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Pharmacological Activities of Crude Platycodin*

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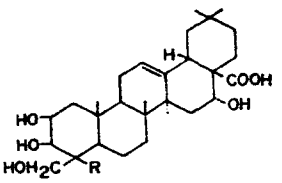
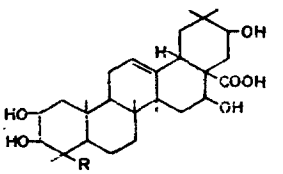
Crude platycodin is a saponin fraction isolated from Platycodi Radix, the roots of *Platycodon grandiflorum* A. DC. (Campanulaceae). In old Chinese book of *Shin-nung-Pen-tsao-king*(神農本草經), the Radix is written as effective as an expectorant in the symptoms of cold, cough, asthma and pulmonary tuberculosis, and as valuable for the control of pleuritis. According to the description, the Radix is active as an expectorant and antiinflammatory drug, and it has been often prescribed in Chinese medicine for cough due to cold, pain in the region along the lowest rib, lung gangrene and pharyngolaryngeal inflammatory pain. As a folk medicine, it is used for treatment of cough with sputum, tonsillitis, laryngeal pain, pulmonary pain, pertussis, asthma, pleuritis and inflammatory diseases.[1]

Previously, several sapogenins from the saponins of the Radix were isolated and reported as the followings; the platycodigenin (I) was isolated from saponin by Akiyama, *et al.*[2,3] and by Kubota[4], and polygalacic acid (II) by Akiyama, *et al.*[5], and platycodigenic acid A(III), B(IV) and C(V) by Kubota, *et al.*[6]



R
I. $-CH_2OH$
II. $-H$
III. $-COOH$



R
IV. $-COOH$
V. $-CH_3$

On its pharmacological studies, however, there have hardly been reported except on the expectorant action by Igarashi[7]. Henceforth the results are concerned with pharmacological activities of crude platycodin.

Acute Toxicity and Central Nervous System Depressant Activity[8]—The median lethal doses of crude platycodin in mice are shown in Table I. Intraperitoneal administration gave a great more toxicity than oral administration did. The ratios shown as LD_{50} *p.o.*/LD_{50} *i.p.*

* Presented on Oct. 5, 1974 at the symposium on "Terpenoids" organized by Natural Products Research Institute, Seoul National University.

Table I—Acute toxicity of crude platycodin

Animals	Administration route	LD_{50}(mg/kg)
Mouse	*p.o.*	420(375.0—470.4)[a]
Mouse	*i.p.*	22.3(19.8—25.1)[a]
Rat	*p.o.*	>800
Rat	*i.p.*	14.1[b]
Guinea pig	*i.p.*	23.1[b]

a) Litchfield-Wilcoxon method
b) Up and down method
Numbers in parentheses indicate the 95% confidence limits.

are 18.8 and 56.7 in mice and rats, respectively. These suggest that crude platycodin is poorly absorbed through the gastrointestinal tract. This result is in agreement with those of Wilson *et al.*[9] and Liener *et al.*[10] that saponins show, in general, low absorbabilities in oral administration. The toxic syndromes are sedative activity such as inhibition of movement and decreases in respiratory rates in both of *i.p.* and *p.o.* administrations. In bulk doses, mice showed hardly spontaneous movements and came to death with intermittent clonic convulsions. In the case of *i.p.* administration, anatomical appearances of mice showed increased peritonial fluids due to exudation and the dead mice exudated the hemolyzed fluids.

Crude platycodin has a hemolytic effect as tested by Fujita *et al.*[11] of which hemolytic index is 36,970 that is corresponding to 1.2 times that of commercial reagent grade saponin (E. Merck, AG.) as a reference and it exhibited a local irritative effect.

In behavioral observation test with mice, crude platycodin exhibited an inhibitory effect in the central nervous system. Especially, marked inhibition of spontaneous movement was shown with a small dose. In autonomic profile, writhing syndrome and mydriasis were observed.

In climbing test, the mean climbing dose (CD_{50}) of crude platycodin is 144.5mg/kg (confidence limit; 83.5~251.0) and in hole cross method, the spontaneous movement of mice was significantly inhibited as compared with control as shown in Fig. 1. Crude platycodin appears to have no anticonvulsive activity because no inhibition against the convulsion induced by electroshock and by pentetrazole has been shown. This fact might be assumed that crude platycodin had no central muscle relaxant activity.

