	-	-					
<i>A. spp.</i>	C	C		-	-	15	-	-	50	-	35	-	-	-	0.5	-	-	-	-
<i>Cassia occidentalis</i>	S	J	0.2	-	45	-	-	-	55	-	-	-	-	-	3.3	-	-	-	-

continued

<i>C. tora</i>	S	J	0.1	--	5	--	--	--	95	--	--	--	--				
<i>Euchresta japonica</i>	R	J	0.5	--	5	15	--	--	35	--	--	45	--				
<i>Gleditschia japonica</i>	Fr	J	0.4	--	--	20	--	--	45	--	--	35	--	0.3	--	--	--
<i>Glycyrrhiza spp.</i>	R	C	0.3	--	--	10	--	--	35	--	35	--	--	20(3.83)			
<i>Glyoin hispida</i>	S	J	--	30	30	--	--	--	40	--	--	--	--				
<i>Pueraria hirsuta</i>	R	J	0.2	--	--	10	--	--	60	--	30	--	--	0.8	--	--	--
<i>Sophora angustifolia</i>	R	J	0.4	--	20	20	--	--	40	--	--	--	--	20(3.90)	2.5	--	--
<i>S. japonica</i>	Fl	J	0.4	--	--	--	--	--	55	--	--	--	--	45(3.98)	0.4	100	--
Rosaceae																	
<i>Crataegus cuneata</i>	Fr	C	--	--	--	--	--	--	70	--	15	--	--	15(3.30)	0.2	40	50
<i>Prunus Armeniaca</i> var. <i>Ansu</i>	S	J	--	--	--	--	--	--	50	--	--	--	--	50(3.80)			
<i>P. Persica</i>	S	J	--	--	--	--	--	--	25	--	--	--	--	75(3.80)			
<i>P. yedoensis</i>	C	J	1.2	--	5	--	--	--	65	--	--	--	--	30(3.80)	0.2	--	--
<i>Sanguisorba officinalis</i>	R	J	0.6	+	--	--	--	--	70	--	--	--	--	30(3.87)	0.7	50	50
Eucommiaceae																	
<i>Eucommia ulmoides</i>	C	C	--	40	--	--	--	--	40	--	10	10	--	--			
Saxifragaceae																	
<i>Astilbe Thunbergii</i>	R	J	--	35	--	--	--	--	65	--	--	--	--	--			
<i>Hydrangea macrophylla</i> subsp. <i>serrata</i> var. <i>Thunbergii</i>	F	J	1.8	+	5	+	--	--	25	--	40	--	--	30(4.95)	1.2	--	--
Papaveraceae																	
<i>Corydalis bulbosa</i>	T	C	0.2	--	--	30	--	--	70	--	--	--	--	--	0.1	--	--
<i>C. spp.</i>	T	K	0.1	--	--	100	--	--	--	--	--	--	--	--	0.1	--	--
Lauraceae																	
<i>Cinnamomum Cassia</i>	C	C	0.6	--	10	--	--	--	65	--	25	--	--	--	1.2	--	--
<i>Lindera strychnifolia</i>	R	J	--	15	15	--	--	--	70	--	--	--	--	--			100(7.98)
Berberidaceae																	
* <i>Epimedium macrathum</i> var. <i>violaceum</i>	H	J	--	20	--	--	--	--	50	--	30	--	--	--			
Lardizabalaceae																	
<i>Ahebia quinata</i>	L	J	--	--	15	--	--	--	30	--	25	--	--	30(4.00)			
Ranunculaceae																	
<i>Aconitum carmichaelii</i>	R	C	0.2	--	50	--	--	--	50	--	--	--	--	--	0.3	--	--
<i>A. japonicum</i>	R	J	0.1	--	45	--	--	--	55	--	--	--	--	--	0.5	--	--
<i>Adonis amurensis</i>	R	J	0.1	--	10	20	--	--	70	--	--	--	--	--	0.1	--	--
<i>Cimicifuga simplex</i> var. <i>ramosa</i>	Rh	J	0.1	--	--	10	--	--	45	--	45	--	--	--	1.0	--	--
