AN INVESTIGATION OF THE
ANTISCORBUTIC VALUE OF THE RAW
JUICES OF ROOT VEGETABLES,
WITH A VIEW TO THEIR ADOPTION AS AN ADJUNCT
TO THE DIETARY OF INFANTS.*

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Low Antiscorbutic Value of Fresh Milk.

IN the study of the distribution among foodstuffs of the antiscorbutic accessory factor made recently by a group of workers in this Institute, a considerable amount of attention has been devoted to the antiscorbutic value of cow's milk. A preliminary report of these experiments was published several months ago in THE LANCET, and the results^{1 2} have shown that cow's milk, even when fresh, is a substance poor in antiscorbutic properties, and that a large daily ration, amounting practically to a complete milk diet, is necessary if scurvy is to be prevented by its agency alone.

This conclusion is in accord with the opinion previously expressed by certain clinicians on the basis of their observation of infant nutrition. Thus Barlow³ in 1894 wrote the following words: "Looked at as antiscorbutic, probably much larger quantities of fresh uncooked meat and fresh milk are needed than fresh vegetables and fresh fruit juices." And at a later date Still⁴ wrote: "The antiscorbutic power of fresh, unboiled milk is evidently slight."

In the case of young guinea-pigs it was found (*loc. cit.*) that a daily ration of 100-130 c.cm. of raw cow's milk was necessary to prevent occurrence of scurvy, and evidence was adduced to show that if the milk had been previously heated or dried a ration equivalent to the above would prove insufficient. These results have recently been confirmed by Miss R. E. Pilgrim, also working in this department, who has kindly permitted us to refer in this place to her experiments which will shortly be published elsewhere. It has been found extremely difficult to carry out the experiments with guinea-pigs. A full-cream milk diet is tolerated with difficulty by these animals, apparently owing to the high fat-content, and separated milk has proved easier of digestion. It has been exceptional to find young guinea-pigs which can consume as much as 100 to 150 c.cm. raw milk daily without digestive disturbances, even when the constipation occurring is mitigated by a daily dose of liquid paraffin. In the rare cases where this has been achieved good health and growth have been maintained for the period of the experiment—three months—and signs of scurvy have been absent or very slight. Upon a similar ration of dried milk this result has not been attained, even when the preparation is not more than 2-3 weeks old. Milk in this form is much better digested, and it is not unusual to find the equivalent of 100-130 c.cm. fresh milk consumed daily without difficulty. But in such cases the animals have suffered from severe scurvy sooner or later, and although life was prolonged the animals lost weight and sank into a miserable condition of chronic scurvy. There is little doubt that dried milk, even when freshly prepared, is inferior to raw fresh milk in respect of antiscorbutic properties.

Question of Extra Antiscorbutic for Infants.

In case of artificially fed infants the use of raw cow's milk is exceedingly rare at the present day. Boiling or pasteurisation of the milk has become necessary to obviate danger from bacterial disease, and for the same reason, as well as on grounds of convenience, the use of dried milk has increased largely in recent times. There is no doubt, however, that infants nourished upon boiled or dried cow's milk receive a smaller allowance of antiscorbutic material than would be provided by a diet of raw milk, and that the amount they obtain may dangerously approach the minimum required. To what extent this is a serious menace must depend upon the degree to which the content of antiscorbutic vitamine in raw cow's milk is in excess of the infant's

requirements and upon the antiscorbutic value originally possessed by the particular sample of milk employed.

In any case the results of the experimental work are strongly in support of those medical authorities who recommend the inclusion of some extra antiscorbutic in the diet of infants nourished upon milk of which the original antiscorbutic value has been diminished by heating or drying.

Expert medical opinion is, however, divided upon this point. Many authorities, impressed with the comparative rarity of pronounced scurvy among infants brought up on boiled or dried milk, consider that the addition to that diet of any extra antiscorbutic is an unnecessary measure (see Coutts, 1918),⁵ (Naish, 1914).⁶ Others consider that the danger of incipient scurvy among artificially fed infants is not as negligible as is supposed (e.g., Hess and Fish, 1914)⁷ (Miller, 1917).⁸ and recommend that raw fruit juice or other antiscorbutic material should be added to the diet. Special attention was called to this point in an editorial article in THE LANCET of Sept. 22nd, 1917, and it is for the benefit of those who find difficulty, on account of cost or scarcity, in providing infants with an extra antiscorbutic in the form of fresh fruit juice that the following experiments as to other available sources were undertaken.

Experimental Work.

The experiments were made with young guinea-pigs, and the methods employed were the same as those described in the previous paper dealing with the antiscorbutic value of fruit juice in THE LANCET of Nov. 30th. The juices were prepared by rubbing the clean-cut surface of the raw vegetable upon an ordinary kitchen grater, placing the pulp in muslin and squeezing gently between the fingers, when the juice runs out readily. Unless otherwise stated, the juice was always prepared fresh every day; expressed raw vegetable juices undergo changes rapidly at room temperature, and were found to deteriorate in respect of antiscorbutic value when stored even at a low temperature in a refrigerator. In the accompanying table are set forth the results obtained

Table showing Antiscorbutic Value of Raw Vegetable and Fruit Juices.