Moderate prolongation of sleeping time induced by hexobarbital sodium was exhibited following its administration. However, hypnotic activity was not recognized because the impediment of motor coordination or the increase of pentetazole-threshold was not observable.

Kinnard *et al.*[12] have reported that a simple "sedative", 2-ethylcrotonyl urea exhibited a moderate degree of depression and hardly exhibited the impediment of motor coordination in the photocell method and the rotarod method, respectively; however, barbiturates decreased the movement only slightly on photocell method and showed potent ataxia in rotarod method, and chlorpromazine fell in between those of the above drugs.

In this study, both of the hole cross method[13] based on the photocell method[14] and the

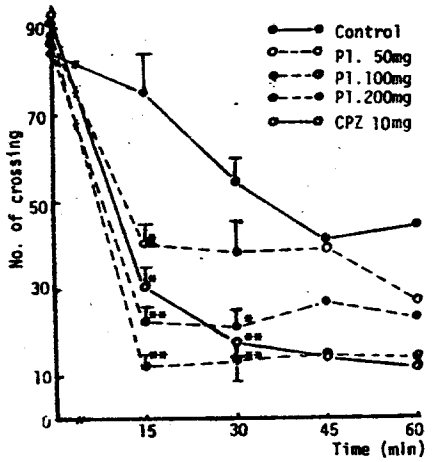


Fig. 1—Effect of crude platycodin and chlorpromazine on motor activity of mice
* Significant at $P<0.05$
** Significant at $P<0.01$

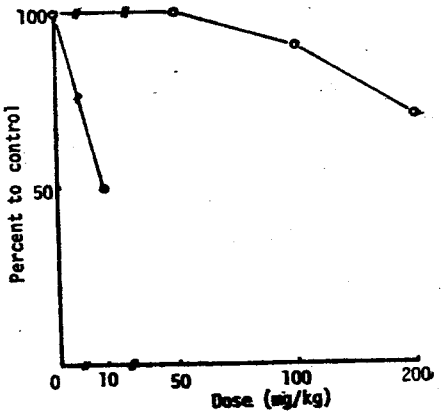


Fig. 2—Effect of crude platycodin and chlorpromazine on motor coordination of mice.
—○— Crude platycodin
—●— Chlorpromazine

rotarod method[15] were applied. From the experiments, it has been demonstrated that weaker impediment of motor coordination with crude platycodin was elicited than that of chlorpromazine as shown in Fig. 2.

The fact of the weak ataxia being caused by crude platycodin and the results from the data, obtained with the inclined plane method that 10mg/kg of chlorpromazine hydrochloride and 200mg/kg of crude platycodin, showed nearly the same degree of activity, indicate crude platycodin had no muscle relaxant activity (Table II).

Crude platycodin shows an analgesic activity in both test of the writhing method induced by acetic acid[16] and of tail pressure method[17] (Fig. 3). And it appears to have also antipyretic activity.

Table II—Effect of crude platycodin and chlorpromazine on motor control on an inclined plane in mice.

Treatment	Dose mg/kg *p.o.*	No. of animals	Sliding angle (mean±S.E.)			Percent increase compared with control	
			Before drugs	After drugs			
				60 min	90 min	60 min	90 min
Control	—	6	47.2±1.1	47.7±3.5	49.5±1.1	—	—
Crude platycodin	50	6	49.0±0.9	52.2±1.1	51.2±2.1	5.5	−0.4
	100	6	47.0±1.2	51.2±1.9	51.3±6.3	7.8	5.2
	200	6	49.5±0.7	54.5±6.1	55.5±1.9	9.0	8.0
Chlorpromazine	10	6	46.0±1.0	52.0±1.4	53.7±2.2	9.9	11.8