<i>C. spp.</i>	Rh	C	0.3	--	--	25	--	--	75	--	--	--	--	--	0.2	--	--
<i>Coptis japonica</i>	Rh	J	+	35	+	--	--	--	65	--	--	--	--	--			
<i>Paeonia albiflora</i>	R	C	0.3	--	20	+	--	--	80	--	--	--	--	--	0.7	--	--
<i>P. albiflora</i> forma <i>hortensis</i>	R	J	0.2	--	15	+	--	--	85	--	--	--	--	--	0.3	--	--
<i>P. suffruticosa</i>	R	J	0.3	--	20	+	--	--	80	--	--	--	--	--	0.1	--	100(4.62)
<i>P. suffruticosa</i>	R	C	0.5	--	20	+	--	--	70	10	--	--	--	--	0.7	--	--
<i>Pulsatilla cerna</i>	R	J	0.1	--	--	20	--	--	45	--	35	--	--	--	0.6	--	--
Nymphaeaceae																	
<i>Nuphar japonicum</i>	Rh	J	0.2	--	20	15	--	--	65	--	--	--	--	--	1.9	--	--
Magnoliaceae																	
<i>Illicium religiosum</i>	Fr	J	--	20	--	--	--	--	80	--	--	--	--	--			
<i>Magnolia Kobus</i>	Fl	J	1.0	--	10	10	--	--	60	--	--	--	--	20(3.69)	0.3	--	--
<i>M. liliflora</i>	Fl	C	+	5	--	--	--	--	20	--	20	--	--	30(3.69)		100	--
<i>M. officinalis</i>	C	C	1.7	+	10	10	--	--	50	--	15	15	--	25(4.45)			
<i>M. obovata</i>	C	J	1.5	+	+	5	--	--	60	10	--	25	--	--	1.8	--	--
Caryophyllaceae																	
<i>Saponaria officinalis</i>	R	J	--	--	--	--	--	--	50	--	--	50	--	--			
Phytolaccaceae																	
<i>Phytolacca decandla</i>	R	J	0.3	--	--	--	--	--	100	--	--	--	--	--			
Amaranthaceae																	
<i>Achyranthus bidentata</i>	R	C	0.2	--	--	15	--	--	55	30	--	--	--	--			
<i>A. japonica</i>	R	J	0.1	--	--	50	--	--	40	10	--	--	--	--			
Polygonaceae																	
<i>Polygonum cuspidatum</i>	R	J	0.1	--	--	15	--	--	85	--	--	--	--	--	0.5	--	--
<i>P. multiflorum</i>	R	J	0.1	+	--	30	--	--	70	--	--	--	--	--	0.1	--	--
<i>Rheum palmatum</i>	Rh	C	0.3	--	10	--	--	--	60	--	30	--	--	--	0.4	--	--
<i>R. undulatum</i>	Rh	J	0.5	--	30	--	--	--	70	--	--	--	--	--	0.4	--	--
<i>R. undulatum</i>	Rh	C	0.1	--	25	--	--	--	75	--	--	--	--	--	0.2	--	--
<i>R. spp.</i>	Rh	K	0.4	--	25	--	--	--	75	--	--	--	--	--	0.5	--	--
Aristolochiaceae																	
<i>Asarum Sieboldii</i>	R	J	0.9	--	45	--	--	--	55	--	--	--	--	--	0.9	--	--
<i>A. Sieboldii</i>	R	K	0.1	--	5	--	--	--	95	--	--	--	--	--			
<i>A. nipponicum</i>	Rh	J	0.6	--	20	10	--	--	70	--	--	--	--	--			
Moraceae																	
<i>Humulus lupulus</i>	Fr	J	2.0	--	--	--	--	--	60	--	40	--	--	--			
<i>Morus alba</i>	C	C	1.2	--	--	--	--	--	30	--	70	--	--	--	4.9	--	--
<i>M. bombycis</i>	C	J	0.4	--	--	--	--	--	30	--	70	--	--	--	0.4	--	--

