Natural Product Sciences
4(4) : 203 ~ 214 (1998)

Bioactive Glycosides from Solanaceous and Leguminous Plants

Toshihiro Nohara, Shoji Yahara, and Junei Kinjo

Faculty of Pharmaceutical Sciences, Kumamoto University, Oe-honmachi 5-1, Kumamoto 862, Japan

Introduction

Because solanaceous and leguminous natural sources are so widely distributed and are used as foodstuffs and folk medicines, we focussed on these plants and are trying to develop natural medicines after proving the effectiveness of these crude drugs and finding the lead compounds among these natural sources.

A. Solanaceous Plants

1. C_{27} Steroids (*Solanum* genera)

We have examined the chemical constituents so far of about thirty-five *Solanum* genera (Table 1) and some solanaceous plants including *Solanum dulcamara*[1], *Solanum nigrum*[2], and *Solanum lyratum*[3], well known as anticancer folk medicines since ancient times. Hence, isolated lots of spirostane, furostane, spirosolane and solanidane glycosides, and provided much new information.[4] From *S. lyratum* the solanidane derivatives showing antitumor activity were obtained (Fig. 1).[3]

A variety of glycosides were subjected to cytotoxicity tests against various tumor cell lines (PC-6, MCF-7, SW620, NUGC-3, and P-388) and it was shown that the component steroidal glycosides are effective and their activities depend not only upon the type of aglycone but also upon the sort of terminal sugar. The chacotriosyl group (Table 2) in the sugar residue, and the spirostanol derivative in the aglycone moiety (Table 3) were the most effective.[5] We propose that the steroidal glycosides enter cells *via* endogenous lectins which are specific receptors for the sugar moiety of the steroidal glycoside. In order to verify this we have to repeat the pharmacological tests. They could be recognized as moderately active anticancer agents which don't show much effectiveness, but they may be developed as natural medicines without side effects. Actually, southern Chinese ingest habitually solanaceous plants as preventives against cancer. Thus,

Table 1. *Solanum* spp. so far examined in our laboratory

Slanum lyratum (4, -, 4)	*S. torvum* (8, 6, -)
S. nigrum (2, -, 6)	*S. gilo* (5, -, -)
S. japonense (3, -, -)	*S. sisymbrifolium* (2, -, -)
S. biflorum (0, 2, -)	*S. achrolcucum* (3, -, 4)
S. aculeatissium (-, 2, -)	*S. integrifolum* (1, -, -)
S. dulcamara (6, -, -)	*S. surattense* (2, -, -)
S. indicum (4, -, 4)	*S. ferox* (-, 3, -)
S. melonga (-, 1, 2)	*S. stramonifolium* (3, -, -)
S. toxicarium (3, 5, -)	*S. jurpeva* (3, -, -)
S. khasianum (-, -, 2)	*S. vanhuerchii* (-, -, 4)
S. mammosum (-, -, 2)	*S. cynathem* (-, -, 2)
S. xanthocarpum (-, -, 2)	*S. lycocarpum* (-, -, 4)
S. paniculatum (7, -, -)	*S. tuberosum* (9, 4, -)
S. verbascifolium (3, -, -)	*S. viarum*
S. abutiloides	*S. sanitwongsei*
S. macrocarpon	*S. aethiopicum*
S. anguivi	*S. demissum*
S. chacoense	

Numbers in parenthesis show the number of the compounds obtained from the respective aerial part, underground part, and fruit, and minus shows parts not yet investigated. Plants with no parenthesis are under investigation.

*Author for correspondence.

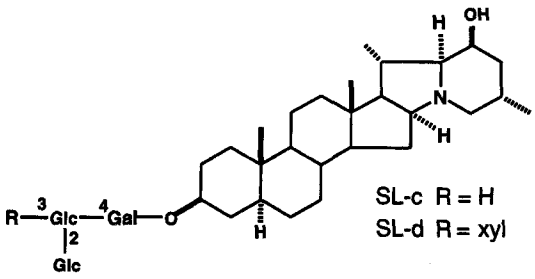


Fig. 1. SL-c and SL-d isolated from *S. lyratum*.

we have substantiated their effectiveness. Furthermore, since *Solanum nigrum* is used for the herpes caused by *Varicella zoster* virus, we applied its 0.5% extract cream to the patients. It brought a good result. We are now measuring the anti-HSV activities of various glycosides using Vero cell to obtain the relationship between the structures and the activities.

2. C_{28} Steroids

Ergostane derivatives were also obtained from the genus of *Datura*[6], *Tubocapsicum*[7], *Physalis*[8], *Nicandra*[9], and *Petunia*[10] in parallel with the studies on *Solanum* genera. Chemically interesting structures are shown in Fig. 2.

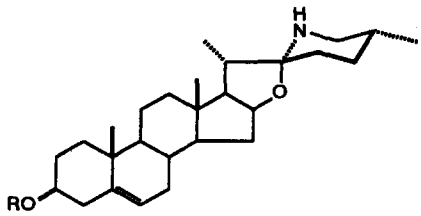


Table 2. Cytotoxicities of Solamargine, SPHA, SPHB, SPHC, and Solasodine (GI_{50} μg/ml)

	R	PC-6	MCF-7	NUGC-3	P388
5-FU		0.31	1.84	2.21	0.06
CDDP		0.19	2.95	0.08	0.01
solamargine	$-glc^{4}rha$ (2 rha)	2.66	2.16	1.95	1.54
	$-glc^{2}rha$	16.76	7.64	10.09	11.93
	$-glc^{4}rha$	35.91	25.96	34.42	Over
	—glc	8.04	9.59	10.76	Over
solasodine	—H	4.25	1.62	1.47	2.18

3. 26-Aminocholesterol Derivative

From *Solanum abutiloides*, three 26-aminocholesterol derivatives (an example shown in Fig. 3) were isolated.[11] These new

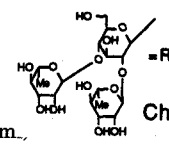


Table 3. Cytotoxicities of dioscin, protodioscin, solamargine, and α-chaconine (GI_{50} μg/m