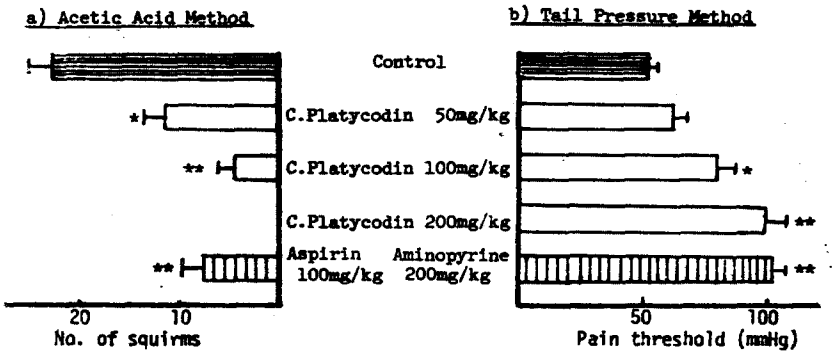


Fig. 3—Analgesic effect of crude platycodin in mice.
* Significant at $P<0.05$
** Significant at $P<0.01$

In the test of antipyretic analgesics by the pressure method, the analgesic activity is not detected when a toxic dose level is not used; in such a case, being the ataxia due to its toxicity resulted as a false positive effect, Collier *et al.*[18] have pointed out a necessity for testing on the motor coordination paralelled with an analgesic activity. In this study carried out by the rotarod method and the inclined plane method, no ataxia was shown at a dose level exhibited an analgesic activity following its administration.

In brief, the results may summarized as follows; crude platycodin is much less toxic in *p.o.* administration than in parenteral administration. It has a central depressant activity, showing mainly sedation and analgesic-antipyresis.

Anti-inflammatory Activity[19]—Crude platycodin showed significant inhibition of carrageenin-induced edema in rats as compared with control. As shown in Fig. 4, aspirin revealed the activity from 1 hr. after its oral administration, however the sample showed it from 15 min after its administration, and the effect of crude platycodin is more potent than aspirin.

As the edema is produced by the injection of carrageenin, histamine and seretonin as the chemical mediators are known to be released during the first 1 hr period, and then kinin is known to be released during next 2.5 hrs, then finally prostaglandins to be released from 2.5 hr after the injection[20]. Crude platycodin inhibited the edema through the time indicated. It suggests that it could inhibit all of the above-mentioned mediators. It also inhibited the acetic acid induced edema in rats (Fig. 5). Kayaoka *et al.*[21] have verified the presence of kinins, especially bradykinin by incubating plasma with 5% acetic acid.

In Table III the effects on granuloma formation are shown. Administration of 50mg/kg and 100mg/kg doses for 7 days inhibited granuloma formation as much as 26.4% and 29.8%, respectively. The differences from the control show statistically significant. Cortisone in doses of 20mg/kg also inhibited significantly the formation, whereas the weights of thymus and adrenal were not signigicantly decreased.

Cygielman *et al.*[22] have reported that local irritant substances had a marked anti-inflamma-

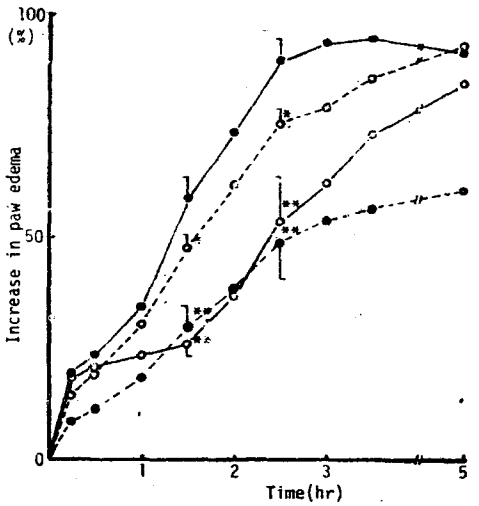


Fig. 4-Anti-inflammatory effect of crude platycodin and aspirin on carrageenin edema of rat paws.
·—·; control, ∘—∘; crude platycodin, 100mg/kg, ·····; crude platycodin 200mg/kg, ∘—∘; aspirin 300mg/kg.
* Significant at $P<0.05$
** Significant at $P<0.01$