continued

Saururaceae																
<i>Houttuynia cordata</i>	H	J	0.4	--	--	30	--	--	35	--	35	--	1.6	--	--	--
Orchidaceae																
<i>Dendrobium officinale</i>	H	C	0.3	+	--	10	--	--	90	--	--	--	0.5	--	--	--
<i>D. moniliforme</i>	H	J	1.3	--	--	35	--	--	65	--	--	--	0.5	--	--	--
Zingiberaceae																
<i>Alpinia japonica</i>	S	J	0.5	--	--	--	--	--	100	--	--	--	2.1	--	--	--
<i>Amomum spp.</i>	Fr	C	0.6	--	--	--	--	--	100	--	--	--	1.3	--	--	--
<i>Curcuma zedoaria</i>	Rh	J	--	--	30	--	--	--	70	--	--	--	--	--	--	--
<i>C. zedoaria</i>	Rh	C	--	--	25	--	--	--	75	--	--	--	0.3	--	--	--
<i>Elettaria cardamomum</i>	S	I	1.3	+	20	20	--	--	60	--	--	--	2.1	--	--	--
<i>Zingiber officinale</i>	Rh	C	3.9	--	--	50	--	--	50	--	--	--	1.4	--	--	--
<i>Z. officinale</i>	Rh	F	1.6	--	--	25	--	--	75	--	--	--	2.8	--	--	--
Iridaceae																
<i>Belamcanda chinensis</i>	Rh	J	0.4	--	--	70	--	--	30	--	--	--	1.6	--	--	--
Dioscoreaceae																
<i>Dioscorea Batatas</i>	R	J	0.1	--	--	25	--	--	75	--	--	--	0.1	--	--	--
<i>D. Batatas</i>	R	C	0.1	--	--	15	--	--	55	30	--	--	0.1	--	--	--
<i>D. bulbifera forma spontanea</i>	R	J	--	--	50	--	--	--	50	--	--	--	--	--	--	--
<i>D. septemloba</i>	Rh	J	--	--	30	--	--	--	40	--	--	30	--	--	--	--
Liliaceae																
<i>Allium tuberosum</i>	S	J	0.1	--	10	--	--	--	20	--	40	--	30(4.30)	0.5	--	--
<i>Anemarrhena asphodeloides</i>	Rh	J	0.4	5	--	25	--	--	70	--	--	--	0.9	--	--	--
<i>Asparagus cochinchinensis</i>	Rh	J	0.3	--	--	50	--	--	50	--	--	--	0.6	--	--	--
<i>Aspidistra elatior</i>	Rh	J	0.3	--	+	--	--	--	20	--	--	--	80(4.01)	--	--	--
<i>Chlorophytum comosum</i>	H	J	0.5	--	--	25	--	--	65	--	10	--	--	--	--	--
<i>C. comosum</i>	Rh	J	--	--	20	--	--	--	80	--	--	--	--	--	--	--
<i>Convallaria majalis</i> var. KEISKEI	R	J	0.2	+	--	15	--	--	35	--	25	25	--	0.7	--	100(7.15)
<i>Fritillaria Thunbergii</i>	Rh	J	0.2	--	25	30	--	--	20	--	--	--	25(3.98)	0.1	--	--
<i>Lilium lancifolium</i>	Rh	J	0.1	--	10	10	--	--	80	--	--	--	--	0.2	--	--
<i>Ophiopogon japonicus</i>	R	J	0.1	--	--	40	--	--	60	--	--	--	--	0.2	100	--
<i>Polygonatum falcatum</i>	Rh	J	--	10	5	--	--	--	85	--	--	--	--	--	--	--
<i>P. officinale</i>	Rh	J	0.1	+	15	15	--	--	65	--	--	--	--	0.2	--	--
<i>Smilax China</i>	Rh	J	--	+	35	--	--	--	65	--	--	--	--	--	--	--
<i>S. glabra</i>	Rh	C	--	--	20	--	--	--	80	--	--	--	--	--	--	--
<i>S. spp.</i>	R	MA	--	15	+	--	--	--	45	30	10	--	--	--	--	--
<i>Veratrum album</i> var. <i>grandiflorum</i>	Rh	J	--	15	--	--	--	--	85	--	--	--	--	--	--	--
<i>Yucca Smalliana</i>	H	J	0.3	15	--	30	--	--	40	--	--	--	15(2.12)	--	--	--
<i>Y. Smalliana</i>	Rh	J	--	--	50	--	--	--	50	--	--	--	--	--	--	--
Stemonaceae																
<i>Stemona japonica</i>	R	J	--	--	50	--	--	--	50	--	--	--	--	30	--	70(6.25)
Araceae																
<i>Acorus Calamus</i> var. <i>asiaticus</i>	Rh	J	0.4	--	+	10	--	--	70	--	--	--	20(4.00)	0.3	--	--
<i>A. gramineus</i>	Rh	J	1.4	--	+	25	--	--	75	--	--	--	--	0.5	--	--
<i>Arisaema serratum</i>	Rh	J	0.1	--	25	25	--	--	50	--	--	--	--	0.3	--	--
<i>A. spp.</i>	Rh	C	0.1	--	+	50	--	--	50	--	--	--	--	0.1	--	--
<i>Pinellia ternata</i>	T	J	0.1	--	35	25	--	--	40	--	--	--	--	0.1	--	--
Cyperaceae																
<i>Cyperus rotundus</i>	Rh	J	0.5	--	15	15	--	--	30	--	--	40	--	0.4	--	--
<i>C. rotundus</i>	Rh	K	0.7	--	20	20	--	--	30	--	--	30	--	--	--	--
Gramineae																
<i>Coix Lachryma-Jobi</i>	S	J	0.1	--	20	+	--	--	50	30	--	--	--	--	--	--
<i>Phragmites communis</i>	Rh	J	--	--	25	25	--	--	50	--	--	--	--	--	--	--
<i>Zea Mays</i>	S	J	--	--	30	15	--	--	55	--	--	--	--	--	--	--
Alismataceae																
<i>Alisma plantago-aquatica</i> var. <i>orientale</i>	Rh	J	0.8	+	--	50	--	--	50	--	--	--	--	2.3	--	--
<i>A. plantago-aquatica</i> var. <i>orientale</i>	Rh	K	1.4	--	--	50	--	--	50	--	--	--	--	3.1	--	--
<i>A. plantago</i> var. <i>parviflorum</i>	Rh	K	0.6	--	--	50	--	--	50	--	--	--	--	3.1	--	--
Typhaceae																
<i>Typha latifolia</i>		J	0.4	--	20	10	--	--	70	--	--	--	--	--	--	--