	PC-6	MCF-7	NUGC-3	P388	SW620
5-FU	0.31	1.84	2.21	0.06	1.43
CDDP	0.19	2.95	0.08	0.01	0.63
spirostane dioscin	1.12	0.64	0.59	0.40	0.64
furostane protodioscin	1.53	1.86	1.69	1.67	1.83
spirosolane solamargine	2.66	2.16	1.95	1.54	1.62
solanidane α-chaconine	1.83	1.54	1.43	1.58	1.46

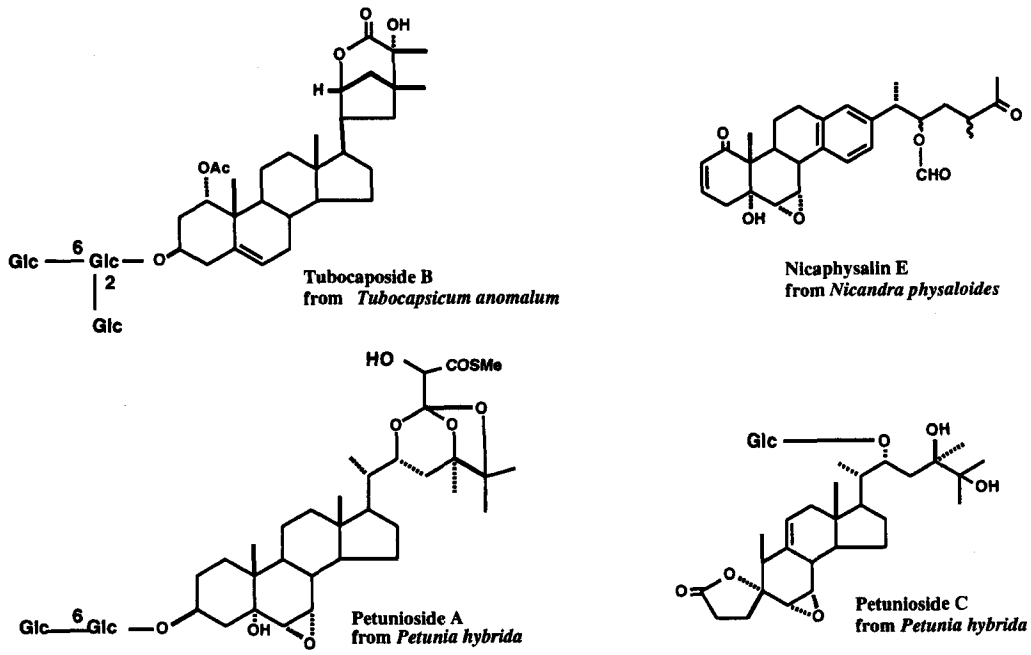


Fig. 2. C_{28} steroids from some solanaceous plants.

natural models are regarded as important key intermediates to the spirosolane and solanidane derivatives on the biogenetic pathway, and could be agents for inhibiting the biosynthesis of cholesterol.

B. Leguminous Plants

1. C-28 Me Oleanane

a. Flowers of *Pueraria lobata*. Since the flower of *Pueraria lobata* (Puerariae Flos) is used to counteract drinking, we examined various *in vivo* tests starting from alcohol metabolism and obtained results shown in Chart 1.[12] From the crude saponin fraction (PF-SP in Chart 1), soyasaponin I, kaikasaponin III, and kakkasaponin I were isolated.

Isoflavonoid fr. (PF-IF) contained kakkalide as major ingredient.[13]

b. Whole Plants of *Abrus cantoniensis*. This crude drug (Abri Herba) has been used as a folk medicine for infectious hepatitis in China. The clinical efficacy of this drug was recently confirmed in China. On separation two crude saponin fractions were obtained. One is less polar than the other.

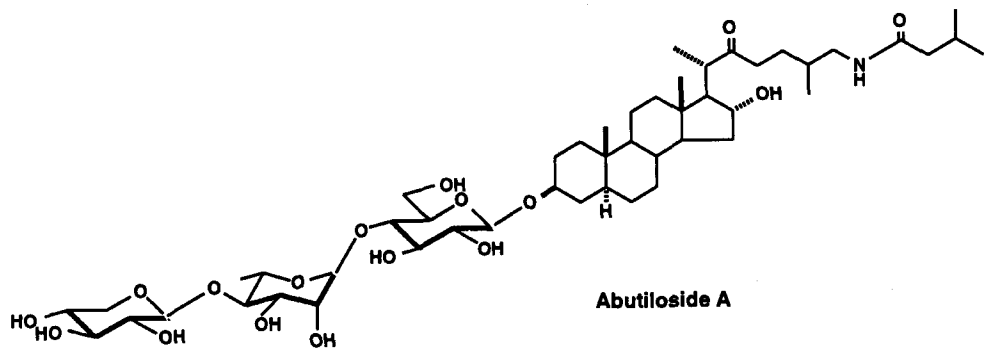


Fig. 3. 26-Aminocholesterol derivative from *S. abutiloides*.