Experiments with guinea-pigs. The diet consisted of oats and wheaten bran *ad libitum*, with 60 c.cm. daily of milk autoclaved at 120° C. for 1 hour; the antiscorbutic element in the diet was provided solely by the measured daily ration of vegetable or fruit juice.

Experiment No.	No. of animals.	Antiscorbutic material employed.	Daily ration.	Duration of experiment (days).	Result.	Degree of protection from scurvy.
Control	4	None.	—	34-40	Death from scurvy, 34th-40th day.	0
1	4	Raw swede juice.	2.5 c.cm.	90-100	Animals enjoyed fair health; no symptoms of scurvy.	++
2	4	Raw carrot juice.	5 c.cm.	34-56	Animals developed severe scurvy.	+
	4	"	10 c.cm.	34-76	"	+
	3	"	20 c.cm.	75-95	Fair health; signs of scurvy in 1 animal out of 3.	++
3	2	Raw beetroot juice.	20 c.cm.	67-88	Definite scurvy in both cases.	+
4	1	Cooked potato (steamed at 100° C. for 30 minutes).	17 g.	47	Slight protection.	+
	3	"	20 g.	73-92	Protection.	++
5	4	Raw cabbage leaves.	0.5 g.	66-90	Scurvy symptoms, but some degree of protection.	+
	5	"	1.5 g.	90	Protection.	++
6	4	Fresh orange juice.	1.5 c.cm.	50-91	Scurvy in 2 cases out of 4.	+
	2	"	3 c.cm.	91-93	Good health, no scurvy.	++
7	2	Grapes, green Spanish.	10 g.	44-51	Severe scurvy.	0
	4	"	20 g.	30-88	Severe scurvy in 3 cases out of 4.	+

0 No protection. + Slight protection. ++ Protection.

with the raw juices of swede, carrot, and beetroot, the immediate aim of the experiments being to determine the minimum amount which, when added to a diet of oats, bran, and autoclaved milk (heated to 120° C. for one hour to reduce its antiscorbutic value to a minimum), was adequate to prevent scurvy and to maintain the animal in health over the

* A companion paper entitled The Relative Content of Antiscorbutic Principle in Limes and Lemons together with Some New Facts and Some Old Observations Concerning the Value of "Lime Juice" in the Prevention of Scurvy, (A) *Experimental Inquiry*, by Harriette Chick, E. Margaret Hume, and Ruth F. Skelton, (B) *Historical Inquiry*, by Alice Henderson Smith, appeared in THE LANCET of Nov. 30th, 1918, p. 735.

period of the experiment. Results obtained with cooked potato (it is not possible to feed guinea-pigs on raw potatoes), fresh orange juice, fresh grapes, and fresh raw cabbage leaves, are added for purposes of comparison.

Comparative Antiscorbutic Value of Various Raw Vegetable Juices.

The juice of the fresh raw swede easily takes the first place in respect of antiscorbutic value. Protection from scurvy was attained with a daily ration of 2.5 c.cm. In case of raw carrot juice, severe scurvy developed in animals receiving daily rations of 5 c.cm. and 10 c.cm.; with a daily ration of 20 c.cm., protection from scurvy was secured and the general condition of the animals was about the same as of those receiving a daily ration of 2.5 c.cm. swede juice. In case of beetroot, the antiscorbutic value was less than that of carrot; animals receiving a daily ration of 20 c.cm. fresh raw juice showed only a small degree of protection, acute symptoms of scurvy supervened in every case, and death from scurvy occurred in several instances before the period of experiment, three months, had expired.

It is thus seen that raw swede juice provides a valuable and inexpensive source of antiscorbutic material. Its value is not markedly inferior to that of fresh orange juice, and it may be regarded as a satisfactory substitute; its value is 10 times that of raw carrot, and more than 10 times that of raw beetroot juice. It has recently been adopted in some infant welfare centres, and there does not appear to be any drawback to its use for the purpose of infant feeding.

Raw carrot has long been popular as an adjunct to the dietary of infants and there is traditional support for its worth. So keen an observer of his own day as Anthony Trollope, in "Barchester Towers," 1857, depicts the older generation in the person of Miss Thorne strongly advising the young mother to smear raw carrot juice and allow it to dry upon the baby's coral, in order to ensure for the infant a healthy set of permanent teeth in the future. "The receipt had been much in vogue in the young days of her (Miss Thorne's) grandmother," who "had the best teeth in the county and carried them to the grave with her at eighty." (Bohn's Library Ed., Bell and Sons, 1913, p. 234.)

It is interesting to observe the root vegetables investigated are widely separated in the vegetable kingdom; the swede belongs to the natural order *Cruciferae*, the carrot to the *Umbelliferae*, the beetroot to the *Chenopodiaceae*, and the potato to the *Solanaceae*. It is significant that the natural order *Cruciferae* should also include the cabbage, most potently antiscorbutic of the vegetables investigated in the present inquiry, and the "scurvy grass" (*Cochlearia officinalis*) and the "cresses," so justly esteemed by the sailors suffering from scurvy in the old days.

