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Influence of "Chilies" (Capsicum Annum, L.) on Digestive Functions and Metabolism.

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The use of chilies or Capsicum as a condiment by tropical and sub-tropical peoples (*e. g.*, in "curry" in Polynesia, Malaysia, India, Arabia, tropical Africa; in "chili-con-carne" in Central America; "lah-ti shou" (hot foods) in southern China) has led us to inquire into the reason for such a widespread habit. We have, therefore, determined the influence of *Capsicum annum, L,* on the digestive functions and basal metabolism. *C. annum, L,* var. gr. Sendt., was employed in the gastric secretion observations on man and in one metabolism experiment.

Salivary secretion. Capsicum produces a copious flow of saliva, both in dog and man. In man 1 cc. of Capsicum extract prepared by grinding 10 gm. fresh Capsicum with 20 cc. distilled water and straining through muslin, was introduced into the mouth, quickly distributed by the tongue and spat out. The mouth was then closed for 5 minutes, at the end of which time the accumulated saliva was collected, measured and compared with the amount obtained during a control period without Capsicum. In the unanesthetized dog the Capsicum extract was injected into the mouth and the saliva collected from fistulae of the submaxillary and parotid ducts.

TABLE I.

Subject		Procedure	Salivary Flow
			cc. per 5 min.
Man		Control	3.5
		Capsicum (1 cc.)	14.8
Dog	'artoid	Control (1 cc. 0.4% HCl)	0.
		Capsicum (0.2 cc.)	1.0 (15 drops)
	ubmaxillary	Control (1 cc. 0.4% HCl)	0.1 (2 drops)
		Capsicum (0.2 cc.)	6.5 (50 drops)

Gastric secretion. For the study of gastric secretion in dogs, Heidenhain- and Pavlov-pouch animals were used. Freshly minced Capsicum was given by mouth (*i. e.*, swallowed), sometimes in gelatine capsules and sometimes without, in amounts ranging from 4 to 20 gm. The following is typical of 23 observations:

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TABLE II.

Time	Procedure	Gastric juice	Free HCl	Total HCl
		cc.	mg. %	mg. %
9-10	Control	0.2	0	—
10-11		0.1	0	—
11	10 gm. Capsicum			
11-12		1.5	0	—
12- 1		1.9	0	—
1-2		1.3	0	—
2-3		1.3	0	—
3-4		1.0	0	—
4	200 gm. meat, 100 cc. water			
4-5		14.0	316	381
5-6		7.6	332	421

The most usual effect of Capsicum upon the stomach appeared to be a slight increase in mucous secretion. It seldom affected the acidity of the gastric juice. Whether with, before or after meals, it neither inhibited nor augmented the usual gastric response.

Experiment with a Rehfuss tube on man showed that the rinsing of the mouth with Capsicum (1 cc.) had no significant secretory (psychic) effect in the subject tested, but that the introduction of Capsicum (20 cc.) into the stomach through the stomach tube caused a distinct response, as shown in the following example. It is of interest to note that on taking Capsicum a warm, tingling sensation is perceived in the epigastrium.

TABLE III.

Time	Procedure	Gastric juice	Free HCl	Total HCl
		cc.	mg. %	mg. %
9:00- 9:15	Control	7.0	0	64.8
9:15- 9:30	"	5.0	0	72.9
9:30- 9:45	"	3.5	0	79.9
9:45-10:00	1 cc. H_2O in mouth	3.0	0	72.9
10:00-10:15	1 cc. Capsicum in mouth	4.0	0	81.0
10:15-10:35	20 cc. H_2O into stomach tube	9.0	0	40.5
10:35-10:55	20 cc. Capsicum into stomach tube	11.7	170	219.0

Pancreatic and biliary secretion. A very slight and transient inhibitory effect on these secretions was obtained on introducing Capsicum into the duodenum of the etherized dog.

Gastric motility. Experiments by the balloon method in dogs with gastric fistulae showed that Capsicum sometimes caused a slight augmentation of tone, but the effect was transient and not constant. Roentgenological observations showed that meals with and without Capsicum are emptied in about the same time.

TABLE IV.