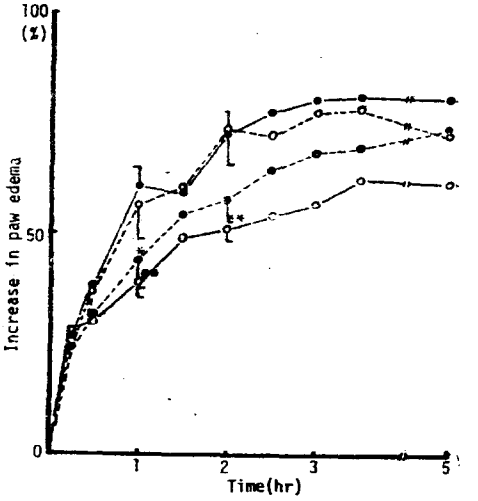


Fig. 5-Anti-inflammatory effect of crude platycodin and aspirin on acetic acid edema of rat paws.
·—·; control, ∘—∘; crude platycodin 100mg/kg, ·····; crude platycodin 200mg/kg, ∘—∘; aspirin 300mg/kg.
* Significant at $P<0.05$
** Significant at $P<0.01$

ory activity in cotton pellet test. In order to avoid this defects the author have tested the potency with oral administration of the saponin.

The effects on adjuvant arthritis were investigated by using Anderson *et al.*[23] method. The results are shown in Table IV which determined the swelling due to the secondary lesion in the paw of rats. The swelling was significantly inhibited with doses of 100mg/kg *p.o.* as

Table III—Effect of crude platycodin and cortisone on the formation of cotton pellet granuloma in rats.

Treatment	Dose mg/kg *p.o.*	No. of animals	Body wt.(g) Initial	Body wt.(g) Gain	Granuloma wt. (mg/100g±S.E.)	Adrenal wt. (mg/100g)
Control	—	6	131	22	23.5±1.8	23.5
Crude platycodin	25	6	126	15	21.3±2.5	21.6
	50	6	125	2	17.3±1.8*	22.2
	100	6	127	3	16.5±2.0*	20.0
Cortisone	20	6	130	15	14.3±1.8**	19.3

The treatment was performed for 7 days.
* Significant at $P=0.05$
** Significant at $P=0.01$

Table IV—Effect of crude platycodin and phenylbutazone on the swelling of the contralateral paws to those treated with adjuvant in rats.

Treatment	Dose mg/kg/day *p.o.*	No. of animals	Vol. increase (%±S.E.)	Thymus wt. (mg/100g±S.E.)
Control(no adjuvant)	—	7	18.5±1.7	165.2±11.5
Control (adjuvant)	—	7	32.3±2.8*	135.3±18.4
Crude platycodin	50	7	28.3±2.1	152.3±16.2
	100	7	25.4±2.2**	162.1±18.2
Phenylbutazone	50	7	24.1±2.5**	155.1±16.6

The treatment was performed for 14 days.
* Significant at $P<0.05$ when compared with control (no adjuvant)
** Significant $P<0.01$ when compared with control (adjuvant)

compared with the positive control.

From the results obtained, crude platycodin appeared to possess inhibitory effect against acute and chronic inflammatory models in rats.

Activities on Gastric Secretion and Experimental Gastric Ulcers[24]—Effects of atropine sulfate and crude platycodin on gastric secretion are presented in Table V. Atropine sulfate (10mg/kg *s.c.*) reduced almost completely all the parameters of gastric secretion. Crude platycodin also reduced significantly all the parameters of gastric secretion. In rats treated with 50mg/kg of crude platycodin, the volumes of gastric juice, acid output and pepsin activity were reduced by about 50%. Crude platycodin in doses of 100mg/kg almost completely inhibited gastric secretion, and gastric samples could be obtained only from 3 and 5 animals out of 10 animals used.

Results obtained in Shay ulceration are summarized in Table VI. Atropine sulfate and crude platycodin significantly prevented Shay ulceration. Crude platycodin in doses of 25mg/kg *i.d.* was as effective as atropine sulfate in doses of 10mg/kg *s.c.* On account of perforation,

Table V—Effect of crude platycodin on gastric secretion in pylorus ligated rats.

Treatment	Dose mg/kg	No. of animals	Volume ml/4hr	Total acidity mEq/L	Acid output μEq/4hr	Pepsin*, mg/4hr as tyrosine
Control	—	12	4.7±0.6	96.7±6.7	467.6±73.3	83.1±10.4
Atropine sulfate	10	12	0.6±0.1**	4.8±0.5**	3.0± 1.4**	11.5± 5.3**
Crude platycodin	25	12	3.5±0.3	83.3±5.1	305.0±49.4	62.7±49.4
	50	12	2.1±0.3**	89.0±5.6	194.4±36.9**	41.9± 6.4**
	100	10	0.4±0.2**	6.2±3.0 (3)	5.6± 2.5 (3)	20.7± 7.3 (5)

Values are mean±S.E.
*Amount of tyrosine, released per 30 min of incubation with bovine serum albumin, during the 4hr of gastric juice secretion.
* Statistically significant at $P<0.05$
** Statistically significant at $P<0.01$

Table VI—Effects of crude platycodin on gastric ulceration in pylorus ligated rats.

