SHORT REPORTS

EFFECT OF RED PEPPER AND CAPSAICIN ON RAT INTESTINAL DISACCHARIDASES.

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Abstract

The activities of disaccharidases such as maltase, lactase, sucrase and trehalase in the rat jejunum were inhibited in vitro by capsaicin in a concentration range of 10^{-7} to 10^{-2} M after 1 hour incubation. When red pepper and capsaicin were introduced to rats by tube–feeding for 1 and 3 days or ad libitum feeding for 7 days at the amount of daily human consumption in Thailand (red pepper 0.1 g and capsaicin 0.1 mg per kg body weight), jejunal disaccharidase activities of rats fed red pepper and capsaicin did not show significant differences compared with those of control rats.

Red pepper is a common spice used daily in foods throughout the world. Its pungent principle, capsaicin, appears in fruits at 0.1-1.0%. Red pepper and capsaicin were found to effect the sensory and cardiovascular system[1-3] as well as the gastrointestinal system. Red pepper and capsaicin were reported to stimulate the gastric secretion of HCl[4], to induce gastritis[5], to have an excitatory effect on the isolated intestine[6], to inhibit glucose absorption in rat jejunum[7], to cause poor fat absorption in rats fed a low–protein diet and cause morphological changes in the absorptive cells of rat duodenum[8-10], to have profound effect on the energy–linked functions particularly oxidative phospho-rylation of isolated rat liver mitochondria[11], to inhibit Na^+-K^+-ATPase activity in hamster but not in rat everted jejunum[12], but long–term feeding of these substances at the amount consumed in general did not affect growth rate, blood constituents and

nitrogen balance[13]. However, information about the effect of red pepper and capsaicin on biochemical changes is still insufficient. Therefore the present communication reports additional data on the effect of red pepper and capsaicin upon rat intestinal disaccharidases.

Adult male wistar strain rats (150–190 g) were divided in 3 groups i.e. control rats, rats fed red pepper and rats fed capsaicin. Rats were offered complete pellet diet and water *ad libitum*.

Red pepper (From the market in Thailand) and capsaicin (E. Merck) were suspended in 0.5 ml distilled water and introduced by tube–feeding into the gastrointestinal tract at the amount of 0.1 g and 1 mg per kg body weight respectively (which is the amount consumed by people in Thailand)[14]. The control rats received only 0.5 ml distilled water. The experiments were done for 1 and 3 consecutive days. Another experiment was undertaken by allowing rats a diet containing red pepper 7×10^{-2}% (w 'w) and capsaicin 7×10^{-4}% (w/w) *ad libitum* for 7 days. From the amount of food consumed by rats, the amount of red pepper and capsaicin received by each rat can therefore be calculated from these mixing ratios. It was finally found that rat in this experiment received average values of 0.12 g red pepper and 1.23 mg capsaicin per kg body weight per day which is approximately the same amount as in the last experiments.

After the last treatment with red pepper and capsaicin for 24 hours, the rats were anesthetized with diethyl ether and the jejunal segments (the second 15 cm of the intestine from the pylorus) were removed to prepare an enzyme solution according to the method of Kimura *et al.*[15] Disaccharidase activities were assayed by Dahlqvist's method[16]. Protein concentration was determined by the method of Lowry *et al.*[17], using bovine serum albumin as standard. Student's "t" test was used to determine significant differences between treatment means.

The *in vitro* study was carried out using the methods described previously. Capsaicin dissolved completely in 50% ethyl alcohol at various concentrations (10^{-2}, 10^{-3}, 10^{-5} and 10^{-7} M) were added to the mixture; and enzyme activities in these tubes were compared with those containing only 50% ethyl alcohol without capsaicin.

The result of the *in vivo* study (Table 1) by tube–feeding rats with red pepper and capsaicin at the amount of daily human consumption in Thailand for 1 and 3 days and *ad libitum* feeding at approximately the same amount for 7 days showed that jejunal disaccharidase activities of rats fed red pepper and capsaicin did not differ significantly from those of control rats. However, the *in vitro* study demonstrated that capsaicin solution at the concentration before mixing of 10^{-2} M could inhibit disaccharidase activities absolutely (Table 2). The inhibitory effect decreased when the concentration of capsaicin solution was lowered (10^{-3}, 10^{-5} and 10^{-7} M.). Per cent of inhibition in Table 2 showed that capsaicin seemed to be a potent inhibitor of trehalase and lactase while it had little inhibitory effect on maltase and sucrase activities.

