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Salmonellas, shigellas and enteropathogenic *Escherichia coli* in uncooked food*

By T. VELAUDAPILLAI, G. R. NILES and W. NAGARATNAM
Medical Research Institute, Colombo, Ceylon

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INTRODUCTION

Salmonella infections due to consumption of contaminated fruit or vegetables have been very rarely reported. Gayler, MacCready, Reardson & McKernan (1955) described an outbreak of infection by *Salmonella miami* involving 17 persons in five families, all of whom had eaten water-melon bought from the same supermarket. This was the only food eaten in common by all the affected persons, and which had not been eaten by any symptomless members of the five families. *S. miami* was grown from the faeces of all the affected persons, and from slices of water-melon still left in their homes, but not from slices of water-melon from the supermarket. It was, however, grown from the shelf in the supermarket on which the knife used for slicing water-melon was stored. Some experiments which these authors carried out showed clearly that *S. miami* multiplied greatly overnight at room temperature in the interior of water-melon. They also mentioned, in an addendum, an unpublished outbreak in which there were six cases of *S. bareilly* infection in two families, and the infecting organism was grown from remaining slices of water-melon.

Apart from these two well-documented outbreaks, occasional outbreaks and sporadic cases of salmonella infection associated with eating fruit or fresh vegetables have been reported in England (Report, 1950, 1954, 1955, 1956). In these reports, however, no distinction is made between outbreaks or cases where the association is proved by isolation of the infecting organism from the food, and those where the association is presumed on purely epidemiological evidence without confirmation by culture from the food.

A preliminary note on the incidence of salmonellas in vegetables and fruits in Ceylon was communicated by Falisevac, Padley & Gulasekharam (1959). As this work was incomplete, a reinvestigation was started on 1 April 1967 and was completed on 15 August 1967, and the results are presented in this paper.

MATERIALS AND METHODS

Fresh vegetables and fruits sold at one of the markets in Colombo and those supplied by the Marketing Department to the Lady Ridgeway Hospital for children were examined. The Marketing Department is a Government organization that

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supplies provisions to some of the hospitals. Deliveries of these to the market and to the Marketing Department were made within 24 hr. of collection from different parts of Ceylon where these were grown. The market and the Marketing Department usually disposed of them within 3–4 days. The vegetables and the fruits from the market were bought at random from different stalls.

Each sample was wrapped separately in sterile kraft paper, and reached the laboratory within $\frac{1}{2}$ hr. There they were put into sterile beakers of 500 ml. capacity and 40 ml. of saline was added. Ash pumpkin, cucumber, pumpkin, snake gourd and papaw are big fruits and the whole fruits could not be introduced into the beakers, so small sliced pieces of these were obtained from the dealers. These fruits were sometimes sold as pieces. The rest of the fruits and vegetables were introduced into the beakers without being cut. Each beaker was gently rotated so that the contents were well mixed. The liquid was transferred into McCartney bottles and centrifuged at 3,000 rev./min. for 30 min. The supernatant was discarded. In the case of the vegetables two loopfuls from the the deposit of each sample, and in the case of the fruits three loopfuls, were plated on S.S. deoxycholate-citrate and MacConkey agar and finally the remaining deposit was put into tetrathionate and selenite broths. These were incubated at 37°C for 18–24 hr. The procedure for isolation and identification of pathogens were described by Velaudapillai, Mendis & Niles (1966).

There were 12 varieties of leaves and shoots (cabbage, celery, gotukola, kankum, kohila, leeks, lettuce, norkoal, nivithi, rhubarb, sarana, spinach), 11 of vegetable fruits (breadfruit, brinjal, butter beans, capsicum chilli, drumstick, elabattu, green beans, green chilli, ladies' finger, long beans, tomatoes), six of gourds (ash pumpkin, bottle gourd, bitter gourd, cucumber, pumpkin, snake gourd), ten of roots and tubers (beet root, carrot, king jam, lotus roots, onions (small), onions (big), potatoes, radish, sweet potatoes and yam), 15 of fruits (ambarella, ash plantain, gaduguda, lavalu, lovi, mango, mangosteen, orange, plantain, passion fruit, papaw, rambuttan, veralu, wood apple, wild olive) and two of pulses (dhal and green grams).

RESULTS

The total numbers of vegetables and fruits that were examined are shown in Table 1, with positive findings. In this table salmonellas, shigellas and enteropathogenic *E. coli* are not separated. As 54 different varieties of vegetables and fruits were examined, they are grouped together according to Nicholls (1961). The distribution of serotypes of *Salmonella*, *Shigella* and *E. coli* among the different foodstuffs is shown in Table 2.

DISCUSSION

Out of a total of 392 fruits examined, only one was positive. The fruits were gathered from trees that grew to a height of over 5 ft.