Treatment	Dose (mg/kg)	No. of animals	Incidence of perforation(%)	Ulcer index (mean±S.E)	% Inhibition
Control(*i.d.*)	—	12	83.3	47.8	—
Atropine sulfate(*s.c.*)	10	12	8.3	14.9±5.4**	68.9
Crude platycodin(*i.d.*)	25	12	8.3	16.2±5.8**	69.4
	50	12	8.3	12.3±4.6**	74.3
	100	12	0	0.8±0.8**	98.4

** Significant at $P<0.01$

gastric samples from control animals could be obtained only from 2 animals out of 12. In rats treated with 100mg/kg of crude platycodin, Shay ulceration was almost completely prevented, and all the parameters of gastric secretion were significantly reduced.

The results of their effects on stress induced ulceration are presented in Table VII. Atropine sulfate significantly reduced the severity of the lesion induced by stress. Crude platycodin in doses of 100mg/kg significantly prevented the stress induced ulceration, but in doses of 25 and 50mg/kg it had no effect. The reduction of ulcer index by 100mg/kg *p.o.* of crude platycodin was as half as that of 10mg/kg *s.c.* of atropine sulfate.

In acetic acid induced ulceration, the curative ratios of crude platycodin in doses of 25 and 50mg/kg were 41 and 20%, respectively. The higher dose of crude platycodin was less effective than the lower dose.

Prevention of Shay ulceration by crude platycodin is due to the inhibition of gastric secretion. In the cases of stress induced ulceration, crude platycodin was not so effective as in the case of Shay ulceration, and only at high dose as 100mg/kg *p.o.* significantly reduced the severity of the lesion. There were no direct relationships between the degree of inhibition of gastric secretion and the reduction of severity of the stress induced ulceration by crude platycodin. Crude platycodin in doses of 25mg/kg was significantly effective on healing of the acetic acid ulcer, however in doses of 50mg/kg, less effective. The similar phenomenon was reported in the case of Fm 100, a fraction from *Glycyrrhiza glabra*, in which lower doses of 400mg/kg were more effective than higher doses of 800mg/kg[25].

Table VII—Effects of crude platycodin on the stress induced ulcer.

Treatment	Dose (mg/kg)	No. of animals	Ulcer index (mean±S.E)	% Inhibition
Control	—	11	30.5±3.7	—
Atropine sulfate	10	12	6.7±2.2*	78.2
Crude platycodin	25	5	31.0±4.0	0
	50	10	28.4±3.6	6.4
	100	11	19.2±3.1*	37.0

* Significant at $P<0.05$

In short, crude platycodin markedly inhibited gastric secretion and prevented peptic ulcers in the pylorus ligated rats, however it had a rather slight effect on stress induced ulceration. Curative effect of crude platycodin in doses of 25mg/kg/day on acetic acid induced ulceration was also observed.

Activities on the Respiratory and Circulatory Systems[26,27]—It has been mentioned previously that large doses of crude platycodin lowered the respiratory rates of mice. This suggests that crude platycodin have some inhibitory activity on the respiratory system.

It also appeared to have antitussive activity in mechanically stimulated method on guinea-pig trachea. The mean antitussive doses(AtD_{50}) determined from the administration of codeine diphosphate and crude platycodin are 5.2 and 6.4mg/kg *i.p.*, respectively. This seems to have some connection with the inhibitory effect on the respiratory system.

In order to investigate the expectorant activity, the author determined the permeability of evans blue into the tracheae of guinea-pigs which were previously *i.v.* administered. The effects of ammonium chloride and crude platycodin on the permeability of the pigment are presented in Table VIII. In guinea-pigs administered crude platycodin directly into stomachs, no increases in vascular permeability were shown, whereas ingested through mouth in divided doses the increases were significantly different as compared with the control.