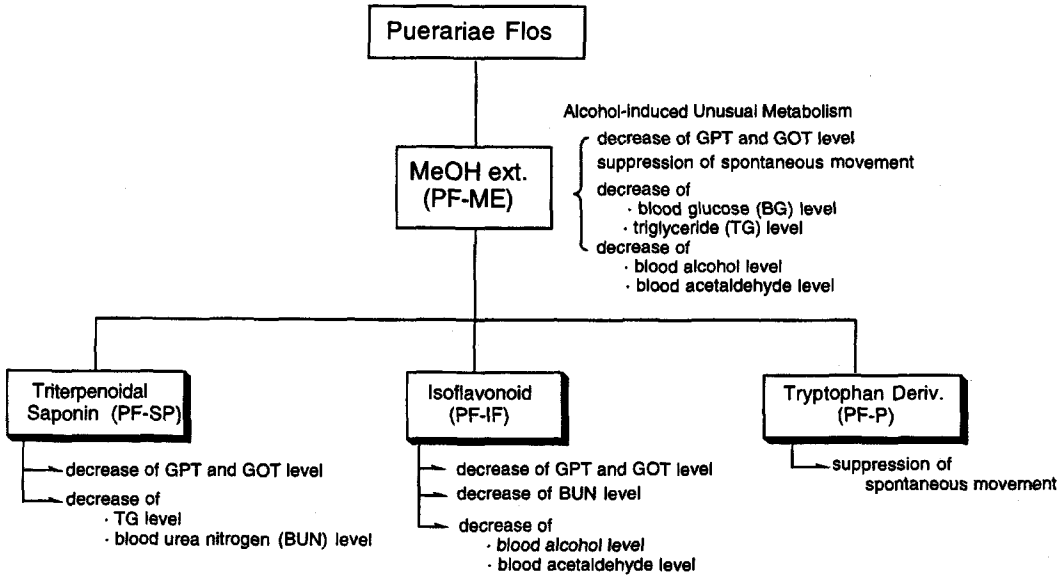


Chart 1. Pharmacological effects of Puerariae Flos and its constituents.

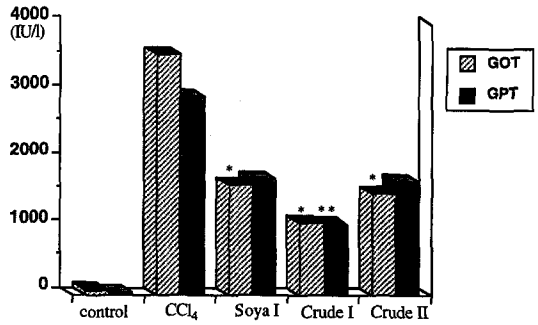


Fig. 4. Effects of Abri Herba extract on mice treated with CCl_4.
Effects of Soyasaponin I (Soya I), Crude saponin I (Crude I) and Crude saponin II (Crude II) on CCl_4 induced liver injury by oral administration; Dose was each 500 mg/kg; Each column represents mean of 10 mice. *P<0.05, **P<0.01.

The efficacy of these fractions and the methanolic extract was confirmed towards liver injury by CCl_4. As shown in Fig. 4 these saponins clearly blocked liver injury compared to the untreated CCl_4 control. Especially, the crude saponin fraction showed 70% inhibition.[14] Since the saponin fraction possessed considerable activity, we tried to examine the chemical ingredients. At first, we investigated their sapogenols to get many new sapogenols, named abrisapogenols (Fig. 5), along with known ones.[15]

The common features of these sapogenols are that they possess a methyl group at C-17 and some oxygen functions on the E-ring. Furthermore, we have isolated several saponins (Fig. 6).[16] New saponins were named abrisaponin. The major saponins were soyasaponin I and abrisaponin I. These saponins have glucuronic acid in the *endo*-sugar chain.

c. Roots of *Pueraria lobata*. This crude drug (Puerariae Radix) is widely used as antispasmodic, antipyretic, and antiperspirant medicine in Chinese orthodox medicines, Kampo. We have first found the presence of triterpenoidal saponins in this crude drug (Fig. 7).[17] Among the above actions of this crude drug, antispasmodic action is explained by daidzein. However, the substances responsible for the other actions have never been isolated from the crude drug. Now, we can guess that the triterpenoid saponin might be responsible for antipyretic and antiperspirant actions.

d. The Others. We have obtained saponins from thirteen plants as listed in Table 4.[18] Of these saponins, seventy two saponins