Vegetables were infected with *Salmonella*, *Shigella* or pathogenic *E. coli* to the extent of 1·3%. The isolation of pathogenic *E. coli* and *Shigella* does not appear to have been reported so far. The vegetables from the market harboured almost an

Table 1. *Results of bacteriological examination of uncooked food*

	Source of food						
	Marketing Department		Market		Total		
	Number		Number		Number		
	examined	positive	examined	positive	examined	positive	% positive
Leaves and shoots (12 varieties)	111	1	317	5	428	6	1·4
Vegetable fruits (11 varieties)	120	2	272	2	392	4	1·0
Gourds (6 varieties)	36	0	78	2	114	2	1·8
Roots and tubers (10 varieties)	155	1	204	4	359	5	1·4
Fruits (15 varieties)	10	0	382	1	392	1	0·3
Pulses (2 varieties)	124	1	0	0	124	1	0·8
Total (56 varieties)	556	5	1253	14	1809	19	1·1

Table 2. *Pathogens isolated from fruits and vegetables obtained from the Lady Ridgeway Hospital (supplied by the Marketing Department) or from the Market*

Fruit or vegetable		Pathogens isolated	
		Hospital	Market
Cabbage	*Brassica cleracea capitata*	—	*Sh. flexneri 2*
Celery	*Apium grabeolens rapaceum*	—	*S. waycross*
Kankum	*Ipomoea reptans*	—	*Sh. flexneri 2*
Leeks	*Allium porrum*	*S. bareilly*	*S. typhimurium* *Sh. flexneri 4*
Lettuce	*Lactuca sativa*	—	*S. inverness*
Spinach	*Spinacia oleracea*	*S. newport*	*Sh. flexneri 4*
Butter beans	*Phaseolus lonatus*	*Sh. flexneri 4*	—
Elabattu	*Solanum xanthocarpum*	—	*S. riogrande*
Green beans	*Phaseolus vulgaris*	*S. bareilly*	—
Pumpkin	*Cucurbita moschata*	—	*Sh. sonnei* *Sh. boydii 4*
Carrot	*Daucus carota*	—	*S. enteritidis* *Sh. boydii 11*
Ash plantain	*Musa paradisiaca*	—	*E. coli* 026:K60
Wild olive	*Eleocarpus oblongus*	—	*S. sandiego*
Dhal	*Lens esculenta*	*S. waycross*	—

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equal number of salmonellas and shigellas while those from the hospital had more salmonellas.

The vegetables, unlike the water-melon, are not cut into pieces before sale. Since they do not have sufficient water and sugar to support growth of pathogenic organisms, vegetables probably merely play a role of mechanical carriers.

The number of each individual vegetable and fruit examined was not high enough for statistical analysis. However, they were arbitarily grouped according to the height to which they grew. On this basis, it was found that 24 varieties of vegetables grew up to a height of about 1 ft. and of these eight were infected while two out of the 18 taller groups were infected. The rate of infection appeared to be inversely related to the height of the plants, probably because of irrigation which wets roots and the leaves of stumpy plants. The water used for this purpose was from canals without bunds or embankments, and shallow wells lacking properly constructed walls, which were subject to human and animal faecal pollution. The possibility of manure, which is chiefly of animal origin, as a contributory factor must be borne in mind.

Out of a total of 556 different fruits and vegetables that were examined from the hospital five (0·9 %) were positive for salmonellas. The corresponding figures for the market were 1253 and six (0·5 %). There were therefore more salmonellas from the hospital vegetables than from the market. Velaudapillai, Jayasundera & Nagaratnam (1966) isolated more salmonellas than shigellas from the same hospital. They also found the incidence of *S. bareilly* to be high. In this study, *S. bareilly* was isolated three times. It is quite possible that some of these and also some of the other salmonella serotypes might have originated from contamination by carriers or the kitchen staff or through aerial contamination. Velaudapillai & Sabanathan (1966) ascribed an outbreak of infantile diarrhoea caused by *E. coli* 0119:K69:H6 in a premature-baby unit to aerial contamination.

The reason why more shigella contamination is found in vegetables from the market than in those supplied by the marketing department is that the former are exposed for a longer time and are subjected to more handling. Moreover, from time to time the dealers sprinkle them with their hands with water from a bucket. The water is not suspect, being the city supply, but the dealers' hands are not above suspicion. This is supported by the isolation of *Shigella flexneri 4* from leeks and spinach from the same stall on consecutive days. Salmonella infection may also be spread in this way. Since lettuce, kankum and wild olive, all of which are eaten raw, and carrot which may be eaten raw, were all found to be contaminated by pathogens, it is of the utmost importance that such vegetables and fruits should be well washed before they are eaten. The dhal might have been contaminated recently as it would not support the growth of organisms in the dry state.

SUMMARY

Centrifuged deposits of washings of vegetables and fruits were plated on S.S. deoxycholate citrate and MacConkey agar for evidence of contamination.

Vegetables like beans, carrots, cabbage, celery, elabattu, leeks, kankum, pump-

kin and spinach were found to be contaminated with *Salmonella*, *Shigella* and enteropathogenic *E. coli*. The extent of contamination of the vegetables which grew to a height of about 1 ft. above the ground was greater than that of the taller varieties. The rate of contamination among fruits was almost negligible.

The contamination might have originated from the water used for irrigation, from manure, or from the handlers of the vegetables.

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