- a) The compound of relative f_R 2.26 to 4.00 range in neutral fraction were examined and the compounds of relative f_R less than 2.26, mostly essential oils were excluded.
b) The compounds of relative f_R 4.00 to 14.00 range in methylesters of acidic substance were examined. Methylesters of fatty acid (relative f_R of methylstearate, methylolinolate: less than 0.5) and compounds of relative f_R less than 4.00 were excluded.
c) Each figure in columns 1-13 shows the relative ratio of a peak area on neutral or acidic fraction in percent. Peak areas are calculated from the product of the height and the width at half height of a peak on the assumption that the detector responses of each compound are identical.
d) The figure in parentheses shows relative f_R of unidentified compounds on 1.5% SE 30. And a sign (+) means a slight presence of a corresponding component.

code for sterols, triterpenes and their retention data

	relative f_R (f_R)			relative f_R (f_R)		
	1.5% SE 30	1.0% XE 60		1.5% SE 30	1.0% XE 60	
1 cholesterol	1.21	1.00 (11.8min)		8 α -amyrin	3.20	1.95
2 campesterol	2.55	1.30		9 lupeol	3.20	2.01
3 stigmaterol	2.73	1.36		10 Δ^7 -stigmaterol	3.42	1.87
4 Δ^7 -stigmaterol	2.80	1.37		11 methyl oleanolate	4.85	--
5 α -spinasterol	2.98	1.62		12 methyl ursolate	5.40	--
6 β -sitosterol	3.02	1.60		13 hederagenin methylster	8.62	--
7 β -amyrin	3.10	1.66		cholestane	1.00 (5.6 min)	--

code for plant parts (P)