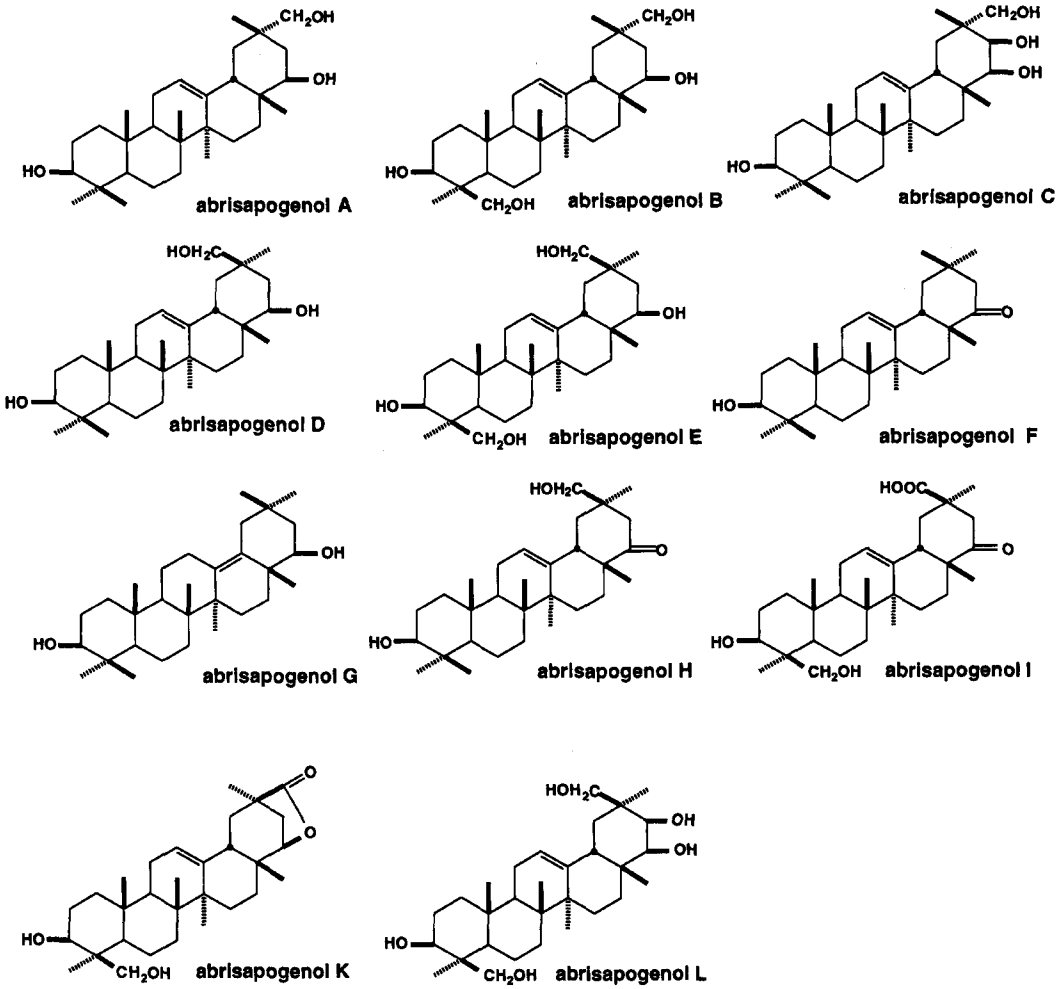


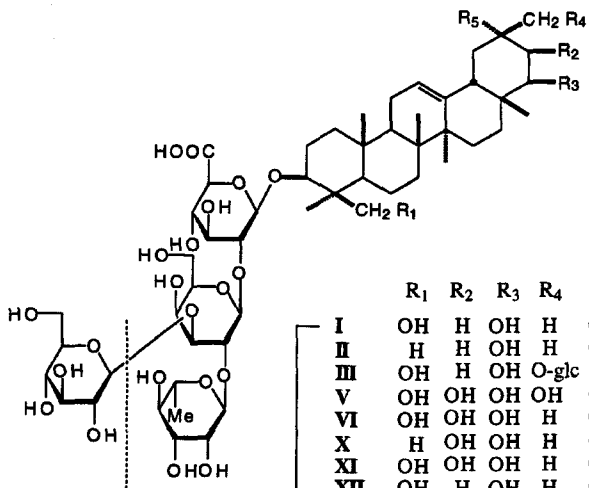
Fig. 5. New sapogenols from Abri Herba.

were new ones including novel twenty one sapogenols.

The known oleanane saponins mostly belong to the type with a carboxylic group at C-28, some of which are used as anticough medicines. In contrast, we deal with the oleanane triterpene saponins replaced by a methyl group and it might be predicted that these type saponins are effective for liver injury. These kinds of saponins are not very abundant except in the legume family. We would expect that the oleanane glycosides in the leguminous plants are able to explain the effectiveness of the respective crude drugs.

e. Structure-Hepatoprotective Relationship

On the way of our hepatoprotective study, from the reason that the antipyretic and perspiration of Puerariae Radix might be related to the inflammatory reaction, we have investigated the conditions for *in vitro* assay method using immunological liver injury of primary cultured rat hepatocytes. This method is regarded as one of the highly correlated to human hepatitis. This slide shows preparations of antiserum against the rat liver plasma membranes and primary cultured rat hepatites. The hepatoprotective activities were quantified by measuring the



	R_1	R_2	R_3	R_4	R_5	
I	OH	H	OH	H	CH_3	(soyasaponin I)
II	H	H	OH	H	CH_3	(kaikasaponin III)
III	OH	H	OH	O-glc	CH_3	(subproside V)
V	OH	OH	OH	OH	CH_3	
VI	OH	OH	OH	H	CH_3	
X	H	OH	OH	H	CH_3	
XI	OH	OH	OH	H	CH_2OH	(kudzusaponin A_3)
XII	OH	H	OH	H	CH_2OH	(robinioside E)
XIII	OH	H	OH	OH	CH_3	(wistariasaponin B_2)
XIV	H	OH	OH	H	CH_2OH	(subproside I)
XV	H	H	OH	H	CH_2OH	
XVI	H	H	OH	OH	CH_3	
XVII	OH	H	OH	H	COOH	(sophoraflavoside II)
XVIII	OH	H	=O	H	CH_3	(dehydrosoyasaponin I)
XIX	H	H	=O	H	CH_3	(phaseoside IV)
XX	H	H	OH	H	COOH	(compound 2)
XXII	H	H	OH	O-glc	CH_3	(subproside IV)

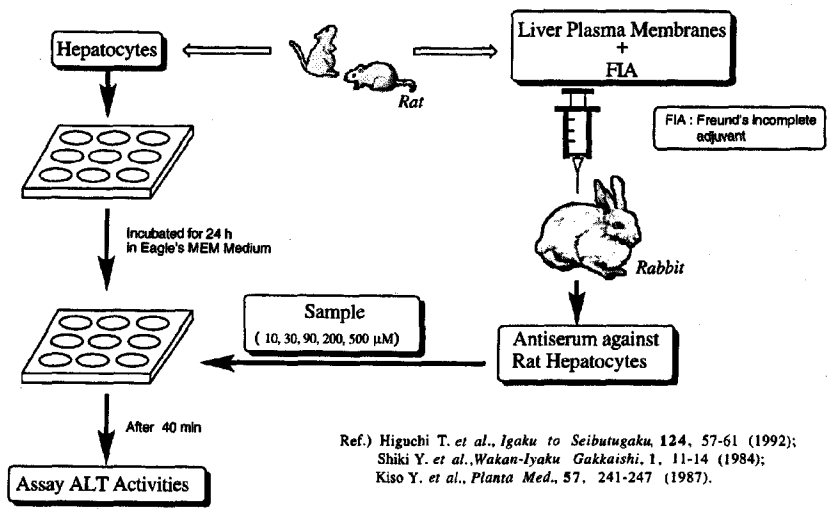
	R_1	R_3	R_4
IV	H	OH	H
VII	OH	OH	H
VIII	H	O-xyl	H
IX	H	OH	O-glc
XXI	H	OH	OH
XXIII	H	=O	H

(R_2 = H, R_5 = CH_3)

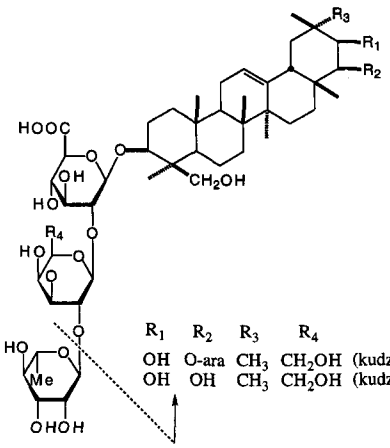
Fig. 6. Abrisaponins from Abri Herba.

