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Effects of Radix Rehmanniae on gastric acid secretion and gastric ulcer formation in rats

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INTRODUCTION

The traditional Chinese medicine Radix Rehmanniae (RR), or Chinese foxglove root, is the root of *Rehmannia glutinosa* Libosch, a Scrophulariaceae plant. It is divided into three types based on differences in its preparation and action: fresh (dRR), dry (dRR), or steamed (sRR). RR contains 23 glucosides (main component: iridoid glucoside), eight carbohydrates, over 20 amino acids, and inorganic ions and trace elements. Its pharmacological effects on many systems are known but not that on the gastrointestinal tract.

Table 1 Effects of dry Radix Rehmanniae (dRR) on gastric juice secretion ($\bar{x} \pm s$)

Groups	*n*	Volume (mL)	Total acidity (μmol/mL)	Total acid output (μmol)
Control	10	2.9 ± 1.9	86.3 ± 16.1	241.3 ± 124.6
100% dRR	10	0.5 ± 0.6[a]	41.9 ± 29.1[a]	32.4 ± 56.6[a]
50% dRR	9	1.4 ± 0.9[a]	61.3 ± 33.6	104.3 ± 100.2[a]
F value		15.319	6.772	11.226

The data were tested with analysis of variance, *q* test was used in multiple comparison. [a]$P < 0.05$, as compared with control.

Table 2 Effects of steamed Radix Rehmannia (sRR) on gastric juice secretion ($\bar{x} \pm s$)

Groups	*n*	Incidence	Number of ulcer	Inhibitory rate
Control	10	90%	10.2 ± 12.3	–
100% dRR	12	33%	3.1 ± 7.6[a]	69.60%
100% sRR	11	36%	1.1 ± 2.2[a]	89.20%
		$\chi^2 = 8.27$	F = 5.5112	

The data were analyzed with k-ws test. "0" means no acid (pH > 7), [a]$P < 0.05$, compared with control.

Table 3 Effects of 100% dRR and 100% sRR on gastric ulcer formation in pylorus ligated rats ($\bar{x} \pm s$)

Groups	*n*	Volume (mL)	Total acidity (μmol/mL)	Total acid output (μmol)
Control	10	2.9 ± 1.9	86.3 ± 16.1	241.3 ± 124.6
100% sRR	6	< 0.1[a]	0[a]	0[a]
50% sRR	10	0.9 ± 0.6[a]	73.3 ± 29.1	72.5 ± 53.4[a]

The means were tested with analysis of variance, *q* test was used in multiple comparison. The rate was analysed with χ^2 test for contingency table data. [a]$P < 0.05$, compared with control.

MATERIALS AND METHODS

Animals

Sprague Dawley rats of both sexes, weighing 160–180 g, were supplied by our university's Centre of Experimental Animals.

Collection and measurement of gastric juice

According to Shay's method, solid food but not drinking water was withheld 48 h before the experiment for all rats. After ether anesthesia, the abdominal wall was incised and the pylorus was ligated. Two hours later, the rat was killed and its cardia was ligated. The stomach was removed and an incision was made along the greater curvature to collect and measure the gastric juice. To calculate the total acidity and total acid output, the gastric acid was titrated with 0.01 mol/L NaOH solution to pH 7 on a Type ZD$_2$ titrator.

Gastric ulcer model

The operative procedure was the same as above. The stomachs were removed, opened, washed with saline, and mucosal lesions were examined with a magnifying glass to count the number and incidence of ulcers 10–12 h after pylorus ligation. The ulcer inhibition rate was calculated as follows:

Ulcer inhibition rate = [(Average number of ulcers in treatment group – Average number of ulcers in control group)/Average number of ulcers in treatment group] × 100%

Preparation and administration of decoction

The dRR and sRR were provided by the Third Affiliated Hospital Pharmacy of Traditional Chinese Medicines. dRR or sRR (20 g) was placed in 200 mL deionized water (prepared by our university's Department of Chemistry), decocted for 30 min, filtered, and 150 mL deionized water was added to the filtrates, which were decocted for 20 min and filtered. The two filtrates were combined and concentrated to 20-mL volume, producing a 100% decoction of dRR or sRR that could be diluted to a 50% decoction with water. A 2.0-mL decoction or deionized water (control) was injected slowly into the duodenum after pylorus ligation in all the rats.

Statistical analysis

The data were analyzed statistically using computer software. Analysis of variance was used for comparing the difference among sample means; the *q* test (Newman–Keuls test) was used for multiple comparison. The data were logarithmically transformed when the homogeneity of variance was not met. If the variances were not equal after logarithmic transformation, we used the rank–sum test (k-ws test) and χ^2 test (for contingency table data) to analyze the difference in rates.

RESULTS

Effects of dRR and sRR on gastric juice secretion and ulcer

Tables 1–3 show that dRR and sRR remarkably inhibited gastric acid secretion and ulcer formation in the pylorus-ligated rats.

Dose–effect relationship

The volume of gastric juice and total acid output in the 50% dRR group were higher than that in the 100% dRR group ($P < 0.05$) (Table 1). The volume of gastric juice, total acidity, and total acid output in the 50% sRR group were also higher than that in the 100% sRR group ($P < 0.05$) (Table 2). The results suggest that the inhibitory effects of dRR and sRR on gastric juice secretion may be dose-dependent.

Comparison between dRR and sRR

The volume, total acidity, and total acid output in the 100% dRR group were all higher than that in the 100% sRR group ($P < 0.05$ or 0.01). Other differences were not statistically significant ($P > 0.05$) (Tables 1–3).

DISCUSSION

Some evidence has proven that the increased gastric juice secretion after pylorus ligation is due to excitation of the mucosal baroreceptors of the antrum and the activation of the vago-vagal reflex, and ulcer formation is related to the copious secretion of gastric juice. Therefore, the acid inhibitory effect of dRR and sRR may result from antagonization of the excitatory action of the vagus nerve. The anti-ulcer action of dRR and sRR may be in agreement with that of the acid inhibition; however, other mechanisms cannot be excluded.

The chemical components of dRR differ somewhat from that of sRR, as do the medical effects. The acid inhibitory effect of sRR is slightly stronger than that of dRR, but the relationship between the difference in activity and ingredients remains unclear.

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