TABLE 1 EFFECT OF RED PEPPER AND CAPSAICIN ON DISACCHARIDASE ACTIVITIES IN RAT JEJUNUM WHEN RATS RECEIVED RED PEPPER AND CAPSAICIN AT 0.1 G AND 1 MG PER KG BODY WEIGHT RESPECTIVELY FOR 1, 3 AND 7 DAYS.[a]

Treatment day (s)	Group of rats		Maltase	Lactase	Sucrase	Trehalase
	Control	(5)	363 ± 33.5	6.0 ± 0.48	82.4 ± 3.7	56.6 ± 2.8
1	Red pepper	(5)	319 ± 20.2 [b]	6.38 ± 0.43 [b]	75.1 ± 1.4 [b]	50.3 ± 2.7 [b]
	Capsaicin	(5)	390 ± 20.4 [b]	7.40 ± 1.12 [b]	88.3 ± 3.1 [b]	60.6 ± 4.3 [b]
	Control	(5)	311 ± 14.8	7.2 ± 0.90	33.9 ± 2.5	38.0 ± 3.2
3	Red pepper	(5)	255 ± 24.1 [b]	7.9 ± 0.60 [b]	32.9 ± 4.7 [b]	38.5 ± 2.0 [b]
	Capsaicin	(5)	291 ± 7.6 [b]	6.8 ± 0.70 [b]	32.0 ± 2.0 [b]	39.1 ± 1.8 [b]
	Control	(6)	220 ± 9.8	3.7 ± 0.30	35.2 ± 1.5	31.8 ± 2.2
7	Red pepper	(6)	251 ± 21.8 [b]	4.5 ± 0.40 [b]	32.3 ± 3.3 [b]	39.8 ± 4.0 [b]
	Capsaicin	(6)	192 ± 11.4 [b]	3.1 ± 0.50 [b]	32.0 ± 2.3 [b]	28.0 ± 3.4 [b]

[a] The results are given as mean ± standard errors. Enzyme activities are expressed as micromoles substrate hydrolyzed per gram protein per minute. The number of animals is given in parentheses.

[b] $P > 0.05$ as compared to control rats.

TABLE 2 EFFECT OF CAPSAICIN ON JEJUNAL DISACCHARIDASE ACTIVITIES *IN VITRO* [a]

Capsaicin (M)	Maltase	Lactase	Sucrase	Trehalase
0	156.96 (0)	6.7 (0)	40.27 (0)	42.7 (0)
10^{-7}	147.43 (6.1)	5.1 (23.9)	39.90 (0.9)	2.9 (93.6)
10^{-5}	117.44 (25.2)	5.0 (25.2)	39.14 (2.8)	2.7 (93.7)
10^{-3}	36.13 (77.0)	4.5 (33.3)	37.17 (7.7)	2.4 (94.4)
10^{-2}	0 (100)	0 (100)	0 (100)	0 (100)

a The results are averages of triplicate assays. Enzyme activities are expressed as micromoles substrate hydrolyzed per gram protein per minute. Per cent of inhibition is given in parentheses.

Disaccharidase activities in the intestinal mucosa are a good index for the investigation of the ability to digest and absorb dietary nutrients[18,19], especially carbohydrate which is the main nutrient for people in Thailand. Reduction of enzyme activities below a critical level by the lack of inducing substrates or by the presence of some modifier can cause a decrease in the ability to digest and absorb and result in a disease[19]. On the basis of this observation, it appears that the intake of red pepper and capsaicin at the amount consumed by people in Thailand could not cause any change in disaccharidase

activities in the rat.   Although the results of the *in vitro* study showed evidence of inhibitory effect on disaccharidases caused by capsaicin solution at the concentration of 10^{-7} to 10^{-2} M; capsaicin may be absorbed into the cells at lower concentration that could not affect disaccharidase activities when animals received red pepper and capsaicin at the amount previously mentioned.   Another assumption is that capsaicin may be absorbed mostly into the body at the duodenum of the intestine, thus not affecting jejunal disaccharidase activities.   The negative result of capsaicin in the *in vivo* study may not be due to insolubility of capsaicin in water (water was used for preparing red pepper and capsaicin suspension in order to correspond with what actually happens in human body), since capsaicin was not found to excrete in the feces or urine of rats fed a diet containing the compound in short or long periods[13].   However, the mechanism of its absorption is not yet known.   An additional possibility is that the recovery of the enzyme activities back to their normal level may occur within 24 hours after the last treatment.   The time course study will be beneficial to elucidate this assumption and should be further investigated.   The question of damage to tissue of the gastrointestinal tract (damage of jejunum has not been reported yet) might be the result of the known irritating effect of capsaicin and this toxic effect might be limited only to some cells which have direct contact with this compound; the remainder of viable cells might be able to maintain their biochemical and physiological functions at a normal state.

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บทคัดย่อ

การทำงานของเอ็นไซม์ไดแซคคาริเดส เช่น มอลเตส แลคเตส ซูเครส และทรีฮาเลส จะถูกยับยั้งโดย สารละลายแคพไซซินที่มีความเข้มข้น 10^{-7} ถึง 10^{-2} โมล่าร์ ในการศึกษาแบบอินวิโทร เมื่อให้หนูได้รับพริกและ แคพไซซินโดยการกรอกเข้าหลอดอาหารเป็นเวลา 1 และ 3 วัน และให้หนูกินอาหารผสมพริก และแคพไซซินอย่าง อิสระเป็นเวลา 7 วัน ในปริมาณเท่ากับที่รับประทานกันทั่วไปในประเทศไทย (พริก 0.1 ก. และแคพไซซิน 0.1 มก. ต่อน้ำหนักตัว 1 กก.) พบว่าการทำงานของเอ็นไซม์ไดแซคคาริเดสของหนูเหล่านี้ไม่แตกต่างจากหนูกลุ่มควบคุม