« Assay Method for Hepatoprotective Drugs Using Primary Cultured Rat Hepatocytes Injured with Antiserum against Rat Liver Plasma Membranes »

Arao T. *et al.*, *Biol. Pharm. Bull.*, **20** (9), 988-991 (1997).



Ref.) Higuchi T. *et al.*, *Igaku to Seibutugaku*, **124**, 57-61 (1992);
Shiki Y. *et al.*, *Wakan-Iyaku Gakkaishi*, **1**, 11-14 (1984);
Kiso Y. *et al.*, *Planta Med.*, **57**, 241-247 (1987).



R_1	R_2	R_3	R_4	
OH	O-ara	CH_3	CH_2OH	(kudzusaponin SA_1)
OH	OH	CH_3	CH_2OH	(kudzusaponin SA_2)

R_1	R_2	R_3	R_4	
H	OH	CH_3	CH_2OH	(soyasaponin I)
OH	OH	CH_3	CH_2OH	(kudzusaponin SA_1)
OH	OH	CH_2OH	CH_2OH	(kudzusaponin A_3)
OH	OH	COOH	CH_2OH	(kudzusaponin B_1)
O-glc	H	CH_3	CH_2OH	(kudzusaponin C_1)
H	O-ara	CH_3	CH_2OH	(kudzusaponin SB_1)
H	O-ara	CH_3	CH_2OH	(kudzusaponin SA_3)
OH	O-xyl	CH_2OH	H	(kudzusaponin A_1)

Fig. 7. Kudzusaponins from Puerariae Radix.

release of ALT (Alanine aminotransferase) into the culture media of primary cultured hepatocytes injured with antiserum against the liver plasma membranes.

By using this method, we have measured hepatoprotective activities of the saponins. As a result, soyasapogenol B glucuronide and soyasapogenol B galactosyl glucuronide were the most effective.

We have established the structure-hepatoprotective relationships, in which the presence of methyl group at C-17, the hydroxyl group at C-21 and galactosyl moiety is important.

2. C-28 COOH Oleanane

a. Barks of *Albizzia julibrissin*. From this crude drug (Albizziae Cortex), several saponins named julibrosides were obtained after careful separation (Figure 8).[19] These oleanane triterpene saponins are different

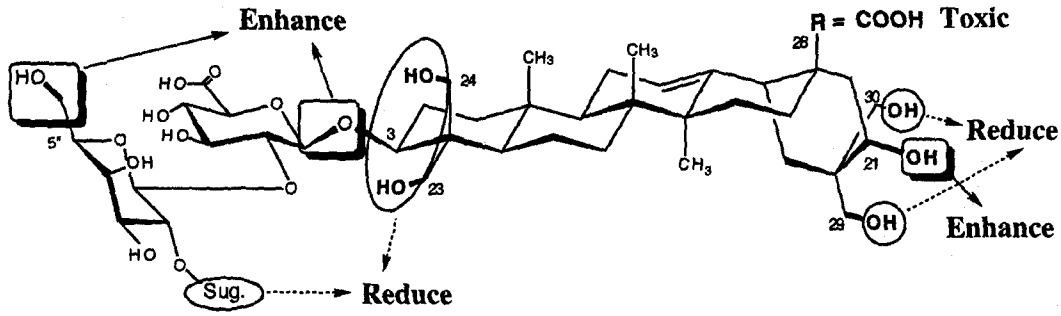
Table 4. Characteristic Oleanane Glucuronides Isolated from Fabaceous Plants

Plants	Parts	Total OGs	New Aglycones	New OGs
Abrus cantoniensis	whole	23	10	11
Abrus precatorius	seed	1	1	0
Aeschynomene indica	whole	1	0	0
Arachis hipogaea	seed	1	0	0
Astragalus complanatus	seed	6	1	4
Astragalus sinicus	seed	6	0	1
Baptisia australis	root	2	0	1
Campylotropis hirtella	root	2	0	0
Canavalia gladiata	root	4	0	2
Crotalaria albida	whole	6	0	2
Dalbergia hupeana	bark	3	2	2
Desmodium styracifolium	whole	2	0	0
Glycine max cv. Kuromame	seed	2	0	0
Glycine soya	aerial	4	0	0
Melilotus officinalis	root	4	0	1
Medicago polymorpha	aerial	1	0	0
Mucuna sempervirens	leaf	2	0	1
Lathyrus palustris	aerial	4	0	2
Lupinus polyphyllus hybrid	root	7	0	5
Lupinus polyphyllus hybrid	seed	4	0	0
Pachyrhizus erosus	tuber	2	0	0
Phaseolus coccineus cv. Murasakihanamame	seed	1	0	0
Phaseolus coccineus cv. Murasakihanamame	aerial	2	0	0
Phaseolus coccineus cv. Ooshirobananamame	seed	3	0	0
Phaseolus vulgaris cv. Uzuramame	seed	2	0	0
Phaseolus vulgaris cv. Taishokintoki	seed	1	0	1
Phaseolus vulgaris cv. Toramame	aerial	2	0	0
Phaseolus vulgaris cv. Toramame	root	3	0	1
Phaseolus vulgaris cv. Torosuku	seed	3	0	0
Pisum sativum	seed	1	0	0
Pueraria lobata	flower	3	0	1
Pueraria lobata	root	12	3	10

Table 4. Continued

Plants	Parts	Total OGs	New Aglycones	New OGs
Pueraria thomsonii	root	5	0	2
Pueraria thomsonii	flower	3	0	0
Robinia pseudo-acacia	bark	13	0	10
Sophora subprostrata	root	11	4	7
Sophora flavescens	root	4	0	3
Vicia faba	seed	1	0	0
Vigna angularis cv. Dainagon	seed	2	0	0
Vigna unguiculata cv. Chuguro	seed	2	0	0
Wisteria brachybotrys	bark	9	0	5
Total 33	41	172	21	72

« Structure Hepatoprotective Relationships of Oleanene Glucuronides »