Nature of Meal	Gastric Emptying Time	
	hr.	min.
300 gm. corn-bean flour, 50 gm. barium,	4	30-36
Ditto + 20 gm. minced Capsicum,	4	15
200 gm. meat, 100 cc. water, 50 gm. barium,	7	25
Ditto + 20 gm. minced Capsicum,	7	35

Bowel movement. Excessive amounts (above 20 gm.) of Capsicum may induce frequent bowel movements, as reported by two of the subjects in the metabolic experiments.

Specific dynamic action. 2 of the 4 individuals tested (Benedict-Knipping method) were well accustomed to eat peppery food. No effect on metabolism was obtained even with the ingestion of 100 gm. fresh Capsicum. The data are presented in the following table:

TABLE V.

Subject	Time	Remarks	R. Q.	Calories per 24 hrs.
C. Y. L.	8:00	Control	0.70	1505
	8:12	63 gm. Capsicum (Var. gr. Sendt.)		
	9:40		0.74	1323
	10:15		0.77	1459
C. Y. L.		Control	0.84	1373
	8:35	100 gm. Capsicum		
	9:00		0.72	1380
	10:00		0.87	1378
P. K. K.	7:55	Control	0.73	1331
	8:30	27 gm. Capsicum followed by 100 cc. water		
	9:30		0.80	1362
	10:30		0.76	1333
Y. K. Y.	8:45	Control	0.78	1592
	9:15	"	0.76	1523
	9:40	45 gm. Capsicum followed by 300 cc. water		
	10:40		0.73	1438
	11:40		0.78	1415
T. Y. L.	9:00	Control	0.73	1393
	9:40	About 10 gm. Capsicum with 300 cc. water		
	9:45		0.76	1379
	11:00		0.75	1475

Conclusions. With the exception of salivary and possibly the human gastric secretion Capsicum in moderate amounts has no significant effect on the digestive functions. It does not affect the metabolism. As its irritant property increases the salivary flow, it no doubt facilitates the swallowing and digestion of dry, starchy food, *e. g.*, cooked rice. In people who take Capsicum regularly, a conditioned reflex may be induced and thus give rise to gastric secretion.

It has been suggested that Capsicum is taken because of its cooling action due to perspiration (chiefly cephalic), but this certainly cannot be true for all persons. One of my subjects in the metabolic experiment ingested 100 gm. fresh Capsicum, yet did not sweat. Probably the main reason for its being widely used and liked is that it stimulates appetite, more especially as a hot climate tends to produce anorexia.

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Growth and Reproduction of Rats on Vitamin C Free Diet.

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Harden and Zilva[1] and Drummond[2] believed that albino rats could not fully dispense with the antiscorbutic vitamin without restriction of their normal development. Osborne and Mendel[3] were unable to accept this conclusion since it had not been ruled out that the delayed development demonstrated by the first named authors was due to a vitamin B deficiency of their yeast preparation. Neither could it be ruled out that the growth-promoting effect of the fruit juices added was due to a more ample supply of vitamin B rather than to the vitamin C content of the juices.

Parsons[4] made the important observation that rats which had been fed on a practically vitamin C free diet for as long as 213 to 247 days showed considerable amounts of this vitamin in their livers. This, as McCollum[5] points out, constitutes conclusive evidence of synthesis of vitamin C by this species. Parson's experiment, however, does not directly answer the question whether better growth and nutrition could be secured by the addition of an antiscorbutic substance to the diet of albino rats.

The experiments here to be reported show that the addition of the antiscorbutic vitamin had no growth-promoting effect when given to white rats which for 2 generations or more had been reared and raised on a vitamin C free diet. The experiments were carried

[1] Harden, A., and Zilva, S. S., *Biochem. J.*, 1918, xii, 408.

[2] Drummond, J. C., *Biochem. J.*, 1919, xiii, 77.

[3] Osborne, T. B., and Mendel, L. B., *J. Biol. Chem.*, 1920, xli, 554.

[4] Parsons, H. T., *J. Biol. Chem.*, 1920, xliv, 587.

[5] McCollum, E. V., "The Newer Knowledge of Nutrition," 2nd ed., 1923.