Bachstrom (Observationes circa Scorbutum, 1734) relates the following remarkable story: "A sailor in the Greenland ships was so over-run and disabled with the scurvy, that his companions put him into a boat, and sent him on shore; leaving him there to perish, without the least expectation of a recovery. The poor wretch had quite lost the use of his limbs; he could only crawl about on the ground. This he found covered with a plant, which he, continually grazing, like a beast of the field, plucked up with his teeth. In a short time he was by this means perfectly recovered; and, upon his returning home, it was found to be the herb of scurvygrass." (Rendering given by Lind, 1757. A Treatise on the Scurvy, 2nd edit.). It is interesting to find that the old legend that the cruciform arrangement of the flower was an indication of especial virtues in the service of man thus receives scientific support at this comparatively late date.

Summary.

1. Cow's milk possesses distinct antiscurvy properties, but these are present in small degree in comparison with other antiscorbutic foodstuffs. Its value in this respect is further reduced after heating or drying. It is therefore advisable to provide some extra antiscorbutic material in the diet of infants nourished upon heated or dried cow's milk.

2. The antiscorbutic value of various materials that might suitably be included in an infant's diet has been experimentally determined by means of experiments with guinea-pigs. Among fresh fruit juices that of the orange is easily the most suitable, and possesses a value about ten times as great as that of fresh grapes. Of the raw vegetable juices examined, raw swede juice proved to be far the most potent, approximating in value to raw orange juice; the raw juice

of carrots was found to be much inferior, and that of beet-roots failed to prevent scurvy in the largest dose (20 c.cm. daily) that could be administered to the experimental animals.

Bibliography.—1. Chick, Hume, Skelton, 1918, THE LANCET, Jan. 5th, and (2) Biochemical Journal, vol. xii., p. 131. 3. Barlow (1894), Bradshaw Lecture, Infantile Scurvy and its Relation to Rickets, THE LANCET, Nov. 10th. 4. Still, Common Disorders and Diseases of Childhood, third edition, 1915. 5. Coutts (1918), Report to the Local Government Board, No. 116. 6. Naish (1914), Pediatrics, vol. xxvi., p. 247. 7. Hess and Fish (1914), American Journal of Diseases of Childhood, vol. viii., p. 385. 8. Miller (1917), Cleveland Medical Journal, August.

HÆMORRHAGIC BRONCHITIS:

CASTELLANI'S BRONCHO-PULMONARY SPIROCHÆTOSIS.

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IN view of the fact that cases of broncho-spirochætosis (Castellani's bronchitis) have recently been observed in Europe—I have first found the disease in France, having recorded a large number of cases of it in Toulon—a few notes on the subject will perhaps be found to be of some practical interest.

This affection and its etiological agent were first described by Castellani in Ceylon in 1905.¹ He called the malady broncho-spirochætosis and the germ *Spirochaeta bronchialis*. Castellani's observations were confirmed in various parts of the tropics, by Branch in the West Indies in 1907, by Jackson in the Philippine Islands in 1908, by Waters in 1908, who recorded a number of cases in India, by Phalen, Kilborne and Chamberlain, Taylor, Chalmers and O'Farrell, Harper, and others in various other tropical countries.

In Europe a few cases were observed in 1915 by Galli Valerio in Switzerland, one case by Lurie in Serbia, and a few by Castellani himself in the Balearic-Adriatic zone. Very little attention, however, was paid in Europe to the disease until it was found in France by myself in 1916. At Toulon, where I have been carrying out the investigation, a comparatively large number of cases has occurred among the native troops coming from the Far East, as well as in Europeans who had never been to the colonies. A special ward in the St. Mandrier Hospital had to be set aside for cases of this disease, and I was placed in charge of it.

Symptomatology.—Mode of Infection.

The symptomatology I have observed in my patients is the following:—

The patient has generally been sent to hospital with the diagnosis of tuberculosis or suspected tuberculosis, and one can easily understand why this diagnosis has been suggested, as in very numerous cases the patient is spitting up blood. The bloody expectoration is often of a peculiar vividly pink colour, somewhat different from what one usually sees in hæmoptysis of tubercular origin.

The cough is frequent, sometimes more severe during the night. The physical examination of the chest in some cases reveals very little or nothing; in other cases there are signs of simple bronchitis with or no emphysema; in others there are signs of consolidation.

The general condition of the patient is often fairly good, even very good, and very often there is no fever.

The blood at times shows a slight degree of anæmia, due to the repeated attacks of hæmoptysis. The number of leucocytes is normal, and so is generally the leucocytic formula. (See figure.)

The microscopic examination of the sputum reveals presence of *S. bronchialis* in enormous numbers; the preparations are teeming with it.

¹ THE LANCET, 1906, i., 1384.