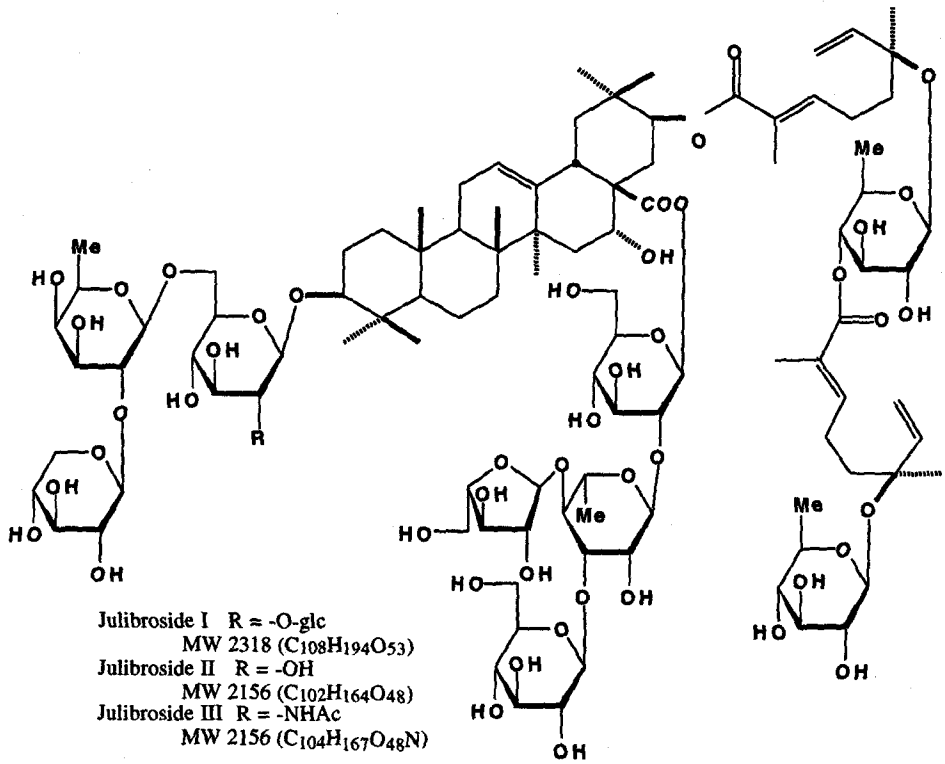


Fig. 8. Albizziae saponins from Albizziae Cortex.

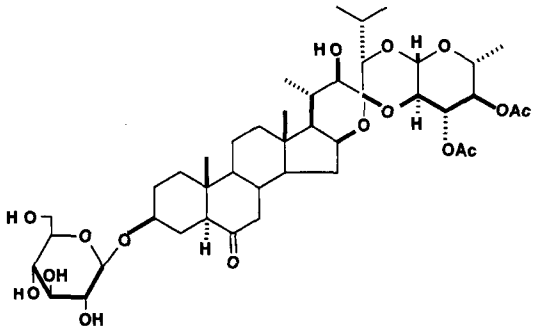


Fig. 9. Growth inhibitor from *Heloniopsis japonica.*

from the above-mentioned ones in respect to the functional group at C-17. Among these saponins, julibrosides II and III possessed strong topoisomerase I activity.

C. Others

1. Cholestane Derivative

During our study on the steroid components among the liliaceous plants, we obtained a novel cholestane derivative, named helojaposide, which is a unique cholestane diglycoside having the ketal carbon at C-23 linked to C-16, and C-2‴ of the fucosyl moiety (Fig. 9). At 10 ppm this showed a significat inhibitory activity for the root growth of rice.[20]

2. Cycloartane

Thalictrum spp. is used as a folk medicine in Japan for treating stomach ache. From this herb fourteen cycloartane-type triterpenoidal saponins were isolated (Fig. 10).[21] Among these the glycosides (thalictoside D, E in Fig. 11, F and G) with the side chain at C-17 possessing a five-membered ring were shown to have strong LTT (lymphocyto transformation test) activity.

D. Transglycosylation

Through our studies on the various glycosides, we have understood that the sugar moiety also plays an important role in the bioactivity, so that we tried to transfer the sugar to another aglycone. Julibrosides possessed anticancer activity, but, when the

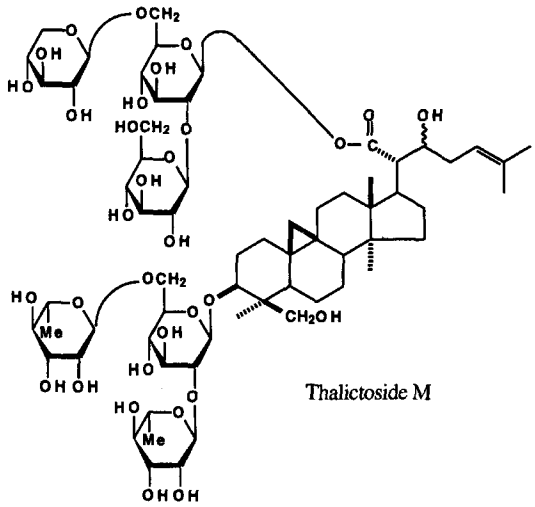


Fig. 10. Thalictoside M from Thalictri Herba.

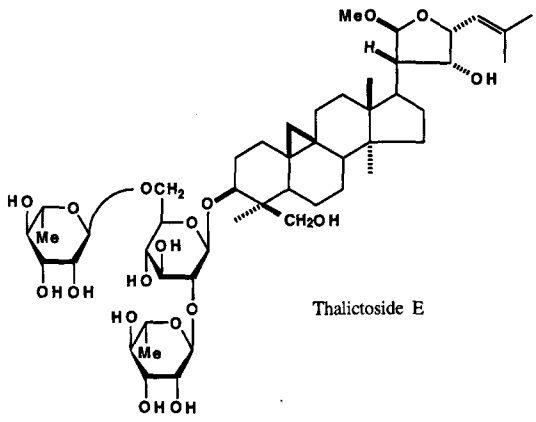


Fig. 11. Cycloartane glycoside having LTT activity.