The increase in vascular permeability into mucous membrane may be regarded to be an expectorant activity. The results are in agreement with Joo[28], who described that expectorant

Table VIII—Effect of crude platycodin and ammonium chloride on the permeability of evans blue into the respiratory tract of guinea-pigs.

Treatment	Dose mg/kg *p.o.*	No. of animals	Amount of E.B.* exuded ($\mu g \pm$S.E.)	Increment (%)
Control	—	6	29.6± 3.55	
Crude platycodin	50	6	27.0± 6.14	−8.8
	100	6	31.1± 4.81	5.1
	80**	6	61.0±12.50***	51.5
Ammonium chloride	200	6	53.5± 9.18***	44.7

* 5% evans blue: 1ml/kg *i.v.*
** The dose was ingested through the mouth in four divided doses.
*** Significant at $P<0.05$

Table IX—Effect of crude platycodin on blood pressure and heart rate of rats.

Crude platycodin (mg/kg, *i.v.*)	0.5	1	5
Blood pressure decreased (mmHg)	53.5	98.5	110
Duration time (sec)	15	26	54
Heart rate decrease (beats/min)	22.9	37.3	126.1

The mean values of blood pressure and heart rate were 127mmHg and 364 beats/min, respectively. The data are mean values of 3 animals.

action of saponins could be an reflex increase in mucosal secretion from pharyngolaryngeal mucous membrane.

The experiment was also performed to test its actions on blood pressure and heart rate in rats by injecting *i.v.* crude platycodin. The results are shown in Table IX. With a dose of 0.5mg/kg *i.v.* of crude platycodin, a transient fall in blood pressure was produced and with increased doses, the effect appeared as dose-responsive, and an decrease in heart rate was the same as with blood pressure.

Further study on peripheral circulation including the coronary and hindquarter vascular beds in anesthetized dogs was carried out. The effects of crude platycodin in doses of 200, 400 and 800μg *i.a.* on the coronary vascular bed were examined in comparison with those of glyceryl trinitrate, 2, 4 and 8μg *i.a.*, papaverine and saponin, 200, 400 and 800μg *i.a.* All these agents exerted a dose dependent vasodilating effect on the coronary vascular bed, as shown in Fig. 6. Close-arterially administered crude platycodin caused significant increase in femoral blood flow as in the case of coronary blood flow. The data are shown in Fig. 7.

From the results of decreases in both peripheral vascular resistances, the vasodilating potency of crude platycodin in doses used was comparable to that of papaverine, and siginficantly superior to that of saponin (E. Merck AG.). Furthermore, crude platycodin clearly showed increases in coronary and femoral blood flows, even when administered intravenously (unpublished).

It is well known that coronary blood flow is influenced by a change in cardiac contractile force. Crude platycodin, even in a relatively high concentration of 1×10^{-3} to 3×10^{-3}g/ml, has been shown to cause a mild depression of contractile force in isolated guinea pig atria.

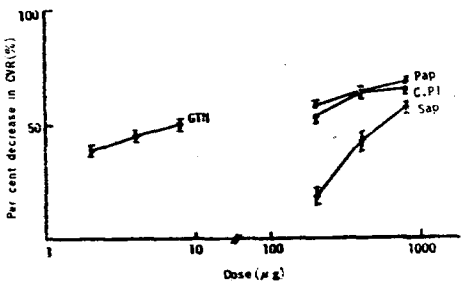


Fig. 6—Effects of crude platycodin, glyceryl trinitrate, papaverine and saponin on coronary vascular resistance in anesthetized dogs. GTN: glyceryl trinitrate, Pap: papaverine, C.Pl: crude platycodin, and Sap: saponin. Abscissa: dose of the agents in μg *i.a.* and ordinate: per cent decrease in coronary vascular resistance. Each point represents the mean value obtained from ten separate experiments performed on different dogs, and vertical bars represent standard errors.