C: cortex, Ca: calyx, Fl: flos, F: folium, Fr: fructus, H: herba, L: lignum, P: pericarpium R: radix, Rh: rhizoma, S: semen, T: tuber

code for source names (S)

C: China, E: Europe, F: Formosa, I: India, In: Indonesia, J: Japan, K: Korea, MA: Middle America, NA: North America

other codes

U: unknown substance, Y: yield(%)

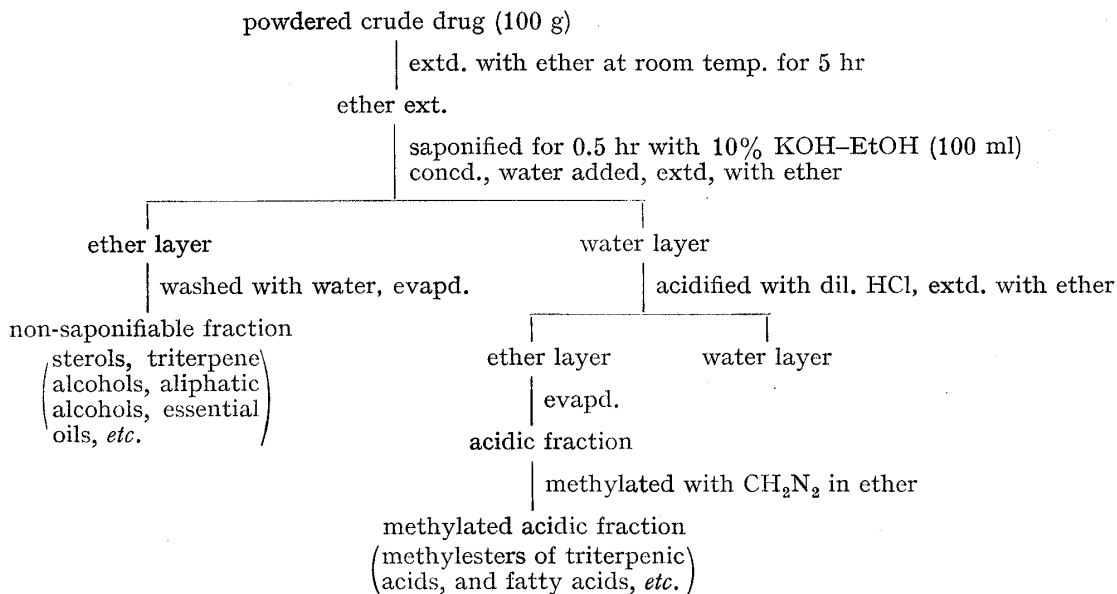


Chart 1. Extraction and Separation of Non-saponifiable and Acidic Fraction

Both the neutral and the methylated acidic fraction were subjected to gas chromatography. Essential oils and methyl esters of fatty acids in the neutral and the acidic fraction, respectively, were all excluded in Table I, because of their much shorter relative retention time (t_R) than that of sterol, triterpene alcohol and triterpenic acid under the condition employed.

Gas Liquid Chromatography—A Shimadzu gas chromatograph Model GC1B equipped with a hydrogen flame detector using the U-shape stainless column, 1.5 m × 4 mm i.d., packed with 1.5% SE30 on Gas chrom P, 80/100 mesh, and Model GC1C with a hydrogen flame detector using the glass tube column, 1.87 m × 4 mm i.d., packed with 1.0% XE60 on Gas chrom W, 60/80 mesh were used.¹⁸⁾ A sample dissolved in ether or acetone was injected with a Hamilton microsyringe. The standard condition for GC1B: Column temp., 236°, Sample heater temp., 310°, Detector temp., 240°, Carrier gas N₂ 60 ml/min, and for GC1C: Column temp., 220°, Sample heater temp., 220° (injected by the "on-column" technique), Detector temp., 240°, Carrier gas N₂ 55 ml/min.

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