ester sugar linkage at C-28 was taken off, the product turned out to have no activity. Therefore, it was supposed that this sugar moiety was important for the activity. Hence, we cut off this sugar moiety as an allyl glycoside. Next, we subjected this compound to ozonolysis to give an aldehyde, which was subsequently converted to an amine by reductive amination with decylamine using cyanoborohydride. The resulting amine was reacted with decanoyl chloride to give a *N*-acyl derivative (Chart 2).[22] Pharmacological tests for the product are currently in progress. Next, we removed the allyl group at an anomeric center and applied the Schmidt

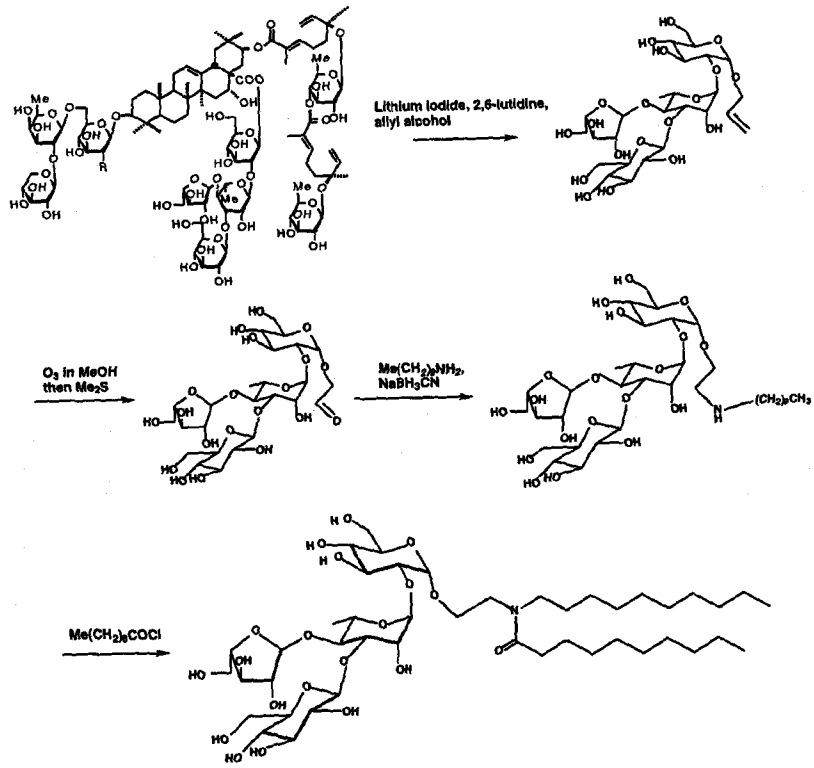


Chart 2. Synthesis of a neoglycolipid.

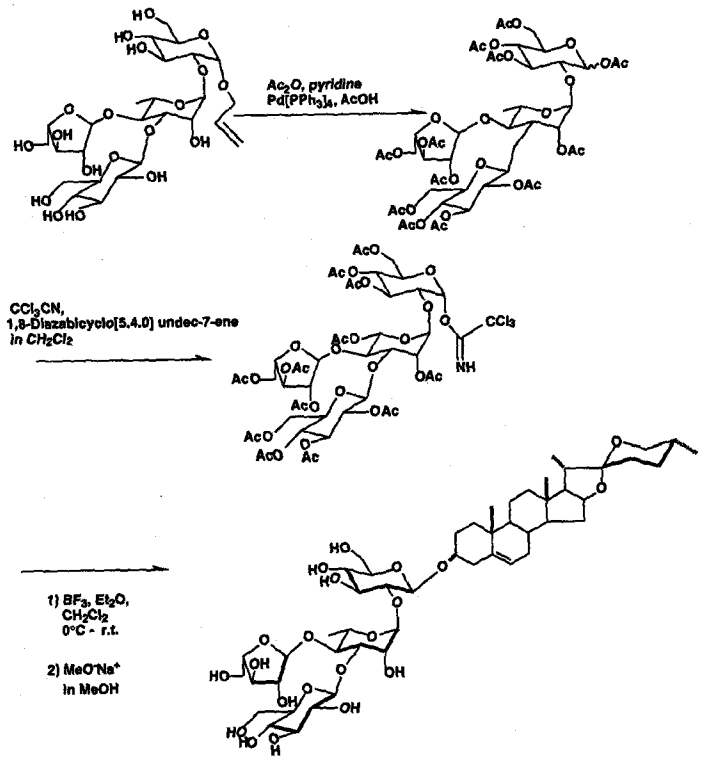


Chart 3. Transglycosylation into the spirostanol.

method. Thus we obtained cholesteryl and diosgenin glycosides in β-form (Chart 3).