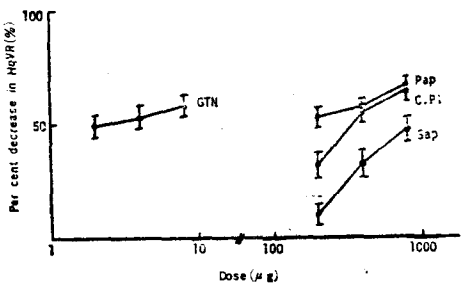


Fig. 7—Effects of crude platycodin, glyceryl trinitrate, papaverine and saponin on hindquarter vascular resistance in anesthetized dogs. GIN: glyceryl trinitrate, Pap: papaverine, C.Pl: crude platycodin, and Sap: saponin. Abscissa: dose of the agents in μg *i.a.* and ordinate: per cent decrease in hindquarter vascular resistance. Each point represents the mean value obtained from ten separate experiments performed on different dogs, and vertical bars represent standard errors.

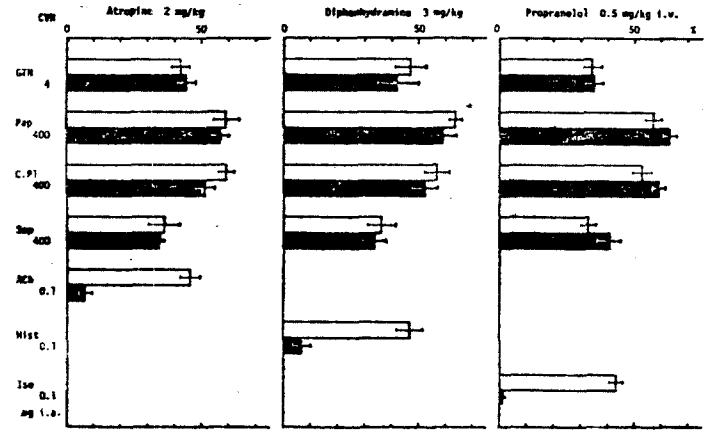


Fig. 8—Influence of atropine, diphenhydramine and propranolol on changes in coronary vascular resistance induced by crude platycodin, glyceryl trinitrate, papaverine and saponin in anesthetized dogs. GTN: glyceryl trinitrate, Pap: papaverine, C.Pl: crude platycodin, Sap: saponin, ACh: acetylcholine, Hist: histamine, and Iso: isoproterenol. Abscissa: per cent decrease in coronary vascular resistance. White column: before treatment with each blocking agent, and black column: after treatment.

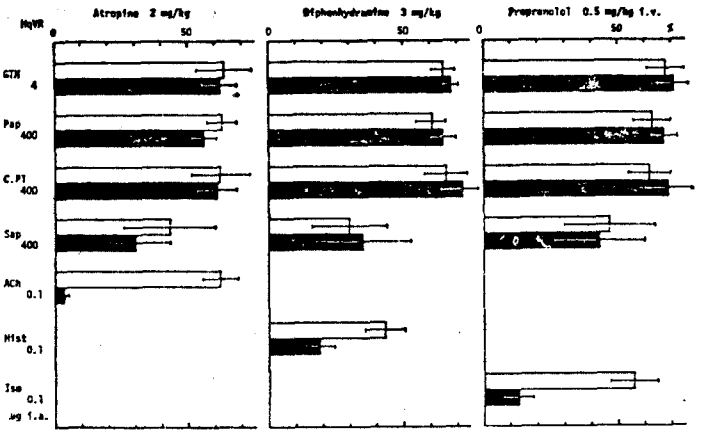


Fig. 9—Influence of atropine, diphenhydramine and propranolol on changes in hindquarter vascular resistance induced by crude platycodin, glyceryl trinitrate, papaverine and saponin in anesthetized dogs. Notations as in Fig. 8, except abscissa: per cent decrease in hindquarter vascular resistance.

For this reason, an increasein coronary blood flow induced by crude platycodin in doses utilized herein, does not appear to be due to a change in contractile force.

In order to study the mechanism involved in its vasodilating effect on peripheral vascular bed, further experiments were conducted. Influence of treatment with atropine, 2mg/kg,

diphenhydramine, 3mg/kg, or propranolol, 0.5mg/kg *i.v.*, on the vasodilating effect of crude platycodin, 400μg *i.a.*, administered into hindquarter vascular bed was observed and compared with those of glyceryl trinitrate, 4μg, papaverine, 400μg, and saponin, 400μg *i.a.* Each corresponding blocking effect of these blocking agents was verified by the administrations of acetylcholine, 0.1μg, histamine, 0.1μg, and isoproterenol, 0.1μg *i.a.*, respectively. Crude platycodin, 400μg *i.a.*, induced 50 to 60% increase in hindquarter vascular resistance in six dogs, and no significant change after treatment with each blocking agent was observed, as is shown in Fig. 8. In the cases of glyceryl trinitrate, papaverine and saponins, no influence on the treatment with atropine, diphenhydramine or propranolol was observed. Similar results were obtained from experiments on hindquarter vascular resistance in six animals, as shown in Fig. 9.