References

1. Y. Y. Lee, F. Hashimoto, S. Yahara, T. Nohara, and N. Yoshida, Steroidal glycosides from *Solanum dulcamara*, *Chem. Pharm. Bull.* **42**: 707 (1994).
2. R. Saijo, K. Murakami, T. Nohara, T. Tomimatsu, A. Sato, and K. Matsuoka, Studies on the constituents of *Solanum plants*. II. On the constituents of immature berries of *Solanum nigrum* L., *Jpn. J. Pharmacog.* **102**: 300 (1982).
3. K. Murakami, H. Ezima, Y. Takaishi, Y. Takeda, T. Fujita, A. Sato, Y. Nagayama, and T. Nohara, Studies on the constituents of *Solanum* plants. V. The constituents of *Solanum lyratum* Thumb. II., e*Chem. Pharm. Bull.* **33**: 67 (1985).
4. a. R. Saijo, C. Fuke, K. Murakami, T. Nohara, and T. Tomimatsu, Two steroidal glycosides, aculeatiside A and B from *Solanum aculeatissimum*, *Phytochemistry* **22**: 733 (1983); b. T. Yamashita, N. Fujimura, S. Yahara, T. Nohara, S. Kawanobu, and K. Fujieda, Structures of three new steroid alkaloid glycosides, solaverines I, II and III from *Solanum toxicarium* and *S. verbascifolium*, *Chem. Pharm. Bull.* **38**: 827 (1990); c. K. Okamura, K. Shingu, S. Yahara, H. Koda, and T. Nohara, Three steroidal glycosides from *Scopolia japonica* Maxim., *Chem. Pharm. Bull.* **40**: 2981 (1992).
5. T. Nakamura, C. Komori, Y. Y. Lee, S. Yahara, T. Nohara, and A. Ejima, Cytotoxicities of *Solanum* steroidal glycosides, *Biolog. Pharm. Bull.* in press.
6. K. Shingu, Y. Furusawa, and T. Nohara, New withanolide, daturametelins C, D, E, F and G-Ac, from *Datura metel* L. (Solanaceous studies XIV), *Chem. Pharm. Bull.* **37**: 2132 (1989).
7. K. Yoshida, K. Shingu, S. Yahara, T. Nohara, N. Marubayashi, I. Ueda, K. Miyahara, and T. Kawasaki, A new class of ergostane glycosides from *Tubocapsicum anomalum*, *Tetrahedron Lett.* **29**: 673 (1988).
8. K. Shingu, S. Yahara, H. Okabe, and T. Nohara, Three withanolides, physagulin E, F and G from Physalis angulata L., *Chem. Pharm. Bull.* **40**: 2448 (1992).
9. K. Shingu, S. Yahara, and T. Nohara, Five new ergostane-related compounds from *Nicandra physaloides*, *Chem. Pharm. Bull.* **42**: 318 (1994).
10. K. Shingu, H. Fujii, I. Ueda, S. Yahara, and T. Nohara, Ergostane glycosides from *Petunia hybrida*, *Phytochemistry* **36**: 1307 (1994).
11. E. Ohmura, T. Nakamura, R. H. Tian, S. Yahara, H. Yoshimitsu, and T. Nohara, 26-Aminocholesterol derivative, a novel key-intermediate of steroidal alkaloids, from *Solanum abutiloides*, *Tetrahedron Lett.* **36**: 8443 (1995).
12. *Y. Niiho, T. Yamazaki, Y. Nakajima, H. Itoh, T.* Takeshita, J. Kinjo, and T. Nohara, Pharmacological studies on Puerariae Flos. II. The effects of Puerariae Flos on alcohol-induced unusual metabolism and experimental liver injury in mice, *Jpn. J. Pharmacog.* **110**: 604 (990).
13. J. Kinjo, T. Takeshita, Y. Abe, N. Terada, H. Yamashita, M. Yamasaki, K. Takeuchi, K. Murakami, T. Tomimatsu, and T. Nohara, Studies on the constituents of *Pueraria lobata* (4). Chemical constituents in the flowers and the leaves, *Chem. Pharm. Bull.* **36**: 1174-1179 (1988).
14. T. Takeshita, Y. Itoh, Y. Sakai, T. Nohara, M. Yasuhara, H. Saito, I. Kitagawa, T. Ariga, N. Irino, and T. Takaoka, Studies on the constituents of Abri Herba effective on experimental liver injuries, 7th Symposium on the Development and Application of Naturally Occurring Drug Materials, Abstracts, p 83, Fukuoka (1989).
15. T. Takeshita, S. Hamada, and T. Nohara, New triterpenoid sapogenols from *Abrus cantoniensis* (I), *Chem. Pharm. Bull.* **37**: 846 (1989).
16. Y. Sakai, T. Takeshita, J. Kinjo, Y. Ito, and T. Nohara, Two new triterpenoid sapogenols and a new saponin from *Abrus cantoniensis* (II), *Chem. Pharm. Bull.* **38**: 824 (1990).
17. J. Kinjo, I. Miyamoto, K. Murakami, K. Kida, T. Tomimatsu, M. Yamasaki, and T. Nohara, Oleanene-sapogenols from Puerariae Radix, *Chem. Pharm. Bull.* **33**: 1293-1296 (1985).
18. a. B. Cui, Y. Sakai, T. Takeshita, J. Kinjo, and T. Nohara, Four new oleanene derivatives from the seeds of *Astragalus complanatus*, *Chem. Pharm. Bull.* **40**: 136 (1992); b. Y. Ding, T. Takeshita, K. Yokoyama, J. Kinjo, and T. Nohara, Triterpenoid glycosides from Sophorae Subprostratae Radix, *Chem. Pharm. Bull.* **40**: 139 (1992); c. B. Cui, J. Kinjo, and T. Nohara, Triterpene glycosides from

the bark of *Robinia pseudo-acacia* L. (I), *Chem. Pharm. Bull.* **40**: 2995 (1992); d. B. Cui, J. Inoue, T. Takeshita, J. Kinjo, and T. Nohara, Triterpene glycosides from the seeds of *Astragalus sinicus* L., *Chem. Pharm. Bull.* **40**: 3330 (1992); e. B. Cui, J. Kinjo, and T. Nohara, Triterpene glycosides from the bark of *Robinia pseudo-acacia* L. (II), *Chem. Pharm. Bull.* **41**: 553 (1993).

19. T. Ikeda, S. Fujiwara, J. Kinjo, T. Nohara, Y. Ida, J. Shoji, T. Shingu, R. Isobe, and T. Kajimoto, Three new triterpenoidal saponins acylated with monoterpenic acid from Albizziae Cortex, *Bull. Chem. Soc. Jpn.* **68**: 3483 (1995).
20. K. Shingu, K. Mito, S. Yahara, T. Nohara, M. Ono, T. Kawasaki, K. Nakano, T. Tomimatsu, M. Haratake, N. Marubayashi, and I. Ueda, A novel cholestane derivative as root growth inhibitor from *Heloniopsis japonica, Tetrahedron Lett.* **33**: 2529 (1992).
21. H. Yoshimitsu, K. Hayashi, M. Kumabe, and T. Nohara, Cycloartane-type glycosides from Thalictri Herba, *Phytochemistry* **38**: 939 (1995).
22. T. Ikeda, T. Kajimoto, T. Nohara, J. Kinjo, and C. Wong, Preparation of a neoglycolipid carrying the oligosaccharide component of saponin from *Albizzia jurbrissin, Tetrahedron Lett.* **36**: 1509 (1995).

(Accepted December 8, 1998)