The results indicated that since there was no influence by the blocking agents used on the responses induced by crude platycodin as well as by glyceryl trinitrate, papaverine or saponin, the mechanism through muscarinic, histaminergic or beta-adrenergic effect might be ruled out from the point of vasodilating activity. Crude platycodin appears to have a direct vasodilating activity on the blood vessels as in the case of glyceryl trinitrate or papaverine.

Activities on Isolated Organs and Other Miscellaneous Activities[19,20]—Crude platycodin in high concentrations of up to 1×10^{-3}g/ml produced neither relaxation nor contraction of isolated guinea pig trachea, however it showed a weak antihistaminergic activity. In guinea pig ileum it exhibited antimuscarinic and antihistaminergic activities of which the pA_2 values were 5.0 and 5.4, respectively. On fundal strip preparation it did not directly affected and anti-serotonin activity was also not observed. Although bradykinin is a mediator of inflammation, its response on rat uterus was not blocked by crude platycodin. This fact indicates that crude platycodin has no influence on receptor site of bradykinin in the uterus. It has also been found that the antiinflammatory agents such as salicylates and phenylbutazone have no antibradykinin activity on that preparation[29]. Therefore, it is suggested that the mechanism of antiinflammatory activity of crude platycodin may be associated with inhibition of the kinin formation system.

Others appear to be inhibition of anaphylactic shock, mydriatic activity and inhibition of intestinal propulsion, but devoid of local anesthetic activity.

A Comparison of Pharmacological Activities of Crude Platycodin with Clinical Uses of Platycodi Radix[30]—In order to make comparison among activities of crude platycodin, its pharmacological spectrum was made[30], according to Takagi method[31]. In this spectrum crude platycodin appears to have marked antiinflammatory, antiulcerative, hypotensive and expectorant activities, and moderate analgesic, antipyretic, antitussive and antimuscarinic activities. And sedative, antihistaminergic and antiallergic activities are slight.

On the other hand, the clinical uses of Platycodi Radix that are infered from 23 sorts of prescriptions used frequently in the Oriental medicine are as follows. Fifty six percent of the indications are for antiinflammation, 10.6% for expectoration, 9.7% for analgesia, 8.0% for antipyresis, 4.4% for hypertension and 3.5% for antitussive. It is prescribed rarely for seda-

tion, antiulceration, antigastritis and antiallergy.

In general, it could not necessarily be expected that the pharmacological activities in experimental animals ran parallel with the clinical applications. However, the fact that the phamacological activities of Platycodi Radix are well known in the practice of mordern and Oriental medicine indicates that its various activities should be carefully shorted for clinical purposes.

As the antiinflammatory activity appeared to be the main action of crude platycodin in the pharmacological spectrum, more than one half of indications in clinical uses of Platycodi Radix was the inflammatory diseases, and its other activities such as antiulcerative, hypotensive and expectorant were applied in treatment of the corresponding diseases. The activities such as analgesic, antipyretic, antitussive, and antiallergic, were also fallen under treatment of the corresponding diseases. Although it has hypertensive, antiulcerative and antigastric secretory activities its application appeared to be insignificant for the clinical uses. The reason might be attributed to the difference in the administration routes of drugs between experimental and clinical cases.

Platycodi Radix contains other components except crude platycodin. The presence of fatty acids, vitamins and saccharides was known[32]. The Radix also contains 0.03% of spinasterol and 0.005% of betulin[33], however, these components may have no pharmacodynamic actions. And Gupta *et al.*[34] reported that the lupeol type triterpenoids such as betulin did not have any antiinflammatory activity and the contents of sterol and betulin in Platycodi Radix are as small as 2.84% and 0.47%, respectively.

Therefore, it may be noted that the pharmacological activities of crude platycodin would support the clinical uses of Platycodi Radix. Furthermore, it is suggested that the potent antiulcerative and vasodilating activities observed have in warrant for further studies.

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